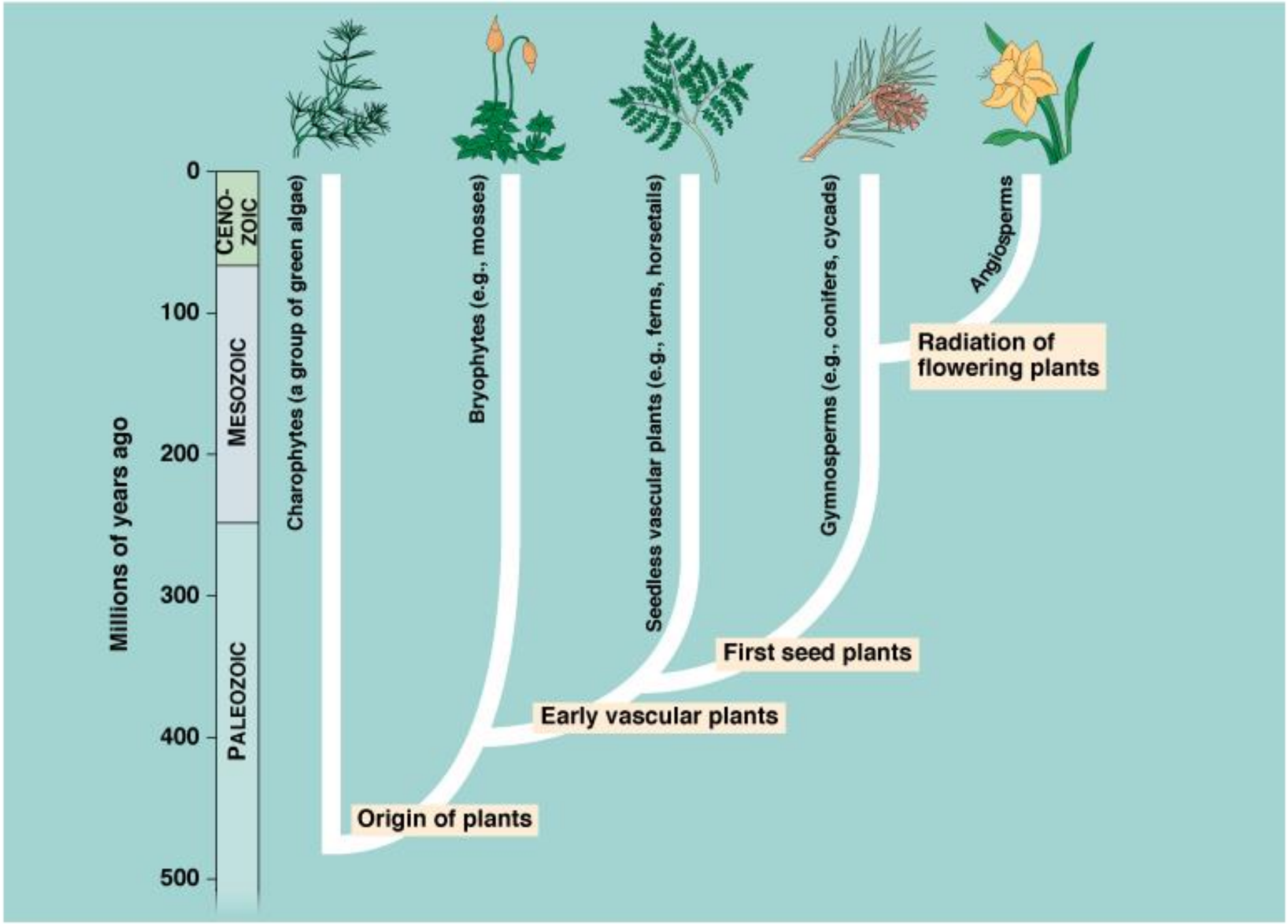
Kingdom Plantae



Reproduction in Algae (20-3)

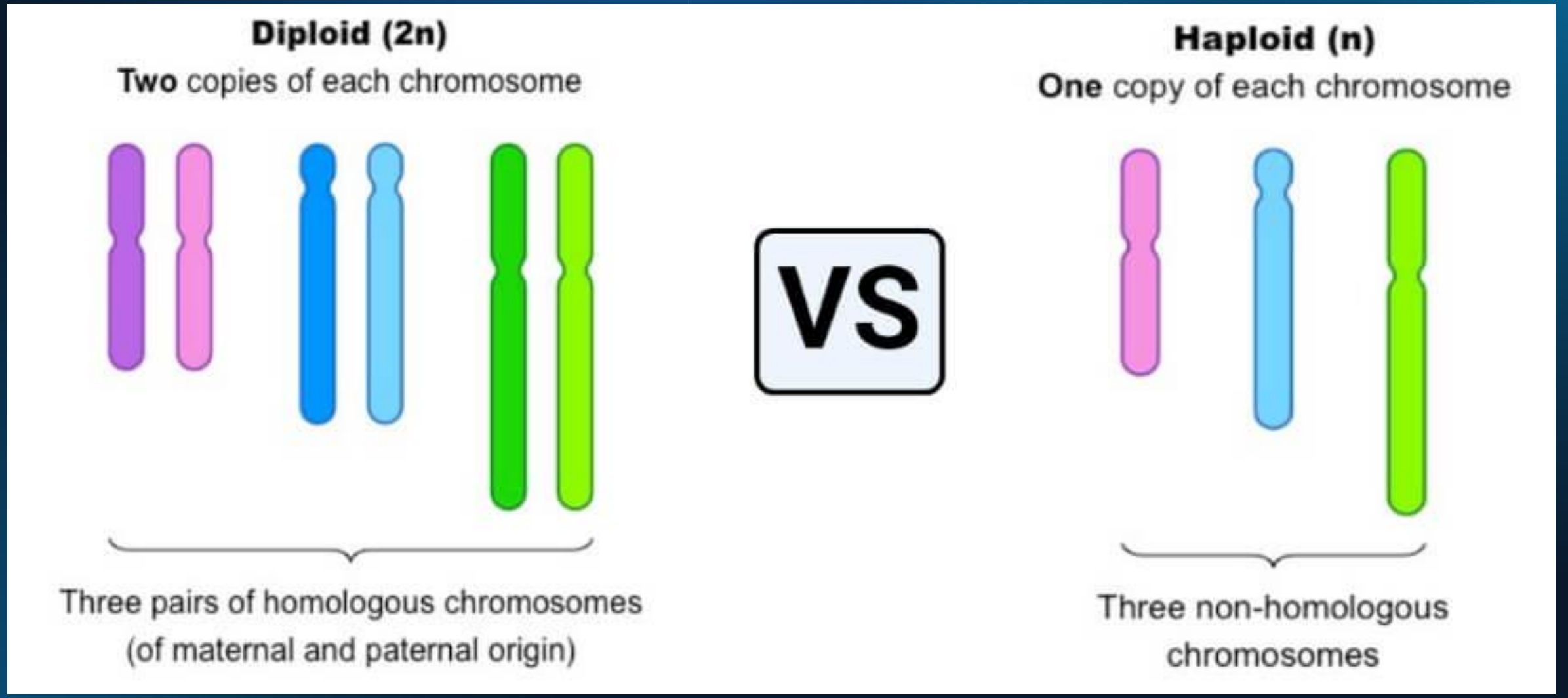
Introduction

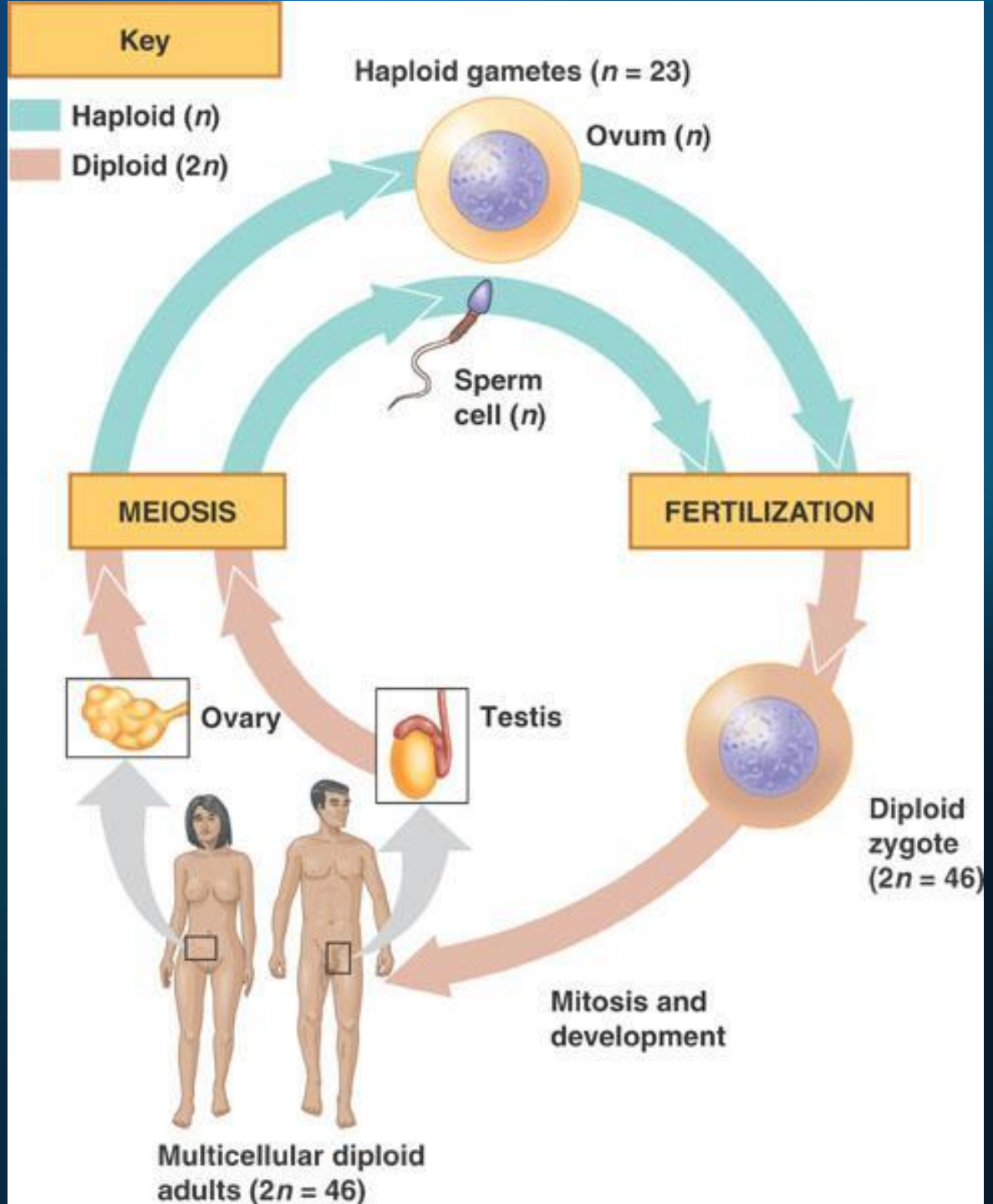
Draw the “life cycle of a human”. Include the following words:

- Meiosis
- Mitosis
- Sperm
- Egg
- Zygote
- Baby

Review the concept of ploidy with your teacher. Now, add “haploid” and “diploid” to your diagram.

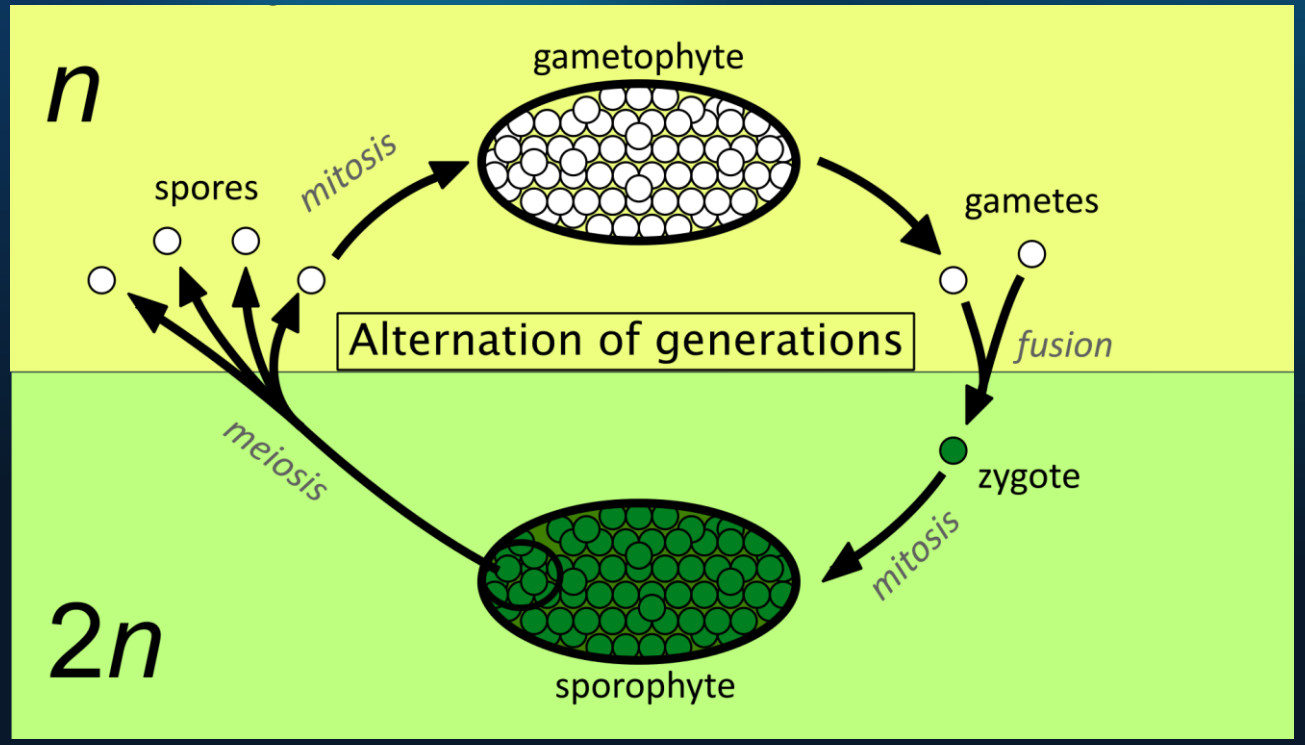
Review: Reproduction Concepts



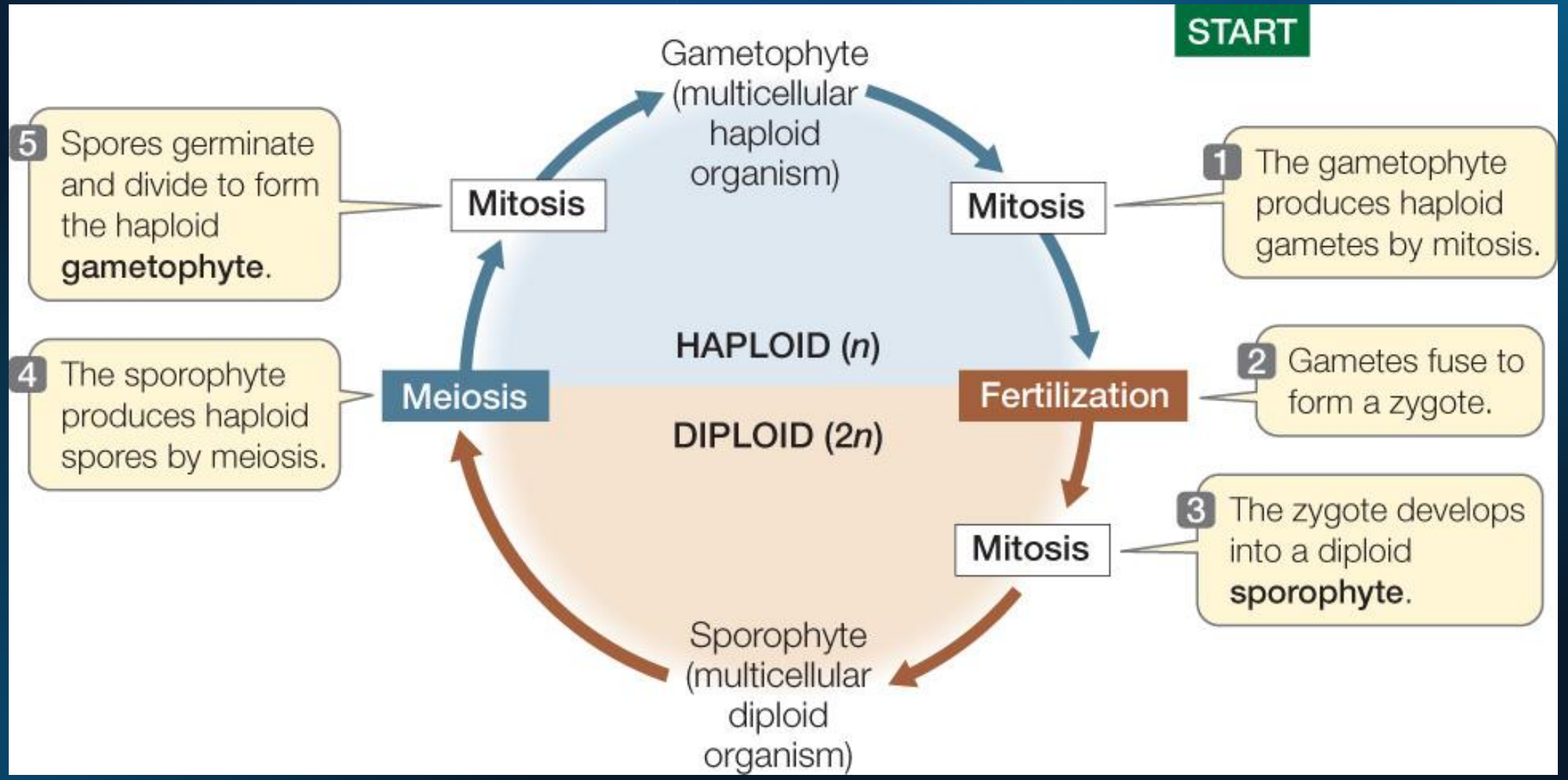

Key
Haploid (n)
Diploid (2n)
Haploid gametes (n = 23)
Ovum (n)
Sperm cell (n)
MEIOSIS
FERTILIZATION
Ovary
Testis
Diploid zygote (2n = 46)
Mitosis and development
Multicellular diploid adults (2n = 46)

