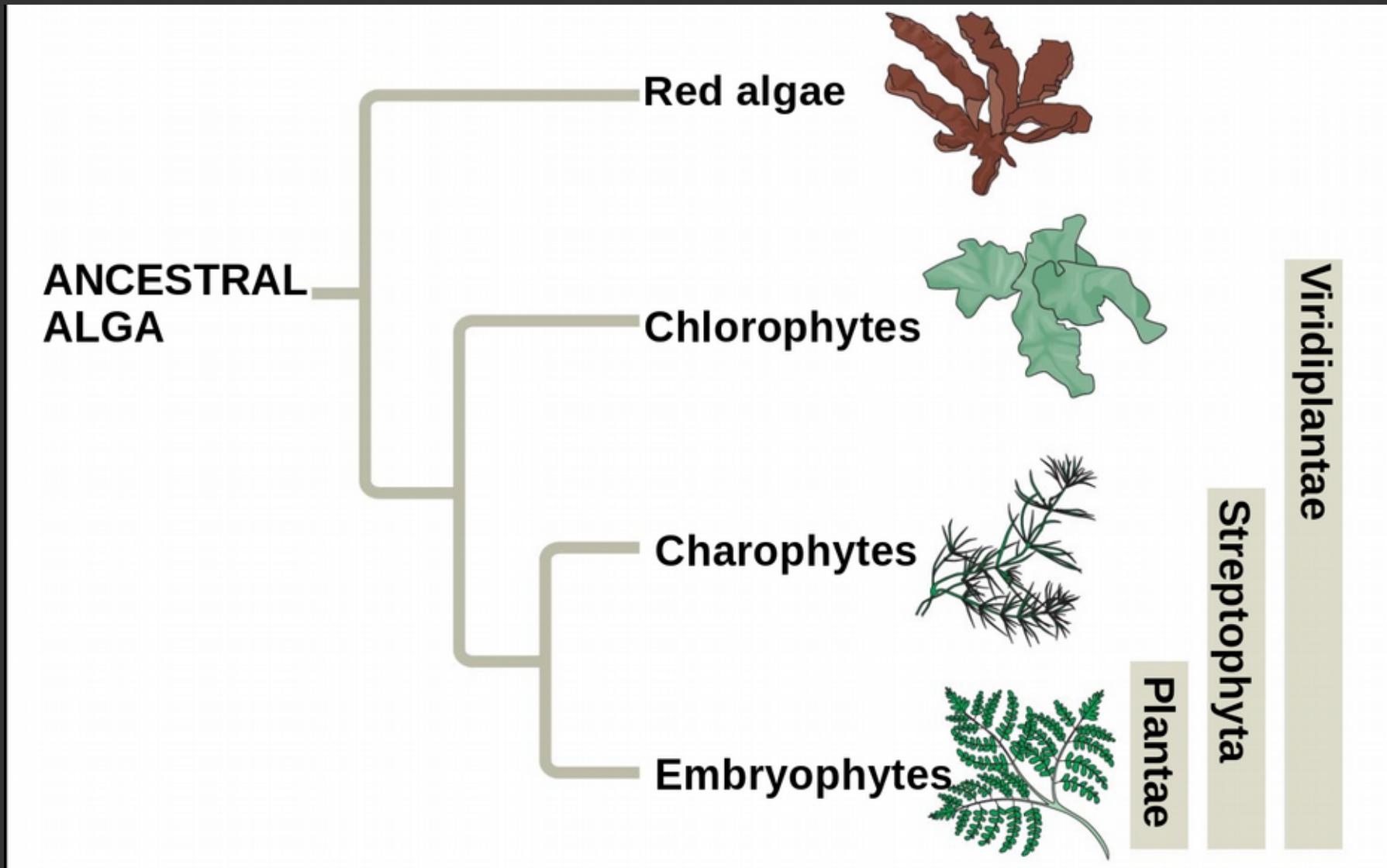


- **Describe the common ancestor of all plants**
- **Describe the derived traits of land plants (embryophytes)**
- **What enabled plant transition to land?  
What were benefits and challenges?**
- **What are the evolutionary trends in plants?**
- **Know the 4 major plant groups and the 10 phyla within them**
- **Be able to map plant traits onto a plant phylogeny**

Land plants evolved from green algae  
Charophytes are the closest relative to land plants



**Charophytes are to plants as choanoflagellates are to animals**



Many characteristics of land plants also appear in a variety of algal clades

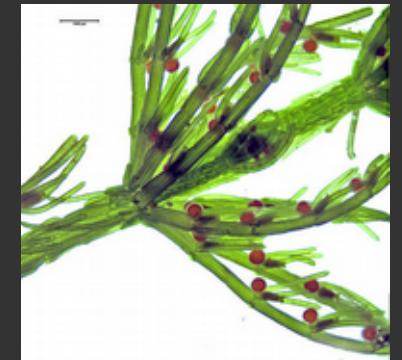
However, land plants share multiple traits with charophytes which include:

Chlorophylls a and b

Cellulose

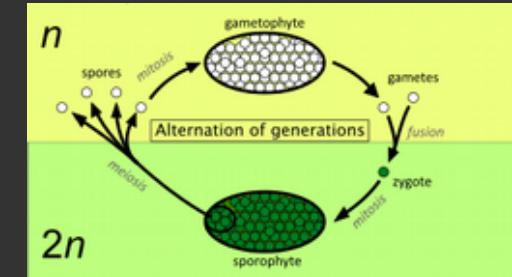
Structure of flagellated sperm

Formation of sporopollenin



# Derived traits of plants (not found in charophytes)

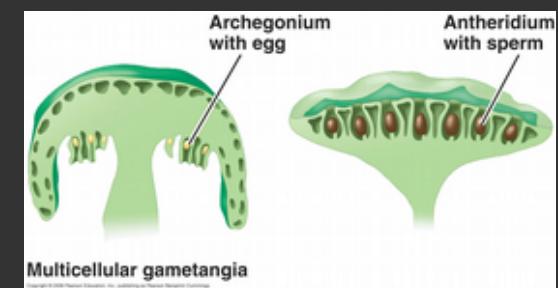
Alternation of generations  
(with multicellular, dependent embryos)



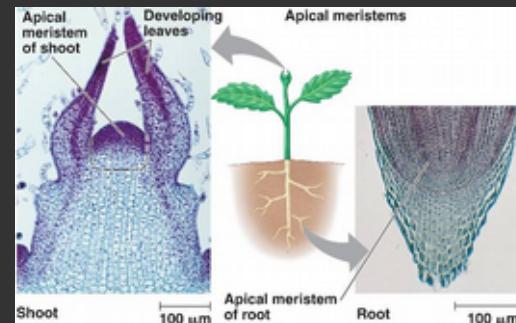
Walled spores produced in sporangia



Multicellular gametangia



Apical meristems



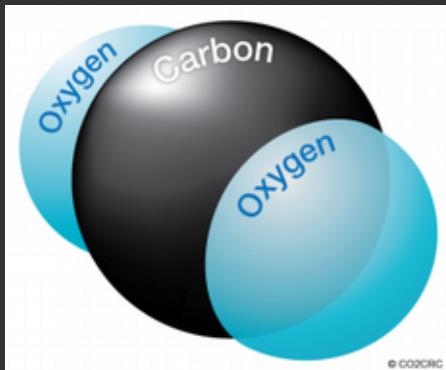
# **Colonizing the land...**

**What adaptive pressures existed to push plants onto land?**

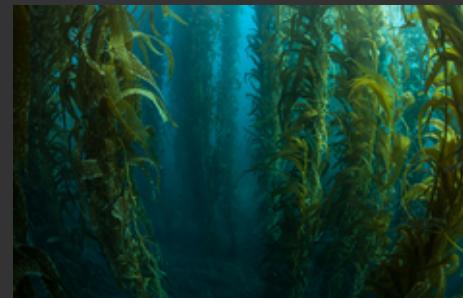
**What do you need in order to move onto land if you are a plant? What are the challenges to be overcome by natural selection?**

# Colonizing the land...

What adaptive pressures existed to push plants onto land?



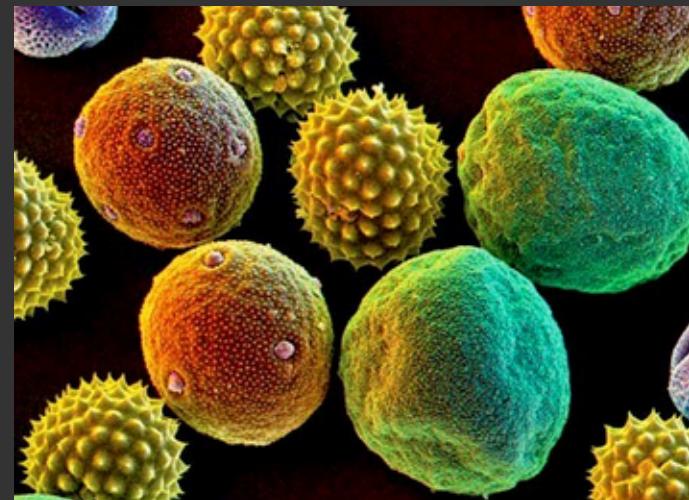
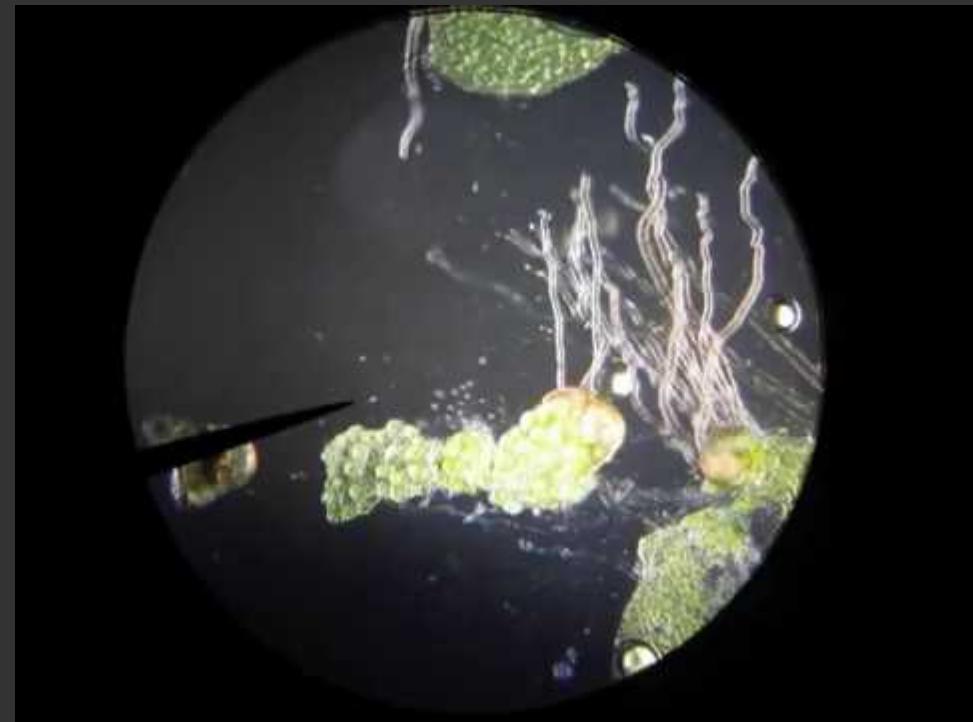
What do you need in order to move onto land if you are a plant? What are the challenges to be overcome by natural selection?



