PARTS OF A PLANT

The most logical starting point for a scientific study of ornamental plants is their macroscopic anatomy (what we can see with the unaided eye).

Members of the higher plants are made up of roots, stems, leaves, and flowers or cones (Figure 1–1). Flowers are the reproductive structures of the Angiospermopsida as cones are for the Coniferopsida. As previously noted, these two Classes are commonly referred to simply as the flowering plants and the conifers.

Roots

Roots are the below-ground portion of the plant. They may be fibrous, with a network of roots reaching out horizontally and vertically through the soil, or they may be tap roots in which one central root grows larger and is more dominant than the others. In both types of root systems, the larger roots are supplemented by many smaller root hairs (Figure 1–2). The principal function of the roots is to absorb water and mineral nutrients from the soil. Much of the absorption occurs through the root hairs. In addition, the roots serve to anchor the plant against toppling by wind and rain. Roots also store food materials produced in the leaves. Specialized roots called **adventitious** roots develop from stems in some plants such as philodendron and from leaves and cut stems of various plants being propagated vegetatively (Figure 1–3).

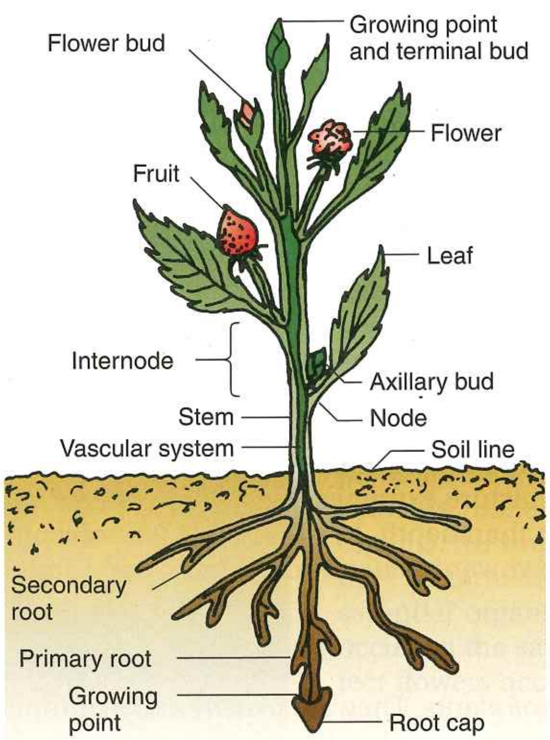

FIGURE 1–1. The principal parts of a flowering plant *(Delmar/Cengage Learning)*

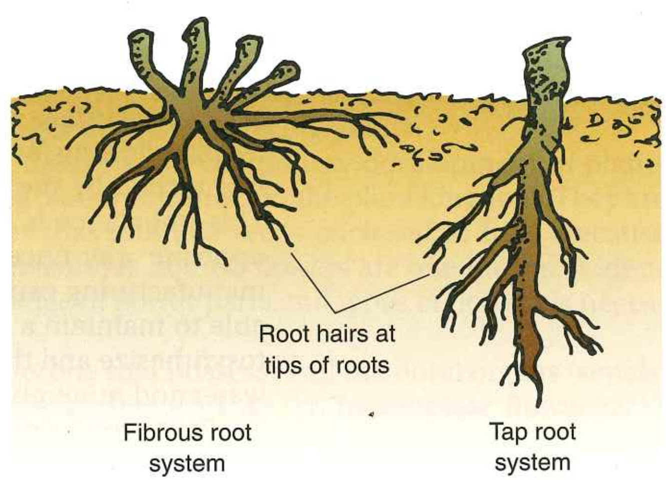

FIGURE 1–2. Typical root systems of plants *(Delmar/Cengage Learning)*

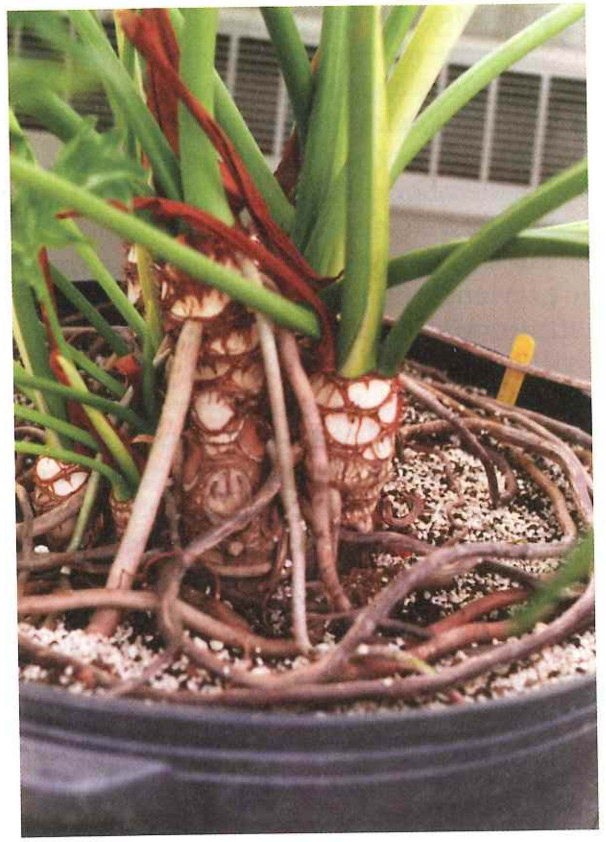

FIGURE 1–3. Adventitious roots are seen on this philodendron. They originate on the lower stem. *(Courtesy Jack Ingels)*