Alternation of Generations

- Kingdom Plantae
- Life cycle alternates between two distinct forms:
  - Haploid (*n*) **gametophyte** generation, creates haploid gametes through mitosis
  - Diploid (2*n*) **sporophyte** generation, creates haploid spores through meiosis



Alternation of Generations



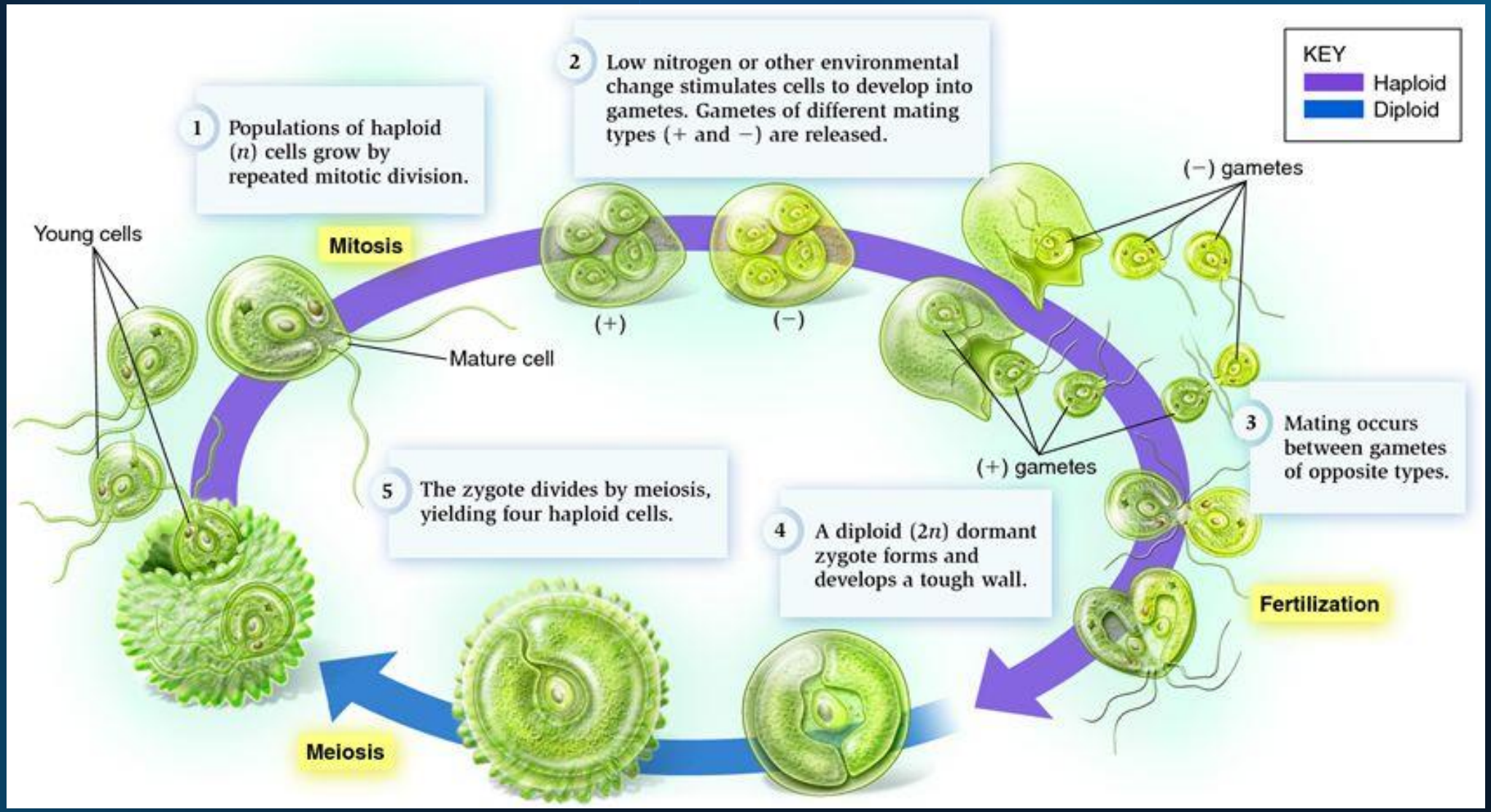
Discussion Questions

1. How does reproduction in Kingdom Plantae differ from reproduction in Kingdom Animalia? (Note: humans are animals.) Which steps/stages are similar? Which steps/stages are unique to Plantae?
2. Imagine you are a plant (diploid sporophyte generation).
   a) How would your family tree look? Include your theoretical children in this family tree.
   b) If asked the question "Who do you look the most like: mom or dad?" how would you respond as a plant? Explain your answer.

CHLAMYDOMONAS – NOT TESTABLE

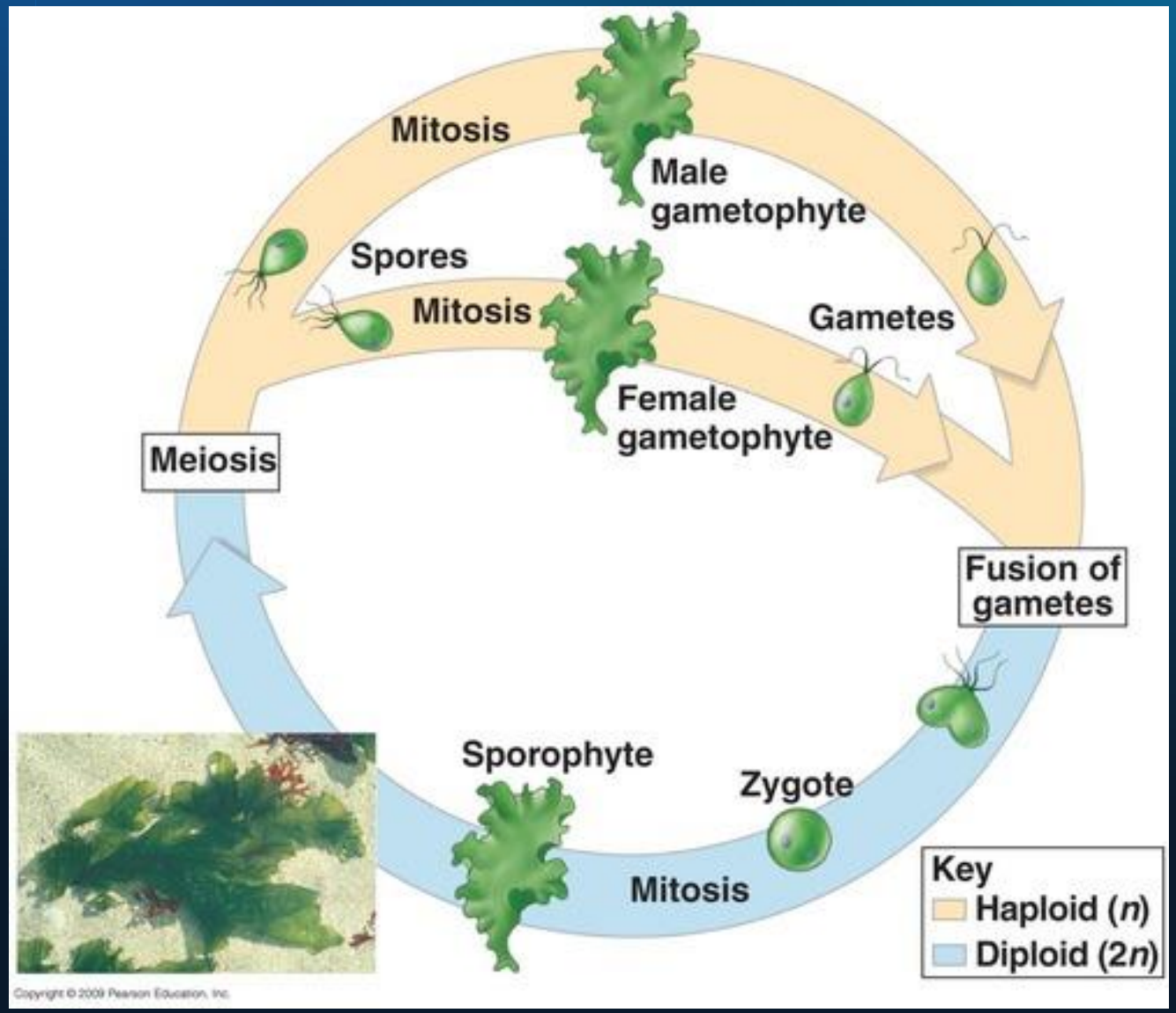
- Unicellular green algae
- Reproduces asexually (mitosis) under favourable conditions
- Poor environmental conditions:
  - Mitotic production of gametes (+ or -)
  - Fusion into diploid zygote with thick outer wall → dormant
  - When conditions become favourable, zygote grows and undergoes meiosis (produce 4 haploid cells)

CHLAMYDOMONAS



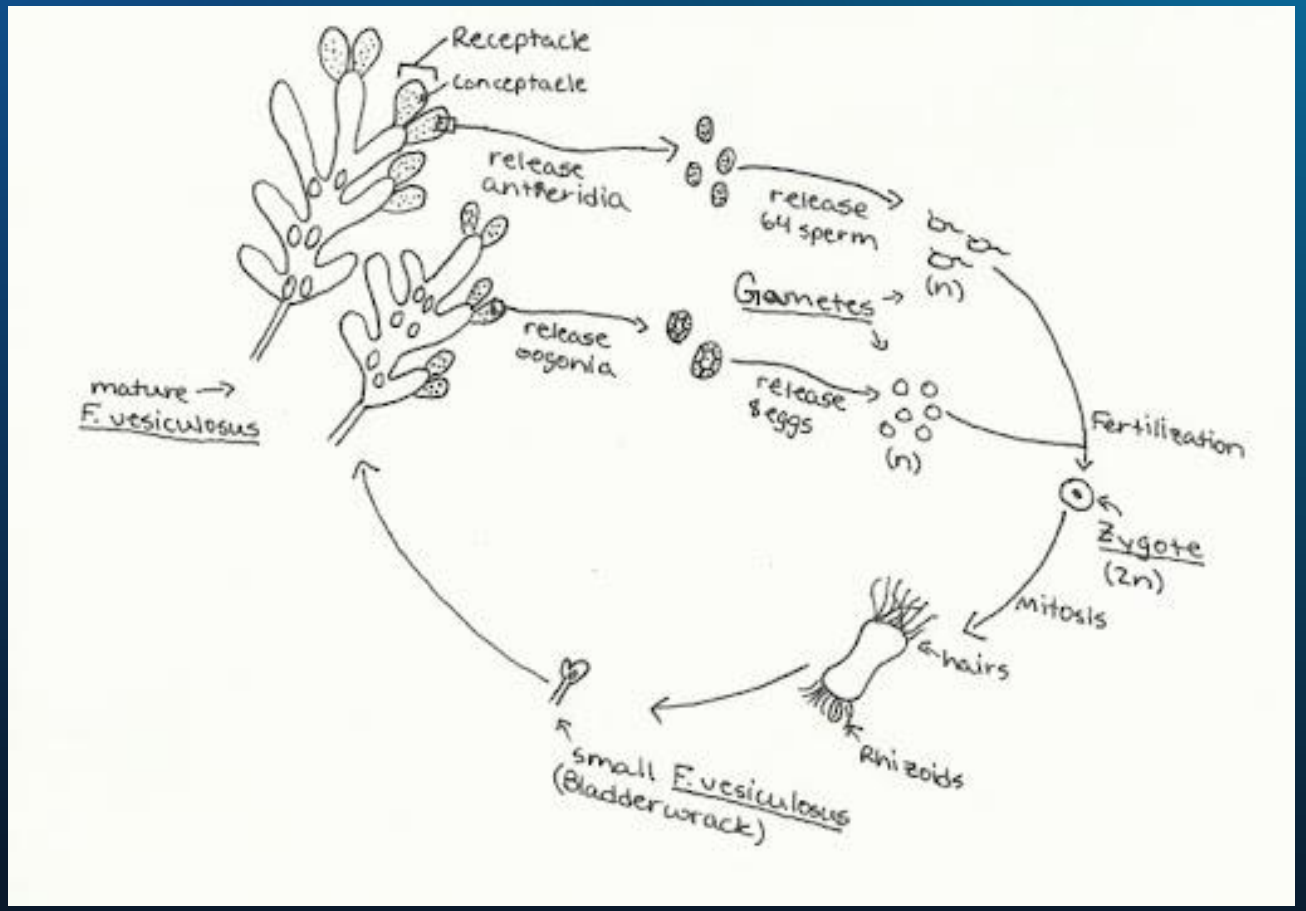
Ulva – not testable

- Diploid sporophyte and haploid gametophyte generations are both multicellular and look almost identical
- No dormant stage



Fucus – NOT TESTABLE

- Multicellular diploid sporophyte
- Unicellular haploid gametophyte (on the tips of the *Fucus* blades) produces eggs or sperm



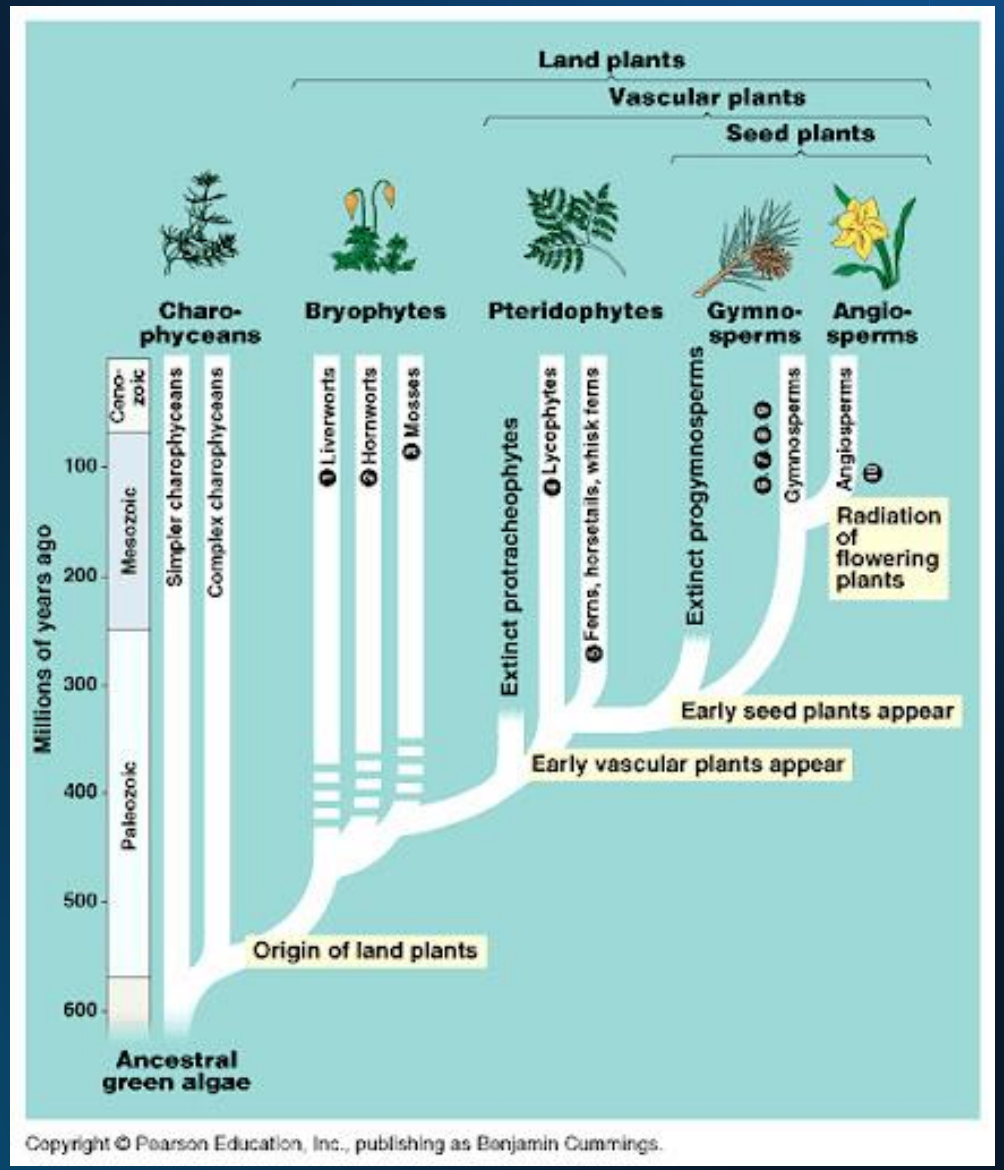
Life cycle of *Fucus* spp. Note: a single diploid sporophyte will produce both male and female gametophytes.

