PLANT STRUCTURE

Domain Eukarya
Kingdom Plantae
Division Anthophyta

Vascular plants have distinctive cell types, all of which are surrounded by a cell wall of cellulose fibers and other molecules secreted by the cells. Just as in animals, cells are organized into tissues that perform different functions, but plants do not have organ systems like those of animals. The tissues of plants are grouped into 3 basic kinds: ground, vascular, and dermal. A meristem is a special embryonic tissue; meristems are the only place where mitotic cell division occurs in plants.

Plants differ from animals in that the tips of roots and stems, called **apical meristems**, remain **embryonic** and retain the ability to form new structures, e.g., leaves, stems, flowers, and roots. In fact, plants can only grow in length by cell division in the apical meristems; this is **primary growth**. Hormones secreted by cells of the apical meristem are transported elsewhere in the plant; thus, the meristem is in part analogous to the endocrine system in animals.

Ground tissues include parenchyma, collenchyma, and sclerenchyma. Thin-walled **parenchyma** cells have a variety of functions such as photosynthesis, starch storage, and secretion; they retain the capacity to divide and are important in repairing damage. Parenchyma cells are also totipotent; they can differentiate into any other cell type if given the right signals. Pliable **collenchyma** cells help strengthen the plant; their walls are irregularly thickened (primarily at the corners) and are made strong with cellulose and pectin; the strings just below the epidermis of celery are an example. **Sclerenchyma** cells have very thick secondary walls that are commonly impregnated with lignin, which makes them quite rigid. There are two types of sclerenchyma cells, elongate fibers and more compact stone cells (sclerids). The fibers of flax plants (*Linum usita*tissimum L.) is made into linen threads for weaving, sewing, and paper making. The gritty texture of pears is caused by stone cells. The hardness of a coconut shell or of a peach pit is also caused by sclerenchyma. Ground tissues are analogous to the supporting connective tissue and skeletal elements in animals.

Collenchyma in celery

Vascular tissues include xylem and phloem; this is the plant's circulatory system. At maturity **xylem** cells are dead and form interconnected tubes throughout the plant. They conduct **water and dissolved nutrients** that the plant absorbed from the soil up to the leaves; their thick, lignified walls allow them to give mechanical support to the plant. Wood is made of xylem cells. **Phloem** cells which also form interconnected tubes are living at maturity and have interconnected cytoplasm; they **conduct other solutes**, chiefly nutrients (e.g., carbohydrates) from areas of food production such as leaves to areas of food use or food storage such as tubers.

Dermal tissue is composed of epidermis. The **epidermis** is a continuous layer of tightly packed cells which cover the stems, leaves, flowers, fruits, and seeds. The outer surface is usually coated with a **cuticle** of waxes embedded in a fatty substance; this is analogous to keratinized outer layer of skin, including your own, in animals that live on land. Leaf epidermis is perforated by **stomata** for gas exchange between the photosynthetic mesophyll (parenchyma) and the surrounding atmosphere. Thus, leaves function in part like lungs.

Dicot **leaves** are much like fern leaves in general structure. The **upper** and **lower epidermis** are covered with a **waxy cuticle** to prevent water loss. The **mesophyll** consists of a **palisade layer** of tall cells just under the upper epidermis, and chains of **spongy mesophyll** cells with **air spaces** between them in the lower part of the leaf. The tall palisade cells are packed with **chloroplasts** and are the site of most of the photosynthesis in the leaf; they are located in the upper part of the leaf where sunlight penetrates most fully. Spongy mesophyll contains air for **gas exchange** with cells of the leaf. **Carbon dioxide** from air is the source of carbon for synthesis of carbohydrates, and **oxygen** gas is a waste product of photosynthesis.

Among the **Anthophyta**, **monocots** and **dicots** are easily distinguished. Generally, in monocots, the leaf veins (vascular bundles) are parallel; in dicots they are branched. Flower parts in monocots are based on multiples of three and in most dicots on multiples of four or five.

