Plant Structure

- Until the late 1990's, flowering plants (angiosperms) were placed into two groups, based on the number of cotyledons (seed leaves) in the embryo.
- Monocots – species with one cotyledon
  - Dicots – species with two cotyledons
- Other features, like flower and leaf structure were also used to define the two groups.
- Recent DNA studies are changing these classifications, however.
- Many of the plants in the dicot group are being re-classified into smaller groups, with the majority of them forming a new clade called ***eudicots***.

Plants have three basic organs: roots, stems, and leaves

- The plant body consists of organs that are composed of different tissues, and these tissues are teams of different cell types.
- The basic morphology of plants reflects their evolutionary history as terrestrial organisms that must simultaneously inhabit and draw resources from two very different environments.
  - Soil provides water and minerals, but air is the main source of CO_2 and light does not penetrate far into soil.
  - To deal with these different environments, plants have evolved two systems:
    - a subterranean **root system**
    - and an aerial **shoot system** of stems and leaves.
- Roots anchor the plant in the soil, absorb minerals and water, and store food.
- There are 2 major types of root systems:
- ***Taproot systems*** consist of one large vertical root (the taproot) that produces many small lateral, or branch roots.
  - Taproots generally penetrate deeply into the ground
  - Anchor the plant in the soil
  - Store food that supports flowering and fruit production
- ***Fibrous root systems*** consist of a mat of thin roots arising from the stem that spread out below the soil surface, with no root standing out as the main one.
  - Shallower than taproot systems
  - Extends the plant's exposure to soil water and minerals
  - Solidly anchors it to the ground
    - Monocots, including grasses, generally have fibrous root systems
- Most absorption of water and minerals in both systems occurs near the root tips, where vast numbers of tiny ***root hairs*** increase the surface area enormously.
  - Root hairs are extensions of individual epidermal cells on the root surface.
- Some plants have roots, **adventitious** roots, arising aboveground from stems or even from leaves.
  - In some plants, including corn, these adventitious roots function as props that help support tall stems.

- Shoots consist of ***stems and leaves***.
- Shoot systems may be vegetative (leaf bearing) or reproductive (flower bearing).
- A ***stem*** is an organ consisting of an alternating system of **nodes**, the points at which leaves are attached, and **internodes**, the stem segments between nodes.
- In the angle (axil) formed by each leaf and the stem is an **axillary bud**.
  - Structure that can form a lateral shoot (branch)
- Most axillary buds of a young shoot are dormant (not growing).
- Growth of a young shoot is usually concentrated at its apex (tip), where there is a **terminal bud** with developing leaves and a compact series of nodes and internodes.
- The presence of a terminal bud is partly responsible for inhibiting the growth of axillary buds, a phenomenon called **apical dominance**.
  - By concentrating resources on growing taller, apical dominance increases the plant's exposure to light.
  - In the absence of a terminal bud, the axillary buds break dormancy (start growing) and give rise to a lateral shoot (branch) complete with its own terminal bud, leaves, and axillary buds.
- ***Leaves*** are the main photosynthetic organs of most plants, but green stems are also photosynthetic.
- While leaves vary extensively in form, they generally consist of a flattened **blade** and a stalk, called the **petiole**, which joins the leaf to a node of the stem.
  - In the absence of petioles in grasses and many other monocots, the base of the leaf forms a sheath that envelops the stem.
- Most monocots have parallel major veins that run the length of the blade, while dicot leaves have a multi branched network of major veins.
- Plant taxonomists use leaf shape, spatial arrangement of leaves, and the pattern of veins to help identify and classify plants.

Plant organs are composed of three tissue systems: dermal vascular, and ground

- Each plant organ – root, stem, or leaf – has dermal, vascular, and ground tissues.
  - Each tissue system is continuous throughout the plant body.
- The ***dermal tissue*** is the outer protective covering.
- It forms the first line of defense against physical damage and pathogenic organisms.
  - Nonwoody plants – dermal tissue consists of a single layer of tightly packed cells called the ***epidermis***.
  - Woody plants – protective tissues known as ***periderm*** replace epidermis in older regions of stems and roots
- The epidermis has other specialized characteristics consistent with the function of the organ it covers.
  - For example, the roots hairs are extensions of epidermal cells near the tips of the roots and play a major role in the absorption of water and minerals
  - The epidermis of leaves and most stems secrete a waxy coating, the ***cuticle***, that helps the aerial parts of the plant prevent water loss.