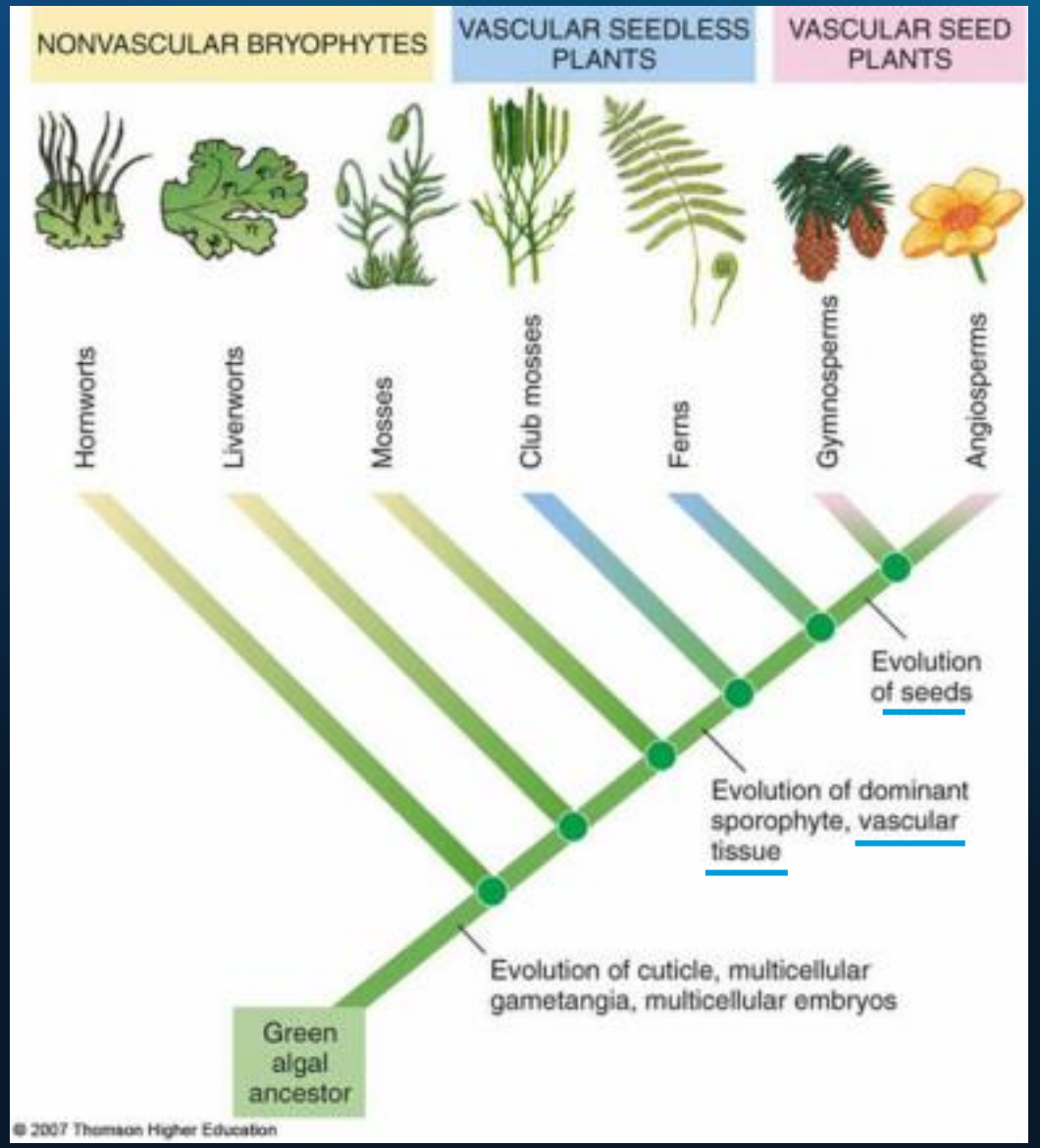
CHAPTER 21

Mosses and Ferns

Plants Invade the Land (21-1)

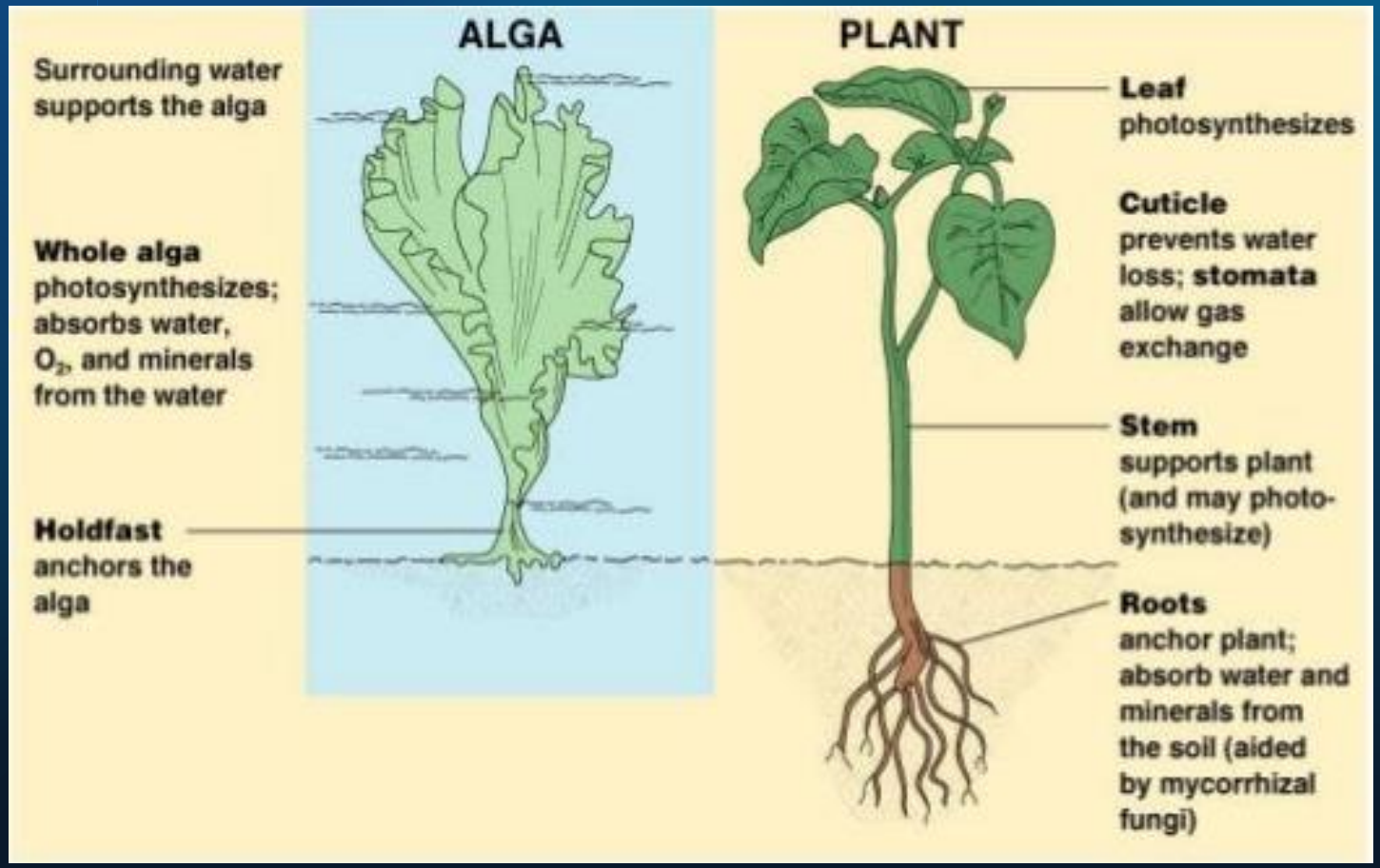
A History Lesson





Demands of Life on Land (pg 450-451)

- Avoid dehydration from evaporation
- Structural support (expose leaves to sun)
- Transport water and nutrients to cells
- Reproduction without water to swim in



A History Lesson (Testable Dates)

- Algae are thought to have evolved up to 1 billion years ago
- Approx 550 mya: algae that could live out of water part-time
- Approx 450 mya: land plants split into two groups:
  - Bryophyta (mosses, liverworts, hornworts)
  - Tracheophyta (ferns, vascular plants)

Bryophyta

(Mosses, Liverworts, Hornworts) (21-2)

Key Characteristics

- **Alternation of generations:** gametophyte is dominant*
- Live only in wet or moist areas (swamps, marshes, rainforests, near streams)
- **Monoecious:** a single individual produces both male and female gametes

*This distinguishes Bryophytes from Tracheophytes, where the sporophyte generation is dominant.

Key Characteristics (Cont.)

- No vascular system: rely on osmosis and capillary action; bryophytes are ***small***
- No protective surface covering to prevent evaporation
- Bryophytes require water for sexual reproduction (sperm have flagella and need to swim to eggs)

Mosses

Note: textbook compares mosses, liverworts, hornworts. You are not required to know the differences.

Liverworts

Hornworts

Bryophyte Anatomy

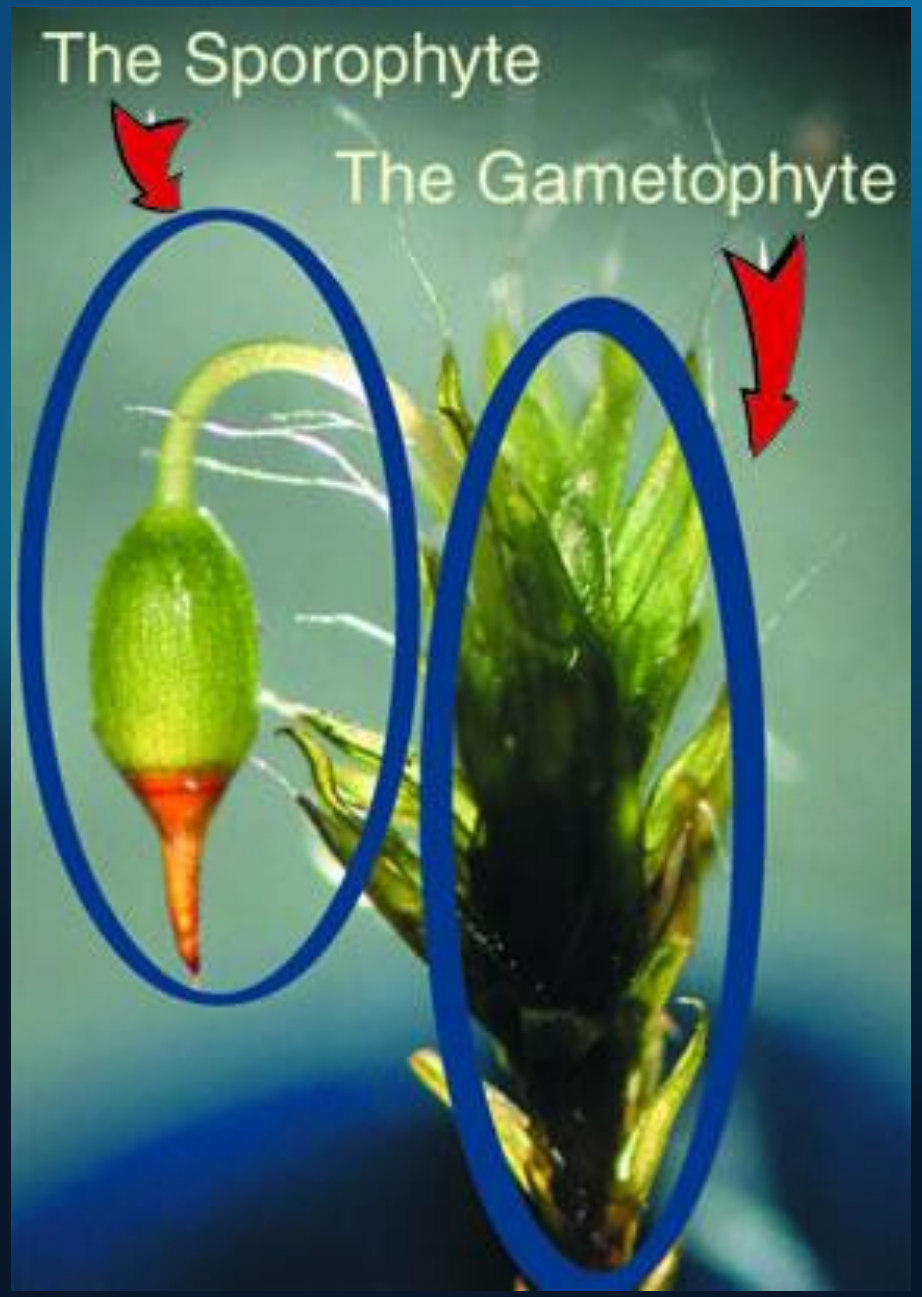
- Small: only a few cm tall
- Thin upright ‘stem’ with ‘leaves’*
- **Rhizoids:** anchor bryophyte to ground**

* Not true leaves because lacking vascular tissue

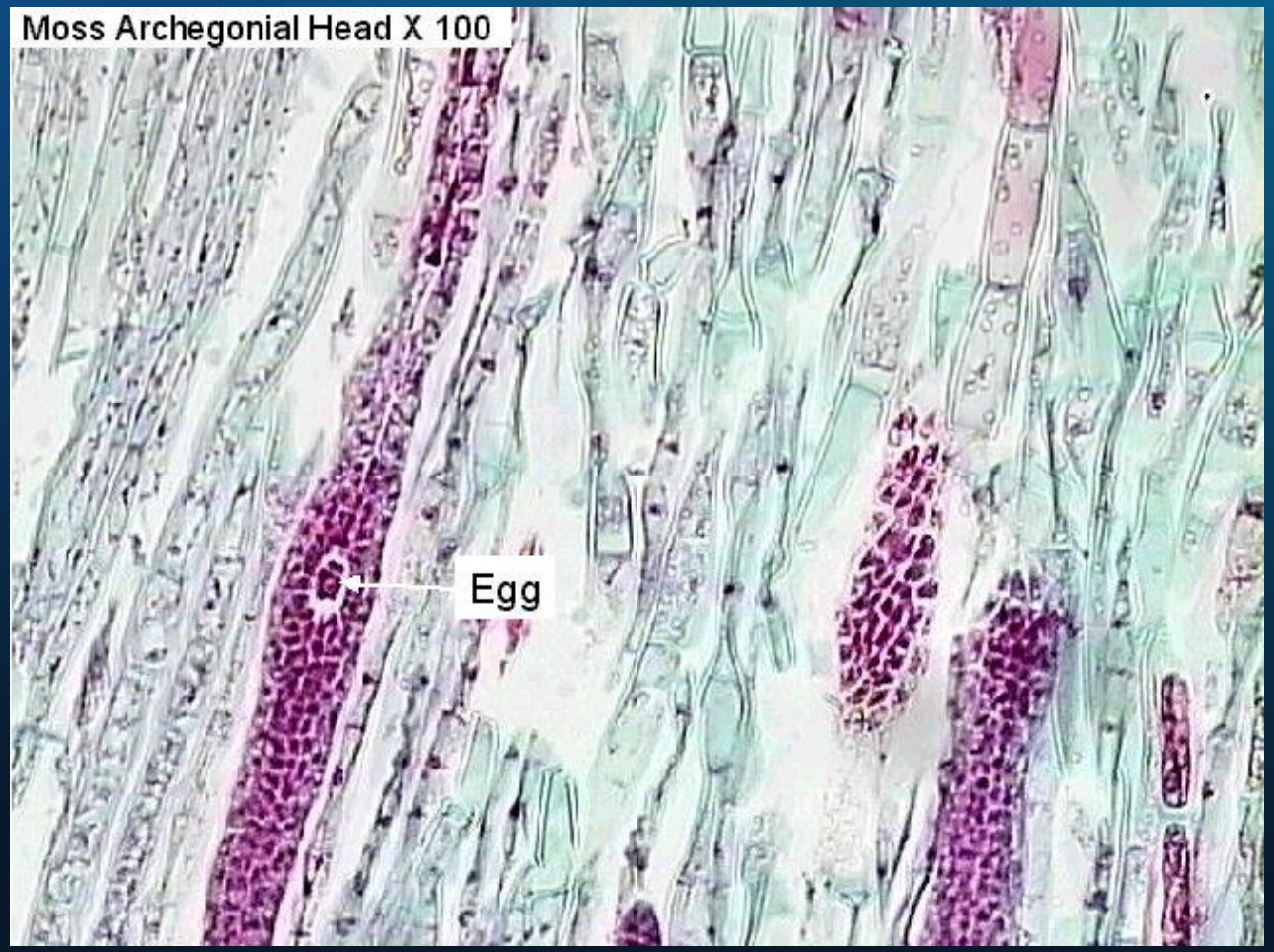
** Rhizoids are not considered roots because they do not play a role in absorption and transport of water and minerals