# First land plants . . .

Traits:

1. No true roots
2. Swimming sperm
3. Sporopollenin
4. Cellulose cell walls



**4 key plant traits:**

**Alternation of generations  
(with multicellular, dependent embryos)**

**Walled spores produced in sporangia**

**Multicellular gametangia**

**Apical meristems**

# Alternation of generations

Label:

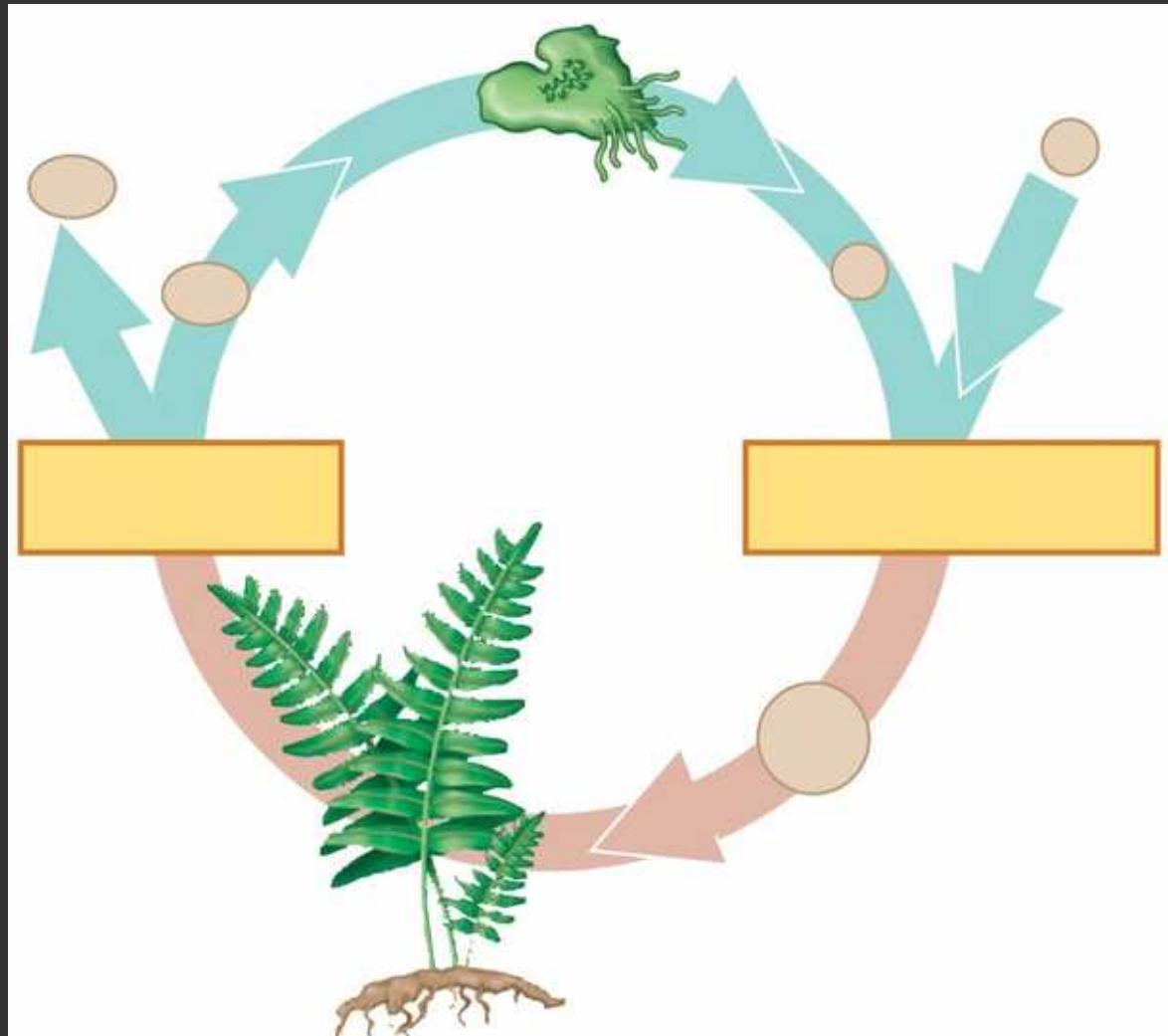
Spores

Zygote

Meiosis

Karyogamy

Ploidy for each



**Multicellular haploid and multicellular diploid stages**

That is, MITOSIS happens in both haploid and diploid stages!

**4 key plant traits:**

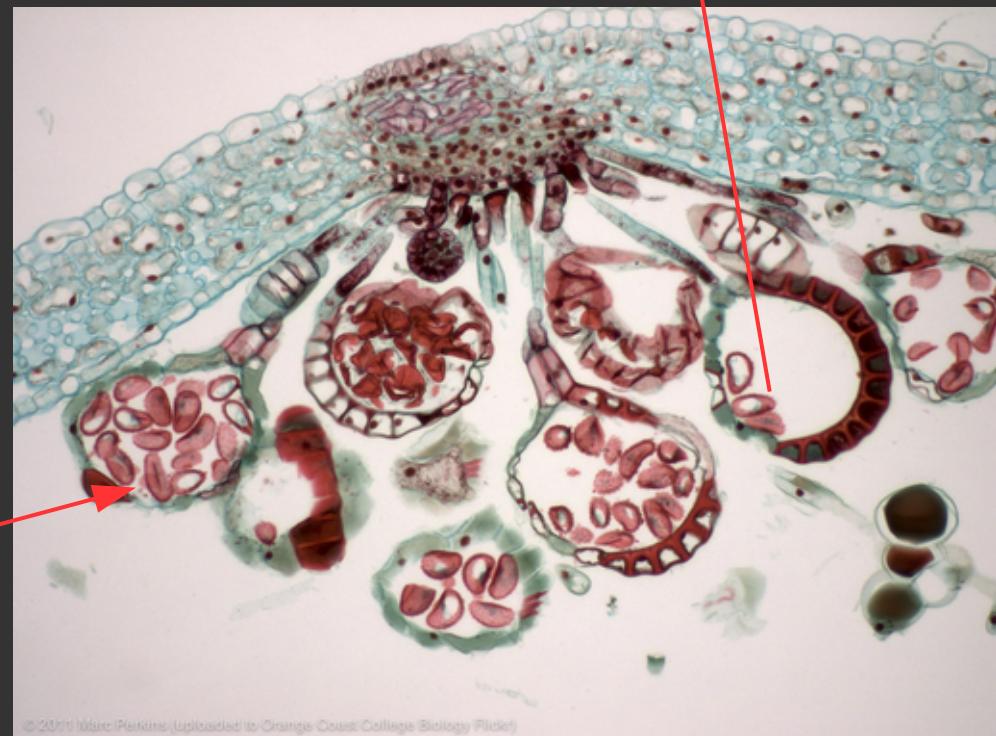
**Alternation of generations  
(with multicellular, dependent embryos)**

**Walled spores produced in sporangia**

**Multicellular gametangia**

**Apical meristems**

# Walled spores in sporangia



**4 key plant traits:**

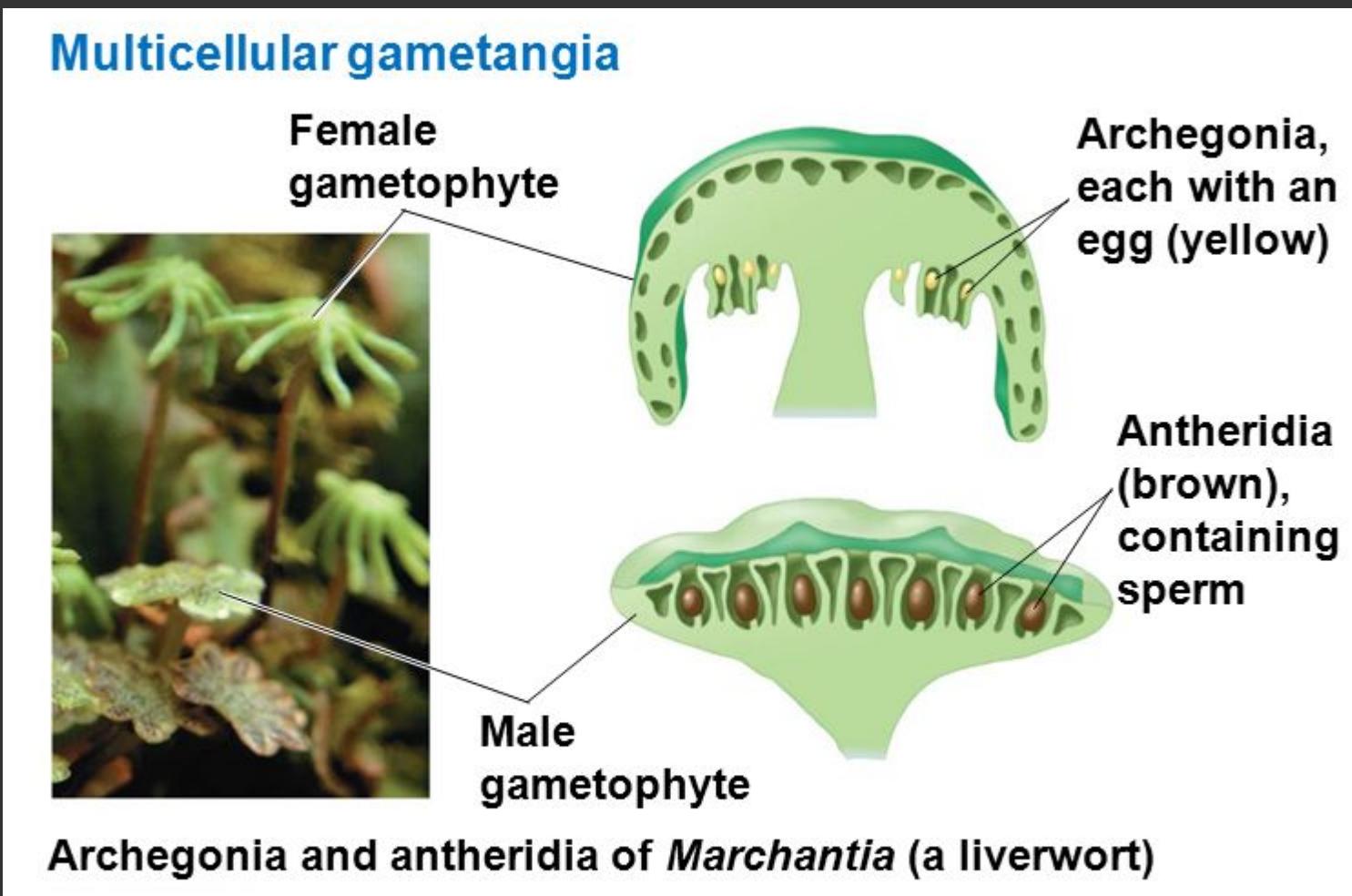
**Alternation of generations  
(with multicellular, dependent embryos)**

**Walled spores produced in sporangia**

**Multicellular gametangia**

**Apical meristems**

# Multicellular gametangia





**How does this plant reproduce?**

**4 key plant traits:**

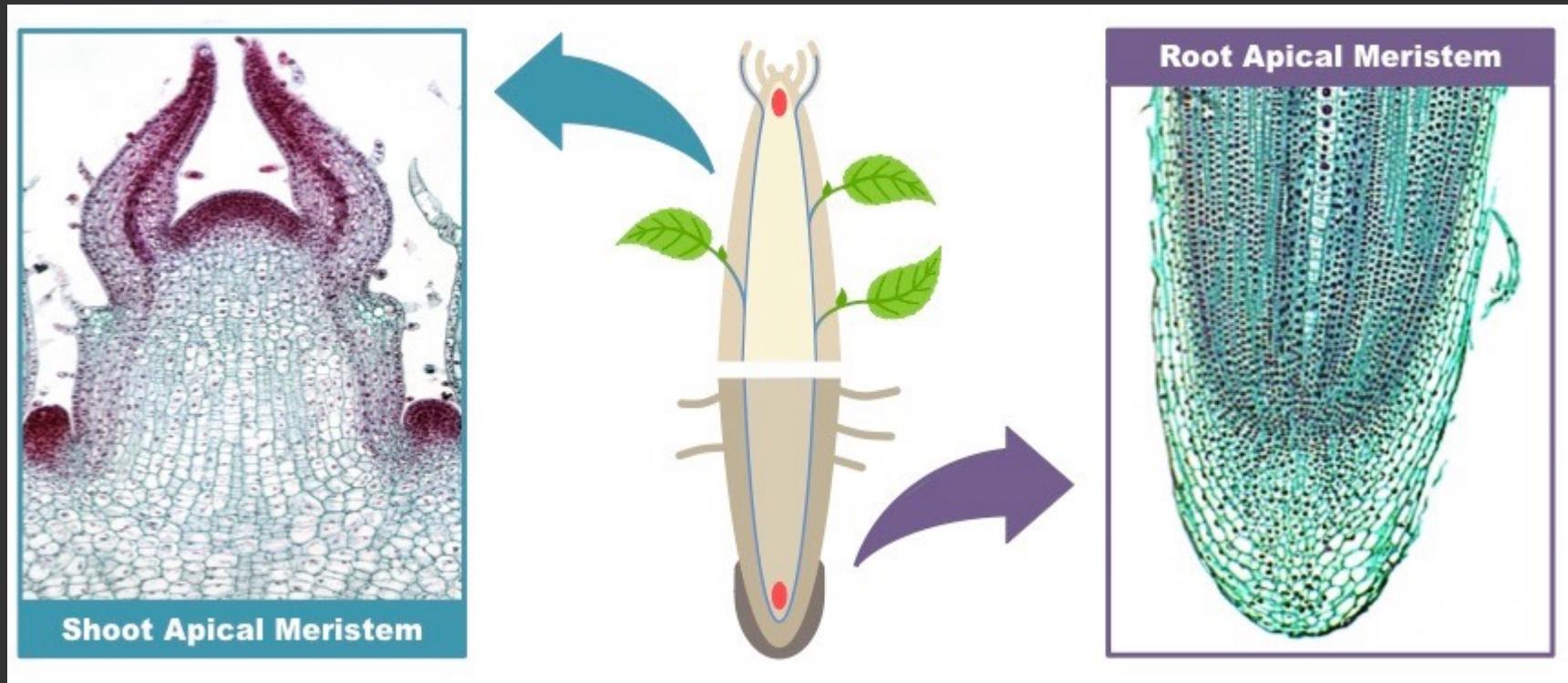
**Alternation of generations  
(with multicellular, dependent embryos)**

