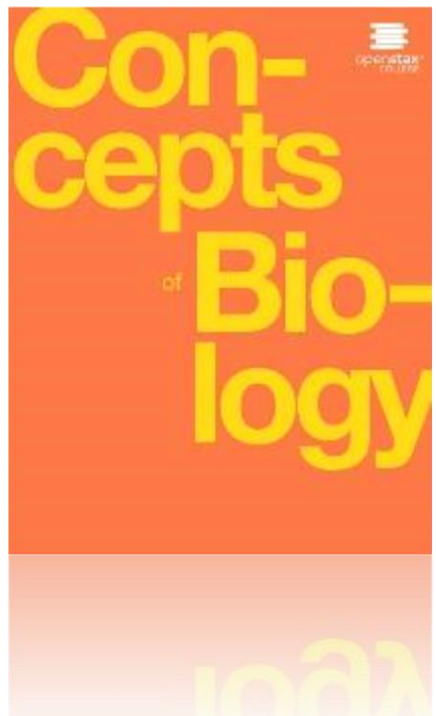
CONCEPTS OF BIOLOGY

Chapter 14 DIVERSITY OF PLANTS

PowerPoint Image Slideshow

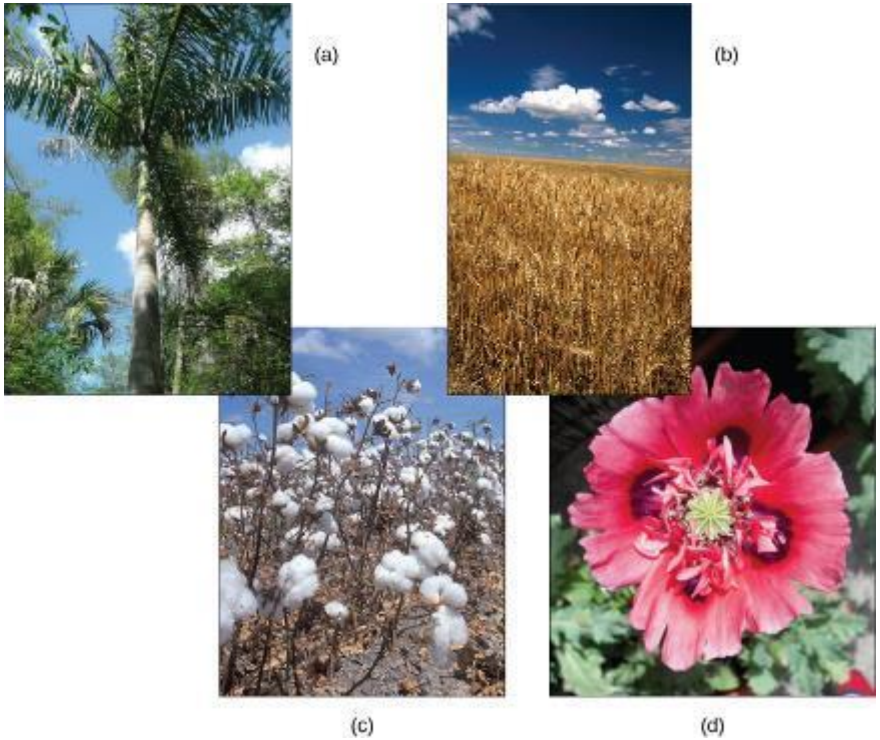


Picture slides by Spuddy Mc Spare
Information slides by Amanda Brammer, M.S. Associate Professor, NTCC

INTRODUCTION

- Plants play an integral role in all aspects of life on the planet.
- Current evolutionary thought holds that all plants are monophyletic (descended from a common ancestor).
- In order to transition from water to land, plants had to evolve strategies:
    - To avoid drying out
    - To disperse reproductive cells in air
    - For structural support
    - To filter sunlight
- Seed plants evolved structures to fully adapt to the driest environments on earth, but seedless plants still require a moist environment.

FIGURE 14.1 DIVERSITY OF PLANTS



Plants dominate the landscape and play an integral role in human societies. (a) Palm trees grow in tropical or subtropical climates; (b) wheat is a crop in most of the world; the flower of (c) the cotton plant produces fibers that are woven into fabric; the potent alkaloids of (d) the beautiful opium poppy have influenced human life both as a medicinal remedy and as a dangerously addictive drug. (credit a: modification of work by "3BoysInSanDiego"/Wikimedia Commons; credit b: modification of work by Stephen Ausmus, USDA ARS; credit c: modification of work by David Nance, USDA ARS; credit d: modification of work by Jolly Janner)

THE PLANT KINGDOM (14.1)

- Most plants are photosynthetic using chlorophyll, located in chloroplasts.
- Plants have cell walls made of cellulose.
- Most plants reproduce sexually but they also have diverse methods of asexual reproduction.
- Plants continue to grow their body mass until they die. They do not stop growing. This is called **indeterminate growth**.

PLANT ADAPTATIONS TO LIFE ON LAND 1 OF 3 (14.1)

- **Desiccation** (drying out) is a constant threat for an organism exposed to air.
- Water provides support to aquatic organisms. However, on land, plants need to develop structural support in air.
- In water, male gametes (sperm) swim to the female gamete (egg). However, on land, the sperm much reach the egg using other methods.
- Also gametes and the zygote must be prevented from drying out on land.
- Life on land offers several advantages, however:
    - Sunlight (for photosynthesis) is more abundant on land than in water.
    - Carbon dioxide for photosynthesis is more abundant in air.
    - Land plants evolved before land animals; thus at first, no predators threatened land plants.

PLANT ADAPTATIONS TO LIFE ON LAND 2 OF 3 (14.1)

- The early land plants did not live far from an abundant source of water and developed survival strategies to combat dryness.
- One strategy is drought tolerance.
    - Mosses can dry out to a brown mat but will soak up water when available and return to their green appearance.
- Another strategy is colonizing environments with high humidity where droughts are uncommon.
    - Ferns live in damp, cool places.
- Later plants moved away from aquatic environments using resistance to desiccation, rather than tolerance.
    - These plants minimize water loss (for example, cacti)

PLANT ADAPTATIONS TO LIFE ON LAND 3 OF 3 (14.1)

- Four major adaptations are found in terrestrial (land) plants:
  - Alternation of generations lifestyle
  - Production of spores in structures called **sporangia**
  - Production of gametes in structures called **gametangia**
  - Apical meristem tissue in roots and shoots

