Plants

- What are plants?
  - Eukaryotic
  - Multicellular
  - Photosynthetic (autotrophs)
Plants

Non-vascular plants  Vascular seedless plants  Gymnosperms  Angiosperms

Evolution of Plants
Evolution of Plants

• Embryo protection
  – External fertilization in algae
  – Embryo develops in tissues of plants
• Vascular tissue

Evolution of Plants

• Seeds

Evolution of Plants

• Flowers
  – More efficient reproduction than wind dispersal
Evolution of Plants Summary

• All of these characteristics help plants adapt to a terrestrial environment
  1. Embryo Protection
  2. Vascular Tissue
  3. Seeds
  4. Flowers

 Alternation of Generations

• Alternation of Generations:
  – Key characteristic in plants
  – Life cycle that switches from diploid (2n) to haploid (1n) and back.
Four Basic Types of Plants

1. Non-Vascular Plants
2. Seedless Vascular Plants
3. Gymnosperms
4. Angiosperms

Non-Vascular Plants

- Lacks Vascular Tissue
- No true roots or leaves

Non-Vascular Plants

- Moss
- Fern
During rainstorms, sperm swim from male reproductive structures to female reproductive structures, where they fertilize the egg. A diploid embryo forms and develops into a diploid moss. The diploid moss develops a capsule, which bursts and releases haploid spores. A spore lands on moist soil and grows into an adult haploid moss.

**Moss Life Cycle**

1. Sperm
2. Egg
3. Spores
4. Diploid moss
5. Haploid moss

**Seedless Vascular Plants**

- Have vascular tissue
- Diploid generation is dominant stage

During rainstorms, sperm swim from male reproductive structures to female reproductive structures, where they fertilize the egg. A diploid embryo forms and continues to grow into an adult diploid fern.

**Fern Life Cycle**

1. Sperm
2. Egg
3. Spores
4. Diploid fern
5. Haploid fern
6. Embryo
7. Fertilization

Adult ferns release haploid spores, which are carried by the wind to a new location.
Seed Producing Vascular Plants

- **Gymnosperms**
  - “Naked Seeds”

- **Angiosperms**
  - “Covered Seeds”

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**SEEDS: STRUCTURE AND GROWTH**

**STRUCTURE**
Fertilization produces a diploid seed, which contains a multicellular embryo and a store of carbohydrate (endosperm) to fuel its initial growth.

**GROWTH**
A seedling draws energy from the endosperm while it extends its leaves upward to begin photosynthesis and its roots downward into the soil to reach water and nutrients.

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**Gymnosperms**

- Most gymnosperms are **conifers** (pine trees)
- Diploid generation is the dominant stage
Ginkgos and Cycads

Male cones release pollen grains that are dispersed by the wind to ovules found beneath the scales of female cones. Pollen grains release sperm that fertilize an egg within the ovule. Fertilization creates a diploid embryo that matures into a seed. Eventually, the seed is released from the female cone, and grows into an adult tree.

Angiosperms

- Flowering plants
- Diploid generation is dominant
- Have protective seed coats
- Have double fertilization
  - Two sperm are involved in fertilization
Angiosperms have developed a way to transfer pollen efficiently from the anthers of one flower to the stigma of another: get an animal to carry it!

**COEVOLUTION: FLOWERS AND THEIR POLLINATORS**

**COLORS AND PATTERNS**
- **WHITE**: Nocturnal pollinators, such as moths and bats
- **BRIGHT**: Visually oriented, diurnal pollinators, such as birds, butterflies, and bees

**FLOWER STRUCTURE**
- **TUBE**: Pollinators with long tongues, such as moths
- **INTRICATE/CLOSED**: Pollinators such as bees
Flower Structure

- **Pistil**
  - Stigma = accepts pollen
  - Style = Transports pollen to ovary
  - Ovary = site of fertilization

- **Stamens**
  - Filament – holds up anther

**ANGIOSPERM LIFE CYCLE**

1. Male anthers release haploid pollen grains that are delivered to the stigma of another flower.
2. A pollen grain produces a tube that extends through the stigma to the ovary. Within the ovule of the ovary, a sperm divides into seven haploid cells. One cell becomes the egg, another cell with two nuclei—will form the endosperm following fertilization by a sperm cell.
3. Two sperm are released by the pollen grain. In a process called double fertilization, one sperm fuses with the egg to form a zygote, while the other sperm fuses with the two nuclei of the endosperm-forming cell.
4. The zygote and the endosperm continue to develop within the ovule, forming a seed that will eventually be released and grow into a mature plant.
HAPLOID AND DIPLOID LIFE STAGES

NON-VASCULAR PLANTS
The majority of the life cycle is spent in the haploid stage.

VASULAR SEEDLESS PLANTS
The haploid and diploid stages are both multicellular and physically independent from one another.

GYMNOSPERMS
The evolution of seeds in gymnosperms almost completely eliminates the prominent haploid stage seen in mosses and ferns.

ANGIOSPERMS
Haploid gametes are further reduced in size, enabling more rapid seed production.

As plants have developed different reproductive strategies, they have progressed from having a prominent haploid stage of life to simply having haploid gametes.

SEED DISPERSAL

HITCHING A RIDE
Seed pods have spines or projections that attach them to passing animals.

FLYING AND FLOATING
The structure of the seed allows it to be carried away from the parent plant by wind or water.
PROVIDING A FOOD SOURCE
Fleshy fruit is a form of bait that lures an animal to eat the seed and carry it far from the parent plant before eliminating it.

SEED DISPERSAL

MYCORRHIZAE
Mycorrhizal fungi grow in association with the roots of plants, securing sugar from the plant and transferring nitrogen and phosphorus from the soil to the plant.

ECTOMYCORRHIZAE
Hyphae press closely against the outer side of the cell wall of the root hairs.

ENDOMYCORRHIZAE
Hyphae grow through cell walls into the space between the cell wall and plasma membrane of root hair cells.