Chapter 28: Plant Structure & Growth
Angiosperm Subcategories

Monocots & Eudicots - these names refer to the first leaves that appear on the plant embryo called seed leaves (AKA-cotyledons)
MONOCOTs

Cotyledons: One cotyledon
Veins in leaves: Usually parallel
Flower parts: Usually in multiples of three
Arrangement of primary vascular bundles in stem: Scattered
Monocots --fibrous roots that spread easily (ex-orchids, lilies, cereal grains)
<table>
<thead>
<tr>
<th>Cotyledons</th>
<th>Veins in leaves</th>
<th>Flower parts</th>
<th>Vascular bundles</th>
</tr>
</thead>
<tbody>
<tr>
<td>EUDICOTS</td>
<td>Two cotyledons</td>
<td>Usually netlike</td>
<td>Usually in fours or fives</td>
</tr>
</tbody>
</table>
Eudicots
--large, vertical root called a taproot goes deep into the soil
(ex-oak, maple, dandelion, orange tree, beans, lettuce)
Roots

--serve as an anchor
--absorbs and transports minerals & water through root hairs - tiny projection or outgrowth of an epidermal cell, ... it increases the amount of surface area
--stores food
ROOT HAIRS
Types of Roots:

- taproot
- fibrous
- adventitious

Modified Roots:

- pneumatophores
- aerial (prop, strangling, buttress)
ROOT MODIFICATIONS
--unusually large taproots that store sugar (carrots, turnips, beets)
SHOOT SYSTEM

Stems
- generally above ground
- function is to support leaves and flowers
nodes—the point at which leaves are attached

internodes—the portions of the stem between nodes
---buds
*terminal buds* - located at the apex & is responsible for the plant growing in length

Terminal buds come in many sizes and shapes. Some trees do not have buds at the ends of the twigs.
*axillary buds* - located in the angles formed by leaf & stem, usually dormant
Apical dominance—the terminal bud produces hormones that inhibit axillary buds from growing.

What might the purpose of this be?

If a plant needs to grow upward to obtain more light then it does not want to waste energy on horizontal growth.
Modifications: **horizontal stems**

**stolon** (or *runner*)
- grows along the surface and reproduces asexually
rhizomes
- underground but close to the surface (iris, ginger)
- spread to form new plants
- end in tubers—enlarged structures that store food (Ex-potatoes)
Leaves - main site of photosynthesis in most plants
Simple
Compound
Doubly compound
Plant leaves are varied also,...

-modified leaves known as **tendrils** coil their tips around stems and other structures to “reach” for light
cactus spines are another example of modified leaves whose purpose is to prevent water loss and protect the plant from predators.
Other examples,...

Grasses and other monocots have leaves without petioles.

Petioles in celery are very large and serve as a food source.

Onions’ layers are leaves attached to very short stems.
Leaf Anatomy
Tissues
Dermal Tissue

EPIDERMIS

--covers, protects with its **cuticle**
--usually a single layer
--sometimes grows outward on root hairs to increase surface area
--contain **stomata** & **guard cells**
Vascular

Xylem
- gives rise to the thickness or girth of a tree or shrub
- these layers are the rings of trees
  + anytime growth is disrupted
  + spring wood cells are larger and thinner-walled than summer wood
transports minerals and **water** throughout the plant
Phloem
- outer layers that transport sugar throughout the plant
- forms part of the bark
Ground

- makes up bulk of the plant
- used for photosynthesis, storage, support
- pith – internal
- cortex - external
PARENCHYMA CELL
--most abundant type of cell in most plants
--relatively unspecialized & flexible
--thin primary walls & no secondary wall
--variety of functions: food storage, photosynthesis, aerobic respiration, help repair injured cells
COLLENCHYMA CELL
--thicker primary wall, no secondary wall
--provide support in still growing parts of a plant
SCLERENCHYMA CELLS

--rigid secondary cell walls hardened with lignin (main chemical component in wood)
--mature ones can’t elongate so they only occur in areas where the plant has stopped growing
--strong support for the plant
Two Types of Sclerenchyma,…

--Fiber = long, slender, usually in bundles (Ex-hemp for rope)

--Sclereid = short, thick, irregular (Ex-nutshells)
WATER-CONDUCTING CELLS

--rigid, lignin-containing secondary cell walls

--arranged end-to-end to form a system of tubes that bring water from the roots to the stems & leaves
TWO TYPES,...(of H\textsubscript{2}O conducting cells)

--Tracheids = long cells with tapered ends & pits for water to move through

--Vessel elements = wider, shorter, less-tapered

These types of cells are dead.
FOOD-CONDUCTING CELL  p. 559
(Sieve-tube member)

--arranged end-to-end
--have thin primary walls, no secondary walls
these cells remain alive
Sieve plates, at the ends of s-t members, have pores that facilitate the flow of fluid from cell to cell. Alongside each s-t member is at least one companion cell, which is connected to the s-t member by plasmodesmata. One of these can serve many s-t’s by producing and transporting proteins to them all.
Life Span

