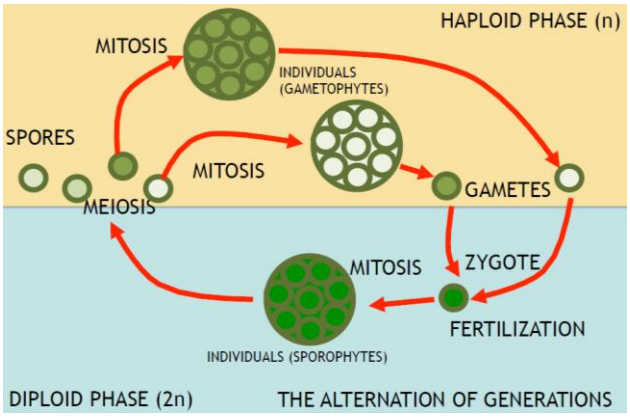
BI 111
Plant Reproduction

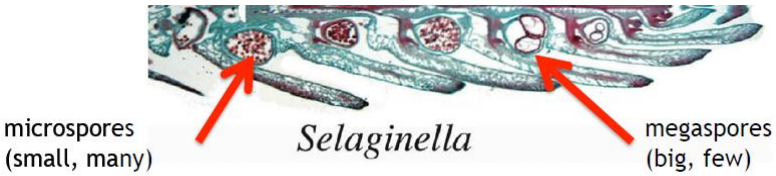
Haplodiplontic Life Cycle: Sporic meiosis

- gametophytes give rise to gametes



Some Vascular Plants Evolved Separate Male and Female Gametophytes

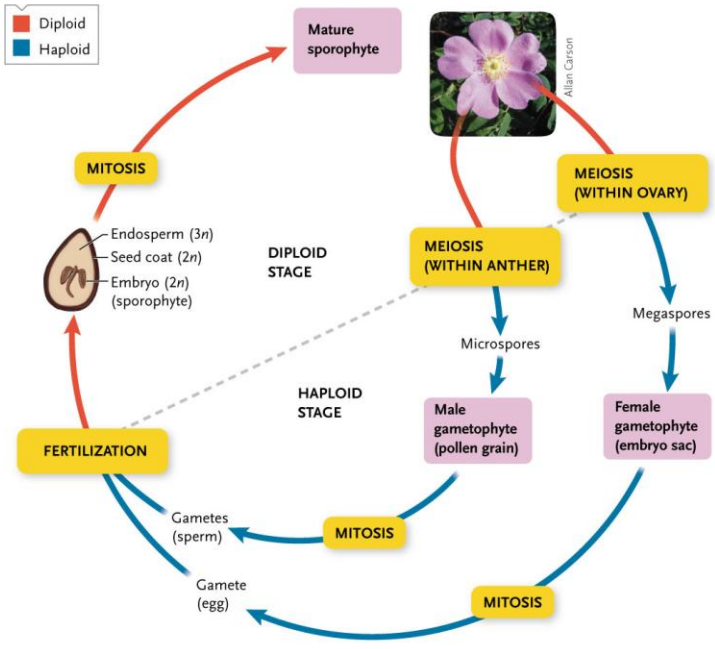
- Heterosporous plants produce 2 types of spores, which develop into(*specialization*) 2 types of gametophytes
  - Female gametes → lots of resources invested in them (large, egg) **embryo sac**
  - Male gametophytes → many cheap, small gametes to help fertilize **pollen grain**



  - Endosporous development
    - In many heterosporous plants, gametophytes produced by spores develop inside spore wall
    - Provides increased protection for gametes, and later, for developing embryo

Flowering Plant Life Cycle

- Haplopid phase and diploid phase
- Flowers are an amazing adaptation
  - Angiosperm is successful
- Signal to attract pollinators
  - Effective way to transfer pollen to another flower
  - Increases reproductive success
- Oldest known example of flowering plant (discovered trapped in amber)
  - Much smaller
  - Petals, sepals, pollen tubes
  - similar characteristics



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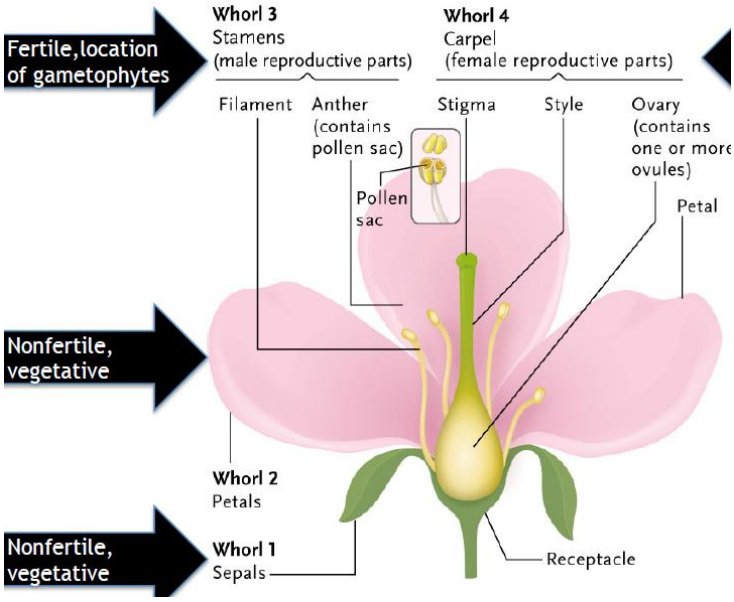
Plant Reproduction