When plants are young, as when they are newly germinated from seeds, the surface area of the roots is greater than the surface area of the leaves, allowing for a greater uptake of mineral nutrients and water than is matched by the photosynthetic activity of the undeveloped leaves. This imbalance is only temporary though, and can eventually tip the opposite way once the leaves expand fully and maximize their food manufacturing capability through photosynthesis. It is generally desirable to maintain a close balance between the ability of a plant to photosynthesize and the root surface area needed to take up the necessary water and minerals.

Roots grow almost continuously throughout the life of a plant. Their rate of growth can be affected by environmental conditions in the soil, such as temperature or moisture extremes. Most root systems will display greater lateral growth than depth. In sites where the soil composition is extremely hard, downward penetration even by tap rooted species may be limited.

Stems

Stems are the central axis of plants. They are usually above ground and may be long or short, single or multiple, and herbaceous or woody (these terms are defined later in the chapter). The principal functions of a stem are to conduct water and minerals absorbed by the roots to the leaves and other above-ground plant parts, and to conduct food materials produced in the leaves to the roots and other plant parts.

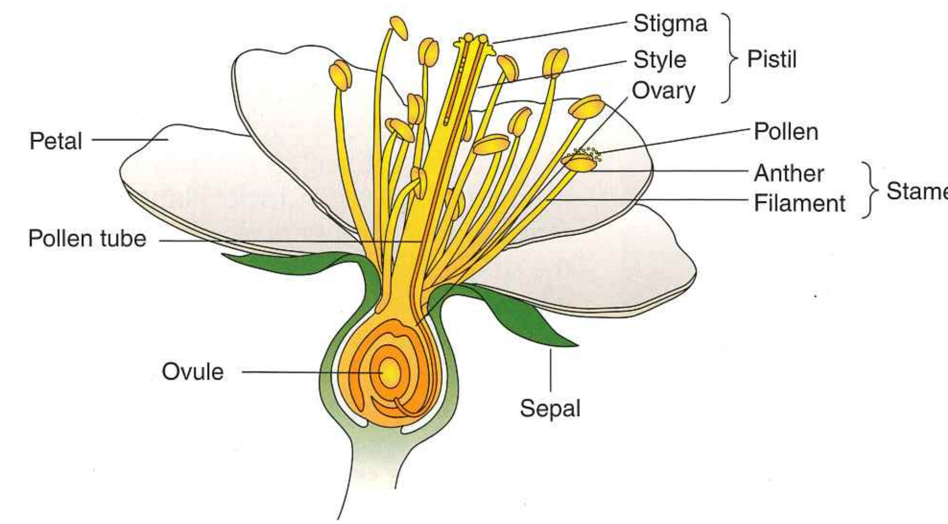

FIGURE 1–4. Longitudinal section of a complete flower *(Delmar/Cengage Learning)*

FIGURE 1–5. A single flower *(Delmar/Cengage Learning. Photo by Marihelen Glass)*

FIGURE 1–6. A cluster (inflorescence) *(Delmar/Cengage Learning. Photo by Marihelen Glass)*

Leaves

Leaves may be thin or flat, thick or fleshy, broad or needle-like. They are appendages of the stem and are the major food manufacturers of the plant. Leaves contain a green pigment, **chlorophyll**, which allows them to use the energy in light to convert carbon dioxide and water into food and oxygen. This process is called **photosynthesis**.

