Scientific Classification IV:

Plantae II

13

13.0 CHAPTER PREVIEW

In this chapter we will:

- Discuss methods of asexual plant reproduction.
- Discuss the two phases of the plant life cycle—the sporophyte and gametophyte phase.
- Discuss specific reproductive cycles for nonvascular plants, seedless vascular plants, gymnosperms, and angiosperms.
- Investigate flower structure and how it relates to angiosperm reproduction.
- Discuss the process of pollination, fertilization, and germination.
- Investigate the specific roles water has in maintaining plant life.
- Study nastic and tropic plant movements and how they occur.
- Identify the processes responsible for transporting materials in xylem.
- Discuss photoperiodism.

13.1 OVERVIEW

Last chapter we learned about the plant characteristics botanists use to classify plants. The traits are used to classify plants into nonvascular plants, vascular/seedless plants, and vascular/seed plants. We also learned quite a bit about the ways in which the two types of angiosperms—monocots and dicots—can differ. In this chapter, we will learn more about the reproductive cycle of the nonvascular plants, the vascular/seedless plants, and the angiosperms. We will also learn the ways in which plants regulate their growth, and the importance water plays in the everyday life of a plant.

Figure 13.1.1

Classification of Plantae—Review

Plant type	Division (Phylum)	Common Name	# of Species
Nonvascular	Bryophyta	moss	10,000
	Hepatophyta	liverwort	6,500
	Anthocerotophyta	hornwort	100
Vascular/seedless	Psilotophyta	whisk fern	10
	Lycophyta	club moss	1,000
	Sphenophyta	horsetail	15
	Pterophyta	ferns	12,000
Vascular/seed			
Gymnosperms	Cycadophyta	cycads	100
	Ginkgophyta	ginkgoes	1
	Coniferophyta	conifers	550
	Gnetophyta	gnetophytes	70
Angiosperms	Anthophyta	flowering plants	240,000
	Monocots		
	Dicots		

13.2 ASEXUAL PLANT REPRODUCTION

All plants can asexually reproduce. Almost any part of a plant can grow into a new plant. Leaves, stems, and roots can, under the right conditions, grow into a new plant. **Vegetative reproduction** is the formation of a new plant from a part of a plant that does not normally reproduce. There are several different types of asexual reproduction. You or your parents may even have done some of these things without realizing that you were causing a plant to reproduce asexually.

Stem cutting is performed by cutting a stem from a plant. This is normally done with herbaceous stems. The cut stem can be placed in water or soil. Roots start to grow from the bottom part of the stem; the stem elongates and leaves form. This is a common way to grow many of the same types of plant starting from one plant.

Some plants have natural ways of asexually reproducing. Strawberries send shoots out from the main plant along the top of the ground. These shoots are called **stolons**. Stolons grow from the plant for a short way, then a new strawberry plant grows at the end of the stolon. The African violet can grow a new plant from a leaf that falls to the jungle floor.

Farmers have long practiced **grafting**. In grafting, a stem from one tree is placed into a notch cut into the trunk of another tree. For example, apple farmers often perform grafting. Some types of apple trees grow better root systems than others. Other types of apple trees grow more apples. Apple farmers cut stems from the good, apple-producing trees and graft them onto the trunks of apple trees that grow good root systems. This allows the apple farmers to maximize their apple production.

13.3 SEXUAL PLANT REPRODUCTION: GENERAL

One of the characteristics of all organisms in Plantae is their common reproductive cycle. The life cycle of all plants can be divided into two parts, or phases. During one phase, the plant lives as a spore-producing plant. This is called the **sporophyte phase**. A **sporophyte** is a plant that produces spores. When a spore grows, it grows into a plant that produces gametes. This is the next phase, the **gametophyte phase**. A **gametophyte** is a plant that produces gametes. When a male gamete—sperm—fertilizes the female gamete—the egg—it forms a zygote. The zygote then grows into a sporophyte plant and the cycle starts over.

To be clear, the sporophyte and gametophyte phases are actual plants. Instead of being called a "plant", biologists call "plants" that produce gametes "gametophytes" and plants that produce spores "sporophytes". The general cycle between sporophyte and gametophyte is shown in Figure 13.3.1. Remember during all of this discussion that all a "gametophyte" is is a plant that produces male and female gametes (eggs and sperm) and all a "sporophyte" is is a plant that produces spores. The fertilized female gamete is called a zygote and grows into a sporophyte. Spores grow into gametophytes. Usually, the gametophyte phase and the sporophyte phase plants do not look the same. For example, the fern gametophyte is a small plant no larger than a nickel. A fern sporophyte, though, grows into the plant that you commonly think of when you see a fern. It is a little confusing but come back to this section for clarification.