Flowers Develop at Tips of Floral Shoots



- Sepals, Petals – Vegetative (not producing reproductive parts)
- Stamens, Carpel – Fertile, location of gametophytes

**know how to find out

- Monocot vs. Eudicot
  - Differences in root structure, stems
- Difference in number of petals
  - Monocots → multiples of 3
  - Eudicots → multiples of 4 or 5
- Difference in terms of leaves
  - Monocots → parallel veins in leaves
- Sepals → protect developing flower; often green but not always
  - Sepals on lilies look very much like petals
  - Protection before they get to pollination phase
- Petals → main function is to attract pollinators
  - Often bright color
  - Sometimes UV light emitting
  - Rely on other species for pollination; therefore need to attract them
- Stamens→male reproductive parts
  - Two parts filament and anther
  - Anther contains the pollen sac; contains pollen grains (male gametophytes)
    - Anthers produce huge amounts of pollen grains (multicellular haploid cells)
    - Gametophyte dominance – spends most of its "life" on haploid phase
- Carpel → female reproductive parts
  - Stigma →tip
    - Pollen gets deposited here
    - Incredibly sticky surface to attract pollen grains while in contact with pollinators
  - Stile → connects stigma to ovary; pollen travels down this "tube"
    - Ovary contains one or more ovules
    - Ovules contain embryo sac
    - Embryo sac contains eggs
    - Eggs female gamete

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Plant Reproduction

Flower Structure

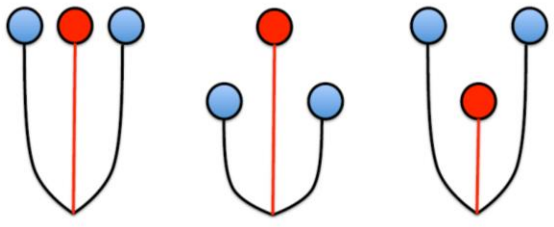
- Perfect flowers → both male and female parts
  - Offspring may be homozygous
    - Often express deleterious recessive alleles
    - Miss out on heterozygotic superiority
- Imperfect flowers → has stamens or carpel, not both
  - to prevent self-pollination
- Dichogamy →sequential hermaphroditism
  - Separation in time
- Protandry male phase comes before the female phase
- Protogyny female phase comes before the male phase
  - Reduces likelihood of self-fertilization.
  - Dichogamy is more effective → protandry; pollen may exist at female phase

Imperfect Flowering Plants

- Monoecious plants
  - Male flowers and female flowers on same plant
    (staminate) (pistilate)
  - Separated in space to reduce self-fertilization → greater range of pollination
  - Male and female flowers on same individual
    - i.e.Corn
- Dioecious plants
  - Rarer
  - Some only produce male flowers, some only female flowers
  - Need to fertilize others, not necessarily self.
    - Need some kind of genetic reassurance
  - Even greater chance of reproduction failure; selective disadvantage
    - i.e. Willows, Ginko, Holly

Herkogamy

- Phenotype separation in space of anthers and stigmas
- Approach herkogamy (pin)
  - Stigmas are above the anthers
  - Most common; most effective in preventing self-fertilization
- Reverse herkogamy (thrum)
  - Stigmas are below the anthers



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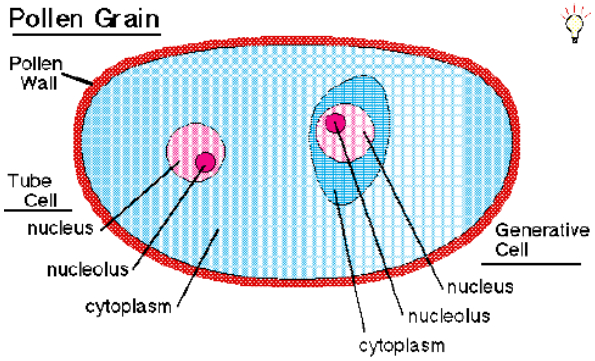
Plant Reproduction

