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Learning goals

- Describe the evolutionary significance of seeds
- Compare and contrast the phyla of gymnosperms
- Describe the role of animals in angiosperm life cycle
- Discuss the evolutionary adaptations of flowering plants



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Importance of the seed

| | |
|---|--|
| Multicellular embryo protected by hard coat | Stored food supply |
| Can travel far away from sporophyte plant | Development of fruits enhanced dispersal |

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Heterosporous: two types of gametophytes

Male gametophytes:

- microsporangia ($2n$) \rightarrow microspore (n) \rightarrow gametophyte (n)
- Many pollen grains
- Dispersed by wind or a pollinator

Female gametophytes:

- megasporangia ($2n$) \rightarrow megaspore (n) \rightarrow gametophyte(n)
- Develop within an ovule
- Ovule and protective tissue are the ovary
- Ovary develops into fruit

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Gymnosperms

- "Naked seeds"
- Exposed on modified leaves (sporophylls)
- Usually form a cone (strobili)
- All lack flowers and fruits

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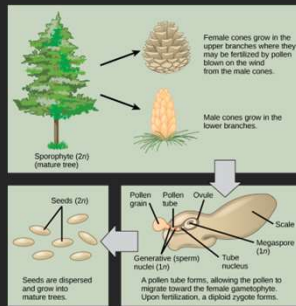
Pines (Coniferophyta)

- More than 100 species
- Northern hemisphere
- Tough needle-like leaves in clusters
- Have thick cuticle and recessed stomata to slow water loss
- Have canals with resin to deter herbivore attacks



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Female and male cones



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Cycads (Cycadophyta)

- Slow-growing gymnosperms
- Tropical and subtropical regions
- Resemble palm trees (but not flowering)
- Large female pinecones



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Ginkgophytes (Ginkgophyta)

- Only one living species remaining (*Ginkgo biloba*)
- Flagellated sperm
- **Dioecious** (male and female reproductive structures form on different trees)



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Understanding check

What are the two types of spores produced by seed plants?

What are the chromosome numbers of each?

What are the fates of each?

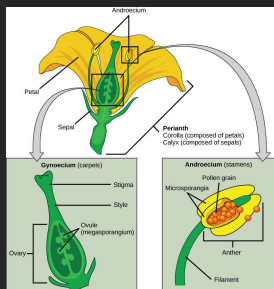
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Angiosperms "enclosed seed" (Anthophyta)

- Ovules are enclosed in diploid tissue at the time of pollination
- **Carpel**, a modified leaf that covers seeds, develops into fruit
- Ovule is surrounded by sporophyte tissue derived from leaves



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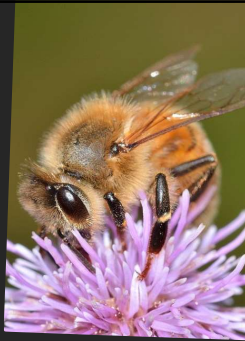
Flower whorls

- **Sepals**: outermost, green, leaf-like
- **Petals**: next layer, colored, attract pollinators
- **Stamens** (androecium): third layer, pollen (male gametophyte) on anther and a filament (stalk)
- **Carpel** (gynoecium): female gametophyte

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Pollination

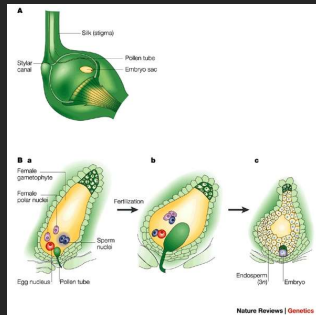
- Mechanical transfer of pollen from anther to stigma
- Pollen develop a pollen tube that is guided to the embryo sac
- One of the pollen grain's two cells lag behind; generative cell divides to two sperm cells
- Pollen grain with its tube and sperm has become a mature male gametophyte



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Angiosperm seeds

- **Double fertilization:**
 - + One sperm unites with egg to form zygote: new embryo sporophyte
 - + Other sperm unites with the two polar nuclei to form the triploid **endosperm**: provides nutrients to embryo
- Integuments develop into impermeable seed coat
- Seed with its dormant embryo and endosperm



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Fruits



- Flower ovary develops into fruit when seed develops
- Ovary wall (pericarp) has 3 layers with different fates
- Three genotypes in one package
 - + Fruit and seed coat from prior sporophyte.
 - + Remnants of the gametophyte
 - + Embryo represents the next sporophyte

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Major groups of angiosperms:

Monocots and dicots



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Fruit dispersal

- Ingestion and transportation by birds or other vertebrates
- Hitching a ride with hooked spines on birds and mammals
- Burial in caches by herbivores (squirrels)
- Blowing in the wind
- Floating and drifting on water

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Understanding check

What is double fertilization?

What are the advantages to having flowers?

What are the advantages to having fruits?

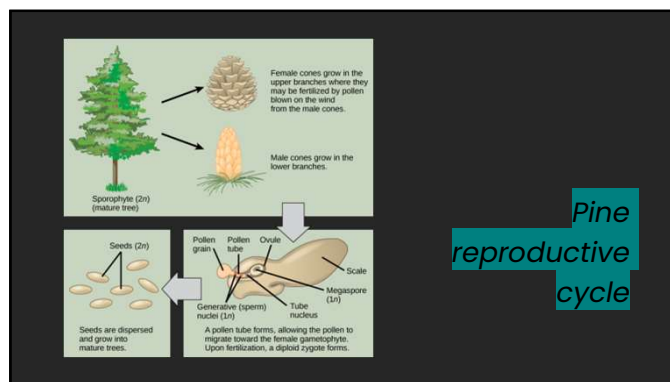
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Part IV: The life cycle of conifers and flowering plants

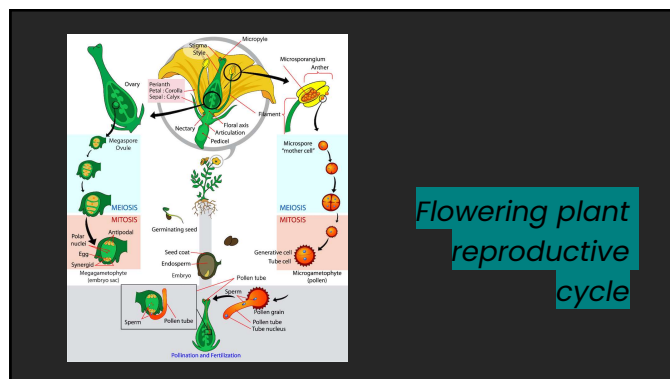
Describe the life cycle of a pine tree

Briefly explain the life cycle of a flowering plant and describe double fertilization.

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