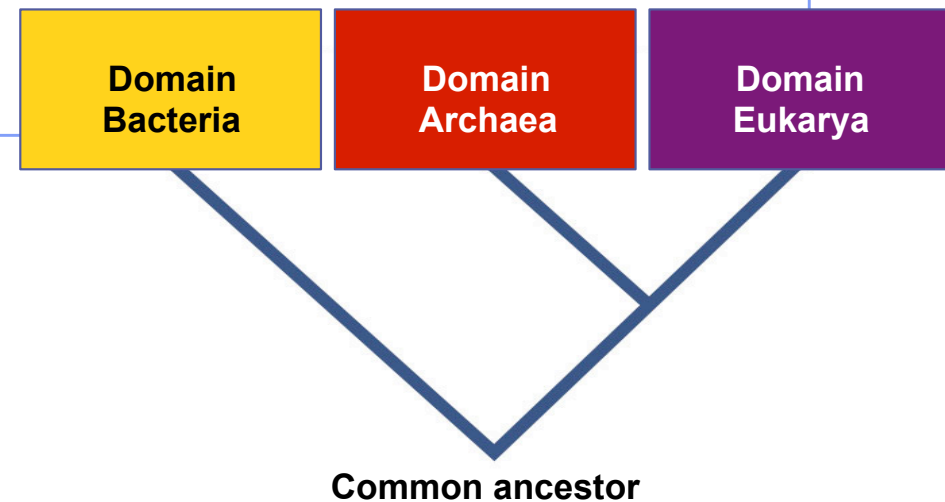




Kingdom: Plants

Domain Eukarya



Adaptations of Modern Land Plants

■ 500 mya land plants evolved from aquatic Green Algae

◆ needed special adaptations for life on dry land

1. protection from drying = from desiccation

- ◆ waxy cuticle (*waterproof wax coating on surface of leaves*)

2. gas exchange (through/around cuticle)

- ◆ stomates (*opening that allow fast diffusion of CO₂/O₂ gasses in & out of leaf cells*)

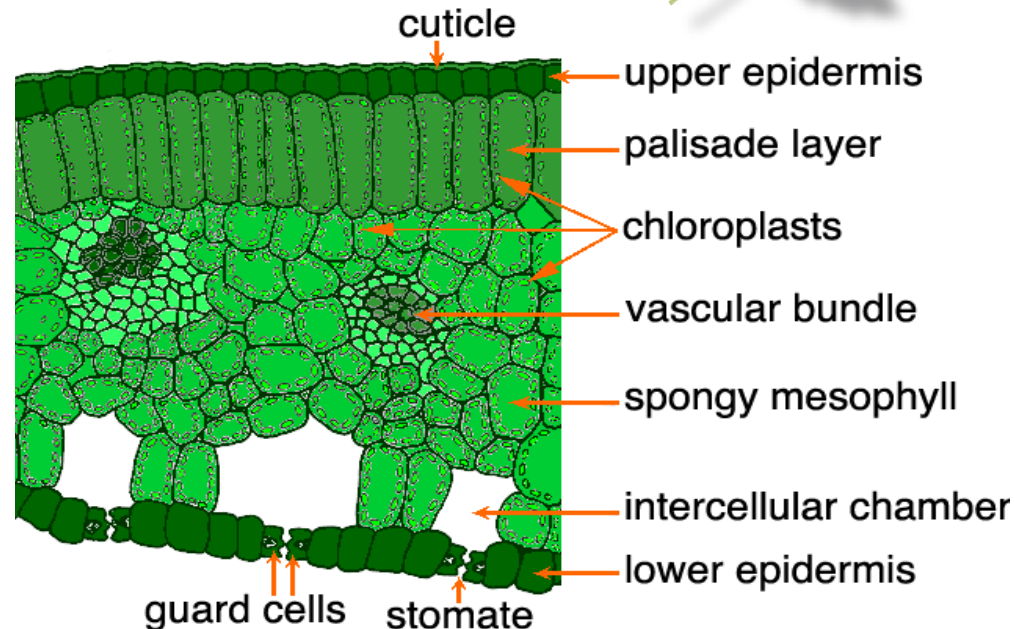
3. water & nutrient conducting systems

- ◆ Vascular System for transporting materials internally

- xylem & phloem

4. UV & dehydration protection for embryo

- ◆ seeds



Modern Plant Classification

Vascular Plants vs Nonvascular Plants

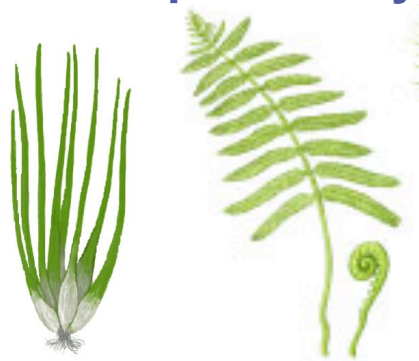
1. Nonvascular Plants also called Bryophytes

- Greek: bryon for “moss” and phyton for “plant”
 - ◆ Ex: Mosses (Phylum Bryophyta), Hornworts (Anthocerotophyta), Liverworts (Phylum Hepatophyta)



2. Vascular Plants (93% of all plant species)

- Vascular Tissue is made up of cells joined into tubes that transport water and nutrients through the plant body
 - ◆ Xylem transports water and minerals
 - ◆ Phloem transports sugars from photosynthesizing cells to rest of plant body



Modern Plant Classification - Vascular Plants

Vascular Plants can be subdivided into Seedless Plants and Seed-Producing Plants:

a) Seedless plants

1. Lycophytes: Club Mosses, Spike Mosses, Quillworts
2. Pterophytes: Ferns, Horsetails, and whisk ferns



b) Seed-Producing plants

◆ Seed = Embryo (2n) packaged with a supply of nutrients inside protective coat

1. Gymnosperms

- Greek “gymnos” for “naked” and “sperm” for “seed”
- Seeds are not enclosed in chambers

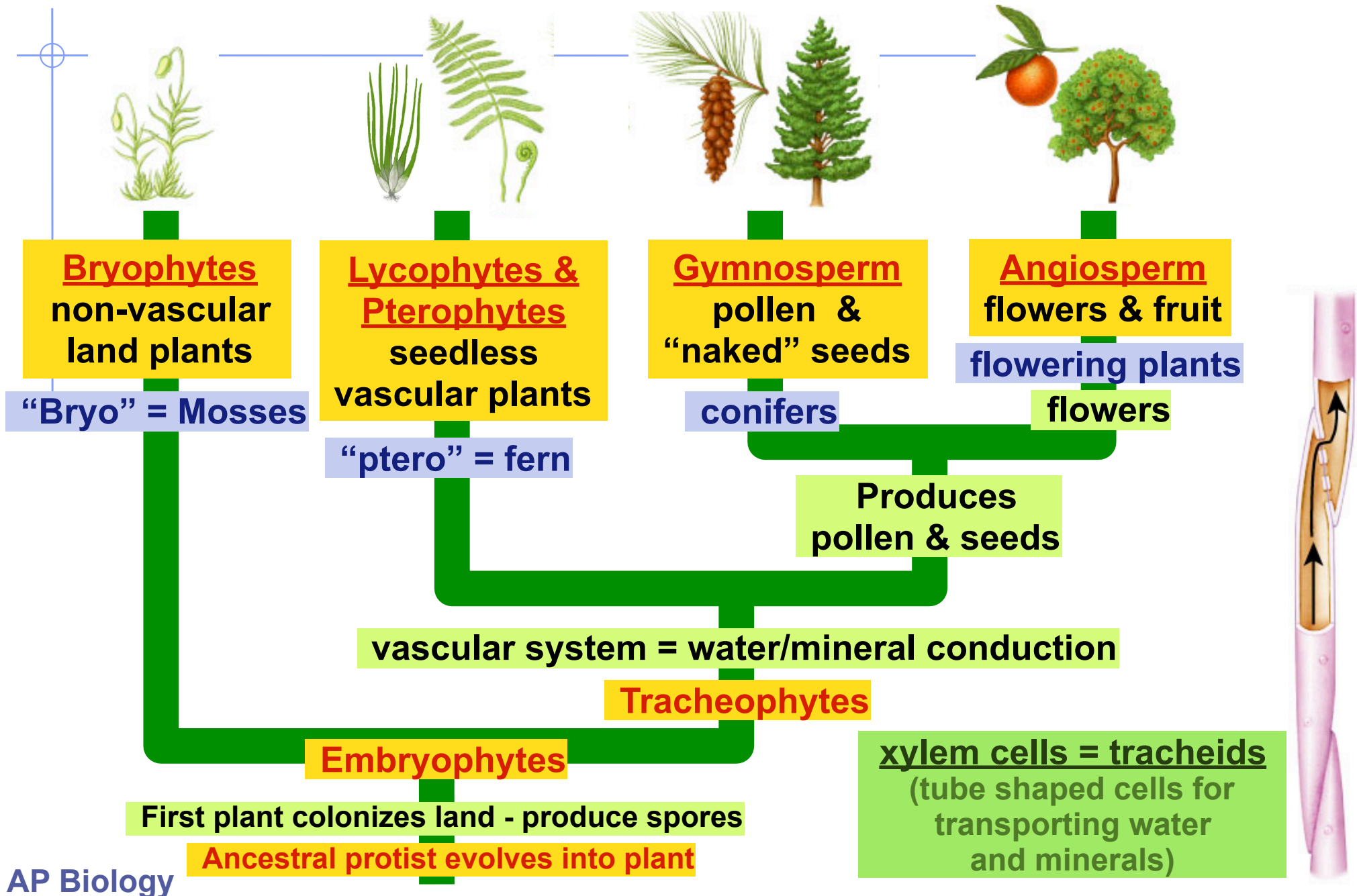


2. Angiosperms (90% of all living plant species)

- Greek “angios” for “container” and “sperm” for “seed”
- Seeds develop inside chambers called ovaries originating in flowers and maturing into fruits