Pollen Grains

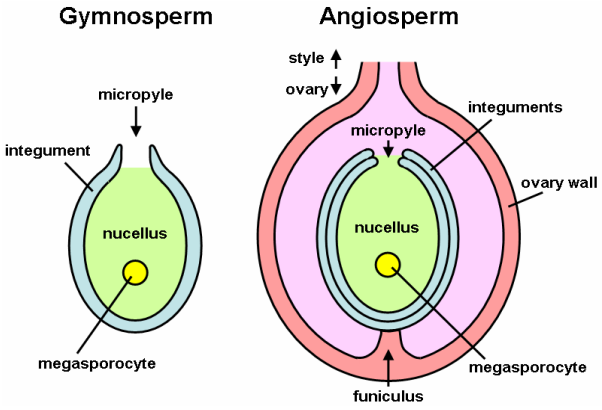


- Meiosis produces haploid microspores
- Mitosis in microspore produces a pollen grain
  - Immature male gametophyte
  - One cell develops into 2 sperm cells
    - generative cell → eventually split to divide once more into sperm cells
  - Other cell produces pollen tube
    - tube cell → vegetative cell; digging long tunnel down the site

Gymnosperm vs. Angiosperm pollen

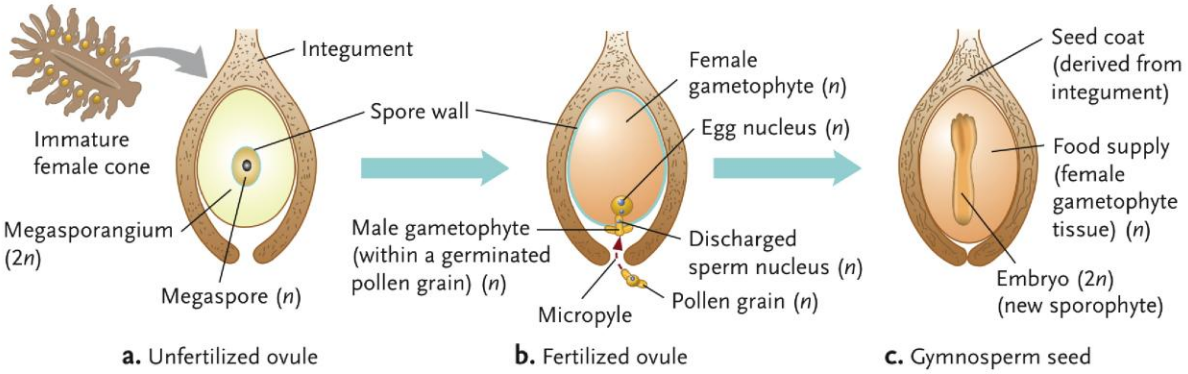
- Angiosperm pollen → sticky to increase chances of being carried to another plant
- Gymnosperm pollen → wing like structures; need to rely on wind for pollination [소나무]

Ovules



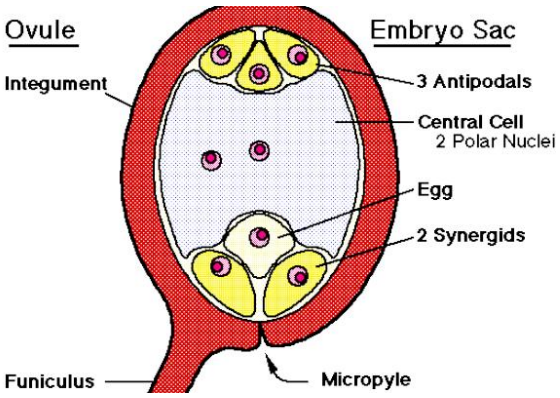
- Form inside carpel, on wall of ovary
- Micopyle opening at one end
- Female gametophyte surrounded by sporophyte tissue
- Gymonosperm (naked seeds); exposed to air (micropyle entrance)
- Angiosperm → embryo sac inside surrounded by sporophyte tissue embedded in the deep base of carpel
  - Reproduction how sperm finds its way there
  - Loss of flagella cannot swing in water → need to dig through female carpel