Monocot leaf

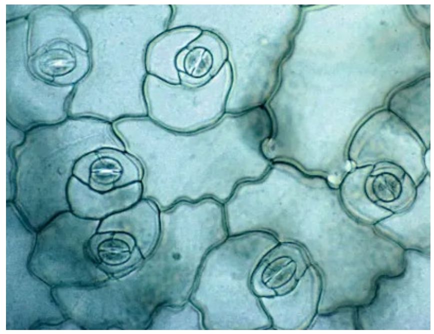
dicot leaf

Slides:

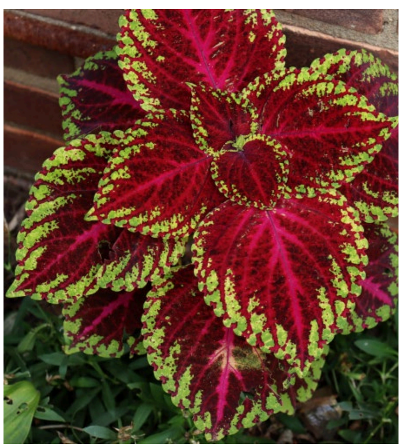
<u>*Syringa* leaf x.s.</u> (dicot). Identify the **upper** and **lower epidermis**, the **palisade mesophyll**, and the **spongy mesophyll**. Pairs of small cells in the lower epidermis that have a space between them control the **stomata**, the openings between air outside the leaf and air in the spaces in the spongy mesophyll. The central rib of a leaf is its main **vascular bundle**, and it gives rise to many side branches. Identify **xylem** and **phloem**, the tissues that transport water and dissolved nutrients respectively throughout the plant. Xylem cells in cross-section are large with thick walls that are probably stained pink. Phloem consists of tiny, thin-walled cells below the xylem; it is probably stained green. Which is towards the top of the leaf, and which is toward the bottom? Why? These vascular cells are surrounded by supporting tissue, some of which is hardened as **sclerenchyma** to give rigidity.

Syringa leaf, cross section

Leaf, lower epidermis. In this view the many pores that allow for movement of gases between surrounding air and air in the spongy mesophyll can be seen. The singular for each pore is **stoma**, the plural **stomata**. Each stoma is surrounded by a pair of **guard cells** which have a thicker wall facing the opening than on the side that is continuous with the surrounding epidermal cells. When water is available, the guard cells swell and bend away from each other (the stoma opens); bending occurs because the thick cell wall on one side is not as stretchy as the rest. The entire epidermis looks like a jig-saw puzzle of cells dotted with stomata.

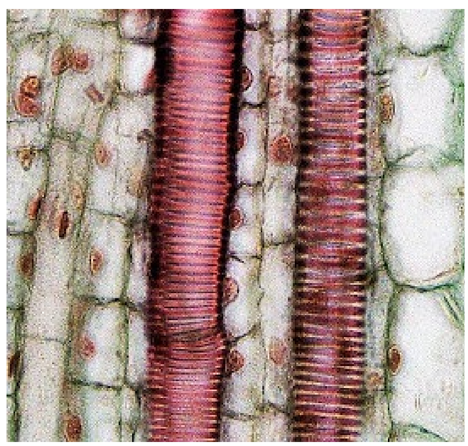


Coleus stem tip. l.s. (dicot). This is a longitudinal section through a common ornamental house plant. You can distinguish the central stem and the leaves branching off it. The very tip of the stem is embryonic tissue called the **apical meristem**; as the plant grows, it differentiates into stem, leaves, and flowers. Meristem present in the axils of the leaves (between the leaf and stem, above the leaf) forms **axillary buds**. Cells of the apical meristem secrete a hormone, auxin, that suppresses growth of the axillary buds; when the apical meristem is removed, the hormonal control is removed, and the axillary buds can grow into new stems. In some areas you can distinguish **xylem** cells that are supported by a coil of thickened wall that is stained pink; this coil around the cell is somewhat like the cartilage rings that hold your trachea (windpipe) open.

