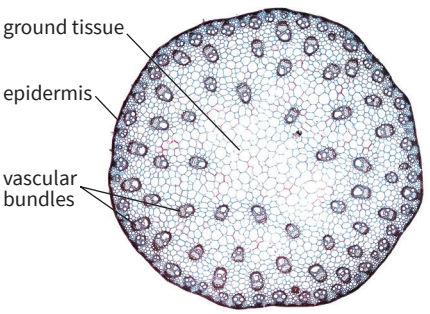
## TISSUE ORGANIZATION OF STEMS, LEAVES, AND ROOTS

By examining the structures of a stem, leaf, and root, the specific organization of the three tissue types in plants can be further emphasized and clarified.

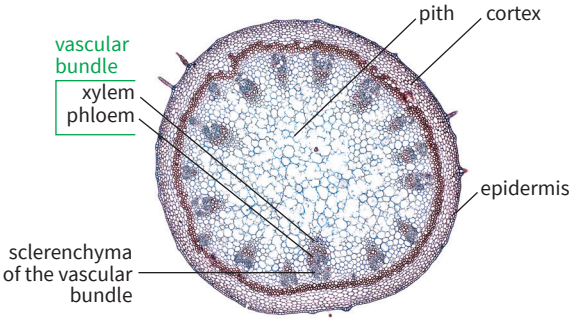
### Tissue Organization in Stems

All parts of plants including the stem are covered with epidermis. The stem is mostly made up of ground tissue, especially in herbaceous plants. The ground tissue is predominantly made up of parenchyma cells. The vascular bundles are embedded in the ground tissue, and the arrangement of these vascular bundles differs in monocots and dicots.

Figure 4.7 illustrates the cross-sections of monocot and dicot stems. The obvious difference between the cross sections of monocot and dicot stems is the arrangement of vascular bundles. In monocots, the vascular bundles are scattered throughout the ground tissue. On the other hand, in dicots, the vascular bundles are arranged in a ring. The xylem of each vascular bundle is near the *pith*, the area that occupies the center. The phloem is adjacent to the *cortex*, the region between the epidermis and the vascular bundles.




(*a*) cross section of stem with scattered vascular bundles (typical of monocots)




(*b*) cross section of stem with vascular bundles forming a ring (typical of eudicots)

**Fig. 4.7** The cross-sections of (*a*) monocot and (*b*) dicot stems showing the three plant tissues—dermal, ground, and vascular tissues.

## Tissue Organization in Leaves

Figure 4.8 is a cutaway drawing of a dicot leaf. The epidermis is covered by the cuticle and is interrupted by stomata flanked by guard cells. A ground tissue called *mesophyll* is sandwiched by the upper and lower epidermis.

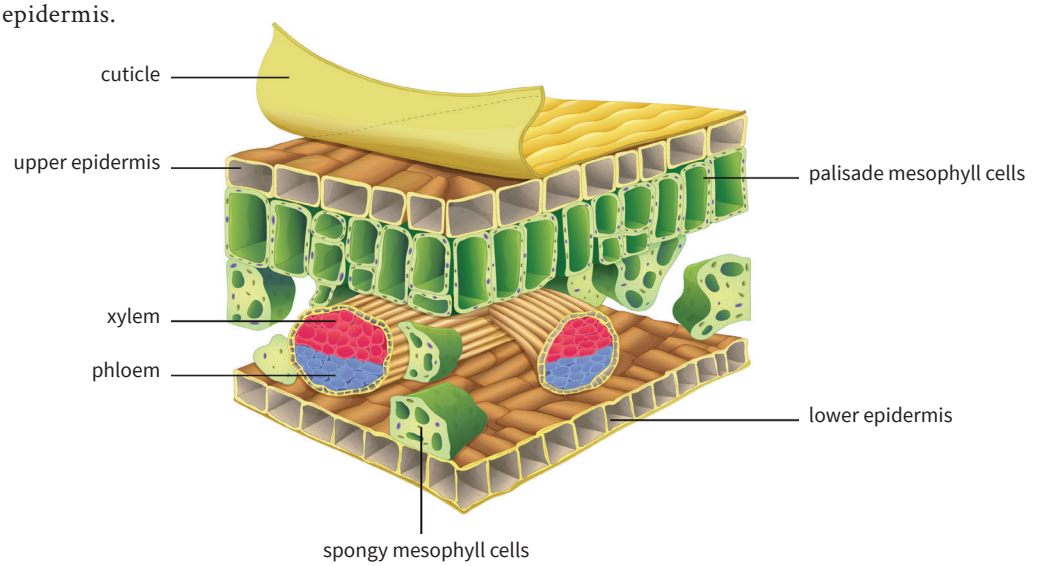



**Fig. 4.8** The diagram of a cross-section of a dicot leaf shows the three plant tissues—dermal, ground, and vascular tissues. The arrangement of the different tissues in the leaf allows plants to photosynthesize efficiently.

Mesophyll is mainly composed of parenchyma cells that are specialized for photosynthesis. In many dicots, the mesophyll is divided into two layers: the palisade and spongy layers (fig. 4.8). *Palisade mesophyll* consists of one or more layers of elongated parenchyma cells located on the upper part of the leaf. *Spongy mesophyll* is found below the palisade layer. The parenchyma cells that comprise it are more loosely arranged. Sclerenchyma fibers are present in the mesophyll.

