Part III. Conserving biodiversity

I. How populations work

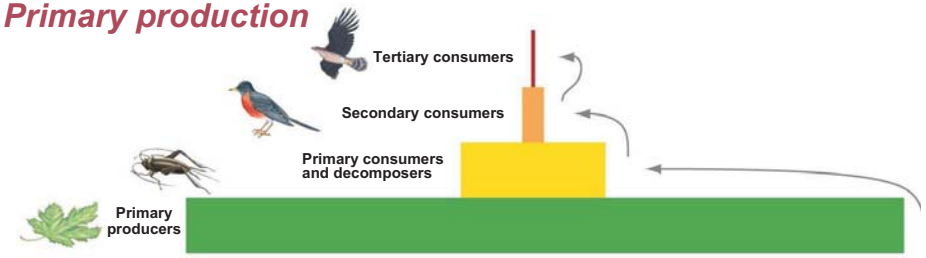
II. How communities & ecosystems work

III. Origins of biodiversity

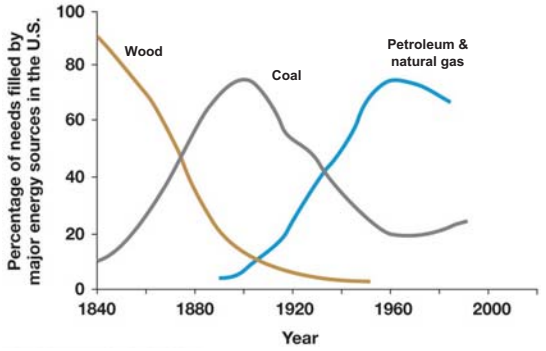
- How do species arise?
- How are phylogenies used to organize diversity?
- Surveys of biodiversity and evolutionary trends
  - Unit 8. Prokaryotes and protists (single-celled organisms)
  - ➢ Unit 9. Green plants and fungi
  - Unit 10. Animals

Plants provide products and services

Primary production



Fuels



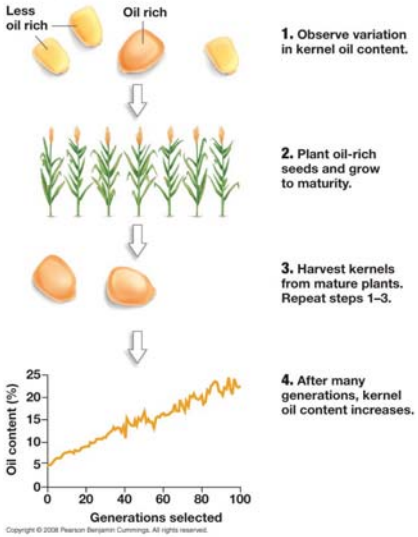
Plants provide products and services

Food production

Plants were domesticated independently at many locations

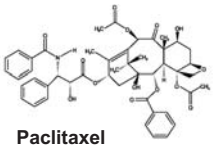
(b) Artificial selection changes the traits of domesticated species.

(b) ARTIFICIAL SELECTION CHANGES THE TRAITS OF DOMESTICATED SPECIES.

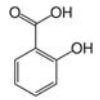


Plants provide products and services

Bioactive compounds



Paclitaxel (Taxol)



Salicylic acid

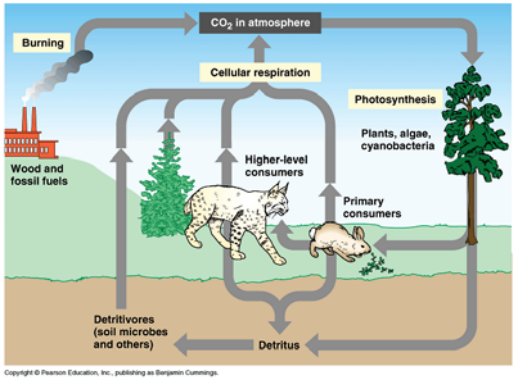
TABLE 30.1 Some Drugs Derived from Land Plants

Compound	Source	Use
Atropine	Belladonna plant	Dilating pupils during eye exams
Codeine	Opium poppy	Pain relief, cough suppressant
Digitalin	Foxglove	Heart medication
Ipecac	Ipecac	Treating amoebic dysentery, poison control
Menthol	Peppermint	Cough suppressant, relief of stuffy nose
Morphine	Opium poppy	Pain relief
Papain	Papaya	Reduce inflammation, treat wounds
Quinine	Quinine tree	Malaria prevention
Quinidine	Quinine tree	Heart medication
Salicin	Aspen, willow trees	Pain relief (aspirin)
Steroids	Wild yams	Precursor compounds for manufacture of birth control pills and cortisone (to treat inflammation)
Taxol	Pacific yew	Ovarian cancer
Tubocurarine	Curare vine	Muscle relaxant used in surgery
Vinblastine, vincristine	Rosy periwinkle	Leukemia (cancer of blood)

Q: Why have plants evolved so many useful compounds?

