30.1A: Plant Tissues and Organ Systems

Plants are made up of meristematic and permanent tissues and are supported by shoot and root organ systems.

Learning Objectives

- Differentiate among the types of plant tissues and organs

Key Points

- There are two types of plant tissues: meristematic tissue found in plant regions of continuous cell division and growth, and permanent (or non-meristematic) tissue consisting of cells that are no longer actively dividing.
- Meristems produce cells that differentiate into three secondary tissue types: dermal tissue which covers and protects the plant, vascular tissue which transports water, minerals, and sugars and ground tissue which serves as a site for photosynthesis, supports vascular tissue, and stores nutrients.
- Vascular tissue is made of xylem tissue which transports water and nutrients from the roots to different parts of the plant and phloem tissue which transports organic compounds from the site of photosynthesis to other parts of the plant.
- The xylem and phloem always lie next to each other forming a structure called a vascular bundle in stems and a vascular stele or vascular cylinder in roots.
- Parts of the shoot system include the vegetative parts, such as the leaves and the stems, and the reproductive parts, such as the flowers and fruits.
Key Terms

- **meristem**: the plant tissue composed of totipotent cells that allows plant growth
- **parenchyma**: the ground tissue making up most of the non-woody parts of a plant
- **xylem**: a vascular tissue in land plants primarily responsible for the distribution of water and minerals taken up by the roots; also the primary component of wood
- **phloem**: a vascular tissue in land plants primarily responsible for the distribution of sugars and nutrients manufactured in the shoot
- **tracheid**: elongated cells in the xylem of vascular plants that serve in the transport of water and mineral salts

Plant Tissues

Plants are multicellular eukaryotes with tissue systems made of various cell types that carry out specific functions. Plant tissue systems fall into one of two general types: meristematic tissue and permanent (or non-meristematic) tissue. Cells of the meristematic tissue are found in meristems, which are plant regions of continuous cell division and growth. Meristematic tissue cells are either undifferentiated or incompletely differentiated; they continue to divide and contribute to the growth of the plant. In contrast, permanent tissue consists of plant cells that are no longer actively dividing.

Meristematic tissues consist of three types, based on their location in the plant. Apical meristems contain meristematic tissue located at the tips of stems and roots, which enable a plant to extend in length. Lateral meristems facilitate growth in thickness or girth in a maturing plant. Intercalary meristems occur only in monocots at the bases of leaf blades and at nodes (the areas where leaves attach to a stem). This tissue enables the monocot leaf blade to increase in length from the leaf base; for example, it allows lawn grass leaves to elongate even after repeated mowing.

Meristems produce cells that quickly differentiate, or specialize, and become permanent tissue. Such cells take on specific roles and lose their ability to divide further. They differentiate into three main types: dermal, vascular, and ground tissue. Dermal tissue covers and protects the plant. Vascular tissue transports water, minerals, and sugars to different parts of the plant. Ground tissue serves as a site for photosynthesis, provides a supporting matrix for the vascular tissue, and helps to store water and sugars.

Plant tissues are either simple (composed of similar cell types) or complex (composed of different cell types). Dermal tissue, for example, is a simple tissue that covers the outer surface of the plant and controls gas exchange. Vascular tissue is an example of a complex tissue. It is made of two specialized conducting tissues: xylem and phloem. Xylem tissue transports water and nutrients from the roots to different parts of the plant. It includes three different cell types: vessel elements and tracheids (both of which conduct water) and xylem parenchyma. Phloem tissue, which transports organic compounds from the site of photosynthesis to other parts of the plant, consists of four different cell types: sieve cells (which conduct photosynthates), companion cells, phloem parenchyma, and phloem fibers. Unlike xylem-conducting cells, phloem-conducting cells are alive at maturity. The xylem and phloem always lie adjacent to each other. In stems, the xylem and the phloem form a structure called a vascular bundle; in roots, this is termed the vascular stele or vascular cylinder.
Figure 1: Cross section of a squash stem showing a vascular bundle: This light micrograph shows a cross section of a squash (Curcurbita maxima) stem. Each teardrop-shaped vascular bundle consists of large xylem vessels toward the inside and smaller phloem cells toward the outside. Xylem cells, which transport water and nutrients from the roots to the rest of the plant, are dead at functional maturity. Phloem cells, which transport sugars and other organic compounds from photosynthetic tissue to the rest of the plant, are living. The vascular bundles are encased in ground tissue and surrounded by dermal tissue.

Plant Organ Systems

In plants, just as in animals, similar cells working together form a tissue. When different types of tissues work together to perform a unique function, they form an organ; organs working together form organ systems. Vascular plants have two distinct organ systems: a shoot system and a root system. The shoot system consists of two portions: the vegetative (non-reproductive) parts of the plant, such as the leaves and the stems; and the reproductive parts of the plant, which include flowers and fruits. The shoot system generally grows above ground, where it absorbs the light needed for photosynthesis. The root system, which supports the plants and absorbs water and minerals, is usually underground.
Figure \(\PageIndex{1}\): Example plant organ systems: The shoot system of a plant consists of leaves, stems, flowers, and fruits. The root system anchors the plant while absorbing water and minerals from the soil.

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