In a monocot leaf, the mesophyll is not differentiated into two layers but consists of the spongy mesophyll only (fig. 4.9). Embedded in the mesophyll in both monocot and dicot leaves are the vascular tissues. The vascular tissue, including the xylem and phloem, is enclosed by *bundle sheath cells*, a layer of cells that regulate the movement of substances between the vascular bundle and the mesophyll. The vascular tissue of the leaf is continuous with the vascular tissue of the stem.

## Tissue Organization in Roots

Figure 4.10 shows the cross-sections of monocot and dicot roots. Covering the root system is the epidermis. In the center is a central cylinder called *stele* where the xylem and phloem are found. In the cross-section of dicot roots, the xylem has a star-like appearance, while the phloem occupies the indentations between the arms of the xylem.

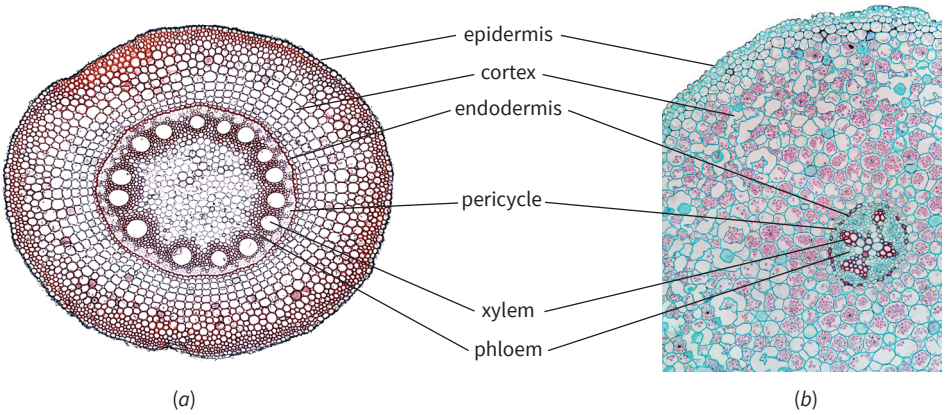



**Fig. 4.10** The cross-sections of (*a*) monocot and (*b*) dicot roots show the dermal, ground, and vascular tissues.

In monocots, the vascular tissue forms a central core of parenchyma cells surrounded by a ring of alternating phloem and xylem tissues. The region between the epidermis and the vascular cylinder is the cortex. The cortex is mainly composed of parenchyma cells that store carbohydrates. It allows the extracellular diffusion of water, mineral, and oxygen from the root hairs inward.

## PLANT MERISTEMS

Plants can grow indeterminately, meaning, they can continuously grow as long as they live. This is possible because they have perpetually dividing, unspecialized tissues known as *meristems*. There are two kinds of meristems that are classified based on their location in the plant: apical and lateral meristems.

### Apical Meristems

*Apical meristems* are also called *primary meristems* because they bring about the formation of the primary plant body. They are located in the apices, specifically in root tips and shoot buds (fig. 4.11). They provide additional cells for plants to grow in length, a process called *primary growth*, which enables roots to extend throughout the soil and the shoots to increase in height.

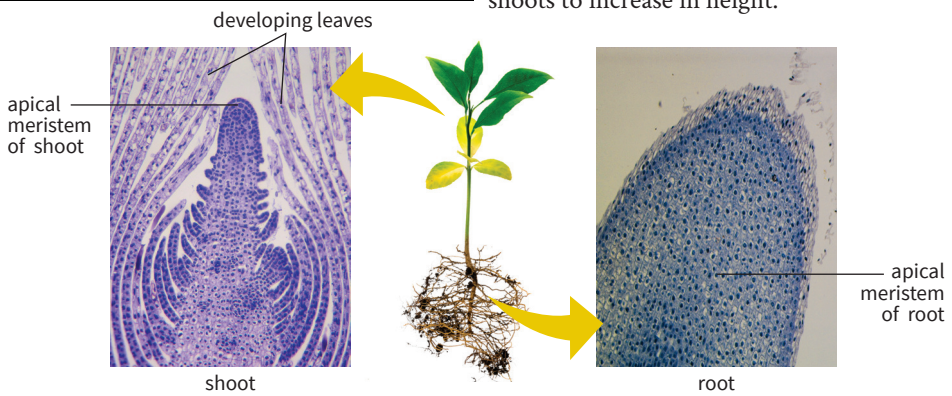



**Fig. 4.11** The cells of the apical meristems of the shoot and root are actively dividing by mitosis, allowing plants to grow in length all throughout their life.

## Lateral Meristems

*Lateral meristems* found in the cambia are responsible for *secondary growth*. The *vascular cambium* is a layer of actively dividing cells that are located between the xylem and phloem tissues, and gives rise to the secondary vascular tissue. In woody plants, the main component of wood is actually the secondary xylem. The *cork cambium* is the lateral meristem that develops into the outer bark of a tree. The secondary tissues formed from the lateral meristems cause the thickening of roots and shoots that occurs in woody plants. Secondary growth is responsible for the increase in girth in woody plants.