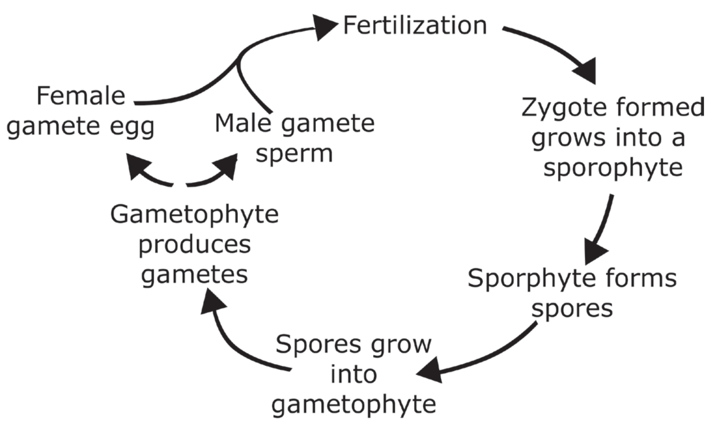


Figure 13.3.1

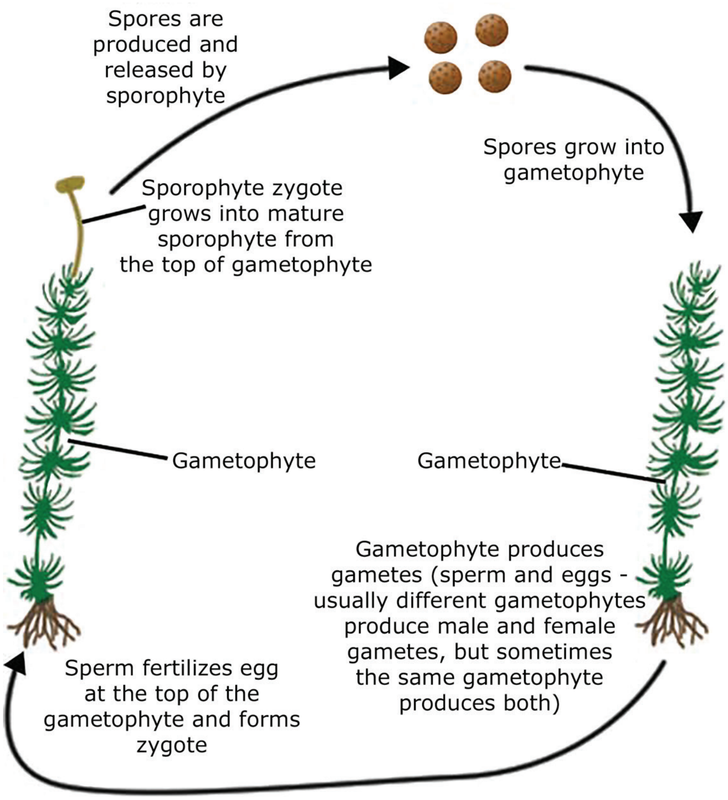
General Plant Reproductive Cycles
All plants follow the life cycle pattern shown here. During the sporophyte phase, the plant is called a "sporophyte". "Sporophyte" is just the generic name for a plant that forms spores to reproduce. Sporophytes produce the spores through meiosis. A spore then grows into a "gametophyte". "Gametophyte" is the generic name for a plant that forms gametes to reproduce. Gametes - sperm and eggs - are produced by mitosis. Sperm (the male gamete) fertilizes the egg (the female gamete) and then the combined sperm and egg (called a zygote) will grow into a sporophyte plant and the cycle starts over.