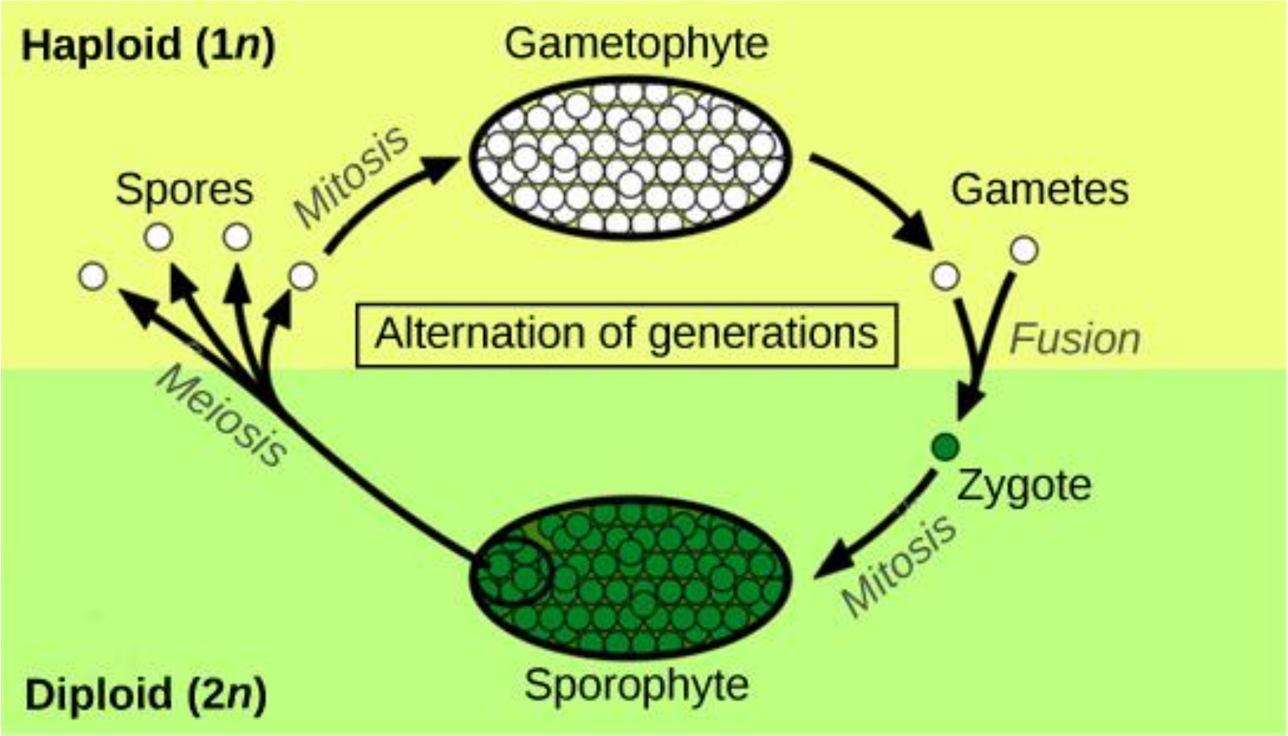
- We will discuss these in the next few slides.

ALTERNATION OF GENERATIONS 1 OF 2 (14.1)

- **Alternation of generations** describes a life cycle in which an organism has both haploid and diploid multicellular stages (Figure 14.2).
    - The haploid (n) multicellular form is called the **gametophyte**
    - The gametophyte produces gametes (n) by mitosis
    - Fertilization of gametes produces a diploid zygote (2n)
    - The zygote develops into the diploid multicellular form called the **sporophyte** (2n)
    - The sporophyte produces spores (n) by meiosis
    - The spores develop into the new gametophyte (n) and the life cycle begins again

**Note: this is a little different from what you are used to in animals. Gametes (sperm and egg) are produced by mitosis, not meiosis. In plants, meiosis produces spores.

FIGURE 14.2 ALTERNATION OF GENERATIONS

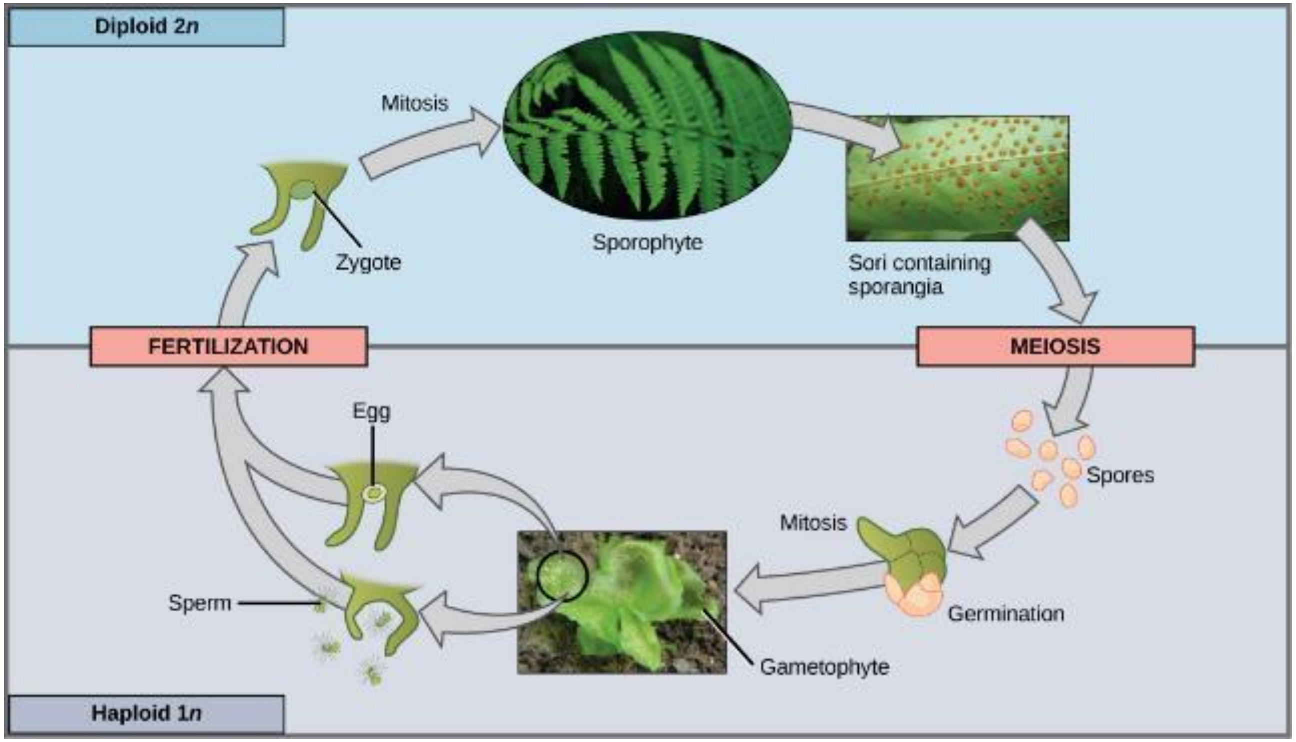


Alternation of generations between the haploid (1*n*) gametophyte and diploid (2*n*) sporophyte is shown. (credit: modification of work by Peter Coxhead)

ALTERNATION OF GENERATIONS 2 OF 2 (14.1)

