UNIT III: PLANT FORM AND FUNCTION

- Plant structure and growth
- Plant nutrition
- Plant reproduction and development

Cardinal Flower  Arabidopsis thaliana  Red Maple
Evolutionary relationships among the Angiosperms. The monocots and eudicots are the largest monophyletic groups among the angiosperms. (The “other groups” remain to be placed accurately on the phylogenetic tree).
Monocotylenous and Dicotyledonous Plants

**Monocots**
- ~65,000 species
- Lilies, irises, orchids, cattails, all the grasses and grains...
- Monocot lineage, taxon, is monophyletic; evolved from dicot ancestor

**Dicots**
- ~175,000 species
- Most trees and shrubs
- Most annual plants – mints, sunflowers, peas, snapdragons
- Most dicots are in members of the Eudicot lineage – a monophyletic taxon

Examples of Monocot angiosperms
Examples of Dicots (more specifically, Eudicots)

Cactus

Flowering Dogwood

Rose

Phylogenetic relationships among Angiosperm lineages

Angiosperms

Non-Angiosperms

Oldest living angiosperm lineages

Several lineages related to magnolia

Monocots

Eudicots

Lineages in green are traditionally called dicots - the seeds of these lineages have two “seed leaves”.

“Dicots” don’t form a monophyletic group -- ie monocots are descended from a “dicot” lineage.

“Eudicots” are a monophyletic group that includes much of the angiosperm diversity.

Source: Freeman (2002)
Phylogenetic relationships of the orders of flowering plants (AGP, 1998)

• Monocots apparently diverged from dicots early in the history of the phylum

http://www.csdl.tamu.edu/FLORA/newgate/cronang.htm
Annual Plants Life cycle (vegetative growth and reproduction) occurs in the course of a single year; die after single year of growth.

Most are entirely herbaceous, i.e., lack secondary growth, secondary tissue (wood); some (e.g., sunflowers) produce poorly developed secondary tissues. Many crop plants (incl. corn, wheat, soybeans) are annuals.

Biennial Plants Narrow definition; life cycle takes two years to complete. Generally, vegetative growth in the first year; flowering and senescence in the second year. Many “biennials” flower in year 3 or later, but all flower only once before dying.

Much less common than annuals. Crop plants include carrots, cabbage. Wild plants include evening primrose, queen anne’s lace

Perennial Plants Life cycle extends for multiple, often many years; flower repeatedly and live for many years. Most vascular plants are perennials.

Many are herbaceous plants (e.g., wildflowers of prairie, wetlands and woodlands) that usually lack secondary growth in stems; stems die back each year following food accumulation, often in substantial roots.

Trees and shrubs have secondary growth and are perennial, they are either deciduous (shed leaves at particular time of year) or evergreen (leaves drop throughout year, plant never appears leafless)

Sources: Raven & Johnson 1999, Purves 2000)
The Angiosperm Body
• root and shoot systems; adaptations to terrestrial life
• structural adaptations of protoplasts and cell walls; specialized functions
• plant tissue systems; dermal, vascular and ground

Plant Growth
• meristems continuously generate cells for new organs
• Primary growth; apical meristems
• (Secondary growth: lateral meristems)
BASIC ORGANIZATION OF PLANT BODY; ADAPTATION TO TERRESTRIAL LIFE

**Root system**: anchor; absorption & transport of water, ions, dissolved mineral nutrients; food storage

• **Shoot system**: stem is scaffold for photosynthetic leaves and reproductive structures; transport of sugars from photosynthetic to non-photosynthetic parts of plant

Solomon et al 1999  Campbell et al 1999

Roots  Shoots
Biological Organization in Plants

**Cells** Plant cells are eukaryotic, with some unique modifications, including the cell wall. Cell types include Parenchyma, Collenchyma, Schlerenchyma,

**Tissues** Tissues plant cells are organized into tissues; groups of cells that form a structural and functional unit. Simple plant tissues consist of single cell type. Complex plant tissues consist of two or more kinds of cells.

**Tissue systems** Groups of tissues that extend throughout plant body; Three main tissue sytems: ground, vascular, dermal

**Organs** Roots, stems, leaves, flower parts, and fruits are referred to as organs because each is composed of several different tissues. The tissue systems of different plant organs form an interconnected network throughout the plant.
In plant cell division, daughter cells secrete a "middle lamella" that will adhere the adjoining cells.

Each the secretes a primary cell wall of cellulose and other polysaccharides, which grows with growing cell.

Depending on cell specialization, after growth to final size, cell may lay down a secondary cell wall of polysaccarides and, depending on cell type, lignin (characteristic of wood) or suberin (characteristic of cork, bark).

Secondary cell walls typically function in structural support or waterproofing.

*Protoplast: cell contents exclusive of cell wall

Purves et. al. 2000
In addition to other features of Eukaryotic cells, plant cells have:

- cell wall
- chloroplasts
- central vacuole
Cell plate formation between two nuclei, during plant cytokinesis
34.7 Plasmodesmata
(a) An electron micrograph shows that cell walls are traversed by pore-like structures called plasmodesmata (dark stain). The green objects are cytoskeletal microtubules (see Chapter 4). (b) Plasmodesmata are partially filled by endoplasmic reticulum.

No plasma membrane blocks the plasmodesma. Many molecules pass freely from cell to cell.
PLANT CELLS ARE ORGANIZED INTO TISSUE SYSTEMS

Plant organs have three tissue systems that are continuous throughout the plant body. The tissue systems derive from meristem tissue; localized regions of cell division.

- **Meristems**: apical & lateral meristems give rise to all cells and tissues
- **Ground tissue system**: storage, secretion, photosynthesis; mostly parenchyma cells
- **Vascular tissue system**: conduct water & minerals (xylem), & carbohydrates, amino acids, hormones… (phloem)
- **Dermal tissue system**: outer protective covering

*We will discuss specialized reproductive tissue in a later lecture*
# THE THREE TYPES OF CELLS AND GROUND TISSUES IN PLANTS

<table>
<thead>
<tr>
<th>Parenchyma</th>
<th>Collenchyma</th>
<th>Sclerenchyma</th>
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<tr>
<td>• Parenchyma cells are relatively unspecialized; large vacuoles, thin walls</td>
<td>• Collenchyma cells provide support to growing stems and leaves; thickened primary cell walls</td>
<td>• Sclerenchyma cells have tough, thick secondary walls, often impregnated with lignin</td>
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<tr>
<td>• most common type of plant cell; responsible for most of plant metabolic functions - primary sites of photosynthesis, starch storage….</td>
<td>• Relatively flexible, allowing organs to bend without breaking</td>
<td>• Two types; fibers and sclereids. Both function to strengthen tissue in which they occur</td>
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(Collected from Solomon et al 1999)