Plants provide products and services

Ecosystem services

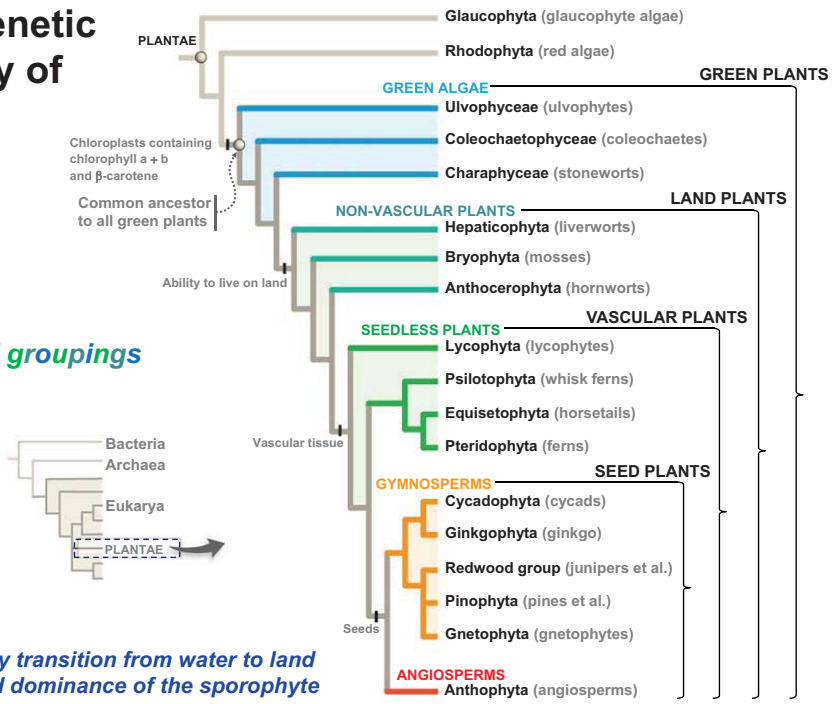


- recycle CO_2, water, nutrients
- produce O_2

- reduce flooding
- purify water

- prevent erosion, soil loss
- moderate local climate

Phylogenetic diversity of plants

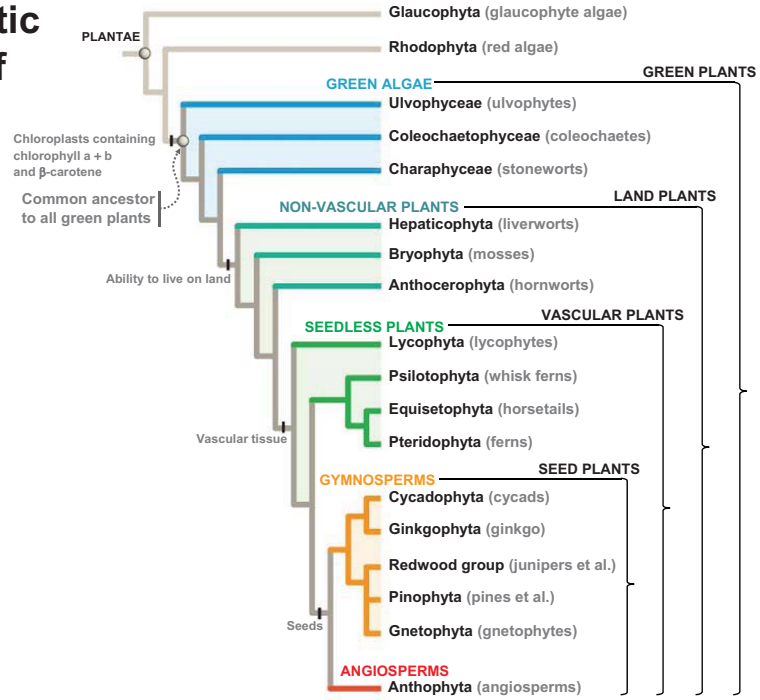


Clades

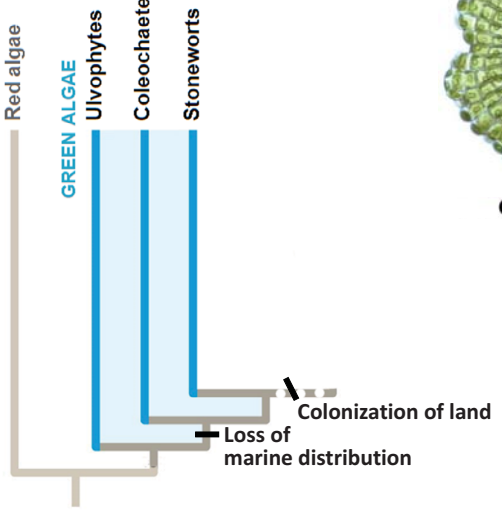
Traditional groupings "Grades"

- *evolutionary transition from water to land*
- *shift toward dominance of the sporophyte*

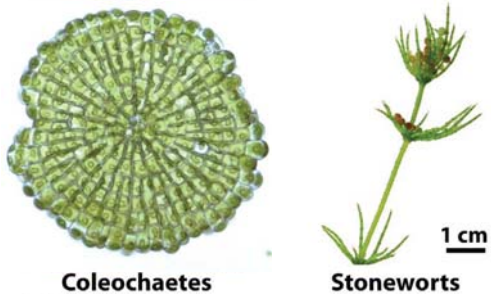
Phylogenetic diversity of plants



"Green algae" – paraphyletic, basal to land plants



Green algae are strictly aquatic.

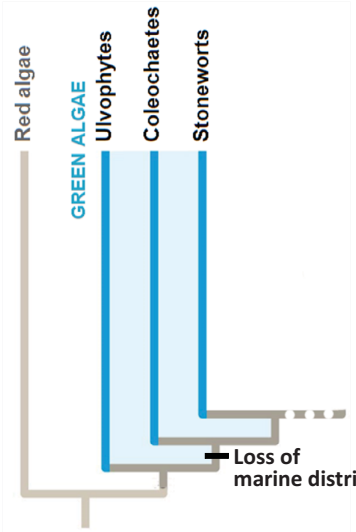


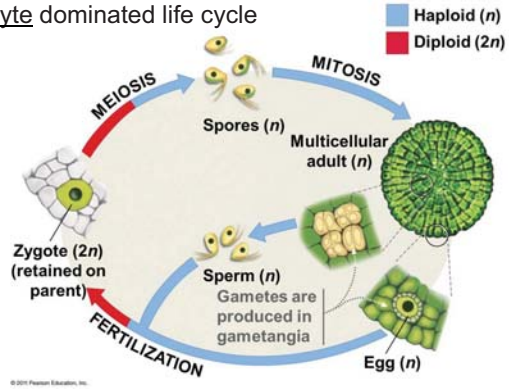
Coleochaetes

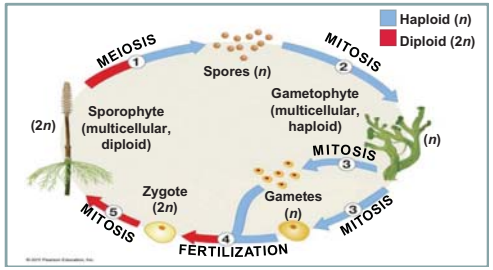
Stoneworts

Ulvophytes

"Green algae" – paraphyletic, basal to land plants
– gametophyte dominated life cycle