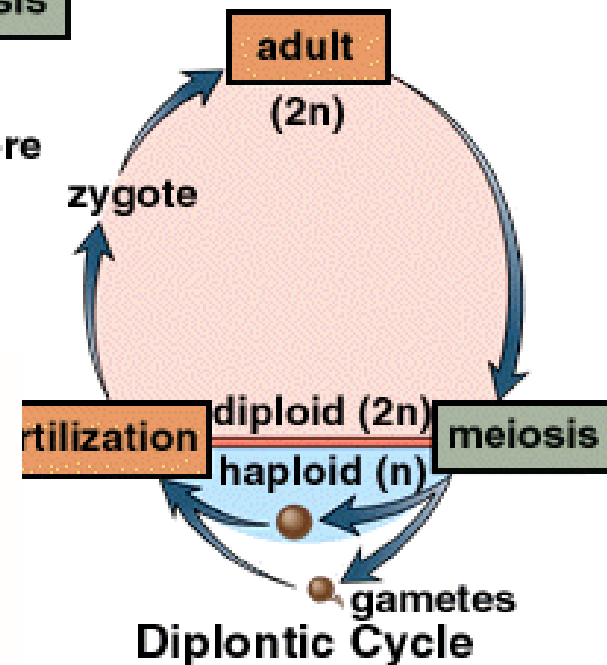
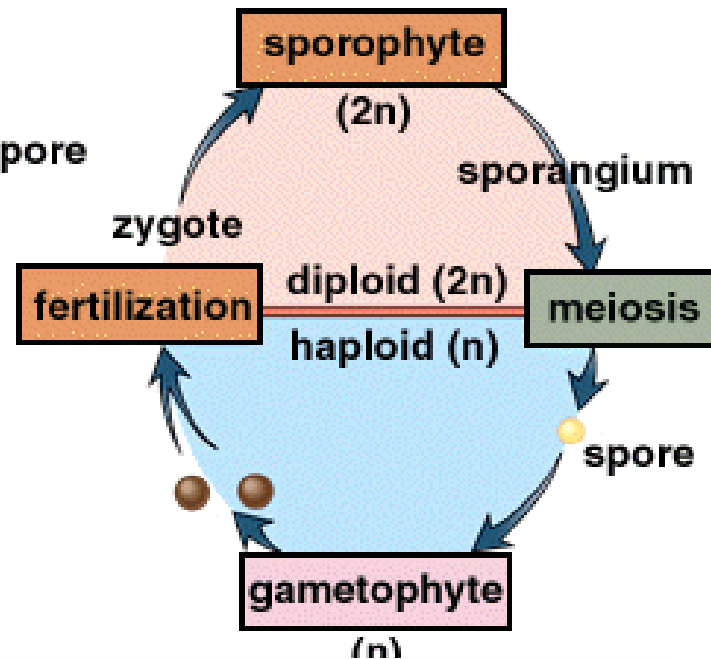
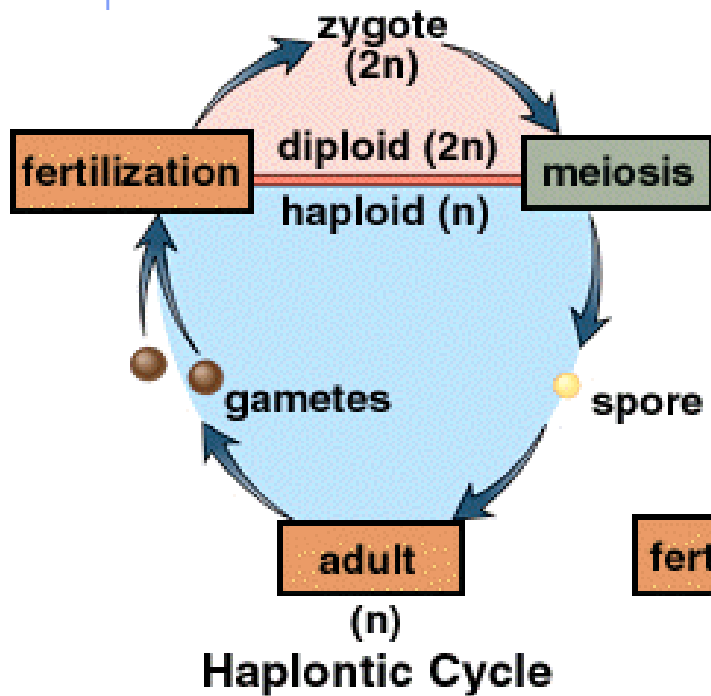


Plant Diversity - Phylogeny



Sexual Life Cycles Differ By Kingdoms

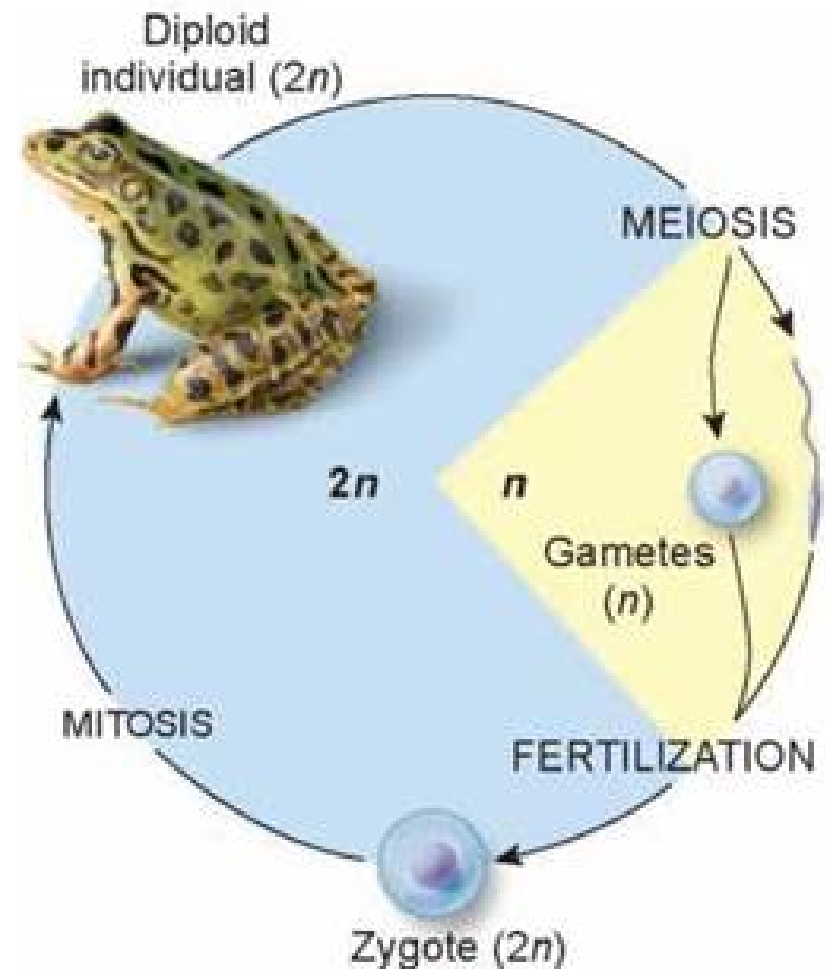
In sexual reproduction, haploid cells or organisms alternate with diploid cells or organisms.



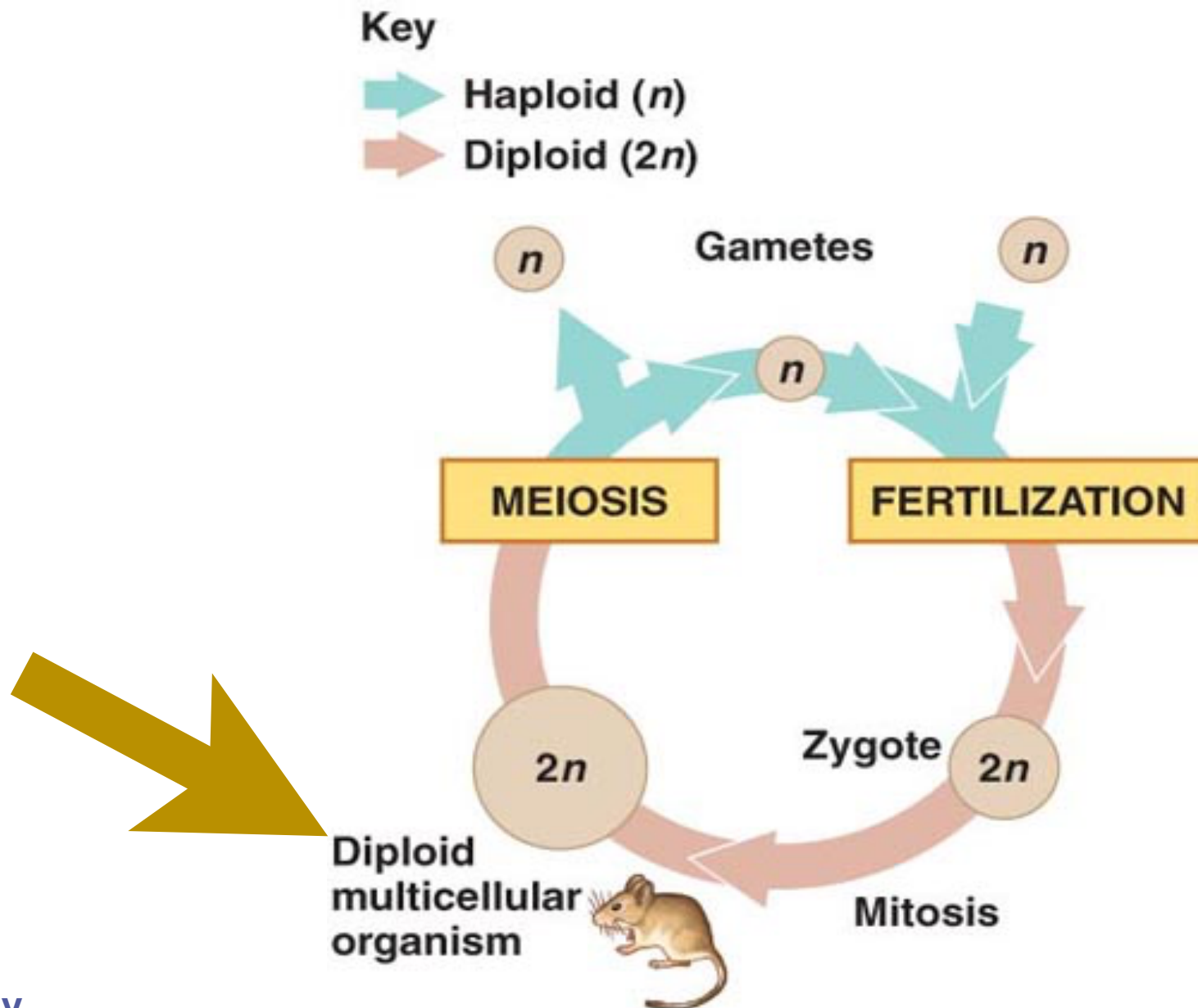
The length of time spent in either haploid or diploid states differs by kingdom.

