


Plants

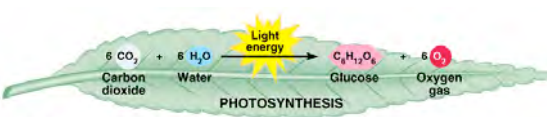


The *Producers*



- Produce the food (photosynthesis)
- Condition the environment
- Create shelter and habitat


Photosynthesis



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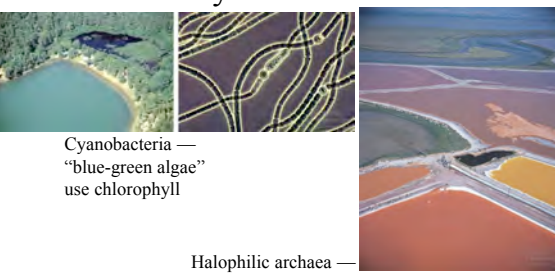
- Glucose for energy fuel, organic chemical monomers, structural polymers.
- Oxygen for aerobic respiration.

Ecological communities are often named for the dominant producers



- Not all producers are plants

Photosynthetic bacteria





Cyanobacteria — “blue-green algae” use chlorophyll

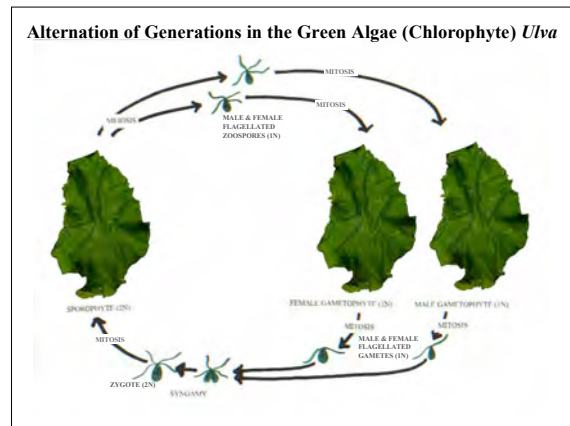
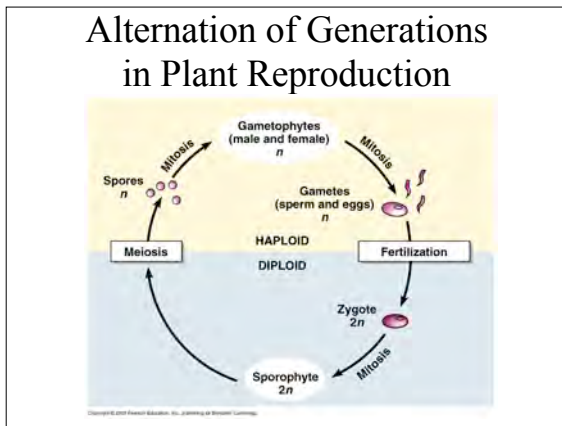
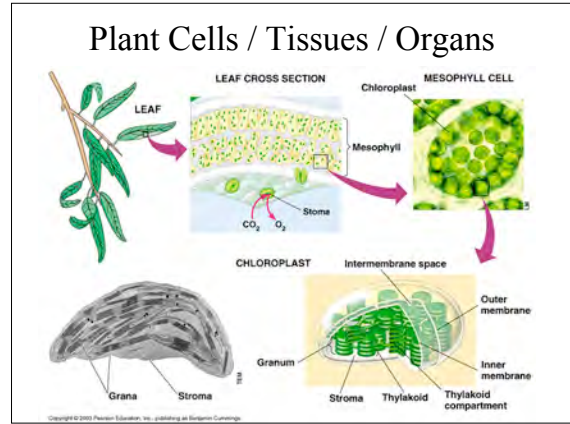
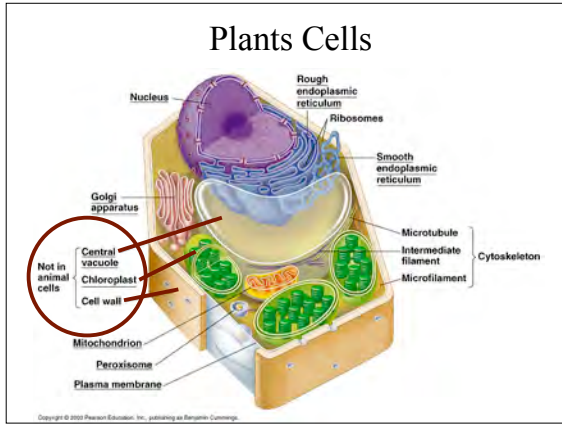
Halophilic archaea — “purple bacteria” use bacteriorhodopsin

