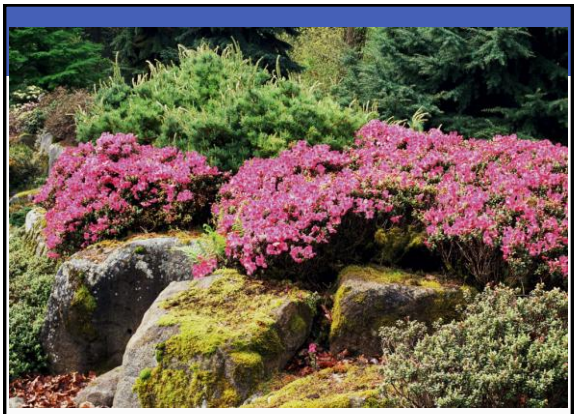
Plants (Lecture I – through Ferns)

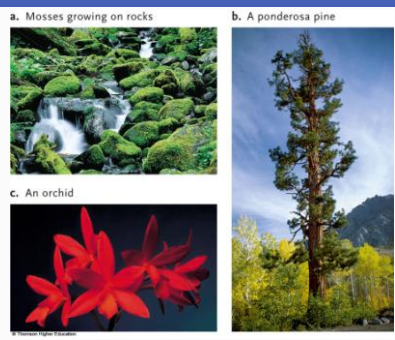
Chapter 27



Kingdom Plantae (1)

- At least 260,000 living species, 10 phyla
- Primary producers, chemical “factories”
- Adaptations
  - Avoid desiccation
  - Physical support
  - Nutrient uptake
  - Sexual reproduction without water

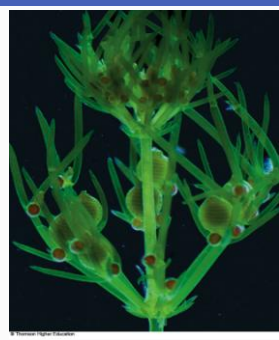
Representatives of Kingdom Plantae



Kingdom Plantae (2)

- Plants and green algae share
  - Cellulose walls
  - Photosynthetic starch
  - Chlorophylls *a* and *b*
- Plants evolved from charophyte green algae 425-490 mya

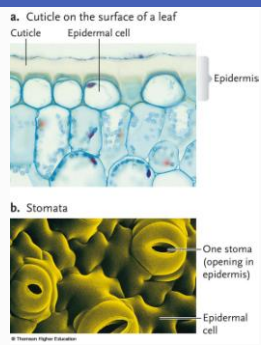
Chara, a Stonewort



Adaptations for Plant Survival on Land

- Sporopollenin
  - Resistant polymer, surrounds zygotes of charophytes, prevents desiccation in plant spores
- Cuticle
  - Outer waxy layer, prevents desiccation
- Stomata
  - Passageways for CO_2 uptake
  - Regulate H_2O loss

Land Plant Adaptations



Adaptations for Plant Survival on Land

- Embryophyte (all land plants): Dependent multicellular embryo sheltered inside parent plant
- Land plants split into bryophytes (nonvascular) and tracheophytes (vascular)
- Tracheophyte adaptations
  - Specialized transport cells
  - Lignin: Strengthens secondary walls
  - Apical meristems: Unspecialized dividing cells, allow branching

Vascular Tissue in Tracheophytes

- Tracheophytes (vascular plants) are taller (> 100 m) and more complex than bryophytes (non-vascular plants)
- Tracheophytes have better support and transport efficiency:
  - Xylem transports water and solutes
  - Phloem transports sugars from photosynthesis
- Bryophytes also lack true roots and stems

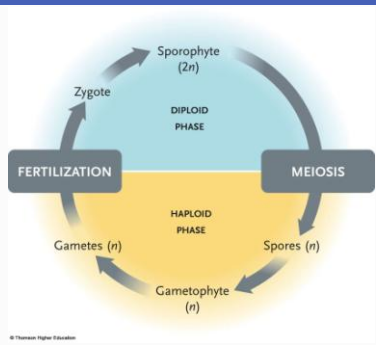
Root Systems

- Roots
  - Anchor plants
  - Absorb water and nutrients from soil
- Rhizome
  - Horizontal, modified stem
  - Penetrates soil, anchors
- Root systems
  - Underground, cylindrical absorptive structures