Bryophyte Life Cycle

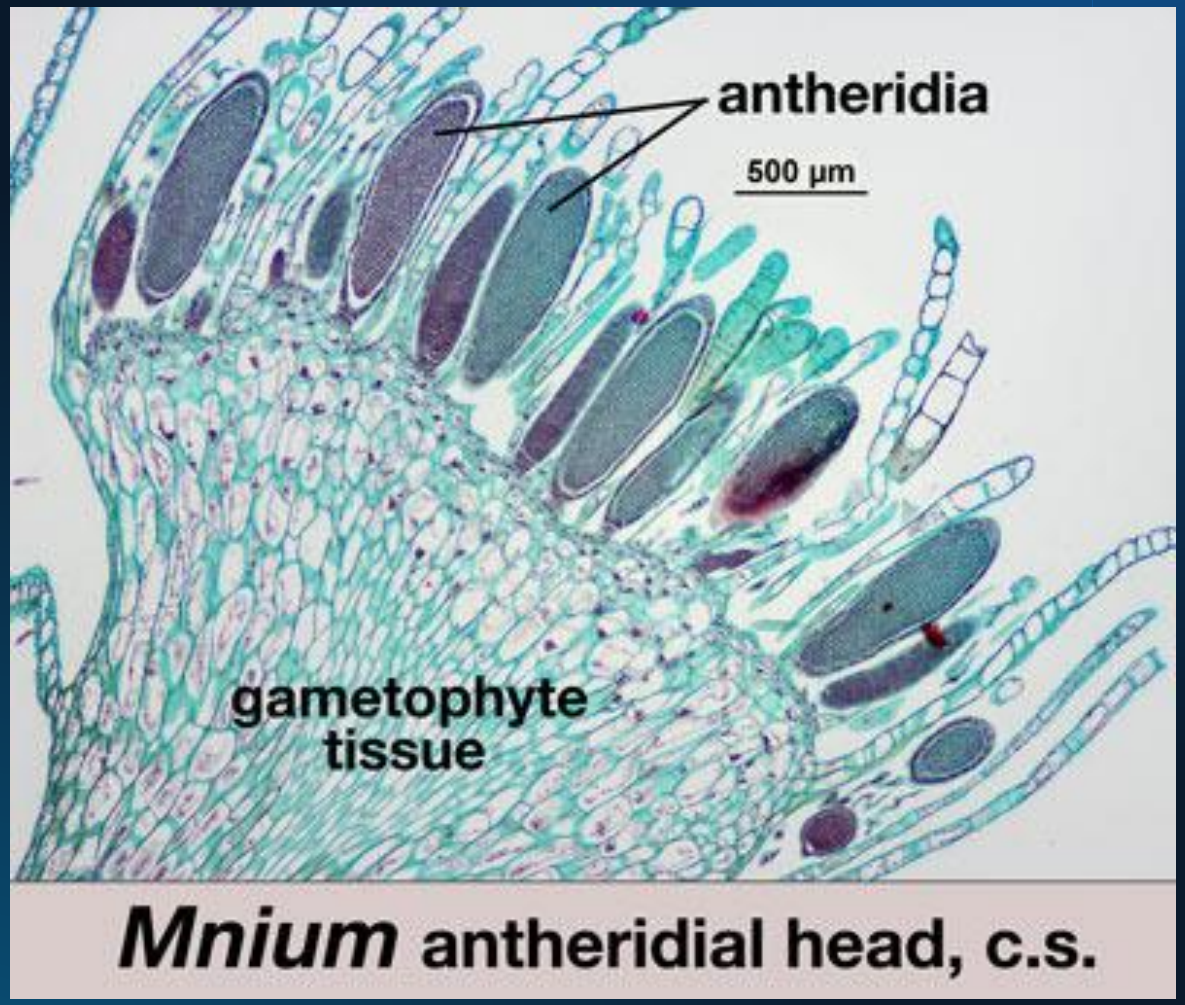
- Haploid **gametophyte** – dominant form
  - **Antheridium** (pl. antheridia): male gametophyte, produces sperm
  - **Archegonium** (pl. archegonia): female gametophyte, produces eggs
- Reminder: water is ***required*** for sexual reproduction in bryophytes.

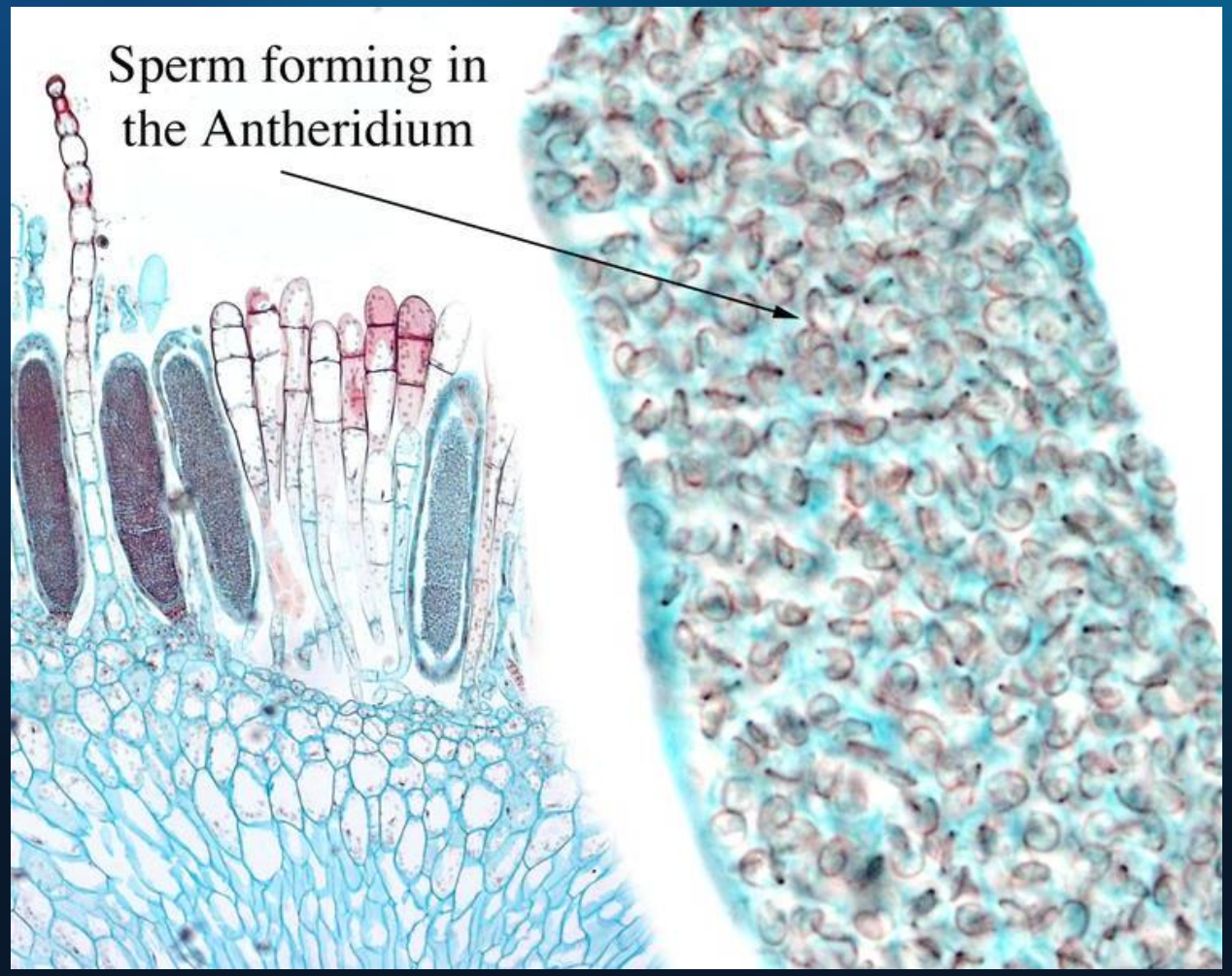


Bryophyte Life Cycle



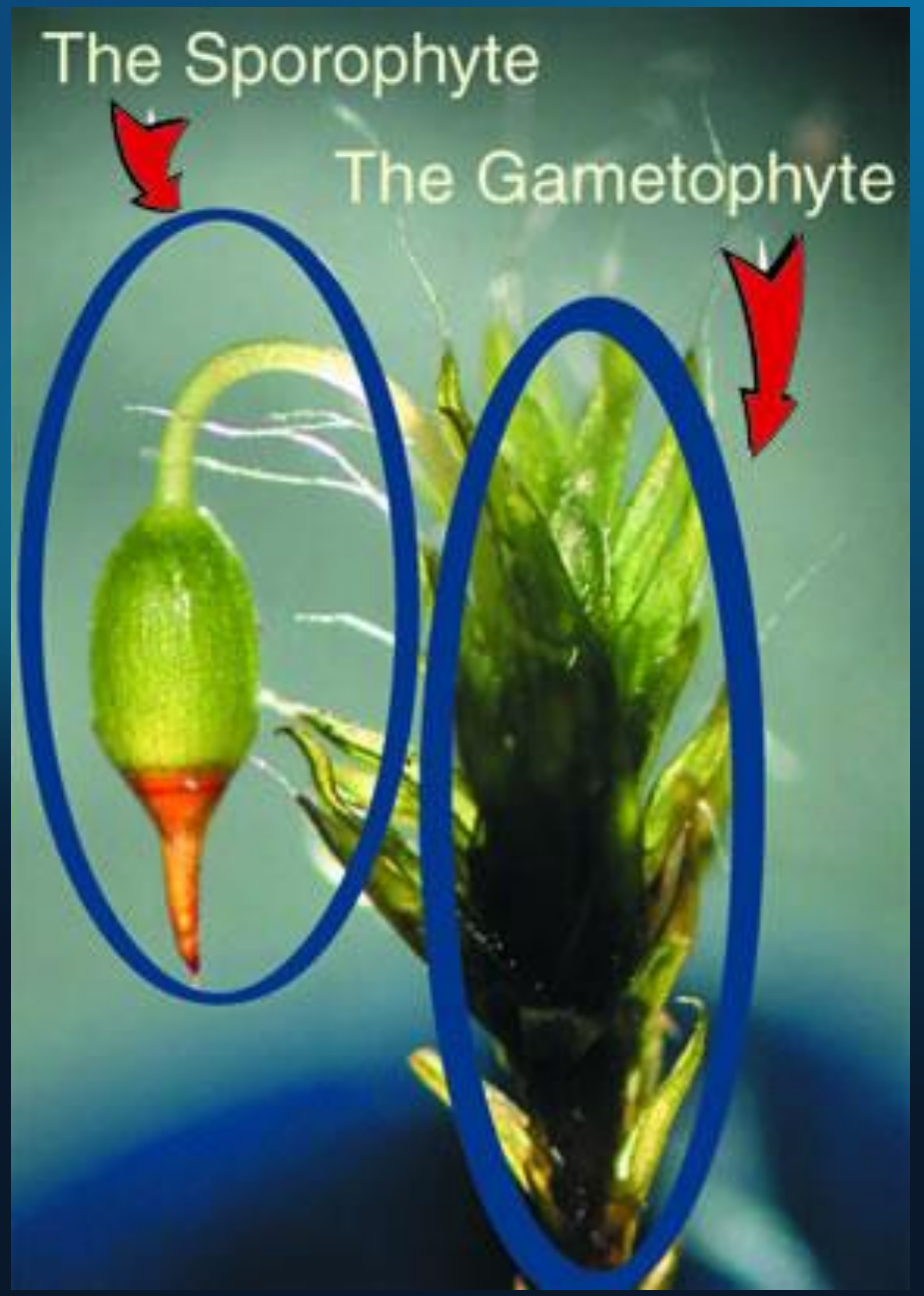
Bryophyte Life Cycle



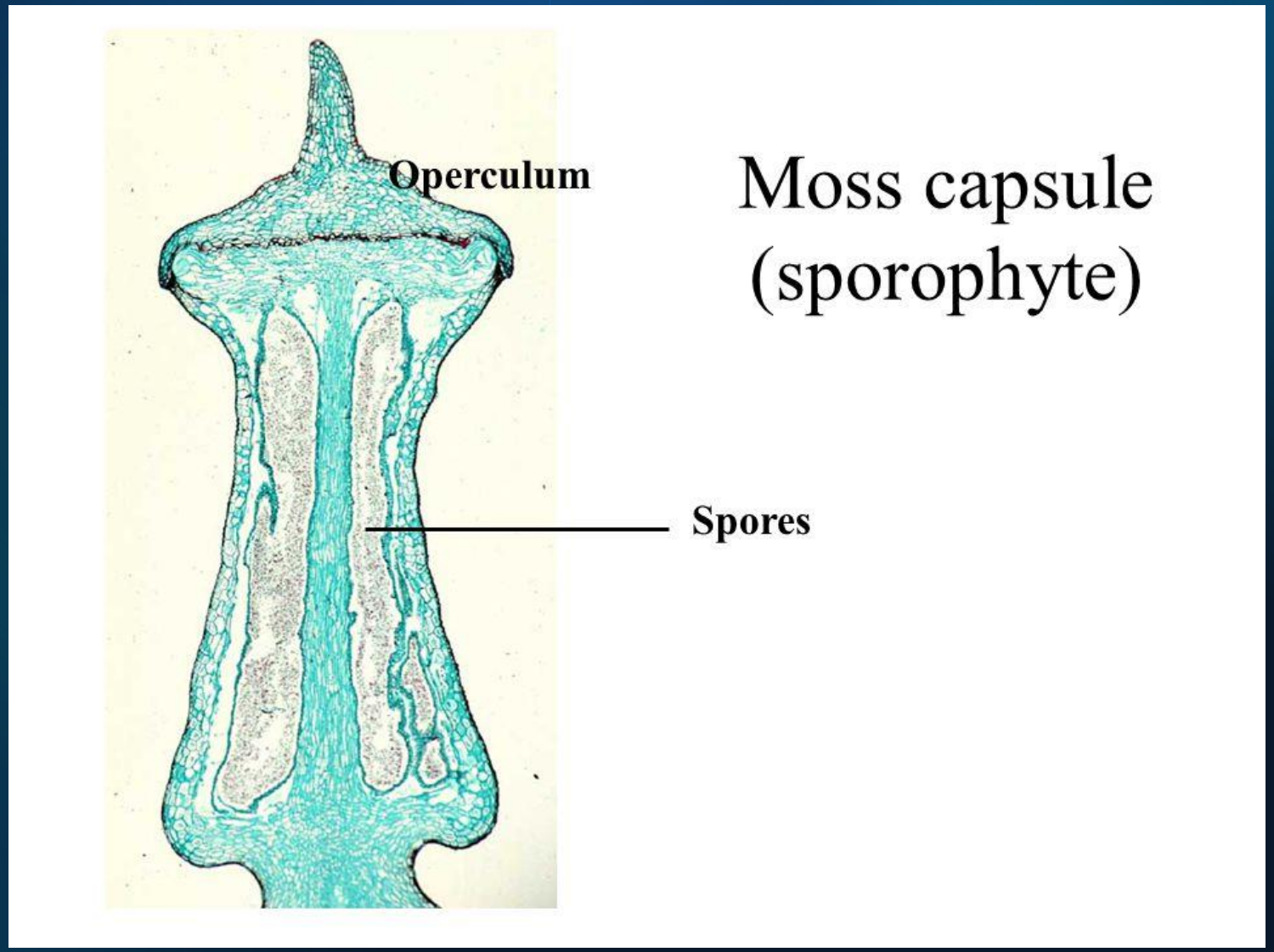


Bryophyte Life Cycle

- After fertilization and germination, diploid **sporophyte** forms:
  - Supplied with water and nutrients from gametophyte
  - Capsule contains spores; stalk connects it to gametophyte
  - Forms spores asexually that are carried off by water and wind to form a new gametophyte

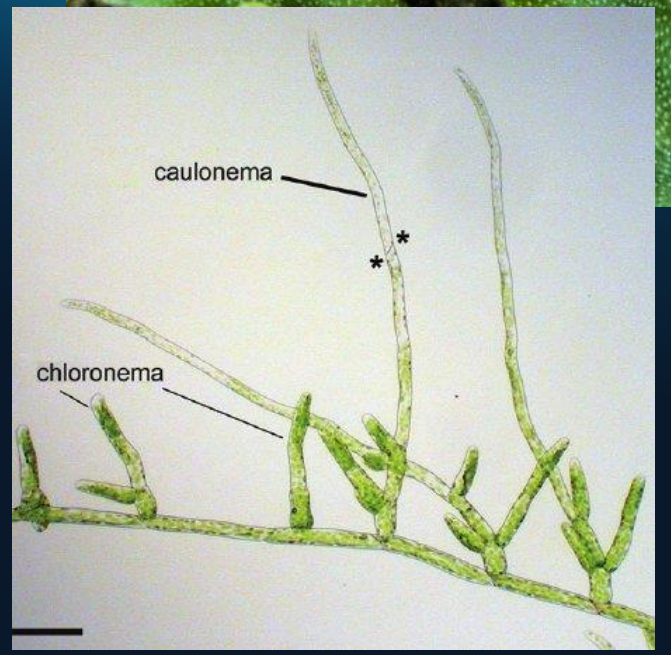


Bryophyte Life Cycle



Bryophyte Fun Facts

- **Splash cups** in some species: distribute sperm from gametophytes when raindrops hit
- Bryophyte spores germinates to form a **protonema**, which resembles a filamentous green algae → evolutionary origins?