Photosynthetic Protists

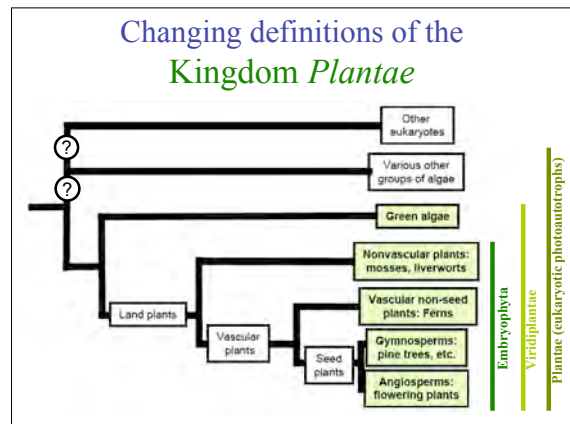
Phytoplankton — earth’s dominant producers!

- Diatoms
 
- Dinoflagellates
 

Plants



- ### Changing definitions of the Kingdom *Plantae*
1. Classical: everything photosynthetic / not an animal
 2. Whitaker's 5-kingdom model: all eukaryotic multicellular photosynthetic organisms
 3. Phylogenetic: "land plants" — exclude the algae = Embryophyta: dependent embryo, meristem growth & differentiation, cuticle
 4. Cladistic: *Viridiplantae* ("green plants") — embryophyta + chlorophyta ("green algae")




Plants

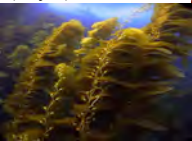
Algae — Aquatic Plants

- Three Divisions (Phyla)

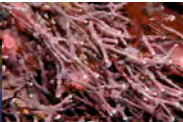
Chlorophyta
"Green Algae"



Phaeophyta
"Brown Algae"
{ including the "kelp" family }

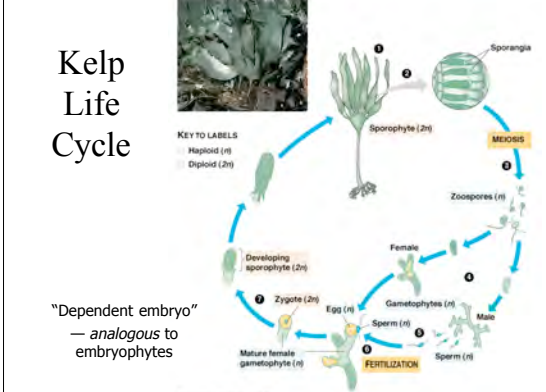


Rhodophyta
"Red Algae"



- Not directly related to each other, nor to terrestrial vascular plants.
- Accessory pigments allow greater light sensitivity at depth.

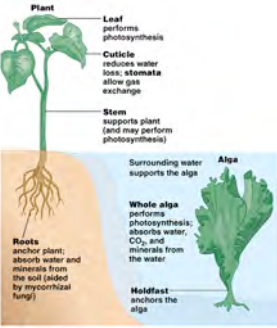
Kelp Life Cycle



KEY TO LABELS
 Haploid (n)
 Diploid (2n)

"Dependent embryo"
 — analogous to embryophytes

Contrast between terrestrial vascular plant form and aquatic algal form.



