Chapter 38

Angiosperm Reproduction and Biotechnology

PowerPoint Lectures for
***Biology*, Seventh Edition**
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Lectures by Chris Romero

- Overview: To Seed or Not to Seed
- The parasitic plant *Rafflesia arnoldii*
  - Produces enormous flowers that can produce up to 4 million seeds

Figure 38.1

- Concept 38.1: Pollination enables gametes to come together within a flower
- In angiosperms, the dominant sporophyte
  - Produces spores that develop within flowers into male gametophytes (pollen grains)
  - Produces female gametophytes (embryo sacs)

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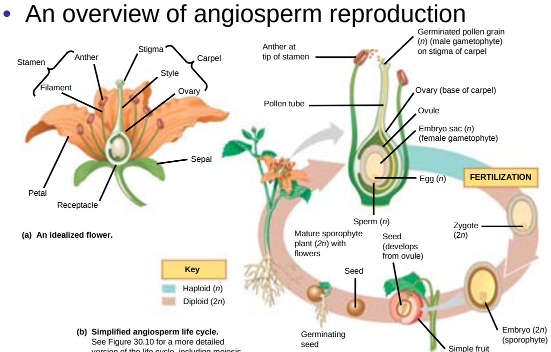
- An overview of angiosperm reproduction



(a) An idealized flower.

(b) Simplified angiosperm life cycle. See Figure 30.10 for a more detailed version of the life cycle, including meiosis.

Figure 38.2a, b

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Flower Structure

- Flowers
  - Are the reproductive shoots of the angiosperm sporophyte
  - Are composed of four floral organs: sepals, petals, stamens, and carpels

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- Many variations in floral structure
  - Have evolved during the 140 million years of angiosperm history

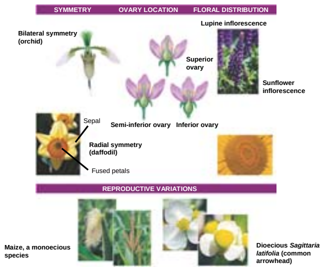
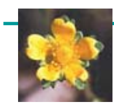
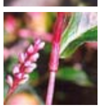


Figure 38.3

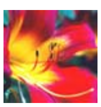
Fig. 38.3



Complete flower



Incomplete flower (knotweed lacking petals)



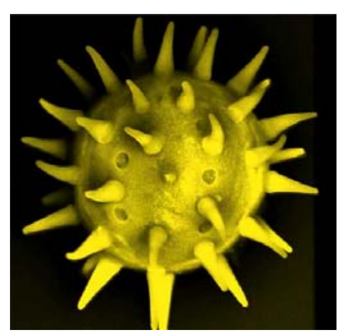
“perfect” flower - bisexual

“imperfect” flower unisexual

Monoecious

Dioecious

Pollen grains



Pollen grain of chamomile

Birch pollen grain

Grass pollen grain

Wind pollination

Insect pollination

Stinkhorn beetles

Gametophyte Development and Pollination

- In angiosperms
  - Pollination is the transfer of pollen from an anther to a stigma
  - If pollination is successful, a pollen grain produces a structure called a pollen tube, which grows down into the ovary and discharges sperm near the embryo sac

- Pollen
  - Develops from microspores within the sporangia of anthers

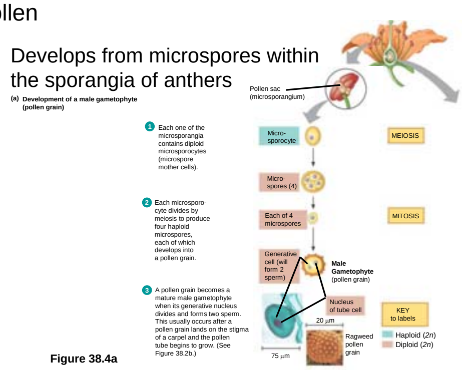


Figure 38.4a

- Embryo sacs
  - Develop from megaspores within ovules

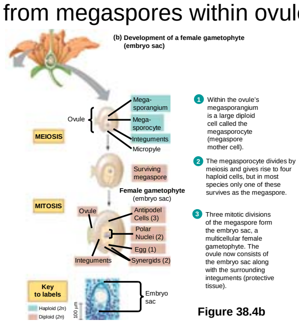


Figure 38.4b

Mechanisms That Prevent Self-Fertilization

- Many angiosperms
  - Have mechanisms that make it difficult or impossible for a flower to fertilize itself

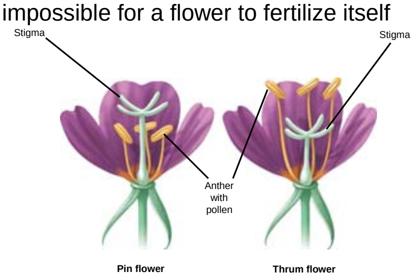


Figure 38.5

- The most common anti-selfing mechanism in flowering plants
  - Is known as self-incompatibility, the ability of a plant to reject its own pollen
- Researchers are unraveling the molecular mechanisms that are involved in self-incompatibility