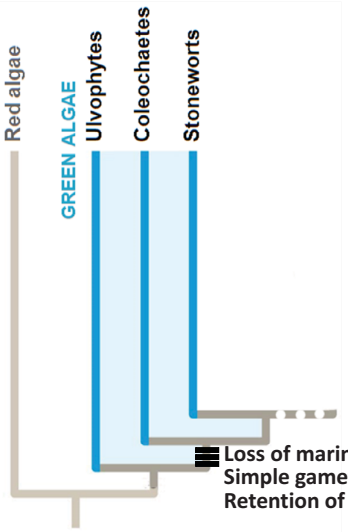


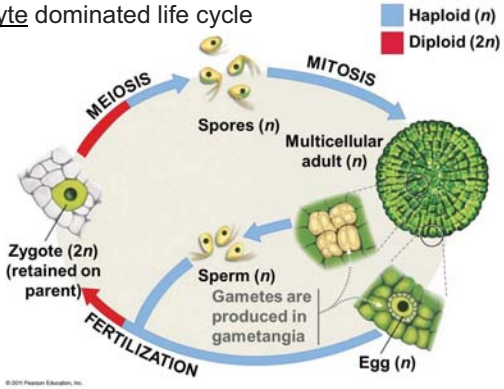




"Generalized" life cycle

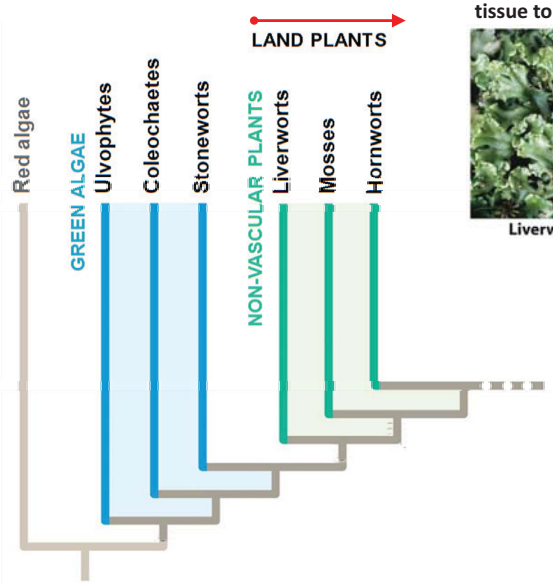
"Green algae" – paraphyletic, basal to land plants
– gametophyte dominated life cycle



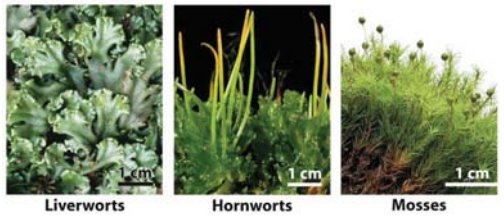


Q: How do sperm reach the egg?

"Nonvascular plants" – paraphyletic, basal land plants



"Nonvascular plants" do not have reinforced vascular tissue to conduct water and provide support.



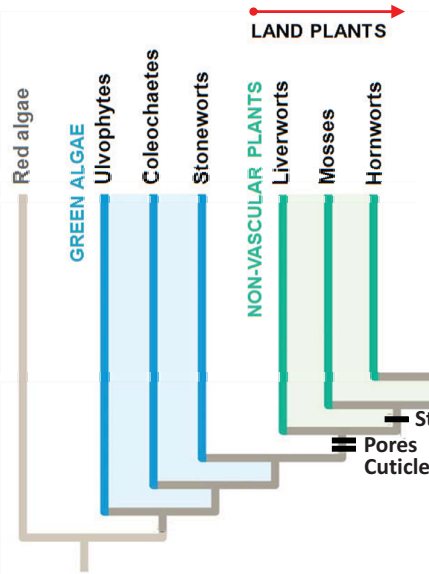
Liverworts Hornworts Mosses

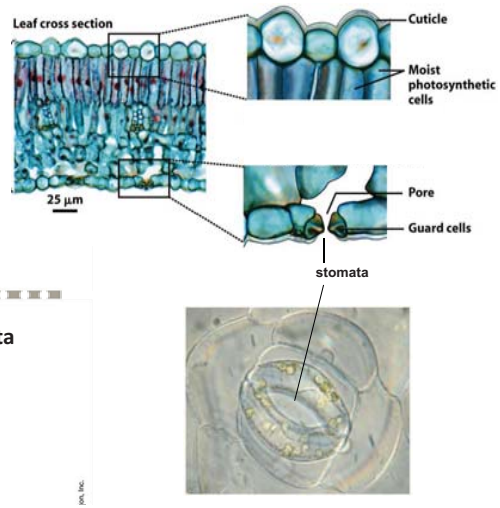
Q: What is the sister group to land plants?

A) Green algae
B) Liverworts
C) Stoneworts
D) Protists
E) Non-vascular plants

"Nonvascular plants" – innovations for life on land

***STRUCTURAL** INNOVATIONS:*
- **cuticle**
- **stomata**

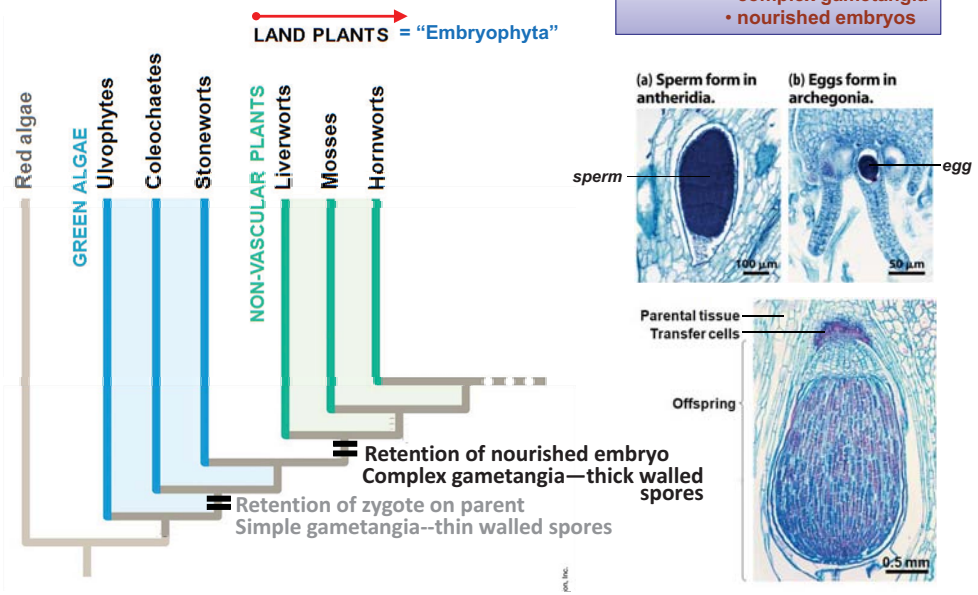




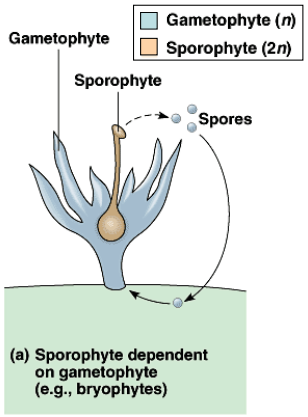
"Nonvascular plants" – paraphyletic, basal land plants