Plant

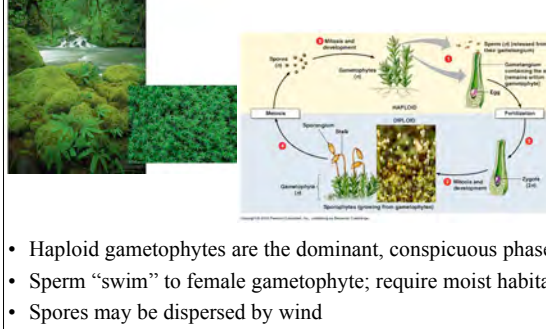
- Leaf performs photosynthesis
- Cuticle reduces water loss; stomata allow gas exchange
- Stem supports plant (and may perform photosynthesis)
- Roots anchor plant; absorb water and minerals from the soil (aided by mycorrhizal fungi)

Alga

- Surrounding water supports the alga
- Whole alga performs photosynthesis; absorbs water, CO₂, and minerals from the water
- Holdfast anchors the alga

- Land plants
 - Photosynthesis and gas exchange in leaves.
 - Nutrient and water uptake from soil by roots.
 - Vascular system transports between leaves & roots.
 - Woody tissues provide erect support.
 - Waxy cuticle resists drying.
- Algae
 - Bathed in medium providing water, nutrients, and dissolved gases — roots, stomata, cuticle, and vascular systems not needed
 - Photosynthesis occurs all over plant body — no leaf specialization
 - Water environment provides buoyancy / woody tissue not needed

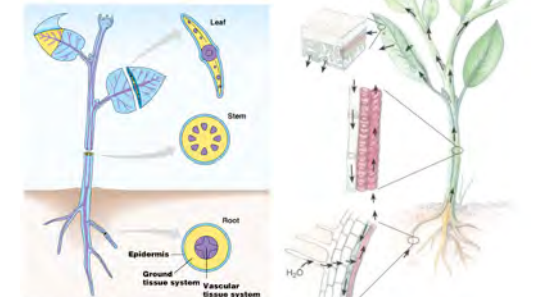
Bryophytes: Mosses



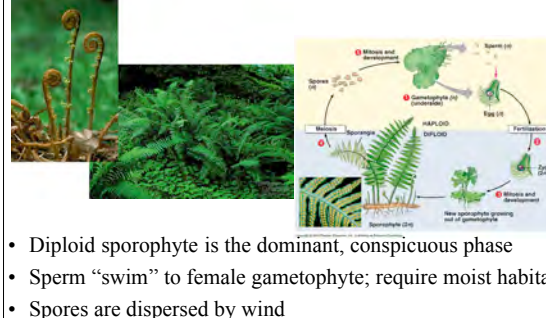
- Haploid gametophytes are the dominant, conspicuous phase
- Sperm "swim" to female gametophyte; require moist habitat
- Spores may be dispersed by wind

Vascular Plants (**Tracheophytes**)

Xylem - up! Phloem - down!

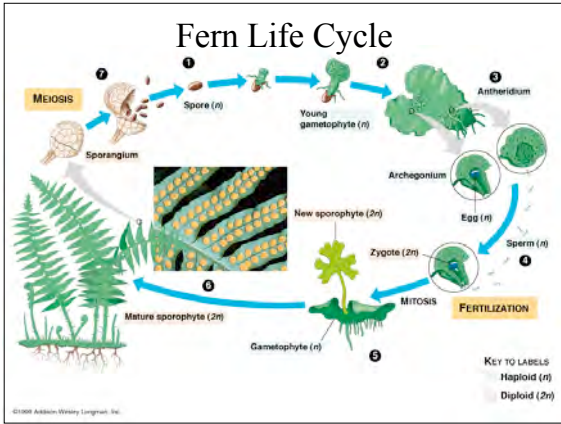


Pterophytes: Ferns



- Diploid sporophyte is the dominant, conspicuous phase
- Sperm "swim" to female gametophyte; require moist habitat
- Spores are dispersed by wind

Plant Biology



Seed-bearing plants (**Spermatophytes**)

Two Clades:

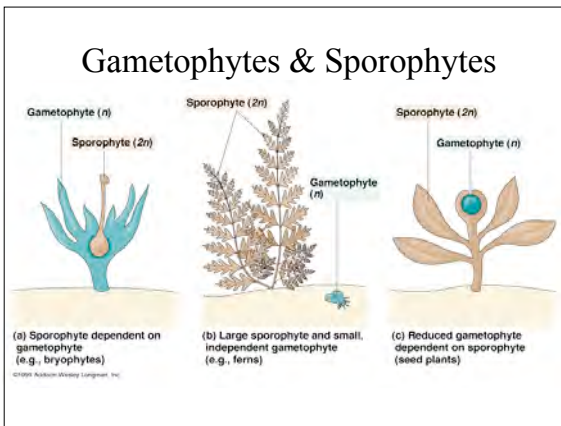
- Gymnosperms “*naked seeds*”
 - Phylum: Conifers “*cone bearers*”