**Walled spores produced in sporangia**

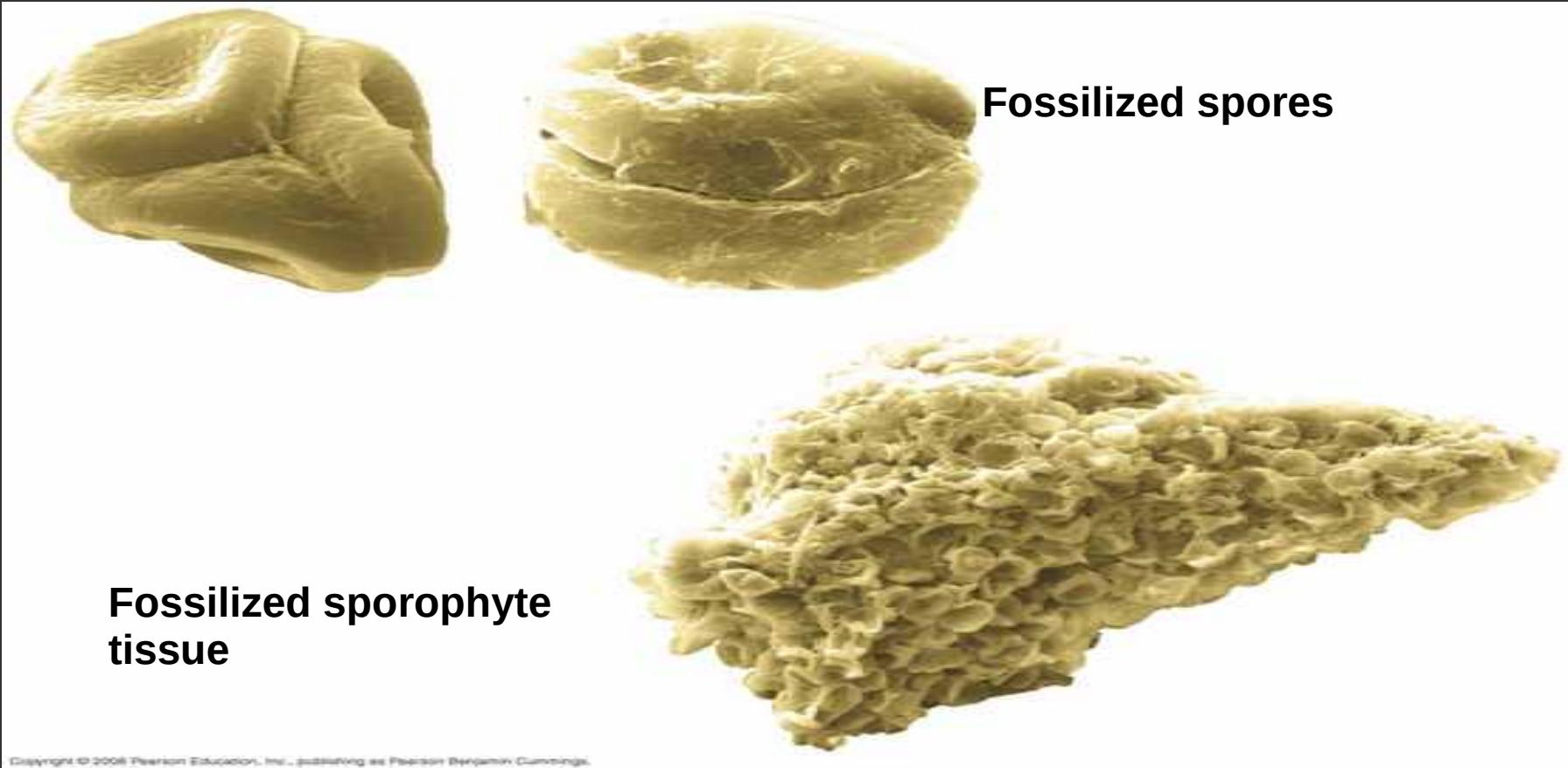
**Multicellular gametangia**

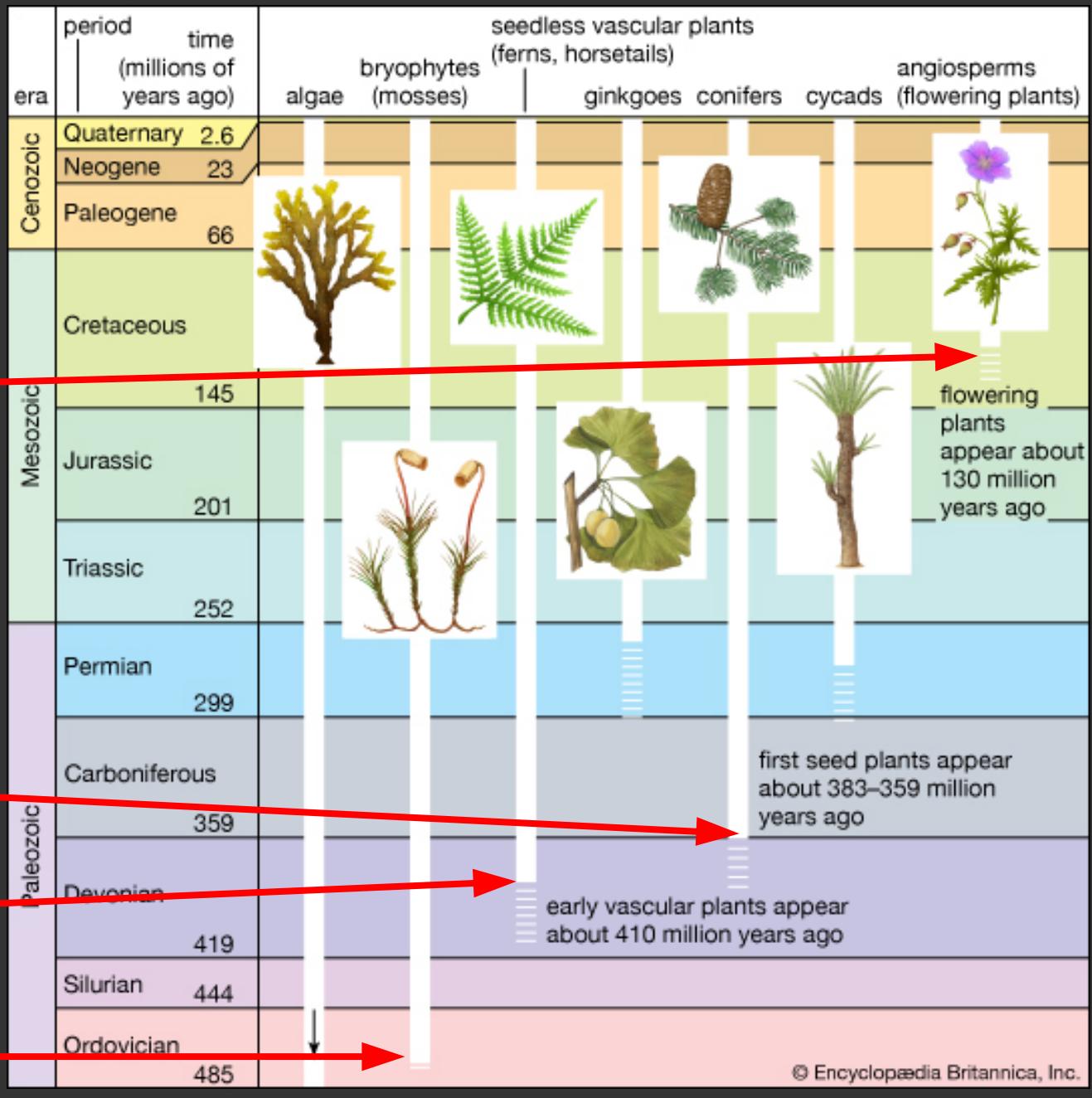
**Apical meristems**

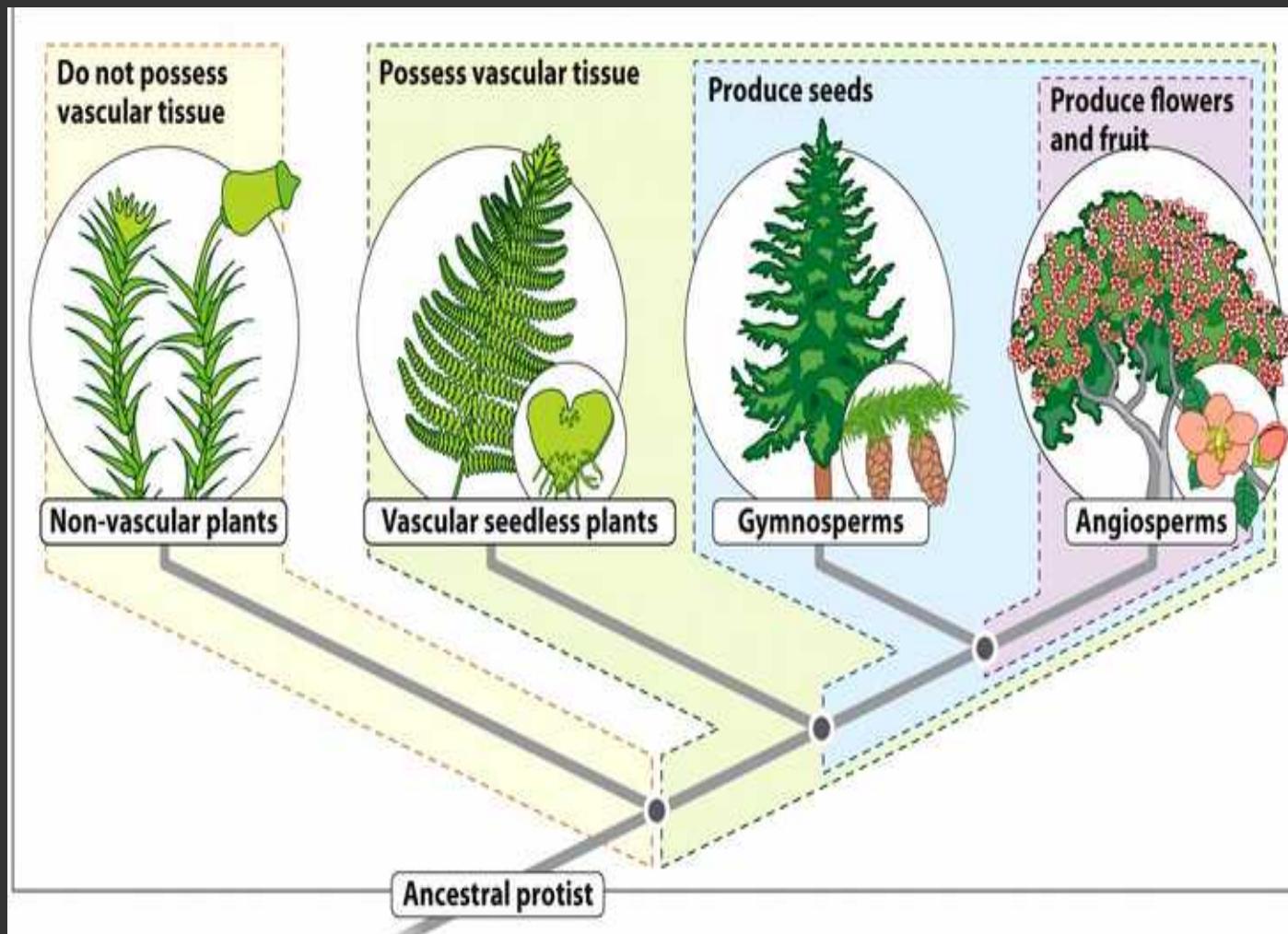
# Apical meristems



Fossils indicate that plants have been on land for at least 475 MY



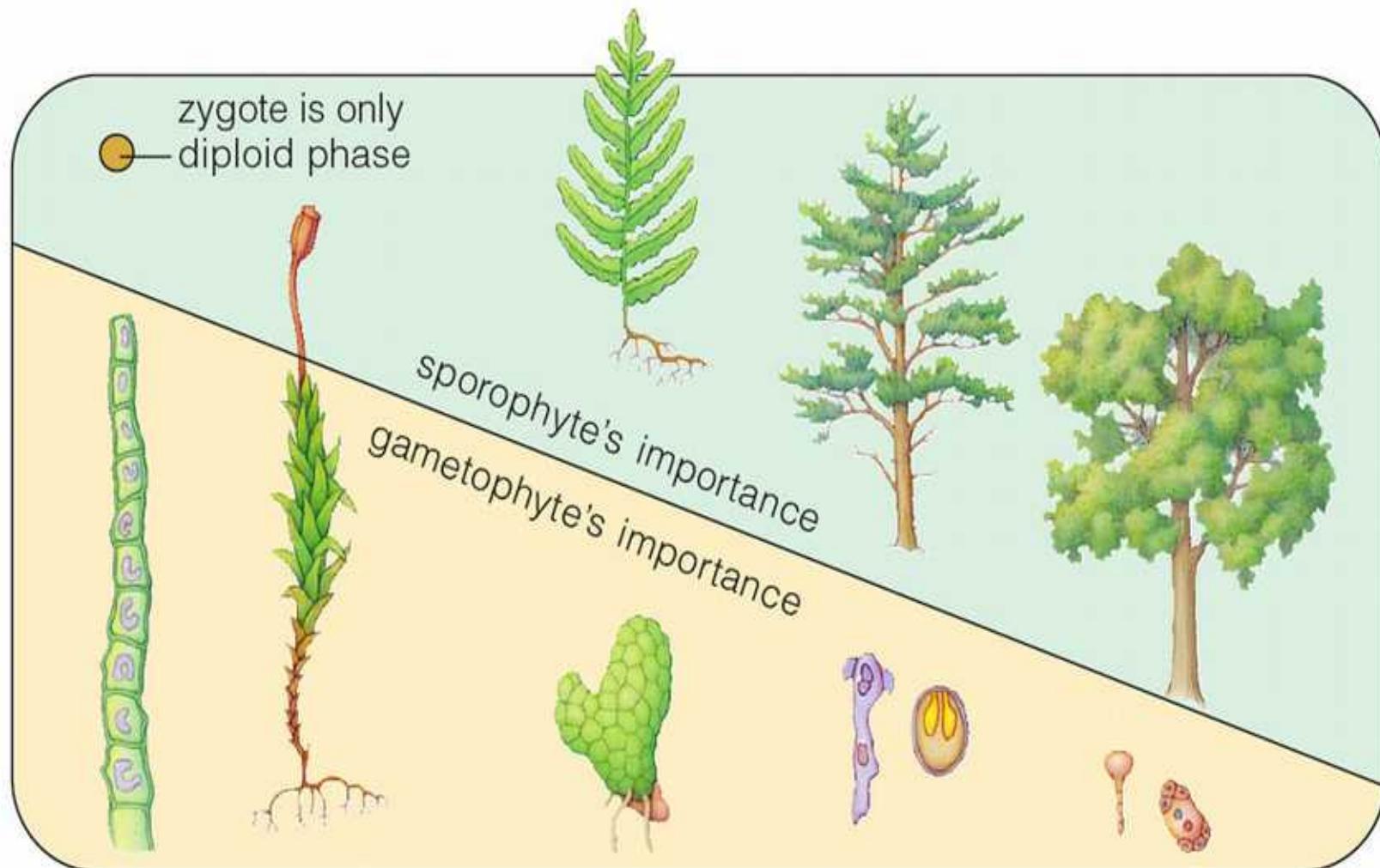




**Table 29.1 Ten Phyla of Extant Plants**

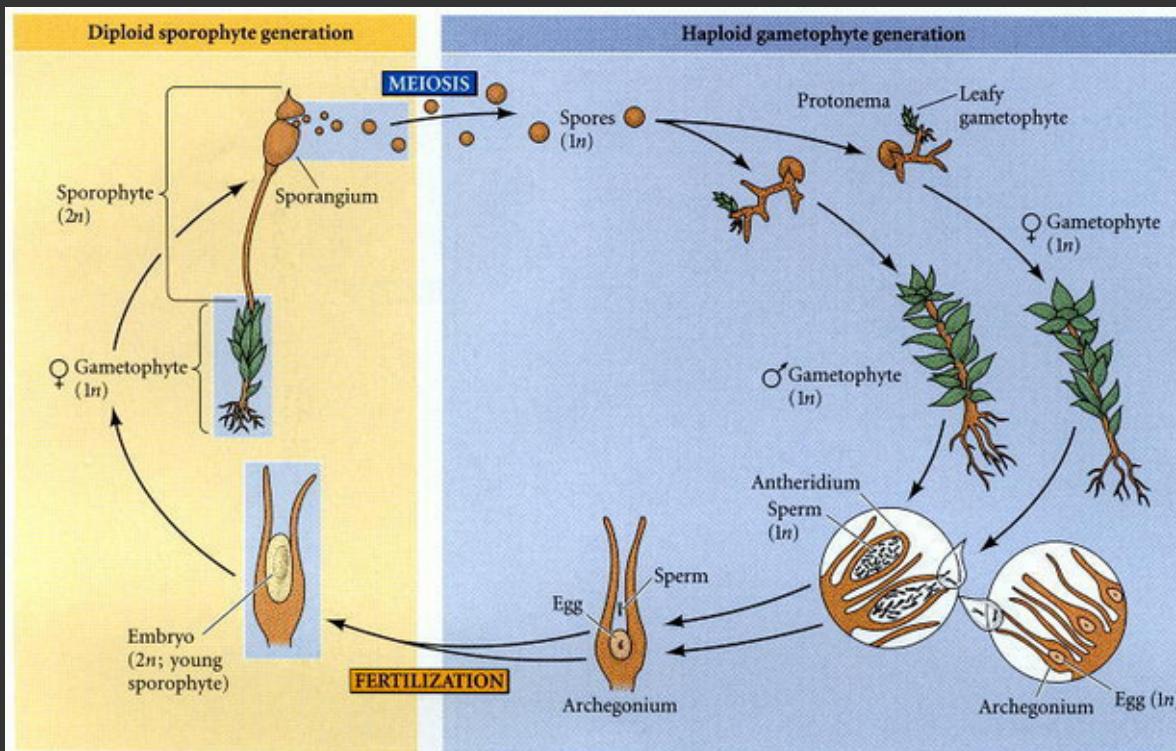
	Common Name	Estimated Number of Species
<b>Nonvascular Plants (Bryophytes)</b>		
Phylum Hepatophyta	Liverworts	9,000
Phylum Anthocerophyta	Hornworts	100
Phylum Bryophyta	Mosses	15,000
<b>Vascular Plants</b>		
