PowerLecture:
Chapter 23
Plant Evolution
Section 23.0: Weblinks and InfoTrac
See the latest Weblinks and InfoTrac articles for this chapter online
Impacts, Issues: **Beginnings, and Endings**

- Conifers are the premier source of lumber, paper, resins, and other forest products

- Deforestation has major ecological effects

Impacts, Issues: **Beginnings, and Endings**

- Nearly all plants are photoautotrophs, affecting the atmosphere

- We know of at least 295,000 kinds of existing plants

Impacts, Issues Video
Section 23.1: Weblinks and InfoTrac
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Setting the Stage for Plants

- Earth's atmosphere was originally oxygen free
- Ultraviolet radiation bombarded the surface
- Photosynthetic cells produced oxygen and allowed formation of a protective ozone layer

Invading the Land

- Cyanobacteria were probably the first to spread into and up freshwater streams
- Later, green algae and fungi made the journey together
- Every plant is descended from species of green algae

The Plant Kingdom

- Nearly all are multicelled
- Vast majority are photoautotrophs
  - Energy from sun
  - Carbon dioxide from air
  - Minerals dissolved in water

Nonvascular Plants

- Bryophytes
- Fewer than 19,000 species
- Three groups
  - Liverworts
  - Hornworts
  - Mosses

Vascular Plants

- Majority of plants
- Have internal tissues that carry water and solutes
- Two groups
  - Seedless vascular plants
  - Seed-bearing vascular plants

Seedless Vascular Plants

- Arose during the Devonian
- Produce spores but no seeds
- Four main groups

Whisk ferns
Lycophytes
Horsetails
Ferns

Seed-Bearing Vascular Plants

- Gymnosperms arose first
  - Cycads
  - Ginkgos
  - Gnetophytes
  - Conifers
- Angiosperms arose later
  - Monocots
  - Dicots

Plant Evolution
Milestones in plant evolution
Section 23.2: Weblinks and InfoTrac
See the latest Weblinks and InfoTrac articles for this chapter online

Evolutionary Trend
Haploid to diploid dominance
Adaptations to Land

- Root systems
- Shoot systems
- Vascular tissues
- Waxy cuticle

Evolutionary Tree for Plants
Evolutionary Tree for Plants
Evolutionary tree for plants

Traits of Seed-Bearing Plants

- Pollen grains
  - Arise from megaspores
  - Develop into male gametophytes
  - Can be transported without water
- Seeds
  - Embryo sporophyte inside nutritive tissues and a protective coat
  - Can withstand hostile conditions

Section 23.3: Weblinks and InfoTrac

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Bryophytes

- Small, nonvascular, nonwooody
- Gametophyte dominates life cycle; has leaflike, stemlike, and rootlike parts
- Usually live in wet habitats
- Flagellated sperm require water to reach eggs

Types of Bryophytes

Mosses (most common)
Liverworts (simplest)
Hornworts

Moss Life Cycle

Moss Life Cycle

Moss life cycle

Peat Mosses

- 350 species
- *Sphagnum* is an example
- Grow in acidic bogs; important ecosystems of cold and temperate regions
- Peat can be harvested and burned as fuel

Marchantia: A Liverwort

- Reproduces asexually by gemmae

- Gametophytes are male or female

Marchantia: A Liverwort

***Marchantia:* A Liverwort**

Section 23.4: Weblinks and InfoTrac

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Seedless Vascular Plants

- Like bryophytes
  - Live in wet, humid places
  - Require water for fertilization
- Unlike bryophytes
  - Sporophyte is free-living and has vascular tissues

Seedless Vascular Plants

Lycophytes (Lycophyta)
Whisk ferns (Psilophyta)
Horsetails (Sphenophyta)
Ferns (Pterophyta)

Seedless Vascular Plants

Seedless Vascular Plants

Ferns (Pterophyta)

- 12,000 species, mostly tropical
- Most common sporophyte structure
  - Perennial underground stem (rhizome)
  - Roots and fronds arise from rhizome
  - Young fronds are coiled “fiddleheads”
  - Mature fronds divided into leaflets
  - Spores form on lower surface of some fronds