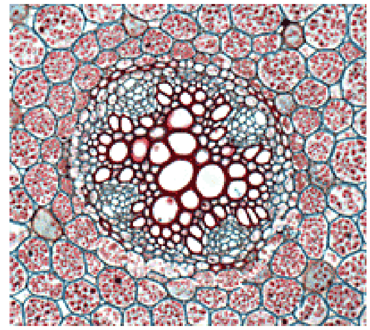


Coleus plant

Coleus stem tip



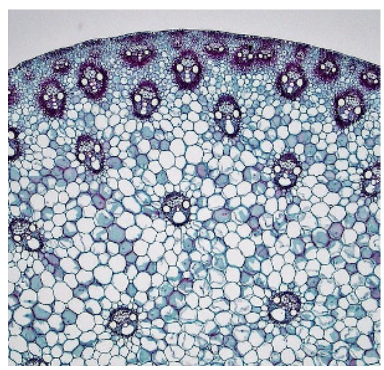
developing xylem



<u>*Ranunculus acris*: mature root x.s.</u> (dicot). **Xylem** forms a cross in the middle of the root with **phloem** in its angles. The group of xylem and phloem cells is a **vascular bundle**. The vascular bundle is located in the center of the root, and it is surrounded by a ring of endodermis cells.

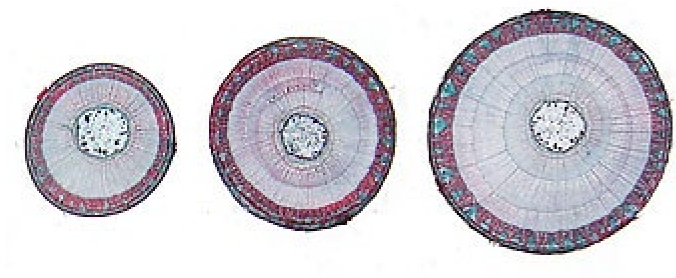
<u>Stem. Monocot and dicot</u>. **Dicot stems** have **vascular bundles** around the **periphery** and not in the center, as the root does. The vascular bundle of the root must divide and spread out into the many bundles of the stem. Broad, thick-walled **xylem** cells are toward the inside of the stem, and **phloem** is toward the outside; the outermost part is a **bundle cap** of **sclerenchyma** cells which give support. The center of the stem is called **pith**. The **monocot stem** has **xylem** and **phloem** in bundles that look like monkey faces. There are two large xylem cells making the eyes; an air space makes the nose; thin-walled phloem makes the forehead, and above it is thick-walled **sclerenchyma**. These are scattered throughout the stem cross section. Cells other than these kinds are **parenchyma**. Both stem examples are of **herbaceous stems**, which lack woody tissue and growth rings. Observe the orientation of the xylem and phloem in each bundle in the monocot stem; is there a pattern?

Dicot stem, cross section



Monocot stem, cross section

<u>*Tilia*. 1, 2, 3, yr. stem c.s.</u> (dicot). Successive year's growth of vascular tissue adds layers of xylem to the stems of woody plants. These are referred to as **growth rings** with the outermost ring being the youngest. The outermost layer of the stem is the cortex or bark; the bark is produced by a meristem called the **cork cambium**. Just deep to it is the **phloem** in which you can see triangular wedges called **rays**. The inner part consists of successive layers of lignified **xylem**. In between the xylem and the phloem is the vascular cambium. The vascular cambium is meristematic, producing new xylem cells to the inside and phloem cells to the outside; the action of the vascular cambium accounts for most of the growth in girth of woody plants.



<u>Grass root tip w.m.</u> (monocot). Just behind the **region of elongation**, the root tips of plants are covered with fine **root hairs** that are similar to the rhizoids we saw in the bryophytes and fern gametophytes. The root hairs maximize water absorption by increasing the surface area of the roots. When you pull up a plant, you shear off the root hairs and the plant may not be able to get enough water when replanted. It is best to dig up a plant in a ball of earth. Beneficial associated fungi (mycorrhizae) are also transferred.

<u>*Zea mays* prop. root tip</u>. (monocot). The blunt **root cap** is tough and and protects the apical meristem as it is pushed through the soil by the dividing and elongating cells. The root cap also produces mucus which lubricates the root tip so that it can penetrate the soil more easily. In the root apical meristem, cells undergo mitosis as you saw in previous lab observations of onion root tips. Cells farther up the root are in the region of elongation and will elongate but not divide again.

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