Fungi & Plants
Domain Eukarya
Kingdom Fungi and Kingdom Plantae

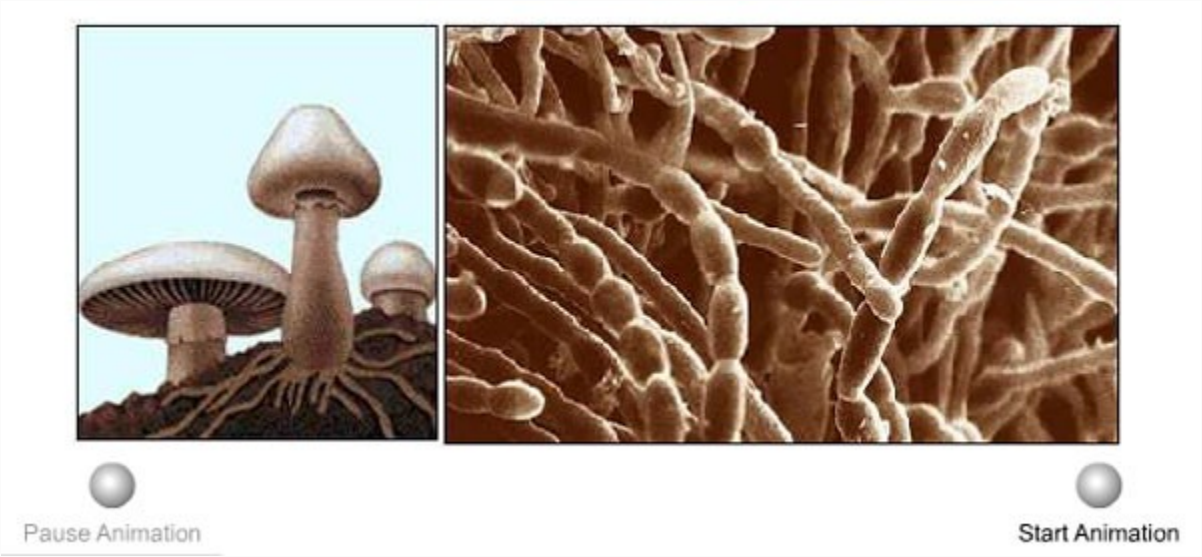
Fungal Traits and Classification

- Fungi are heterotrophs that obtain nutrition from their environment by extracellular digestion
  - Most are free-living saprobes
  - Others live on or in other organisms
- They disperse by producing fungal spores
  - Cells or clusters of cells, often with a thick wall

Characteristics of Fungi

- Some fungi live as single cells (yeasts)
- Most are a multicelled (molds, mushrooms)
  - Multicelled fungi grow as a mesh of branching filaments (**mycelium**)
  - Each filament is one **hypha**

Animation: Mycelium



Ecology of Fungi

- Some decompose organic wastes and remains
  - Help recycle nutrients in ecosystems
- Some form beneficial partnerships with plants, photosynthetic cells (lichen), or herbivores
- Some are parasites or pathogens

Multicelled Fungi

Phylogeny and Classification – major fungal groups

- Chytrids and zygote fungi (zygomycetes)
  - No dikaryotic stage
- Sac fungi (ascomycetes) and club fungi (basidiomycetes)
  - Dikaryotic mycelium

Key Concepts
Traits and Classification

- *Fungi are single-celled and multicelled heterotrophs*
- *They secrete digestive enzymes onto organic matter, then absorb the released nutrients*
- *They reproduce sexually and asexually by producing spores*
- *Zygote fungi, club fungi, and sac fungi are major groups. They can be divided based on their spores!!!*

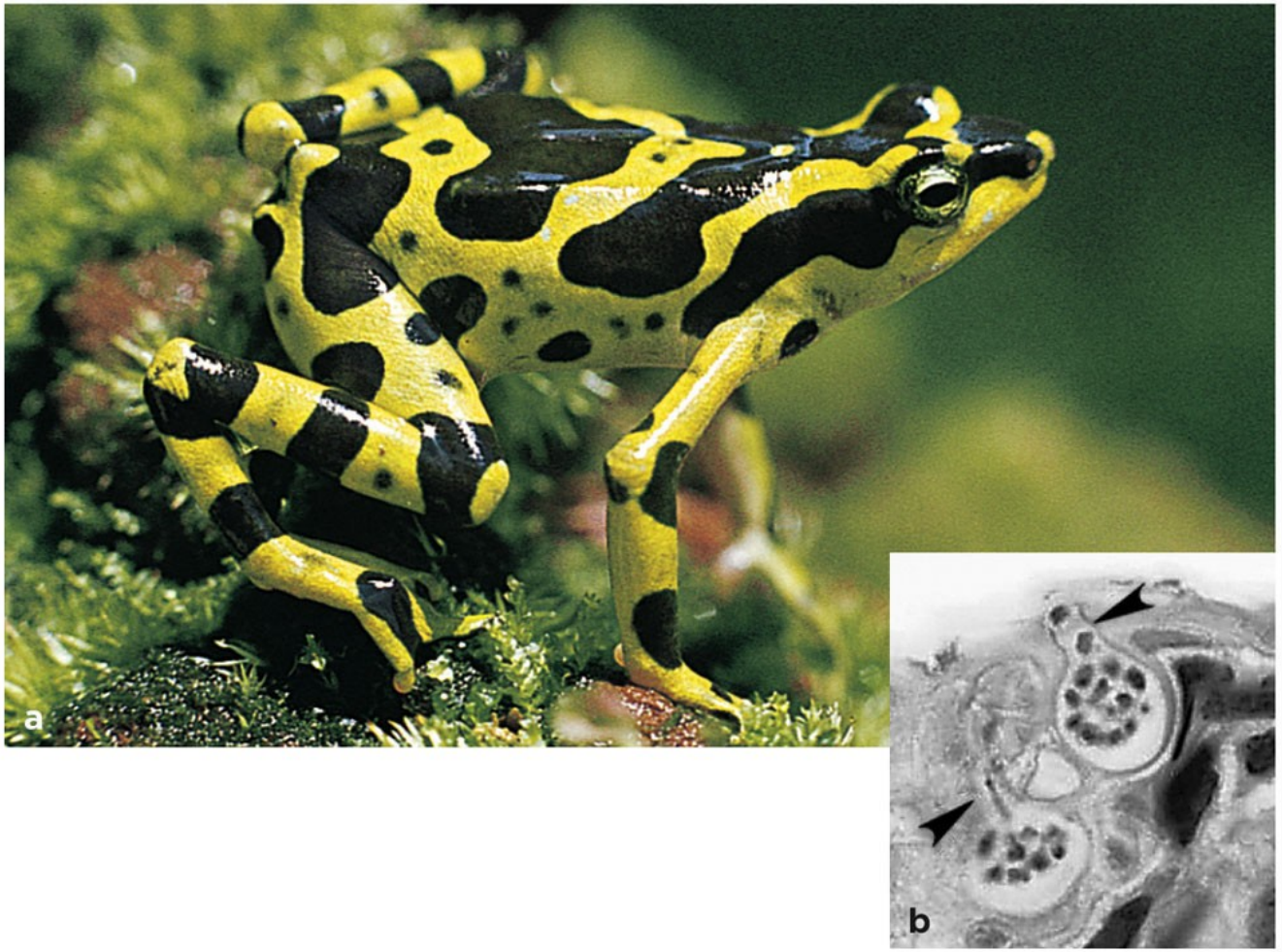
The Flagellated Fungi

- **Chytrids** are the only modern fungi with a life cycle that includes flagellated cells
  - Some feed on organic wastes and remains
  - Some live in guts of herbivores and help digest cellulose
  - Some are parasites

http://www.youtube.com/v/kf9H_RjLIa0

A Parasitic Chytrid

- A frog parasite, *Batrachochytrium dendrobatidis*



Zygote Fungi and Relatives

- Only **zygote fungi** (zygomycetes) produce a thick-walled diploid spore (zygospore) during sexual reproduction

- Zygote fungi form a branching haploid mycelium on organic material, and inside living plants and animals

Typical Zygote Fungi

- *Rhizopus* species
  - Include black bread mold, molds that spoil foods, and the fungus that causes zygomycosis

- *Pilobolus*
  - Produces specialized spore-bearing hyphae with fluid-filled sacs that blast spores up to 2 meters

http://www.youtube.com/v/PXwLddA4Ctw

Spore Bearing Structures of *Pilobolus*

http://www.youtube.com/v/9CRNmde0WUc

Sac Fungi—Ascomycetes

- Sac fungi are the most diverse fungal group
  - Some are single cells (yeasts), but in most a haploid mycelium dominates the life cycle
- Sac fungi are the group that most often causes diseases in humans

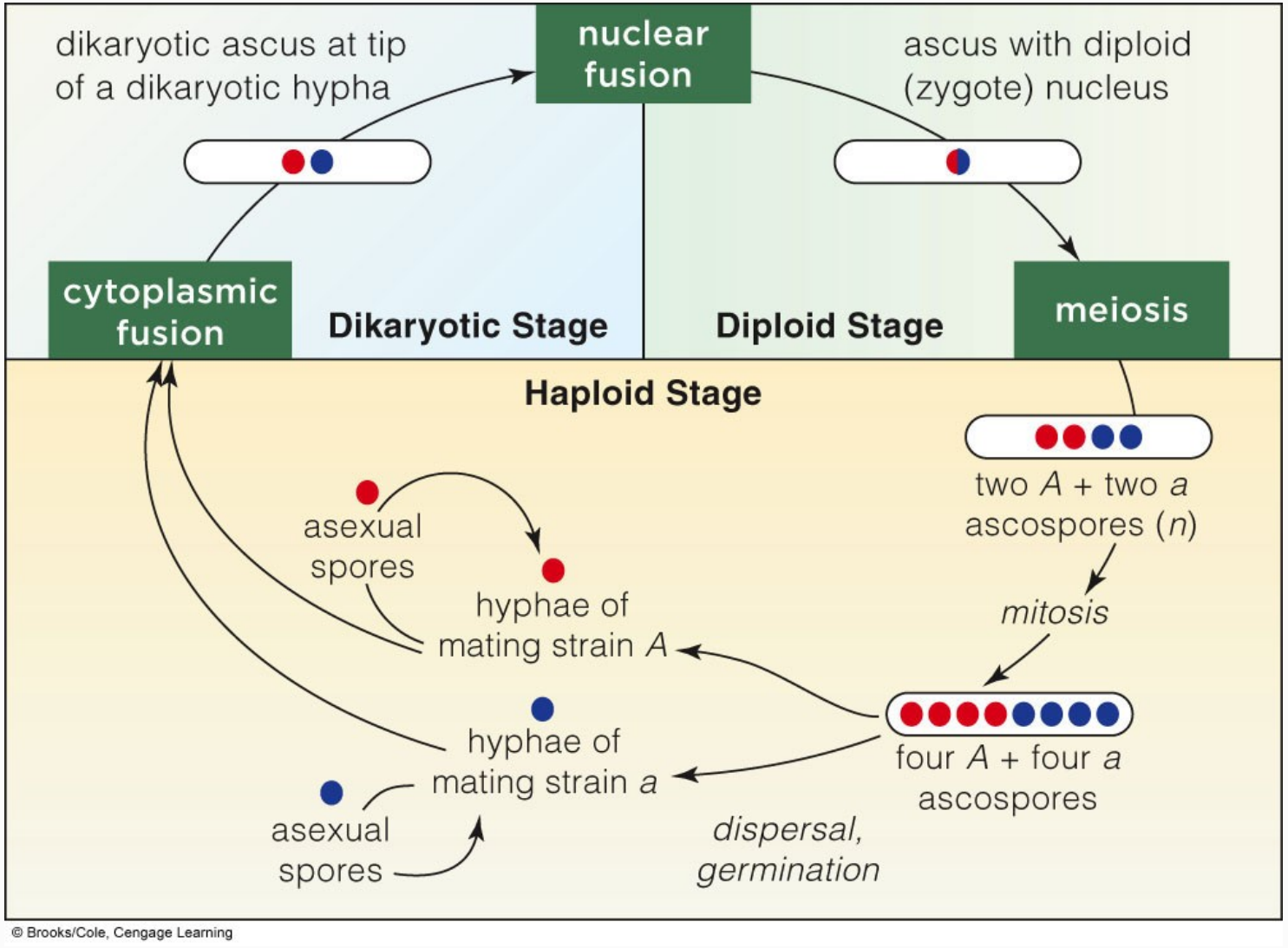
Sexual Reproduction

- Sac fungi that reproduce sexually typically form spores inside an ascus

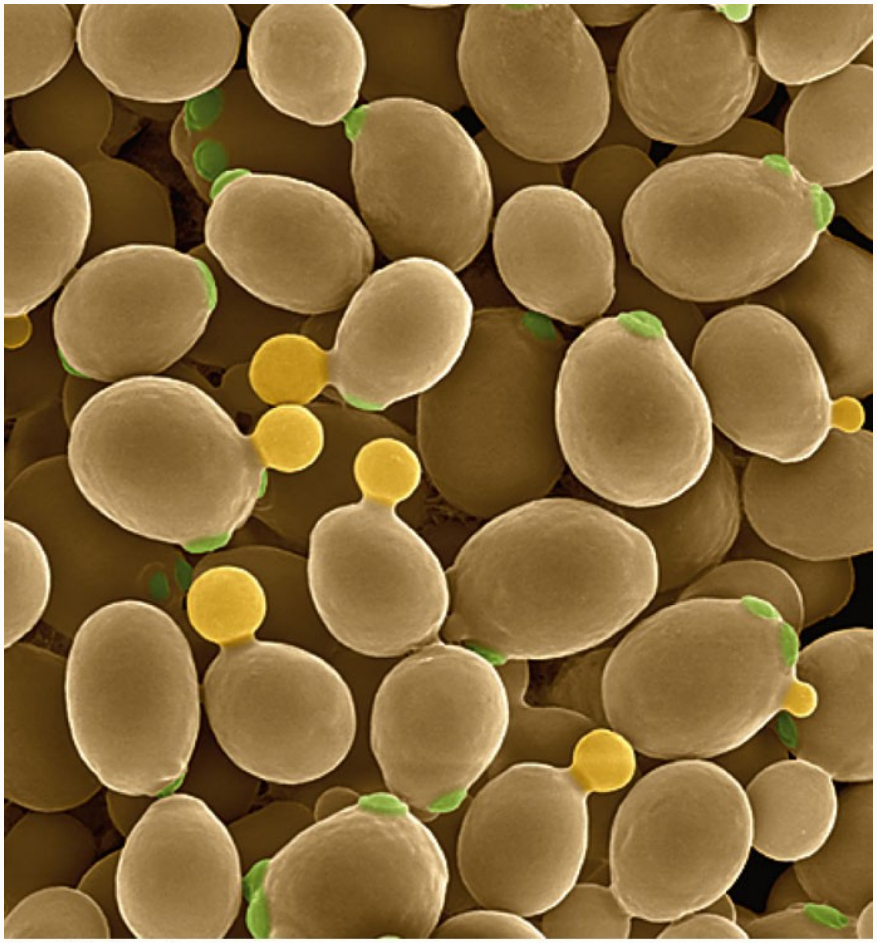
- **Asci**
  - Saclike structures that form on a fruiting body (**ascocarp**) consisting of dikaryotic hyphae