13.4 PLANT REPRODUCTION: NONVASCULAR PLANTS

The nonvascular plants do not produce seeds, but they do make spores (all plants make spores). The nonvascular plants are classified into the divisions Bryophyta (hornworts), Hepatophyta (liverworts), and Anthocerotophyta (mosses). Recall these plants are all small in size and live in moist environments. This is to be sure they reproduce properly. During the gamete phase, the male gametes (sperm) swims to the female gamete (the egg). Without the moist environment, the sperm would not be able to swim to the egg to fertilize it. The sperm fuses to the egg and injects its DNA into the egg. The DNA of the sperm combines with the egg. **Fertilization** is the name of the process of the sperm uniting with the egg and their chromosomes combining. After fertilization, the new cell grows into a sporophyte plant. The sporophyte produces spores by mitosis. When a spore lands in a spot favorable for it to grow, it grows into a gametophyte plant, and the cycle starts all over.

Figure 13.4.1

Moss Reproductive Cycle
Moss is a typical nonvascular plant. The gametophyte form of the plant is the "moss" that we are familiar with from the pictures in Chapter 12. Gametophytes produce gametes—both male sperm and female eggs. The sperm fertilizes the egg and a zygote forms. The zygote grows into a sporophyte out of the top of the gametophyte. Sporophytes produce spores, which grow into gametophytes and the cycle starts over.

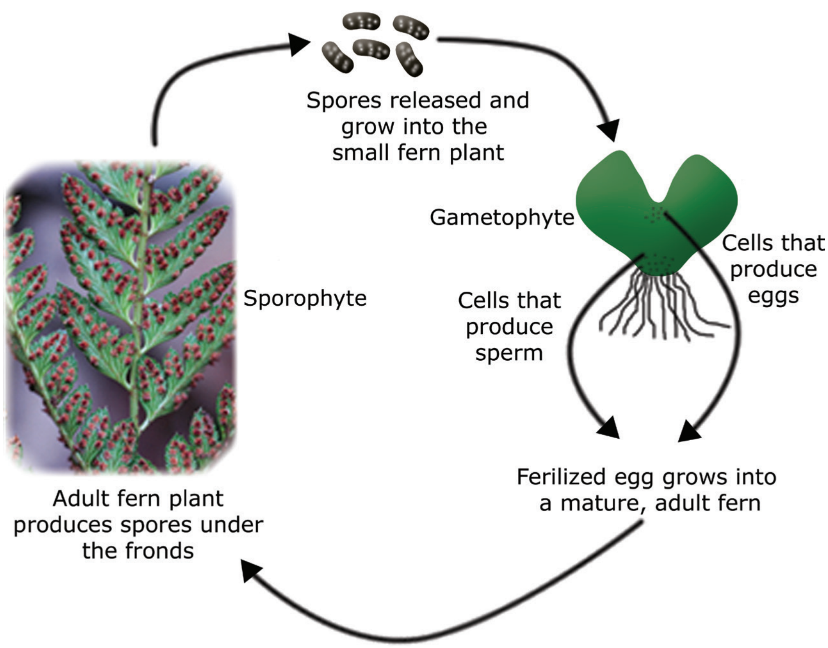


13.5 PLANT REPRODUCTION: VASCULAR SEEDLESS PLANTS

The vascular seedless plants have a sporophyte phase and gametophyte phase, as all plants do. Since the ferns are the best studied and understood, we will look at their cycle. Fern gametophytes are physically small plants. Most are no larger than a dime. They have structures that make sperm and eggs. The sperm cell fertilizes an egg cell, and a sporophyte plant grows from the product of the fertilization. Fern sporophytes are large. When you see a fern plant, you are looking at the sporophyte phase of a fern. The sporophyte plant makes spores. Spores grow into gametophytes, and the cycle starts again.

Figure 13.5.1

Fern Life Cycle
Like the nonvascular plants, fern sperm requires a moist environment to be able to swim to the egg and fertilize it. The gametophyte phase is a very small plant that produces sperm and eggs. Fertilization occurs and a zygote is formed which grows into a sporophyte. The sporophyte phase is the "fern plant" we are familiar with when we think of what a fern looks like. The sporophyte produces fern spores that grow into a gametophyte and the cycle starts over.



13.6 PLANT REPRODUCTION: GYMNOSPERMS

All gymnosperms produce seeds, but not flowers. The best understood gymnosperm species are conifers, or pine trees. Conifer reproductive structures are **cones**. Each pine tree has male and female cones. The male cones produce male spores, and the female cones produce female spores. Remember that in this alternating life cycle that plants have, spores grow into gametophytes. And a gametophyte is a plant that produces gametes.