- Some plants
  - Reject pollen that has an *S*-gene matching an allele in the stigma cells
- Recognition of self pollen
  - Triggers a signal transduction pathway leading to a block in growth of a pollen tube

- Concept 38.2: After fertilization, ovules develop into seeds and ovaries into fruits

Double Fertilization

- After landing on a receptive stigma
  - A pollen grain germinates and produces a pollen tube that extends down between the cells of the style toward the ovary
- The pollen tube
  - Then discharges two sperm into the embryo sac

- In double fertilization
  - One sperm fertilizes the egg
  - The other sperm combines with the polar nuclei, giving rise to the food-storing endosperm

- Growth of the pollen tube and double fertilization

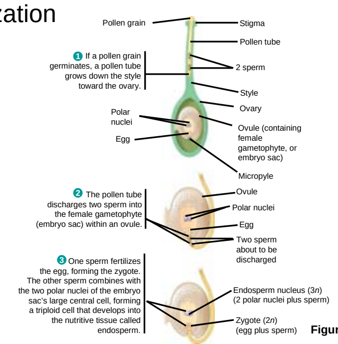


Figure 38.6

From Ovule to Seed

- After double fertilization
  - Each ovule develops into a seed
  - The ovary develops into a fruit enclosing the seed(s)

Endosperm Development

- Endosperm development
  - Usually precedes embryo development
- In most monocots and some eudicots
  - The endosperm stores nutrients that can be used by the seedling after germination
- In other eudicots
  - The food reserves of the endosperm are completely exported to the cotyledons

Embryo Development

- The first mitotic division of the zygote is transverse
  - Splitting the fertilized egg into a basal cell and a terminal cell

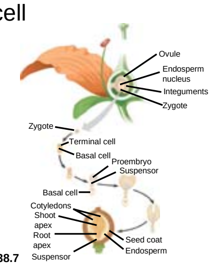
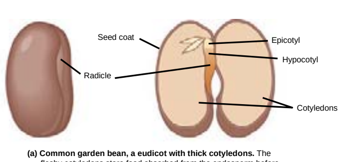


Figure 38.7

Structure of the Mature Seed

- The embryo and its food supply
  - Are enclosed by a hard, protective seed coat

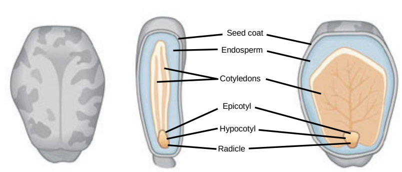
- In a common garden bean, a eudicot
  - The embryo consists of the hypocotyl, radicle, and thick cotyledons



(a) Common garden bean, a eudicot with thick cotyledons. The fleshy cotyledons store food absorbed from the endosperm before the seed germinates.

Figure 38.8a

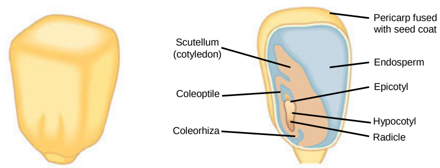
- The seeds of other eudicots, such as castor beans
  - Have similar structures, but thin cotyledons



(b) Castor bean, a eudicot with thin cotyledons. The narrow, membranous cotyledons (shown in edge and flat views) absorb food from the endosperm when the seed germinates.

Figure 38.8b

- The embryo of a monocot
  - Has a single cotyledon, a coleoptile, and a coleorhiza



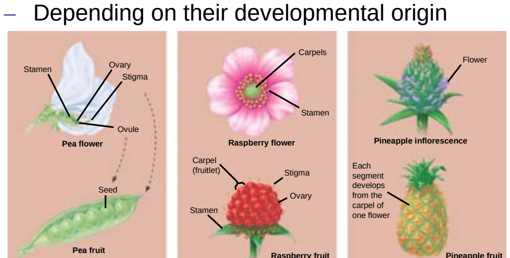
(c) Maize, a monocot. Like all monocots, maize has only one cotyledon. Maize and other grasses have a large cotyledon called a scutellum. The rudimentary shoot is sheathed in a structure called the coleoptile, and the coleorhiza covers the young root.

Figure 38.8c

From Ovary to Fruit

- A fruit
  - Develops from the ovary
  - Protects the enclosed seeds
  - Aids in the dispersal of seeds by wind or animals

- Fruits are classified into several types
  - Depending on their developmental origin



(a) Simple fruit. A simple fruit develops from a single carpel (or several fused carpels) of one flower (examples: pea, lemon, peanut).