Ascocarps

Sexual Reproduction



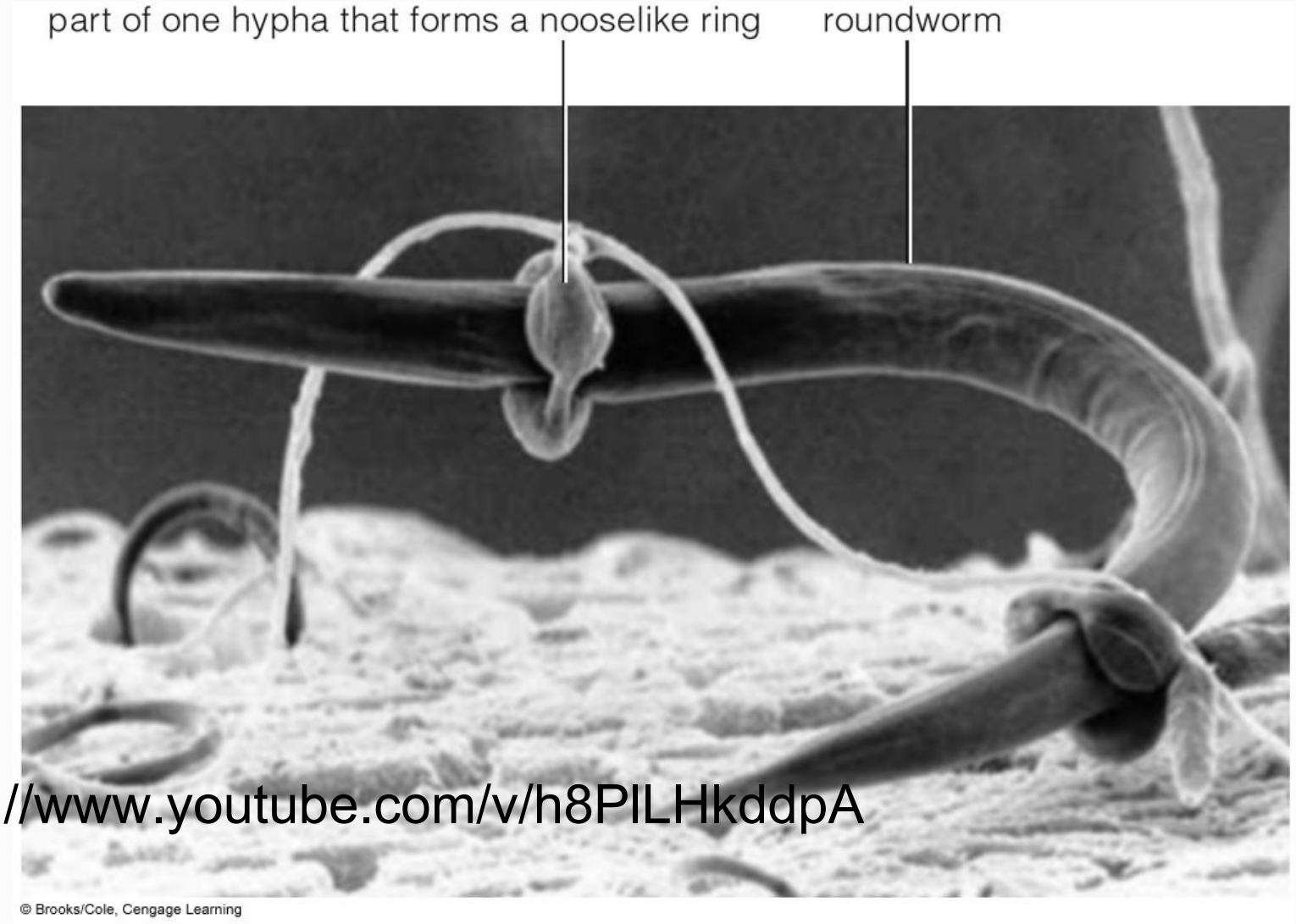
Asexual Reproduction - yeast & multicelled fungus – don't need to know, but it's cool!!!



Human Uses of Sac Fungi

- Food and beverages
  - Baking yeast and fermentation (*Saccharomyces, Aspergillus*), blue cheese (*Penicillium*)
- Drugs
  - Antibiotics (*Penicillium*, *Cephalosporium*)
  - Statins (*Aspergillus*)
- Natural herbicides and pesticides
  - *Arthrobotrys*

A Predatory Fungus: *Arthrobotrys*

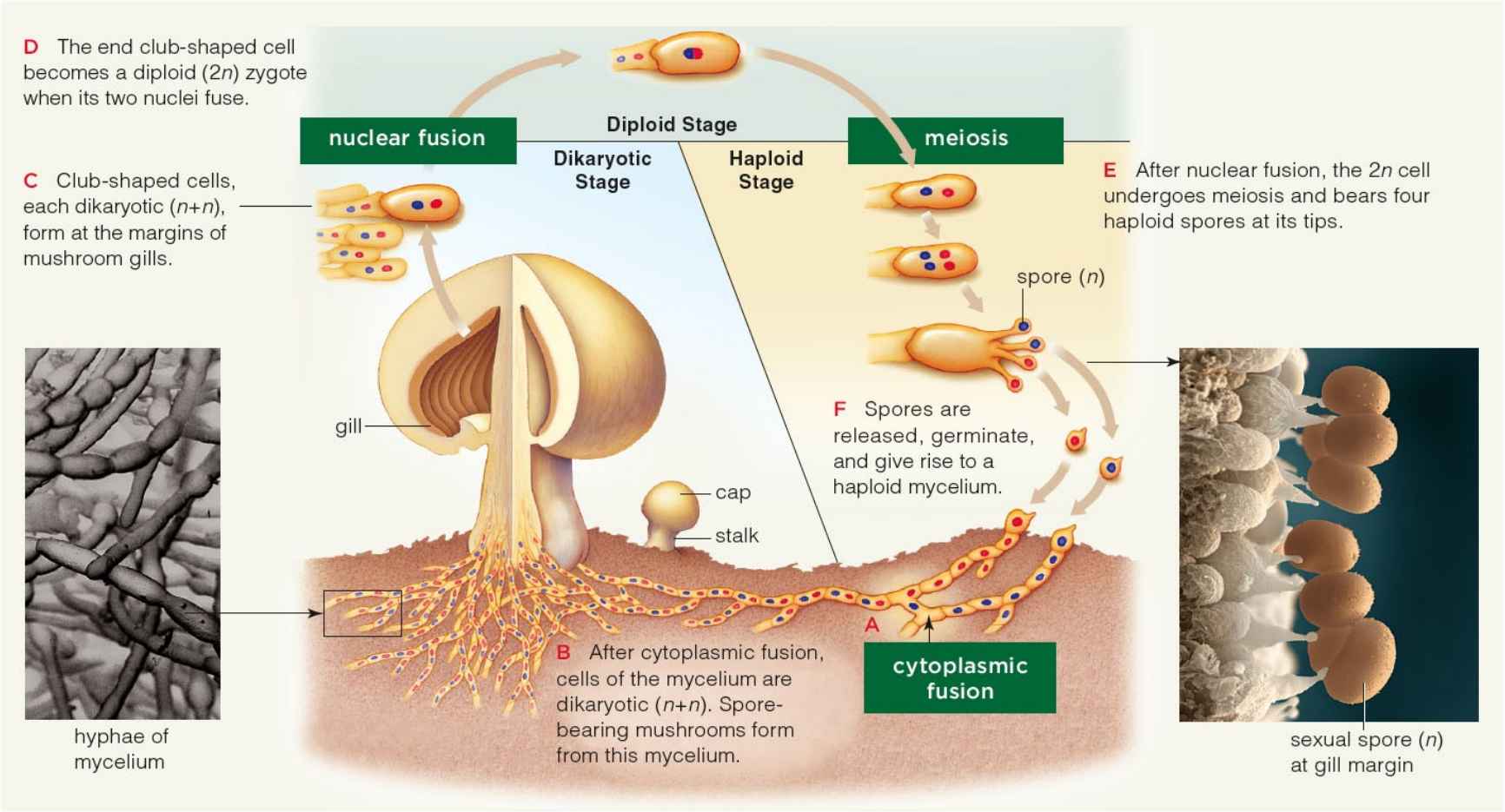


http://www.youtube.com/v/h8PILHkddpA

Club Fungi—Basidiomycetes

- Club fungi are typically multicelled fungi in which a dikaryotic mycelium dominates the life cycle
- They form sexual spores inside club-shaped cells that develop on a fruiting body (basidiocarp) composed of interwoven dikaryotic hyphae

Club Fungus Life Cycle



Club Fungus Diversity

- Club fungi make the largest and most elaborate fruiting bodies of all fungi

- Club fungi include edible mushrooms (chanterelles), poisonous mushrooms (death cap), and plant pathogens (smuts and rusts)

Club Fungus Diversity

Key Concepts
The Major Groups

- *In zygote fungi, which include many molds, the single-celled zygote produces spores by meiosis*
- *Many sac fungi and club fungi make complex spore-bearing structures such as mushrooms*
- *Meiosis in cells on these structures produces spores*

The Fungal Symbionts

- Fungi form associations with plants and with single-celled photosynthetic species
  - Lichens
  - Mycorrhizae

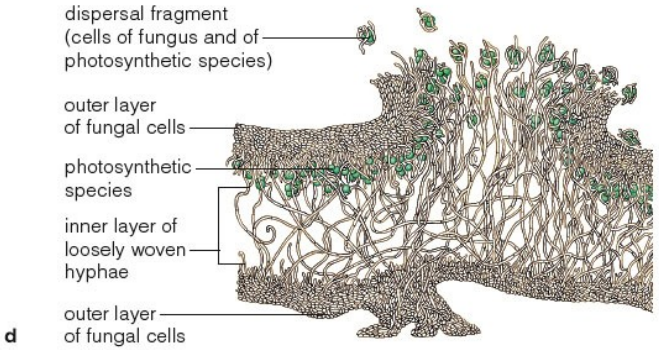
Lichens

- **Lichen**
  - Consists of a fungus and photosynthetic cells
  - A symbiotic interaction between a sac fungus (or club fungus) and a green alga or cyanobacterium

- **Mutualism**
  - A symbiotic interaction that benefits both partners

Lichens


a
b
c


dispersal fragment
(cells of fungus and of
photosynthetic species)
outer layer
of fungal cells
photosynthetic
species
inner layer of
loosely woven
hyphae
outer layer
of fungal cells
d