- annual
- biennial
- perennial

Plant Growth

- indeterminate growth – throughout lifetime
- determinate growth – ceases after a certain size
Primary growth – length using apical meristems (herbaceous)

Secondary growth – thickness using lateral meristems (herbaceous & woody @ same time but different locations)
Primary Growth of Roots

- Root Cap (protects against soil)
- Zone of cell division (mitosis)
- Zone of elongation (pushes through soil by getting longer)
- Zone of maturation (differentiation)
Primary Growth of Shoots

- dome-shaped mass of dividing cells @ tip of terminal bud

leaf primordia – finger-like projections along flanks of apical meristem
Secondary Growth

Vascular Cambium (p. 569)

- forms layer between primary xylem & primary phloem

- as lifespan continues, it adds more to each, producing secondary xylem and secondary phloem
Cork cambia – epidermis is pushed out & splits forming a layer of periderm

Lenticels – raised areas in periderm that allow gas exchange
Chapter 29

Resource Acquisition, Nutrition, & Transport in Vascular Plants
Water potential – combined effects of solute [ ] & physical pressure $\Psi$

✓ Determines direction of movement of water

✓ Water’s capacity to perform work when it moves from a region of higher $\Psi$ to a region of lower $\Psi$
Ψ = 0MPa (megapascals) pure water open to the atmosphere & @ room temperature

1Mpa = 10 atmospheres of pressure

Ψ = Ψρ + Ψs

solute potential – is also called osmotic potential

• any dissolved chemical
• adding solutes always lowers Ψ
pressure potential – physical pressure on a solution

- Can be positive or negative

turgor pressure – cell contents press plasma membrane against cell wall

*water moves in the direction of higher to lower water potential
tonoplast – vacuole wall

symplast – cytoplasmic continuum (through plasmodesmata)

apoplast – cell wall & extracellular spaces continuum
Transport Mechanisms

Short Route Transport
1. across cell walls & plasma membrane
2. symplast movement
3. along apoplast

Long Distance Transport
1. Bulk flow - movement of a fluid driven by pressure
   Ex: xylem & phloem
Transport Functions

1. Roots, Water & Minerals (short transport)

**mycorrhizae** – symbiotic structures consisting of plant roots united w/fungal hyphae (filaments)

- hyphae absorb water & minerals & transfer
- surface area!
2. Ascending up the Xylem (long distance)

Endodermis – innermost layer of cells in root cortex

- contains Casparian strip – waxy strip that water & minerals cannot go through
- forces solution to be selected & passed into symplast
- water & minerals can then pass into xylem cells
a. pushing xylem sap – root pressure from the absorption of minerals
may cause *guttation* – water pushed out of the leaves
b. Pulling xylem sap;

Transpiration-Cohesion-Tension Theory

transpiration – loss of water vapor from the leaf by diffusion & evaporation

(imbibition, adhesion, cohesion, surface tension)
3. Reducing the Rate of Transpiration

- **Stomata & guard cells**
  - Turgid > open (K+, light, circadian rhythms)
  - Flaccid > closed

- **Xerophytes**
  - Leaf modifications ex: thick cuticle, spines

- **CAM (crassulacean acid metabolism)**
4. Translocation

source – from photosynthetic area

sink – sugar storage
Pressure Flow Model  p. 594

a. bulk flow by positive pressure

b. active transport puts sugar into sieve tubes

c. water flows in by osmosis

d. positive pressure forces sap to flow

e. pressure is relieved by sugar going into sink

f. xylem recycles water
Soil & Plant Nutrition
Topsoil

Inorganic Components

cation exchange – positively charged nutrients that can be absorbed w/soil solution into root hairs

Nutrients 4%

45% Carbon
6% Hydrogen
45% Oxygen

Nitrogen
Phosphorus
Potassium
Calcium
Magnesium
Sulfur
Iron
Manganese
Copper
Zinc
Boron
Molybdenum
Chlorine

CHO (Carbohydrates)
Leaching — negatively charged nutrients that can also be absorbed but are washed away into groundwater.
Organic Components

**Humus** – dead & decaying organisms & other organic material

*more humus, more fertile

**Loams** – most fertile
Issues w/Topsoil

1. **Irrigation** – comes from surface water but mostly from aquifers

**Land subsidence**: sinking due to aquifer damage
**salinization**: soil becomes too salty, water potential becomes more negative

**drip irrigation**: reduces salinization by slow release of water directly at root zone
2. Fertilization

Commercial – concentrated, immediate, not long lasting (N,P,K 3 number code)

Organic – gradual, but long lasting
3. **Soil pH**

-most plants like slightly acidic for cation exchange

-can adjust soil pH for nutrient needed

Add sulfate if too basic
Add lime if too acidic
4. **Erosion** – windbreaks, contour patterns, terracing, no-till drill

5. **Soil Compaction**
6. Phytoremediation – using plants that naturally take up certain nutrients & harvesting them to clean up the soil
Plant Nutrition

essential element – required for life cycle including reproduction

macronutrients – needed in large quantities

micronutrients – trace elements for cofactors, etc.