Animal Sexual Life Cycle

- In animals, mostly multicellular diploid organisms, the completion of meiosis in specific tissues produces gametes (*haploid cells whose ONLY purpose is to fuse during fertilization*).
- Meiosis, therefore, is followed quickly by fertilization, which produces diploid cells again (starting with a zygote).
 - ◆ These diploid cells divide by mitosis for form a multicellular diploid organism.
- The vast majority of the life cycle is spent in the diploid stage.
 - ◆ Dominant stage: Multicellular Diploid ($2n$)

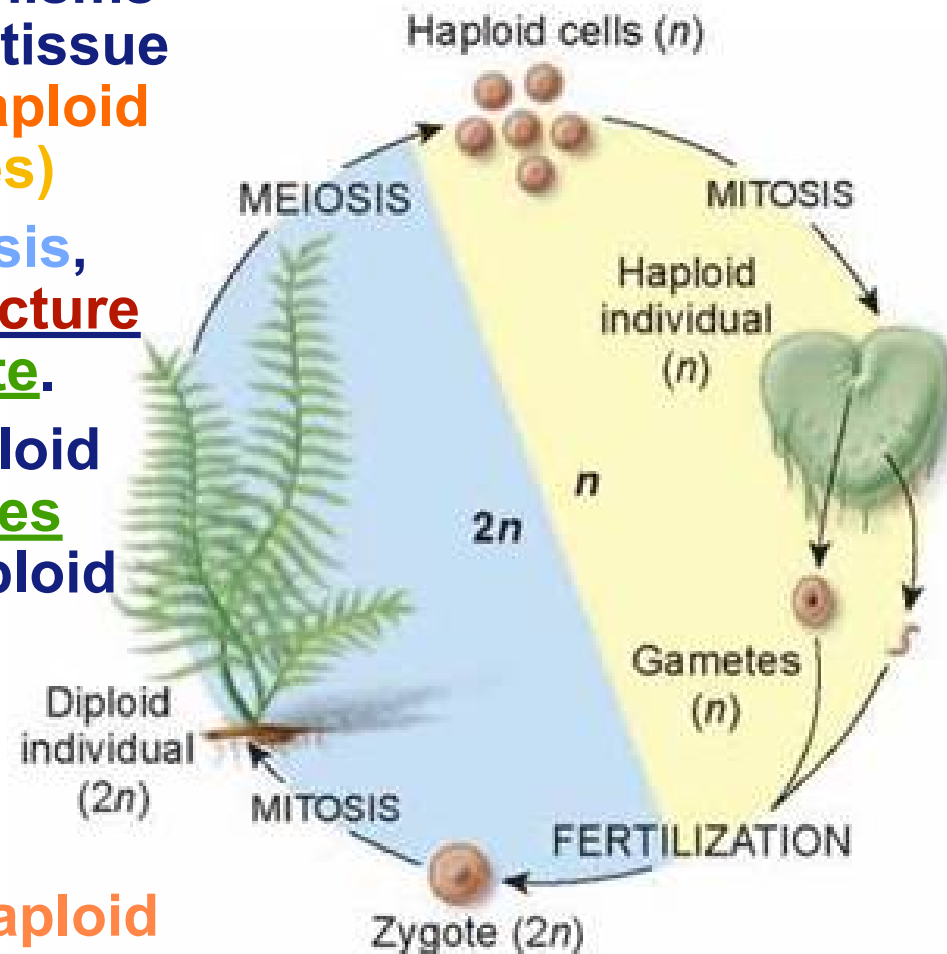


Animal Sexual Life Cycle

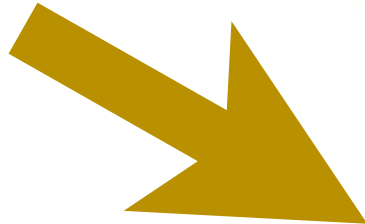


Plant Sexual Life Cycle - Known as Alternation of Generation

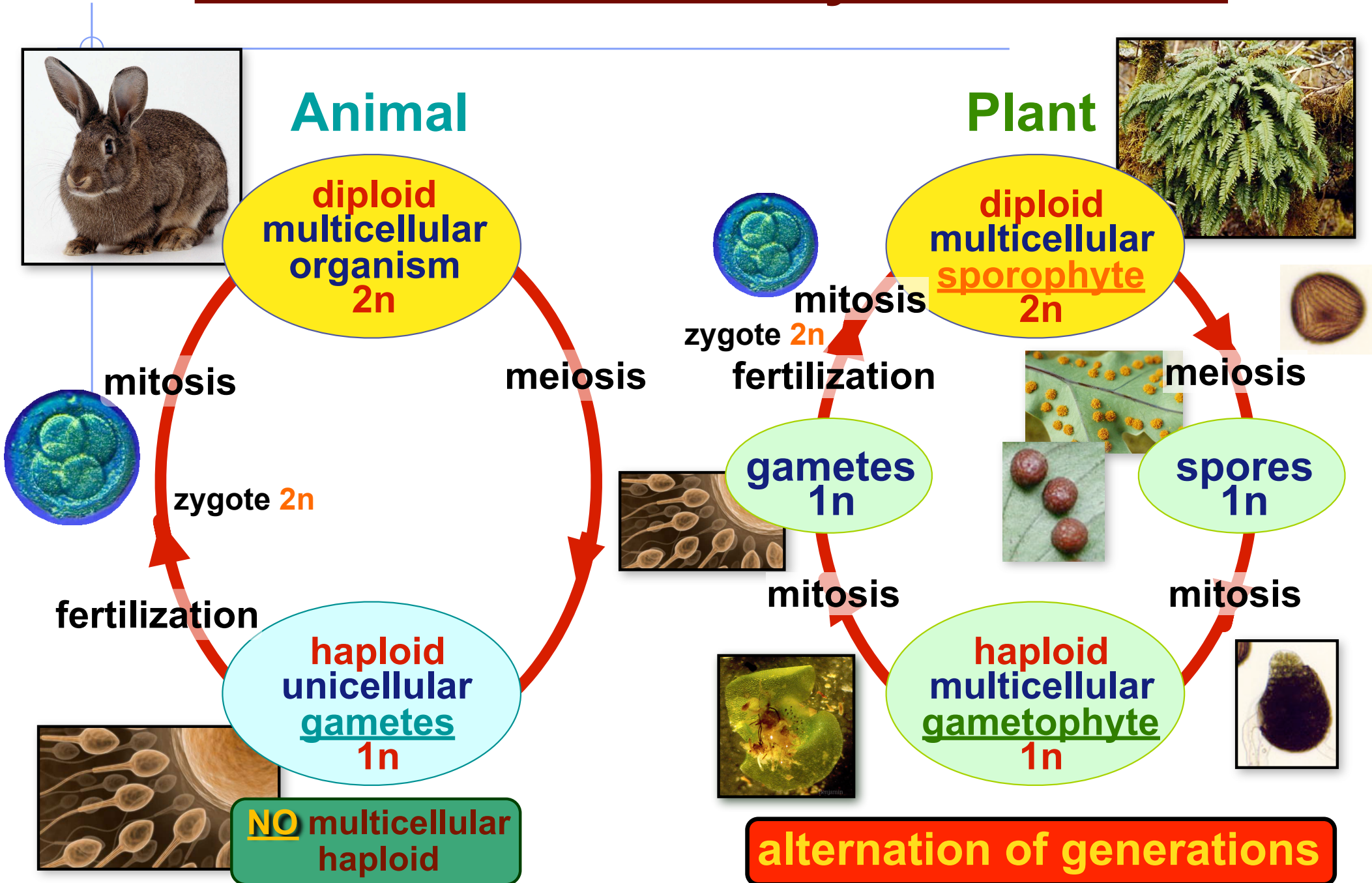
- In plants, multicellular diploid organisms referred to as sporophytes contain tissue that undergoes meiosis, forming haploid cells, known as spores (not gametes)
- Haploid spores then divide by mitosis, forming a multicellular haploid structure or organism, called the gametophyte.
- Some cells of this multicellular haploid phase of life eventually form gametes by mitosis, which fuse to form a diploid zygote through fertilization.
- The zygote then divides by mitosis into a multicellular diploid sporophyte again.
 - ◆ Dominant stage: Multicellular Haploid (n) in non-vascular Mosses, Multicellular Diploid (2n) in vascular Plants.