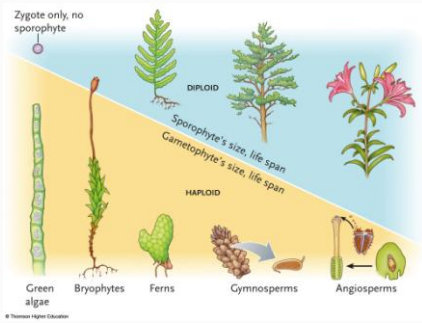
Shoot Systems

- Stems and leaves from apical meristems
- Leaves function in the absorption of light energy and CO_2
- Stems grew larger and branched extensively after the evolution of **lignin**

Plant Alternation of Generations

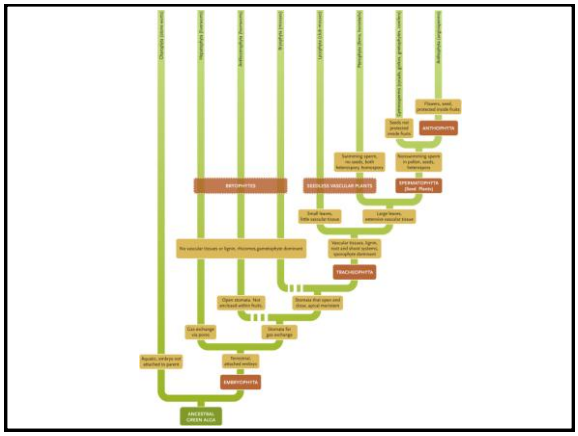


Evolutionary Trend from Haploid to Diploid



Some Vascular Plants Evolved Separate Male and Female Gametophytes

- Homosporous plants produce 1 type of spore
  - Gametophytes bisexual (sperm and eggs)
  - Motile sperm require liquid water
- Heterosporous plants produce 2 types of spores
  - Female gametophyte produces eggs, site of fertilization
  - Male gametophyte (pollen grain) nonmotile sperm transfer into female gametophyte



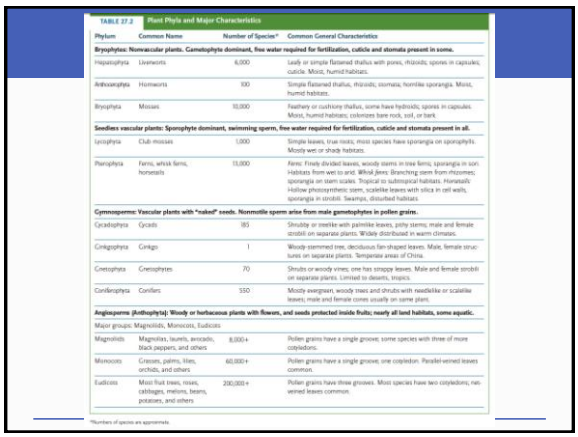


TABLE 27.2 Plant Phyla and Major Characteristics

Phylum	Common Name	Number of Species*	Common General Characteristics
Bryophytes: Nonvascular plants. Gametophyte dominant, free water required for fertilization, cuticle and stomata present in some.			
Hepatophyta	Liverworts	6,000	Leafy or simple flattened thallus with pores, rhizoids; spores in capsules; cuticle. Moist, humid habitats.
Anthocerophyta	Hornworts	100	Simple flattened thallus, rhizoids; stomata; hornlike sporangia. Moist, humid habitats.
Bryophyta	Mosses	10,000	Feathery or cushiony thallus, some have hydroids; spores in capsules. Moist, humid habitats; colonizes bare rock, soil, or bark.
Seedless vascular plants: Sporophyte dominant, swimming sperm, free water required for fertilization, cuticle and stomata present in all.			
Lycophyta	Club mosses	1,000	Simple leaves, true roots; most species have sporangia on sporophylls. Mostly wet or shady habitats.
Pterophyta	Ferns, whisk ferns, horsetails	11,000	*Ferns:* Finely divided leaves, woody stems in tree ferns; sporangia in sori. Habitats from wet to arid. *Whisk ferns:* Branching stem from rhizomes; sporangia on stem scales. Tropical to subtropical habitats. *Horsetails:* Hollow photosynthetic stem; scalelike leaves with silica in cell walls; sporangia in strobili. Swamps, disturbed habitats
Gymnosperms: Vascular plants with "naked" seeds. Nonmotile sperm arise from male gametophytes in pollen grains.			
Cycadophyta	Cycads	185	Shrubby or treelike with palmlike leaves, pithy stems; male and female strobili on separate plants. Widely distributed in warm climates.
Ginkgophyta	Ginkgo	1	Woody-stemmed tree, deciduous fan-shaped leaves. Male, female structures on separate plants. Temperate areas of China.
Gnetophyta	Gnetophytes	70	Shrubs or woody vines; one has strappe leaves. Male and female strobili on separate plants. Limited to deserts, tropics.
Coniferophyta	Conifers	550	Mostly evergreen, woody trees and shrubs with needlelike or scalelike leaves; male and female cones usually on same plant.
Angiosperms (Anthophyta): Woody or herbaceous plants with flowers, and seeds protected inside fruits; nearly all land habitats, some aquatic.			
Major groups: Magnoliids, Monocots, Eudicots			
Magnoliids	Magnolias, laurels, avocado, black peppers, and others	8,000+	Pollen grains have a single groove; some species with three of more cotyledons.
Monocots	Grasses, palms, lilies, orchids, and others	60,000+	Pollen grains have a single groove; one cotyledon. Parallel-veined leaves common.
Eudicots	Most fruit trees, roses, cabbages, melons, beans, potatoes, and others	200,000+	Pollen grains have three grooves. Most species have two cotyledons; net-veined leaves common.