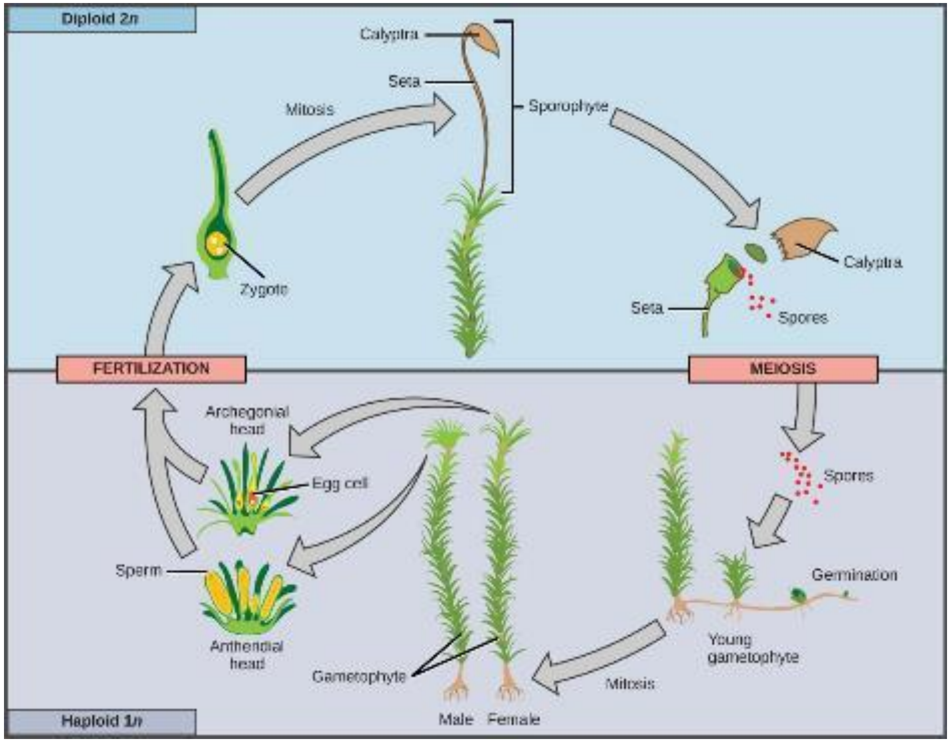
- In seed plants, (ferns, trees, grasses), the most obvious (dominant) generation is the sporophyte (2n). See Figure 14.3.
    - When you look at a fern or a tree, you are looking at the sporophyte. The gametophyte is hard to observe.
- In seedless plants (mosses and their relatives), the most obvious (dominant) generation is the gametophyte (n). See Figure 14.4.
    - When you look at a green carpet of moss, you are looking at the gametophyte. The sporophyte is hard to observe.
- Protection of the embryo is a major requirement for land plants. The embryo must be sheltered from drying out and other environmental hazards.
- In seedless plants (mosses and their relatives), the sperm have flagella that allow them to swim to the egg for fertilization. This ties the seedless plants to water.

FIGURE 14.3 LIFE CYCLE OF A FERN



This life cycle of a fern shows alternation of generations with a dominant sporophyte stage. (credit “fern”: modification of work by Cory Zanker; credit “gametophyte”: modification of work by “Vlmastra”/Wikimedia Commons)

FIGURE 14.4 LIFE CYCLE OF A MOSS



This life cycle of a moss shows alternation of generations with a dominant gametophyte stage. (credit: modification of work by Mariana Ruiz Villareal)

APICAL MERISTEMS (13.1)

- The shoots (stems) and roots of plants grow in length through cell division of tissues called **apical meristems** (Figure 14.5).
  - Apical meristems occur at the tips of shoots and roots.
  - They give rise to all of the specialized tissues of the plant (they are stem cells).
  - These cells continue to divide throughout the life of the plant.
  - They allow plants to grow upward towards sunlight and downward into the soil to access water and minerals.

FIGURE 14.5 APICAL MERISTEM

This apple seedling is an example of a plant in which the apical meristem gives rise to new shoots and root growth.

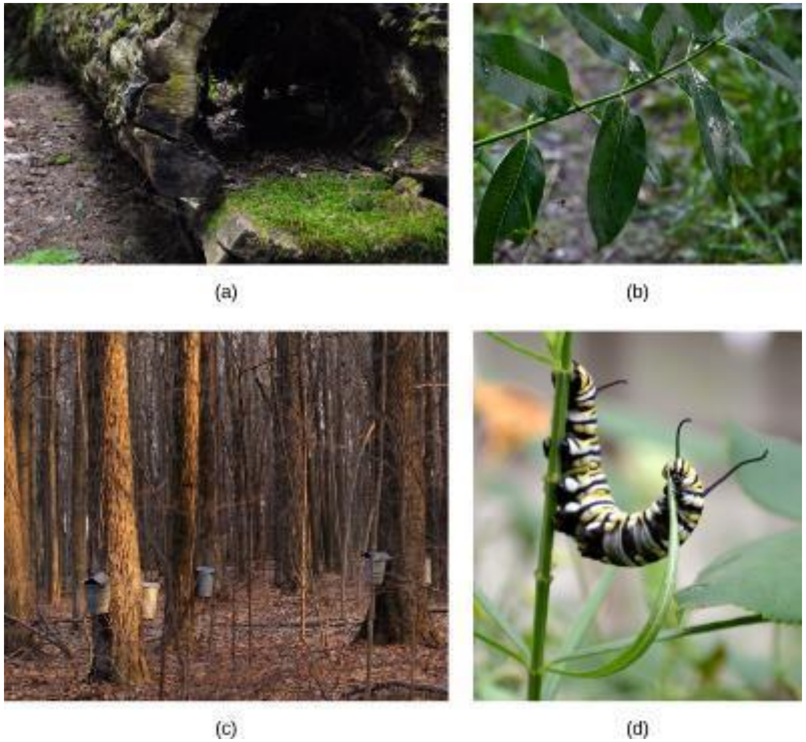
ADDITIONAL LAND PLANT ADAPTATIONS 1 OF 2 (14.1)

- As plants adapted to dry land, new organs and structures made their appearance (Figure 14.6).
- Evolution of a shoot allowed plants to grow taller and capture more light.
- Incorporation of more rigid molecules in stems allowed more support on land.
- The evolution of vascular tissues (**xylem and phloem**) allowed the plant to become larger. These tissues conduct water, minerals and food from photosynthesis throughout the plant.
- Roots evolved to take up water and minerals and to anchor the shoot in the soil.

ADDITIONAL LAND PLANT ADAPTATIONS 2 OF 2 (14.1)

- A waxy, waterproof covering called the **cuticle** coats leaves and stems in land plants.
    - The cuticle prevents uptake of carbon dioxide needed for photosynthesis.
    - Pores that can open and close called **stomata** evolved to allow movement of gases and water vapor into and out of the leaves and stems.
- Plants also evolved a range of protective organic molecules that can cause disease and even death in predatory animals.
- As plants coevolved with animals, they developed sweet and nutritious compounds that lure animals into dispersing pollen, fruits or seeds.

FIGURE 14.6 PLANT ADAPTATIONS



Plants have evolved various adaptations to life on land. (a) Early plants grew close to the ground, like this moss, to avoid desiccation. (b) Later plants developed a waxy cuticle to prevent desiccation. (c) To grow taller, like these maple trees, plants had to evolve new structural chemicals to strengthen their stems and vascular systems to transport water and minerals from the soil and nutrients from the leaves. (d) Plants developed physical and chemical defenses to avoid being eaten by animals. (credit a, b: modification of work by Cory Zanker; credit c: modification of work by Christine Cimala; credit d: modification of work by Jo Naylor)

THE MAJOR DIVISIONS OF LAND PLANTS (14.1)

- Land plants are classified into 2 major groups according to the presence or absence of vascular tissue (Figure 14.8).
- Plants that lack vascular tissue are called **nonvascular plants**.
  - This group includes the mosses, liverworts and hornworts (bryophytes). They appeared early in plant evolution.
  - These plants do not have seeds.
- **Vascular plants** have a network of conducting tissue (vascular tissue). Vascular plants are divided into 2 groups:
  1. Seedless vascular plants (ferns, club mosses, whisk ferns, horsetails)
  2. Seed plants, which is the largest group of all existing plants. Seed plants include:
     - **gymnosperms** (cone bearing plants like pines)
     - **angiosperms** (flowering plants)

FIGURE 14.8 MAJOR DIVISIONS OF PLANTS

<table>
<tr><th colspan="7">Embryophytes: The Land Plants</th></tr>
<tr><th colspan="3">Nonvascular Plants “Bryophytes”</th><th colspan="4">Vascular Plants</th></tr>
<tr><td rowspan="5">Liverworts</td><td rowspan="5">Hornworts</td><td rowspan="5">Mosses</td><th colspan="2">Seedless Plants</th><th colspan="2">Seed Plants</th></tr>
<tr><th>Lycophytes</th><th>Pterophytes</th><th>Gymno-sperms</th><th>Angio-sperms</th></tr>
<tr><td>Club Mosses</td><td>Whisk Ferns</td><td rowspan="3"></td><td rowspan="3"></td></tr>
<tr><td>Quillworts</td><td>Horsetails</td></tr>
<tr><td>Spike Mosses</td><td>Ferns</td></tr>
</table>

This table shows the major divisions of plants.