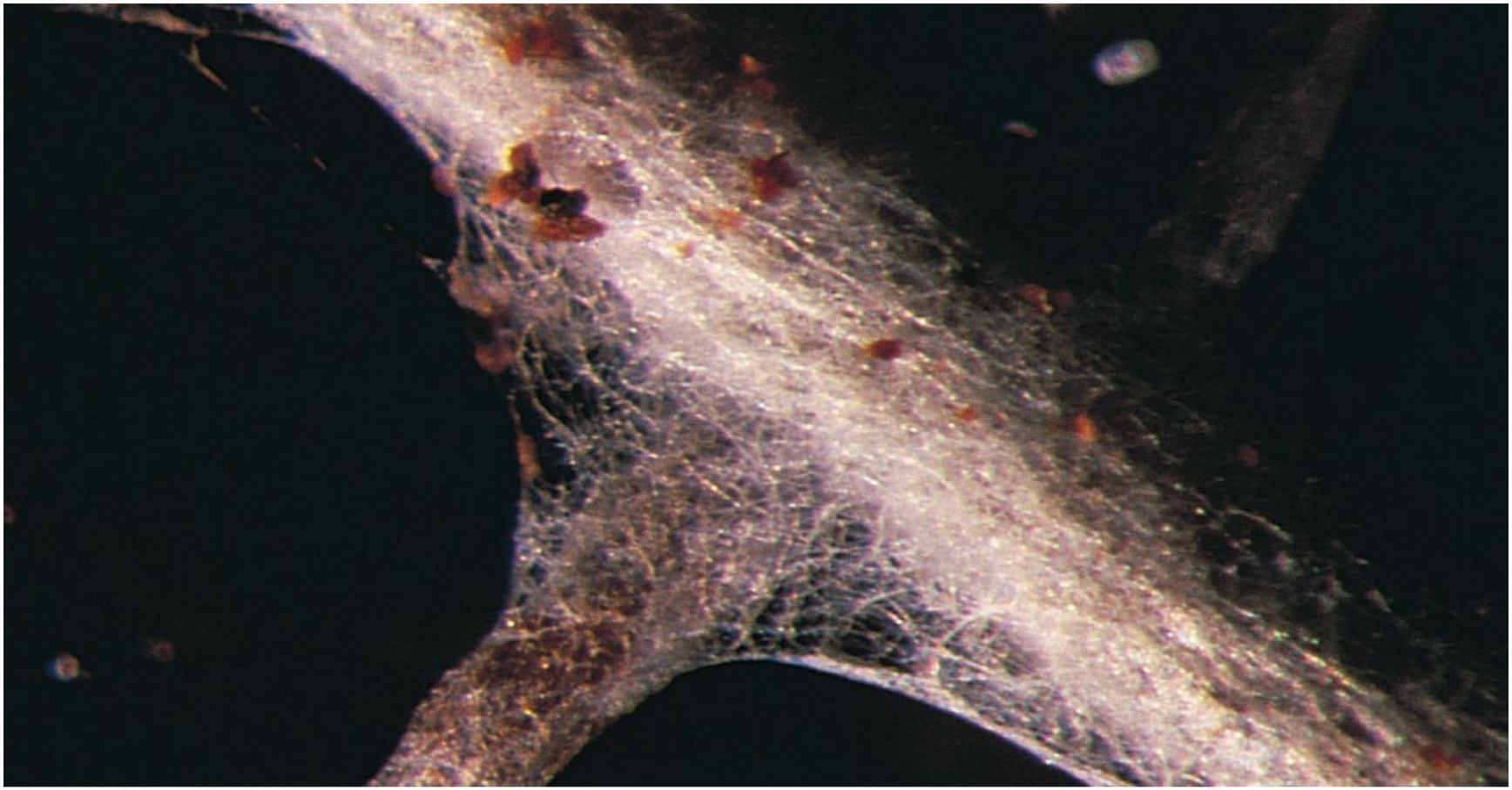
Animation: Lichens

http://www.youtube.com/v/b0sjFcMnoK0

Mycorrhizae – The Fungus-Root

- **Mycorrhizae**
  - A partnership between soil fungi and tree roots

Mycorrhizae



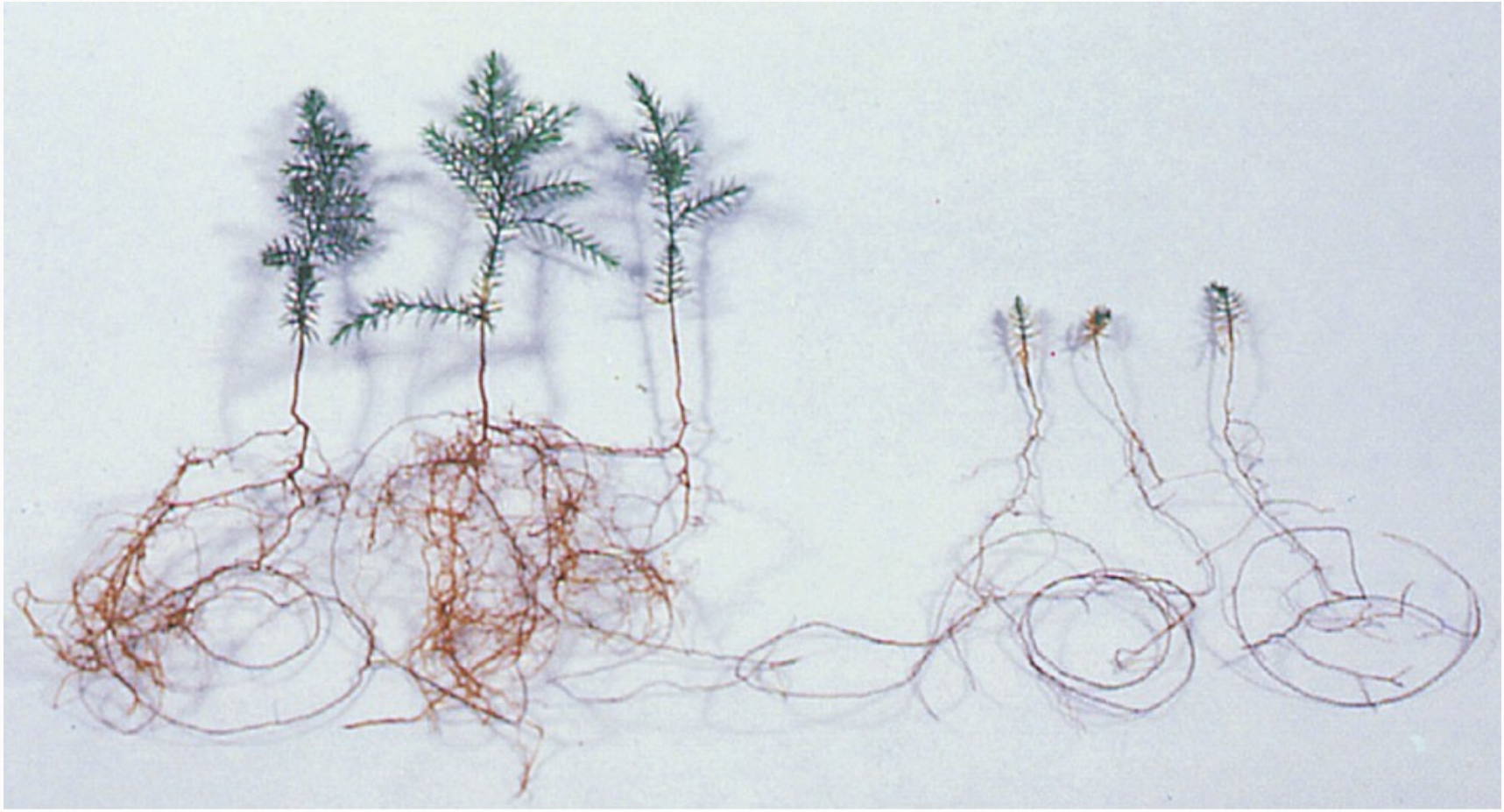
Mycorrhizae Function

- Hyphae of mycorrhizae grow through soil and increase the absorptive area of their partner

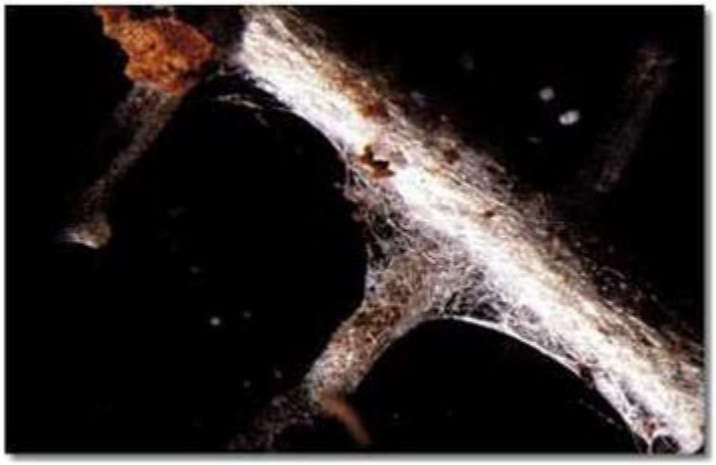
- Both partners benefit
  - Fungus concentrates nutrients for plant
  - Plant supplies sugars to the fungus

Benefits of Mycorrhizae

- Juniper seedlings without and with mycorrhizae



Animation: Mycorrhiza



http://www.youtube.com/v/bq1bTduTzC0

Key Concepts
Living Together

- *Many fungi live on, in, or with other species*
- *Some live inside plant leaves, stems, or roots*
- *Others form lichens by living with algae or cyanobacteria*

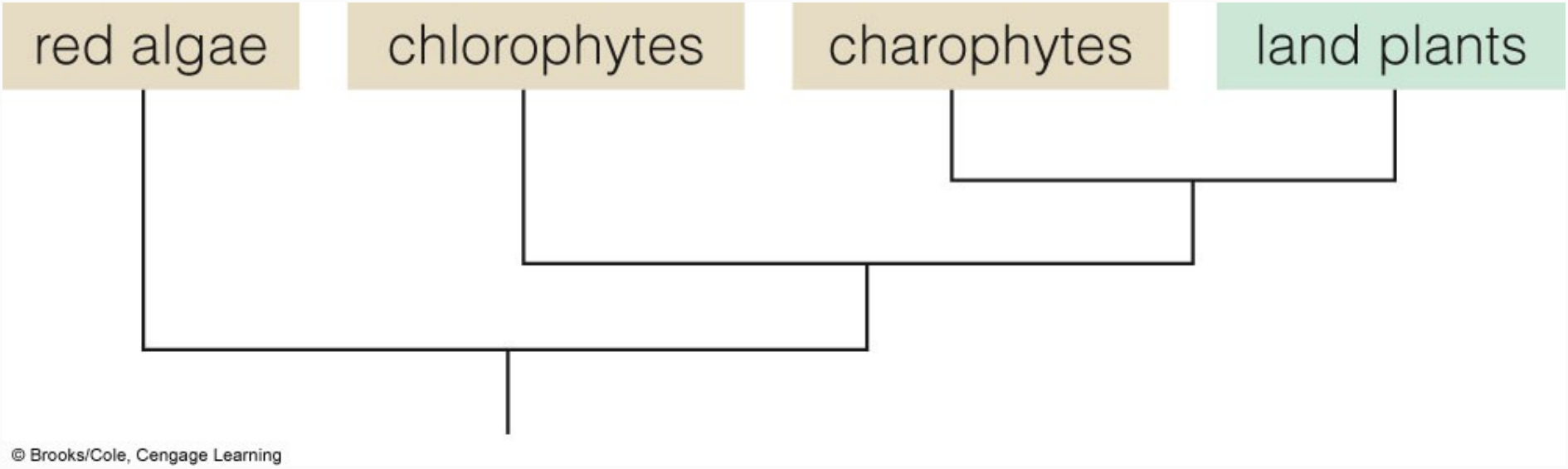
Fungal Infections

- Fungi cause:
  - Histoplasmosis
  - Valley fever
  - *Candida* (“yeast”) infections
  - Ringworm
  - Athlete's foot
  - Ergotism – witch hunts!
- Eating some club fungi can be fatal

The Land Plants

Evolution of Land Plants

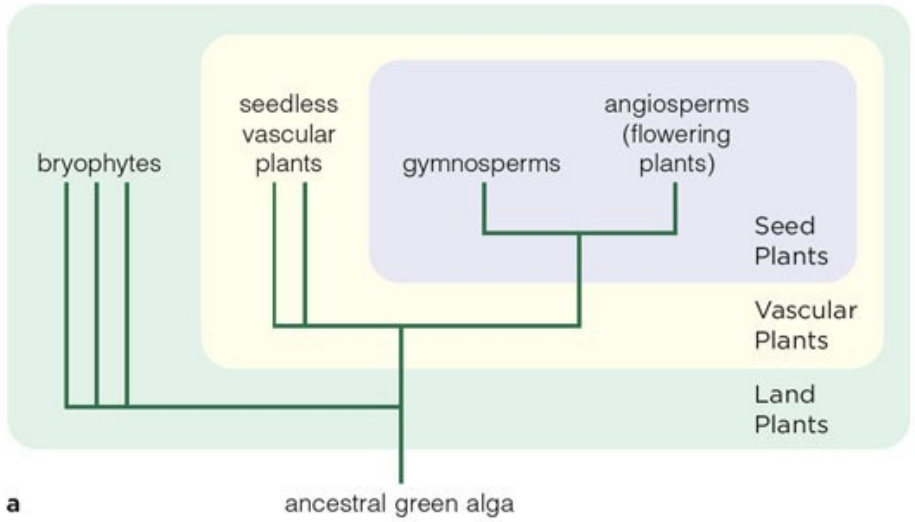
- Land plants evolved from a lineage of green algae (charophytes) after the ozone layer made life on land possible



Evolution of Land Plants

- Bryophytes include three early diverging land plant lineages
- Vascular seedless plants evolved next
- The first seed plants were gymnosperms, from which angiosperms (flowering plants) evolved

Evolutionary Tree for Land Plants



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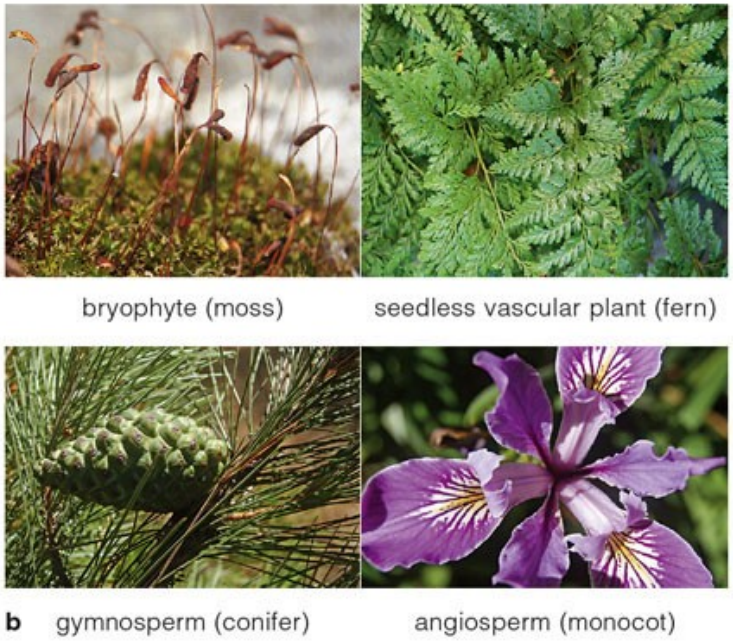


b

Diversity of Modern Land Plants

Table 23.1 Diversity of Modern Land Plants

Bryophytes	
Liverworts	9,000 species
Mosses	15,000 species
Hornworts	100 species
Seedless Vascular Plants	
Lycophytes	1,100 species
Whisk ferns	7 species
Horsetails	25 species
Ferns	12,000 species
Gymnosperms	
Cycads	130 species
Ginkgos	1 species
Conifers	600 species
Gnetopytes	70 species
Angiosperms (Flowering Plants)	
Basal groups (e.g., magnoliids)	9,200 species
Monocots	80,000 species
Eudicots	>180,000 species