Some plants and some algae



Animal vs. Plant life cycle!!!!!!!!!!!!!!!!!!!!



First land plants - Bryophytes

Bryophytes Phyla

◆ Ex: mosses, hornworts & liverworts

◆ non-vascular plants

- no water transport system
- no true roots



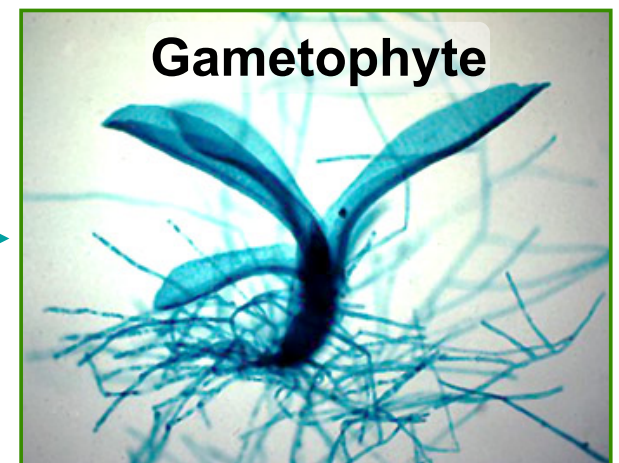
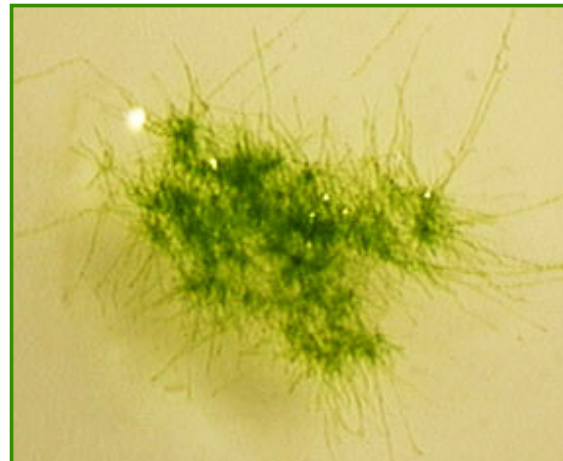
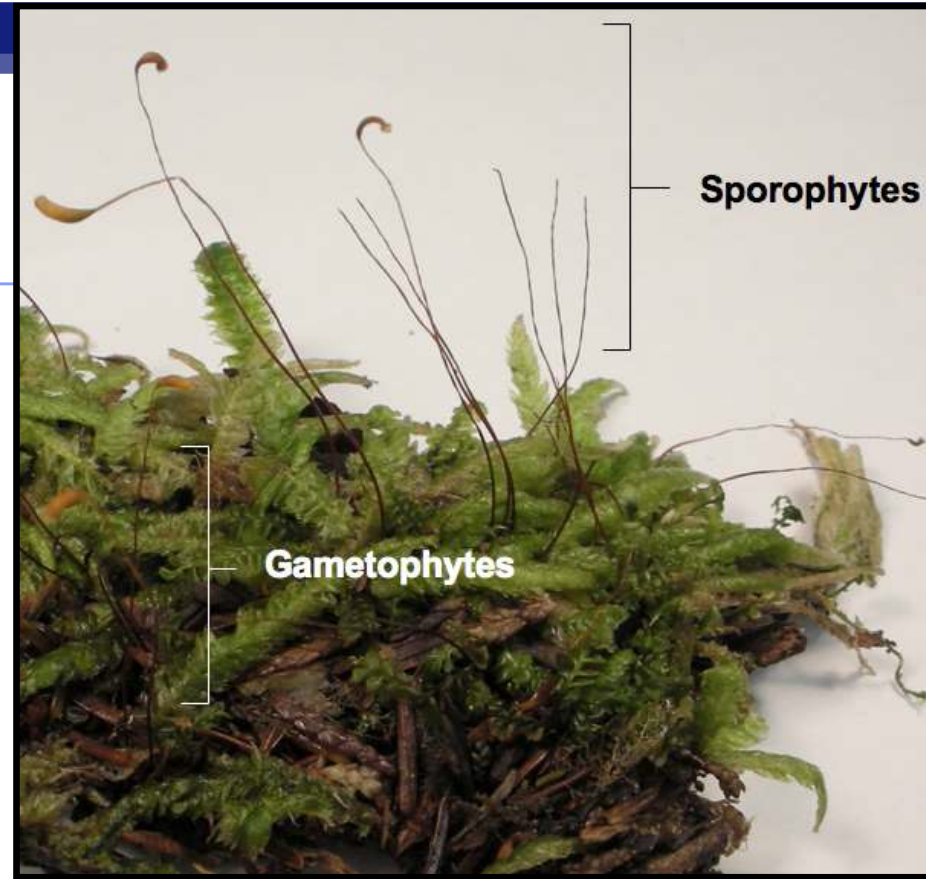
- ◆ Sporophyte ($2n$) plant organisms produces spore (n - haploid cell) by meiosis (*spore is **NOT** a gamete - it does not get fertilized*)
 - When single-celled spore (n) is released from sporophyte, it germinates and grows into a multicellular gametophyte (n) through mitosis



Bryophytes Phyla

- ◆ If spore (single haploid cell) is deposited on an appropriate surface, it a “leafy” gametophyte, which is **multicellular & haploid!!!**

- This haploid multicellular gametophyte is the moss you usually see growing in moist environments.



Bryophyte Gametophyte

- The gametophyte (n) produces the sex organs (gametangia) that make gametes (n) by mitosis since the gametophyte is already haploid!
 - ◆ **Gametophyte is low to ground**
 - Lacks vascular tissue to transport water & minerals upward quickly enough to make up for water loss by evaporation
 - ◆ water/minerals move through gametophyte from cell to cell by diffusion not through bulk transport through xylem vessels
 - Body parts too thin to support weight of tall plant



Multicellular Gametangia

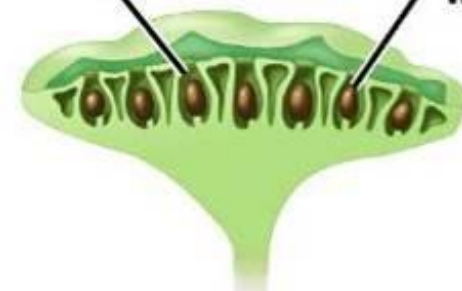
Archegonium with egg

Female gametophyte



Male gametophyte

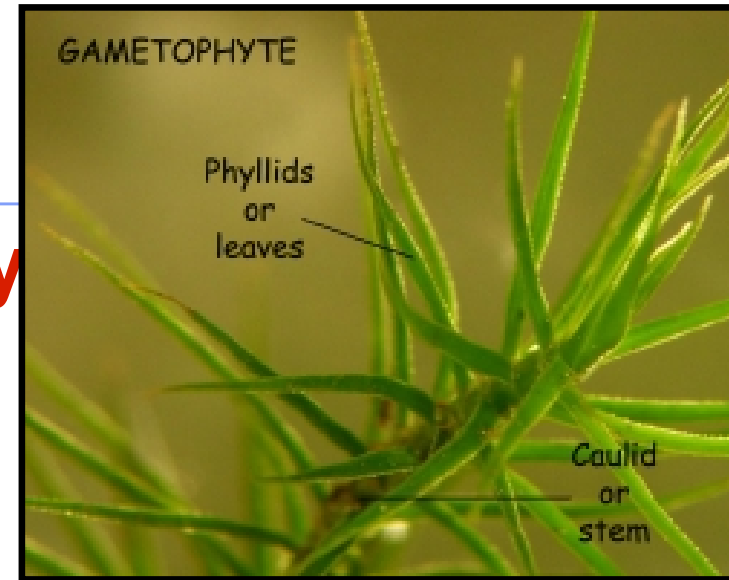
Antheridium with sperm



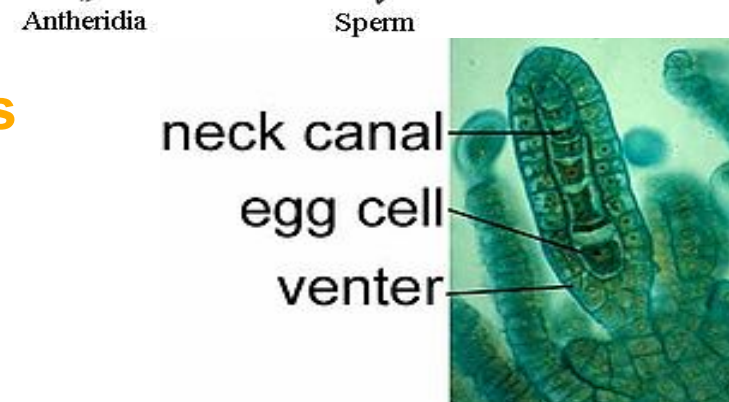
Bryophyte Gametophytes

■ Moss life cycle is dominated by multicellular HAPLOID gametophyte(n) stage

- ◆ Multicellular Gametophyte (n) is larger and lives longer than multicellular sporophyte (2n)
 - fuzzy moss plant you are familiar with and see is haploid!!!
- ◆ Types of Gametangia (parts of individual multicellular gametophyte that make gametes (n) by mitosis):
 1. Single Eggs are produced by mitosis in pear shaped archegonia organ
 2. Multiple Sperm are produced by mitosis in each antheridium organ