PLANT CHARACTERISTICS CHART (14.1)

Plant Characteristics				
Type of plant	**nonvascular**	**seedless vascular**	**seed--gymnosperms**	**seed--angiosperms**
vascular tissue	no	yes	yes	yes
roots, stems, leaves	no	yes	yes	yes
seeds	no	no	yes	yes
dominant generation	gametophyte	sporophyte	sporophyte	sporophyte
need water for fertilization	yes	yes	no	no
embryo protection	none	none	cones	flowers, fruits
examples	moss, liverwort	fern, whisk fern	conifers, gnetophytes	flowering plants
	hornwort	horsetail, club moss	ginkos, cycads	

SEEDLESS PLANTS (14.2)

- Seedless plants represent only a small fraction of the plants in our environment.
- They tend to grow in damp, shaded environments (Figure 14.9).
- Millions of years ago, seedless plants dominated the landscape and their decomposing bodies created large deposits of coal.

FIGURE 14.9 A SEEDLESS PLANT

Seedless plants like these horsetails (*Equisetum* sp.) thrive in damp, shaded environments under the tree canopy where dryness is a rare occurrence. (credit: Jerry Kirkhart)

BRYOPHYTES 1 OF 2 (14.2)

- The nonvascular plants are informally called **bryophytes**. This group includes the mosses, liverworts and hornworts.
    - They are the closest living relative of early terrestrial plants.
    - They mostly thrive in damp environments, although some grow in deserts.
    - They do not have vascular tissue (xylem and phloem).
    - They do not have true roots or leaves. They have structures that resemble roots and leaves.
    - Their sperm are flagellated and swim to the egg. Thus they are tied to water for fertilization.
    - The most obvious generation is the gametophyte (n). The sporophyte (2n) is barely noticeable.

BRYOPHYTES 2 OF 2 (14.2)

- Liverworts are likely the plants most closely related to the ancestor that moved to land.
  - They have colonized many habitats on land.
  - Some of their gametophytes form green structures that resemble the lobes of the liver (Figure 14.10).
- Hornworts have a short blue-green gametophyte.
  - They have colonized many habitats on land.
  - The sporophyte is a long and narrow pipe-like structure attached to the gametophyte (Figure 14.11).
- Mosses live everywhere from the tundra to the floor of tropical forests (Figure 14.12).
  - In the tundra, they slow down erosion, store moisture and nutrients, provide shelter for small animals and food for larger herbivores.
  - They are sensitive to air pollution and are used to monitor the quality of air.

FIGURE 14.10 LIVERWORTS

(a) A 1904 drawing of liverworts shows the variety of their forms.

(b) A liverwort, *Lunularia cruciata*, displays its lobate, flat thallus. The organism in the photograph is in the gametophyte stage.

FIGURE 14.11 HORNWORTS

Hornworts grow a tall and slender sporophyte. (credit: modification of work by Jason Hollinger)

FIGURE 14.12 MOSSES

This green feathery moss has reddish-brown sporophytes growing upward. (credit: “Lordgrunt”/Wikimedia Commons)

VASCULAR PLANTS (14.2)

- The vascular plants are the dominant group of land plants.
- Several evolutionary adaptations explain their success and their spread to so many habitats.
- Vascular tissues: xylem and phloem
    - **Xylem** is responsible for the transport and storage of water and minerals
    - **Phloem** transports sugars, proteins and solutes throughout the plant
- Roots in vascular plants transfer water and minerals from the soil to the rest of the plant better than the root-like structures observed in non-vascular plants.
    - Roots help to anchor plants in the soil.
    - Roots form associations with fungi called mycorrhizae.
- Leaves in vascular plants improved the efficiency of photosynthesis because leaves capture more sunlight.

SEEDLESS VASCULAR PLANTS (14.2)

- In both seedless vascular plants and in seed plants, the sporophyte (2n) is the most obvious generation.
- Water is still required for fertilization, so most favor a moist environment.
- Club mosses are the earliest group of seedless vascular plants (Figure 13.13).
- Horsetails only have a single living genus and are usually found in damp environments and marshes (Figures 14.14 and 14.15).
- Whisk ferns consist of a stem only. However, the roots and leaves were lost during evolution. Photosynthesis takes place in the stem.
- Ferns are the most advanced seedless vascular plants (Figure 14.16).
    - They live in many environments from the tropics to temperate forests and are restricted to moist shaded places.
- Many of the seedless vascular plants formed large trees and swamp forests during the Carboniferous period (Figure 14.17).

FIGURE 14.13 CLUB MOSS

Lycopodium clavatum is a club moss. (credit: Cory Zanker)

FIGURE 14.14 HORSETAILS

Horsetails thrive in a marsh. (credit: Myriam Feldman)

HORSETAILS FIGURE 14.15

Thin leaves originating at the joints are noticeable on the horsetail plant. (credit: Myriam Feldman)

FIGURE 14.16 A TREE FERN

Some specimens of this short tree-fern species can grow very tall. (credit: Adrian Pingstone)

FIGURE 14.17 GEOLOGICAL TIME SCALE

EON	ERA	PERIOD	MILLIONS OF YEARS AGO
Phanerozoic	Cenozoic	Quaternary	1.6
		Tertiary	66
	Mesozoic	Cretaceous	138
		Jurassic	205
		Triassic	240
	Paleozoic	Permian	290
		Carboniferous	360
		Devonian	410
		Silurian	435
		Ordovician	500
		Cambrian	570
Proterozoic			2500
Archean			3800?
Pre-Archean			

This chart shows the geological time scale, beginning with the Pre-Archean eon 3800 million years ago and ending with the Quaternary period in present time. (credit: modification of work by USGS)

CONCEPT IN ACTION

Go to the website below to see an animation of the life cycle of a fern and to test your knowledge.

[Launch Animation]

SEED PLANTS: GYMNOSPERMS (14.3)

- The order in which plant groups colonized and is:
    - Plants related to modern mosses (non-vascular)
    - Liverworts and hornworts (non-vascular)
    - Primitive vascular plants related to ferns (seedless vascular)
    - Gymnosperms (seed plants that form cones)
    - Angiosperms (seed plants that form flowers and fruits)

THE EVOLUTION OF SEED PLANTS (14.3)

- In seed plants, the sporophyte generation is the most obvious (dominant) as it is in seedless vascular plants.
- Two adaptations to drought distinguish seed plants from seedless vascular plants: **seeds and pollen**
    - Both adaptations were essential to colonization of land.
    - They allowed seed plants to break their dependence on water for reproduction and development of the embryo.
    - The pollen grains carry the male gametes (sperm).
    - Pollen can drift far from the plant that bore it, spreading the plant's genes and reducing competition with other plants.
    - The seed offers embryo protection, nourishment and allows the embryo to be dormant in harsh conditions.
    - Seeds allow plants to disperse through space and time.