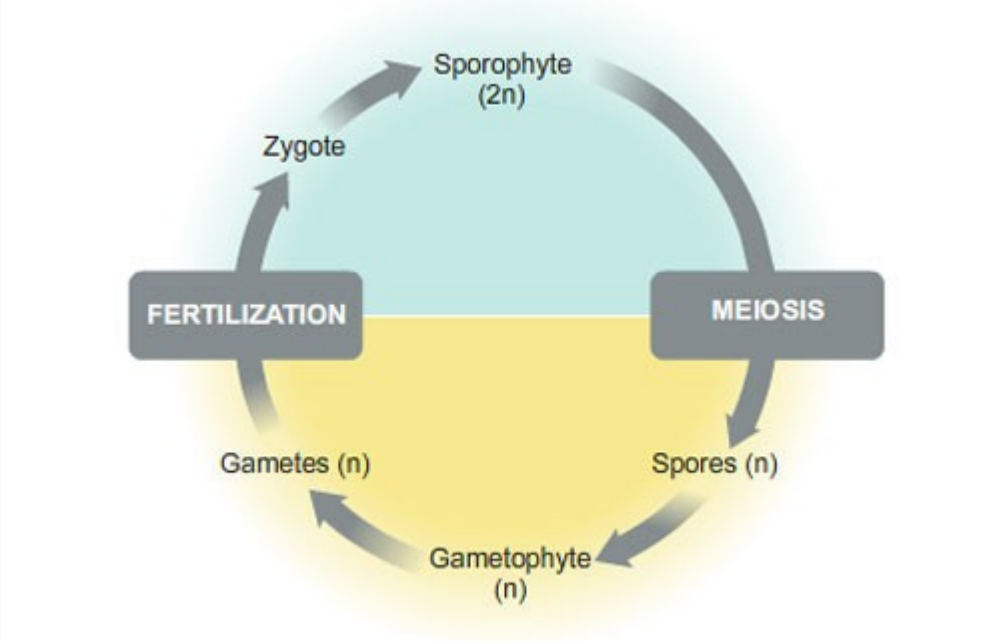
Evolutionary Trends Among Plants

- Over time, the spore-producing bodies of plants became larger, more complex, and better adapted to dry habitats

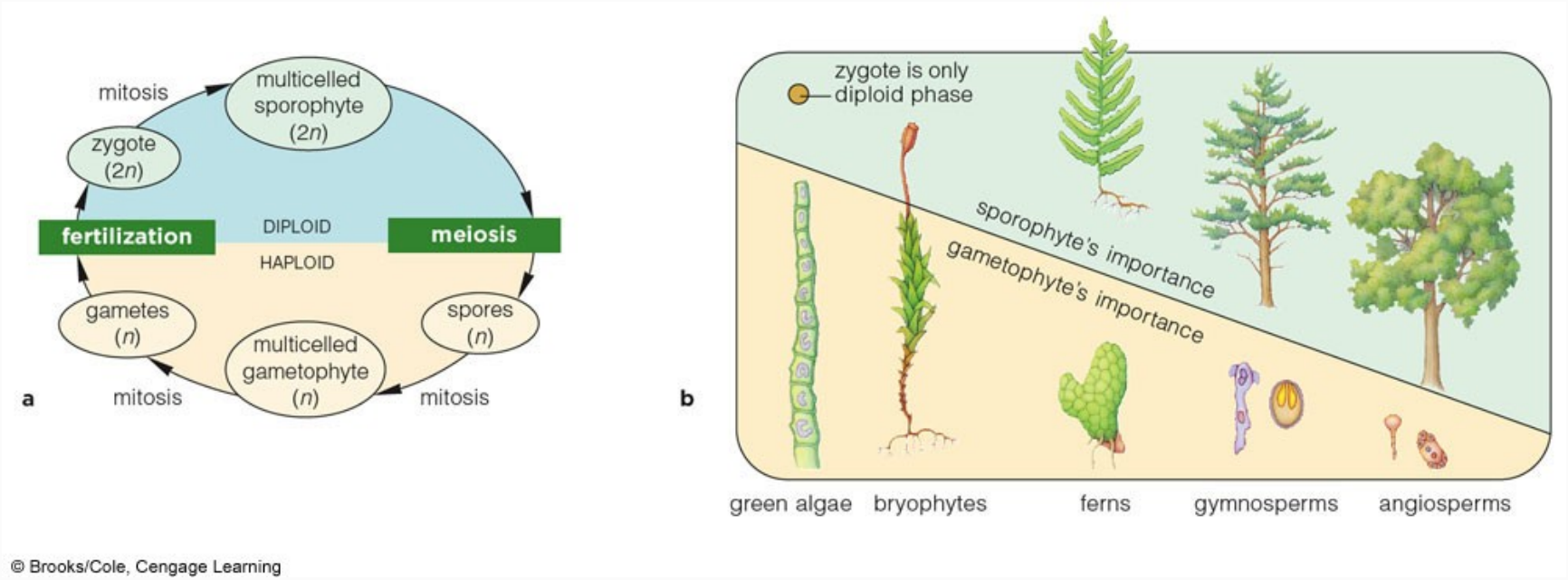
From Haploid to Diploid Dominance

- Plants shifted from gametophyte-dominated life cycle (in bryophytes) to sporophyte-dominated life cycle (in other plants)
  - **Gametophyte:** Haploid stage that forms gametes by mitosis
  - **Sporophyte:** Diploid stage that forms spores by meiosis

Animation: Alternation of generations

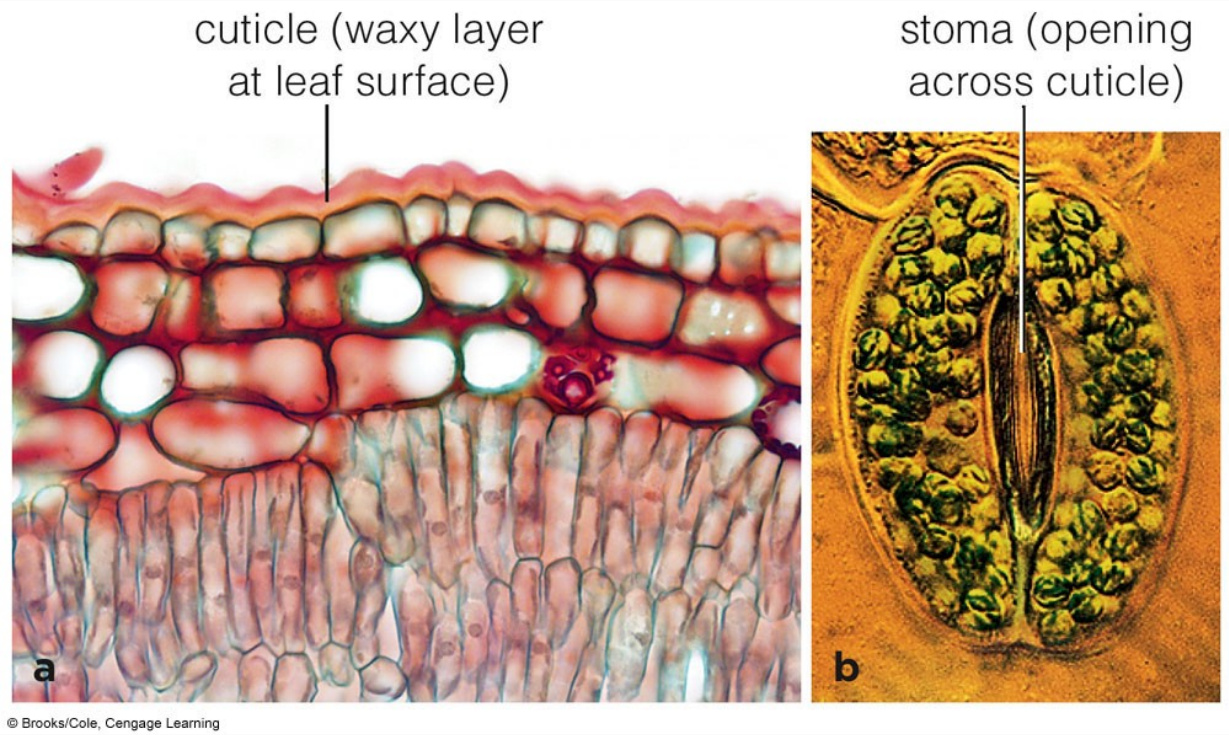


Life Cycle of Land Plants



Roots, Stems, and Leaves

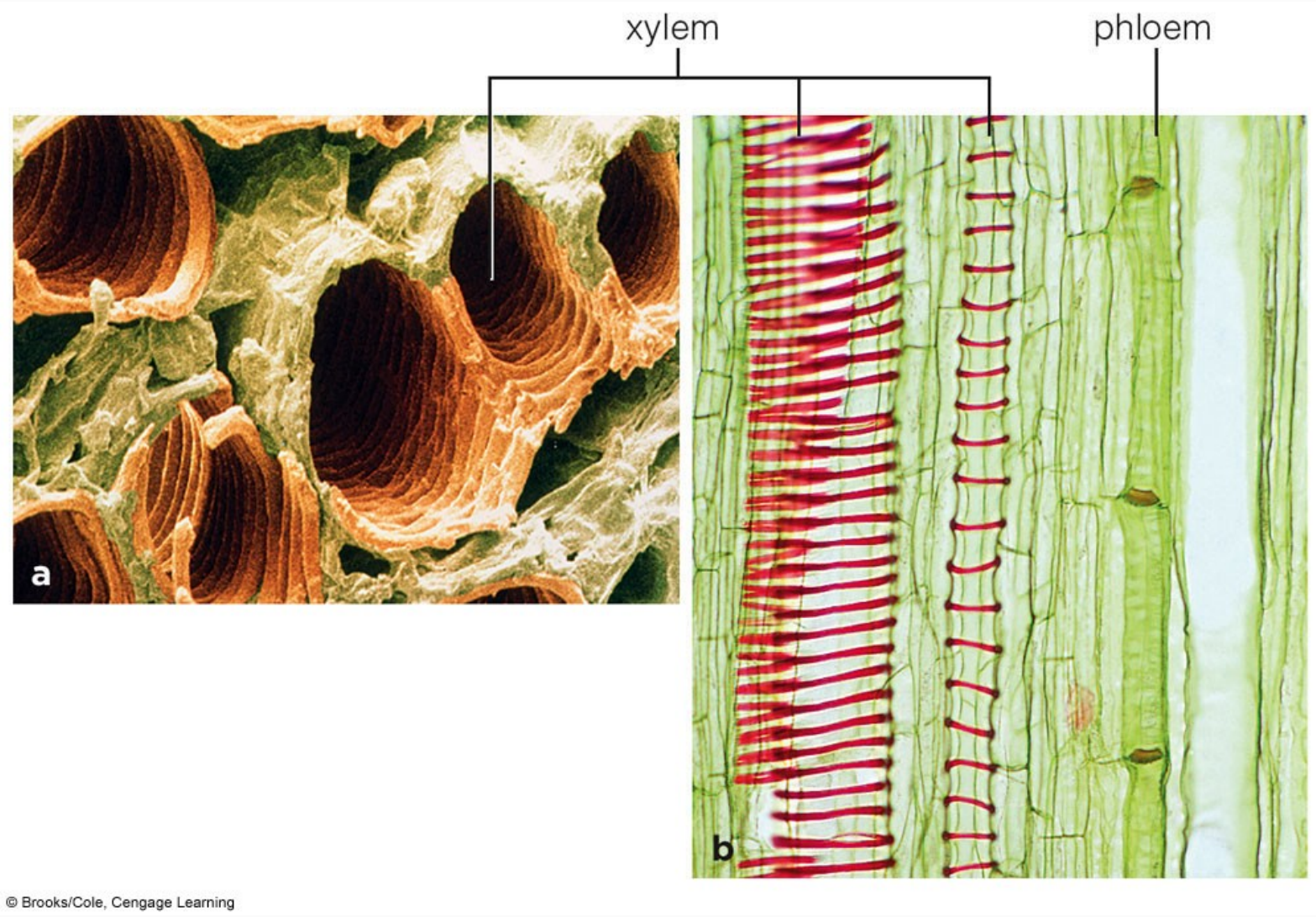
- Life on land favored water conserving features
  - **Cuticle**: Waxy layer that restricts evaporation
  - **Stomata**: Openings across the cuticle



Roots, Stems, and Leaves

- In vascular plants, a system of vascular tissue reinforced by **lignin** distributes materials through leaves, stems, and roots of sporophytes
  - **Xylem**: Distributes water and minerals
  - **Phloem**: Distributes products of photosynthesis

Vascular Tissues



Pollen and Seeds

- Bryophytes and seedless plants release spores

- Only seed-bearing vascular plants release pollen grains and seeds
  - **Pollen grain**: A walled, immature gametophyte that will give rise to the sperm
  - **Seed**: An embryo sporophyte and some nutritive tissue enclosed inside a waterproof coat

Two Lineages of Seed-Bearing Vascular Plants

- Gymnosperms
  - Cycads, conifers, ginkgos, and gnetophytes
- Angiosperms (flowering plants)
  - Most modern plants
  - Seeds form inside floral tissue that later develops into a fruit