Cones or Flowers

Cones are the reproductive structures of the conifers such as pines, spruce, and firs. Cones contain naked, unenclosed seeds on the upper surface of each cone scale. The conifers are slightly more primitive in evolutionary development than the flowering plants.

Flowers epitomize the peak of evolutionary development in plants and make the flowering plants dominant in the plant kingdom. They are reproductive structures that produce seeds enclosed in fruit. Because the varying anatomical features of their flowers are one means of identifying plants, a knowledge of flower parts and types of flowers is necessary for horticulturists.

A **complete flower** is one that possesses all the floral organs (sepals, petals, stamens, and pistils) (Figure 1–4). An **incomplete flower** lacks one or more of these organs. In addition to being complete or incomplete, flowers may be perfect or imperfect. A **perfect flower** has both stamens (male reproductive organs) and pistils (female reproductive organs). An **imperfect flower** lacks one or the other. Imperfect flowers may be termed pistillate or staminate depending on which of the two essential organs they possess. If both pistillate and staminate flowers occur on the same plant, it is said to be **monoecious**. If the two imperfect flowers occur on separate plants, the plants are termed **dioecious**. Willows and hollies are examples of dioecious ornamental plants.

Flowers may be produced as single blossoms such as roses or lilies (Figure 1–5), in clusters (**inflorescences**) such as gladioli or snapdragons (Figure 1–6), or as composite flowers such as chrysanthemums (Figure 1–7). Composite flowers give the appearance of a single blossom but are actually a grouping of many tiny flowers.

FIGURE 1–7. A composite flower *(Delmar/Cengage Learning. Photo by Marihelen Glass)*

THE STRUCTURE OF PLANT PARTS

All living organisms except viruses have the cell as their basic structural unit. A single plant part, such as a leaf, may be composed of millions of cells. The cells of plants may range in size from 1/25,000 of an inch to nearly 4/10 of an inch. Plant cells can best be visualized as three-dimensional chambers which, when joined together, are responsible for the shape, size, appearance, and function of all the earth's plants. Plants grow from seeds to maturity by the enlargement of existing cells and the production of new ones.

All plant cells are basically alike (Figure 1–8). Nevertheless, leaves do not look like stems, and roots and flowers are equally different. Some parts of the plant photosynthesize, and other parts do not. Some parts are rigid, like stems, and other parts are pliable, like leaves. As cells group together, they become differentiated in their functions. Large groups of similar cells carrying on the same function are termed tissues. Groups of tissues make up the organs of plants (Figures 1–9, 1–10, and 1–11). From the diagrams, several facts should be noted.

The Cell

Tiny though they are, plant cells are not hollow like empty boxes. Each cell is comprised of a variety of components, and each component has