Questions

1. List the characteristics of bryophytes.
2. What is the name of the structure that anchors bryophytes down? Why are these not considered true roots?
3. Give three reasons why bryophytes require water.
4. What does alternation of generations mean?
5. Define gametophyte. Define sporophyte. (Include: ploidy, what it makes and how it makes it.)
6. During which months would we expect to see the most sporophytes? The least? Explain briefly.

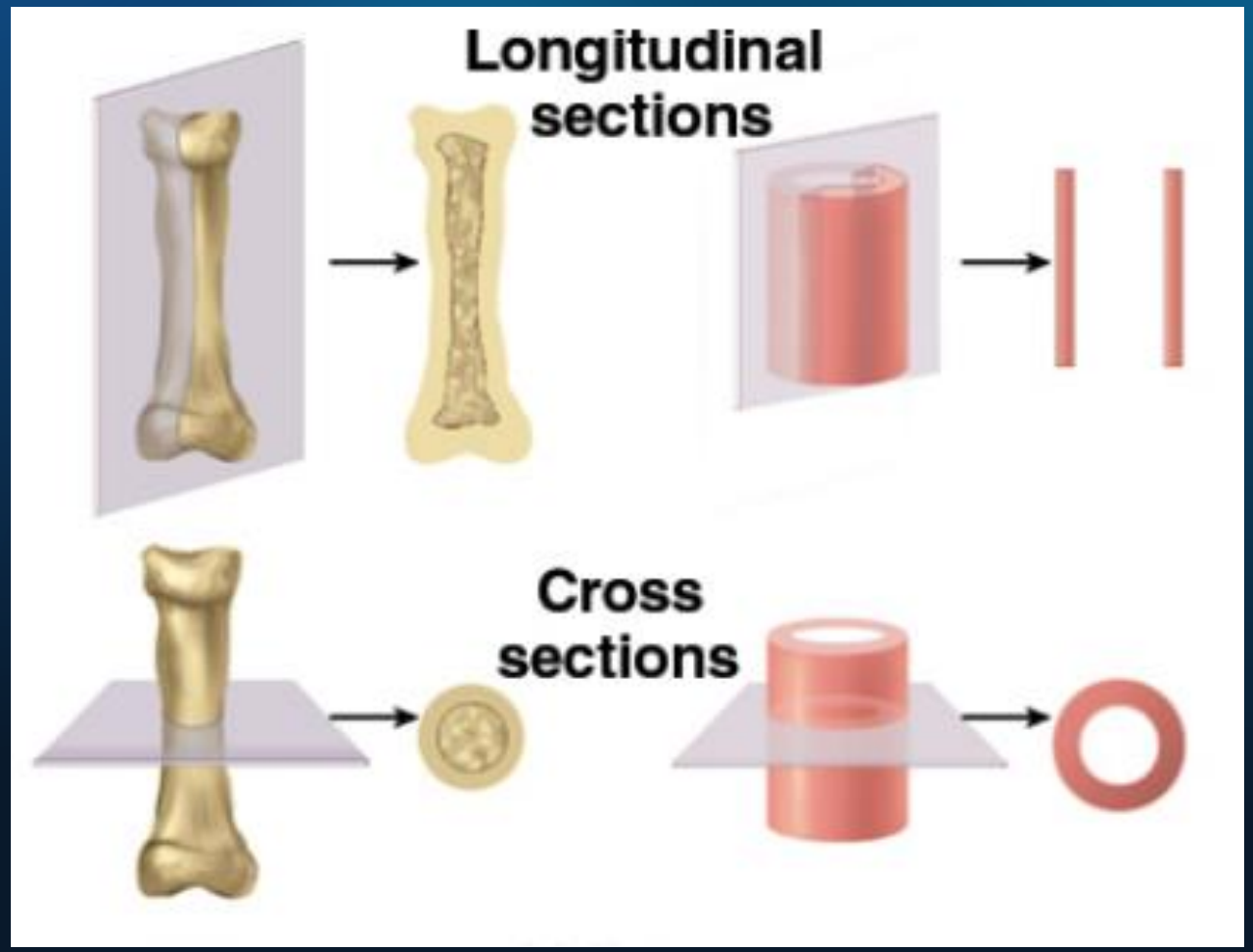
Moss Videos

Moss Life Cycle: has some extra, untestable material but provides a good visual
https://www.youtube.com/watch?v=2kY7uzeYWFc&ab_channel=NookNattapon

“The Hidden Superpowers of Moss”: FYI only
https://www.youtube.com/watch?v=SS2vTGeME3Y&ab_channel=SciShow

Cross Section vs Longitudinal Section

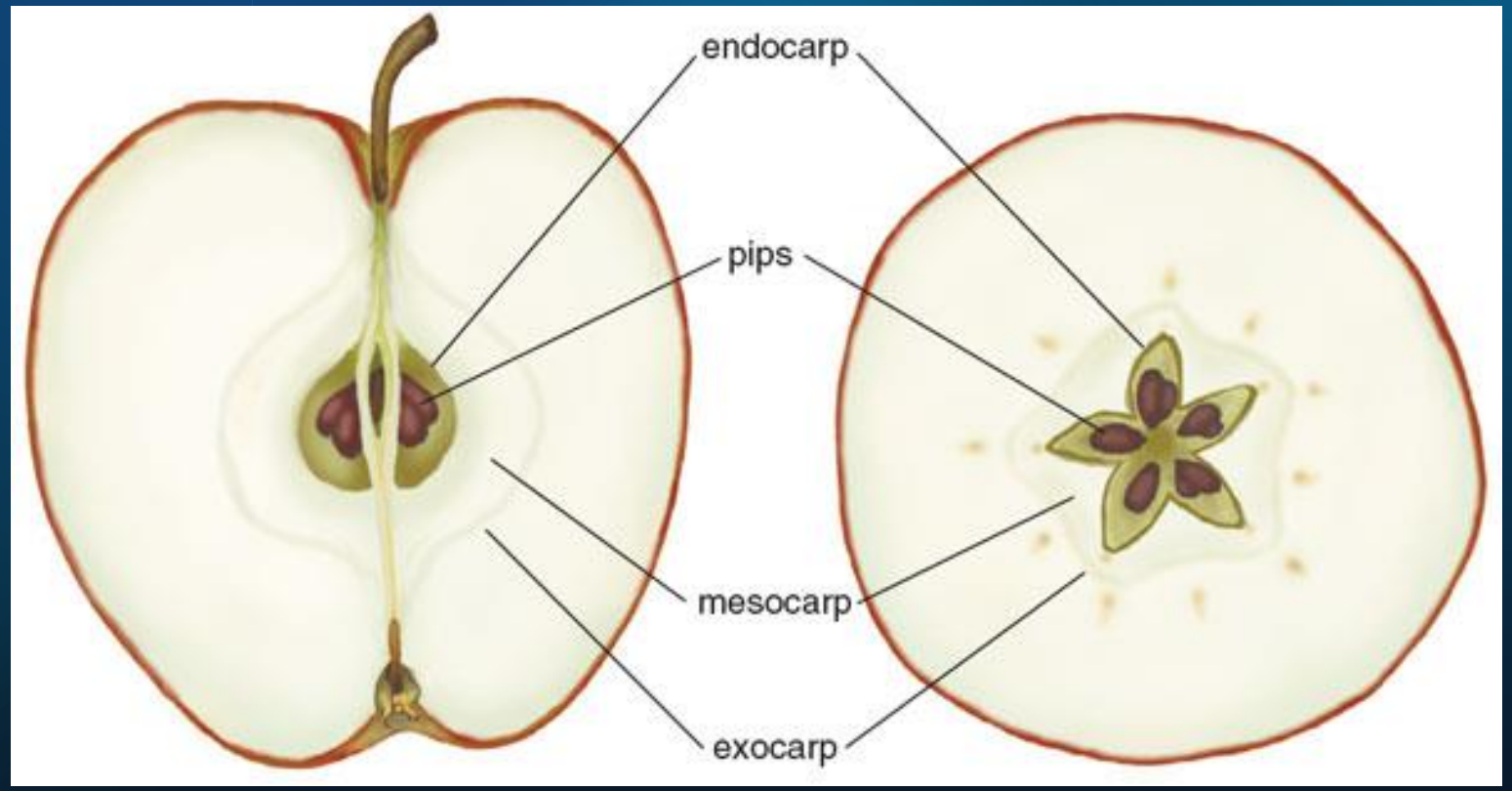
On slides, you will often see "c.s." (cross section) or "l.s." (longitudinal section). These terms refer to how the slide was prepared: by cutting a slice along the longest direction (l.s.), or perpendicular to this (c.s.).



Cross Section vs Longitudinal Section

These are slices of an apple.

Which is the cross section? Which is the longitudinal section?



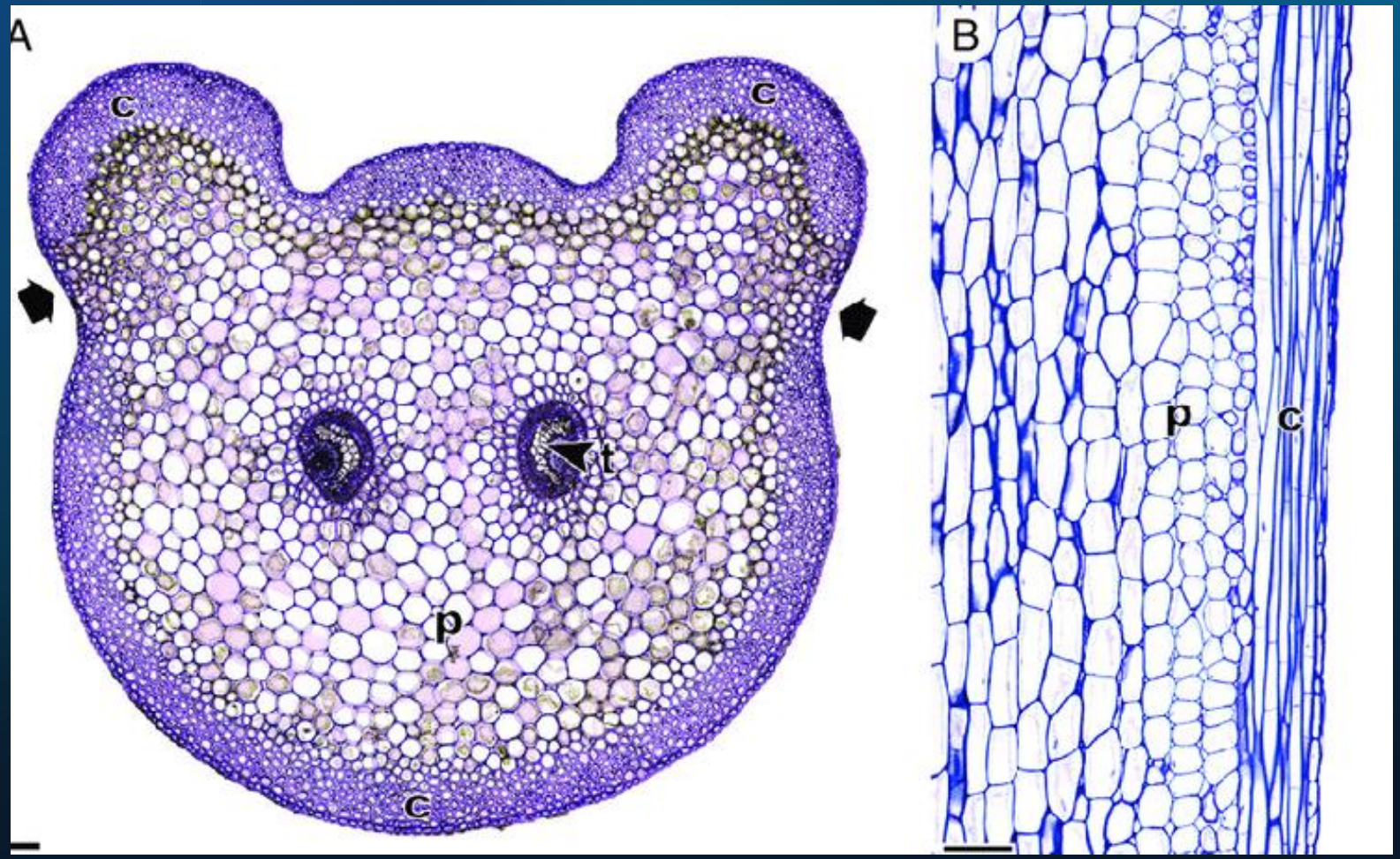
Cross Section vs Longitudinal Section

These are slides of an earthworm.

Which is the cross section? Which is the longitudinal section?

Cross Section vs Longitudinal Section

These are slides of a plant stem. Which is the cross section? Which is the longitudinal section?



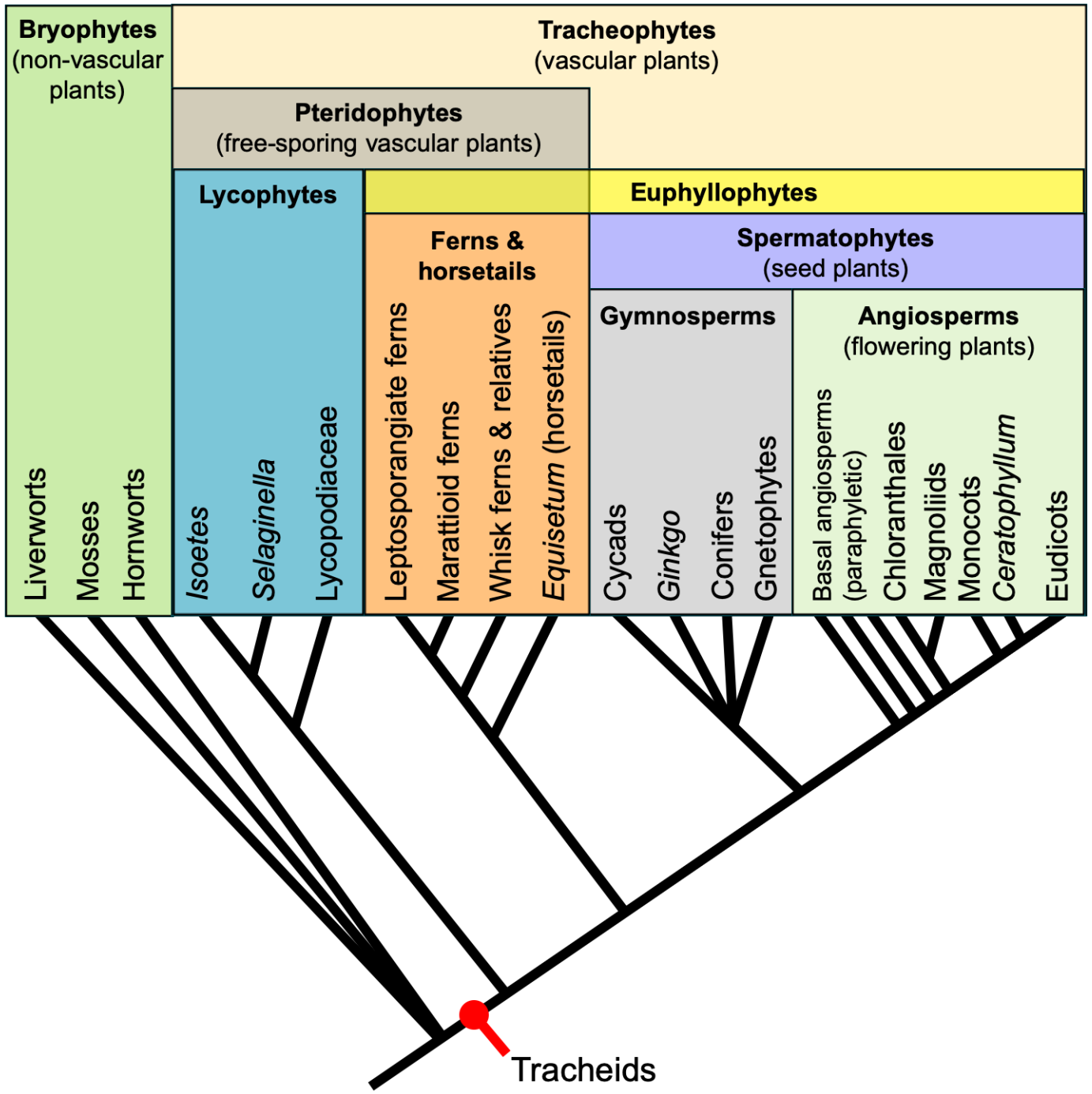
Microscopy Follow-up Questions

1. Explain how the Mnium female gametophyte differs from the male gametophyte. How do these structural differences relate to the function of each?

   (i.e. How is the male gametophyte well suited to transport sperm in the presence of water? How is the female gametophyte well suited to receive sperm, then to protect the developing embryo?)

