Plant Diversity

(Freeman Ch 30 & 40)

Videos
28-3, 28-5, 39-3

25 February 2010
ECOL 182R UofA
K. E. Bonine
Lecture Schedule (middle third)

18 Feb KB - **Fungi**, Ch31

23 Feb KB - **Prokaryotes & Protists**, Ch28&29
25 Feb KB - **Plant Diversity, Form, Function**, Ch30&40

2 Mar KB - **Plant Form and Function**, Ch36&37
4 Mar KB - **Plant Function**, Ch38&39

9 Mar KB - **Plant Ecology**, Ch50,52,53
11 Mar KB - **Ecology**, Ch50,52,53

13-21 Mar Spring Break

23 Mar KB - **Biology of the Galapagos**
             Wikelski 2000 and http://livinggalapagos.org/
25 Mar KB - Part 2. Discussion and Review.

30 Mar KB - **EXAM 2**
Plant Diversity

- From Sea to Land
- Origins, Relationships, Diversity
- Shared Derived Traits (Synapomorphies)
- Nonvascular to Vascular Plants
- Seedless to Seeds
Figure 29-8

Eight major lineages of eukaryotes (protist branches are in color)
The Evolution of Land Plants
(from the edge of the swamp...)

Eukaryotic Green stuff
Land plants retain derived features they share with a green algae (Charales):
• **Chlorophyll a and b.**
• **Starch** as a storage product.
• **Cellulose** in cell walls.

### Original Land Plants Related to Algae

See Figure 30.9
Land Plants are Monophyletic

Land plants are monophyletic, all descendants from a single common ancestor.

Synapomorphy: development from an embryo protected by tissues of the parent plant. Therefore, also called embryophytes.

(phyton = plant)
Land Plants Comprise ~Ten Clades

**Nonvascular** (3 clades)
- paraphyletic group
- liverworts,
- hornworts
- mosses

**Vascular** plants, or *tracheophytes* (7 clades)—all have conducting cells called - *tracheids*.
- monophyletic group
Moving to Land

Plants first appeared on land between 400-500 million years ago.

Environmental Challenges:

1. 
2. transport to all parts 
3. (fight gravity) 
4. disperse 

Some challenges met immediately, others took millions of years.
Biological history

Plants first appeared on land between 400-500 million years ago.

<table>
<thead>
<tr>
<th>ERA</th>
<th>PERIOD</th>
<th>ONSET</th>
<th>MAJOR EVENTS IN THE HISTORY OF LIFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>Quaternary</td>
<td>1.8 mya</td>
<td>Humans evolve; many large mammals become extinct</td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>65 mya</td>
<td>Diversification of birds, mammals, flowering plants, and insects</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Cretaceous</td>
<td>144 mya</td>
<td>Dinosaurs continue to diversify; flowering plants and mammals diversify. Mass Extinction at end of period (=76% of species disappear)</td>
</tr>
<tr>
<td></td>
<td>Jurassic</td>
<td>206 mya</td>
<td>Diverse dinosaurs; radiation of ray-finned fishes</td>
</tr>
<tr>
<td></td>
<td>Triassic</td>
<td>248 mya</td>
<td>Early dinosaurs; first mammals; marine invertebrates diversify; first flowering plants; Mass Extinction at end of period (=65% of species disappear)</td>
</tr>
<tr>
<td>Paleozoic</td>
<td>Permian</td>
<td>290 mya</td>
<td>Reptiles diversify; amphibians decline; Mass Extinction at end of period (=96% of species disappear)</td>
</tr>
<tr>
<td></td>
<td>Carboniferous</td>
<td>354 mya</td>
<td>Extensive &quot;fern&quot; forests; first reptiles; insects diversify</td>
</tr>
<tr>
<td></td>
<td>Devonian</td>
<td>417 mya</td>
<td>Fishes diversify; first insects and amphibians. Mass Extinction at end of period (=75% of species disappear)</td>
</tr>
<tr>
<td></td>
<td>Silurian</td>
<td>443 mya</td>
<td>Jawless fishes diversify; first ray-finned fishes; plants and animals colonize land</td>
</tr>
<tr>
<td></td>
<td>Ordovician</td>
<td>490 mya</td>
<td>Mass Extinction at end of period (=75% of species disappear)</td>
</tr>
<tr>
<td></td>
<td>Cambrian</td>
<td>543 mya</td>
<td>Most animal phyla present; diverse algae</td>
</tr>
<tr>
<td></td>
<td>Precambrian</td>
<td>600 mya</td>
<td>Ediacaran fauna</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5 bya</td>
<td>Eukaryotes evolve; several animal phyla appear</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.8 bya</td>
<td>Origin of life; prokaryotes flourish</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 bya</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>mya, million years ago; bya, billion years ago.
### Biological History