- Angiosperms “*vessel seeds*”
 - Phylum: Anthophytes “*flowering plants*”



- The visible plant body is the diploid sporophyte
- The gametophytes are transient microscopic structures
 - Female gametophyte within the ovule
 - Male gametophyte within the pollen grain
- Pollen grains resist desiccation — allow transport of sperm independent of water
- After fertilization, ovule develops into seed bearing the embryo



Gymnosperms “*naked seeds*” Conifers “*cone bearers*”

World’s largest biome: boreal coniferous forest [taiga]
World’s largest organisms: sequoia & coast redwood

Conifers include the world’s largest organisms

Tallest — coastal redwoods

Most massive — giant sequoia

Angiosperms — the flowering plants

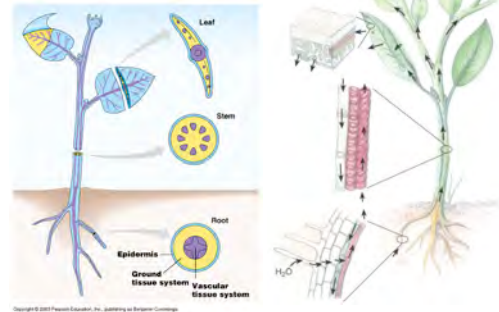
>250,000 known living species = 90% of all plant species

Shoot system: Terminal bud, Flower, Blade, Petiole, Axillary bud, Stem.

Root system: Taproot, Root hairs.

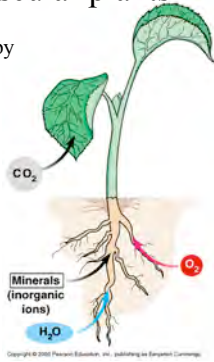
Vascular-plant structure

Vascular Plants
Xylem - up! Phloem - down!

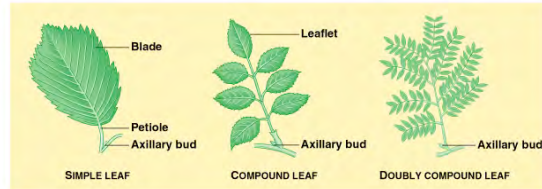


Gas exchange in vascular plants

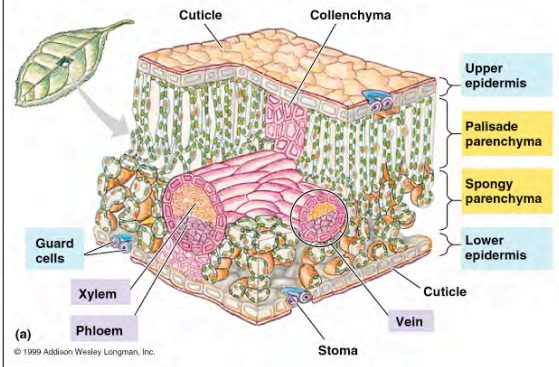
- CO_2 taken *in* and O_2 given *out* by leaves for/from **photosynthesis**.
- Dissolved O_2 taken *in* with H_2O from soil by roots for tissue **respiration**.
- During daylight: $\text{O}_2 \text{ out} > \text{O}_2 \text{ in}$
- In dark of night: $\text{O}_2 \text{ out} < \text{O}_2 \text{ in}$



Leaf Anatomy
in Dicot Angiosperms

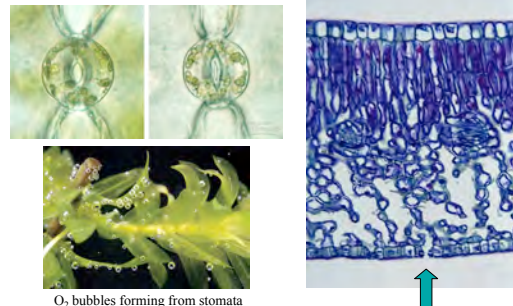


Leaf Anatomy



Stomata — “little mouths”

— adjustable openings for gas exchange on the undersides of leaves



Plant Biology

Two main classes of angiosperms:

- Monocots — grasses & grains (~70,000 spp.)
- Dicots — non-grasses (~180,000 spp.)