(b) Aggregate fruit. An aggregate fruit develops from many separate carpels of one flower (examples: raspberry, blackberry, strawberry).

(c) Multiple fruit. A multiple fruit develops from many carpels of many flowers (examples: pineapple, fig).

Figure 38.9a–c

Seed Germination

- As a seed matures
  - It dehydrates and enters a phase referred to as dormancy

Seed Dormancy: Adaptation for Tough Times

- Seed dormancy
  - Increases the chances that germination will occur at a time and place most advantageous to the seedling
- The breaking of seed dormancy
  - Often requires environmental cues, such as temperature or lighting cues

From Seed to Seedling

- Germination of seeds depends on the physical process called imbibition
  - The uptake of water due to low water potential of the dry seed

- The radicle
  - Is the first organ to emerge from the germinating seed
- In many eudicots
  - A hook forms in the hypocotyl, and growth pushes the hook above ground

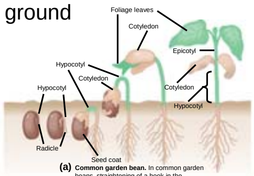


Figure 38.10a

(a) **Common garden bean.** In common garden beans, straightening of a hook in the hypocotyl pulls the cotyledons from the soil.

- Monocots
  - Use a different method for breaking ground when they germinate
- The coleoptile
  - Pushes upward through the soil and into the air

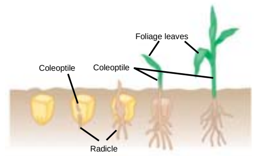


Figure 38.10b

(b) **Maize.** In maize and other grasses, the shoot grows straight up through the tube of the coleoptile.

- Concept 38.3: Many flowering plants clone themselves by asexual reproduction
- Many angiosperm species
  - Reproduce both asexually and sexually
- Sexual reproduction
  - Generates the genetic variation that makes evolutionary adaptation possible
- Asexual reproduction in plants
  - Is called vegetative reproduction

Mechanisms of Asexual Reproduction

- Fragmentation
  - Is the separation of a parent plant into parts that develop into whole plants
  - Is one of the most common modes of asexual reproduction

- In some species
  - The root system of a single parent gives rise to many adventitious shoots that become separate shoot systems

Figure 38.11

Vegetative Propagation and Agriculture

- Humans have devised various methods for asexual propagation of angiosperms

Clones from Cuttings

- Many kinds of plants
  - Are asexually reproduced from plant fragments called cuttings

Grafting

- In a modification of vegetative reproduction from cuttings
  - A twig or bud from one plant can be grafted onto a plant of a closely related species or a different variety of the same species

Test-Tube Cloning and Related Techniques

- Plant biologists have adopted *in vitro* methods
  - To create and clone novel plant varieties

(a) Just a few parenchyma cells from a carrot gave rise to this callus, a mass of undifferentiated cells.

(b) The callus differentiates into an entire plant, with leaves, stems, and roots.

Figure 38.12a, b

- In a process called protoplast fusion
  - Researchers fuse protoplasts, plant cells with their cell walls removed, to create hybrid plants

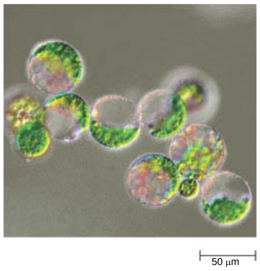


Figure 38.13

- Concept 38.4: Plant biotechnology is transforming agriculture
- Plant biotechnology has two meanings
  - It refers to innovations in the use of plants to make products of use to humans
  - It refers to the use of genetically modified (GM) organisms in agriculture and industry

Artificial Selection

- Humans have intervened
  - In the reproduction and genetic makeup of plants for thousands of years

- Maize
  - Is a product of artificial selection by humans
  - Is a staple in many developing countries, but is a poor source of protein

Figure 38.14

- Interspecific hybridization of plants
  - Is common in nature and has been used by breeders, ancient and modern, to introduce new genes

Reducing World Hunger and Malnutrition

- Genetically modified plants
  - Have the potential of increasing the quality and quantity of food worldwide

Figure 38.15

Figure 38.16

The Debate over Plant Biotechnology

- There are some biologists, particularly ecologists
  - Who are concerned about the unknown risks associated with the release of GM organisms (GMOs) into the environment

Issues of Human Health

- One concern is that genetic engineering
  - May transfer allergens from a gene source to a plant used for food

Possible Effects on Nontarget Organisms

- Many ecologists are concerned that the growing of GM crops
  - Might have unforeseen effects on nontarget organisms

Addressing the Problem of Transgene Escape

- Perhaps the most serious concern that some scientists raise about GM crops
  - Is the possibility of the introduced genes escaping from a transgenic crop into related weeds through crop-to-weed hybridization

- Despite all the issues associated with GM crops
  - The benefits should be considered