In gymnosperms

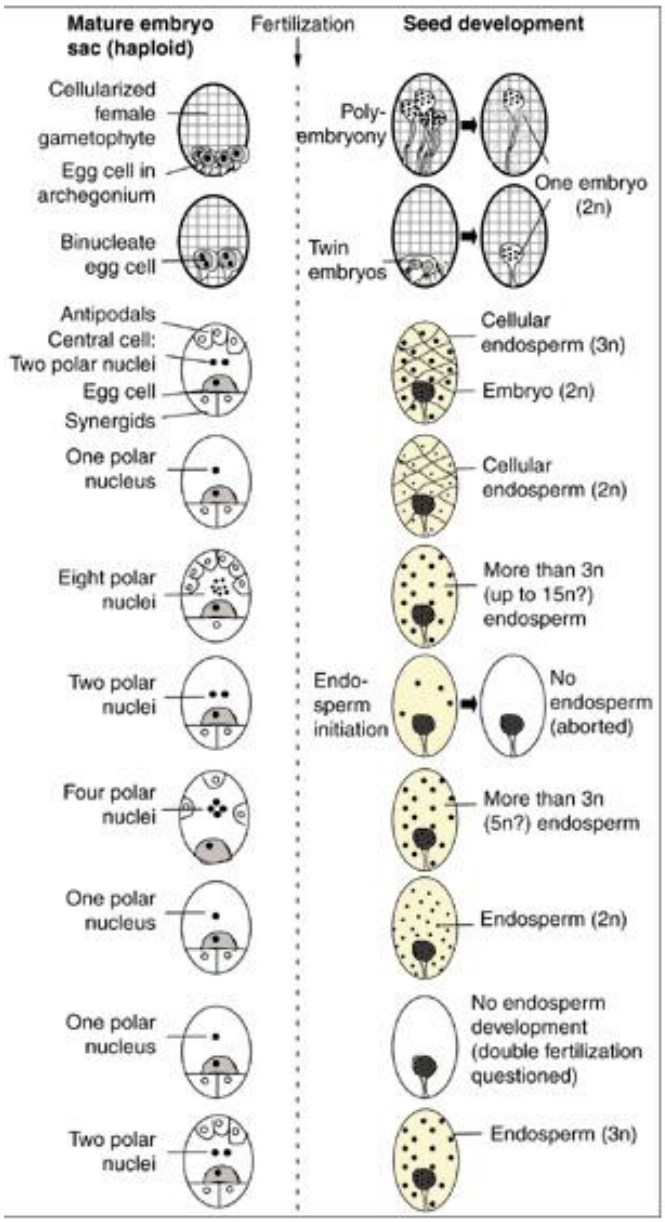


BI 111
Plant Reproduction

Ovules



- Meiosis produces four haploid megaspores
  - One undergoes mitosis 3x without cytokinesis producing eight nuclei in a single large cell
  - Eventually forms female gametophyte
  - Egg cell
  - Two synergids → role: pollination
  - Two polar nuclei→ gives rise to endosperms
- Bind structure of female gametophyte surrounded by sporific tissue
- Small structure made up of 7 cell structure
  - Follows signals sent by the synergids (male travelling to find its way)
  - Antipodals → don't seem to do much



Clicker

1. The female gametophyte of an angiosperm is the
   a. Embryo sac
2. In the angiosperm life cycle, which of the following is not a member of the sporophyte generation (multicellular diploid)
   a. Pollen
      (sporophyte generation → carpel, anther, ovary, petal)

REMEMBER

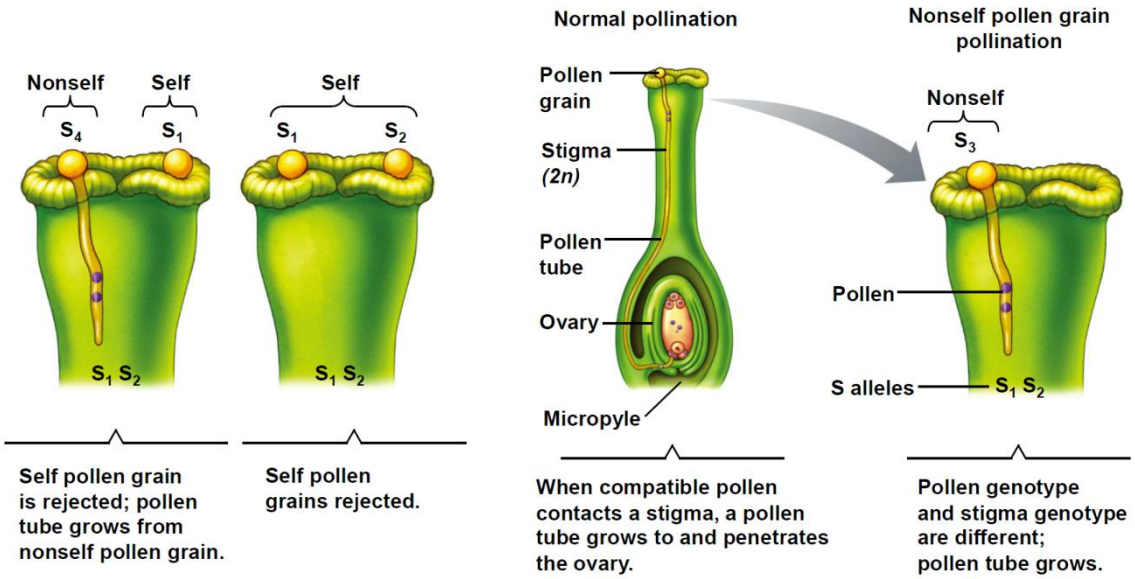
Multicellular, haploid cell → gametophyte

Stimans = male reproductive organ..?