Dispersal Methods: Spores and Seeds

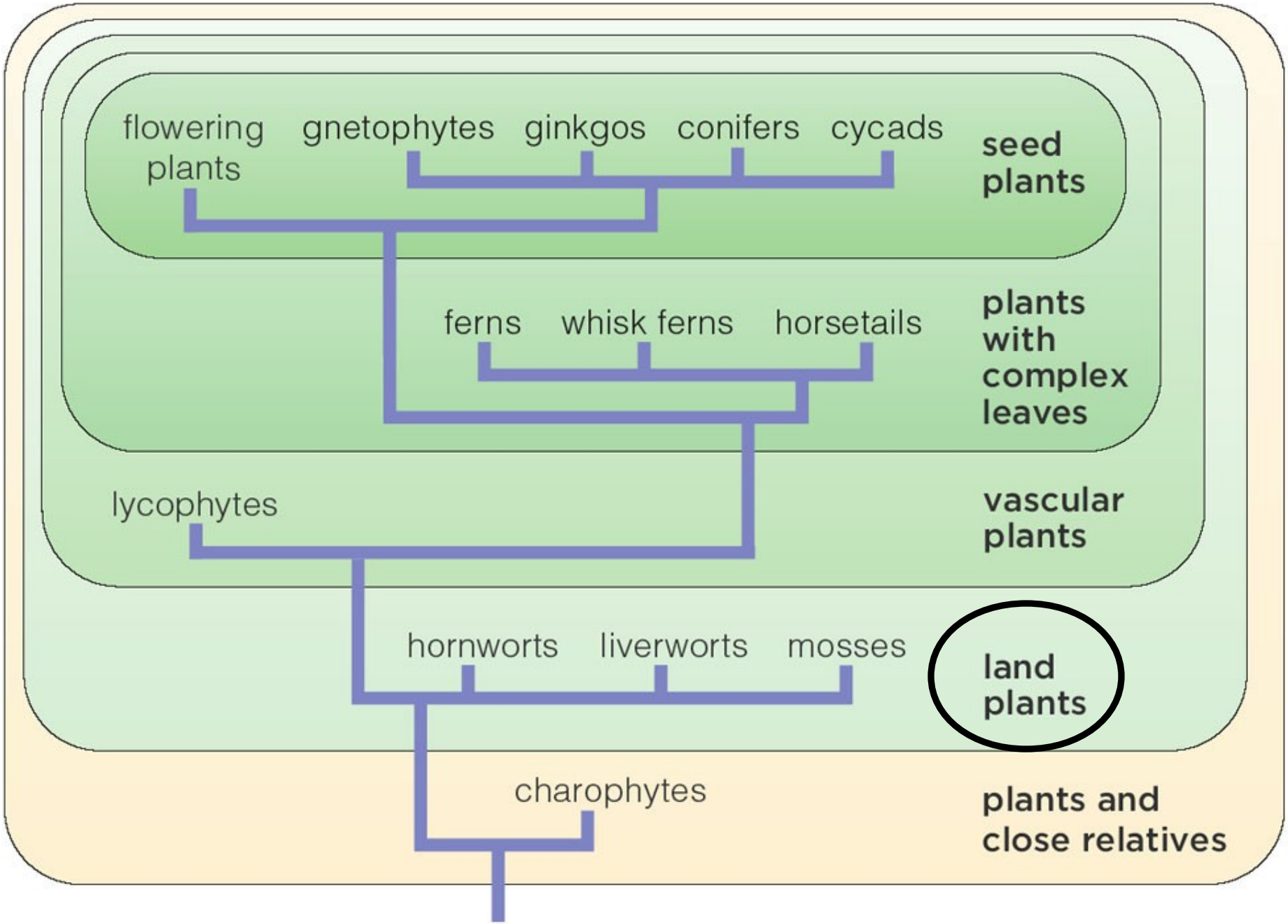
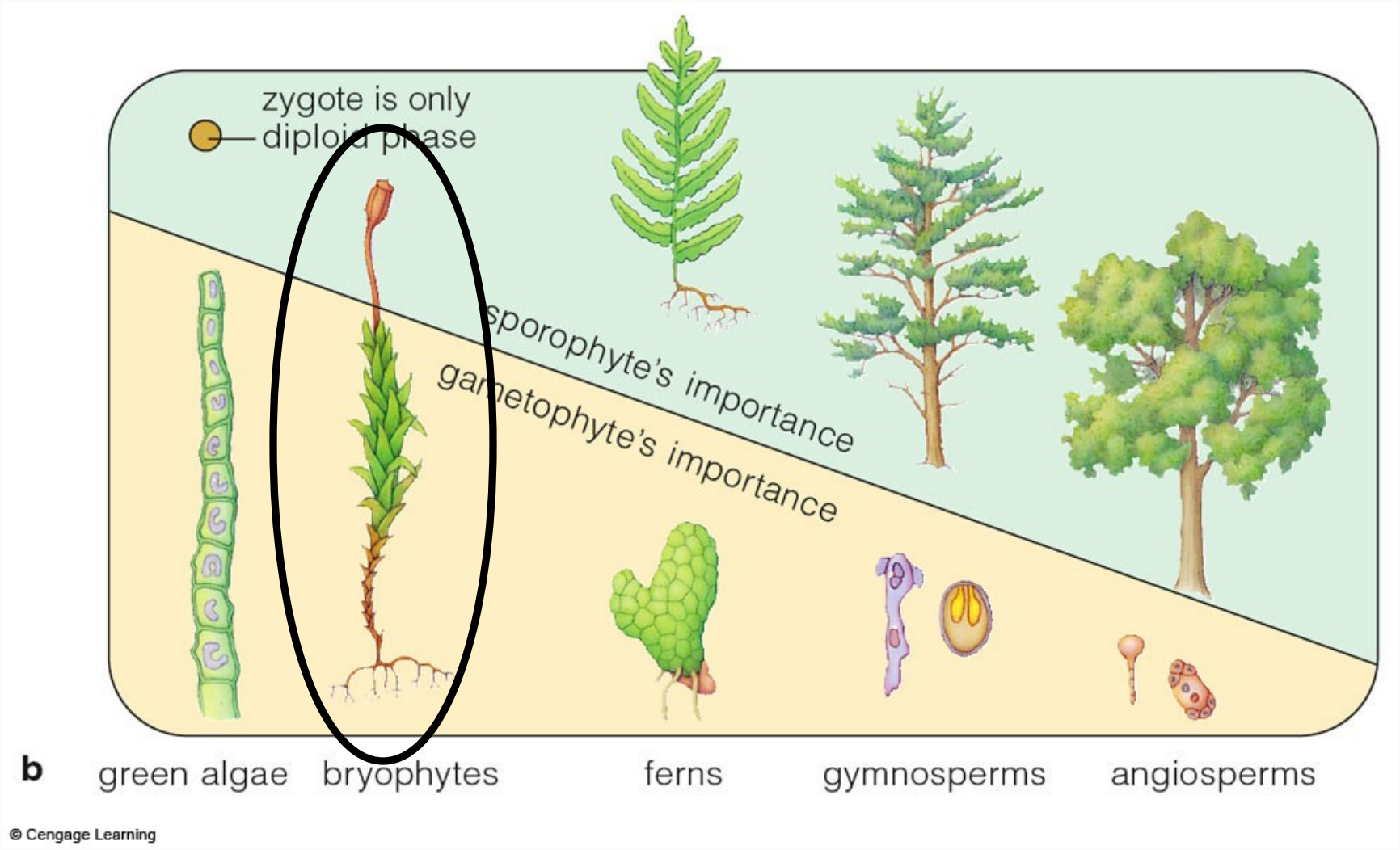


Fig. 21.3, p.335

Evolutionary Trends in Plant Life Cycles



The Bryophytes

- **Bryophytes** include three land plant lineages – liverworts, hornworts, and mosses – with a gametophyte-dominated life-cycle

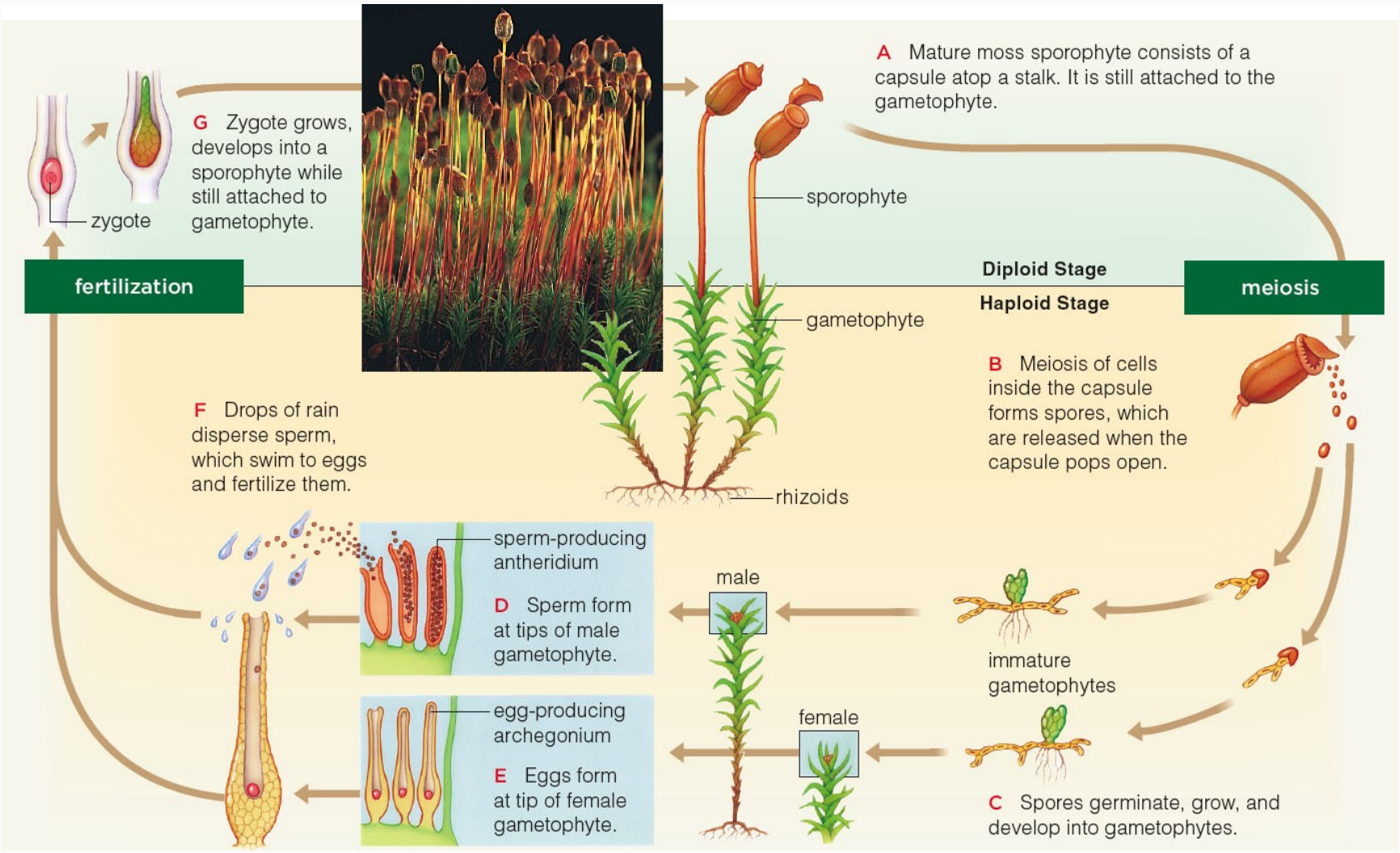
Characteristics of Bryophytes

- Nonvascular (no xylem or phloem)
- Sperm swim through water to eggs
- The sporophyte forms on, and is nourished by, the dominant gametophyte
- Spores are the dispersal form