GYMNOSPERMS (14.3)

- Gymnosperm means “naked seed”
- Gymnosperms are cone-bearing plants
- The wood of gymnosperms is more primitive than the wood of angiosperms
- Characteristics of gymnosperms include:
  - Naked seeds
  - Separate male and female gametes
  - Pollination by wind
  - Tracheids, special vessels that transport water and solutes within the vascular system

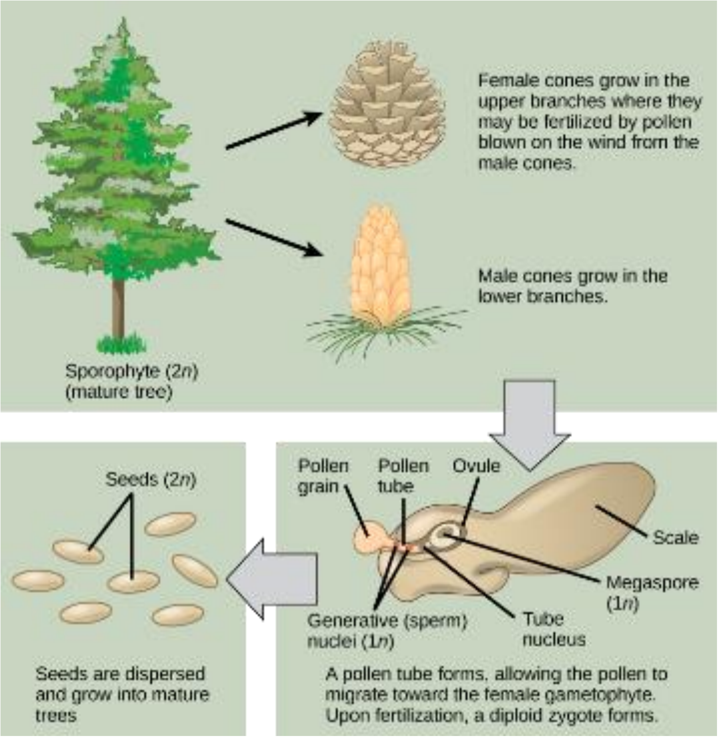
LIFE CYCLE OF A CONIFER 1 OF 2 (14.3)

- We will briefly look at the life cycle of a conifer (pine tree):
- Male cones grow in the lower branches.
    - Within the male cones, spores are created by meiosis. The spores develop into pollen grains (male gametophyte).
    - Each pollen grain contains 2 cells: one cell will become 2 sperm and the other will become a pollen tube.
- Female cones grow in the upper branches, where they may be fertilized by pollen blown on the wind from male cones.
    - Within the female cone, spores are created by meiosis. The spores develop into the female gametophyte, which houses the egg.

LIFE CYCLE OF A CONIFER 2 OF 2(14.3)

- In the spring, male pine cones release large amounts of yellow pollen, which is carried by the wind.
- Some pollen will land on female cones. This is called **pollination**. If they do, a pollen tube grows very slowly from the pollen grain.
- Eventually, the pollen tube reaches the egg. Two sperm are formed and one is not used. The other unites with the egg; this is called **fertilization**.
- After fertilization, the zygote gives rise to the embryo plant, which becomes enclosed in a seed.
- Fertilization and seed development in pines can take up to 2 years after pollination!

FIGURE 14.19 LIFE CYCLE OF A CONIFER



This image shows the lifecycle of a conifer.

GYMNOSPERM CONCEPT IN ACTION

Watch this video to see the process of seed production in gymnosperms.

Link to Video

DIVERSITY OF GYMNOSPERMS 1 OF 2 (14.3)

- Conifers are the dominant phylum of gymnosperms, with the most variety of species (Figure 14.20).
  - Most are tall trees that bear scale-like or needle-like leaves.
  - Conifers are predominant at high altitudes and cold climates.
  - Most conifers are evergreen and include pines, spruces, firs, and cedars.
  - Many conifers are harvested for paper and timber.
- Cycads thrive in mild climates and are often mistaken for palms because of the shape of their leaves (Figure 14.21).
  - They bear large cones and may be pollinated by beetles, rather than wind like other gymnosperms.
  - They dominated the landscape during the age of the dinosaurs.
  - They are often used as ornamental shapes in gardens.

DIVERSITY OF GYMNOSPERMS 2 OF 2 (14.3)

- Ginkgophytes include only one surviving species, *Ginkgo biloba* (Figure 14.22).
  - It is planted in public places because it is resistant to pollution.
  - Usually only male plants are planted because the seeds on female plants smell like rancid butter.
- Gnetophytes are the closest relatives to angiosperms (flowering plants). This group contains:
  - Several species of tropical and subtropical vines.
  - An unusual desert plant called *Welwitschia* that can live for up to 2000 years.
  - The genus *Ephedra* (Figure 14.23), which grows in the United States and Mexico. It is used to produce the decongestant ephedrine. Because ephedrine is similar to amphetamines, its use is restricted to prescriptions.

FIGURE 14.20 CONIFERS

Conifers are the dominant form of vegetation in cold or arid environments and at high altitudes. Shown here are the (a) evergreen spruce, (b) sequoia, (c) juniper, and (d) a deciduous gymnosperm: the tamarack *Larix larcinia*. Notice the yellow leaves of the tamarack. (credit b: modification of work by Alan Levine; credit c: modification of work by Wendy McCormac; credit d: modification of work by Micky Zlimen)

FIGURE 14.21 A CYCAD

This *Encephalartos ferox* cycad exhibits large cones. (credit: Wendy Cutler)

FIGURE 14.22

This plate from the 1870 book *Flora Japonica, Sectio Prima (Tafelband)* depicts the leaves and fruit of *Gingko biloba*, as drawn by Philipp Franz von Siebold and Joseph Gerhard Zuccarini.