- ***__Vascular tissue__***, continuous throughout the plant, is involved in the transport of materials between roots and shoots.
  - ***__Xylem__*** transports water and dissolved minerals upward from roots into the shoots.
  - ***__Phloem__*** transports food (organic nutritents) made in mature leaves to the roots and to non photosynthetic parts of the shoot system.
  - The vascular tissue of a root system is collectively called the ***__stele__*** (Greek for pillar).
- ***__Ground tissue__*** is tissue that is neither dermal tissue nor vascular tissue.
  - Ground tissue that is internal to the vascular tissue is called ***pith.***
  - Ground tissue that is external to the vascular tissue is called ***cortex***.
- The functions of ground tissue include photosynthesis, storage, and support.

Common Types of Plant Cells

- Like any multicellular organism, a plant is characterized by cellular differentiation – the specialization of cells in structure and function.
  - Differentiation is sometimes evident within the **protoplast**, the cell contents exclusive of the cell wall.
  - Cell wall modifications also play a role in plant cell differentiaion.
  - Some of the major types of plant cells are as follows:
    - Parenchyma cells
    - Collenchyma cells
    - Sclerenchyma cells
    - Water-conducting cells of the xylem
    - Sugar-conducting cells of the phloem

Review of the Plant Cell Wall

- A mature cell wall consists of a **primary cell wall,** a **middle lamella** with sticky polysaccharides that hold cells together, and layers of **secondary cell wall.**
- ***__Parenchyma cells__*** – the "typical plant cell"
  - Have primary walls that are relatively thin and flexible, and most lack secondary walls
  - Least specialized (structurally speaking)
  - Perform most of the metabolic functions of the plant, synthesizing and storing various organic products.
  - The fleshy tissue of a typical fruit is composed mainly of parenchyma cells.
  - Most parenchyma cells have the ability to divide and differentiate into other types of plant cells when necessary.
- ***__Collenchyma cells__***, grouped into strands or cylinders, help support young parts of the plant shoot.
  - Have thicker primary walls than parenchyma cells
  - Young stems and petioles often have strands of collenchyma cells just below their epidermis, providing support without restraining growth – an example of this type of cell are the strings of a celery stalk.
  - Functioning collenchyma cells are living and flexible and elongate with the stems and leaves they support, without restraining growth.

- ***Sclerenchyma cells*** also function as supporting elements of the plant, with thick secondary walls usually strengthened by lignin.
  - They are much more rigid than collenchyma cells.
  - Unlike parenchyma cells, they cannot elongate and occur in plant regions that have stopped lengthening.
  - Many sclerenchyma cells are dead at functional maturity, but they produce rigid secondary cells walls before the protoplast dies.
- The ***water conducting elements of xylem***, the **tracheids** and **vessel elements**, are tubular, elongated cells that are dead at *functional maturity*.
  - The thickened cell walls form a nonliving conduit through which water can flow.
- ***Tracheids*** are long, thin cells with tapered ends.
  - Because their secondary walls are hardened with lignin, tracheids function in support as well as transport.
- ***Vessel elements*** are generally wider, shorter, thinner walled, and less tapered than tracheids.
  - Vessel elements are aligned end to end, forming long micropipes, **xylem vessels**.
  - The ends are perforated, enabling water to flow freely.
- In the ***sugar conducting cells of the phloem***, sucrose, other organic compounds, and some mineral ions move through tubes formed by chains of cells called **sieve-tube members**.
  - These are alive at functional maturity, although they lack the nucleus, ribosomes, and a distinct vacuole.
  - The end walls between sieve-tube members, called the **sieve plates**, have pores that facilitate the flow of fluid from cell to cell along the sieve tube.
  - A non conducting, but nucleated **companion cell**, connected to the sieve-tube member by numerous channels, assist the sieve-tube cells.