<b>Seedless Vascular Plants</b>		
Phylum Lycophyta	Lycophytes	1,200
Phylum Pterophyta	Monilophyta	Pterophytes
		12,000
<b>Seed Plants</b>		
<b>Gymnosperms</b>		
Phylum Ginkgophyta	Ginkgo	1
Phylum Cycadophyta	Cycads	130
Phylum Gnetaophyta	Gnetophytes	75
Phylum Coniferophyta	Conifers	600
<b>Angiosperms</b>		
Phylum Anthophyta	Flowering plants	250,000

# Evolutionary trends in plant life cycles



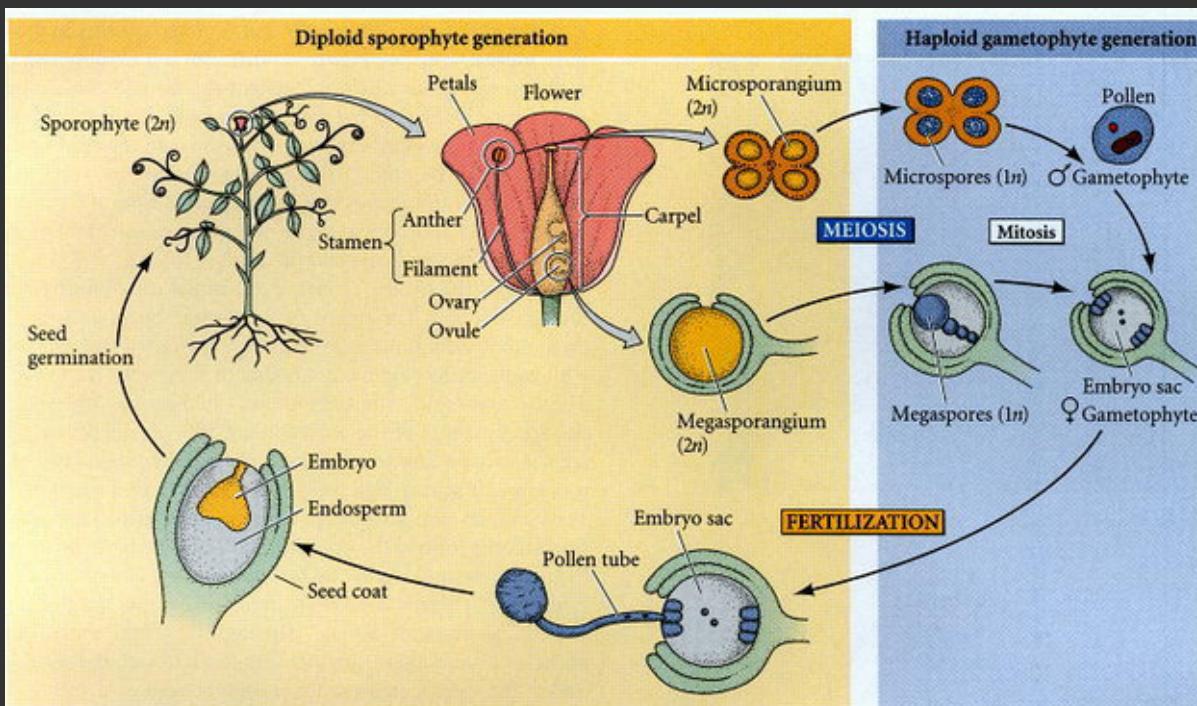
**b** green algae    bryophytes    ferns    gymnosperms    angiosperms

## Moss (bryophyte)



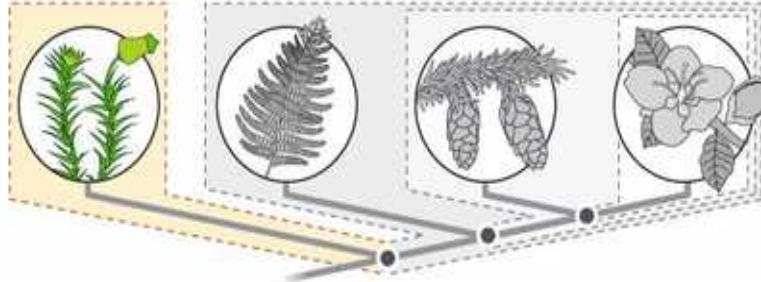
Sporophyte is dependent on Dominant gametophyte