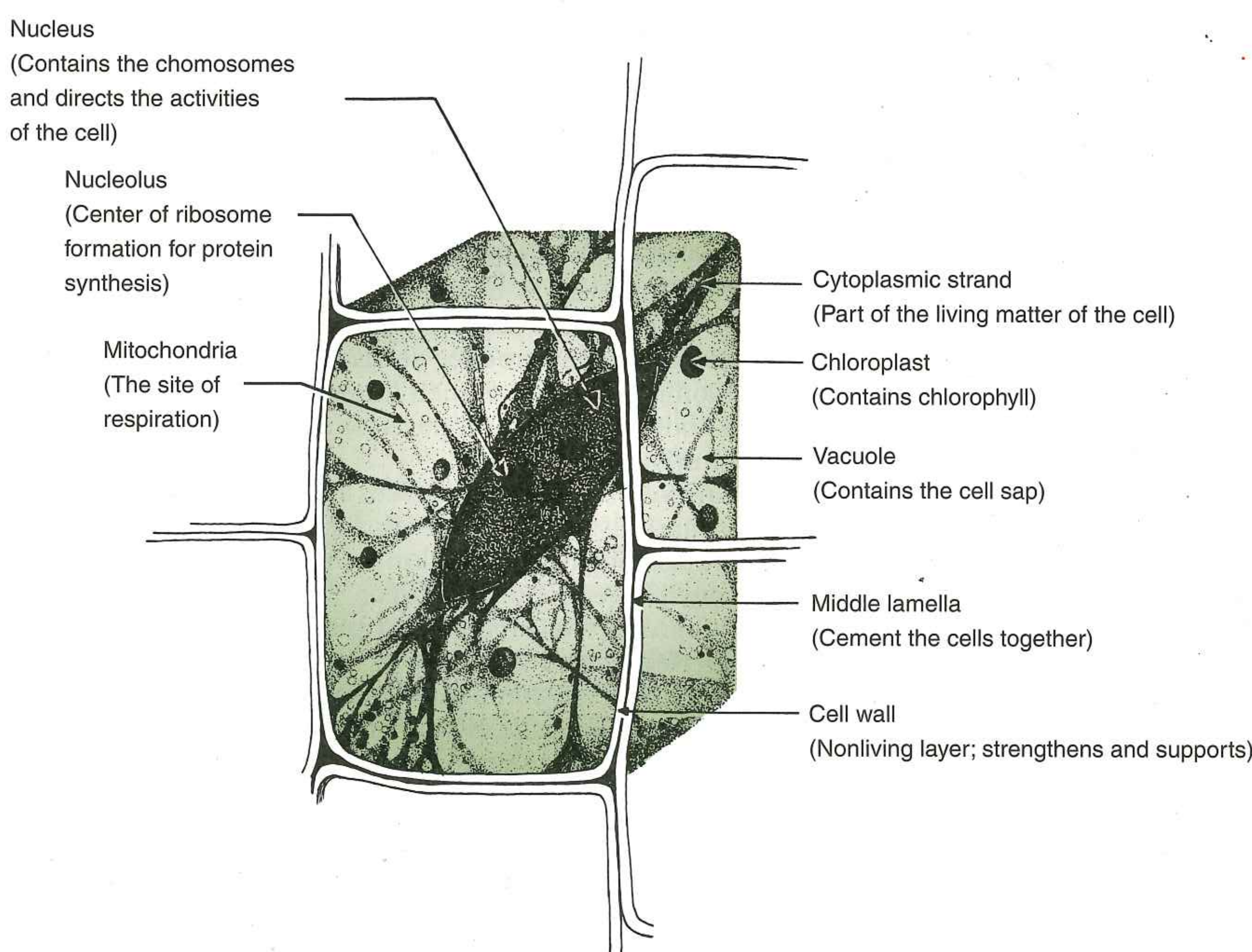

FIGURE 1–8. A typical plant cell with major parts identified and labeled *(Delmar/Cengage Learning)*