2) reproductive features

***REPRODUCTIVE** INNOVATIONS:*
- **complex gametangia**
- **nourished embryos**

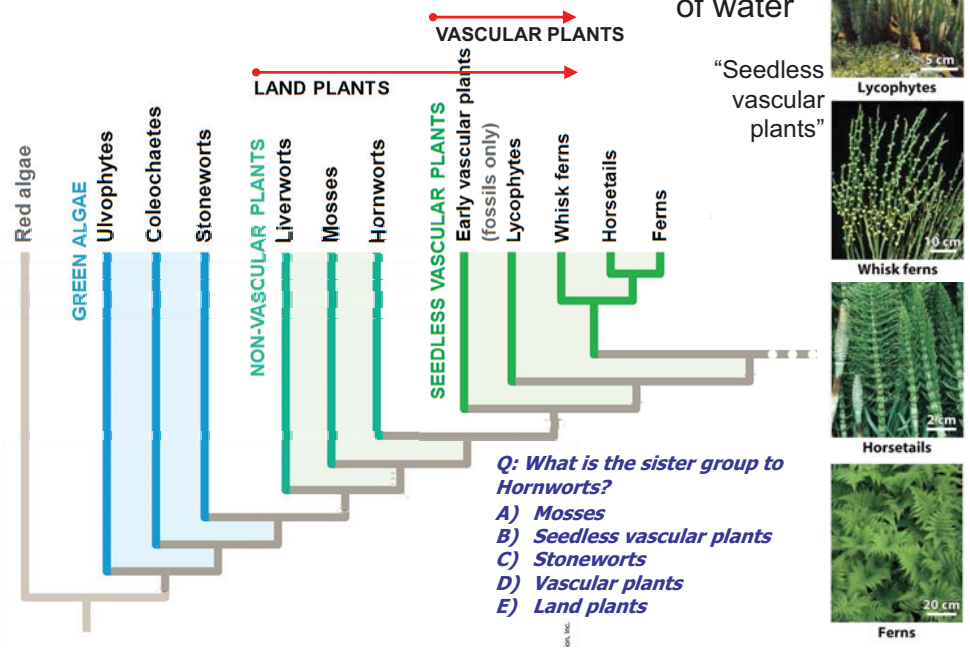


"Nonvascular plants" – gametophyte dominated



Moss
(non-vascular)

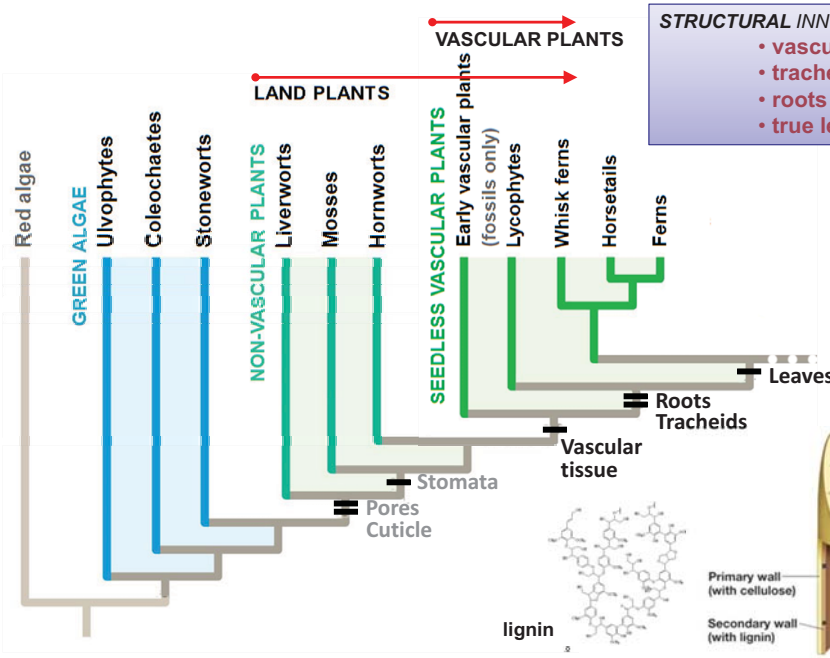
Vascular plants – less dependent on availability of water

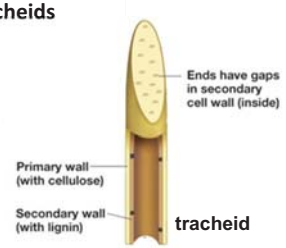


"Seedless vascular plants"

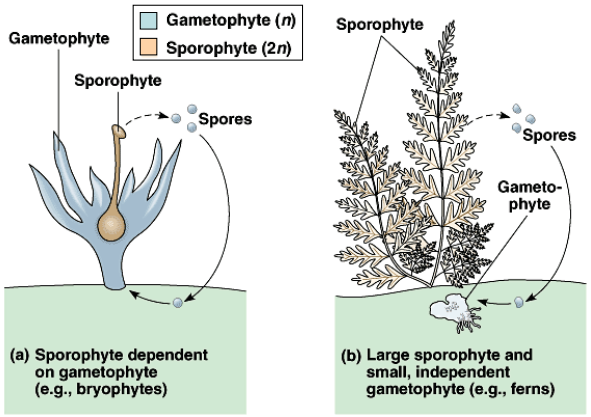
Vascular plants – less dependent on availability of water

***STRUCTURAL** INNOVATIONS:*
- **vascular tissue**
- **tracheids**
- **roots**
- **true leaves**



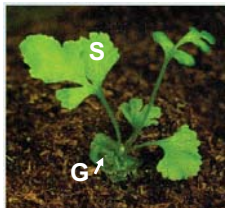


Vascular plants – shift toward sporophyte-dominated life cycle

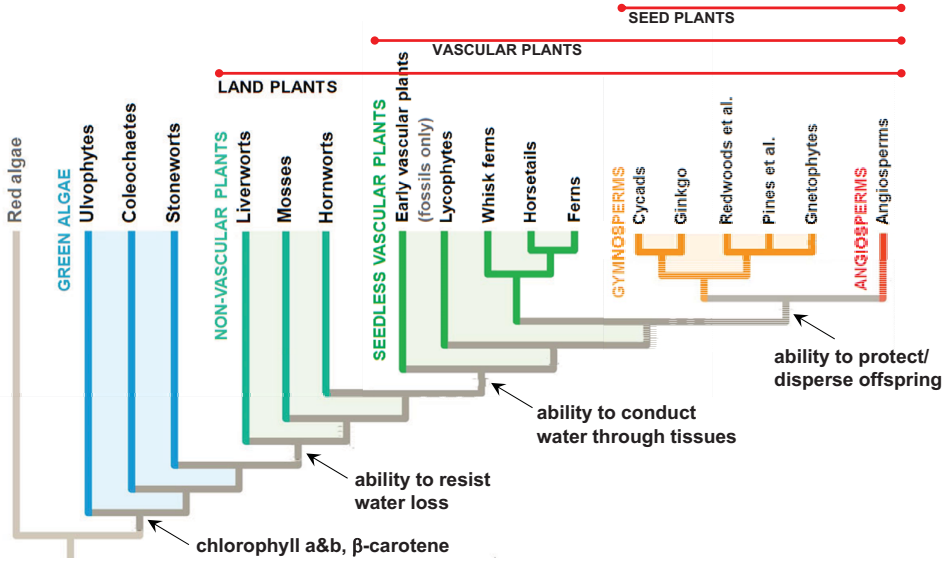


Moss (non-vascular)