*Numbers of species are approximate.

Trends in Plant Evolution

TABLE 27.1 Trends in Plant Evolution

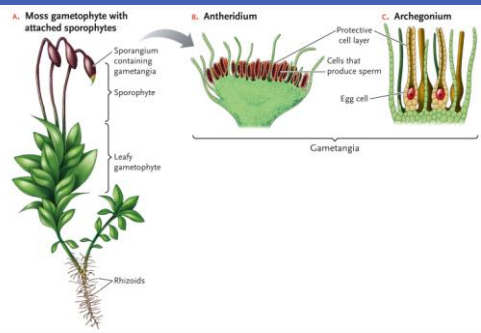
Traits derived from algal ancestor: cell walls with cellulose, energy stored in starch, two forms of chlorophyll (*a* and *b*); possibly, sporopollenin in spore wall.

Bryophytes	Ferns and Their Relatives	Gymnosperms	Angiosperms	Functions in Land Plants
Cuticle →				Protection against water loss, pathogens
Stomata →				Regulation of water loss and gas exchange (CO_2 in, O_2 out)
Nonvascular →	Vascular →			Internal tubes that transport water, nutrients
	Lignin →			Mechanical support for vertical growth
	Apical meristem →			Branching shoot system
	Roots, stems, leaves →			Enhanced uptake, transport of nutrients and enhanced photosynthesis
Haploid phase dominant →	Diploid phase dominant →			Genetic diversity
One spore type (homospory) →	Two spore types (heterospory) →			Promotion of genetic diversity
Motile gametes →		Nonmotile gametes →		Protection of gametes within parent body
Seedless →		Seeds →		Protection of embryo

Bryophytes: Nonvascular Land Plants

- Found in wet to moist habitats
  - Can grow as epiphytes, independently on another organism (e.g., moss growing on a tree trunk)
  - 1) Produce flagellated sperm and 2) lack a vascular system
- Gametangia produce gametes in shelter
  - Archegonia produce eggs
  - Antheridia produce sperm

Structures Enclosing Plant Gametes



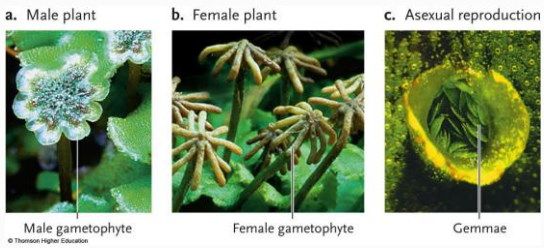
Bryophytes

- Body plan ***analogous*** with tracheophytes
  - No true roots, leaves, or stems
  - Gametophyte larger than attached sporophyte
- Evolutionary position unclear

Liverworts

- Phylum Hepatophyta (liverworts)
  - Perhaps first land plants?
  - Simple thallus (gametophyte)
  - No true stomata
  - Some have gemmae (cuplike asexual reproductive structure on thallus)