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Earth forms</td>
</tr>
<tr>
<td>2</td>
<td>Origin of Life</td>
</tr>
<tr>
<td>6</td>
<td>Oldest fossils</td>
</tr>
<tr>
<td>13</td>
<td>Photosynthesis evolves</td>
</tr>
<tr>
<td>20</td>
<td>Eukaryotic cells</td>
</tr>
<tr>
<td>27</td>
<td>Abundant life</td>
</tr>
</tbody>
</table>

- **11**: Aquatic life
- **28**: First land plants
- **29**: Forests
- **30**: Birds

Moss
Adaptations for Land

1. **Cuticle**
   - waxy covering that **retards water**
2. **Gametangia** enclosing gametes
3. Embryos in a protective structure
4. **Pigments** that protect against UV radiation
5. Spore walls containing **sporopollenin**
   - resists **desiccation** and
6. **Mutualistic relationships with fungus**
   - to promote from soil
Plants Help Create Soil

Ancient plants contributed to soil formation.

Acids secreted by plants help break down rock.

Organic material from dead plants contributes to soil structure.

Create habitat and pave way for succession of other species.
Nonvascular Plants Are Similar to Ancestral Land Plants

Today’s nonvascular plants are thought to be similar to the first land plants. They grow in moist environments in dense mats. They are small, there is no system to conduct water or minerals from soil to plant body parts.
Extant Plants

Discuss ancestral first, then derived

Common ancestor of land plants
- Protected embryos
- Apical growth
- Tracheids
- Microphylls
- Club mosses

Land plants
- Liverworts
- Hornworts
- Mosses
- Whisk ferns
- Horsetails
- Most ferns
- Gymnosperms
- Flowers, carpels, triploid endosperm
- Flowering plants

LIFE 8e, Figure 28.7
Three Nonvascular Clades
(paraphyletic group)

Liverworts

Hornworts

Mosses
Alternation of Generations

and

Size and independence of gametophyte or sporophyte changes

All plants have alternation of generations (= multicellular haploid & multicellular diploid)
Moss Lifecycle
(Nonvascular Plant)

Sporophyte (2n) and attached to, required for egg and sperm to meet.
Nonvascular: Gametophyte Dominates

In nonvascular plants:

gametophyte is larger, longer-lived, and more self-sufficient than the sporophyte.

Gametophyte generation is ________

sporophyte may or may not be photosynthetic, but is always nutritionally dependent on the gametophyte, and is permanently attached.

_________ of the ___________ generation is a major theme in plant evolution.
Nonvascular Plant Reproduction

Male: antheridium

Female: archegonium

Antheridium (n)

Egg (n)

Archegonium (n)
Nonvascular Plant Reproduction

Base of archegonium grows to protect embryo during early development.

(land plants aka embryophytes)
Life cycle of a moss

Mosses are group to plants

Video 28-3
Moss...

*Sphagnum* grows in swampy places. The upper layers of moss compress lower layers that are beginning to decompose, forming *peat*.