2. You viewed a longitudinal section of a Polytrichum sporophyte. Draw your prediction of what the cross section would look like.

Tracheophytes:
(First Vascular Plants) (21-3a)


Bryophytes
(non-vascular plants)
Tracheophytes
(vascular plants)
Pteridophytes
(free-sporing vascular plants)
Lycophytes
Euphyllophytes
Ferns & horsetails
Spermatophytes
(seed plants)
Gymnosperms
Angiosperms
(flowering plants)
Liverworts
Mosses
Hornworts
Isoetes
Selaginella
Lycopodiaceae
Leptosporangiate ferns
Marattioid ferns
Whisk ferns & relatives
Equisetum (horsetails)
Cycads
Ginkgo
Conifers
Gnetophytes
Basal angiosperms (paraphyletic)
Chloranthales
Magnoliids
Monocots
Ceratophyllum
Eudicots
Tracheids

A History Lesson (Testable Dates)

- Ancient tracheophytes (400 mya): huge trees that made up Earth's first forests
- Fossilized remnants became coal and fossil fuels in Carboniferous period (360-300 mya)

Coal and Fossil Fuels: a Non-Renewable Resource

It took 100 million years after tracheophyte evolution for fungi and other decomposers to evolve the ability to break down lignin and cellulose. This is why coal and fossil fuels are a non-renewable resource.

Article: https://www.nationalgeographic.com/science/article/the-fantastically-strange-origin-of-most-coal-on-earth

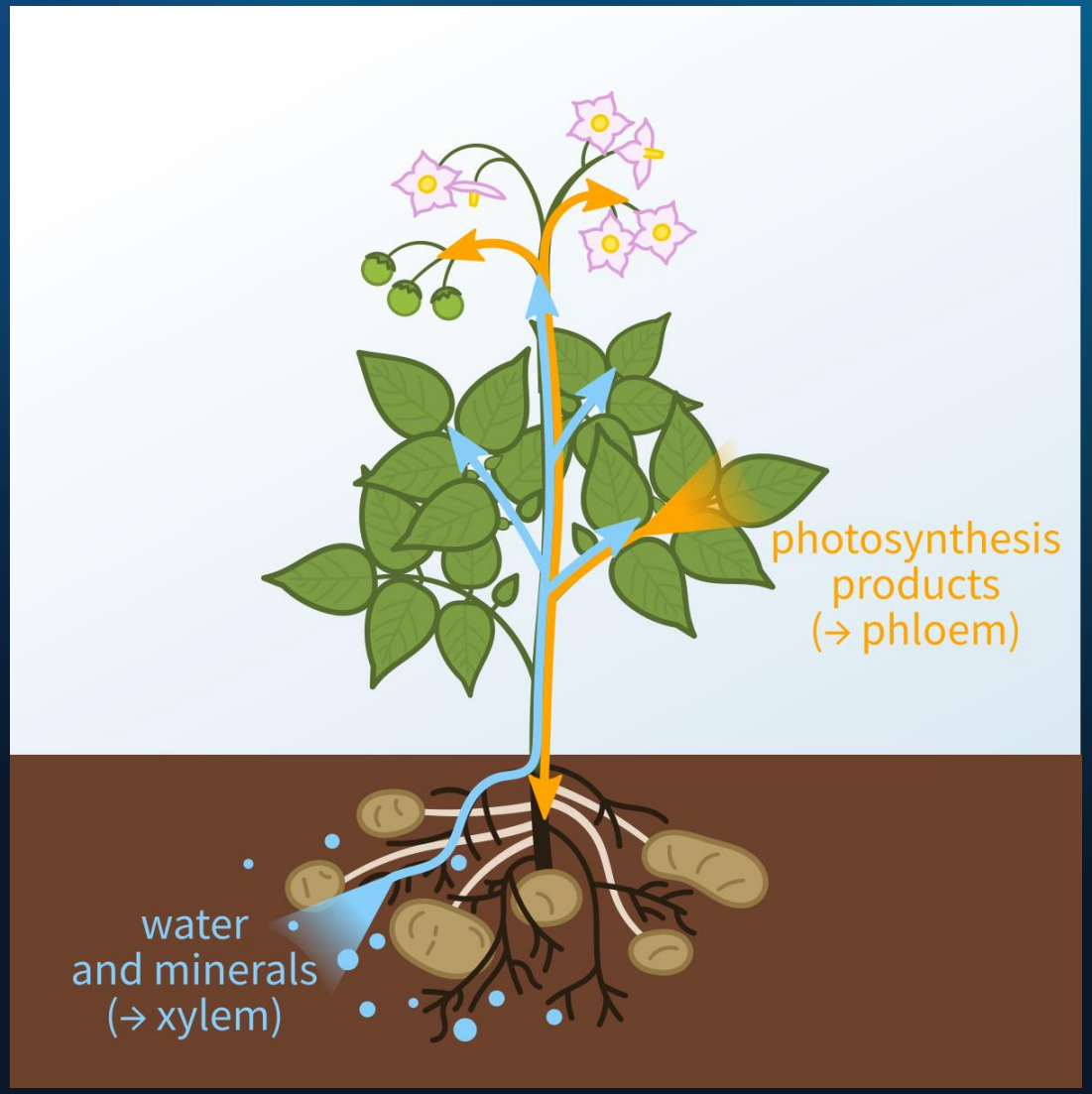
Key Characteristics

- Varied terrestrial habitats: not dependent on wet environment
- Vascular tissues (xylem, phloem, tracheid cells)
- True roots
- True leaves with a waxy cuticle
- Monoecious

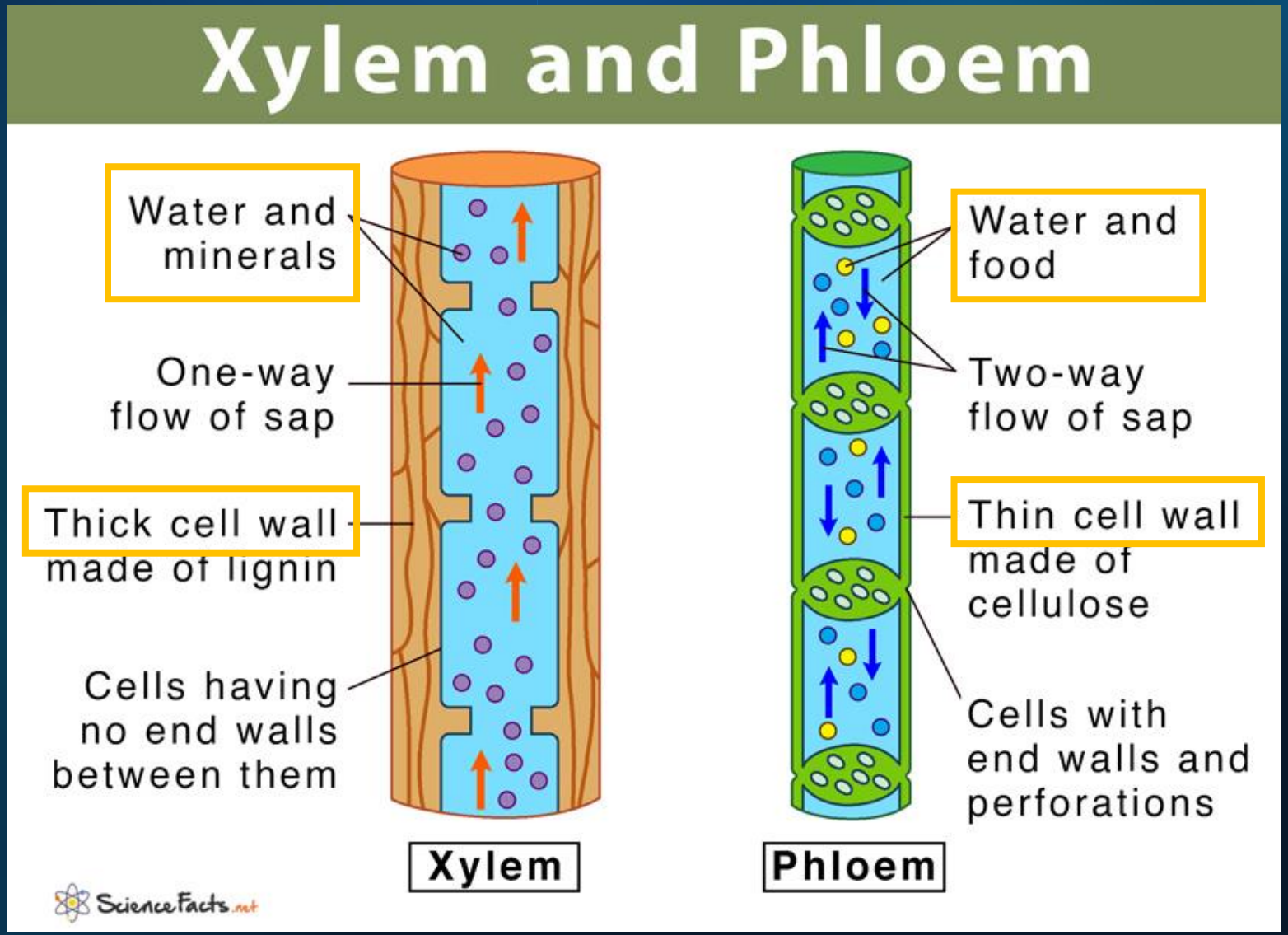
Vascular Tissues: a brief overview

Vascular tissues:

- Transport water and the products of photosynthesis throughout the plant
- Includes xylem and phloem



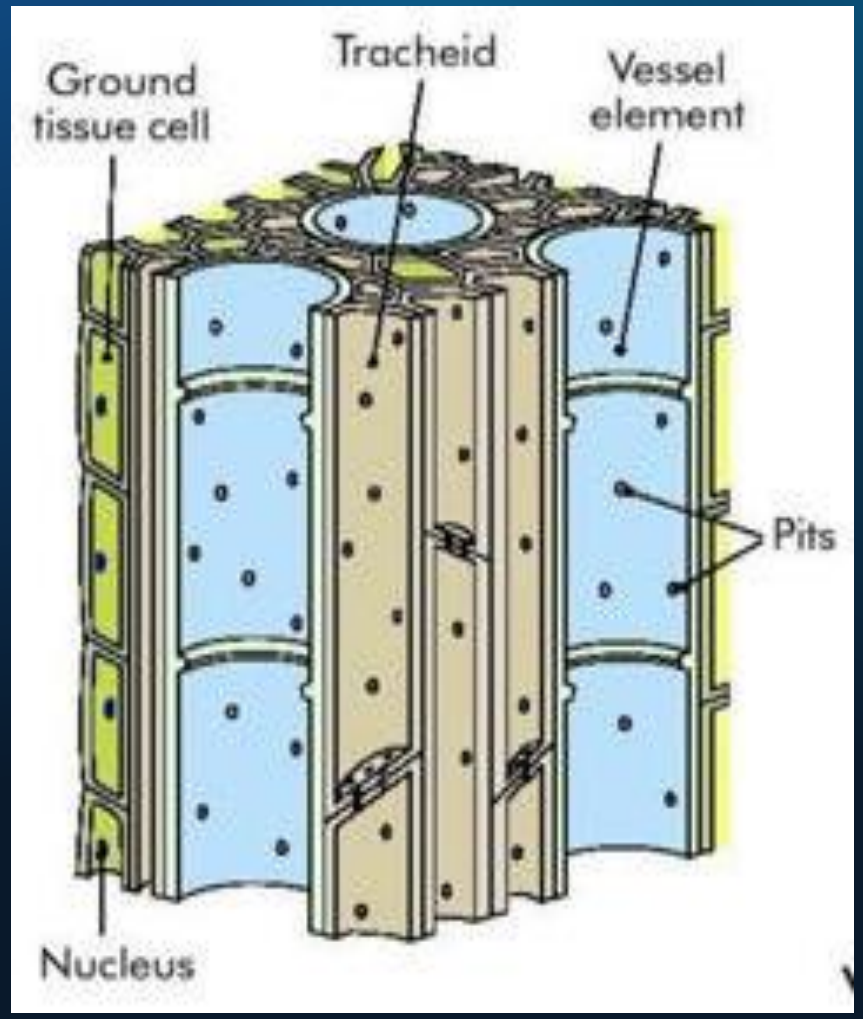
Vascular Tissues: a brief overview

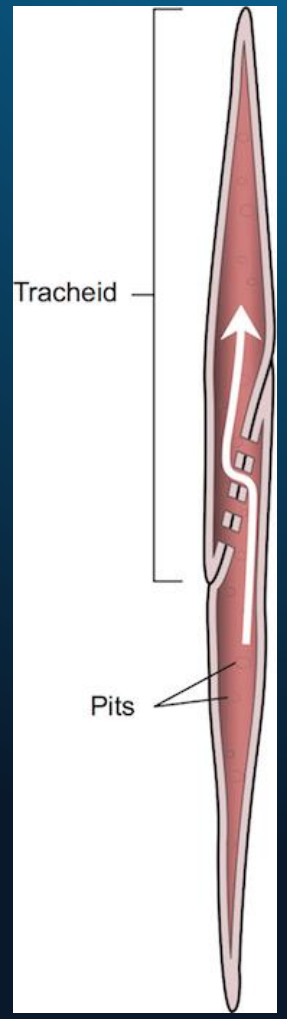


Vascular Tissues: a brief overview

Xylem: moves water and minerals from the roots to other parts of the plant

- **Tracheid cells:**
  - Carry water
  - Have thick, strong cell walls strengthen plant stems





Vascular Tissues: a brief overview

Phloem: movement of nutrients and the products of photosynthesis

Vascular Tissues: Recap

1. Why are vascular tissues important? How did the development of vascular tissues allow the rapid diversification and evolutionary success of tracheophytes?
2. Summarize the differences between xylem and phloem.
3. What is a tracheid cell? What does it do?