Fern (seedless vascular plants)



Evolutionary transition from water to land

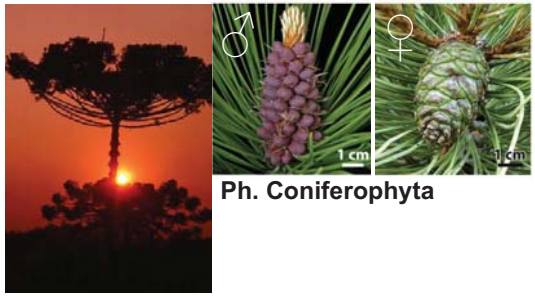


Seed plants – largely independent of water

Gymnosperms

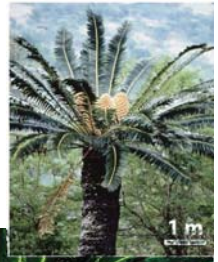
- "naked seeds"
- 4 extant phyla, monophyletic

Ph. Ginkgophyta



Ph. Coniferophyta

Ph. Cycadophyta

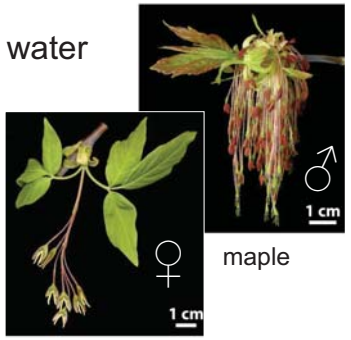


Ph. Gnetophyta

Seed plants – largely independent of water

Angiosperms (Phylum Anthophyta)

- 235,000+ species!
- flowers and fruits: complex interactions with animal dispersers



maple

cactus!

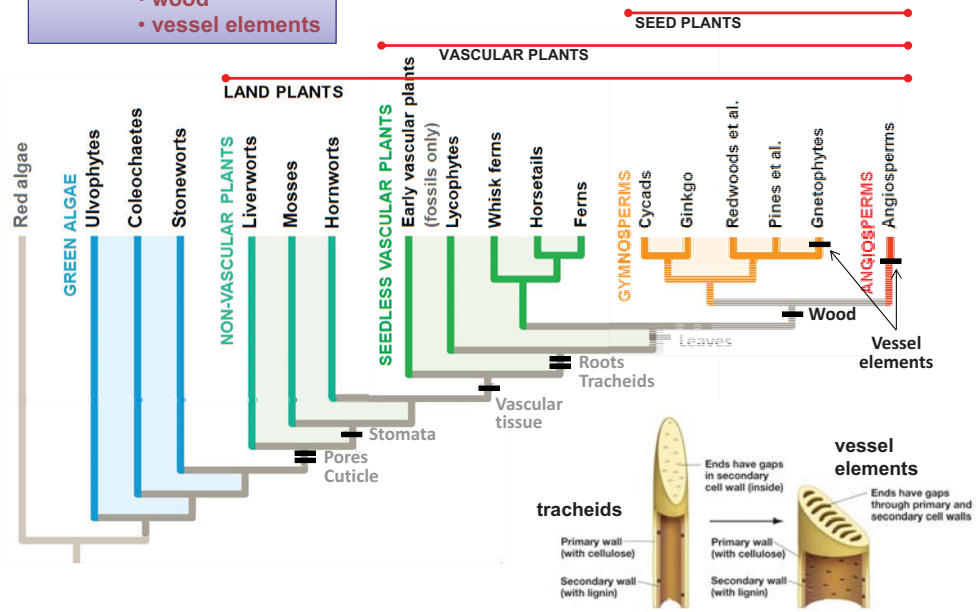
orchid!

stinking arum!

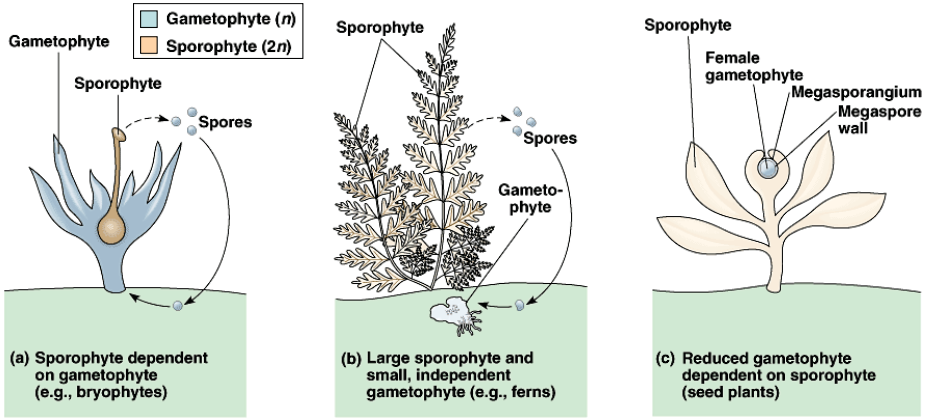
saprophyte!

Seed plants – largely independent of water

***STRUCTURAL** INNOVATIONS:*
- wood
- vessel elements

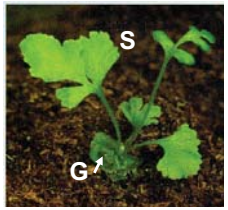


Seed plants – further shift to dominance of sporophyte

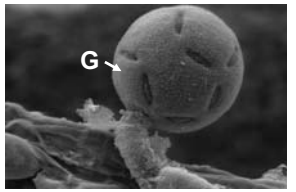


Moss
(non-vascular)

Fern
(seedless vascular plants)

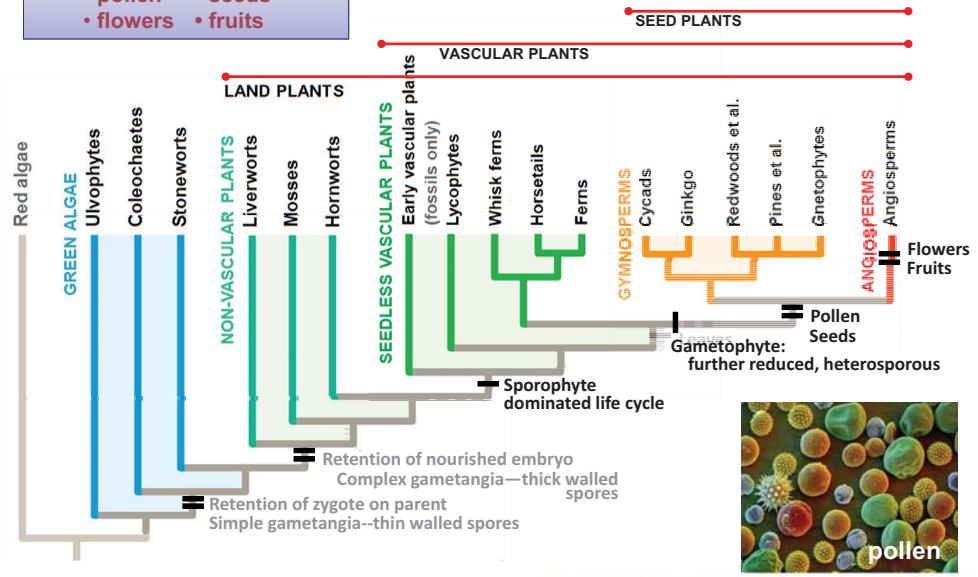


Flowering plant
(vascular seed plants)