Seed leaves	Leaf veins	Stems	Flowers	Roots
MONOCOTS One cotyledon	Main veins usually parallel	Vascular bundles in complex arrangement	Floral parts usually in multiples of three	Fibrous root system
DICOTS Two cotyledons	Main veins usually branched	Vascular bundles arranged in ring	Floral parts usually in multiples of four or five	Taproot usually present

Vascular Plants

Xylem - up! Phloem - down!

Secondary xylem & phloem in woody plants

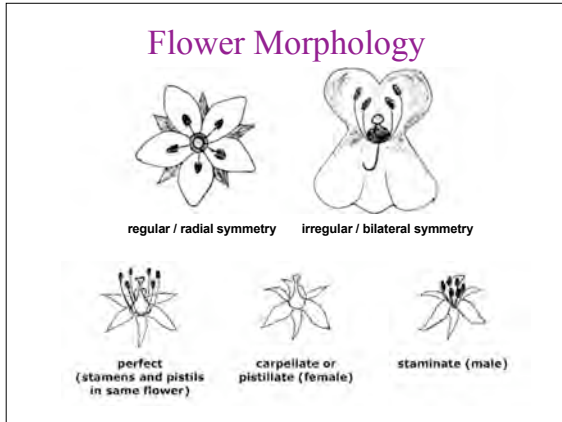
Annual growth rings in woody plants

Seed-plant reproduction

Spermatophytes

Gymnosperms “naked seeds”

Conifers “cone bearers”



Flowers

- **Complete flower**
 - calyx+corolla+stamens+carpels
- **Hermaphroditic:**
 - Both male + female organs in same flower
- **Monocious:**
 - Separate male flowers & female flowers on the same plant
- **Diocious:**
 - Separate male flowers & female flowers on separate plants

Lily [note non-green sepals!]

Staminate flower

Carpellate flower

Begonias

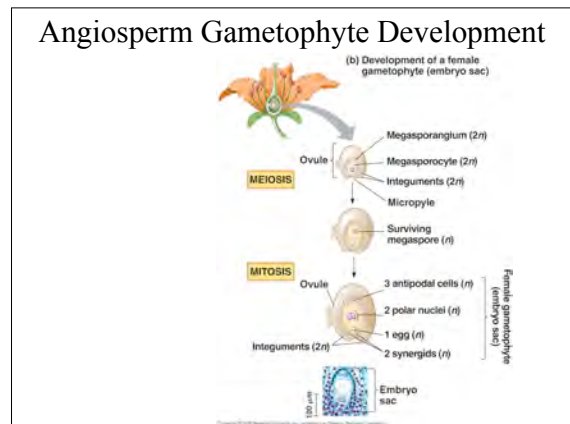
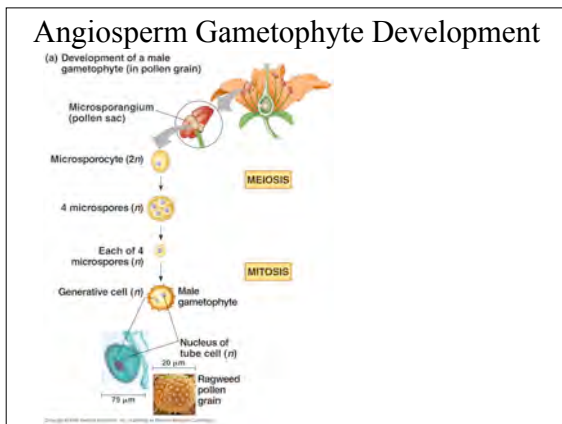
Flower Morphology and Ovary Position

