Ch. 29
Plant Diversity I
How Plants Colonized Land
Essential Question

How did plants make the transition from water to land?
Plant history

- cyanobacteria (algae) on land 1.2 billion years ago

- 500 million years ago - plants on land

- currently about 290,000 species
  locations - all except mountain tops, some desert and polar regions

- important for other organisms to survive
  - stabilize landscapes, supply oxygen, base of food chain
Characteristics that land plants have in common with protists (algae)

1. brown, green, red algae
   multicellular
   eukaryotic
   photoautotrophic

2. green algae, dinoflagellates, brown algae
   cell walls - cellulose

3. green algae, euglenoids, some dinoflagellates
   chloroplasts - chlorophyll a and b
Charophyceans

closest relative of land plants
green algae

traits that land plants share with only charophyceans

A. Structural/biochemical evidence
1. **rosette cellulose-synthesizing complexes**
   - rose shaped proteins in plasma membrane
   - other plants = linear
   - higher % of cellulose
2. **peroxisome enzymes** = peroxisomes
   - lower loss of organic products by photorespiration

3. **Flagellated sperm**
   - land plants with sperm and charophyceans is similar

4. **Phragmoplast**
   - cytoskeletal elements that help form cell plate in mitosis

http://botit.botany.wisc.edu/images/130/Meiosis/Lilium_microsporogenesis/Phragmoplast_Cell_Plate.html
B. Genetic evidence
-nuclear and chloroplast gene comparison between plant and algae closest to charophyceans (*Charo* and *Coleochaete*)
C. Adaptations for land
   - charophyceans live on pond/lake edges
   - edges can dry
   - form a *sporopollenin* - polymer
     - prevent desiccation
     - could live on land

   - once on land
     - ample sunlight, carbon dioxide, soil nutrients, lack of herbivores & pathogens
A. Traits of land plants that Charophyceans do not have
-evolved as derived traits

1. **Apical meristems** - regions of cell division
tips of shoots and roots
-cells become surface epidermis
-shoot apical meristems - generate leaves
2. Alternation of Generations
   - reproductive cycle
   - derived characteristic of land plants (not present in relative of land plants and charophyceans)
   - both multicellular haploid and multicellular diploid stages
**gametophyte**-haploid reproduce by mitosis to make eggs and sperm.

**sporophyte** - diploid produce spores (haploid by meiosis)
3. walled spores produced in Sporangia

- **sporangia** = produce spores
- spores made by sporocytes by meiosis
- wall of spores = sporopollenin

![Fern spore](image)
4. **Multicellular gametangia**
gametes have multicellular organs called **gametangia**

female gametangia = **archegonia**

male gametangia = **antheridia**

[Images of archegonium and antheridium]
5. **Multicellular, dependent embryos**
   develop from zygotes in female **placental transfer cells** in embryo - help nutrients get from maternal tissue to embryo
other adaptations for land
   a. adaptations of water conservation
      1. **cuticle** - polymers of polyesters and waxes
         - waterproofing to prevent desiccation

      2. **stomata** - pores
         areas of gas exchange, and water evaporation

Cuticle

[Image: http://employees.csbsju.edu/ssaupe/images/stomata/mettler.jpg]
b. Adaptations of water transport (vascular tissue*)

**xylem** - carry water and minerals up from roots
- made of dead cells

**phloem** - carry nutrients (sugars, amino acids, other organic products

* absent in bryophytes (mosses)
c. secondary compounds
   - products of secondary metabolic pathways (branches off primary metabolic pathways)
   - alkaloids
   - terpenes bitter - help against herbivores
   - tannins

   - phenolics (flavenoids) - absorb UV rays, symbiotic relationships with soil microbes
Bryophytes - "nonvascular plants"

liverwort  moss

hornwort  moss
life cycle of moss
moss life cycle
In life cycle - gametophyte stage is dominant stage

Sperm needs water (dew droplets) to get sperm to eggs

**Protonemata** - mass of green, branched, one-celled thick filaments that absorb water, cell to cell or some have conducting tissue
Sphagnum moss (peat moss)

peat bog

closeup

leaf
mummy found in peat bog
origin of vascular plants

carboniferous period - vascular plants began to diversify and seed plants not evolved yet

420 million years ago  
-no taller than 50 cm.  
-branched sporophytes
**main traits of vascular plants:**

1. life cycles- dominant sporophytes (larger) than gametophyte

2. transport in vascular tissues
   - **xylem**- water/minerals
     - has tracheids-tube-shaped cells (dead cells) that carry water/minerals up from roots
     - have **lignin** in cell walls
   - **phloem** - sugar conducting cells (living)
     - arranged in tubes
     - transport sugar, amino acids
3. **Evolution of roots**
   - organs that anchor plants, absorb water and nutrients from soil

4. **Evolution of leaves**
   - organs that increase surface area for collecting solar energy for photosynthesis
   - **microphylls** - small spine shaped leaves with single vein
     410 million years ago
   - **megaphylls** - leaves with highly vascular system; 370 million years ago
Hypothesis for evolution of leaves

(a) Microphylls
May have originated from sporangia

(b) Megaphylls
May have evolved from the fusion of branched stems
-evolution of sporophylls (modified leaves with sporangia)

**homosporous** - one type of sporophyll with one type of spore

**heterosporous** - two types of sporophylls and two kinds of spores

**megasporophylls** - produce megaspores - make female gametophytes

**microspores** - develop into male gametophytes
Pteridophytes

Club moss  Whisk fern

horsetail  fern
Lycophyte
Life cycle of a fern
fern sorus
Fern gametophyte
fern sporophytes
Artist's conception of carboniferous forest based on fossil evidence
-only plants with vascular tissue can have true roots, stems, and leaves
So - what adaptations allowed plants to grow on land?