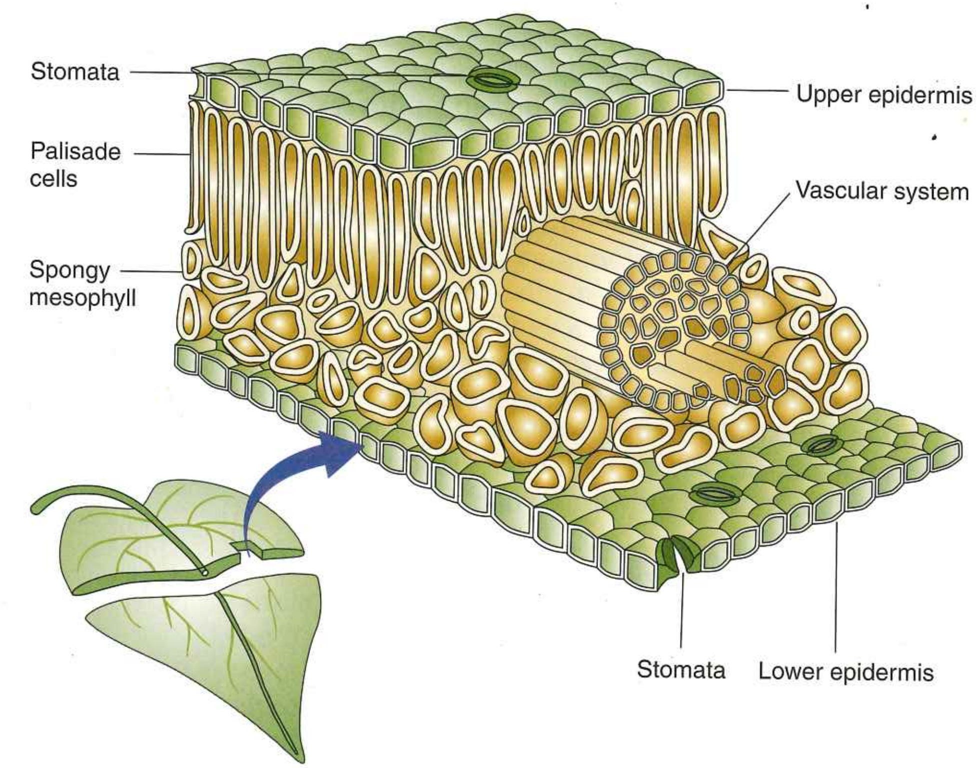

FIGURE 1–9. Cross section of a leaf *(Delmar/Cengage Learning)*

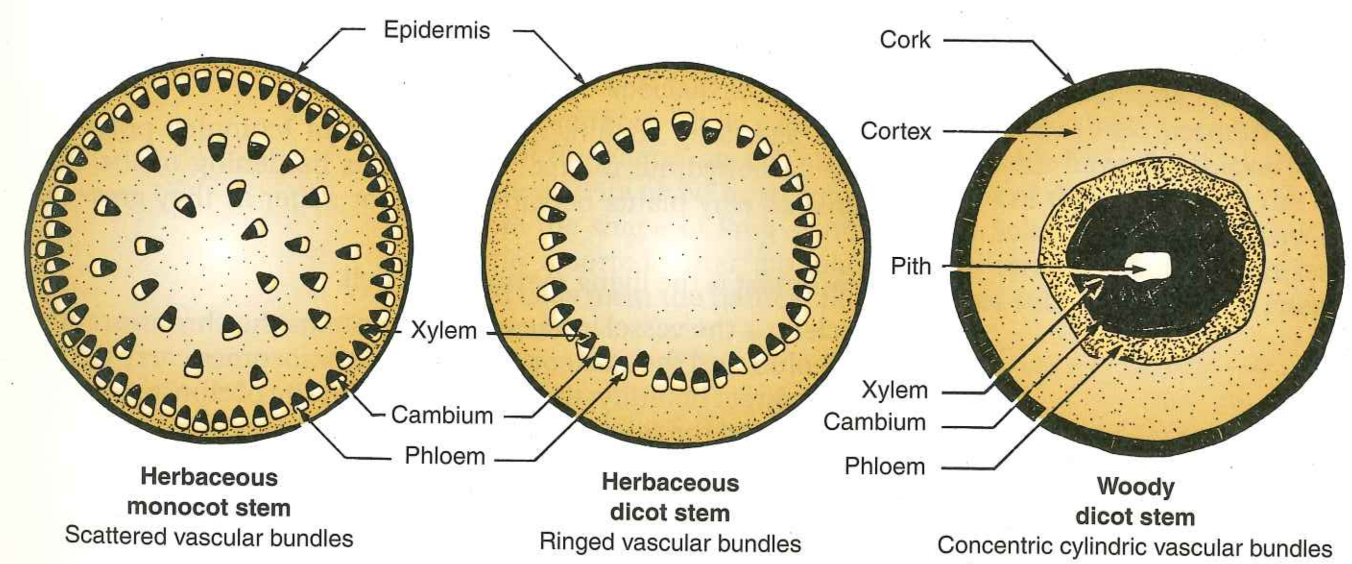

FIGURE 1–10. Cross sections of different types of plant stems *(Delmar/Cengage Learning)*

a vital role to play in the growth, reproduction, and differentiation of the cell (Figure 1–8).

- The cell wall is the foremost distinction between plant and animal cells, since animal cells lack walls. Usually multilayered, the cell wall has a primary wall on the outside, a secondary wall on the inside, and a cementing agent between them termed the middle lamella. The wall is composed of a matrix of carbohydrates reinforced by cellulose molecules arranged in long, rod-like structures.