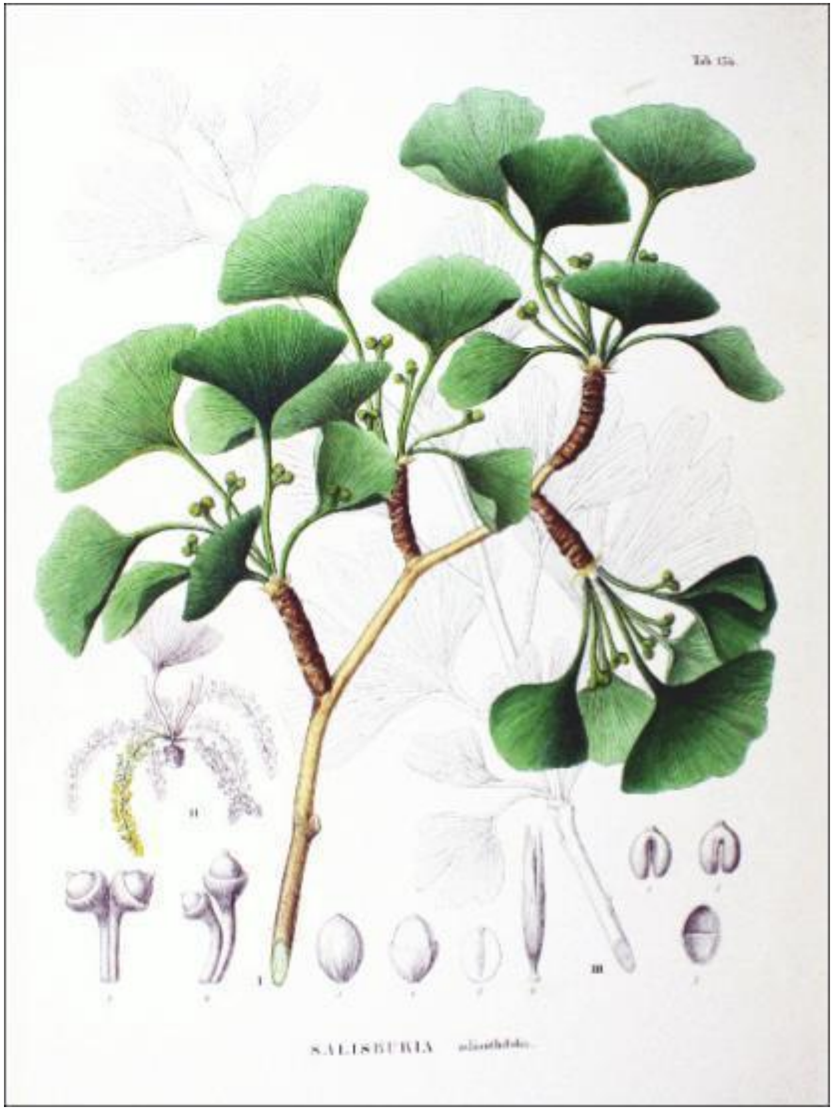


FIGURE 14.23 *EPHEDRA*

Ephedra viridis, known by the common name Mormon tea, grows in the western United States. (credit: US National Park Service, USDA-NRCS PLANTS Database)

WELWITSCHIA CONCEPT IN ACTION

Watch this BBC video describing the amazing strangeness of *Welwitschia*.

Link to Video

SEED PLANTS: ANGIOSPERMS

- The angiosperms (flowering plants) have successfully evolved to dominate most terrestrial ecosystems.
  - The angiosperms are second only to insects in terms of diversity (Figure 14.24).
- Angiosperm success is the result of 2 novel structures that ensure reproductive success:
  - Flowers allowed plants to develop cooperative relationships with insects to disperse pollen in a targeted way.
  - Fruit protects the developing embryo and serves as an agent of dispersal of seeds.

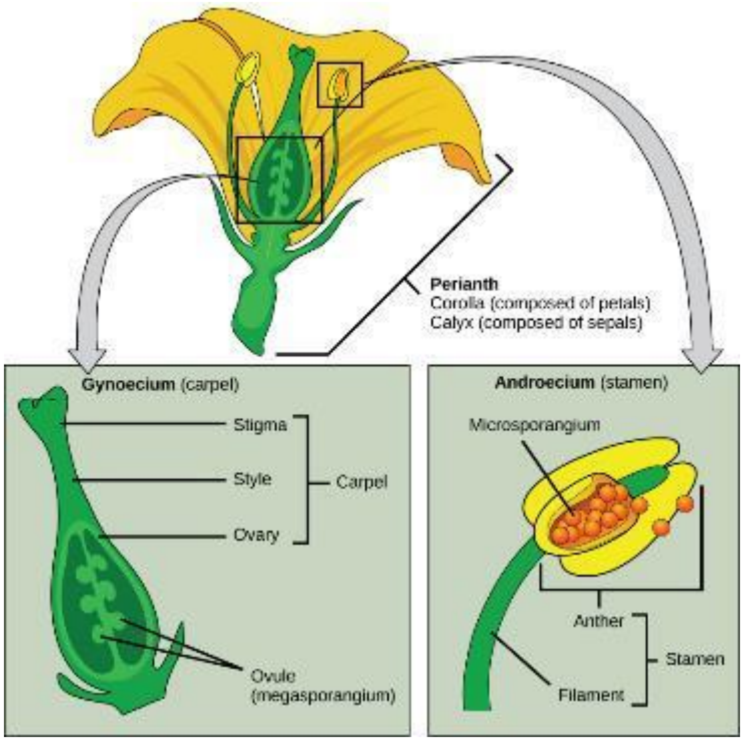
FIGURE 14.24 DIVERSITY OF ANGIOSPERMS

These flowers grow in a botanical garden border in Bellevue, WA. Flowering plants dominate terrestrial landscapes. The vivid colors of flowers are an adaptation to pollination by insects and birds. (credit: Myriam Feldman)

FLOWERS (14.4)

- Flowers are modified leaves arranged around a central stalk. They contain the following structures:
    - **Sepals**—green structures that surround the floral bud before it opens; usually photosynthetic
    - **Petals**—inside the sepals; colorful to attract pollinators
    - **Carpal**—the female sex organs; contains the ovary at its base
    - **Stamens**—the male sex organs; surrounds the central carpal; contains the spores which develop into pollen grains
- The ovary contains one or more ovules that will each develop into a seed upon fertilization.
- A perfect flower, like the one described above, carries both male and female floral organs (Figure 14.25)

FIGURE 14.25 STRUCTURE OF A FLOWER



This image depicts the structure of a perfect and complete flower. Perfect flowers carry both male and female floral organs. (credit: modification of work by Mariana Ruiz Villareal)

FRUIT 1 OF 2 (14.4)

- The seed forms in an ovary, which enlarges as the seeds grow.
- As the seed develops, the walls of the ovary also thicken and form the fruit.
- A **fruit** is a fertilized, fully grown ripened ovary.
  - Many foods commonly called vegetables are actually fruit (eggplants, zucchini, string beans, tomatoes, peppers, cucumbers, etc.).
  - Acorns and winged maple keys are also fruit.
- Fruit can be described as fleshy or dry.
  - Fleshy fruit includes berries, peaches, apples, grapes, etc.
  - Dry fruit includes rice, wheat, nuts, etc.

FRUIT 2 OF 2 (14.4)

- Fruits are an agent of dispersal.
  - The light, dry fruits of some trees and dandelions are carried by the wind.
  - Coconuts float in water.
  - Some fruits are colored and sweet to attract herbivores, which eat the fruit and disperse the seeds in their feces.
  - Some fruits have hooks or curs that cling to the clothes of humans or f

THE LIFE CYCLE OF AN ANGIOSPERM 1 OF 3 (14.4)

- The sporophyte (2n) is dominant in angiosperms, as in all vascular plants.
- Like the gymnosperm life cycle, spores develop into male gametophytes (pollen grains) and female gametophytes inside the ovule (Figure 14.26).
- Like gymnosperms, the pollen grain contains 2 cells.
    - One becomes the pollen tube
    - The other divides to form 2 sperm
- The female gametophyte is inside the ovule, and at maturity, consists of 8 nuclei in 7 cells. This is called the **embryo sac**.