Development of angiosperm gametophyte

Self-incompatibility

- Selectively control "who" they mate with
- Pollen [express a specific phenotype)
    - Specific allele on the stigma
- Changes the chemical composition if they sense that the pollen is part of their system (self)
- Male & female parts: give offspring the best chance of interbreeding
- Not all plants, or even the same species have self-incompatibility



Cost/Benefits/Consequences of self-incompatibility

- Micropile
    - The tube will eventually reach the micropile and to the egg
- Endosperm
    - Oily
    - Carbohydrates

Double fertilization

- One sperm nucleus fuses with one egg nucleus to form a diploid (2n) zygote
- Other sperm nucleus fuses with the central cell, to form triploid (3n) endosperm tissue
- What adaptive benefits are associated with double fertilization
    - Fertility assurance
    - Selectively invest

Fruit

- Matured or ripened ovary
- Protects seeds
- Helps disperse seeds by animals, wind, or water
- Fruit wall (pericarp) develops from ovary wall
    - Pericarp → the hard surface
        - i.e. coconut (surface) →thick, fleshy (peach) hard, dry (hazelnut
- Diversity of Fruit types
    - Simple fruit → peach
    - Aggregate fruit → raspberry
    - Accessory fruit → strawberry [yellow "seeds" → fruit wall]
    - Multiple fruit → pineapple
    - Maple fruit → has wings; seed (in carpel)

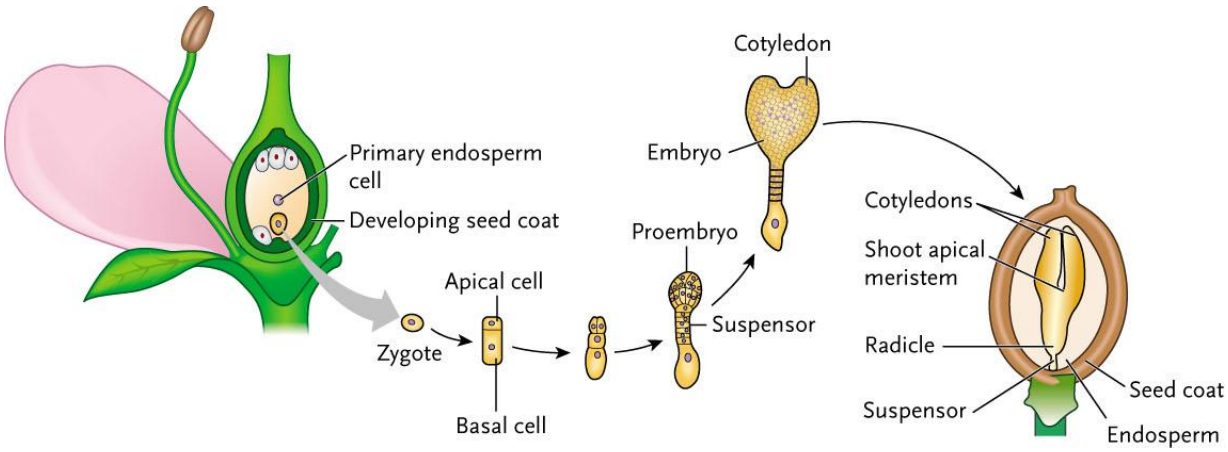
Clicker

1. Genetic self-incompatibility tends to increase **out-crossing**
2. Which of the following flowering arrangements promotes self-pollination? Monoecious
3. The **pericarp** develops from a flower's **ovary wall**

Seeds

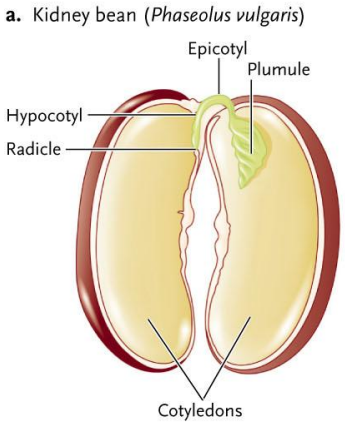
- Structure forms when ovule matures after sperm fertilization through pollination
    - Embryo sporophyte (diploid)
    - Surrounded by nutritive tissues
    - Protective seed coat
- Seeds are major adaptations for uncertain environments
    - Long distance transport
    - Potential dormancy
- Mature ovule encased by protective seed coat (AKA Testa)
- Embryo has lengthwise axis
    - Root apical meristem at one end
    - Shoot apical meristem at other end