Table 29.1 p. 579
Mineral Deficiency

-minerals are moved from source-to-sink translocation

*too much of a good thing
Genetic Modification
- resistance
- uptake of nutrients
Plant Relationships

1. Plant Growth – *Rhizobacteria* enhance growth by producing chemicals, antibiotics, etc.

2. Nitrogen Cycle Bacteria
   a. ammonifying bacteria: decomposers in humus-rich soil release ammonia
   b. nitrogen-fixing bacteria: convert nitrogen gas into NH$_3$ which is turned into NH$_4^+$
c. Nitrogen Fixation (p. 583)

1) Mutualism – *Rhizobium* bond w/legumes (soybeans, alfalfa) causing nodules to form

2) *Rhizobium* becomes bacteroids – contained w/in vesicles of root

3) fix nitrogen for plant while plant supplies carbs
3. Crop Rotation

4. Fungi

**Ectomycorrhizae**
- dense sheath, thick
- helps w/ water & minerals especially phosphate
- woody plants
arbuscular mycorrhizae (endomycorrhizae)
grows along surface of root
most plants
Nutrition Modifications
p. 586
CHAPTER 30: REPRODUCTION & DOMESTICATION OF FLOWERING PLANTS

Angiosperms

Flower – specialized shoot w/modified leaves

> complete flowers – all 4 basic floral organs (sepals, petals, stamens, carpels)

> incomplete flowers – lack 1 or more organs
Flower Parts  

Sepals = modified leaves that protect the flower bud before it opens, *(usually green)*

FYI -- Sepals sometimes look like petals of a flower and are not green like in the orchid pictured below.
Petals = advertisement to insects and other pollinators
Stamen = male organs

Anther = sac in which pollen develops, found at tip of stamen on filament (stalk)
carpel = female organ (contains stigma, style, ovary)

stigma = sticky receiving surface for pollen grains, found at tip of carpel

style = leads to ovary
Ovary = houses reproductive structure, found at base of carpel
Ovule = housed in the ovary and contains developing egg and supporting cells
Pistil—single carpel or group of fused carpels
Floral Variations

- Symmetry – bilateral or radial
- Ovary Location – superior, semi-inferior, inferior
- Floral Distribution – individual or inflorescences
- Reproductive – monoecious, dioecious (self-incompatibility)
Angiosperm Reproduction p. 600

Sporophyte = diploid plant body that produces haploid spores by meiosis

-the haploid cell then divides using mitosis
--each one of these becomes a gametophyte
Pollen Grain

- Gametophyte undergoes meiosis and forms 4 haploid cells called microspores.
- Each microspore goes through mitosis and forms 2 haploid cells.
- Thick walls form around each cell and it is now ready to be released from the anthers.
Contains immature male gametophyte
Egg

- Central cell in ovule that enlarges & goes through meiosis which forms 4 haploid megaspores
- Only 1 megaspore survives, enlarges and goes through mitosis
- This produces the embryo sac
- The embryo sac contains the haploid egg (surrounded by 2 integuments) that is ready to be fertilized
Pollination = the delivery of pollen to the stigma of a carpel

After wind or animals deposit pollen on the stigma, the tube cell creates a pollen tube.

The pollen tube grows downward into the **micropyle** (through integument).

As this is taking place, the pollen becomes sperm.

p. 602-603
when the pollen tube reaches the **embryo sac**, it releases the sperm

one sperm fertilizes the egg to form the zygote & the other gives up its nucleus to the embryo sac

that cell becomes 3N or triploid and will nourish the zygote

the formation of the zygote and the triploid cell is called **double fertilization**
triploid cell becomes the endosperm – a nutrient-rich, multicellular mass that will nourish the embryo until it becomes self-supporting
- zygote divides into terminal & basal cell
--- basal cell becomes proembryo
----- apical meristem comes out between cotyledons
continual division until the ovule’s coat loses most of its water

once the seed coat is formed, the seed goes dormant until optimal conditions are met
Fruits – mature ovary

**pericarp** – thickened wall of fruit

p. 606 (fleshy or dry)
**Simple** – single carpel or several fused carpels

**Aggregate** – single flower w/more than 1 separate carpel

**Multiple** - inflorescence
Asexual Reproduction
(vegetative reproduction)

Mechanisms:

**fragmentation** – parts of parent plant become whole plants

**apomixis** – unfertilized seed production
Types:

**Cuttings** – shoot, stem cutting or vegetative bud (forms callus)

**Grafting** – scion twig or bud placed on stock root system (similar species)

**Test tube** – starting w/cells

transgenic = genetically modified (foreign DNA)