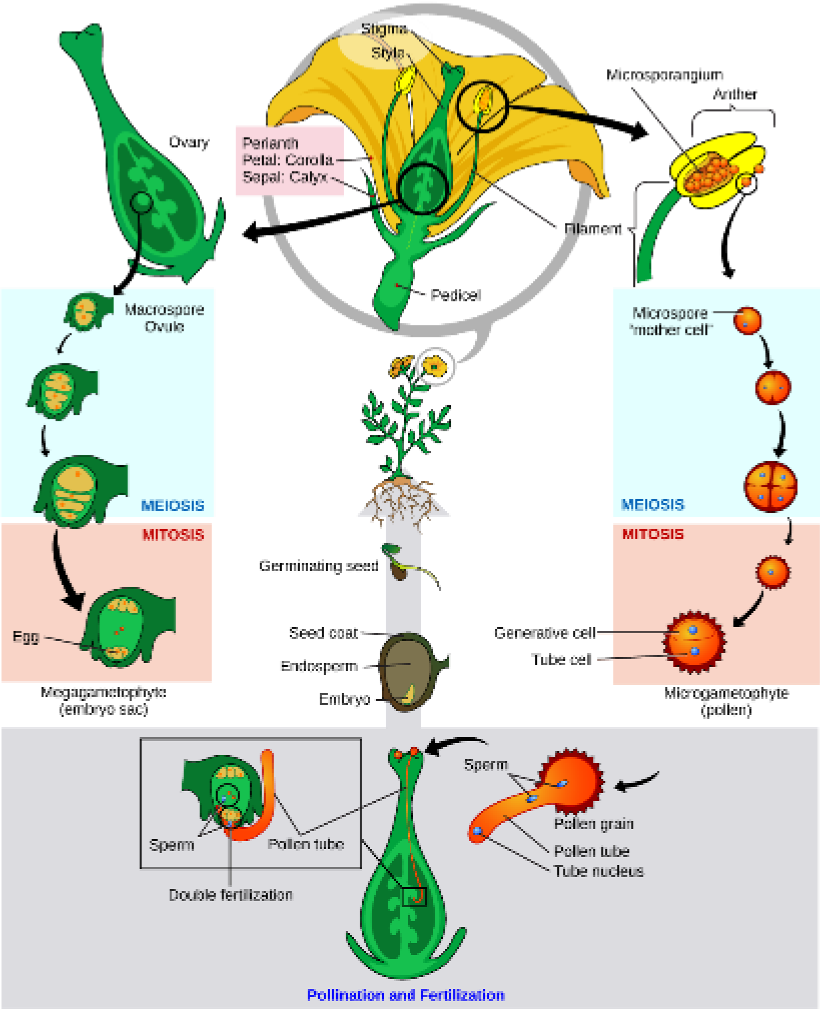
THE LIFE CYCLE OF AN ANGIOSPERM 2 OF 3 (14.4)

- When the pollen grain lands on the carpel, a pollen tube is formed and grows down until it reaches the ovule.
- The two sperm cells are deposited into the embryo sac.
    - One fuses with the egg to form the zygote. The zygote develops into the new sporophyte plant.
    - The other sperm unites with 2 of the other 8 cells. The resulting tissue is called **endosperm** and serves as a food reserve for the plant.
    - Since both sperm function in angiosperms, the event is called **double fertilization**. This did not happen in gymnosperms (Figure 14.27).

THE LIFE CYCLE OF AN ANGIOSPERM 3 OF 3 (14.4)

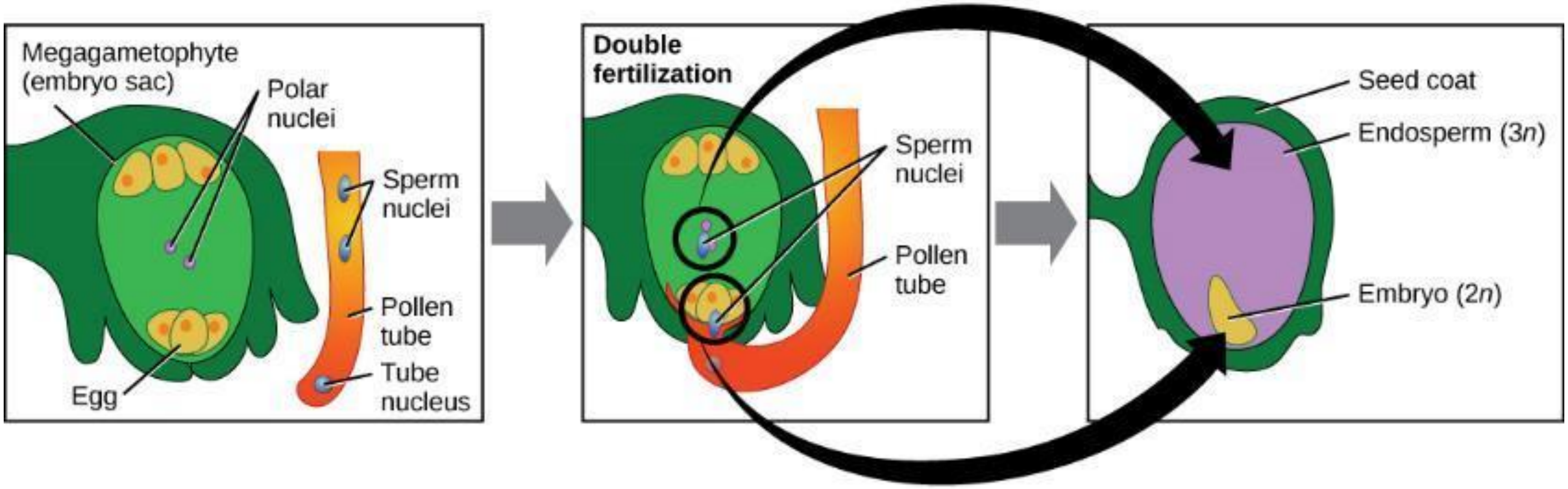
- The embryonic sporophyte develops a root and one or 2 cotyledons, embryonic seed leaves.
  - A seed forms containing a tough coat, the endosperm with food reserves and the well-protected embryo.
- A plant that has both stamens and carpels on the same flower is called a perfect flower. These plants sometimes self-pollinate.
  - However, this is a form of inbreeding and can lead to genetic defects.
  - Thus, cross-pollination is preferred.
- Some plants have male and female flowers on different plants. The term for this is **dioecious** (Figure 14.28).
- A plant that has perfect flowers or has both male and female flowers on the same plant is called **monoecious.**

FIGURE 14.26
LIFE CYCLE OF AN ANGIOSPERM



This diagram shows the lifecycle of an angiosperm. Anthers and ovaries are structures that shelter the actual gametophytes: the pollen grain and embryo sac. Double fertilization is a process unique to angiosperms. (credit: modification of work by Mariana Ruiz Villareal)

FIGURE 14.27 DOUBLE FERTILIZATION



Double fertilization occurs only in angiosperms. (credit: modification of work by Mariana Ruiz Villareal)

FIGURE 14.28 MONOECIOUS VS DIOECIOUS PLANTS

Monoecious plants have both male and female reproductive structures on the same flower or plant. In dioecious plants, males and females reproductive structures are on separate plants. (credit a: modification of work by Liz West; credit c: modification of work by Scott Zona)

DIVERSITY OF ANGIOSPERMS 1 OF 2 (14.4)

- All modern angiosperms originated from a single ancestor.
- Flowering plants are divided into 2 major groups, based on the structure of the **cotyledon**, which is an embryonic seed leaf. Monocots and eudicots differ in other factors as well, including the structure of veins, pollen and flower parts.
    - **Monocots** include grasses and lilies and have one cotyledon
    - **Eudicots** include flowering plants that have two cotyledons
- Basal angiosperms are a group of plants that are believed to have branched off before the separation into monocots and dicots, because they exhibit traits of both groups.

DIVERSITY OF ANGIOSPERMS 2 OF 2 (14.4)

- Basal angiosperms include the magnolias, tall trees that bear large, fragrant flowers with many parts.
    - Other basal angiosperms include the laurels, lotuses and the plant that produces black pepper (Figure 14.29).
- Monocots have a single cotyledon in the seedling.
    - This group includes the lilies, orchids, grasses and palms.
    - True woody tissue is rarely found in monocots.
    - Many important crops, such as rice, cereals, corn, sugar cane, bananas and pineapple are monocots (Figure 14.30).
- Eudicots are characterized by the presence of two cotyledons.
    - This group includes 2/3 of all flowering plants (Figure 14.30).
    - They can be woody or herbaceous (no woody tissue).
    - It is not always easy to tell whether a plant is a monocot or eudicot.