Long ago, continued compression led to the formation of ______
Harvesting Peat from a Bog
Navajo Power Plant, Page, AZ
Paleozoic: Carboniferous

- Large glaciers and swamp forests of treeferns and horsetails.

- Fossilized forests formed the fossil we now mine for coal.
Vascular Plants Arose from Nonvascular

Recently, fossilized fragments of ancient liverworts have been discovered.
Vascular Plants Comprise Seven Clades

10 clades of land plants:

**Nonvascular** (3 clades)
- liverworts, hornworts, and mosses
- paraphyletic group

**Vascular plants**, or *tracheophytes* (7 clades)
- conducting cells called *tracheids*
- monophyletic group
Extant Plants

Common ancestor of land plants

Protected embryos

Apical growth

Tracheids

Microphylls

Club mosses

Hornworts

Mosses

Liverworts

Horsetails

Most ferns

Whisk ferns

Pteridophytes

Euphyllophytes

Seed plants

Vascular plants

Land plants

Seedless

Flowers, carpels, triploid endosperm

Gymnosperms

Flowering plants

LIFE 8e, Figure 28.7

See Fig 30.12
Evolution of Vascular Plants

Vascular plants have a branching,

Mature sporophyte is nutritionally independent from the gametophyte.

Still must have water for part of the life cycle—for the flagellated, swimming sperm.
Evolution of Leaves

Megaphylls:
Figure 28.17 Horsetails

(A) Sporangium
   Fertile shoot

(B) Leaves

Equisetum arvense

Equisetum palustre
Life cycle of a fern

Vascular but Seedless

LIFE 8e, Figure 28.19 (Part 1)
The Life Cycle of a Homosporous Fern

Sporophyte and Gametophyte are each free-living.

Mature gametophyte (about 0.5 cm wide)
- Archegonium
- Egg
- Sperm

Mature sporophyte (typically 0.3–1 m tall)
- Embryo
- Sporophyte
- Roots

HAPLOID (n)
- Meiosis
- Sporangium
- Microsorum sp.

DIPLOID (2n)
- Fertilization

Sporangium
- Germinating spore

Sori (clusters of sporangia)

*BIOLOGY 8e, Figure 28.20*
Early Vascular Plants

During the Permian, the continents came together to form Pangaea. Extensive glaciation occurred late in the Permian. Lycophyte-fern forests were replaced by gymnosperms.
If you could imagine a living tree as old as the pyramids of Egypt, what do you think it would look like? It would look like a bristlecone pine, *Pinus longaeva*, the oldest known tree species in the world.

The bristlecone pine only lives in scattered, arid mountain regions of six western states of America, but the oldest are found in the Ancient Bristlecone Pine Forest in the White Mountains of California. There the pines exist in an exposed, windswept, harsh environment, free of competition from other plants and the ravages of insects and disease. The oldest bristlecones usually grow at elevations of 10,000 to 11,000 feet.
The oldest known tree is "Methuselah", which is 4,789 years old. To keep Methuselah from harm, this tree isn't labeled, as the other trees are. An older tree called Prometheus was killed shortly after it was discovered in 1964. This happened when a geologist searching for evidence of Ice Age glaciers was taking some core samples from several bristlecones. Just as he realized he had found a tree over 4,000 years old, his coring tool broke. Amazingly the U.S. Forest Service gave him permission to cut down the tree. Prometheus turned out to be 4,950 years old. It was a 300 year old tree when the pyramids were being built in Egypt.

Bristlecone Pine

Laboratory of Tree-Ring Research
http://www.ltrr.arizona.edu/
Which of the following are vascular plants?

a Juniper  
b Sunflower  
c Fern  
d Moss  
e Horsetail  
f Liverwort  
g Lily
Seed Plants

(Gymnosperms & Angiosperms)

Small seeds

Large seeds

Penny
Late in the Devonian, some plants developed **secondary growth**: thickened woody stems of xylem.

First species with secondary growth were the **progymnosperms**: seedless vascular plants, now extinct.