Hornworts

http://www.youtube.com/v/jcWYAnmm-QE

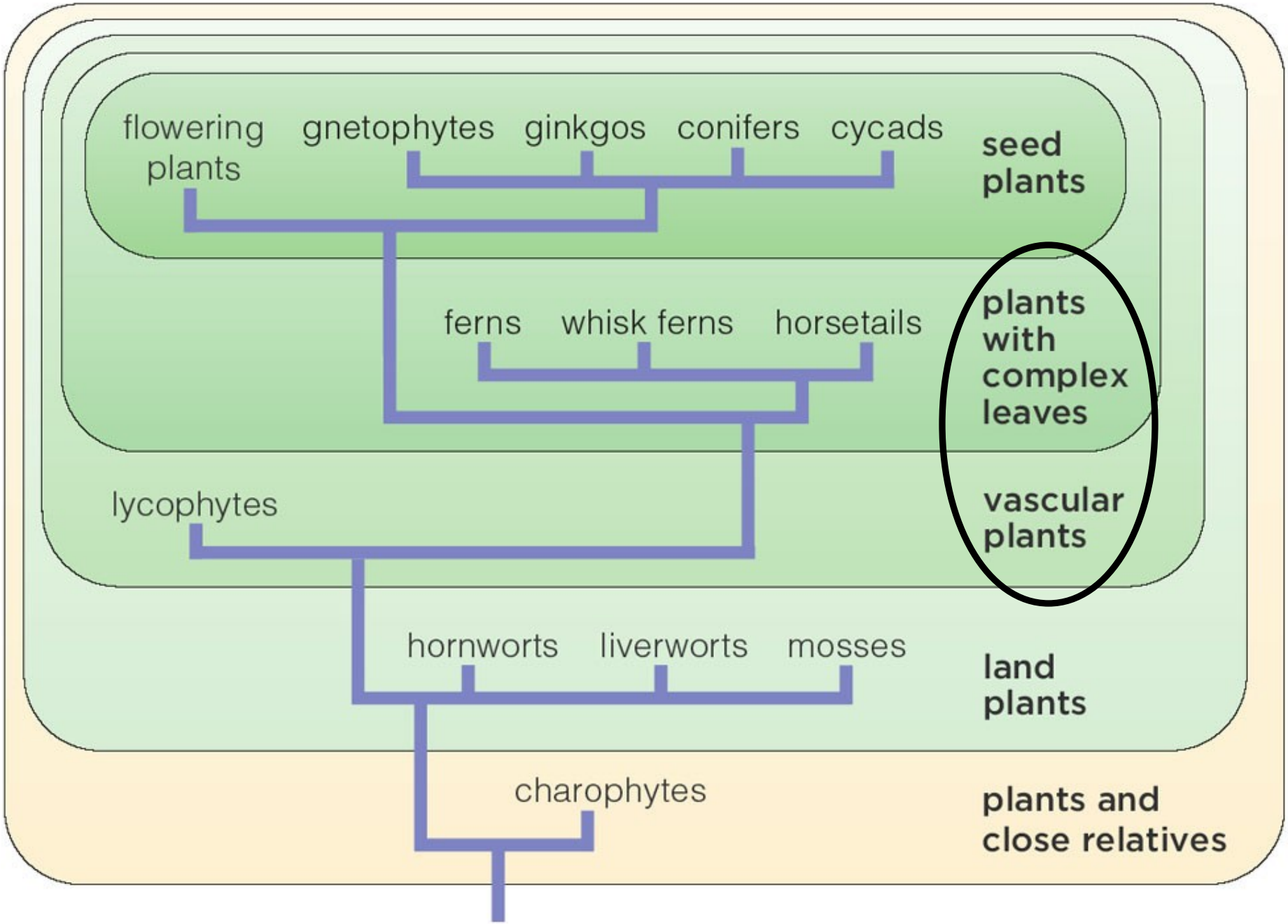
Moss Life Cycle: *Polytrichum*



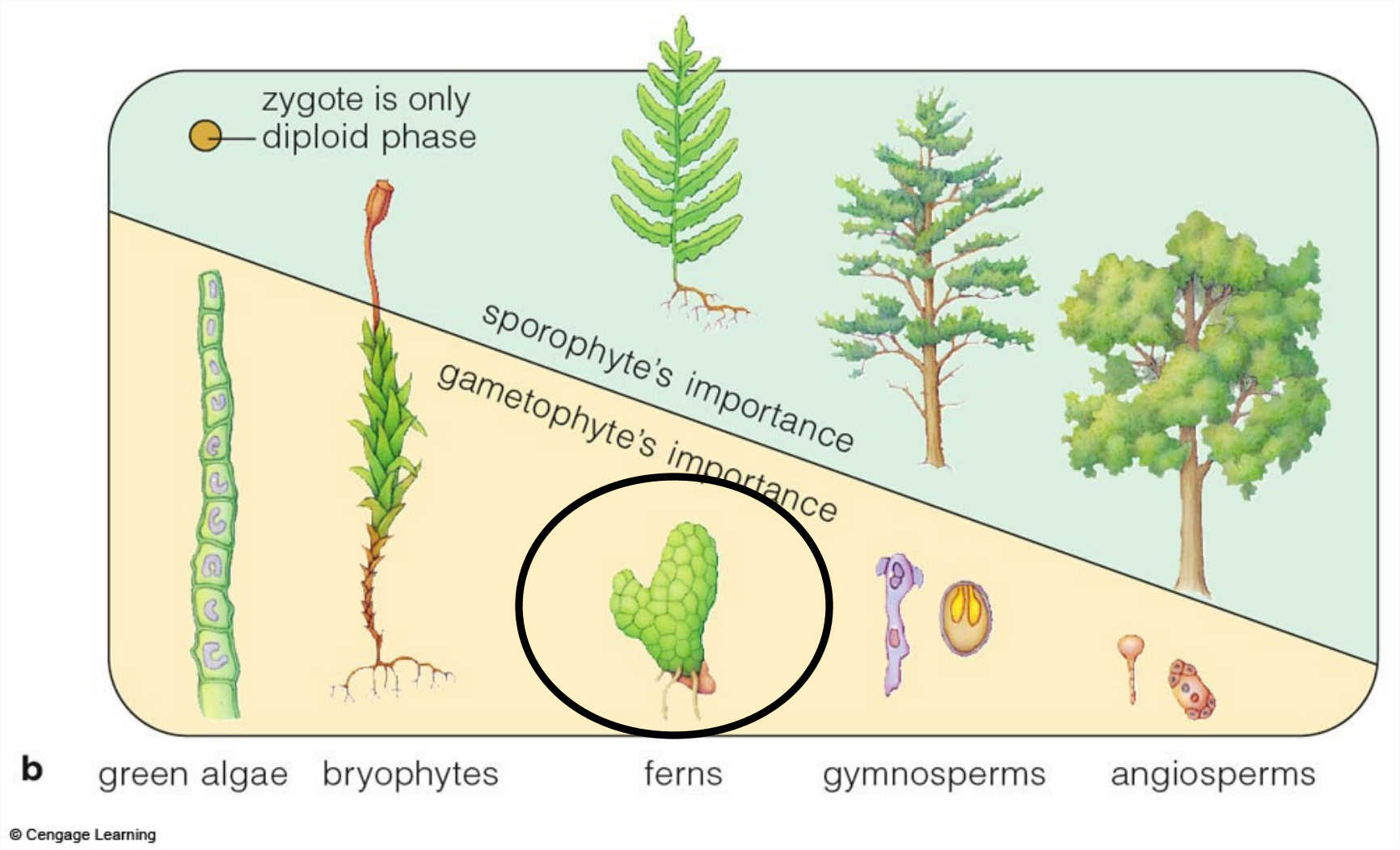
Key Concepts
Early-Diverging Plant Lineages

- *Three plant lineages (mosses, hornworts, and liverworts) are commonly referred to as bryophytes, although they are not a natural group*

- *The gamete-producing stage dominates their life cycle, and sperm reach the eggs by swimming through droplets or films of water*



Evolutionary Trends in Plant Life Cycles



Seedless Vascular Plants

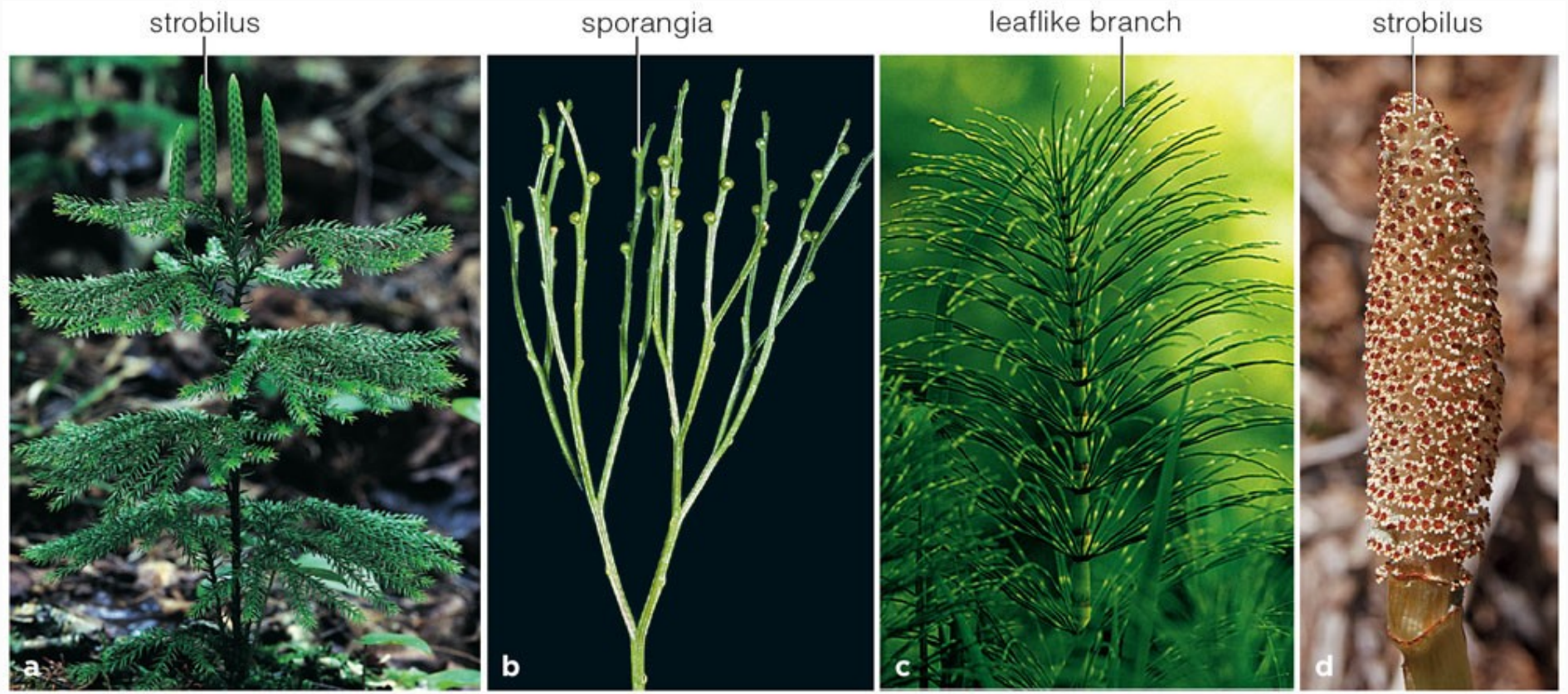
- A sporophyte with lignified vascular tissue (xylem and phloem) dominates the life cycle

- Four groups of seedless vascular plants
  - **lycophytes, whisk ferns, horsetails, ferns**

NO SEEDS, BUT VASCULAR TISSUE!!!

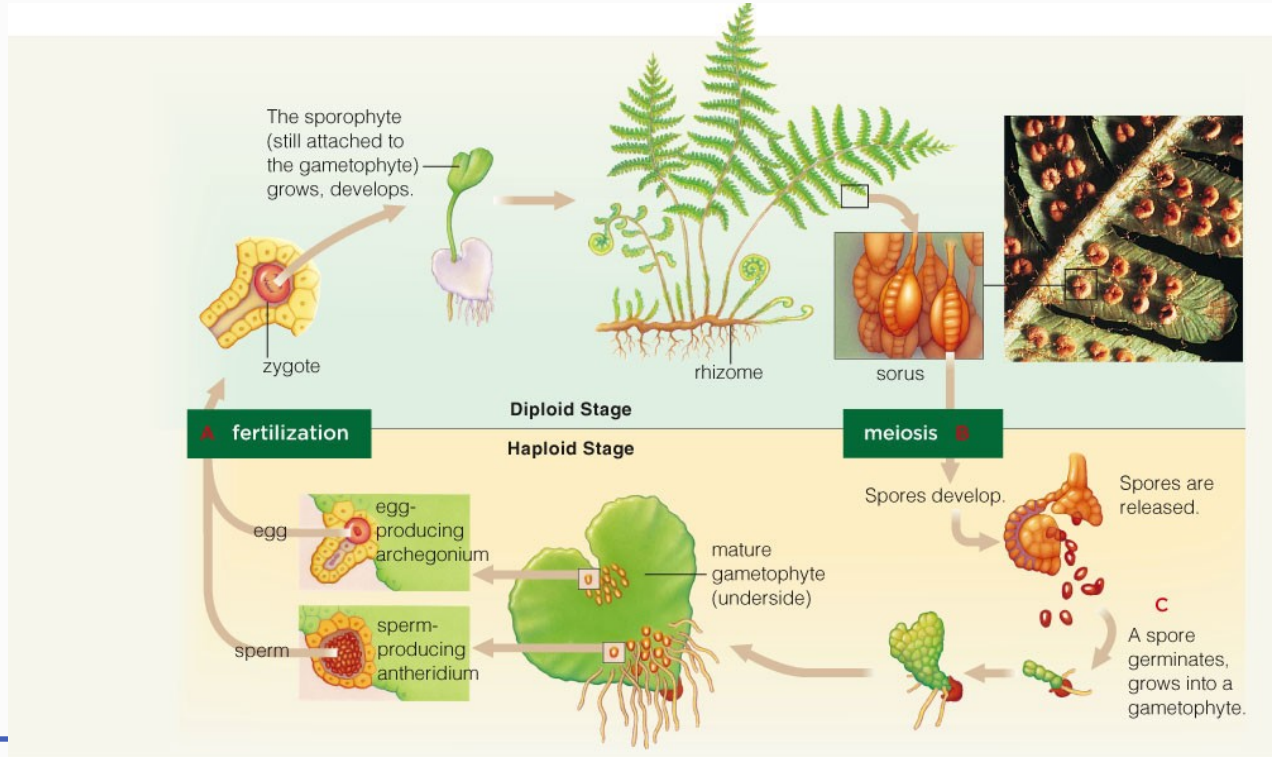
Seedless Vascular Plants

- Club moss (*Lycopodium*), whisk fern (*Psilotum*), and horsetails (*Equisetum*)



Ferns – No Seeds, Much Diversity

- **Ferns**
  - The most diverse seedless vascular plants
  - Spores are dispersed from clusters of sporangia (**sori**) on lower surfaces of frond leaves



Fern Diversity

Key Concepts
Seedless Vascular Plants

- *Lycophytes, whisk ferns, horsetails, and ferns have vascular tissues but do not produce seeds*
- *A large spore-producing body that has internal vascular tissues dominates the life cycle*
- *As with bryophytes, sperm swim through water to reach eggs*