Seed plants – largely independent of water

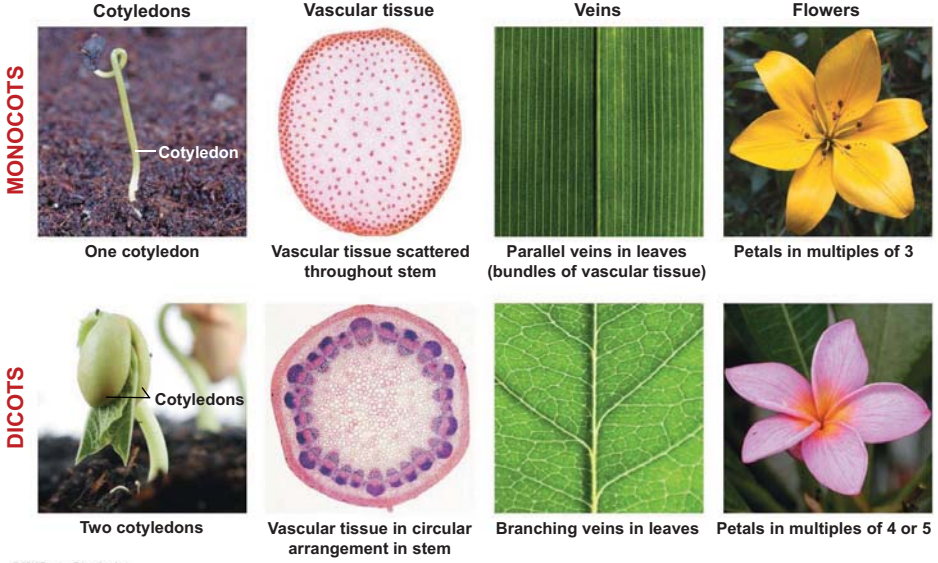
***REPRODUCTIVE** INNOVATIONS:*
- pollen
- seeds
- flowers
- fruits



Q: What part of the life cycle is pollen?

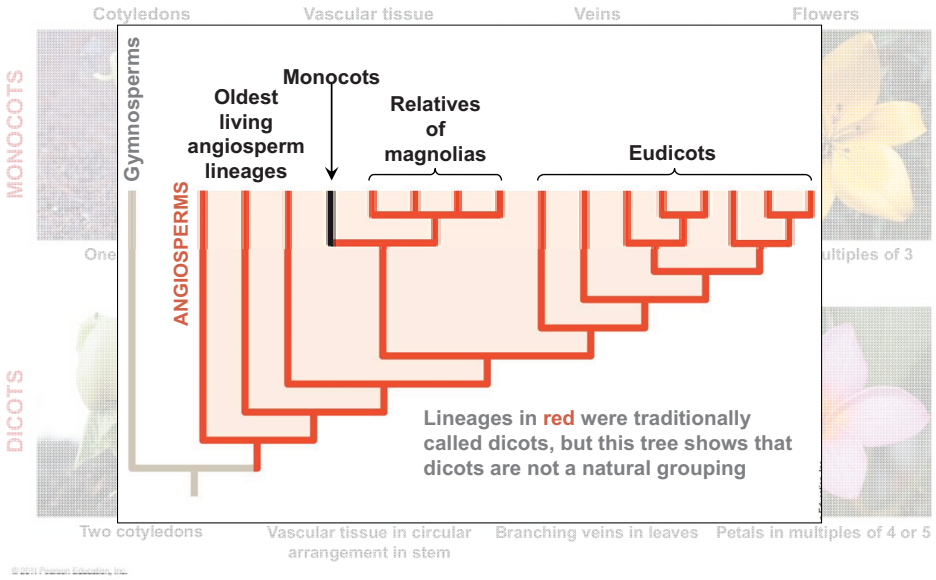
Seed plants – largely independent of water

Angiosperms (Phylum Anthophyta)



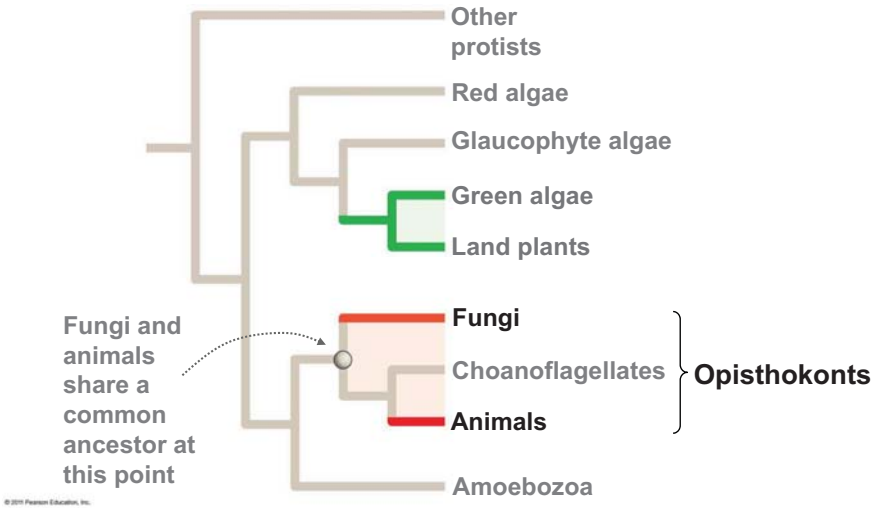
Seed plants – largely independent of water

Angiosperms (Phylum Anthophyta)



Opisthokonts

- **Choanoflagellates, Animals, Fungi**
- **flagella** (locomotion)
- **chitin** (structure)
- **glycogen** (energy storage)



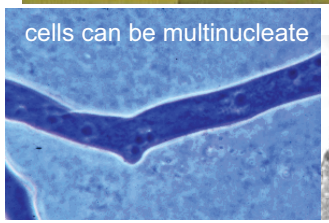
Fungi – "master recyclers and traders"

