<table>
<thead>
<tr>
<th>Classification</th>
<th>Common Name</th>
<th>Estimated Number of Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nonvascular Plants (Bryophytes)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum Hepatophyta</td>
<td>Liverworts</td>
<td>9,000</td>
</tr>
<tr>
<td>Phylum Anthocerophyta</td>
<td>Hornworts</td>
<td>100</td>
</tr>
<tr>
<td>Phylum Bryophyta</td>
<td>Mosses</td>
<td>15,000</td>
</tr>
<tr>
<td><strong>Vascular Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seedless Vascular Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum Lycophyta</td>
<td>Lycophytes</td>
<td>1,200</td>
</tr>
<tr>
<td>Phylum Pterophyta</td>
<td>Pterophytes</td>
<td>12,000</td>
</tr>
<tr>
<td><strong>Seed Plants</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gymnosperms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum Ginkgophyta</td>
<td>Ginkgo</td>
<td>1</td>
</tr>
<tr>
<td>Phylum Cycadophyta</td>
<td>Cycads</td>
<td>130</td>
</tr>
<tr>
<td>Phylum Gnetophyta</td>
<td>Gnetophytes</td>
<td>75</td>
</tr>
<tr>
<td>Phylum Coniferophyta</td>
<td>Conifers</td>
<td>600</td>
</tr>
<tr>
<td><strong>Angiosperms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phylum Anthophyta</td>
<td>Flowering plants</td>
<td>250,000</td>
</tr>
</tbody>
</table>
Seedplants

What traits are unique to angiosperms?

- Flowers, seeds protected in fruits, embryo nourished by endosperm
- Seeds in exposed ovules

GYMNOSPERMS

- Heterospory, ovule, seeds, pollen, nonswimming sperm, secondary growth (wood)

SPERMATOPHYTA (seed plants)

ANTHOPHYTA

Cycads, Ginkgos, Conifers, Gnetales, Angiosperms

Ancestral seedless plant
Angiosperms: vascular plants that have seeds and flowers (seed is covered by a fruit)
Phylum Anthophyta: Angiosperms

- *Anthos* is Greek for flower

- Flower is a specialized shoot that can have four modified leaves into the following organs:
  - sepals,
  - petals,
  - stamen (contain pollen)
  - carpel (contain ovules)
Development of gametophytes in angiosperms

(a) Development of a male gametophyte (pollen grain). Pollen grains develop within the microsporangia (pollen sacs) of anthers at the tips of the stamens.

1. Each one of the microsporangia contains diploid microsporocytes (microspore mother cells).
2. Each microsporocyte divides by meiosis to produce four haploid microspores, each of which develops into a pollen grain.
3. A pollen grain becomes a mature male gametophyte when its generative nucleus divides and forms two sperm. This usually occurs after a pollen grain lands on the stigma of a carpel and the pollen tube begins to grow. (See Figure 38.2b.)

(b) Development of a female gametophyte (embryo sac). The embryo sac develops within an ovule, itself enclosed by the ovary at the base of a carpel.

1. Within the ovule’s megasporangium is a large diploid cell called the megasporocyte (megaspore mother cell).
2. The megasporocyte divides by meiosis and gives rise to four haploid cells, but in most species only one of these survives as the megaspore.
3. Three mitotic divisions of the megaspore form the embryo sac, a multicellular female gametophyte. The ovule now consists of the embryo sac along with the surrounding integuments (protective tissue).

Key to labels:
- Haploid (n)
- Diploid (2n)
- Male gametophyte (pollen grain)
- Female gametophyte (embryo sac)
- 20 μm
- 75 μm
- Ragweed pollen grain
- Antipodal cells (3)
- Polar nuclei (2)
- Egg (1)
- Synergids (2)
- Embryo sac
- Ovule
- Megaspore
- Integuments
- Meiosis
- Mitosis
Angiosperms have double fertilization and the development of a fruit

- **Double fertilization:**
  - Pollen tube discharges two sperm into the female gametophyte
  - Sperm + egg $\rightarrow$ embryo ($\_\_\_n$)
  - Sperm + two nuclei $\rightarrow$ endosperm ($\_\_\_\_n$)

Ovule develops into seed

**Ovary develops into a fruit**

What is the advantage to having flowers?
Trends in angiosperm evolution

- This species (125 million years old) may represent the sister group to all angiosperms
Fruit protects the seed and aids in dispersal

Why is there an advantage for improving dispersal?
Pollination by animals has influenced angiosperm evolution

We associated flowers with colorful petals and sweet fragrances, but not all flowers have those accessories, why? (disadvantage)

Plants without showy flowers and no nectar, are most likely pollinated by __________.
Pollination by animals has influenced angiosperm evolution

90% of angiosperms are pollinated by animals

What does the animal get in return?