Development of a Eudicot Embryo



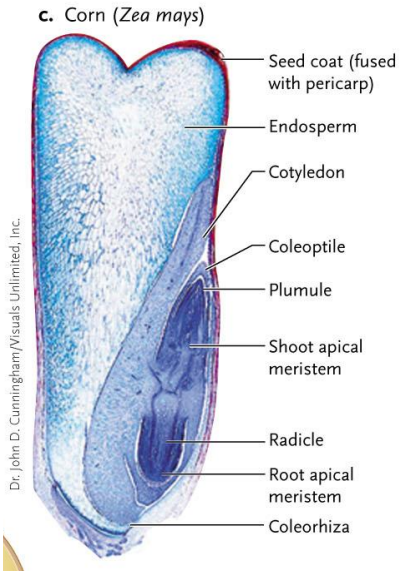
Eudicot embryos

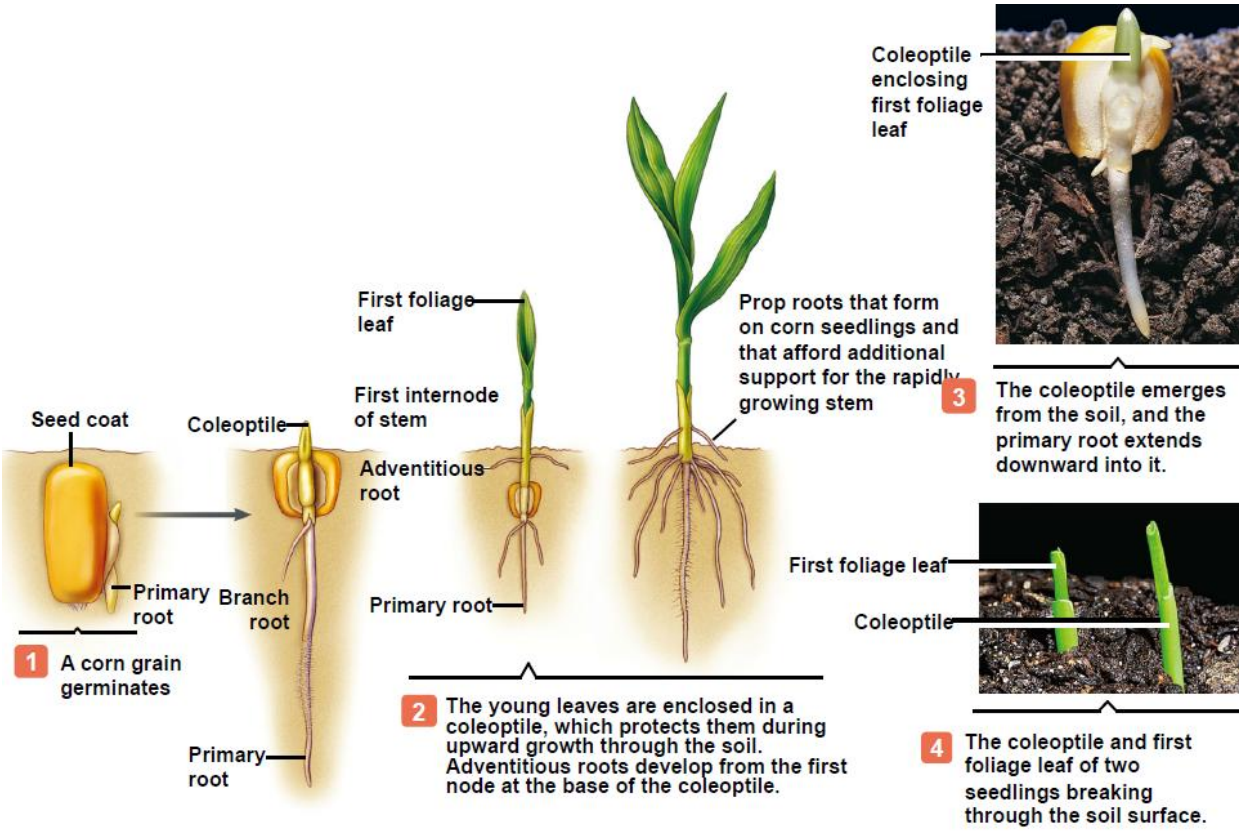
- Two cotyledons (seed leaves)
- Embryonic shoot
  - Upper **epicotyl** and lower **hypocotyl**
- Embryonic root
  - **Radicle**