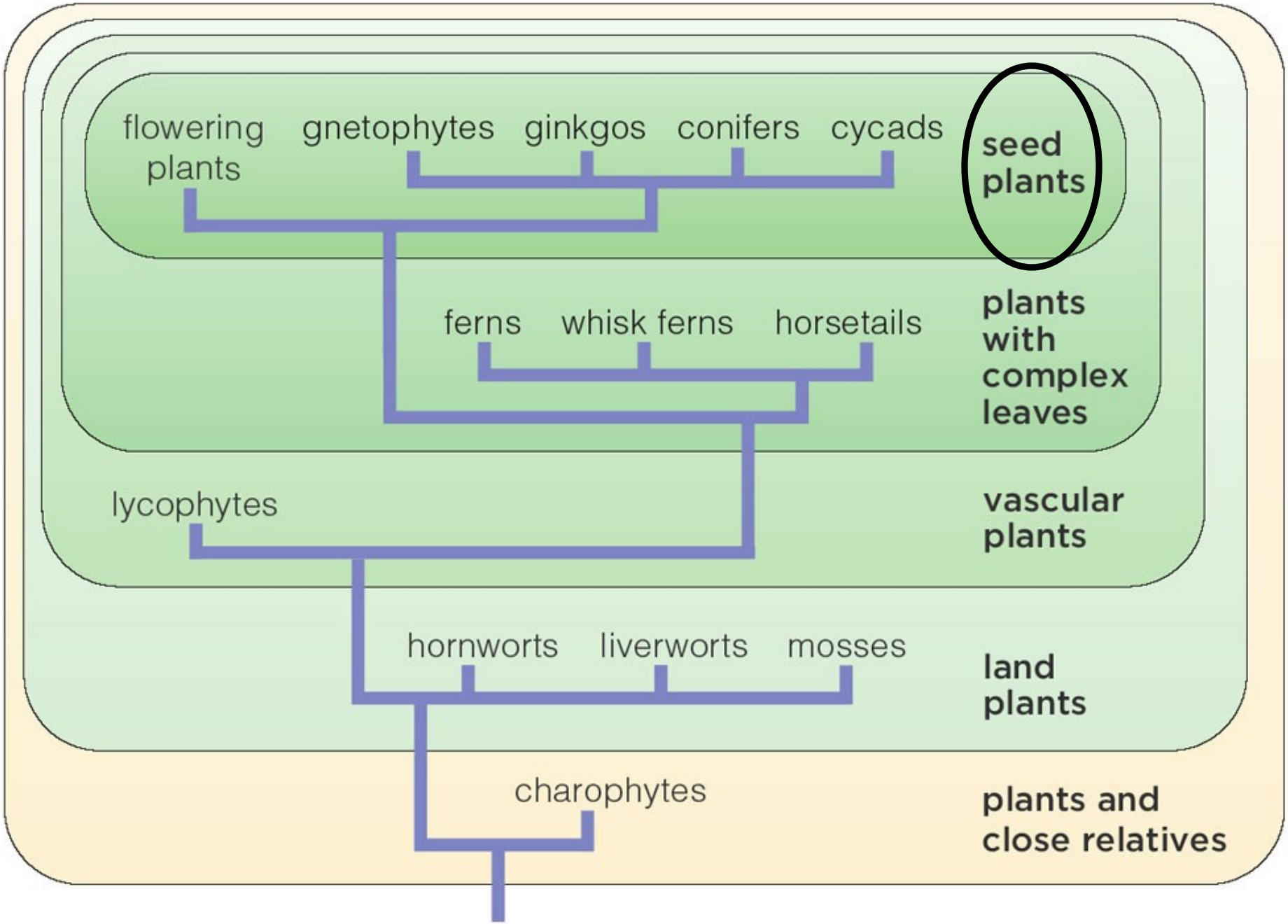
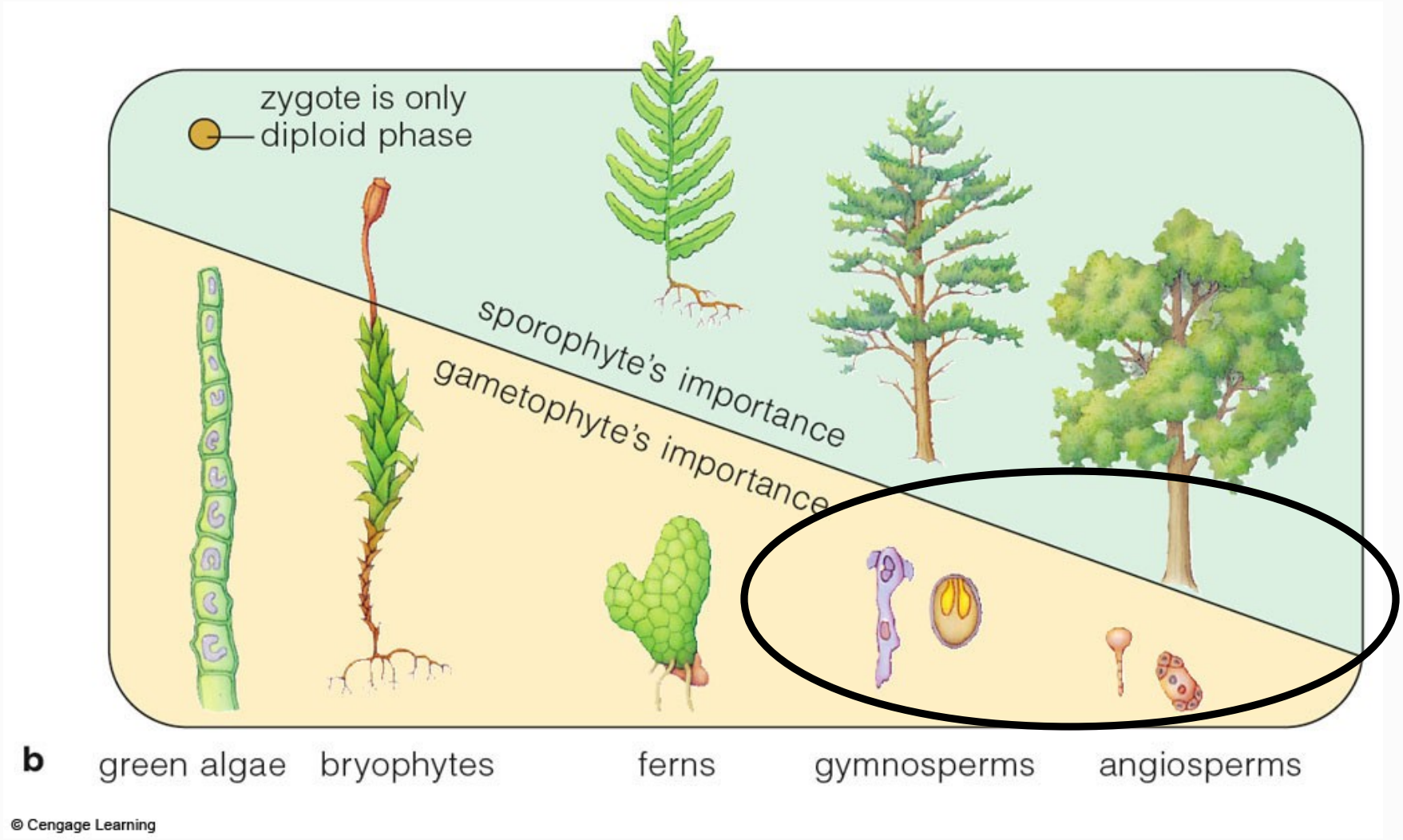


Fig. 21.3, p.335

Evolutionary Trends in Plant Life Cycles



Seed-Bearing Plants

- Seeds and pollen allowed gymnosperms and angiosperms (flowering plants) to survive and thrive in drier habitats

Modified Spores

- **Microspores** become sperm-producing male gametophytes (pollen grains)
- **Megaspores** develop into egg-producing female gametophytes inside ovules

Pollen

- Seed plants release pollen grains which allow fertilization to occur even in the absence of environmental water

Seeds

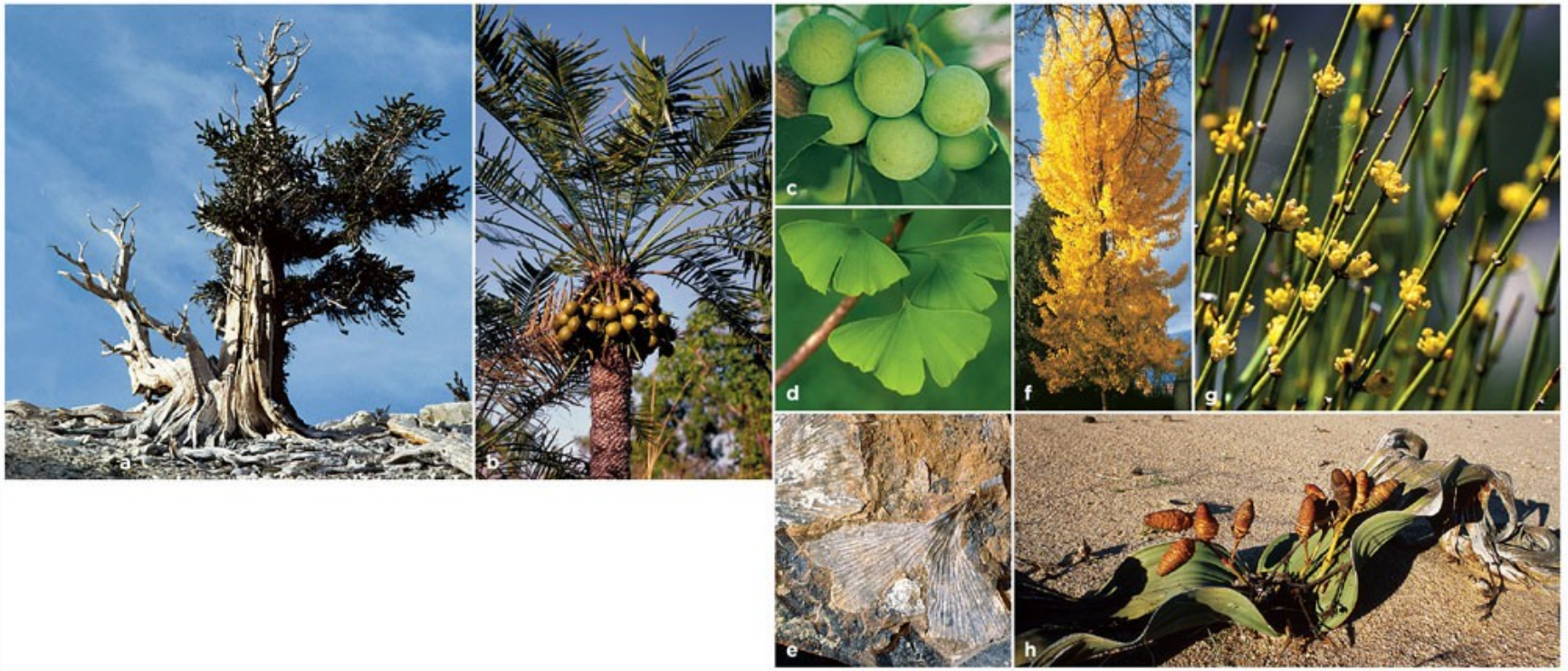
- A **seed** is a mature ovule
  - Includes nutritive tissue and a tough seed coat that protects the embryo sporophyte inside the seed from harsh conditions

Gymnosperms—
Plants With Naked Seeds

- **Gymnosperms**
  - Vascular seed plants with “naked” seeds
  - One of the two modern lineages of seed plants

- Gymnosperms include **conifers** (such as pines), **cycads**, **ginkgos**, and **gnetophytes**

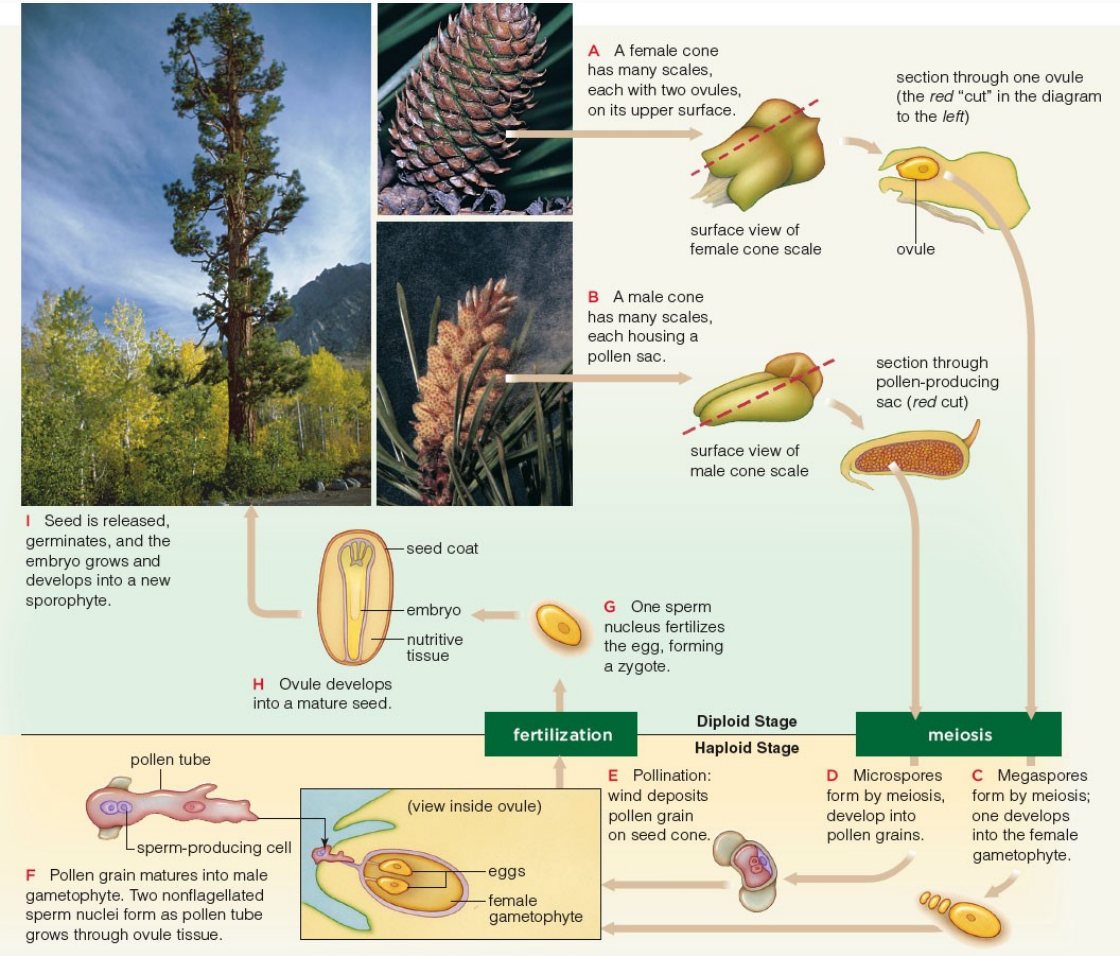
Some Gymnosperms



http://www.youtube.com/v/o6Se_9y68P0

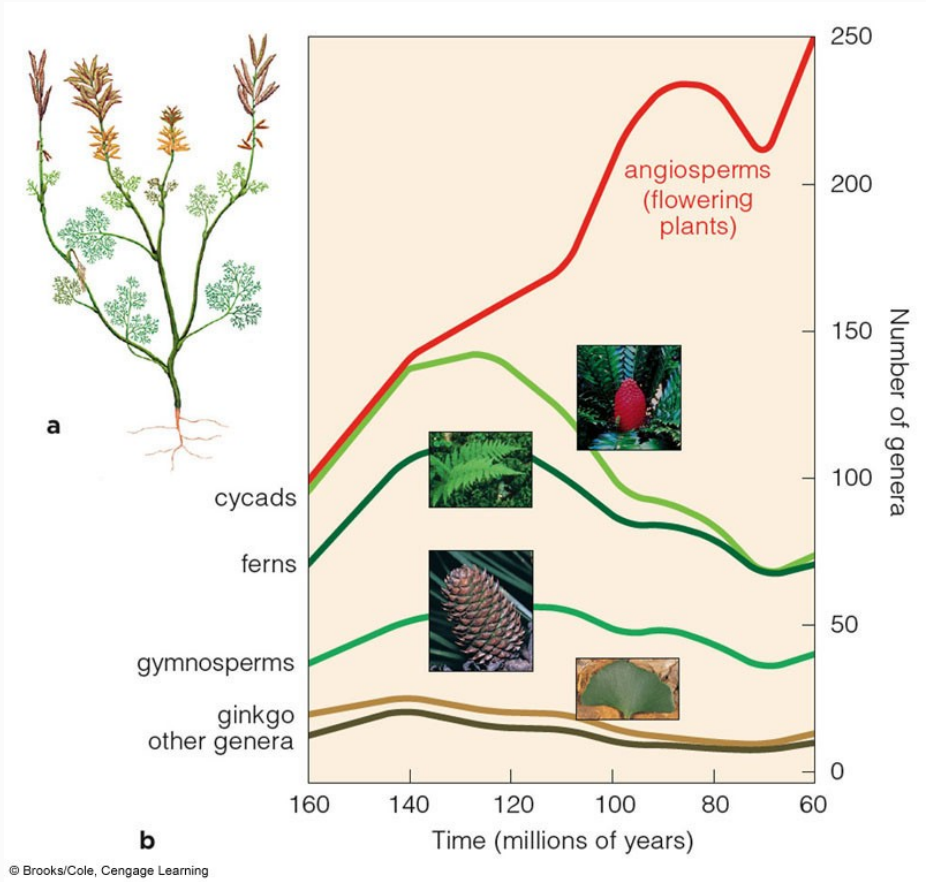
Gymnosperm Life Cycle

- Gymnosperms release pollen and seeds



Angiosperms—
The Flowering Plants

- Angiosperms are the most diverse plant lineage and the only plants that make flowers and fruits