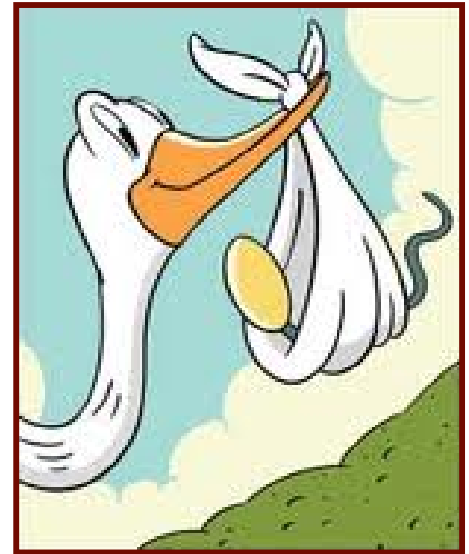


Moss antheridia
400x



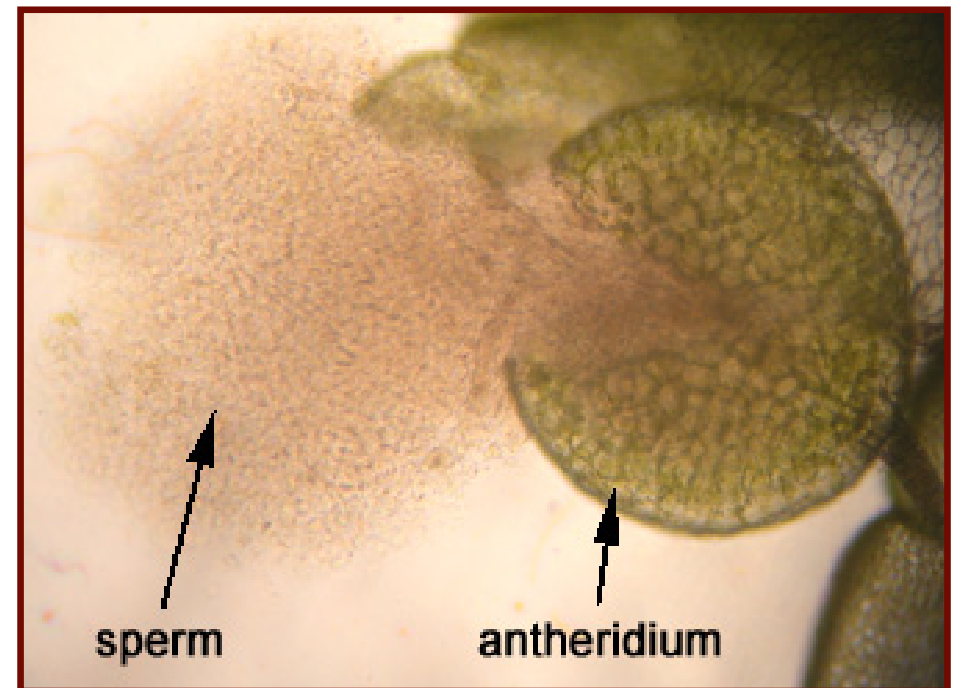
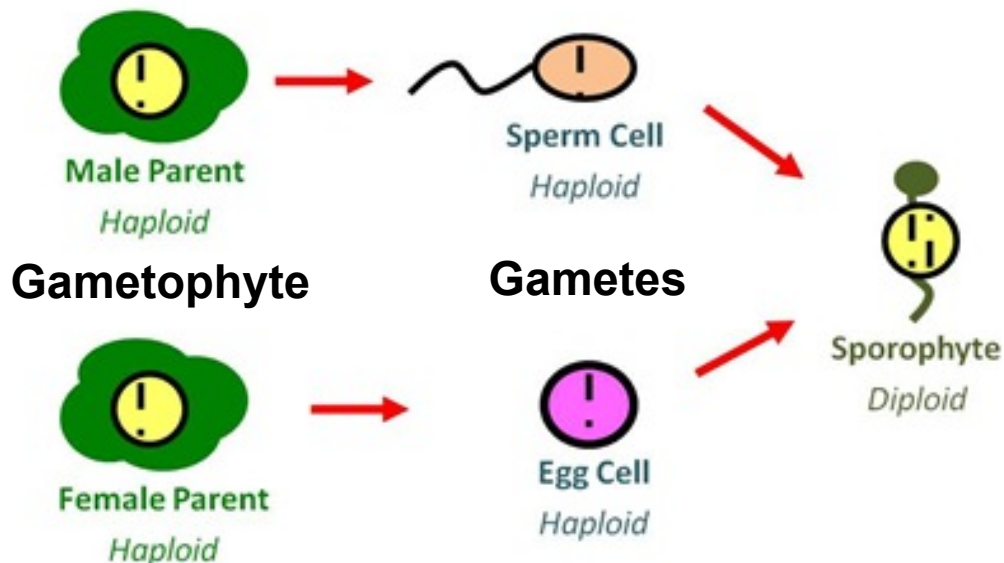
Bryophyte Gametes

- Mosses have Swimming Sperm!
 - ◆ Flagellated sperm
 - Sperm must swim to egg in archegonia
 - ◆ REQUIRES A FILM OF WATER
 - ◆ BRYOPHYTES OFTEN LIVE IN MOIST ENVIRONMENTS & REMAIN CLOSER TOGETHER!



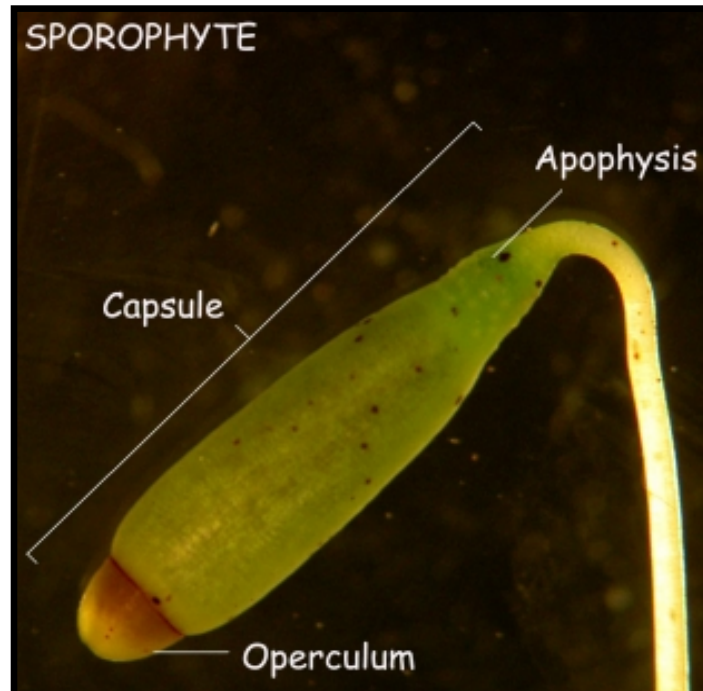
Moss Reproduction -1st Generation

Gametophytes produce Sporophyte



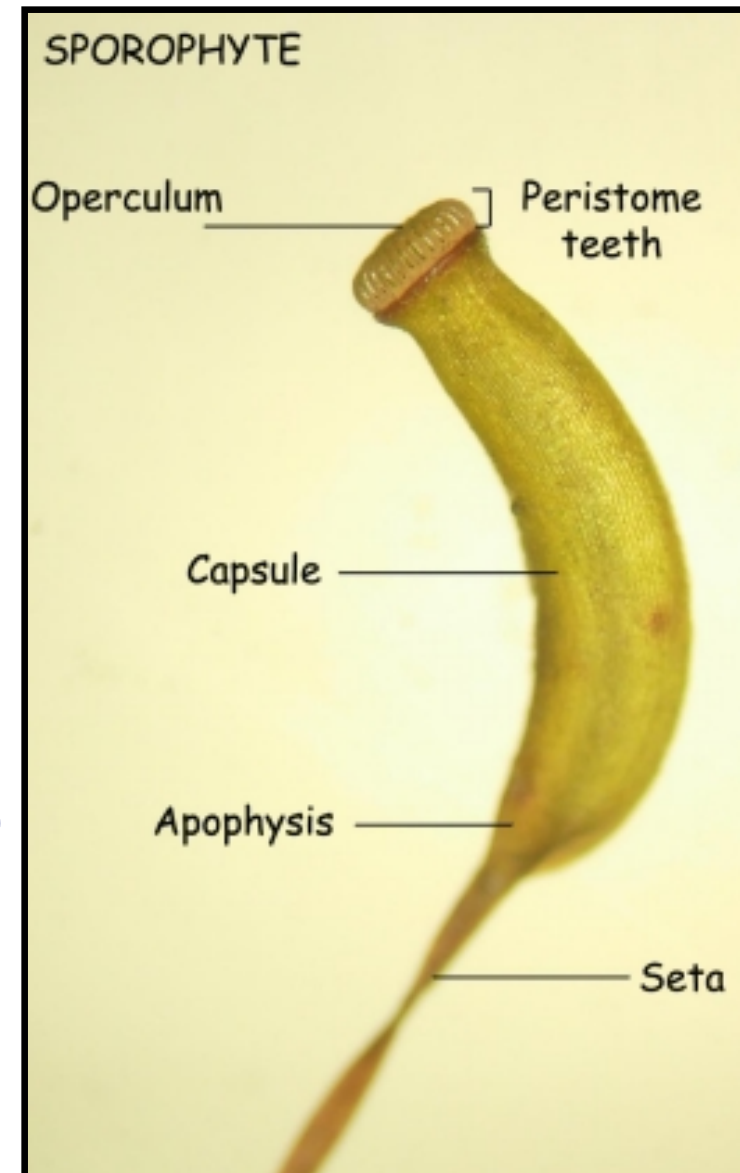
Bryophyte Sporophyte (has no vascular tissue)

- After fertilization and the creation of a zygote ($2n$) mitosis starts:
 - ◆ Diploid embryos are formed and are retained in the archegonia of the gametophyte as they develop into sporophytes
- Sporophyte ($2n$) is dependent on gametophyte for survival!!!
 - ◆ Remains attached to gametophyte
 - Absorbs sugar, amino acids, minerals, and water from gametophyte via diffusion.