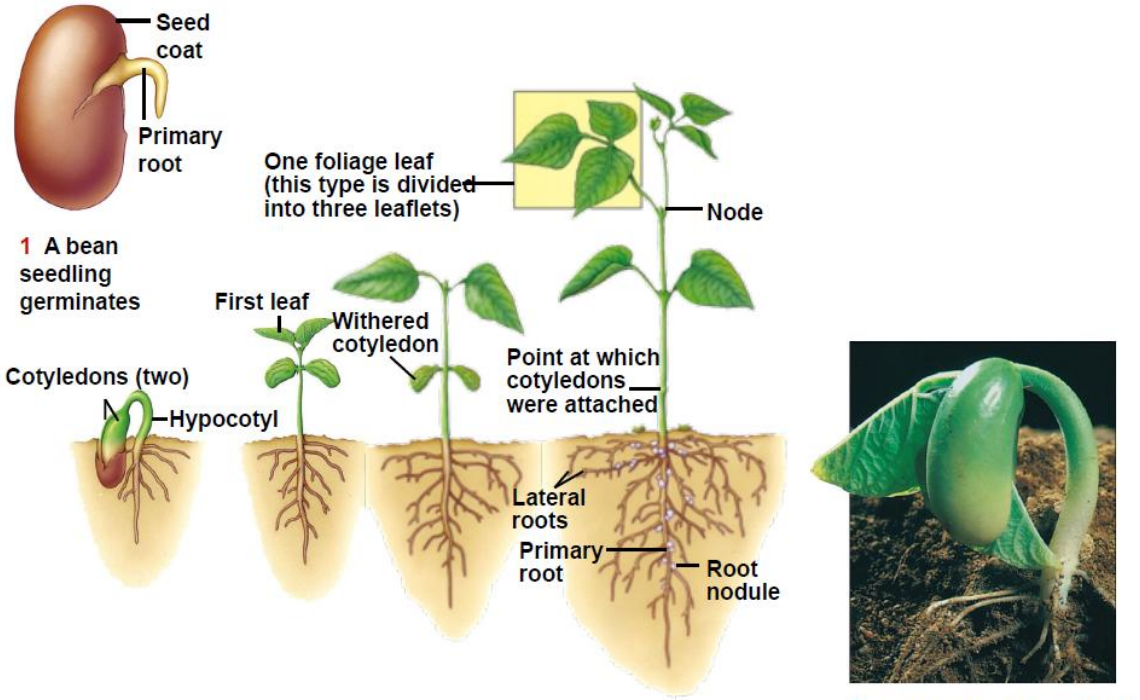


Monocot embryos

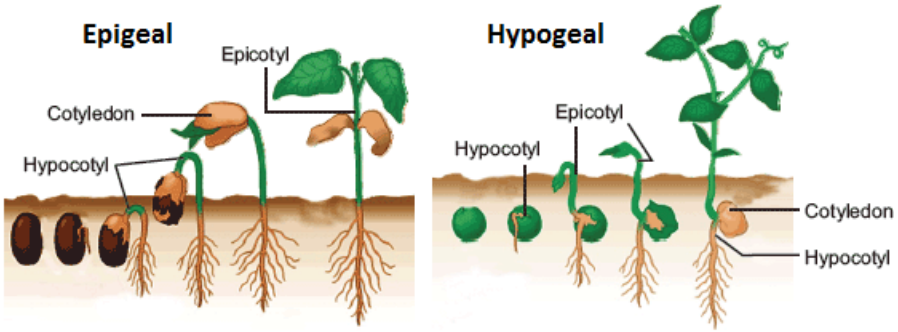
- Single cotyledon
  - **Scutellum** absorbs nutrients from endosperm
- Coleoptile
  - Protects shoot apical meristem and first leaves
- Coleorhiza
  - Protects radicle




Seed coat
Coleoptile
Primary root
Branch root
Primary root
1 A corn grain germinates
First foliage leaf
First internode of stem
Adventitious root
Primary root
Prop roots that form on corn seedlings and that afford additional support for the rapidly growing stem
2 The young leaves are enclosed in a coleoptile, which protects them during upward growth through the soil. Adventitious roots develop from the first node at the base of the coleoptile.
Coleoptile enclosing first foliage leaf
3 The coleoptile emerges from the soil, and the primary root extends downward into it.
First foliage leaf
Coleoptile
4 The coleoptile and first foliage leaf of two seedlings breaking through the soil surface.


Seed coat
Primary root
1 A bean seedling germinates
One foliage leaf (this type is divided into three leaflets)
Node
First leaf
Withered cotyledon
Point at which cotyledons were attached
Cotyledons (two)
Hypocotyl
Lateral roots
Primary root
Root nodule
2 Food-storing cotyledons are lifted above the soil surface when cells of the hypocotyl elongate. The hypocotyl becomes hook-shaped and forces a channel through the soil as it grows. At the soil surface, the hook straightens in response to light.
3 Leaves breaking through the seed coat
Stepped Art