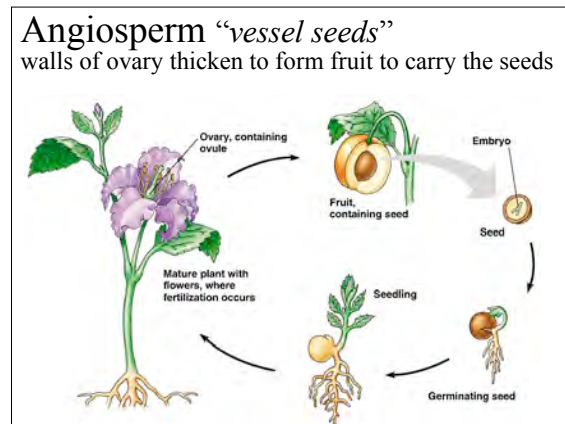
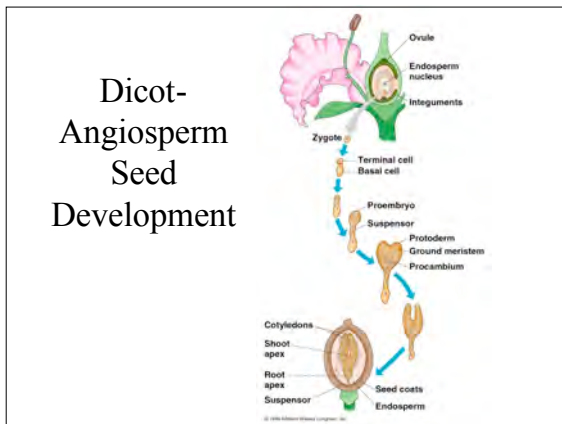
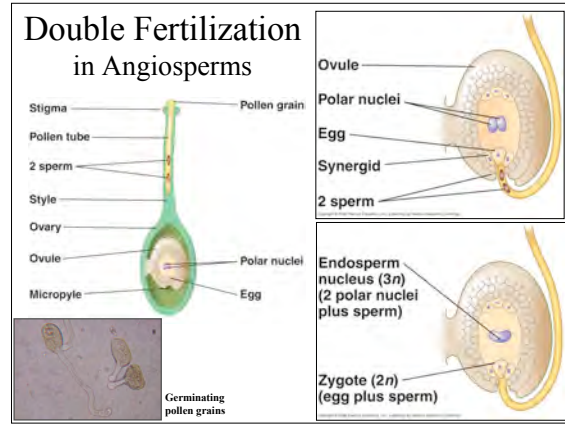
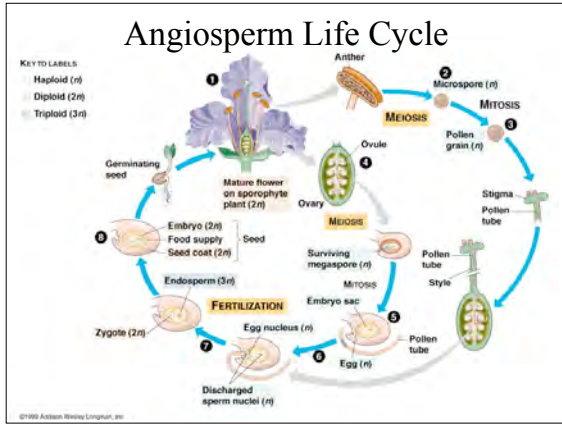
Hypogynous flower with superior ovary **Perigynous flower with superior ovary** **Epigynous flower with inferior ovary**

- **Hypogynous** (flower "below ovary"): ovary positioned on the peak of the receptacle (torus). Other flower parts arise below the base of the carpels. E.g., Pea.
- **Perigynous** (flower "around ovary"): ovary positioned in cup-like torus. Other flower parts arise from edge of the cup. E.g., Rose.
- **Epigynous** (flower "above ovary"): ovary completely embedded and fused within the receptacle. Other flower parts arise from the top of the ovary. E.g., Apple.