**Wood**: proliferated xylem, gives support and allows plants to grow above their competitors for sunlight.
Figure 29.1 Highlights in the History of Seed Plants

Nonseed vascular plants
- Seed ferns
- Progymnosperms

Rise of seed plants
- Devonian
- Carboniferous
- Permian

Gymnosperms dominant
- Triassic
- Jurassic
- Cretaceous

Angiosperms dominant
- Tertiary
- Cenozoic

Millions of years ago
- 417
- 354
- 290
- 248
- 206
- 144
- 65
- 1.8
- Present

Quaternary
Seed Plants Took Over

Surviving seed plants fall into two groups: and cycads :

: flowering plants
Evolution of Plants

Horsetails and ferns (Pteridophytes) replaced by plants

Figure 2.6 Terrestrial plant species richness. Ferns, gymnosperms, and angiosperms have, in turn, dominated the world’s flora. (Modified from Signor 1990.)
Gymnosperms

Extant gymnosperms are probably a clade.

_Gymnosperm:_ the ovules and seeds are not protected by ovary or fruit tissue.
Gymnosperms

Four major groups of living gymnosperms:

- **Cycads**: Cycadophyta—140 species
- **Ginkgos**: Ginkgophyta—one living species, Ginkgo biloba
- **Gnetophytes**: Gnetophyta—90 species in 3 genera
- **Conifers**: Coniferophyta—600 species, the cone bearers

- Cycads and Ginkgos still have
Living fossils: Gingko

(a) Triassic
(~200mya)
Gingko biloba

Cycas revoluta

UA Campus

http://arboretum.arizona.edu/plantwalks.html
48

Gymnosperms

(A) Encephalartos villosus  cycad

(B) Ginkgo biloba

(C) Welwitschia mirabilis  gnetophyte

(D) Sequoiadendron giganteum

Gymnosperms
Gymnosperm Evolution

Most living gymnosperms have only tracheids for water conduction and support.

Angiosperms have vessel elements and fibers alongside of tracheids.
Tracheids have gaps in their secondary cell walls.

Cross section through top of tracheid

Secondary cell wall
Primary cell wall

Water flow

Water passes through primary cell wall

Figure 29-11a Biological Science, 2/e © 2005 Pearson Prentice Hall, Inc.
Vessels have gaps in their primary and secondary cell walls.

Cross section through top of vessel

Secondary cell wall
Primary cell wall

water flow

Figure 29-11b Biological Science, 2/e © 2005 Pearson Prentice Hall, Inc.
Evolution of Seed Plants

Gametophyte generation is reduced even further than it is in ferns. Haploid gametophyte develops partly or entirely while attached to the sporophyte.
Figure 29.3 The Relationship between Sporophyte and Gametophyte Has Evolved (Part 1)

Nonvascular

Sporophyte (2n)

Gametophyte (n)

Sporophyte (2n)

Seedless

Vascular

Gametophyte (n)
Figure 29.3 The Relationship between Sporophyte and Gametophyte Has Evolved (Part 2)

Angiosperm
Gymnosperm Example:

Megasporangium (cone)

Microsporangium (strobili)
Evolution of Seed Plants

Megasporangium is surrounded by *integument* made of sporophytic structures.

Megasporangium and the integument together form the *ovule* (which develops into a *seed*).
Evolution of Seed Plants

In the microsporangium, microspores produce the male gametophyte, or **pollen** grain with **sporopollenin** in walls, the most resistant biological compound known.

Reproduction becomes ______________ of ______________ in some Gymnosperms!

How did this affect the evolution & diversification of seed plants?
Conifers (Pine Cones...)

A **cone** is a modified stem, bearing a tight cluster of scales (reduced **branches**), specialized for reproduction. **Megaspores** are produced here.

**Strobilus**: cone-like structure; scales are modified **leaves**. **Microspores** are produced here.

Recall that evolution by natural selection typically involves modification of existing structures.
Pine Life Cycle

• Wind carries pollen grains from strobilus to cone.