Different modes of germination



- Epigeal → the radical is taken out of the ground and pulled up by the hypocotyl
  - Fast, early growth
  - Seeds are small
  - Don't have huge reserves
  - Tend to grow better in places with lots of sun (carbon fixation)
  - Poorly in nutrient rich soil
- Hypogeal →the epicotyl grows into a hook
  - Seeds are much larger
  - More resources
  - Grow in soils of poor nutrient values
  - More resorts
  - Grows slower →Later in life they grow faster
  - More tollerant to grazers (things that eat plants from the surface)

Vegetative Reproduction

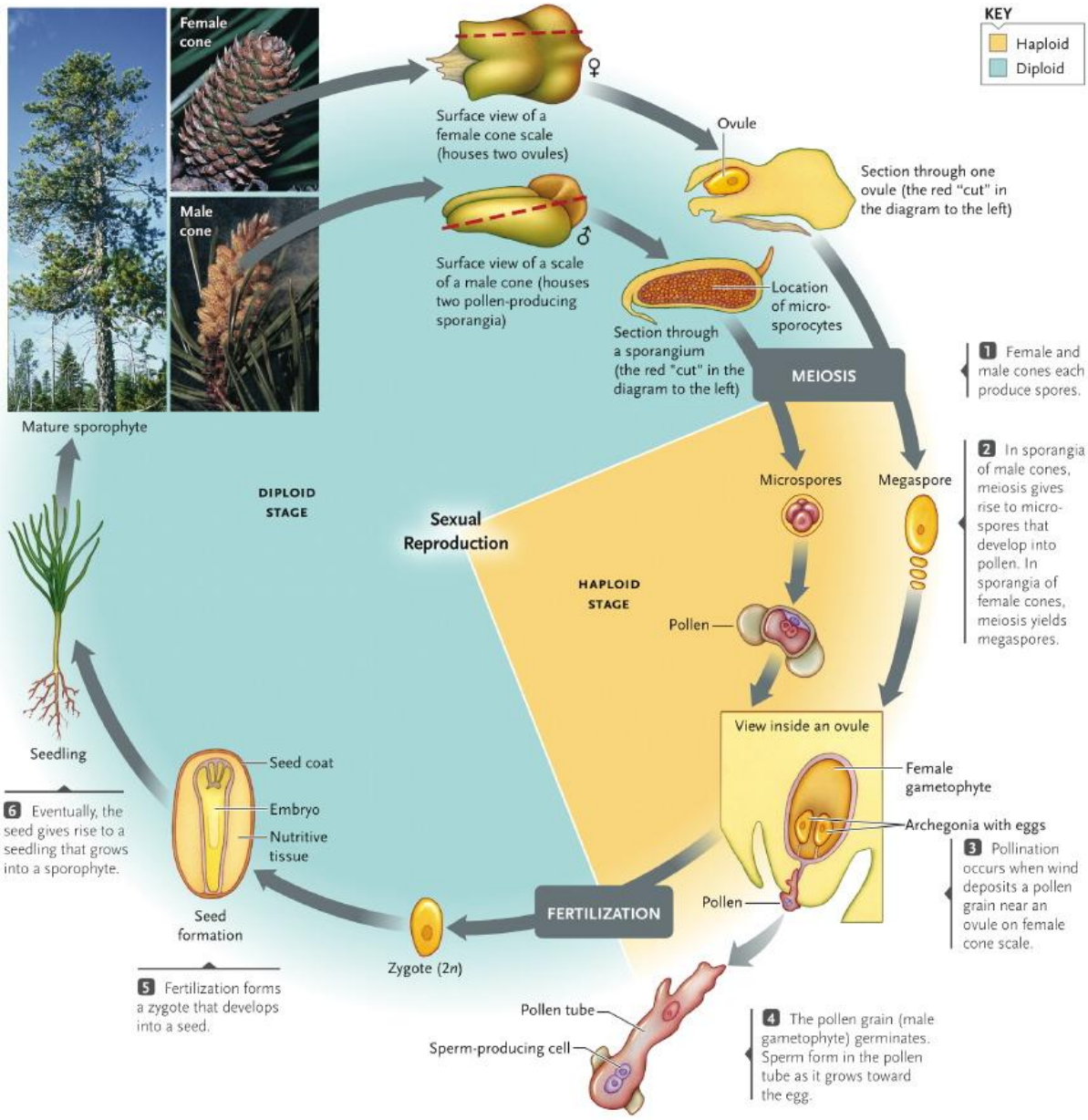
Pros	Cons
- Easy to do - Don't need to relate on a pollen reproduction - Offspring are genetically identical to its parents - Isolated plant → if there are no more plants to reproduce with	- Pathogens - Could get rid of a stack of plants

Q: the coleoptile protects developing **stem** in growing **monocots**

Which of the following neither nourishes nor transfer nutrients? **pericarp**

BI 111
Plant Reproduction

Life Cycle of *pinus ponderosa*



BI 111
Plant Reproduction

Life Cycle of a flowering plant