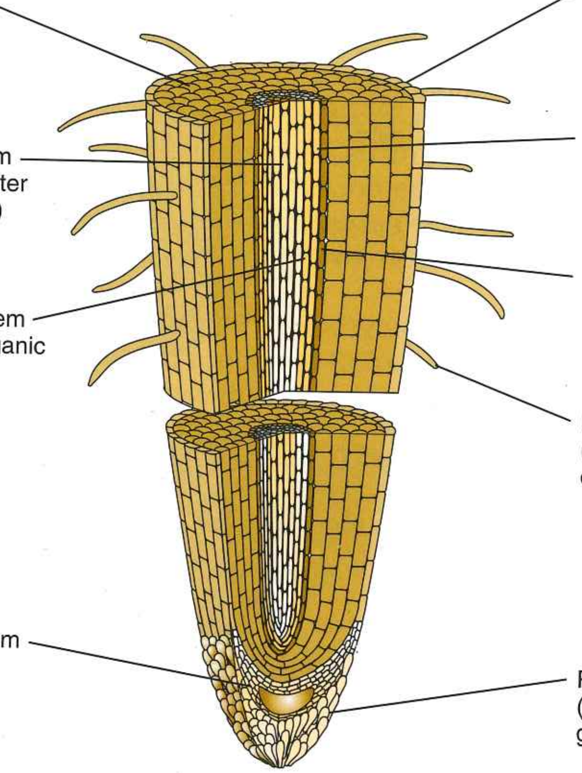

FIGURE 1–11. Cross section of a root tip

As cells age, they acquire deposits of lignin (complex polymers) within the carbohydrate matrix. The result is hardening of the cells, which explains why plants become woody or stiffer as they grow and age.

- The **protoplast** is the living matter of the cell.
- The **nucleus** is the vessel in the cell that contains the chromosomes, the nucleolus, and the nucleoplasm. The chromosomes carry the genes that direct heredity; the nucleolus is the site of ribosome production; and the nucleoplasm supports it all.
- **Chloroplasts** contain the chlorophyll pigment which is vital to photosynthesis.
- **Cytoplasm** is all of the living material in the cell other than the nucleus. (Cytoplasm + nucleus = the protoplast.)
- The **vacuole** is a cavity within the cytoplasm. It is lined with a membrane and filled with salts, various pigments, and organic materials that are collectively termed the cell sap.
- The **plasma membrane** surrounds the protoplast like a thin plastic bag, separating it from the cell wall. The membrane is semipermeable and controls what substances pass into and out of the cell.
- **Cytoplasmic strands** connect the protoplasts of adjacent cells, making the living material of the cells continuous within the plant.

- **Mitochondria** are specialized regions of the plant cell in which respiration occurs. They are enclosed by a double membrane, the innermost of which is folded like an accordion. That increases the surface area in which the chemical reactions of respiration can occur.

Although most plant cells contain the same components, they do not all serve the same function. Some remain simple (embryonic) and primarily divide and create new cells, permitting the plant to grow. Meristematic cells are such cells. They are concentrated at the tips of shoots and roots in most plants, which explains why those plants grow from their extreme ends (their apical meristems), not their bases. An obvious exception is the grasses, which grow at the base, not at the tips of their blades. Grassy monocots have their meristems located at their base, a convenient property that allows mowing without cutting off the growth cells.

Meristems also occur in other parts of the plant. Defined by their location; for example, axillary meristem (in the axils of leaves) and basal meristems (at the base or crown of a plant), they enable the plant to grow in places other than just the shoot.

Other cells, although originating from the meristematic cells, assume other roles in the plant as a result of their differentiation. Parenchyma cells are specialized cells comprising the cortex and pith tissues in stems and the spongy mesophyll tissue in leaves. Most present in leaves, flowers, and fruits, these cells allow the plant to heal its wounds, secrete and excrete materials, and store food. They are also the site of photosynthesis within the plant where they contain chloroplasts. Collenchyma cells are also specialized to provide plants the structural strength they need for support. Their cell walls are unevenly thick, permitting flexibility of the plants' stems. Sclerenchyma cells have the thickest walls and are also involved in structural support of the plant when the cells assume the shape of long slender fibers. Sclerenchyma cells can also assume assorted other globular shapes, termed *sclerids*. Enmassed, sclerid cells form the hardest plant features such as the pits in cherries and peaches.