• Two sperm travel through pollen tube; one degenerates after fertilization.

Note that pollinization does NOT equal fertilization.
Figure 29.8 The Life Cycle of a Pine Tree

1. Immature cone
2. Scale of cone
3. Ovule
4. Section through scale
5. Megasporocyte
6. Megasporangium
7. Functional megaspore
8. Pollen chamber
9. Strobili
10. Microspores
11. Pollen grain
12. Female gametophyte
13. Egg
14. Sperm
15. Male gametophyte
16. Archeogonium
17. Developing embryos
18. Zygote
19. Fertilization
20. Mature cone
21. Seed
22. Wing
23. Seed coat
24. Embryo
25. Winged seed
26. DIPLOID (2n)
27. HAPLOID (n)
After fertilization, diploid zygote divides to produce an embryonic sporophyte. Growth is then suspended, the embryo enters a dormant stage, with the end product being a multicellular seed.

How might suspension of growth be a fitness advantage?
Evolution of Seed Plants

Seeds have tissues from three generations:
1. Seed coat develops from the sporophyte parent (integument).
2. Female gametophytic tissue from the next generation contains a nutrient supply for developing embryo.
3. Embryo is the new sporophyte generation.
Evolution of Seed Plants

Seeds and Secondary Growth are the main reasons for the success of seed plants—currently the dominant life forms in terrestrial environments.
Evolution of Seed Plants

Seeds are well-protected resting stages. May remain **viable** for many years, **germinating** when conditions are favorable. **Seed coat** protects from drying out as well as predators. Many seeds have adaptations for **dispersal**.
Then came the FLOWERS!
## Origin of Land Plants

<table>
<thead>
<tr>
<th>GROUP</th>
<th>COMMON NAME</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NONVASCULAR PLANTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hepatophyta</td>
<td>Liverworts</td>
<td>No filamentous stage; gametophyte flat</td>
</tr>
<tr>
<td>Anthocerophyta</td>
<td>Hornworts</td>
<td>Embedded archegonia; sporophyte grows basally (from the ground)</td>
</tr>
<tr>
<td>Bryophyta</td>
<td>Mosses</td>
<td>Filamentous stage; sporophyte grows apically (from the tip)</td>
</tr>
<tr>
<td><strong>VASCULAR PLANTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lycophyta</td>
<td>Club mosses and allies</td>
<td>Microphylls in spirals; sporangia in leaf axils</td>
</tr>
<tr>
<td>Pteridophyta</td>
<td>Horsetails, whisk ferns, ferns</td>
<td>Differentiation between main stem and side branches (overlapping growth)</td>
</tr>
<tr>
<td><strong>SEED PLANTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gymnosperms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycadophyta</td>
<td>Cycads</td>
<td>Compound leaves; swimming sperm; seeds on modified leaves</td>
</tr>
<tr>
<td>Ginkgophyta</td>
<td>Ginkgo</td>
<td>Deciduous; fan-shaped leaves; swimming sperm</td>
</tr>
<tr>
<td>Gnetophyta</td>
<td>Gnetophytes</td>
<td>Vessels in vascular tissue; opposite, simple leaves</td>
</tr>
<tr>
<td>Coniferophyta</td>
<td>Conifers</td>
<td>Seeds in cones; needle-like or scale-like leaves</td>
</tr>
<tr>
<td>Angiosperms</td>
<td>Flowering plants</td>
<td>Endosperm; carpels; gametophytes much reduced; seeds within fruit</td>
</tr>
</tbody>
</table>

*Note: No extinct groups are included in this classification.*
Angiosperms

Oldest angiosperm fossils are Cretaceous, 140 million years old.
Radiation was explosive; angiosperms became dominant in only 60 million years.
Over 250,000 species exist today.