Liverwort *Marchantia*

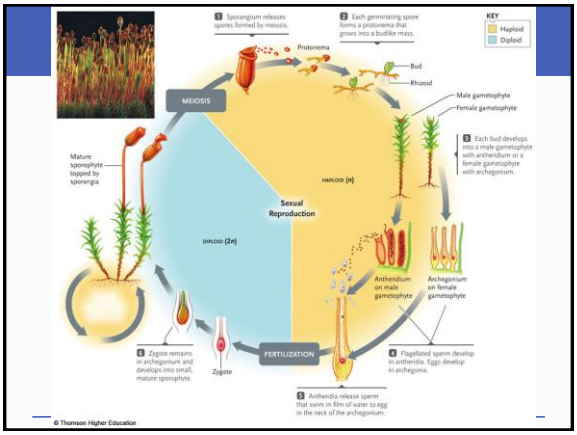


Hornworts

- Phylum Anthocerophyta (hornworts)
  - Plantlike and algalike features
  - Have algalike protein bodies (pyrenoids)

Mosses

- Phylum Bryophyta (mosses)
  - Most resemble vascular plants
  - Protonema haploid, filamentous web produces leafy gametophytes
  - Leafy moss produces gametangia, may be bisexual or unisexual
- Only a few bryophytes have primitive transport cells
- Ecological functions include soil production and primary producers in harsh conditions

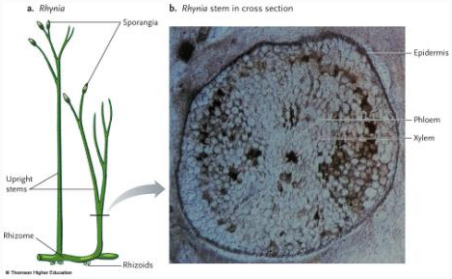


Early Seedless Vascular Plants

- Seedless vascular plants release spores and have **motile sperm**
- **Sporophyte separates from gametophyte and has vascular tissue**
- First seedless plants: Herbs without woody tissue
- Woody plants (secondary growth) developed in Carboniferous

Phylum Rhyniophyta

Rhynia (extinct)

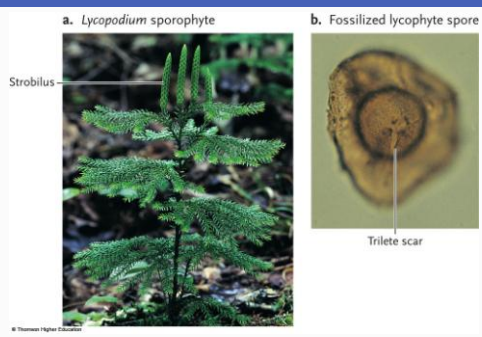


Lycophyte Tree

Phylum Lycophyta

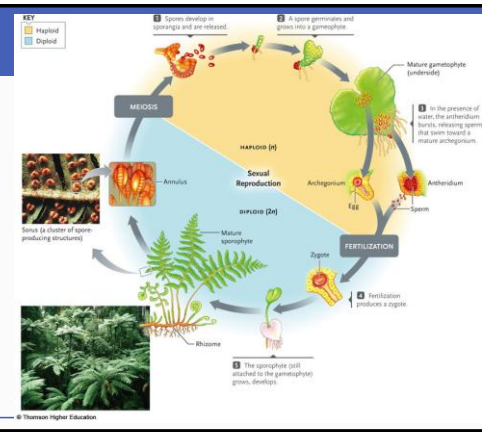
- Lycophytes
  - Small, vascular seedless plants; club mosses, spike mosses, and quillworts
  - Dominated carboniferous forests as trees
- Sporophylls
  - Sporangia produced on specialized leaves
  - Cone or strobilus: Cluster of sporophylls
- Gametophyte is nonphotosynthetic, requires mycorrhizae (fungus root)

Lycophytes



Phylum Pterophyta

- Ferns, whisk ferns, horsetails
  - Vascular seedless plants
  - Abundant during carboniferous as trees
  - Formed coal fossils (with lycophyta)
- Complex ***frond*** leaves in sporophyte
  - Node: Point on stem where leaf attaches
  - Sorus on fronds
  - Annulus encloses cluster of sporangia



Athyrium filix-femina, lady fern

Whisk Ferns

- Whisk ferns lack true roots and leaves
  - Rhizoid mycorrhizal
  - Stem epidermal cells conduct photosynthesis
  - Core has xylem and phloem

Horsetails

- Horsetails have whorls of scalelike leaves
  - Accumulate silica in their tissues
  - Strobili on specialized stems