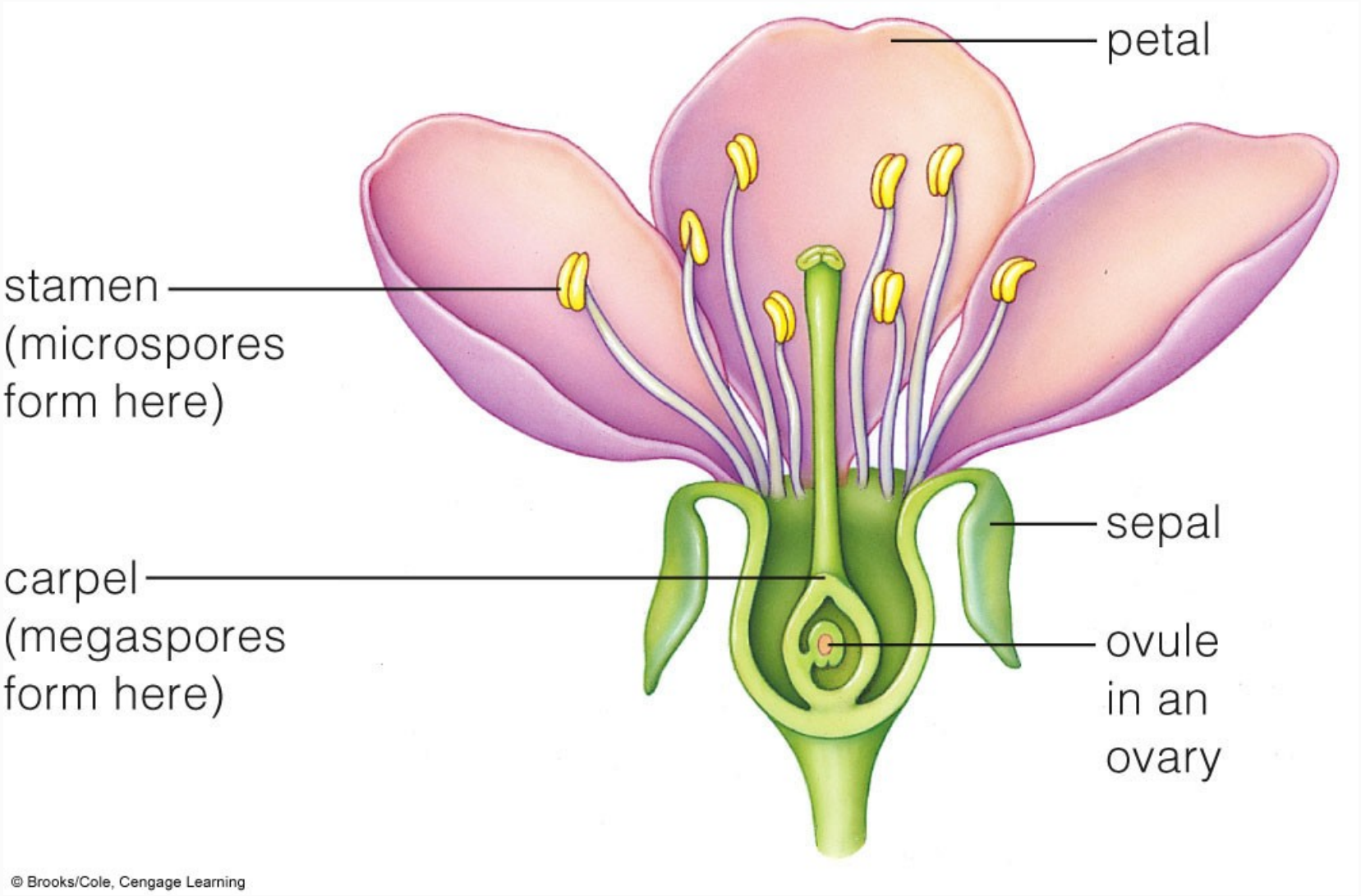
Keys to Angiosperm Success

- Short life cycles and rapid growth
- Specialized reproductive structures (flowers)
- Specialized pollination and dispersal structures
  - Wind and animal pollinators
  - Fruits that float or stick
  - Seeds that survive animal digestive tracts

Specialized Angiosperm Structures

- A **flower** is a specialized reproductive shoot
- Seeds develop inside the **ovaries** (chambers that enclose ovules) of flowers
- After fertilization, an ovary becomes a **fruit**

Flower Structures – don't worry about for lecture!!!

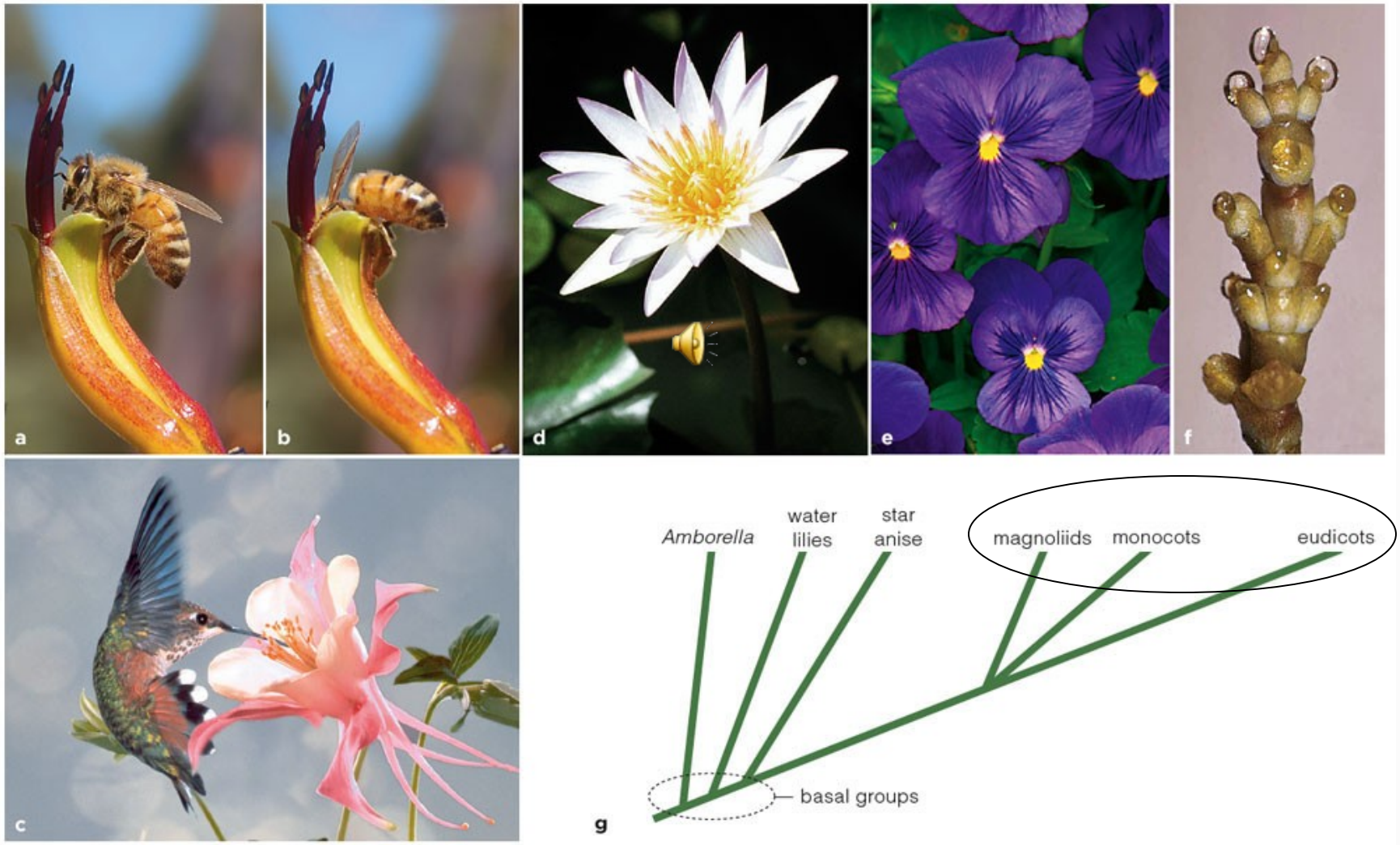


Pollination and Coevolution

- **Pollinators**
  - Animals (such as insects that feed on pollen) move pollen grains from male parts of one flower to female parts of another

- **Coevolution**
  - Over time, plants and their animal pollinators jointly evolved; changes in one exerts selection pressure on the other

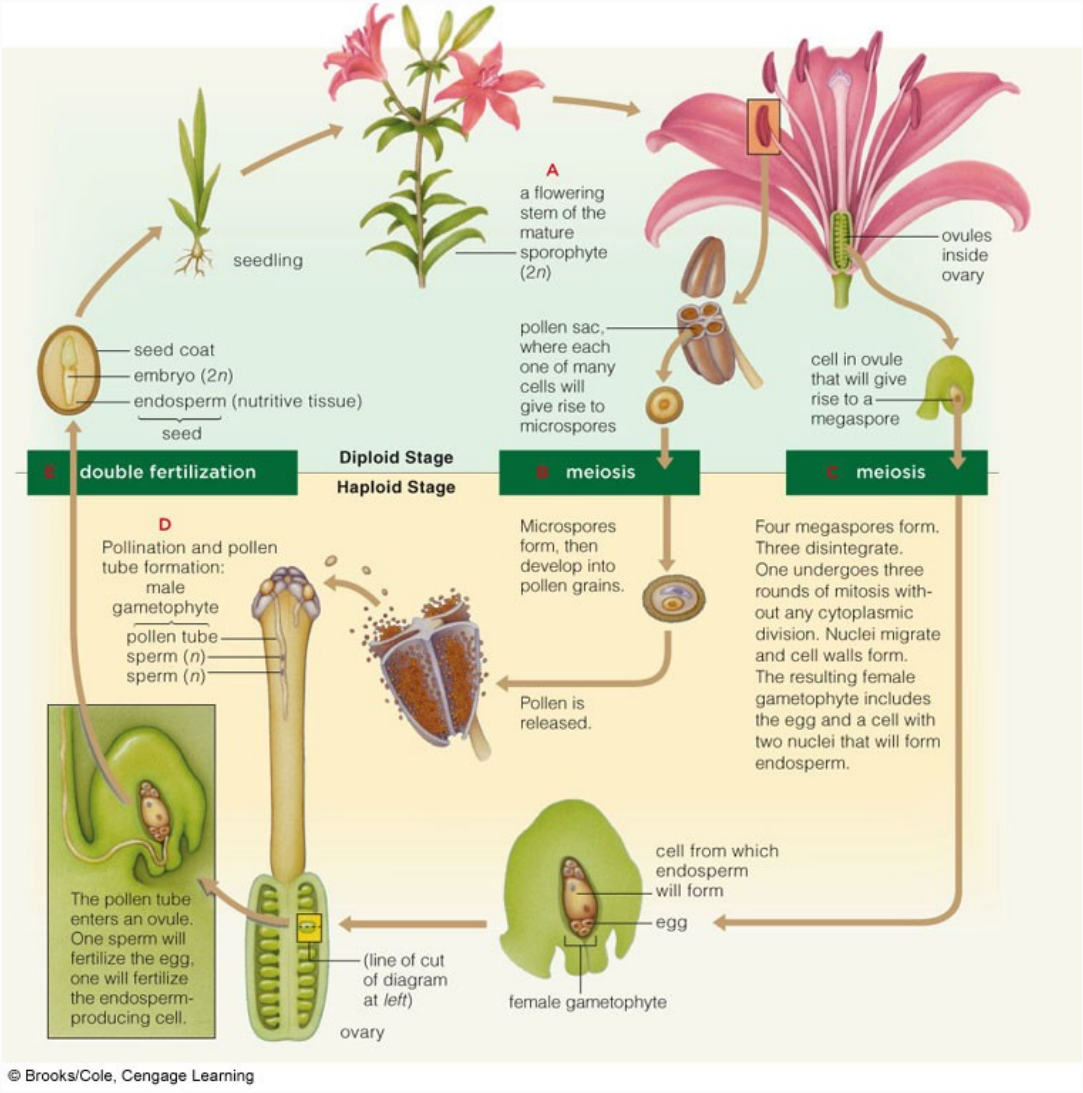
Flowering Plant Diversity



Focus on a Flowering Plant Life Cycle

- Flowering plants form eggs in ovaries and pollen in stamens
- Flowering plants make fruits containing seeds which supply their embryo sporophytes with **endosperm**, a nutritive tissue – double fertilization!!!

Life Cycle: *Lilium*



Key Concepts
Seed-Bearing Vascular Plants

- *Gymnosperms and, later, angiosperms radiated into higher and drier environments*
- *Both produce pollen and seeds*
- *Nearly all crop plants are seed plants*
- *In angiosperms, flowers and fruits further enhanced reproductive success*

Summary: Plant Evolutionary Trends