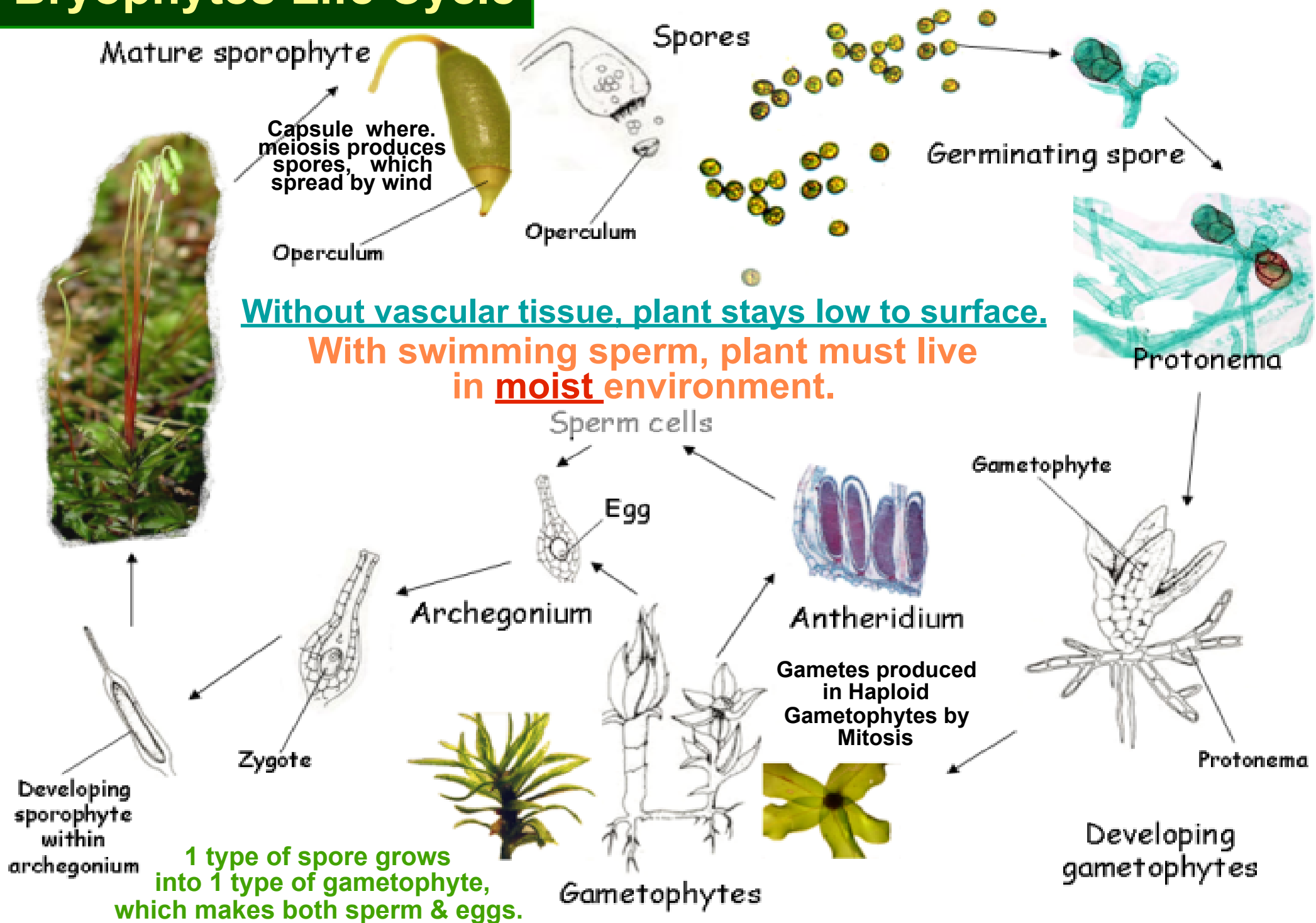


First land plants - Bryophytes

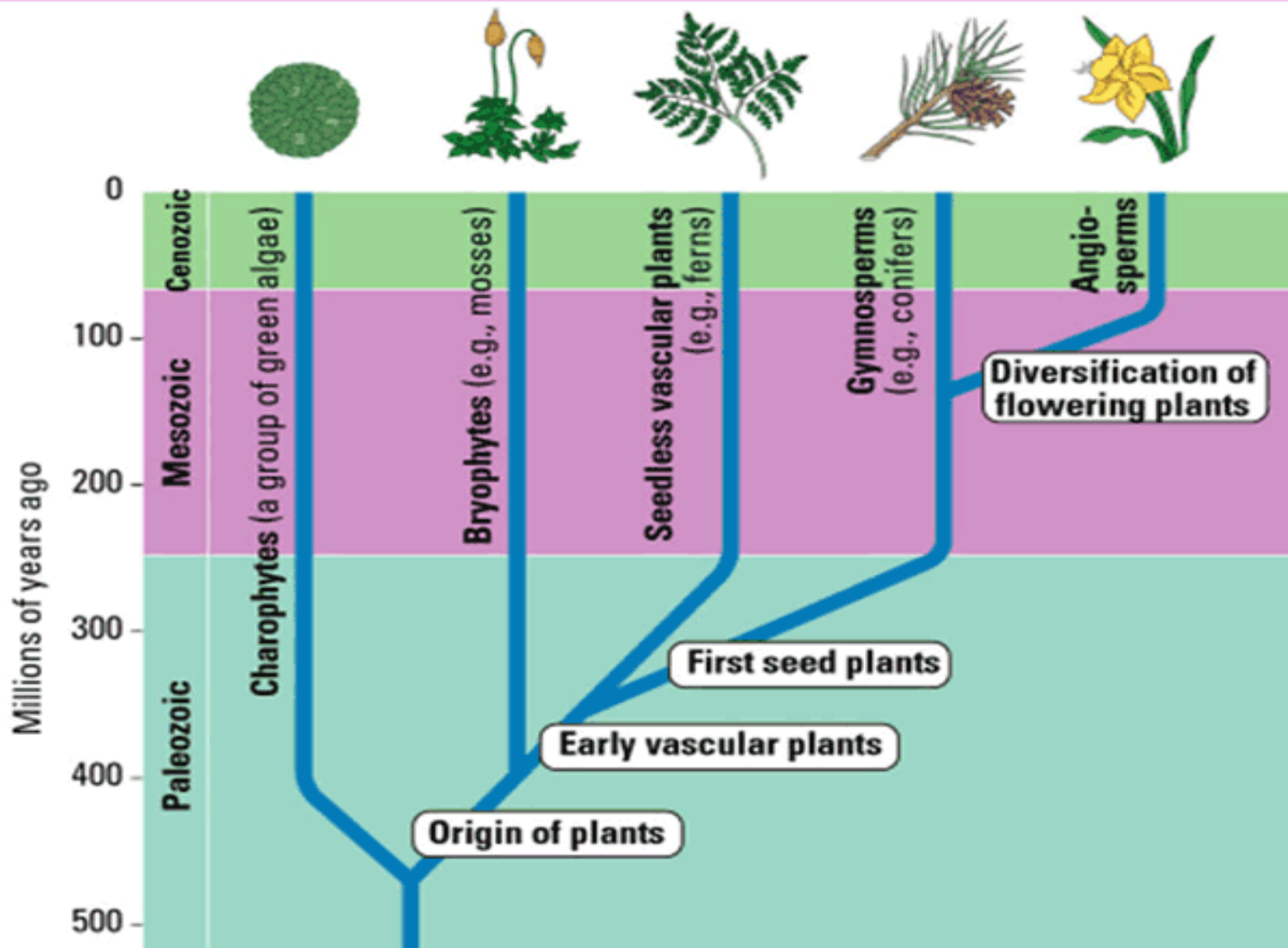
- Sporophyte (2n) - produces spores (n)
 - ◆ Foot - absorbs nutrients from gametophyte
 - ◆ Seta - stalk that conducts materials to sporangium
 - ◆ Capsule - the sporangium (2n) that produces spores (n) through meiosis
- The capsule opens under dry conditions and allows spores (n cells) to fly away in the wind
 - ◆ spores are haploid, which divide by mitosis to form a new gametophyte



Bryophytes Life Cycle



Vascular Plants Evolve from a Subset of Bryophytes



First Vascular Plants Evolve 420 m.y.a.