BASAL ANGIOSPERMS FIGURE 14.29

The (a) southern spicebush belongs to the *Laurales*, the same family as cinnamon and bay laurel. The fruit of (b) the *Piper nigrum* plant is black pepper, the main product that was traded along spice routes. Notice the small, unobtrusive clustered flowers. (c) Lotus flowers, *Nelumbo nucifera*, have been cultivated since antiquity for their ornamental value; the root of the lotus flower is eaten as a vegetable. The (d) red berries of a magnolia tree, characteristic of the final stage, are just starting to appear. (credit a: modification of work by Cory Zanker; credit b: modification of work by Franz Eugen Köhler; credit c: modification of work by "berduchwal"/Flickr; credit d: modification of work by "Coastside2"/Wikimedia Commons)

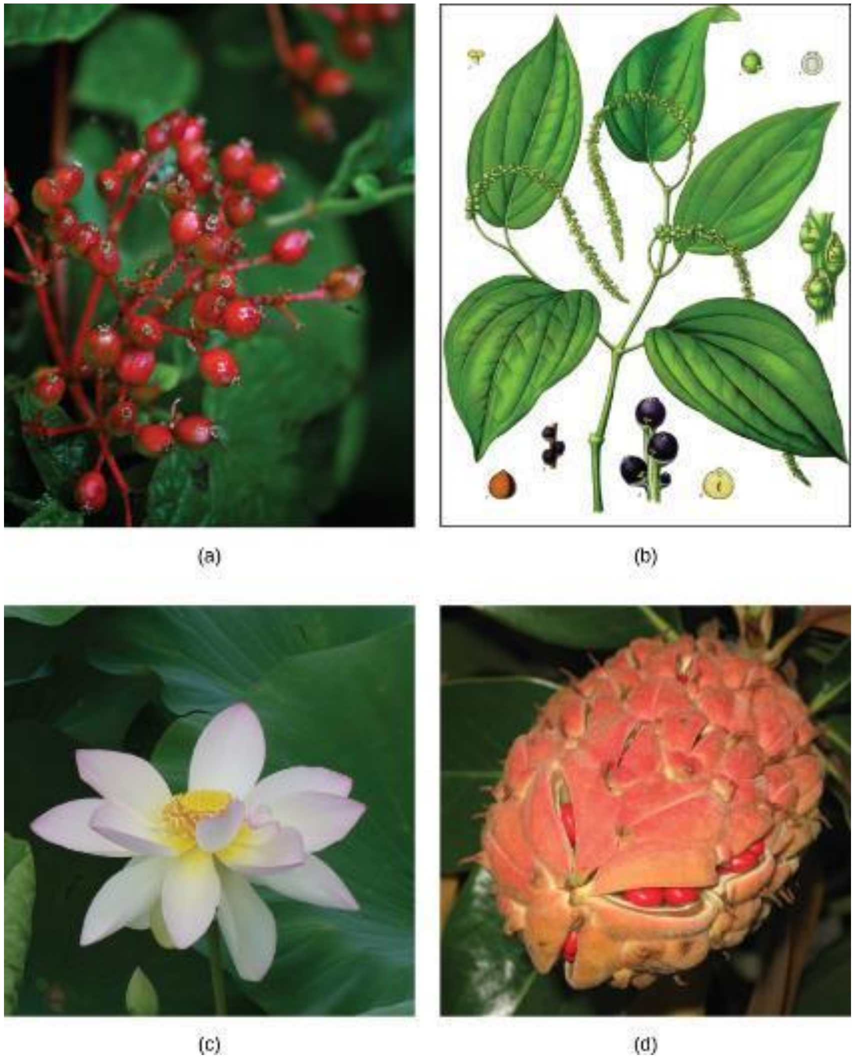
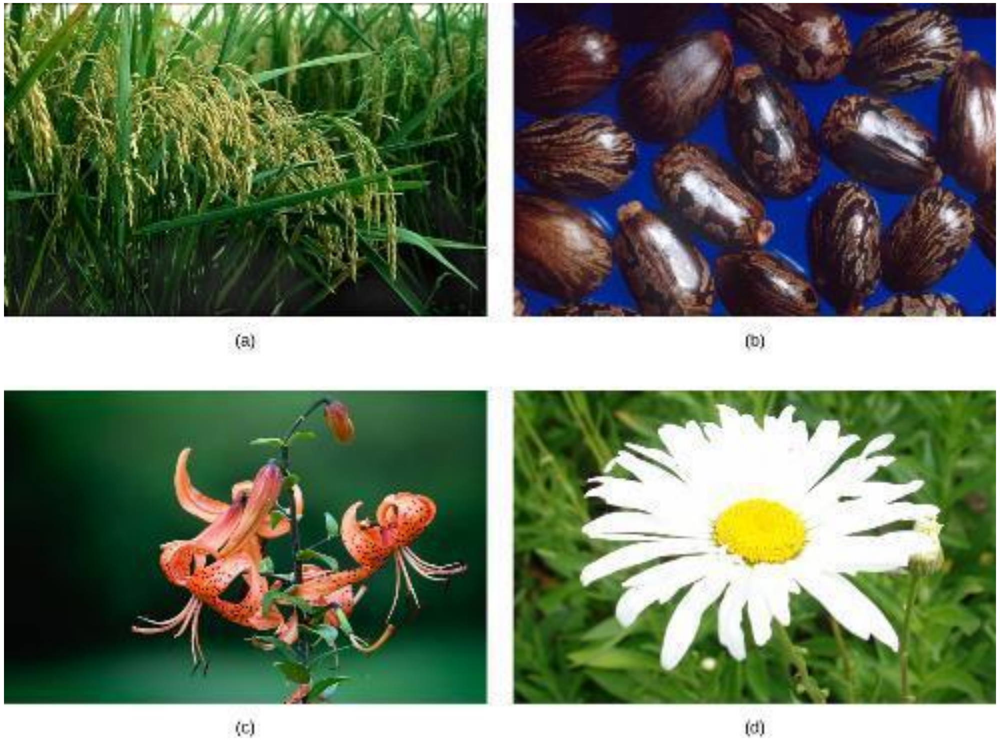


FIGURE 14.30 MAJOR FOOD CROPS



The major crops in the world are flowering plants. One staple food, (a) rice, is a monocot, as are other cereals, while (b) beans are eudicots. Some popular flowers, such as this (c) lily are monocots; while others, such as this (d) daisy are eudicots. (credit a: modification of work by David Nance; credit b: modification of work by USDA, ARS; credit c: modification of work by “longhorndave”/Flickr; credit d: modification of work by “Cellulaer”/NinjaPhoto)

POLLINATION CONCEPT IN ACTION

Explore this website for more information on pollinators.

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VOCABULARY

- Indeterminate growth
- Desiccation
- Sporangia
- Gametangia
- Alternation of generations
- Gametophyte
- Sporophyte
- Apical meristems
- Cuticle
- Stomata
- Nonvascular plants
- Vascular plants
- Gymnosperms
- Angiosperms
- Bryophytes
- Xylem
- Phloem
- Seeds
- Pollen
- Pollination
- Fertilization
- Sepal
- Petal
- Carpal
- Stamen
- Fruit
- Embryo sac
- Double fertilization
- Endosperm
- Dioecious
- Monoecious
- Monocot
- Eudicot