How does the animal know that there is a reward?

Coevolution is used to describe cases where two (or more) species reciprocally affect each other’s evolution
Pollination partly responsible for flower diversity

Flowers have coevolved with specific animals attract them and assure pollination

Bee pollinated flowers have nectar guides that reflect UV light

Birds are attracted to bright red and orange but no particular scent

Beetles are drawn to fruity odors but are indifferent to color

Night pollinated flowers are large, light colored and highly scented some even produced the smell of rotting flesh attracting carrion flies and beetles

All this is costly for the plant so natural selection will favor plants that
## Angiosperm groups

<table>
<thead>
<tr>
<th>Monocots</th>
<th>Dicots</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Embryos</strong></td>
<td><strong>Embryos</strong></td>
</tr>
<tr>
<td>One cotyledon</td>
<td>Two cotyledons</td>
</tr>
<tr>
<td><strong>Leaf venation</strong></td>
<td><strong>Leaf venation</strong></td>
</tr>
<tr>
<td>Veins usually parallel</td>
<td>Veins usually netlike</td>
</tr>
<tr>
<td><strong>Stems</strong></td>
<td><strong>Stems</strong></td>
</tr>
<tr>
<td>Vascular bundles usually complexly arranged</td>
<td>Vascular bundles usually arranged in ring</td>
</tr>
<tr>
<td><strong>Roots</strong></td>
<td><strong>Roots</strong></td>
</tr>
<tr>
<td>Fibrous root system</td>
<td>Taproot usually present</td>
</tr>
<tr>
<td><strong>Flowers</strong></td>
<td><strong>Flowers</strong></td>
</tr>
<tr>
<td>Floral parts usually in multiples of three</td>
<td>Floral parts usually in multiples of four or five</td>
</tr>
</tbody>
</table>

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All angiosperms have double fertilization

So all angiosperms form an endosperm

But only in monocots does the endosperm persist

In dicots
The endosperm is absorbed by the two cotyledons
Humans welfare depends greatly on seed plants.

Table 30.2 A Sampling of Medicines Derived from Plants

<table>
<thead>
<tr>
<th>Compound</th>
<th>Example of Source</th>
<th>Example of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine</td>
<td>Belladonna plant</td>
<td>Pupil dilator in eye exams</td>
</tr>
<tr>
<td>Digitalin</td>
<td>Foxglove</td>
<td>Heart medication</td>
</tr>
<tr>
<td>Menthol</td>
<td>Eucalyptus tree</td>
<td>Ingredient in cough medicines</td>
</tr>
<tr>
<td>Morphine</td>
<td>Opium poppy</td>
<td>Pain reliever</td>
</tr>
<tr>
<td>Quinine</td>
<td>Quinine tree</td>
<td>Malaria preventive</td>
</tr>
<tr>
<td>Taxol</td>
<td>Pacific yew</td>
<td>Ovarian cancer drug</td>
</tr>
<tr>
<td>Tubocurarine</td>
<td>Curare tree</td>
<td>Muscle relaxant during surgery</td>
</tr>
<tr>
<td>Vinblastine</td>
<td>Periwinkle</td>
<td>Leukemia drug</td>
</tr>
</tbody>
</table>

Source: Adapted from Randy Moore et al., Botany, 2nd ed. Dubuque, IA: Brown, 1998. Table 2.2, p. 37.
The major difference between angiosperms and gymnosperms is the __________.

- presence or absence of alternation of generations
- dominance or lack of dominance of the sporophyte generation
- production of two different types of spores
- presence or absence of vascular structures
- presence or absence of a protective covering over the ovule

After fertilization, the ______ develops into a seed and the _____ develops into a fruit.

- egg ... ovary
- ovule ... ovary
- ovary ... ovule
- egg ... ovule
- pollen grain ... ovule

A pea pod is formed from _____. A pea inside the pod is formed from _____.

- an ovary ... an ovule
- endosperm ... an ovary
- an ovary ... a pollen grain
- an anther ... an ovule
Both gymnosperms and angiosperms have _____.
- pollen, seeds, and ovules
- pollen and seeds
- pollen
- ovules
- seeds

The male gametophytes of flowering plants are also referred to as _____.
- embryo sacs
- male sporophytes
- none of these
- pollen grains

The role of double fertilization is to produce
A) Endosperm
B) Cotyledons
C) Fruit
D) a triploid embryo
E) Seed coat
Study guide

Chapter 29
Interactive questions 29.2, 29.4 29.5, 29.6
Complete phylogenetic tree
Multiple choice 1, 4, 6-10, 13, 14

Chapter 30
Interactive questions 30.2, 30.3, 30.4, 30.5
Test your knowledge true or false, multiple choice 1-9