## Flower (angiosperm)



Gametophyte is dependent on Dominant sporophyte

# **“Bryophytes”**



## **THE NON-VASCULAR PLANTS**

**Mosses**



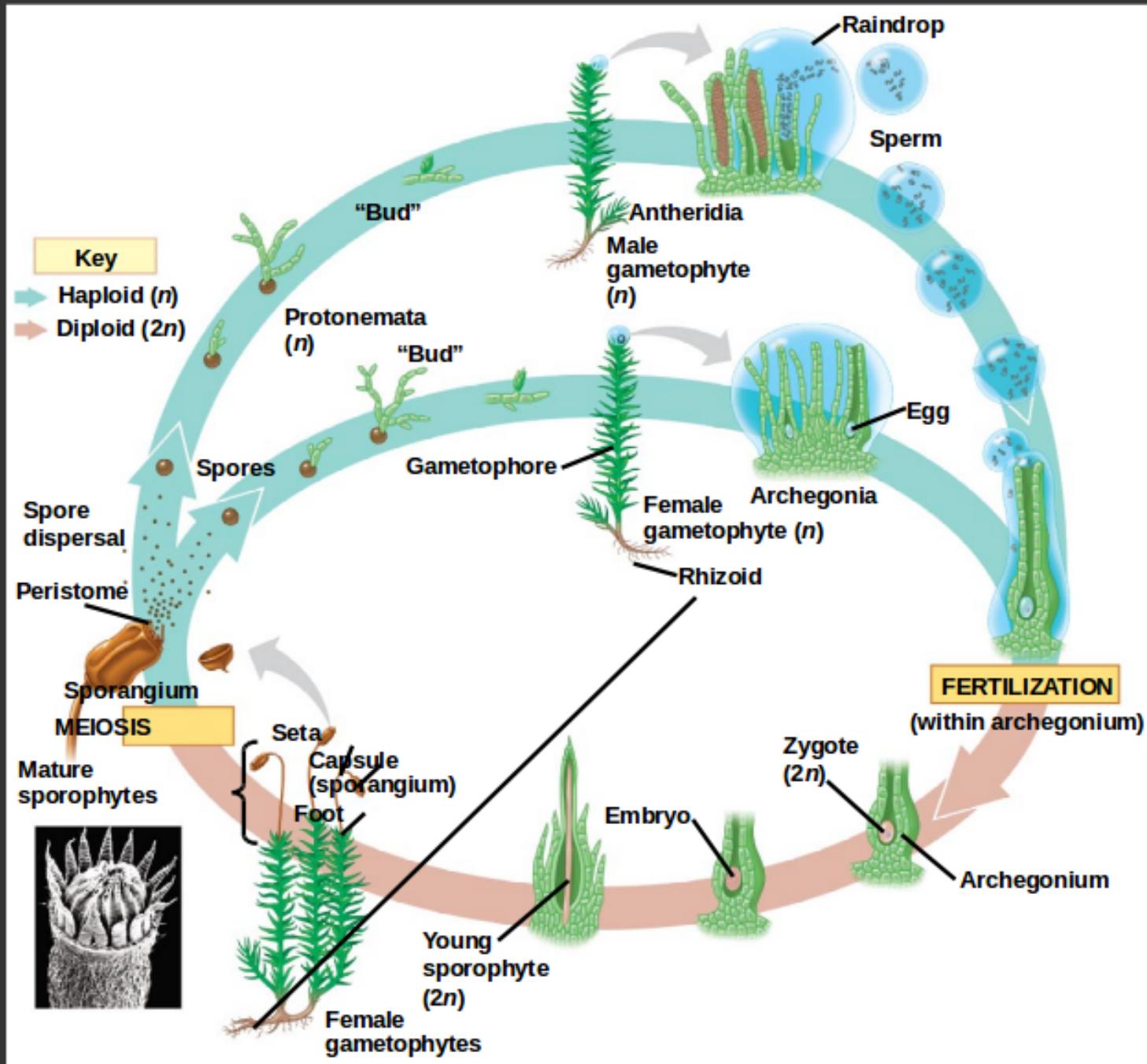
**Hornworts**



**Liverworts**



# Bryophyte life cycle



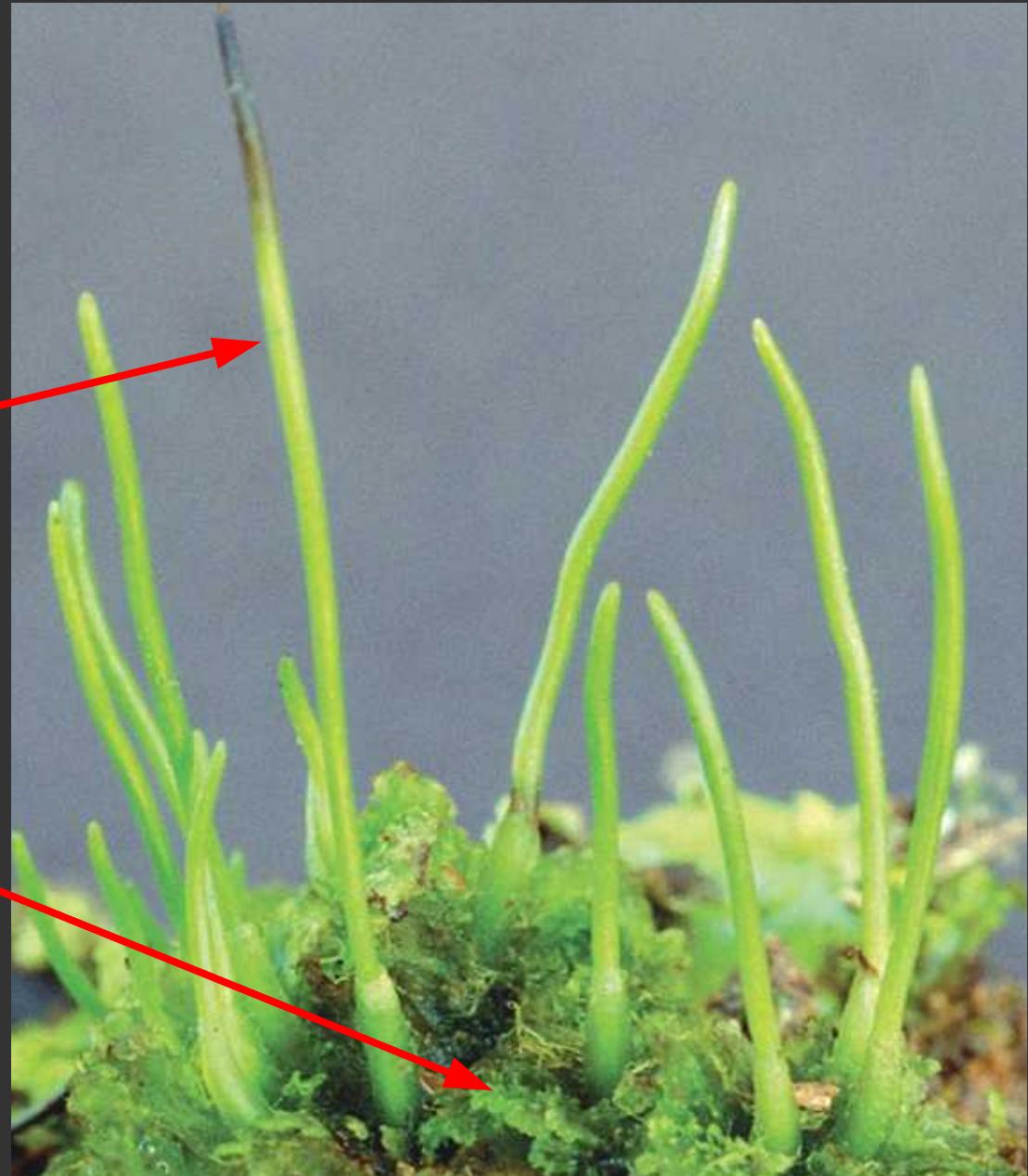
# Hepatophyta (Liverwort)



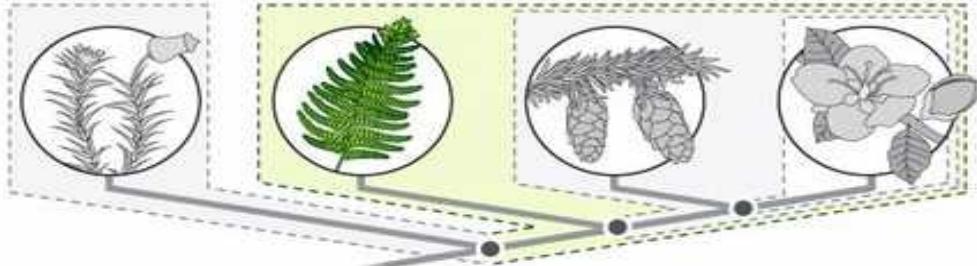
# **Anthocerophyta (Hornwort)**

**Sporophyte**

**Gametophyte**





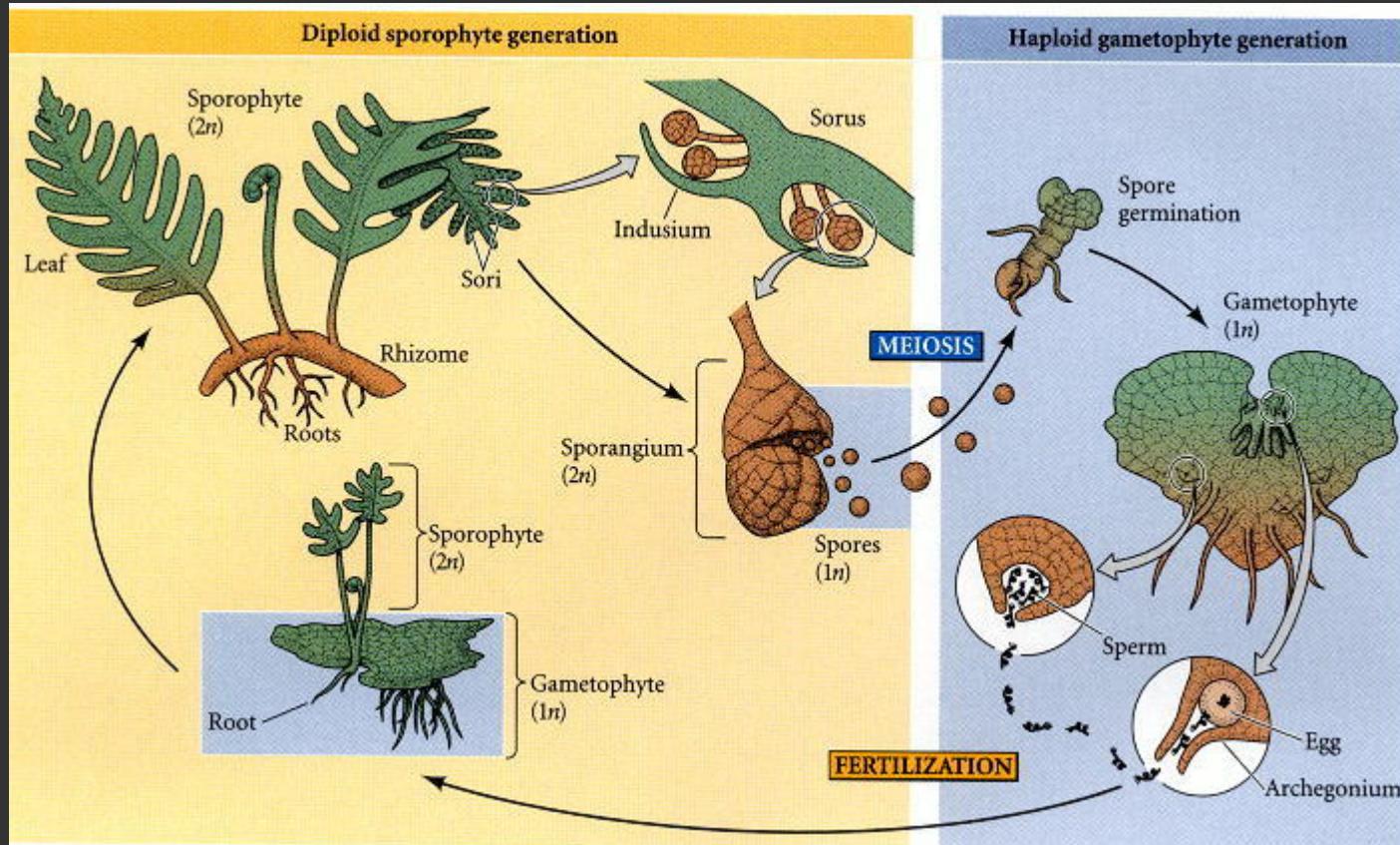


## THE VASCULAR SEEDLESS PLANTS



**Table 29.1 Ten Phyla of Extant Plants**

	Common Name	Estimated Number of Species
<b>Nonvascular Plants (Bryophytes)</b>		
Phylum Hepatophyta	Liverworts	9,000
Phylum Anthocerophyta	Hornworts	100
Phylum Bryophyta	Mosses	15,000
<b>Vascular Plants</b>		
<b>Seedless Vascular Plants</b>		
Phylum Lycophyta	Lycophytes	1,200
Phylum Pterophyta	Pterophytes	12,000
<b>Seed Plants</b>		
<b>Gymnosperms</b>		
Phylum Ginkgophyta	Ginkgo	1
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Phylum Coniferophyta	Conifers	600
<b>Angiosperms</b>		
Phylum Anthophyta	Flowering plants	250,000