- **Lycophytes:** Spike Moss, Club moss & Quillwort.
- **Pteridophytes: FERNS!!!**
 - ◆ **Vascular systems - Water/mineral transport system**

- **Xylem & phloem**
 - ◆ **Xylem** = conducts water and minerals
 - **Tube-shaped cells called tracheids & vessel elements carry minerals and water up roots**
 - **Cells walls strengthened by polymer lignin**
 - ◆ **Phloem** = cells arranged into tubes to transport organic molecules
- **Allowed plants to grow TALLER**
 - ◆ **Increased competition for sunlight resulted in taller plants being favored by natural selection**



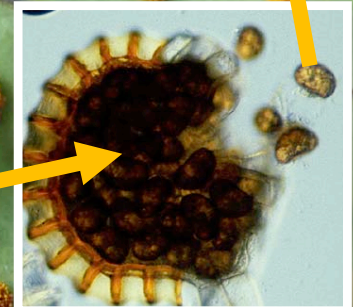
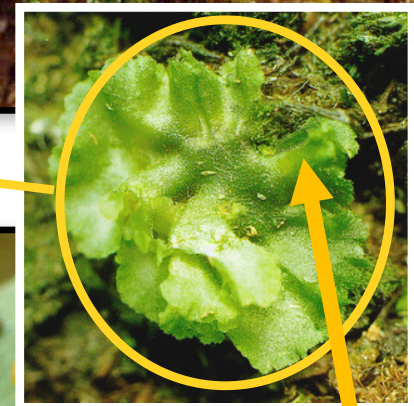
Pterophytes (Ferns) & Lycophytes

- Life cycle dominated by SPOROPHYTE stage now
 - ◆ leafy fern plant you are familiar with is diploid $2n$ sporophyte!!!
- Sporophytes ($2n$) make spores (n)
 - ◆ haploid cells which land on the ground and multiply by mitosis to form a haploid n gametophyte
 - ◆ In ferns, clusters, SORI, of sporangia (spore-producing organs where cells divide by meiosis) are found on sporophylls

diploid



haploid



SORI



First vascular plants (seedless)

- Spores land in dirt and divide by mitosis to produce a small INDEPENDENT multicellular (n) gametophyte
 - ◆ The multicellular, haploid gametophyte later produces both egg and sperm by mitosis
- Ferns still had to live in moister environments because they had swimming sperm
 - ◆ Have flagellated sperm
 - Sperm still needs water to travel in to reach egg!

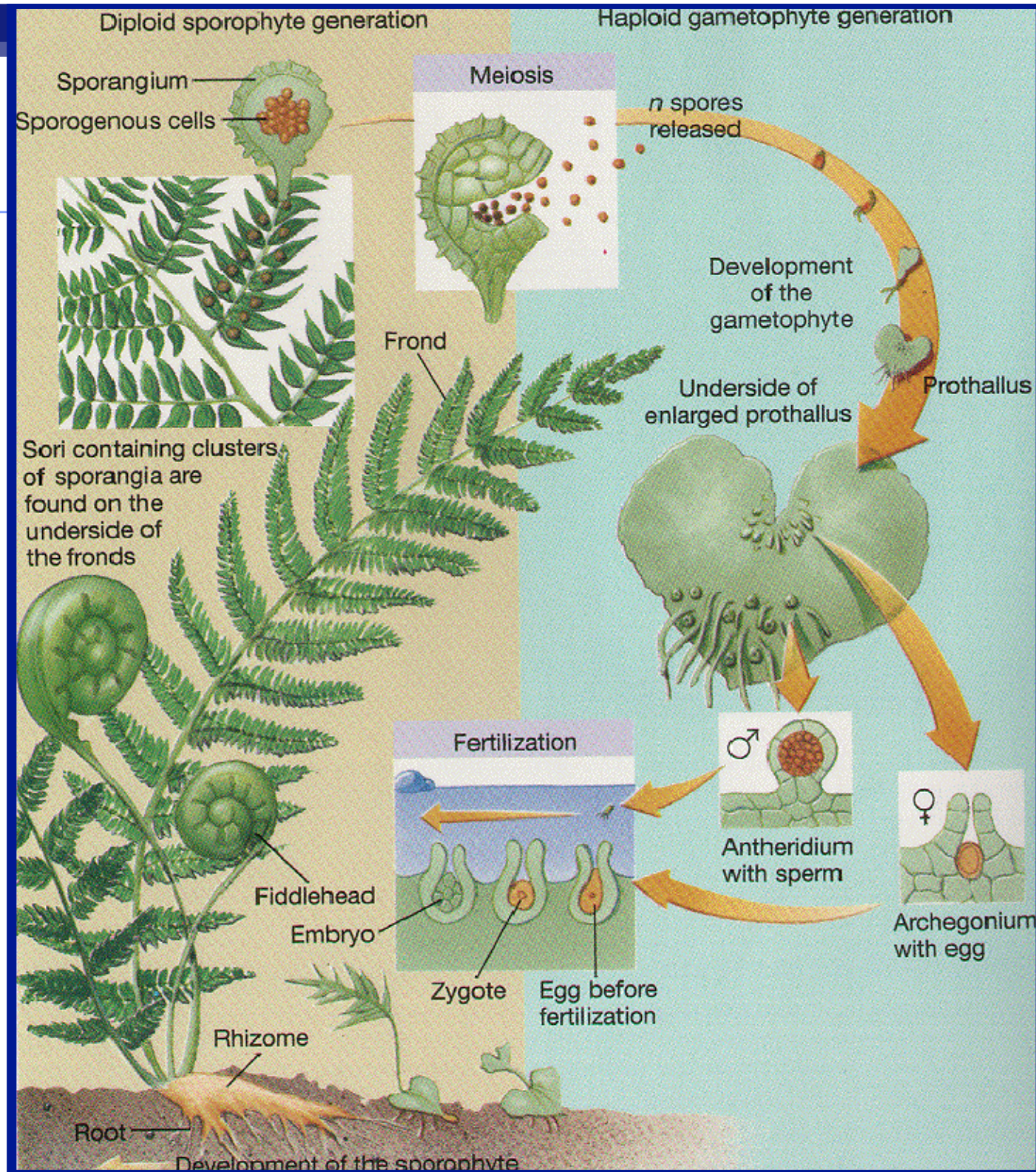


Where must ferns live?

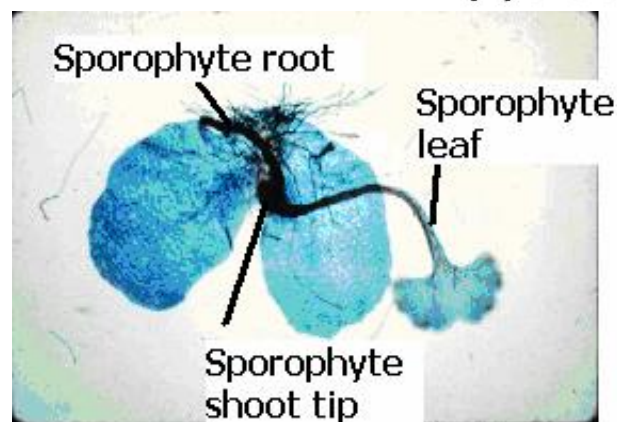
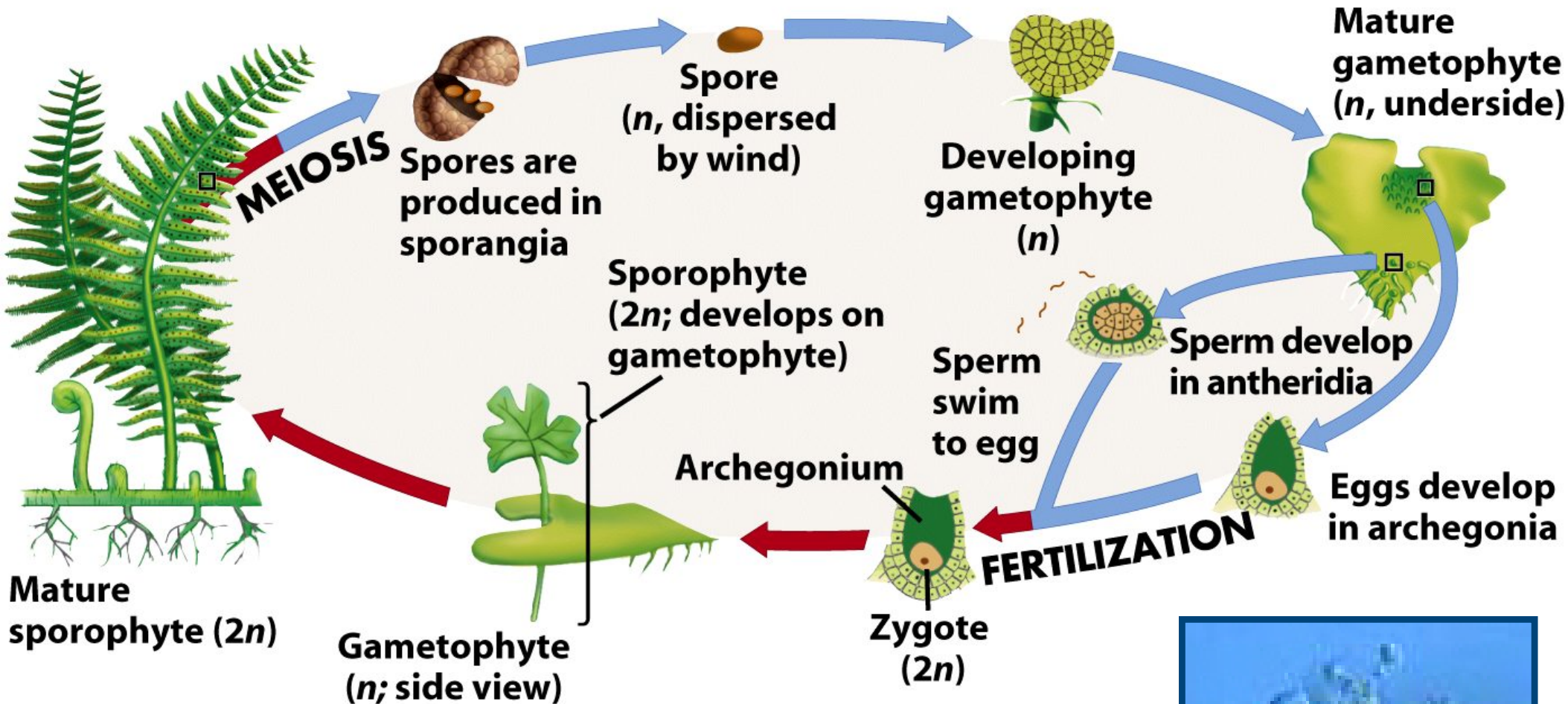