Fern Life Cycle

Fern Life Cycle

Fern life cycle

Section 23.5: Weblinks and InfoTrac

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Carboniferous

- Giant lycophytes and horsetails
- Sea level rose and fell repeatedly
- Remains of swamp forests were repeatedly submerged and compressed
- Formation of coal

Carboniferous

Carboniferous

Section 23.6: Weblinks and InfoTrac

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Rise of Seed-Bearing Plants

- Seeds appeared about 360 million years ago

- Seed ferns and gymnosperms were dominant at first
- Angiosperms arose later

Seed-Bearing Plants

- Microspores that give rise to pollen grains
- Megaspores inside ovules
- More water-conserving than seedless vascular plants

Pollen

- Pollen grains are sperm-bearing male gametophytes that develop from microspores
- Allows transfer of sperm to egg without water
- Can drift on air currents or be carried by pollinators

Ovules

- Female reproductive structures that become seeds
- Consist of:
  - Female gametophyte with egg cell
  - Nutrient-rich tissue
  - Jacket of cell layers that will form seed coat

Section 23.7: Weblinks and InfoTrac

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Videos: CNN

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- Biology, 2003, Vol. 7, *Ephedra Dangers* (2:00)

Gymnosperms

- Plants with “naked seeds”
- Seeds don’t form inside an ovary
- Four groups

Conifers	Ginkgos
Cycads	Gnetophytes

Conifer Characteristics

- Widest known, largest number of living species
- Woody trees or shrubs
- Most are evergreen
- Bear seeds on exposed cone scales
- Most produce woody cones

Cycads

- Most diverse during age of dinosaurs
- Only 100 living species
- Palmlike appearance
- Pollen-bearing and seed-bearing cones on different plants

Ginkgos

- Diverse during age of dinosaurs
- One surviving species, *Ginkgo biloba*
- Deciduous trees are male or female

3 Genera of Gnetophytes

- *Gnetum*
- *Welwitschia*
- *Ephedra*

Pine Cones

- Woody scales of a “pine cone” are the parts where megaspores formed and developed into female gametophytes
- Male cones, where microspores and pollen are produced, are not woody

Pine Life Cycle

Conifer Distribution

- Reproduce more slowly than angiosperms; at competitive disadvantage in many habitats

- Still dominate in far north, at higher elevations, and in certain parts of southern hemisphere

Pine life cycle

Pine cones

Section 23.8: Weblinks and InfoTrac

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Angiosperms

- Flowering plants

- Dominant land plants (260,000 species)

- Ovules and (after fertilization) seeds are enclosed in an ovary

- Three main groups: magnoliids, monocots, and eudicots

Monocot life cycle
Angiosperm Evolutionary Tree

Double Fertilization
- Distinctive feature of angiosperms

- Male gametocyte delivers two sperm to an ovule

- One fertilizes egg; other fertilizes a cell that gives rise to endosperm

Section 23.9: Weblinks and InfoTrac
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Flowering Plant Life Cycle

Flower parts
Section 23.10: Weblinks and InfoTrac
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Videos: CNN
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- Env. Sci., 2003, Vol. 6, *Deforestation* (2:35)

- Env. Sci., 2004, Vol. 7, *Deforestation* (2:18)

- Env. Sci., 2004, Vol. 7, *Desertification* (2:45)

People and Plants
- Plant domestication began about 11,000 years ago

- About 3,000 species have been used as food

- Now about 200 plants are major crops

Nonfood Uses of Plants
- Lumber, paper, and fuel
- Furniture
- Rope
- Thatched roofing
- Natural insecticides
- Drugs

Plants of Abuse
- Tobacco plants are *Nicotiana sp.*
- *Cannabis sativa* is source of marijuana
- Coca leaves are used to produce cocaine

- Toxic plant alkaloids, such as henbane and belladona, have been used as poisons and as medicine

Deforestation

- Deforestation is the mass removal of all trees from large tracts for logging, agriculture, and grazing

- Greatest in Brazil, Indonesia, Colombia, and Mexico

- Sustainable development

Kelp Forest Channel Islands, CA
Saguaros
Sequoias