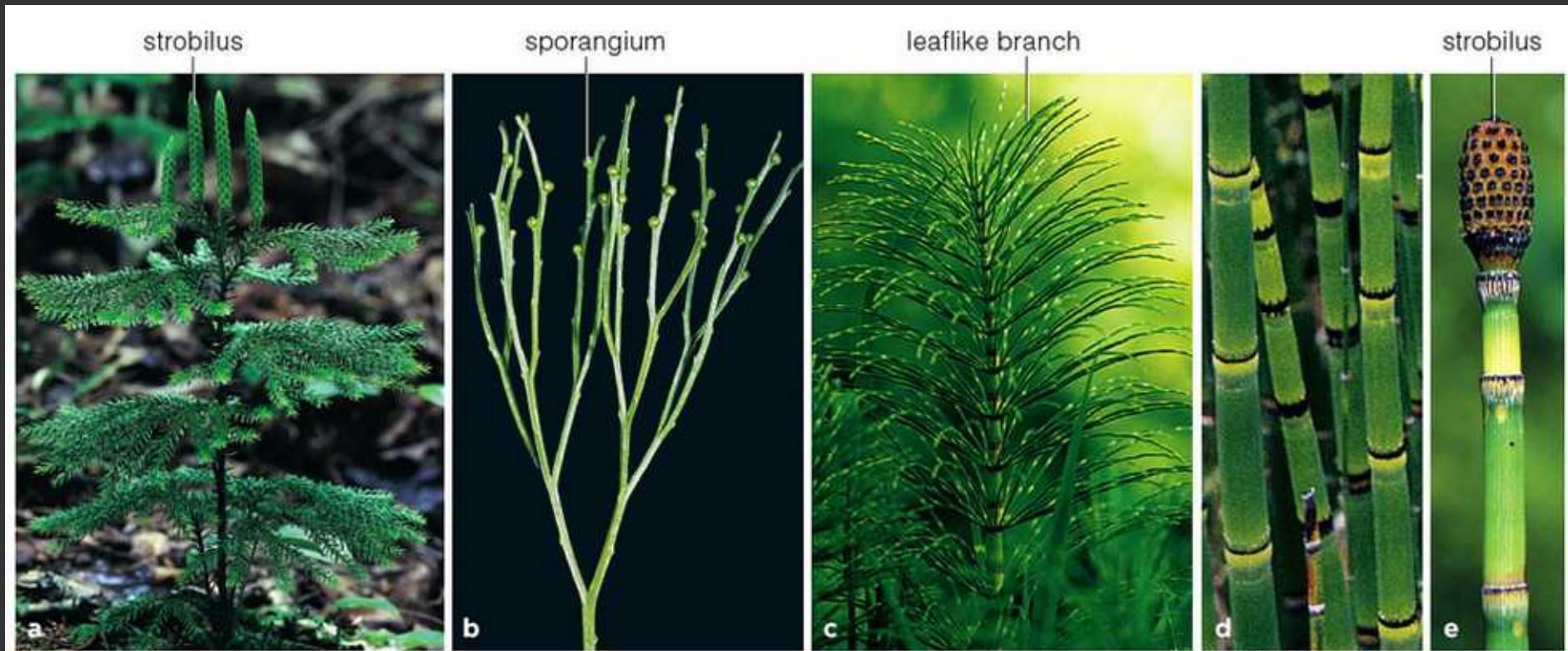
Most ferns are **homosporous**....

One type of spore grows into gametophyte that can produce male and female sex organs.

# Seedless Vascular Plants

Lycophytes - club mosses

Pteridophytes - true ferns, horsetails, whisk ferns



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Club moss

Lycophyte

whisk fern

horsetail

Pteridophytes

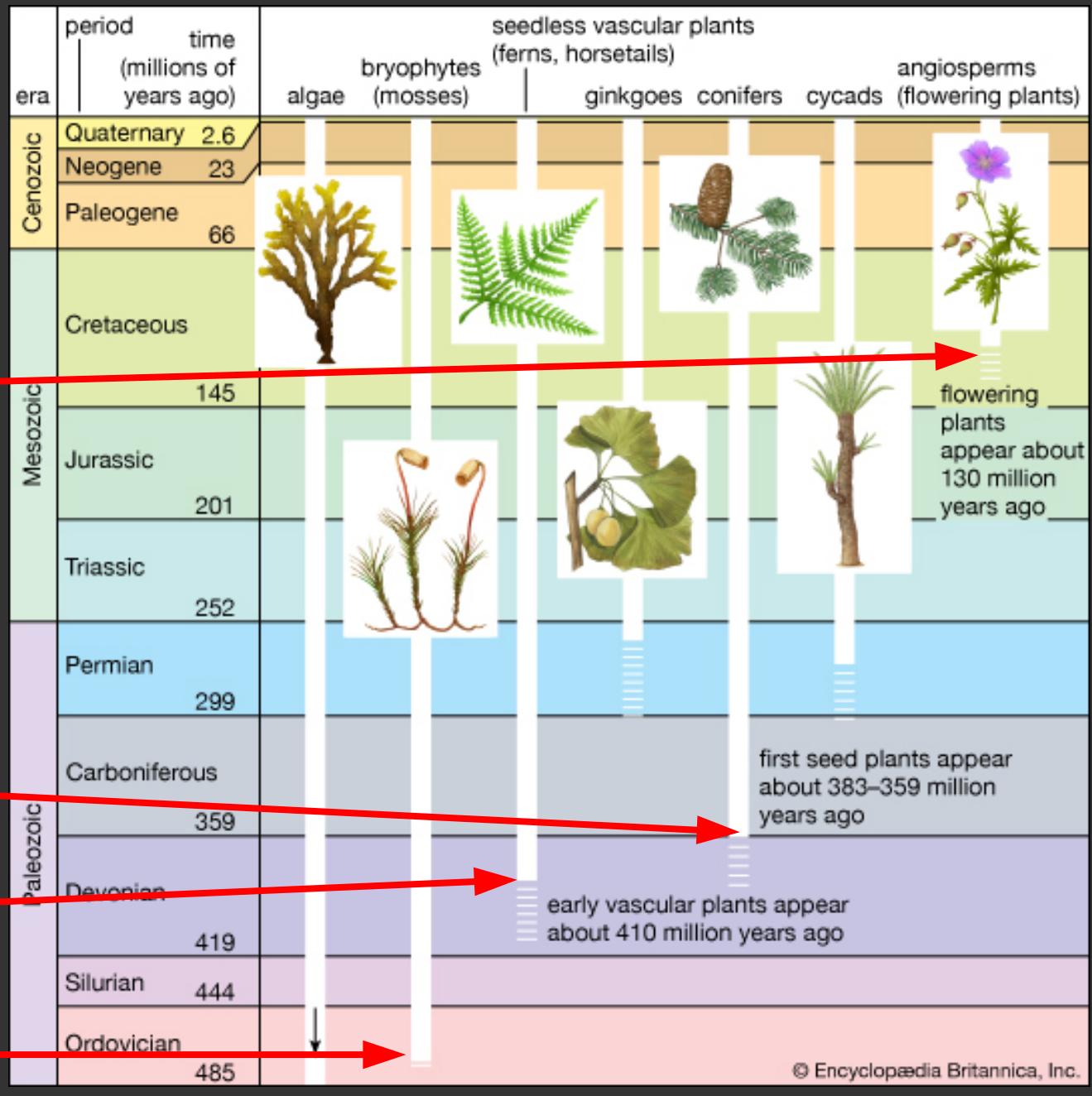
# Lycophyta (club mosses)

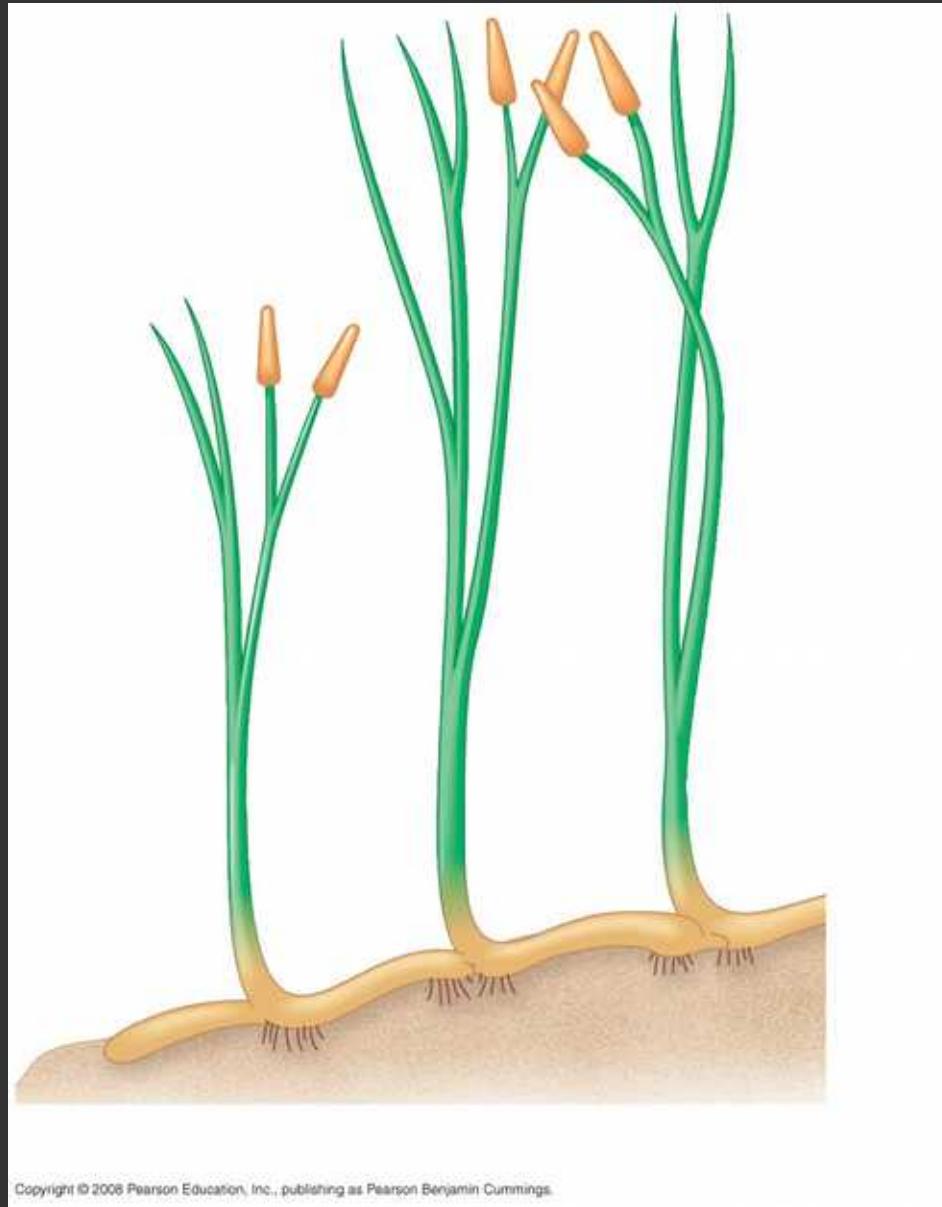


# Pterophyta (ferns and friends)



- Fossils of the forerunners of vascular plants date back about 420 million years
- Living vascular plants are characterized by:
  - Life cycles with dominant sporophytes separate from the gametophyte, along with flagellated sperm
  - Vascular tissues called xylem (with tracheids) and phloem