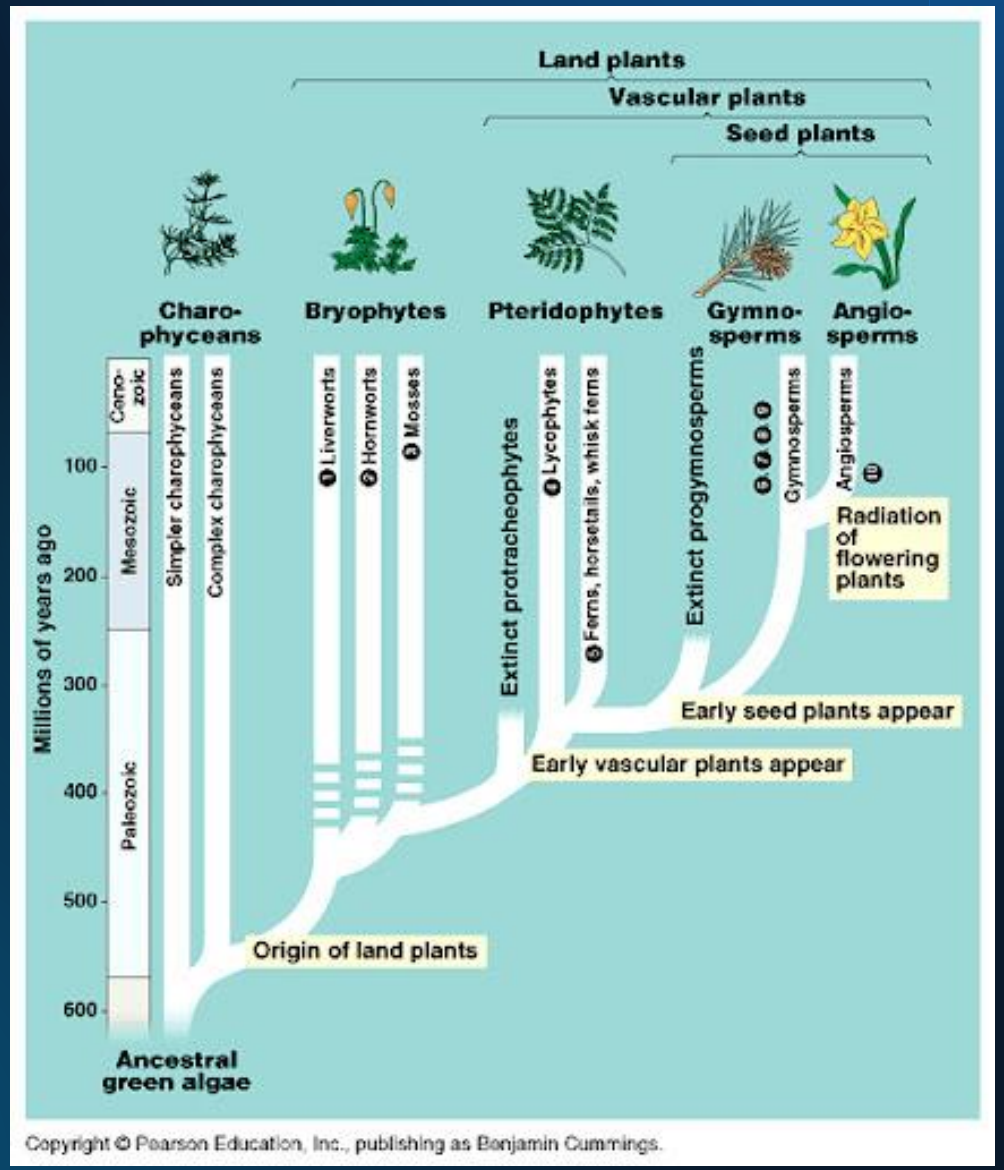
Types of Tracheophytes

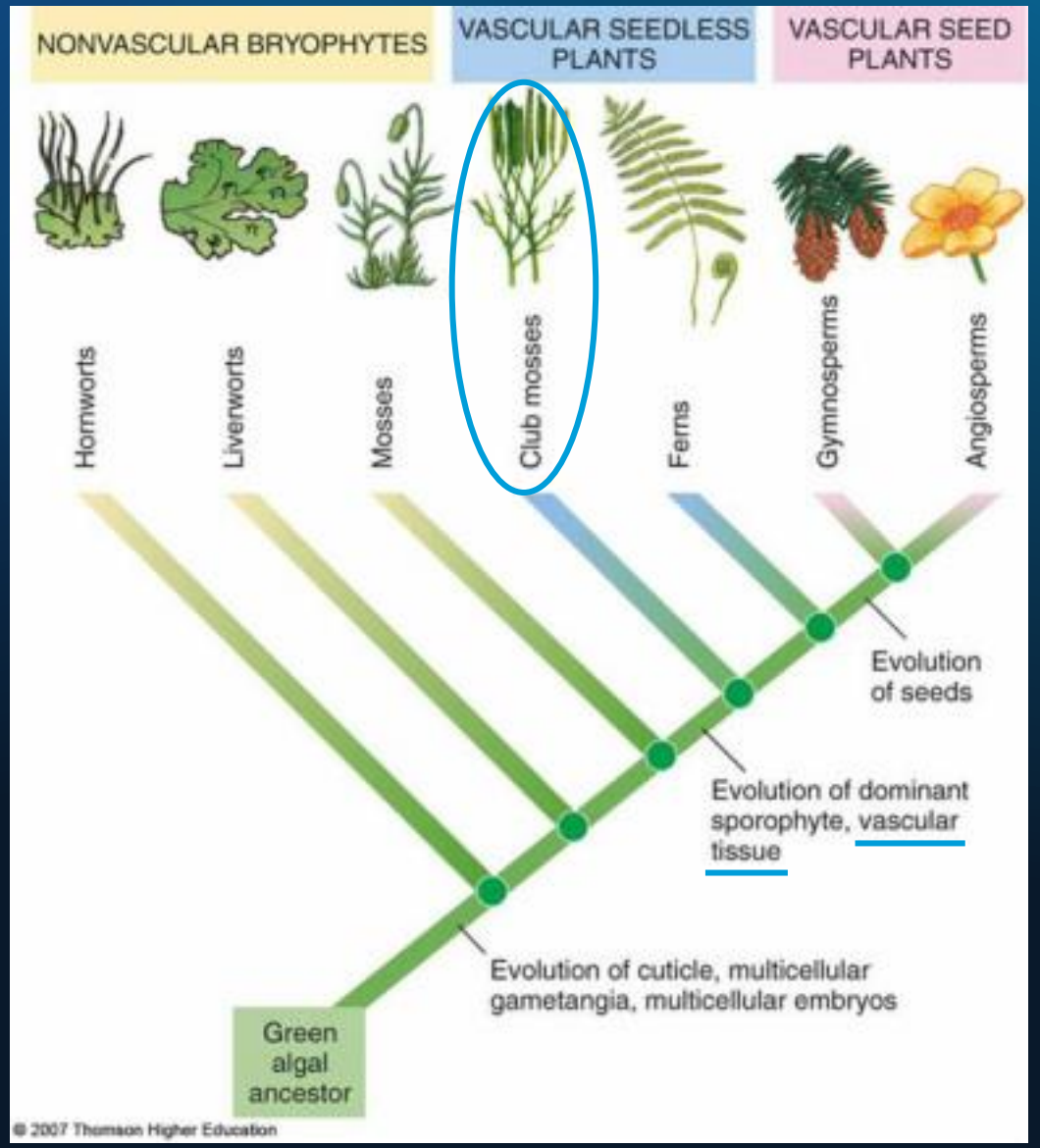
CLUB MOSSES AND HORSETAILS

FERNS

[NOTE, GYMNOSPERMS AND ANGIOSPERMS ARE ALSO CONSIDERED TRACHEOPHYTES… WILL BE TAUGHT LATER]

A History Lesson





Club Mosses (Lycophytes) and Horsetails (Sphenophytes)

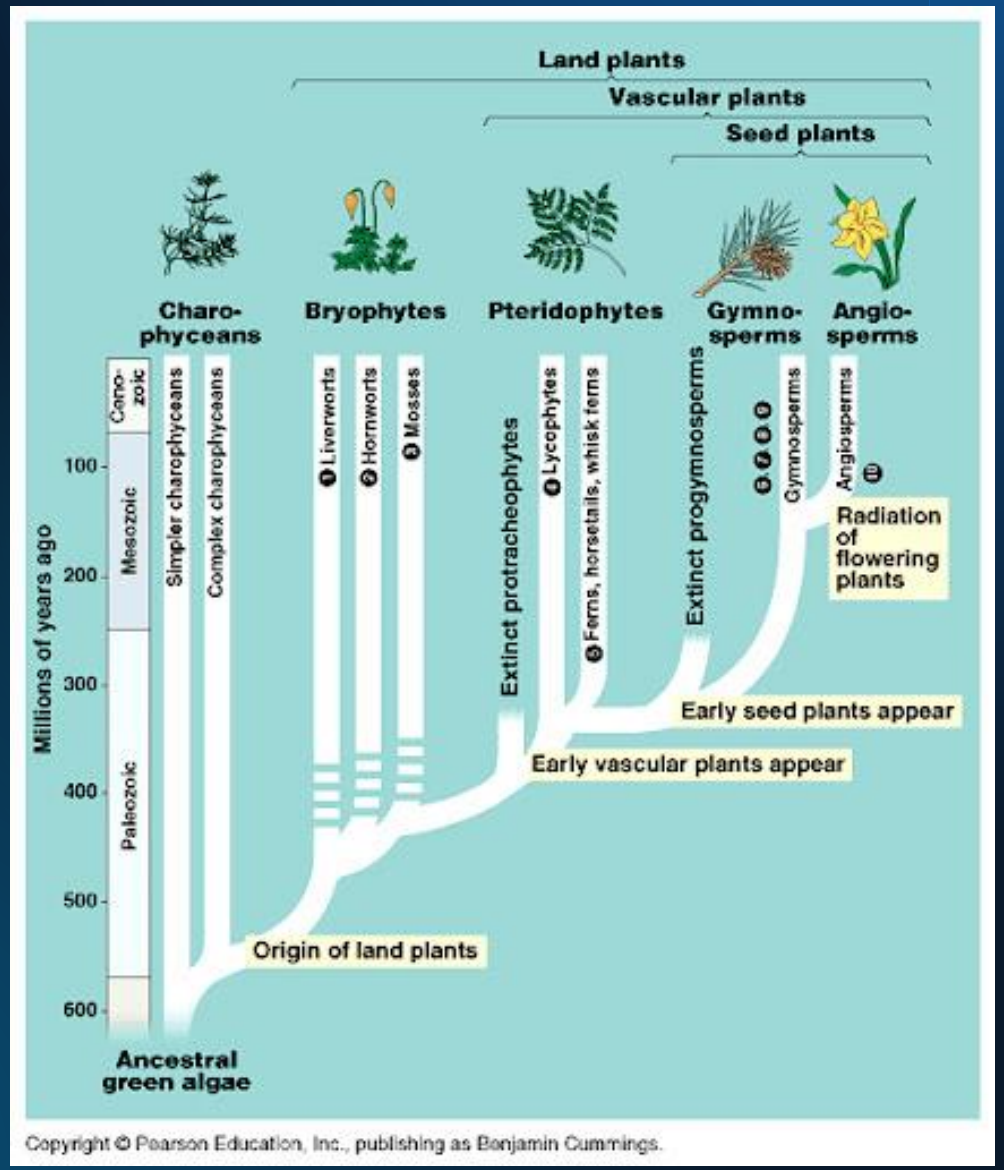
- Few species
- Descendants of ancient tracheophytes: as the climate changed, they were out-competed by other land plants
- Small plants, live in moist woodlands and near streams and marshes
- + All the basic characteristics of Tracheophytes

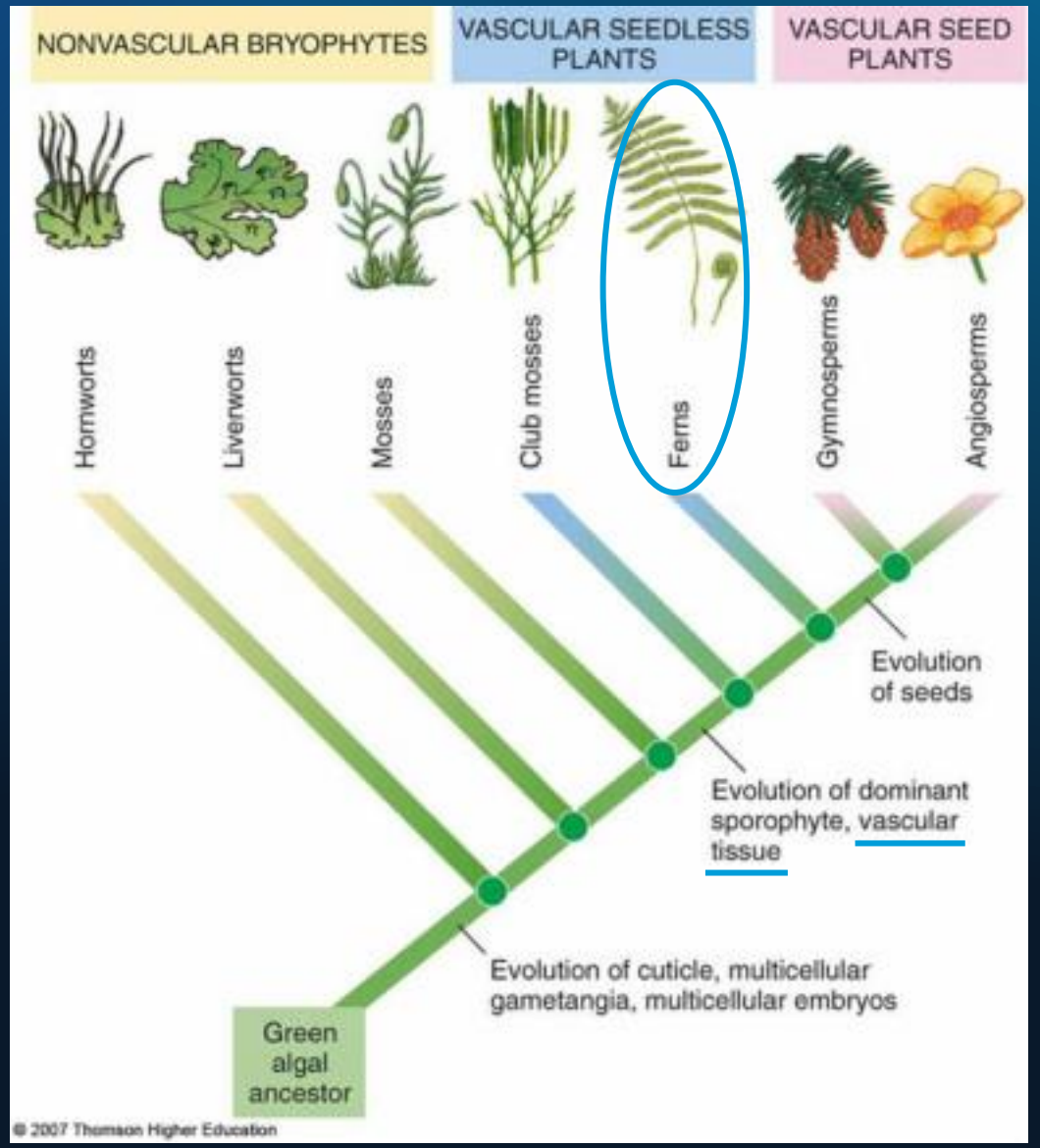
Lycopodium (club moss example)

Equisetum (horsetail example)

- Common name: ‘horsetail’ or ‘scouring rush’; can scrape pots and pans
- Common weed

A History Lesson





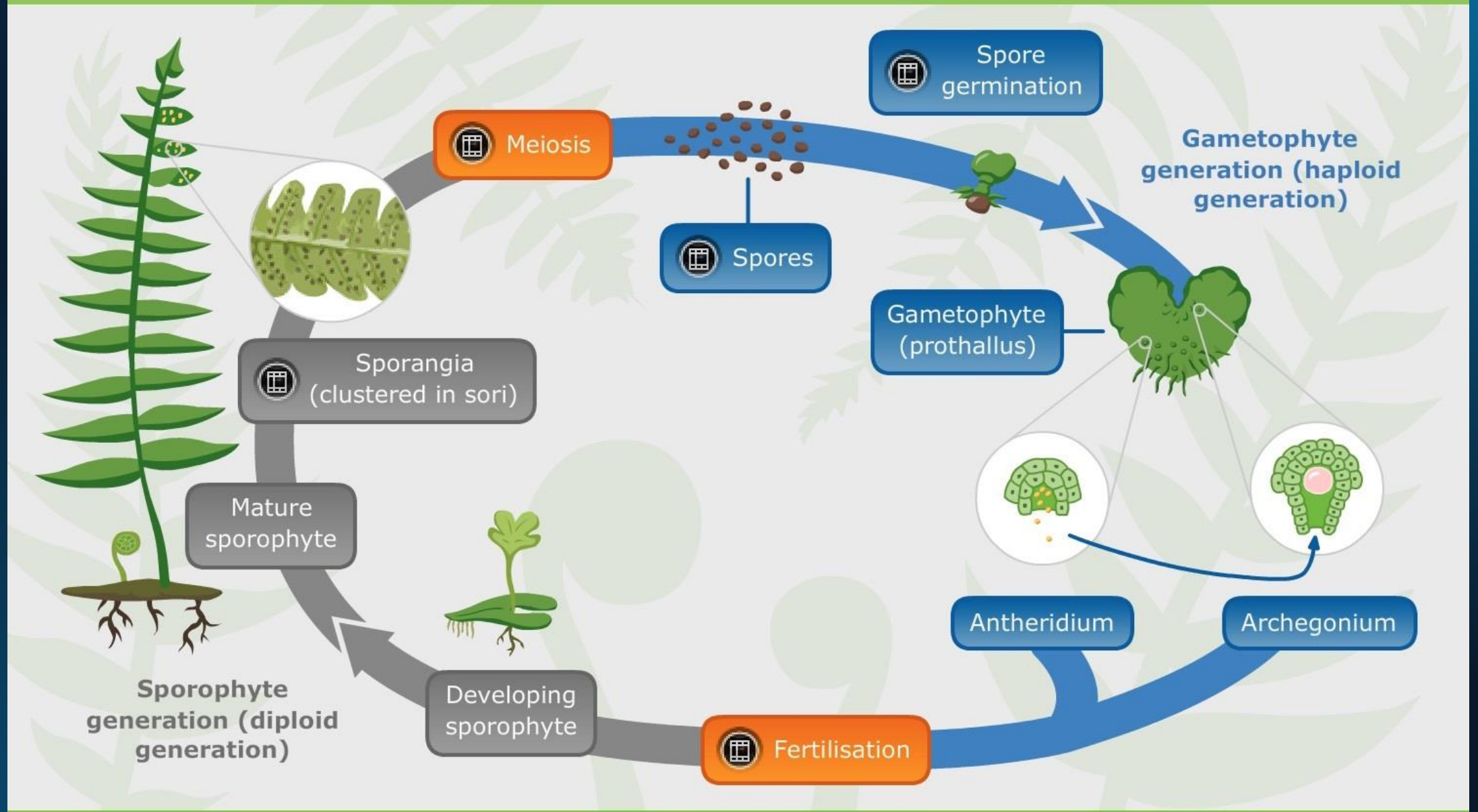
Ferns

- 11,000 extant species
- Evolved **400 mya** (from ancient tracheophytes)
- Well-developed anatomy: true vascular tissues, roots, rhizomes, fronds
- Up to a meter tall
- Most abundant in wet habitats, e.g. rainforests
- + All the basic characteristics of Tracheophytes

Fern Life Cycle: Overview

- **Alternation of generations:** diploid sporophyte is dominant
- Sexual reproduction requires standing water for sperm to swim to eggs