Floral characters relevant to pollination

FLOWER	Bats	Bees	Beetles	Birds	Butterflies	Flies	Wind
color	dull white, green, purple	bright white, yellow, blue	dull white, green	red, orange, white	red, orange, purple	dull brown, purple	dull green, brown
odor	strong, fruity	fresh, mild, pleasant	fruity, spicy	none	spicy, none	putrid	none
shape	regular, bowl-shaped. Closed during day	tubular with shallow landing platform	large, bowl-shaped	large, funnel-shaped; perch support, but no landing platform	narrow tube with wide landing pad	shallow funnel or trap-like	regular or petals reduced or absent; stigmata protruding
bloom time	night	day	day	day	day	any time	any time
nectar	abundant; hidden	usually present; not hidden	sometimes present; not hidden	abundant; deeply hidden	abundant; deeply hidden	usually none	none





A fruit is a structure to protect and disperse the embryos within the seeds

- Simple fruits develop from a single ovary of a single flower
- Compound fruits develop from the fusion of many ovaries or many flowers

Placentation

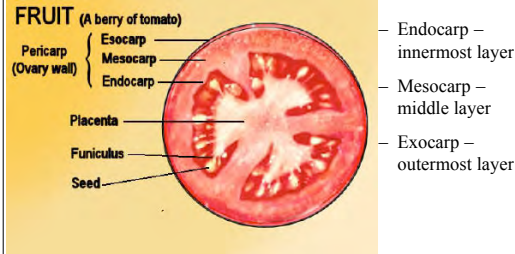
Attachment of ovules to ovarian wall

Becomes more conspicuous as ovary develops into fruit

Placentation types: Parietal, Marginal, Axile, Free Central, Free basal, Basal erect, Apical pendulous.

Fruit: vessel (*angio-*) containing seeds

- **Pericarp** – derived from ovarian wall (carpel). Surrounds seeds while they develop



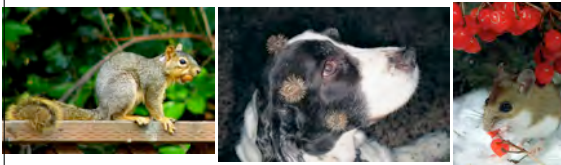
Fruit: agents of seed dispersal

- **Autochory**: self dispersed (explosive or recoil)
- **Anemochory** (wind-) & **Hydrochory** (water-dispersed)



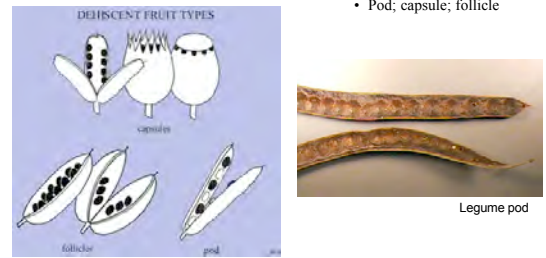
Fruit: agents of seed dispersal

- **Autochory**: self dispersed (explosive or recoil)
- **Anemochory** (wind-) & **Hydrochory** (water-dispersed)
- **Zoochory** (animal-dispersed)
 - **Synzoochory** – stockpiling & sloppy feeding
 - **Epizoochory** – attach/adhere to fur/feathers/feet
 - **Endozoochory** – digestion-resistant seeds pass through gut



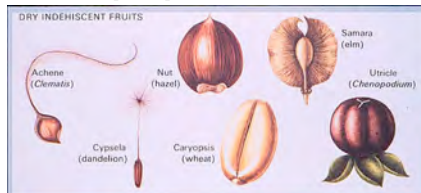
Fruit Types

- **Simple Fruit**: derived from a single ovary
 - **Dehiscent Fruit**: fruit remains attached to plant. Splits open to release mature seeds



Fruit Types

- **Simple Fruit**: derived from a single ovary
 - **Indehiscent Fruit**: fruit dispersed with seeds.
 - **Dry Fruit**: pericarp hardens
 - **Grain (Caryopsis)**: pericarp thin, fused to seed coat
 - **Achene**: pericarp thin, not fused to seed
 - **Nut**: pericarp forms thick shell, not fused to seed



Fruit Types

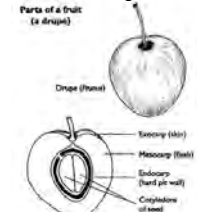

- **Simple Fruit**: derived from a single ovary
 - **Indehiscent Fruit**: fruit dispersed with seeds.
 - **Fleshy Fruit**: mesocarp thick/pulpy/juicy (= sarcocarp)
 - **Berry**: endocarp thin
 - » **Bacca (true berry)**: exocarp □ thin skin
 - » Tomato, grape, coffee bean, cucumber
 - » **Hesperidium**: exocarp □ thick rind
 - » Citrus