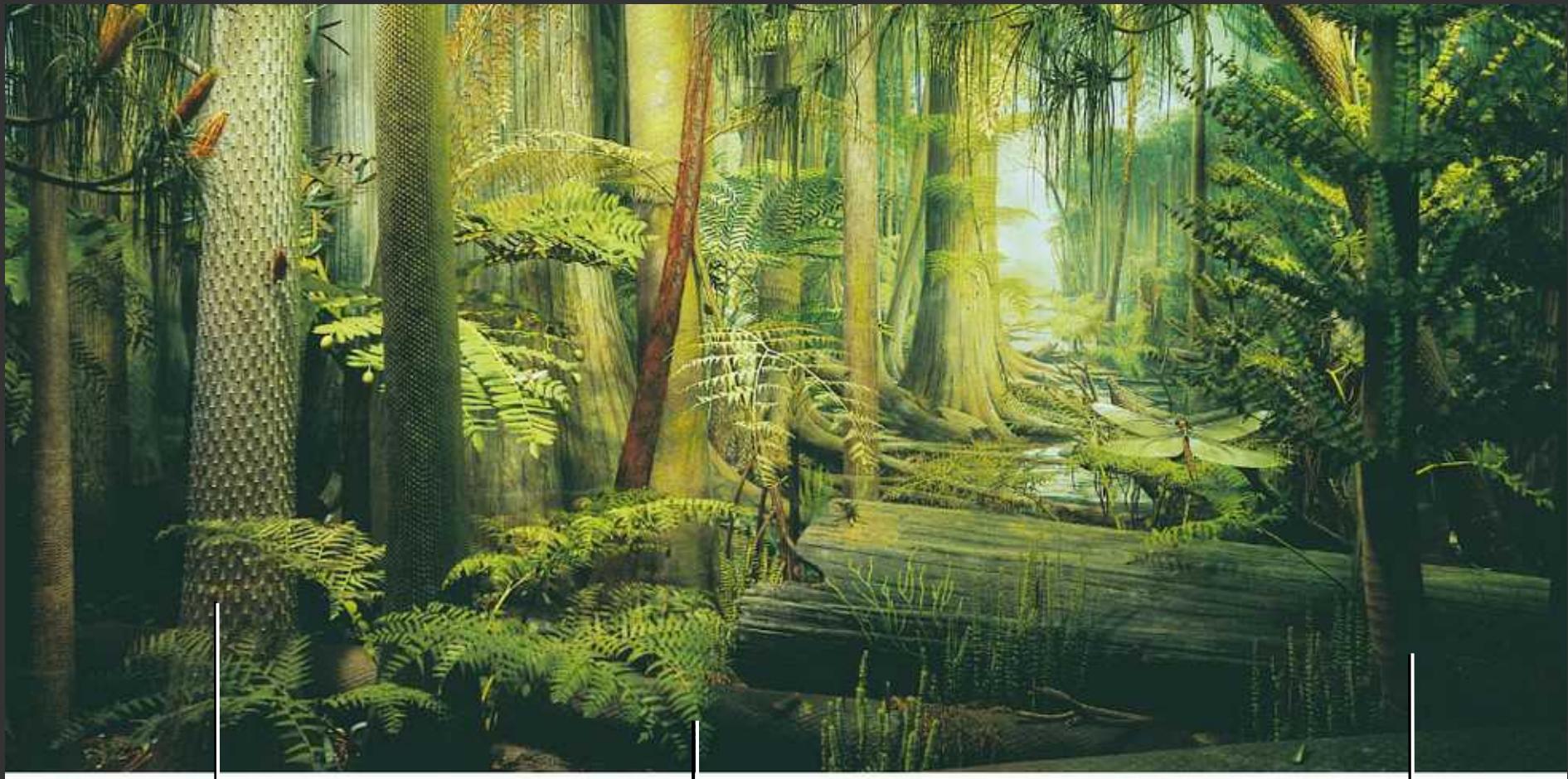




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## Sporophytes of *Aglaophyton major*

# Carboniferous Period



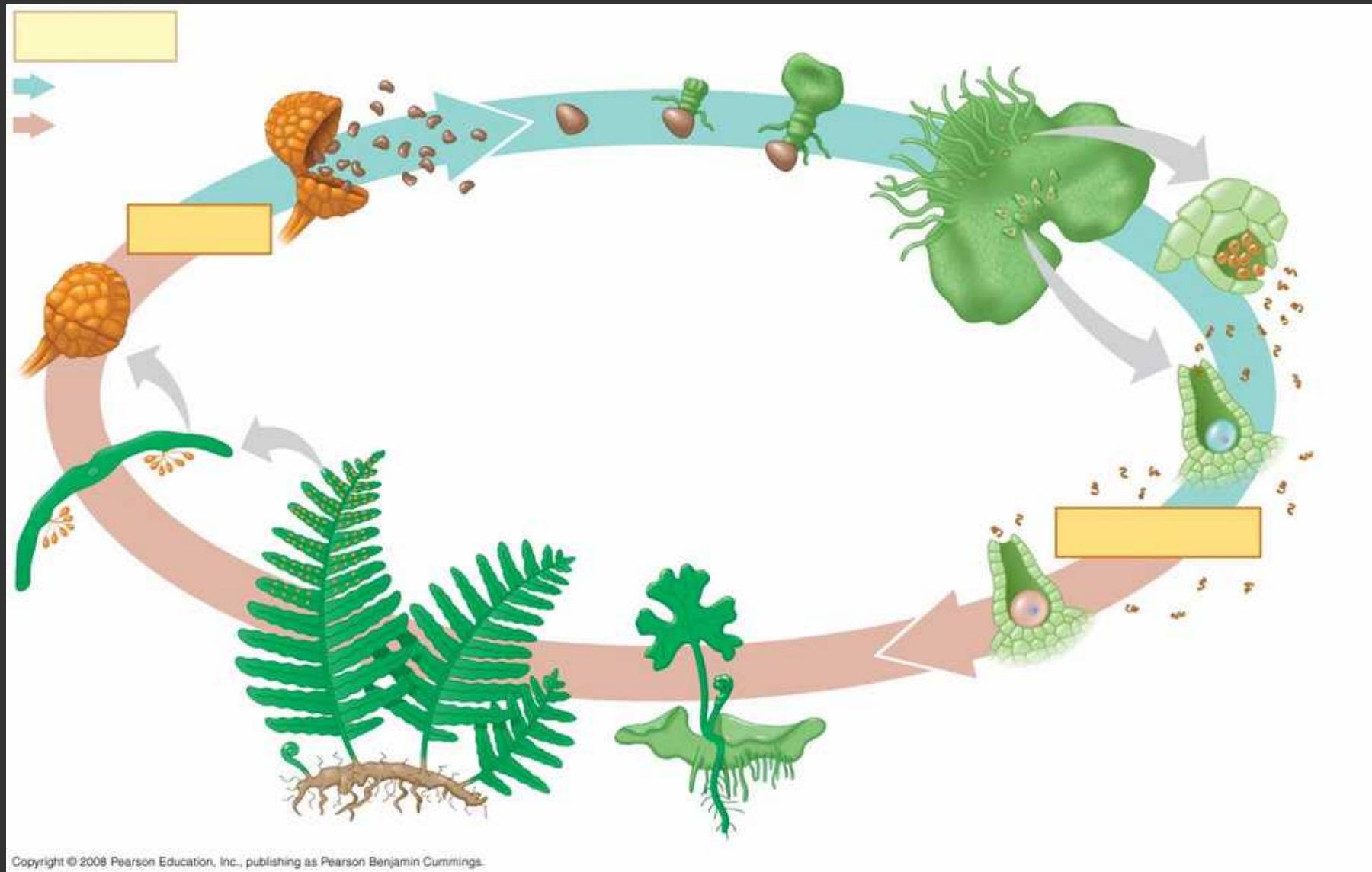
© Cengage Learning

stem of a giant lycophyte ( *Lepidodendron*),  
which could grow 40 meters (131 feet) tall

seed fern ( *Medullosa*); its seeds  
were about the size of walnuts

stem of a giant horsetail ( *Calamites*),  
which was almost 20 meters (66 feet) tall

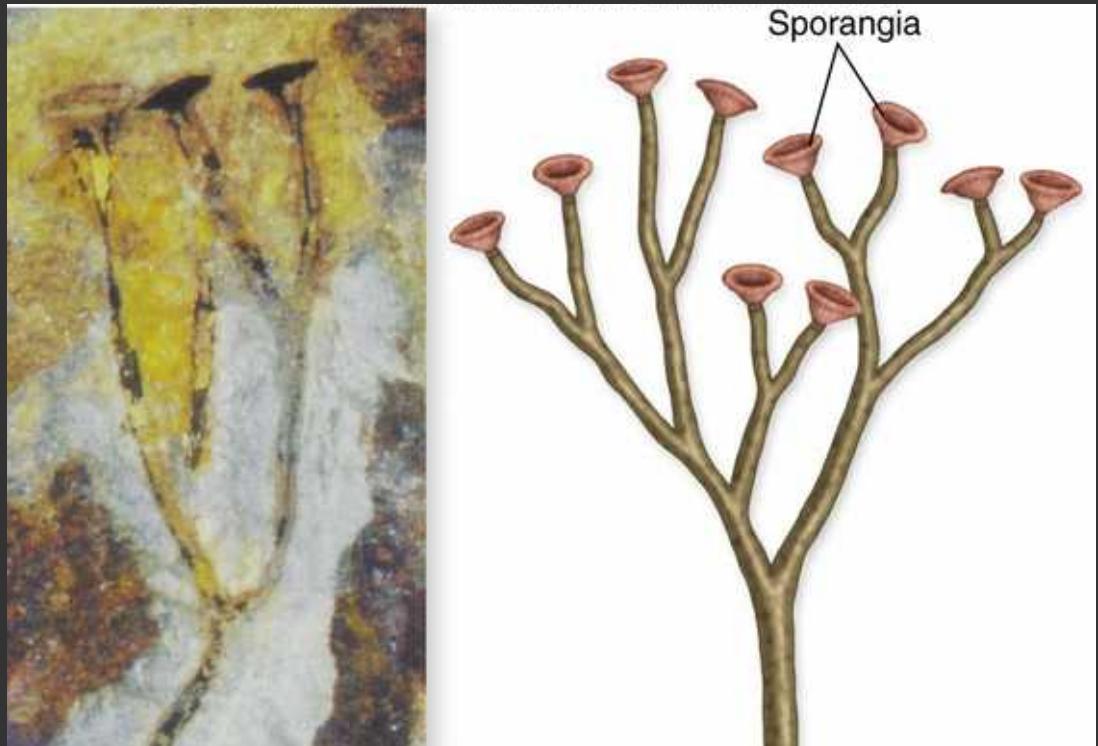
# Sporophyte is dominant



# Features of Ancient Vascular Plants

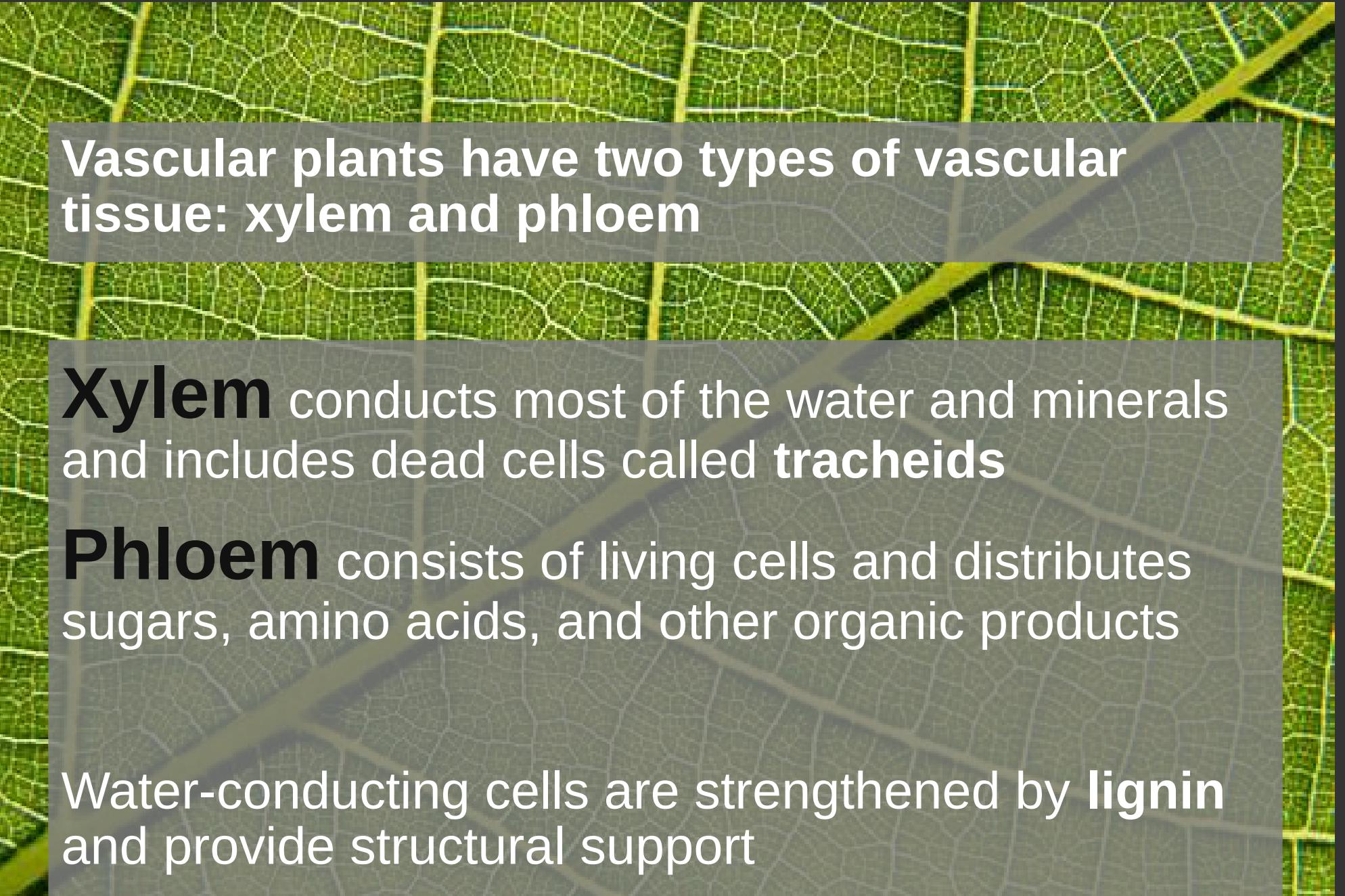
***Cooksonia***, one of the first vascular (Xylem and Phloem) land plants, appeared about 420 MYA, Late Silurian