Stems

The transport of water, nutrients, and food materials between leaves and roots occurs in the **vascular bundles**.

The bundles constitute a system that reaches from the roots to the leaves, running in both directions. Water and mineral nutrients that enter the roots are carried upward to the leaves and other above-ground parts in the xylem. The xylem extends to all parts of the plant. It also offers structural support to plants, especially the woody trees and shrubs. As parts of the xylem mature, the tissue becomes nonliving, further contributing to the structural strength of the plant. The products resulting from the photosynthetic activity of the leaves are moved downward for storage in the roots and other tissues of the plant. Those products move in the part of the vascular system termed the phloem. Like the xylem, the phloem also contributes to the structural support of the plant. While it remains a living system, the tissue breaks down as it ages and is replaced by new tissue. Although likened to a hollow pipe, the phloem is actually a linkage of elongated specialized cells, **sieve elements**, that conduct the food produced during photosynthesis to other parts of the plant.

There are two types of stems, defined by how their vascular tissues are arranged. Monocotyledons (monocots) are plants that have one cotyledon (seed leaf), while dicotyledons (dicots) have two cotyledons. Figure 1–10 illustrates how the stems of monocots and dicots differ in the arrangement of their vascular bundles.

Stems increase in diameter due to the activity of the **cambium** tissue that produces the xylem and phloem.

Because the stem is the major pipeline connecting the roots to the rest of the plant, it is logical that it serves as the site for the initiation of leaves and buds. The **node** is the location on a stem where a bud is initiated. The buds may develop into leaves or flowers. Some buds contain both leaves and flowers. The space between nodes is termed the **internode**. A further discussion of the location of buds as a means of identifying certain plants is included in Chapter 2.

Some stems don't look like stems at all. Instead they function mainly as food storage structures in the form of corms, bulbs, tubers, rhizomes, and stolons. Many familiar flowers, grasses, and vegetables have these unusual stem types.

Leaves

Where the vascular tissues extend into leaves, they form a network of veins. The pattern of the veins (venation) is important in the classification and identification of many plants.

Gaseous exchange between the air outside the plant and the intercellular spaces inside the plant occurs through pores termed stomata or stomates (singular stomate). The plant loses water vapor through the stomata when they are open. That water loss is known as transpiration. When the stomata are closed, transpiration is reduced (Figure 1–9).

The upper and lower epidermis are covered by a waxy **cuticle** (not shown), which keeps the leaf basically impermeable to water and helps some plants retain internal moisture.

Leaf Color

Plant color in general, and leaf color in particular, results from the presence of pigments within the cells. In the majority of higher plants, including the ornamentals, chlorophyll is the pigment in greatest abundance. That is why most living, nondormant plants appear green. Other pigments are present in plants, however. **Xanthophyll** (bright yellow), **carotene** (orange), and **anthocyanins** (red) are pigments that occasionally dominate in plants such as the coleus or in the blossoms of most plants, but they usually await the aging of the leaf and the loss of the chlorophyll pigment to reveal their presence.

Roots

The root elongates in the region of the **apical meristem**. That is the region where the cells are most actively dividing. The apical meristem is protected by the **root cap** as the root presses through the soil.

As important as the apical meristematic region is to the growth of roots, it is not the area of the most rapid water and nutrient absorption. Rather, it is in the area of the root hairs where the fastest absorption occurs. Very little water or nutrient absorption occurs at the tips of roots or in older roots. It is the root hairs that number in the thousands and are only a cell in thickness that amplify the absorbing surface area of a plant's root system (Figure 1–11).

Seeds

The Gymnosperms and Angiosperms are seed-bearing plants. A seed is a miniature plant. It develops through the sexual reproduction process and is initially dormant. It awaits the provision of proper environmental conditions that permit it to germinate.

The miniature plant is termed an **embryo**. It is enclosed by a seed coat if it has two cotyledons, or by a pericarp if it has only one cotyledon. As noted previously, plants that produce one or two cotyledons are termed monocots or dicots, respectively. Cotyledons supply nutrients to the embryo until it can begin photosynthesizing to allow its further development.