Female gametophyte even more reduced—usually only seven cells.
Angiosperm Synapomorphies

- **Xylem** with vessel elements and fibers
- **Phloem** with companion cells

- Triploid endosperm
- Ovules and seeds
(a) Small reproductive structures

[Image: Close-up of a small plant with a flower and a tip of a sewing needle.]

[Scale bar: 1 mm]

Tip of sewing needle

Plant

Flower

Large reproductive structures

[Image: A large flower held by a person in a forest.]
Basic parts of a flower

Female
- Carpel
  - Style
  - Ovary
- Stigma

Male
- Anther
  - Filament
- Stamen

Perianth
- Petal
- Sepal
- Receptacle

Figure 40-6a  Biological Science, 2/e  © 2005 Pearson Prentice Hall, Inc.
Carpels

Angiosperm: “enclosed seed”—the ovules and seeds are enclosed in a modified leaf called a carpel.

Carpels provide protection, and may interact with pollen to prevent self-pollination.
Figure 29.12 Carpels and Stamens Evolved from Leaflike Structures

(A) Carpel evolution

Carpels

Sporangia
Modified leaflike structure
Cross section
Fused carpel

(B) Stamen evolution

Stamens

Austrobaileya sp.
Magnolia
Lily

Sporangia
Cross section
Flowers

Stamens bear microsporangia; consist of filament and anther.

Carpels bear megasporangia. One or more carpels form the pistil—stigma, style, and ovary.
Flowers

**Petals (corolla)** and **sepals (calyx)** are modified leaves. Often play a role in attracting pollinators. The calyx often protects the flower bud before it opens.
Flowers

Perfect flowers: have *both* mega- and microsporangia.

Imperfect flowers: either mega or microsporangia.

**Monoecious**: “one-housed”; male and female flowers occur on the same plant.

**Dioecious**: “two-housed”; male and female flowers on different plants.
**Inflorescence**: grouping of flowers. Different families have characteristic types.
(C) *Pennisetum setaceum*

Spikes
Angiosperm Lifecycle
Double Fertilization (in Angiosperms)

• One sperm nucleus unites with the egg nucleus to form the zygote.
• Second sperm nucleus moves through the female gametophyte and fuses with the polar nuclei in the central cell to form a single triploid \( (3n) \) cell.
• This triploid cell undergoes a series of mitotic divisions that form a triploid tissue called _______
• Endosperm stores nutrients that will be needed by the _______
Double Fertilization Produces a Zygote and an Endosperm Nucleus

**POLLEN TUBE GROWTH AND FERTILIZATION**

1. Pollen grain germinates on the stigma. Pollen tube begins growing down the style.
2. The tube-cell nucleus moves into pollen tube, and the generative cell nucleus divides by mitosis to form two sperm in pollen tube.
3. Pollen tube completes growth toward the egg by passing through micropyle and discharging the two sperm into a cell adjacent to egg.
4. One sperm unites with egg to form zygote. The other fuses with the two polar nuclei to form endosperm (nutrient tissue).
Inside the ovary, the ovule develops into a seed consisting of:

• The developing embryo (2n)
• The endosperm (3n), which provides nutrition to the growing embryo
• Additional food storage tissue formed from the megagametophyte, called perisperm
• Outermost layer of tissue, the integument, develops into the seed coat

The ovary itself develops into a fruit.
• The ovary wall, aka pericarp, often thickens & separates into distinct layers.
The Angiosperms: Flowering Plants

• Specialized leaves (petals and sepals) are important for attracting pollinators
  - Many angiosperms are animal-pollinated increasing the likelihood of outcrossing (in exchange for nectar or pollen)
  - Coevolution has resulted in some highly specific interactions, but most plant-pollinator systems are not highly specific

• Evolutionarily ancient angiosperms have a large and variable number of floral structures (petals, sepals, carpels, and stamens)
  - Evolutionary trend within the group:
    • reduction in number of floral organs,
    • differentiation of petals and sepals,
    • changes in symmetry, and
    • fusion of parts.
Pollination Syndromes