- Only a few centimeters tall
- No roots or leaves
- Homosporous** (producing only one type of spore)



**Modern vascular plants have:**

- Dominant sporophyte generation
- Vascular tissue
- Roots
- Stems
- Leaves



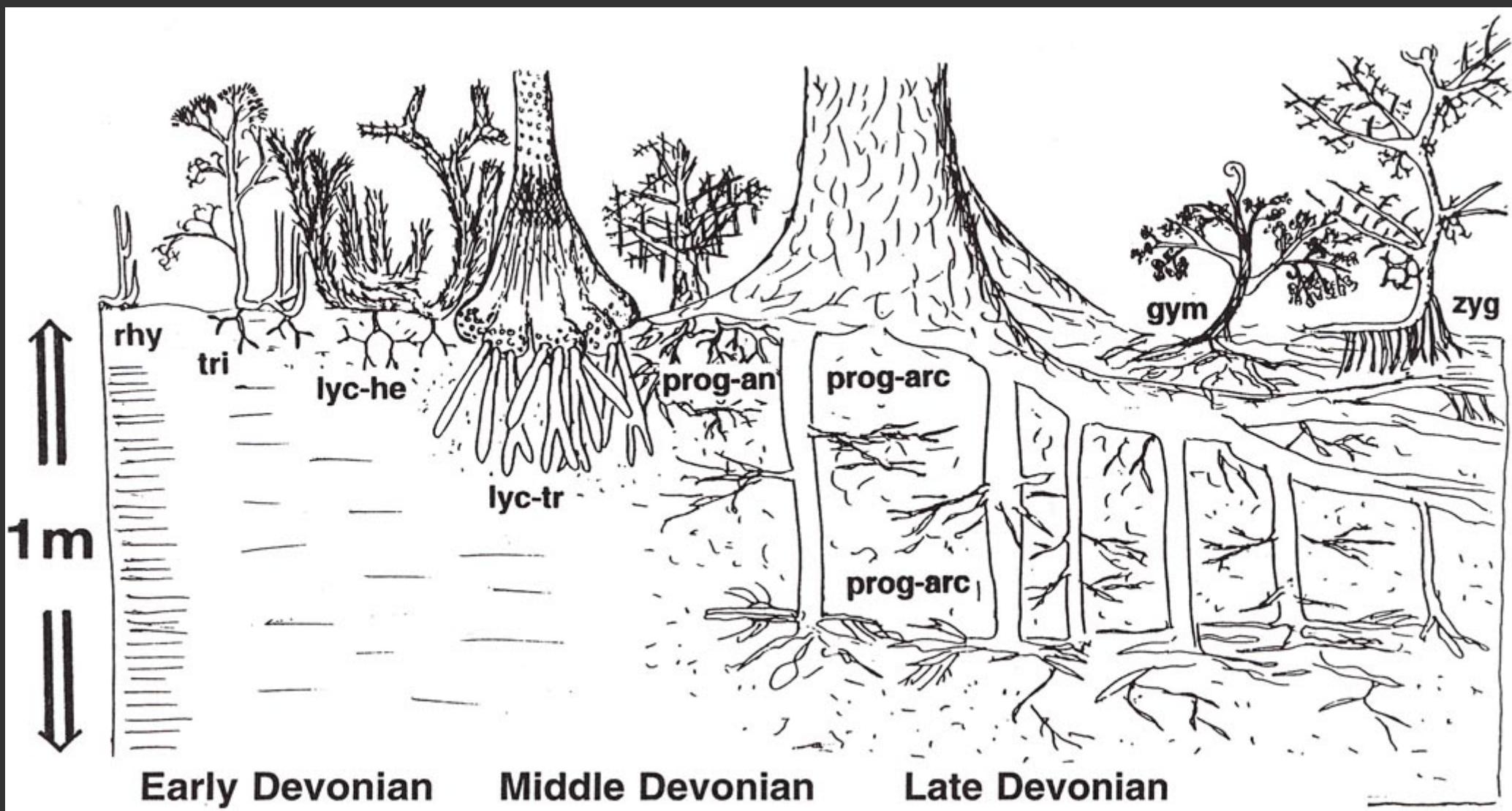
**Vascular plants have two types of vascular tissue: xylem and phloem**

**Xylem** conducts most of the water and minerals and includes dead cells called **tracheids**

**Phloem** consists of living cells and distributes sugars, amino acids, and other organic products

Water-conducting cells are strengthened by **lignin** and provide structural support

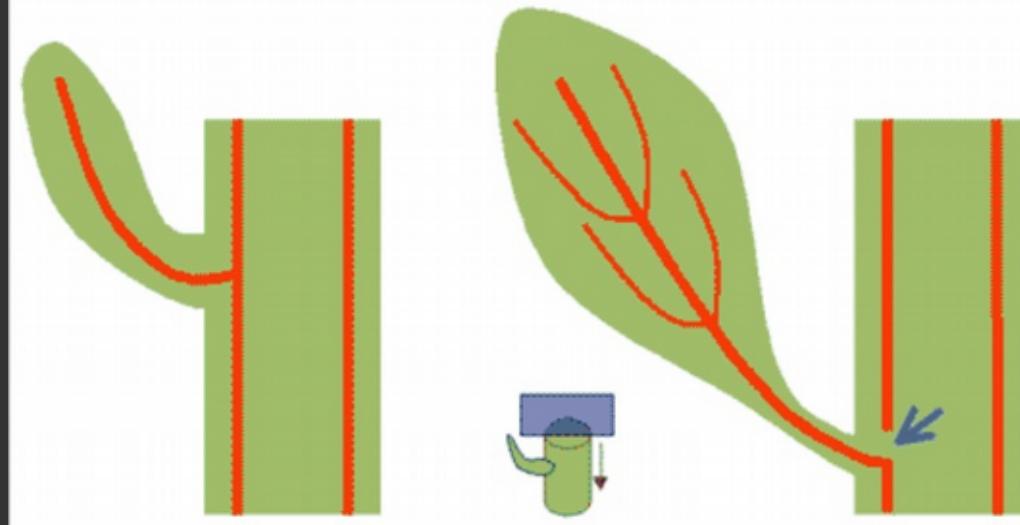
# Evolution of roots

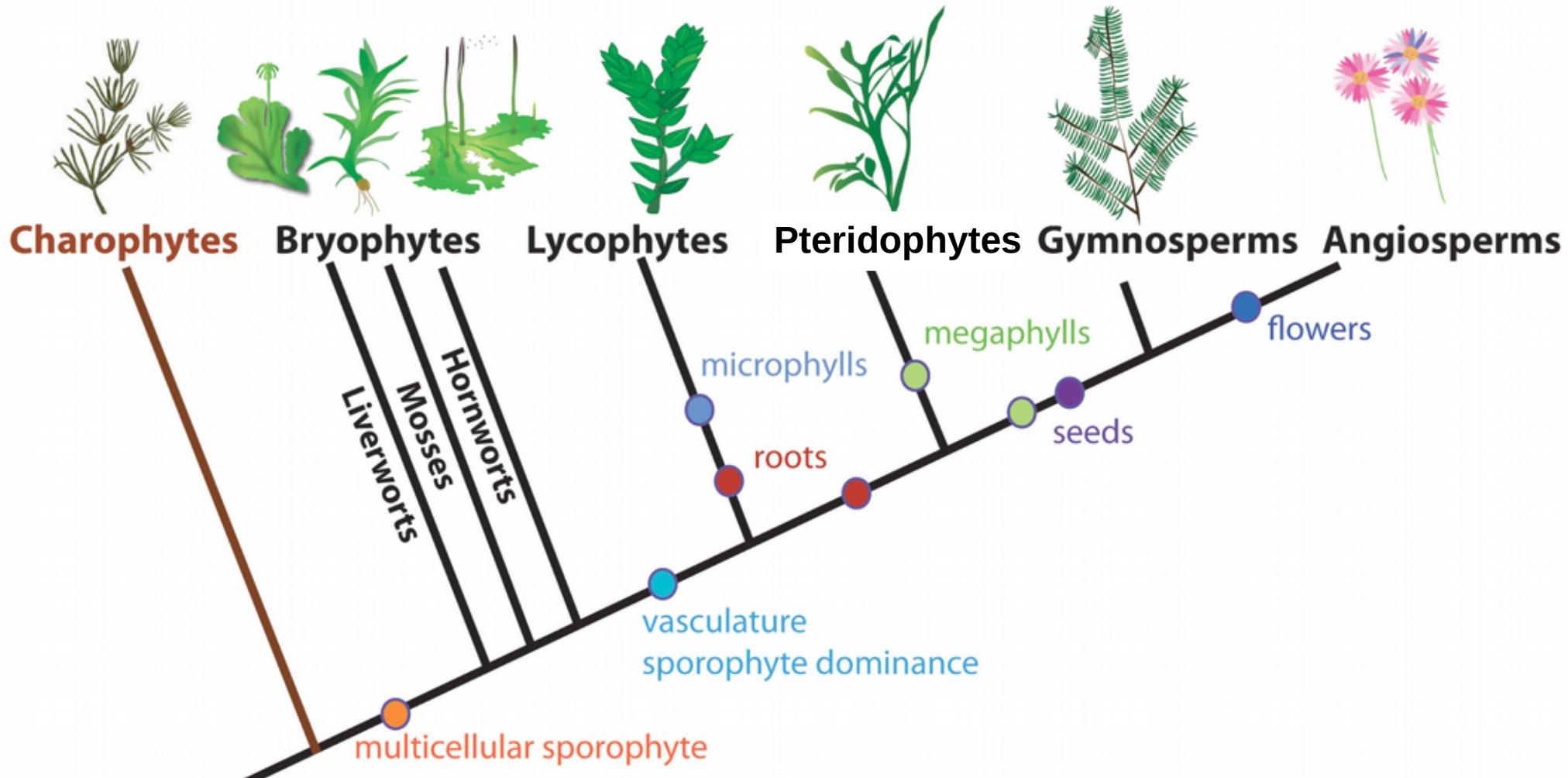


# Leaves increase surface area of plants



Microphyll vs. Megaphyll







Charophyceans



Bryophytes  
(nonvascular plants)

Liverworts      Hornworts      Mosses

Land plants

Vascular plants

Seedless vascular plants

Seed plants

Lycophtyes  
(club mosses, spike mosses, quill worts)

Pterophytes  
(ferns, horsetails, whisk ferns)



Gymnosperms      Angiosperms

Origin of seed plants  
(about 360 mya)

Origin of vascular plants  
(about 420 mya)

Origin of land plants  
(about 475 mya)

Ancestral  
green alga