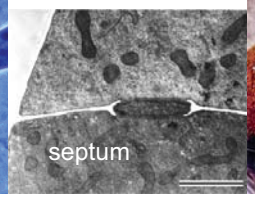
chitin cell wall

unicellular or multicellular

8.9 km²
2400 years old
605 tons!

morphologically simple



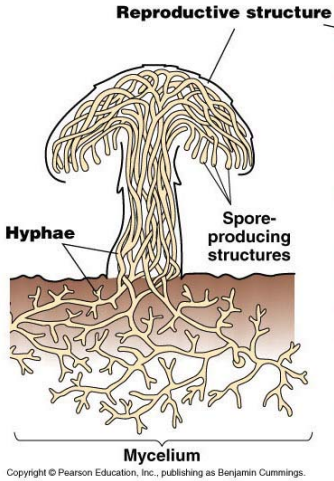


Fungi – absorption, unusual reproduction

chitin cell wall

unicellular or multicellular

morphologically simple



Fungi – absorption, unusual reproduction

chitin cell wall

unicellular or multicellular

morphologically simple

adapted for extracellular digestion and absorption

hyphae provide high SA:volume

reproductive diversity

- asexual and sexual
- variation in spore morphology
- variation in spore-forming structures

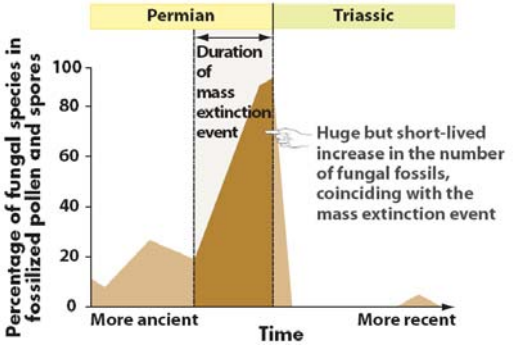
Ecological roles of fungi

1) decomposers

saprophytes: digest dead plant material

enzymes: lignin peroxidase and cellulase
→ one of few organisms that can digest wood

critical part of carbon cycle



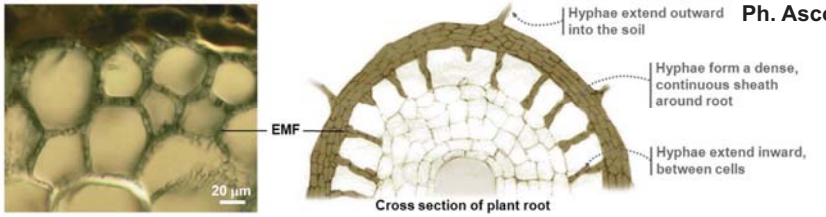
Ecological roles of fungi

2) Mutualists—plant root mycorrhizae

Ectomycorrhizae (temperate and boreal forests) → nitrogen limiting

form sheaths around roots and penetrate between root cells

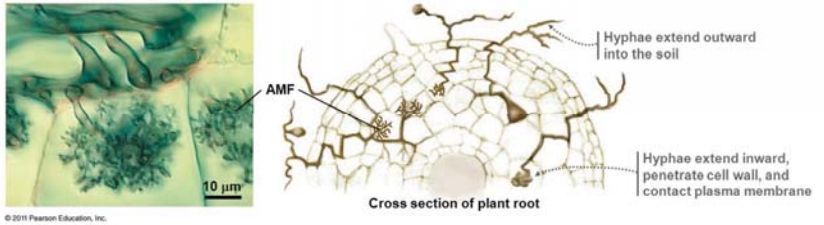
Ph. Basidomycota
Ph. Ascomycota



Arbuscular mycorrhizae (grasslands and tropical forests) → phosphorus limiting

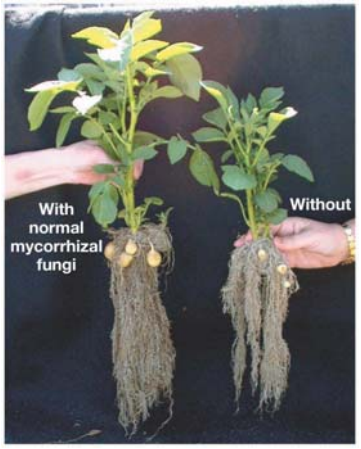
contact plasma membranes of root cells

Ph.Glomeromycota

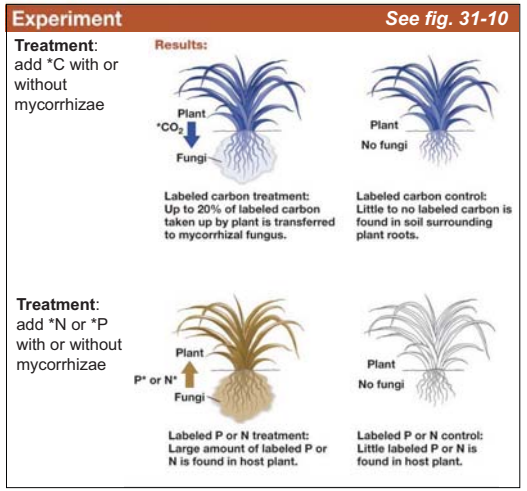


Ecological roles of fungi

2) Mutualists—plant root mycorrhizae



Q: Is the relationship mutualistic?

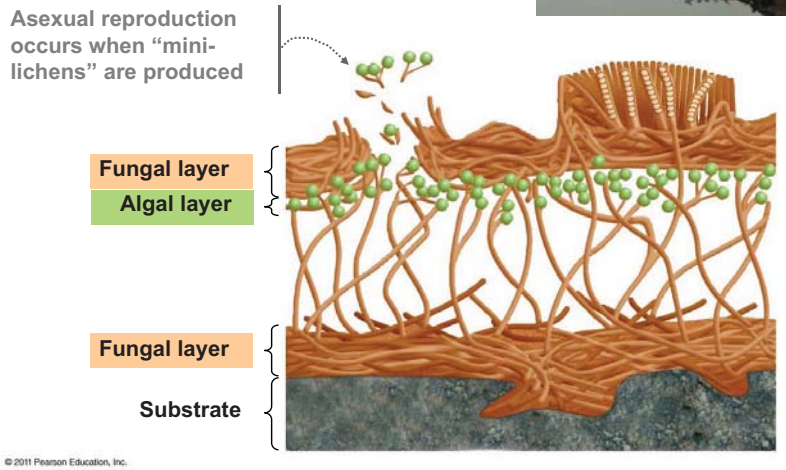


Conclusion: The relationship between plants and mycorrhizal fungi is mutualistic. Plants provide mycorrhizal fungi with carbohydrates. Mycorrhizal fungi supply host plants with nutrients.