Fruit Types

- **Simple Fruit:** derived from a single ovary
 - **Indehiscent Fruit:** fruit dispersed with seeds.
 - **Fleshy Fruit:** mesocarp thick/pulpy/juicy (= sarcocarp)
 - **Drupe:** endocarp thickens/hardens □ pit around single seed

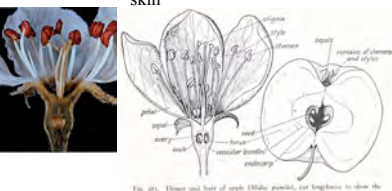
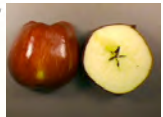
» Peach, cherry, plum, mango, olive, coconut

Fruit Types

- **Simple Fruit:** derived from a single ovary
 - **Indehiscent Fruit:** fruit dispersed with seeds.
 - **Accessory Fruit (Anthocarp):** pericarp thin; other flower parts contribute to much of fruit structure
 - **Pome:** papery pericarp from inferior ovary forms core around seeds; receptacle/perianth form fleshy layer & skin

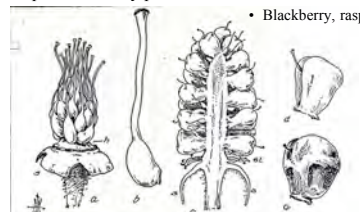
» Apple, pear

Fruit Types

- **Compound Fruit:** derived from multiple ovaries or multiple flowers
 - **Aggregate drupes:** from flowers with multiple ovaries; each drupelet with tiny pit

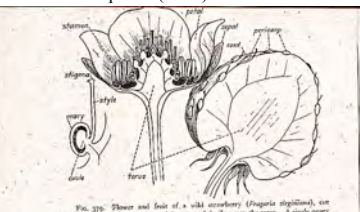

• Blackberry, raspberry



Fruit Types

- **Compound Fruit:** derived from multiple ovaries or multiple flowers
 - **Aggregate achenes with accessory fruit:** from flowers with multiple ovaries; multiple achenes on fleshy receptacle (torus)

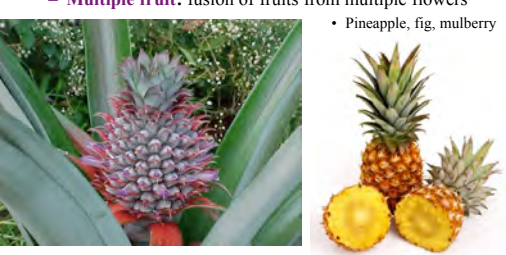
• Strawberry

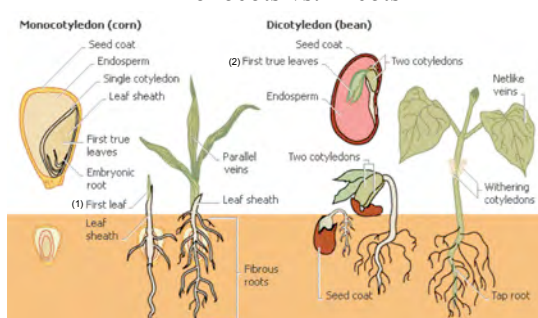
Fruit Types

- **Compound Fruit:** derived from multiple ovaries or multiple flowers (**inflorescence**)
 - **Multiple fruit:** fusion of fruits from multiple flowers

• Pineapple, fig, mulberry



Seed Development Monocots vs. Dicots



Monocotyledon (corn)

- Seed coat
- Endosperm
- Single cotyledon
- Leaf sheath
- First true leaves
- Embryonic root
- (1) First leaf
- Leaf sheath
- Fibrous roots

Dicotyledon (bean)

- Seed coat
- (2) First true leaves
- Two cotyledons
- Endosperm
- Netlike veins
- Two cotyledons
- Parallel veins
- Leaf sheath
- Withering cotyledons
- Taproot