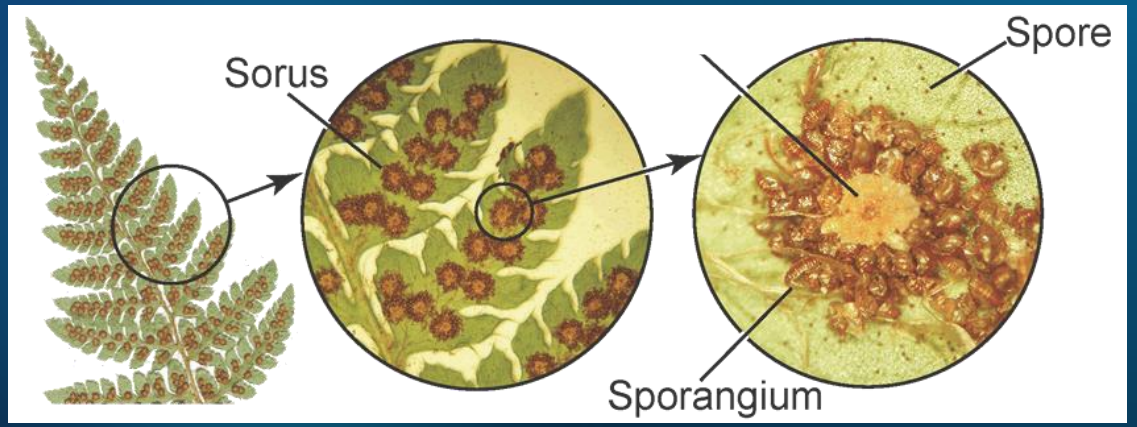
FERN LIFE CYCLE



Fern Life Cycle (Spores)

Sporophytes have **sori** on underside of fronds

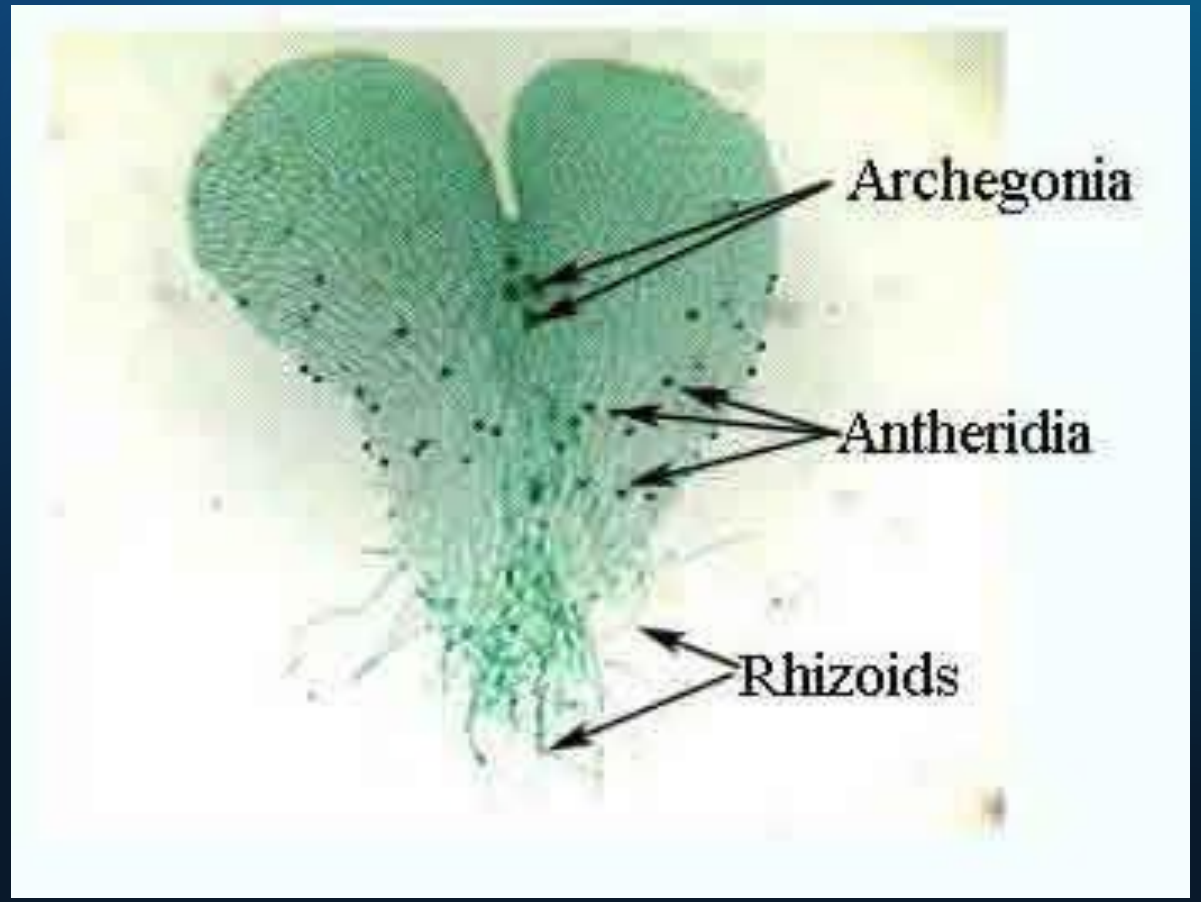
- Sori contain spore-producing structures
- Spores are carried large distances by wind and water

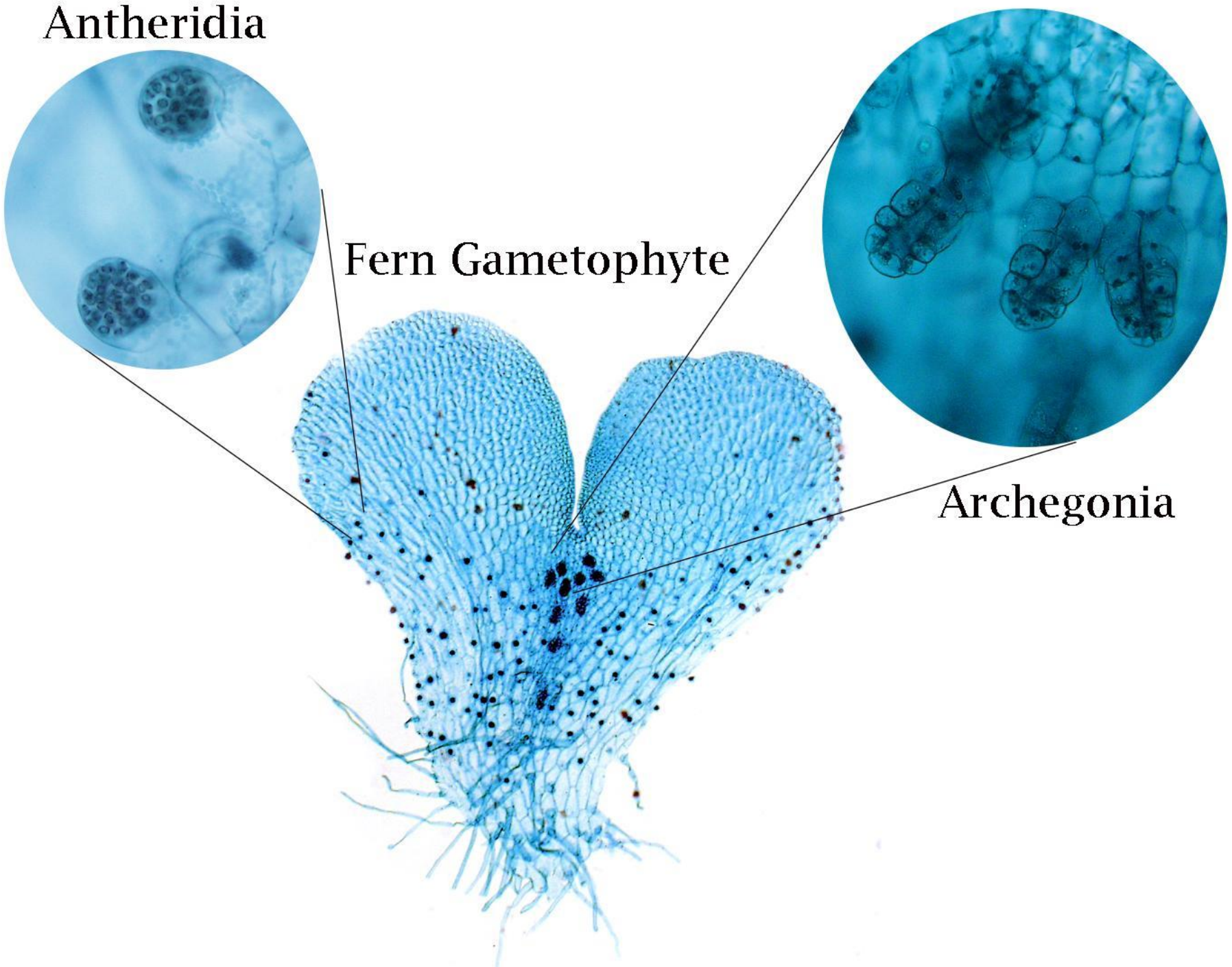


Fern Life Cycle (Gametophyte)

Spore germinates into gametophyte called **prothallium**

- Prothallium is tiny, lacks vascular tissues, grows only in moist areas
- Prothallium has archegonia and antheridia which produce eggs and sperm, respectively



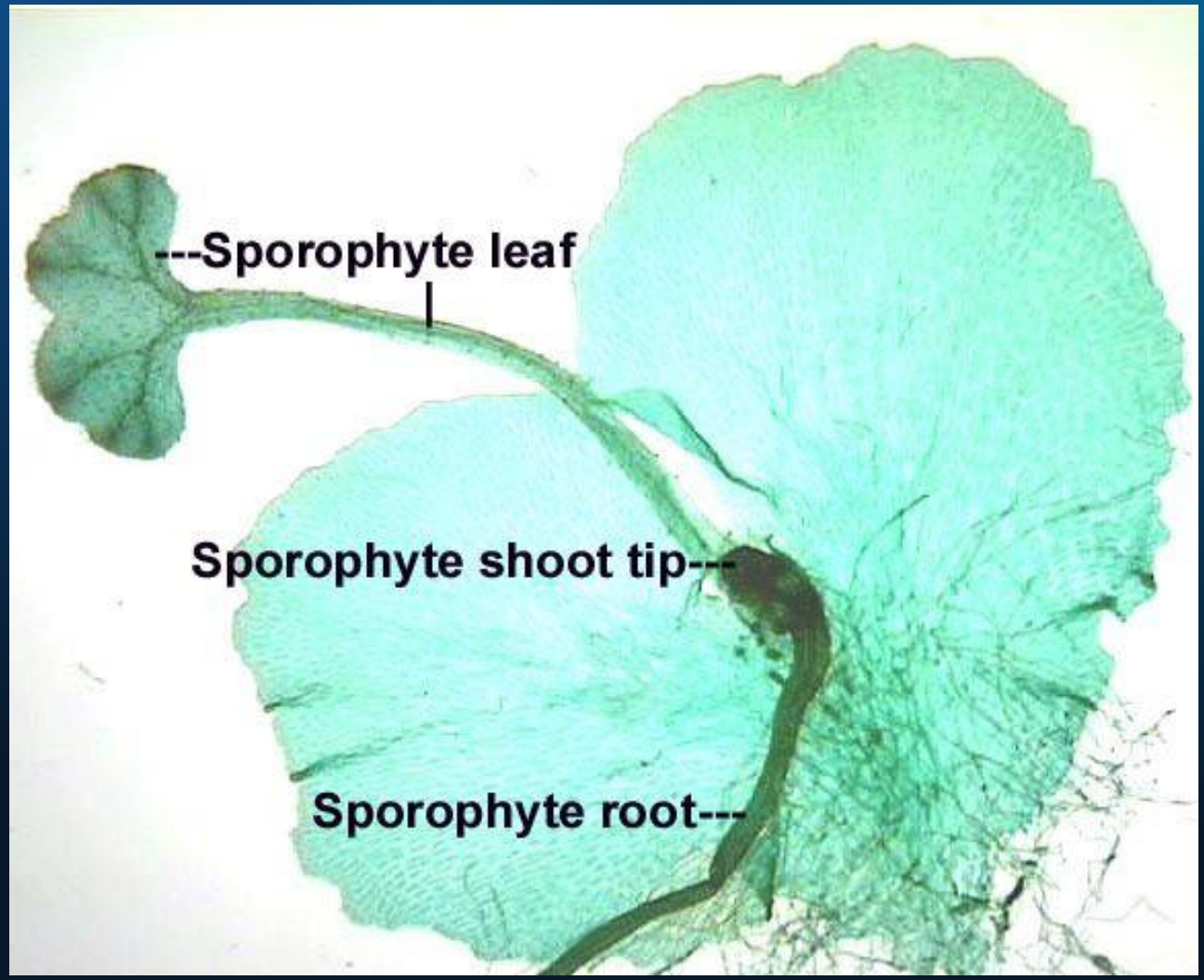


Why are archegonia more centralized, while antheridia are located towards the outside?

How do archegonia and antheridia differ from the same structures in bryophytes?

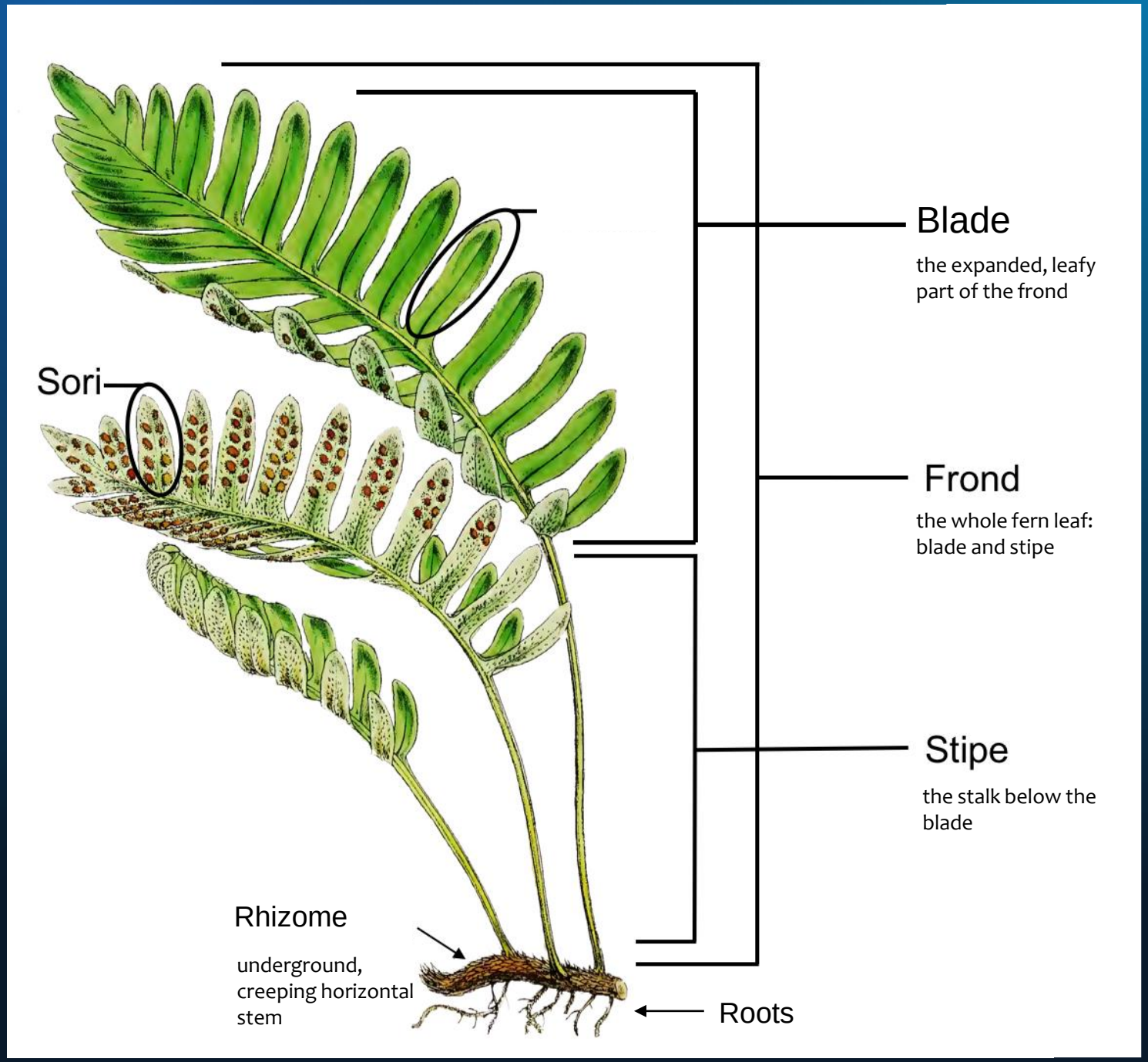
Fern Life Cycle (Sporophyte)

Fertilization → diploid zygote grows into new sporophyte plant and gametophyte withers



Fern Anatomy: Sporophyte

I'm sori about all the vocabulary…



Discussion Questions

1. What is vascular tissue? Name and briefly describe the types of vascular tissue.
2. How are ferns adapted to life on land?
3. What generation in ferns is most obvious? What substance is needed by ferns to reproduce sexually?
4. Compare and contrast ferns and bryophytes. (life cycle, anatomy)
5. Even though ferns survive under many of the same environmental conditions as mosses, ferns are able to grow much larger than mosses. Why is this so?
6. Which parts of the fern sporophyte are visible? Which are below ground?

Where Mosses and Ferns Fit Into the World (21-4)

- Well adapted to specific habitats:
  - Mosses: damp areas
  - Ferns: shadows of forests (can thrive with little light)
- Medicinal (treat burns, bruises)
- Food: eat fiddleheads (young fern fronds)

Where Mosses and Ferns Fit Into the World, continued (21-4)

- Gardening:
  - Decorative mosses and ferns
  - Add moss to garden soil (improves ability to retain water, increases soil acidity)