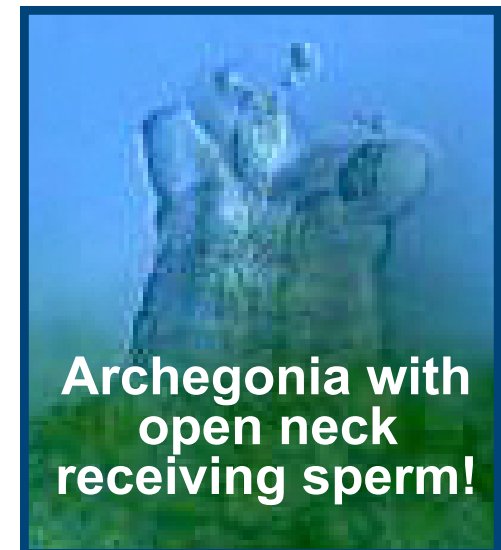
Pterophyte (Fern) Life Cycle



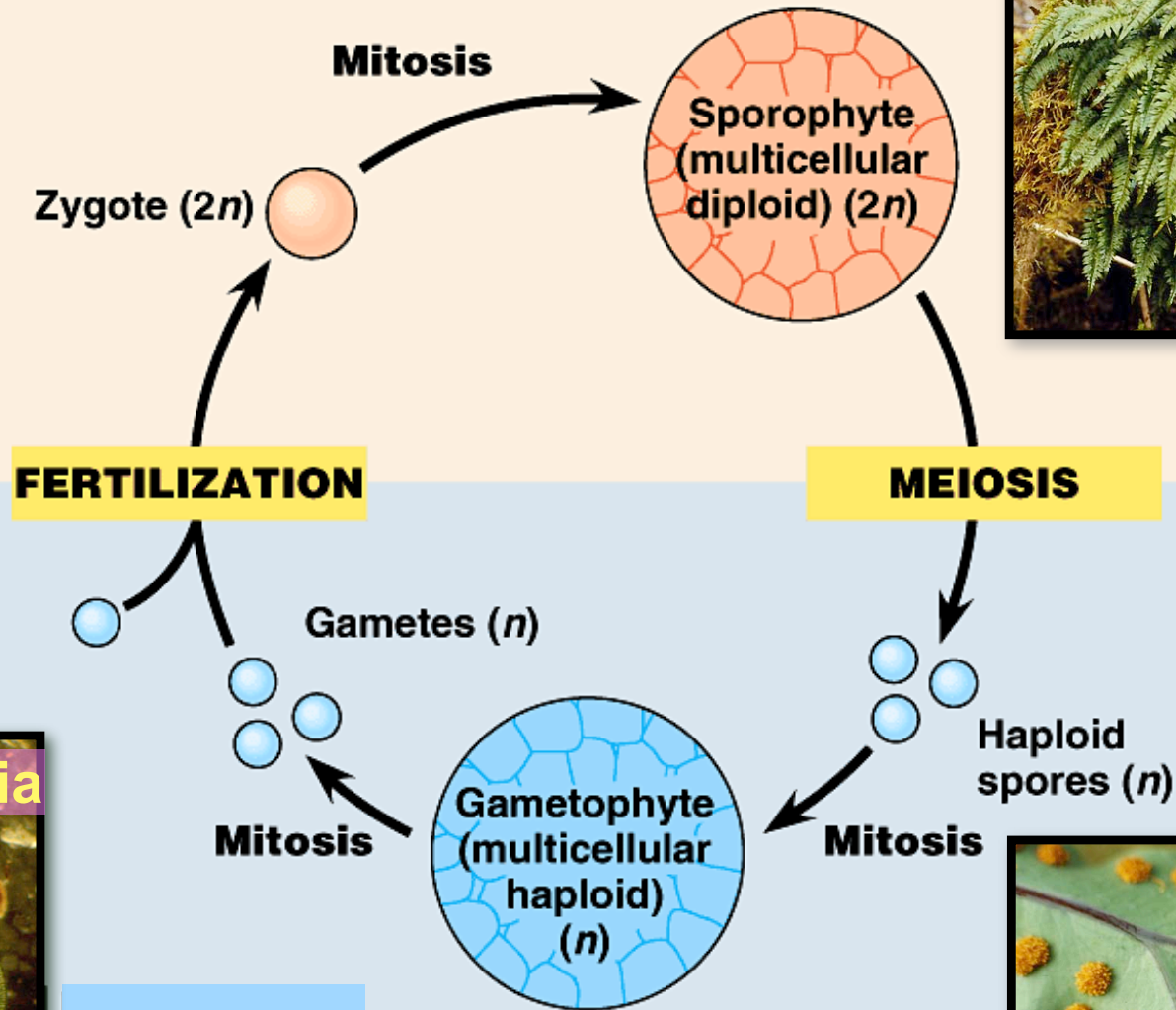
Ferns: Sporophyte is large and long lived but, when young, depends on gametophyte for nutrition.



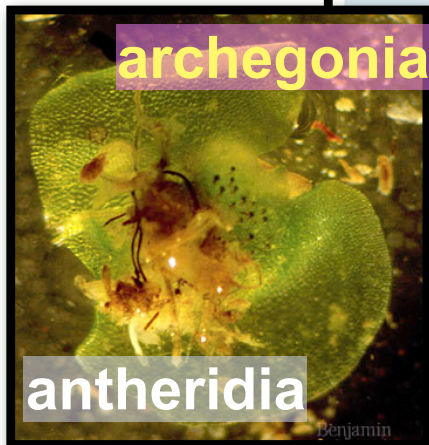
- **Gametophyte is barely visible.**
- **Independent Sporophyte continues to grow while the gametophyte dies.**



Alternation of Generations



diploid

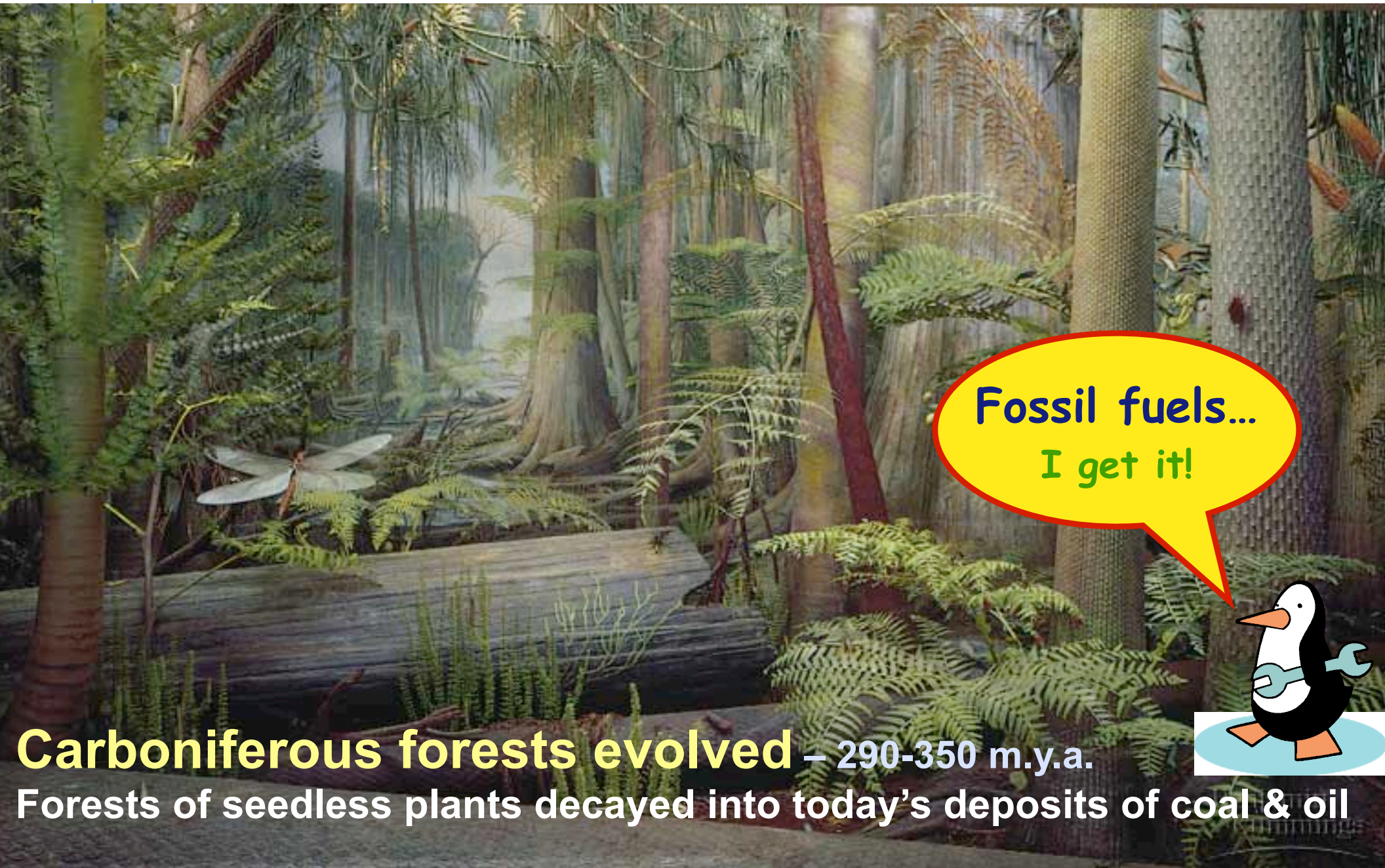


haploid



Ferns are Homosporous:
Gametophyte produces male & female gametes

Early Pteridophytes: Tree Ferns



Fossil fuels...
I get it!



Carboniferous forests evolved – 290-350 m.y.a.

Forests of seedless plants decayed into today's deposits of coal & oil