Ecological roles of fungi

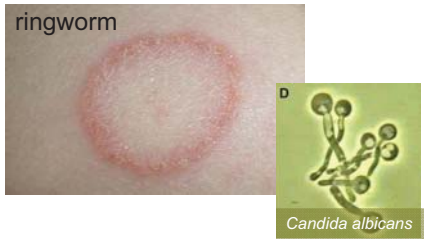
2) Mutualists—lichens

Cross section of a lichen



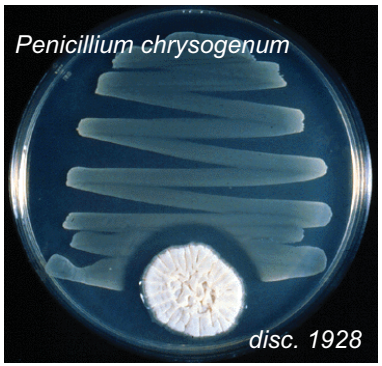
Ecological roles of fungi

3) Parasites



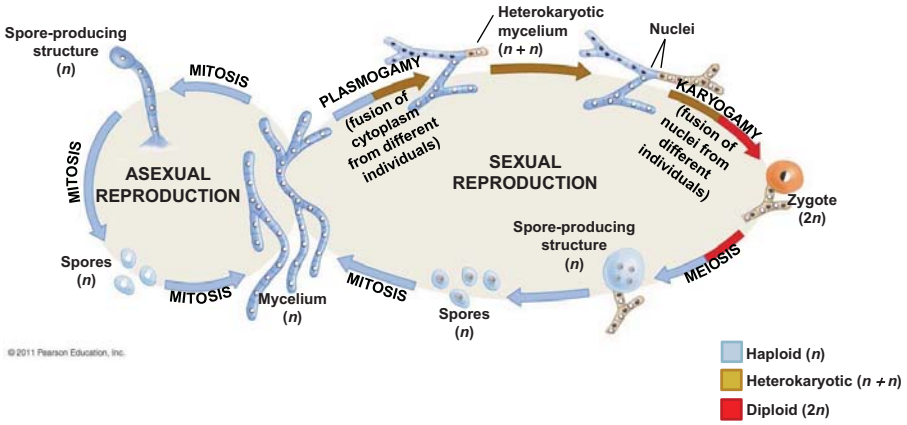
Uses of fungi

4) Human food and medicine



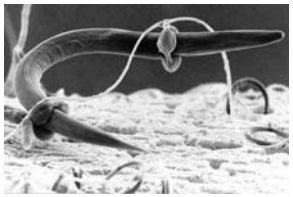
Generalized fungal life cycle

- **Fungal sex!** "plasmogamy" (fusion of hyphae) → **heterokaryotic mycelium**
  "karyogamy" (fusion of nuclei) → **zygote**
- **Fungal sexes!** compatability of "mating types"

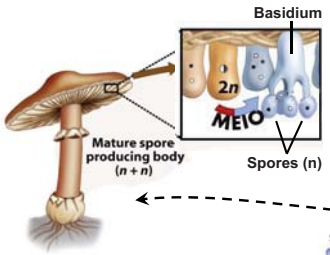


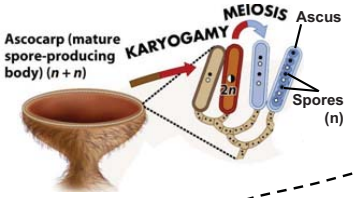
Generalized fungal life cycle and a few variations…

Ascomycota

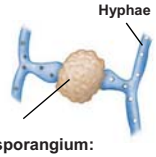


Basidomycota

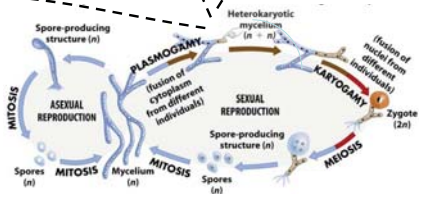




Zygomycota



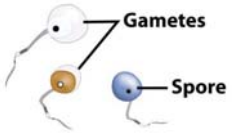
Zygosporangium:
thick coated "zygote" formed directly; produces spores



Generalized fungal life cycle and a few variations…

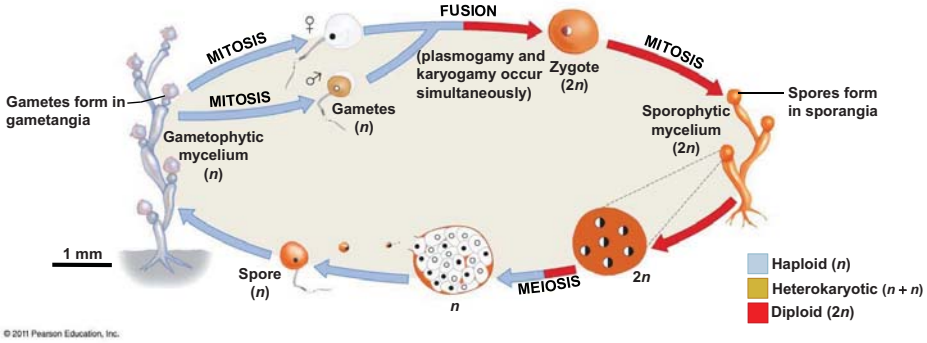
Chytridiomycota

many parasitic



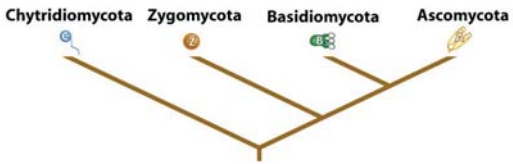
motile gametes & spores

Chytrids include the only fungi with alternation of generations



Do reproductive/ecological diversity have a phylogenetic pattern?

According to traditional thinking, there are four phyla of fungi.



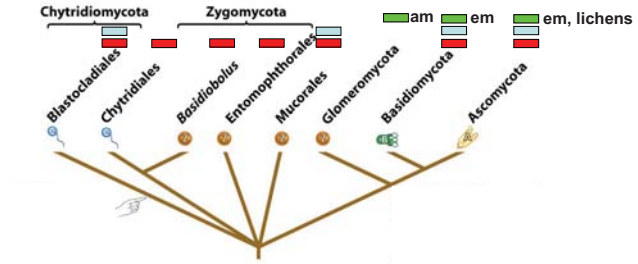
Chytridiomycota (make chytrid-like motile gametes and spores)

Zygomycota (make zygote with tough outer coat)

Basidiomycota (make pedestal-like basidium)

Ascomycota (make sac-like ascus)

DNA sequence data have revealed that Glomeromycota, Basidiomycota, and Ascomycota are monophyletic.



mutualists
saprophytes
parasites