- **Beetle flowers**: dull color, strong odor
- **Bee flowers**: blue or yellow with nectar guides
- **Moth and butterfly flowers**: long corolla tube
- **Bird flowers**: lots of nectar, red, odorless
- **Bat flowers**: lots of nectar, dull colors, strong odors
- **Wind**: no nectar, dull colors, odorless
Flowers pollinated by moths tend to bloom at night, are white, and are long and tubular.
Wind pollinated angiosperms
Xanthopan morgani predicta
Pollination by mammals!
Video 39.3 Pollination of a night-blooming cactus by a bat
Fruit & seed dispersal

- **Wind**: fruits & seeds have “wings”
- **Water**: fruits & seeds float
- **Animal** (endozoochory): fleshy, edible fruits
- **Animal** (exozoochory): bristles, hooks, or sticky substances
Simple

APRICOT: Each flower contains one ovary.

Aggregate

RASPBERRY: Each flower contains many ovaries.

Multiple

PINEAPPLE: Many flowers with many ovaries combine.
Mistletoe berries stick to bird feet.
Many seeds have bristles or hooks that stick to animal fur.
The Angiosperms: Flowering Plants

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  - Evolutionary trend within the group:
    • reduction in number of floral organs,
    • differentiation of petals and sepals,
    • changes in symmetry, and
    • fusion of parts.
Asteraceae

2 types of flowers
Angiosperm Diversification

More than 250,000 species

Common ancestor of angiosperms

Carpels; triploid endosperm; seeds in fruit

Vessel elements

Amborella

Water lilies

Star anise

Magnoliids

Monocots

Eudicots

Carpels fused by tissue connection

Only one cotyledon

Pollen with three grooves
Plants Support Our World

Plants contribute to **ecosystem services**: processes by which the environment maintains resources that benefit humans.

Plants are **primary producers**: photosynthesis traps energy and carbon, making them available to consumers.
Plants Support Us

Seed plants are our primary food source. Twelve are most important: rice, coconut, wheat, corn, potato, sweet potato, cassava, sugarcane, sugar beet, soybean, common bean, banana.

Half of the world’s population gets most of its food energy from...
Plants Support Us

Many medicines come from seed plants. Medicines are found by screening large numbers of plants, or screening large numbers of chemical compounds.

Ethnobotanists also discover medicinal plants by studying people and their uses of plants all over the world.
### TABLE 29.1

**Some Medicinal Plants and Their Products**

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>PLANT SOURCE</th>
<th>MEDICAL APPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine</td>
<td>Belladonna</td>
<td>Dilating pupils for eye examination</td>
</tr>
<tr>
<td>Bromelain</td>
<td>Pineapple stem</td>
<td>Controlling tissue inflammation</td>
</tr>
<tr>
<td>Digitalin</td>
<td>Foxglove</td>
<td>Strengthening heart muscle contraction</td>
</tr>
<tr>
<td>Ephedrine</td>
<td><em>Ephedra</em></td>
<td>Easing nasal congestion</td>
</tr>
<tr>
<td>Menthol</td>
<td>Japanese mint</td>
<td>Relief of coughing</td>
</tr>
<tr>
<td>Morphine</td>
<td>Opium poppy</td>
<td>Relief of pain</td>
</tr>
<tr>
<td>Quinine</td>
<td>Cinchona bark</td>
<td>Treatment of malaria</td>
</tr>
<tr>
<td>Taxol</td>
<td>Pacific yew</td>
<td>Treatment of ovarian and breast cancers</td>
</tr>
<tr>
<td>Tubocurarine</td>
<td>Curare plant</td>
<td>As muscle relaxant in surgery</td>
</tr>
<tr>
<td>Vincristine</td>
<td>Periwinkle</td>
<td>Treatment of leukemia and lymphoma</td>
</tr>
</tbody>
</table>