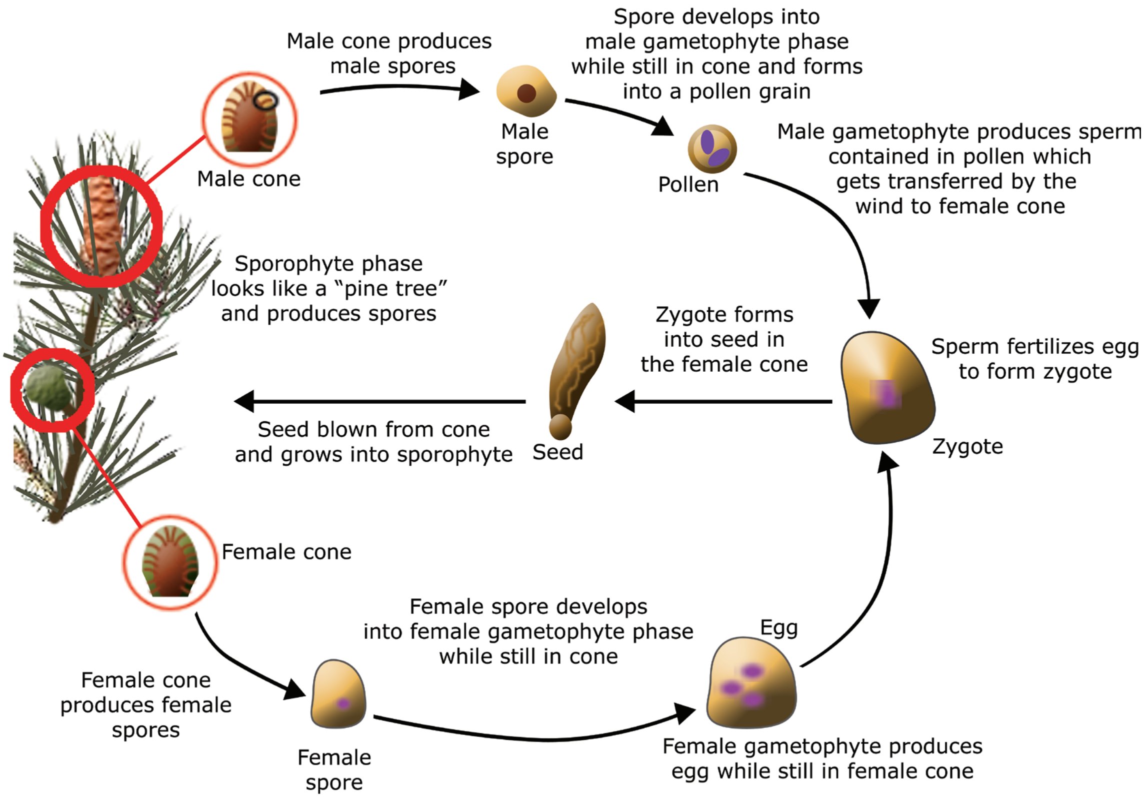
It so happens that the gametophytes of the gymnosperms are small and do not "grow" as we think of it. Both the female and male gametophyte "plants" stay inside of the cones. (That is why botanists use the word "phase" instead of "plant.") The male spore grows into a microscopic gametophyte plant while it is still in the cone. This gametophyte plant is so small that it is contained in a tiny grain of pollen. **Pollen** is actually the male gametophyte plant. While it is still a grain of pollen, the gametophyte plant produces sperm. The female gametophyte also stays in the cone and produces the female gametes—eggs.

Pollen is transferred to the female cone by the wind. **Pollination** is the transfer of pollen. The sperm from the pollen fertilizes the egg in the pine cone. This forms a zygote which is enclosed in a seed. This seed will grow into a sporophyte plant. The seed is blown out of the cone by the wind. If the seed lands in an area favorable for it to grow, it will grow into a new pine tree. This is the sporophyte phase, and the cycle starts all over again.

Figure 13.6.1

Conifer Reproductive Cycle

Male pine cones produce male spores, and female cones produce female spores. The male spores are called pollen. They grow into the male gametophyte while the spores are still in the male cone. The male gametophyte is housed in a small structure called pollen. So pollen is the male gametophyte phase of a conifer. This is obviously not a "plant" as you and I think of a plant since it is very small. The male gametophyte produces sperm while it is still in the pollen. The female spores grow into the female gametophyte while they are still contained within the cone. Also while the female gametophyte is still in the cone, it produces eggs. Wind blows pollen from the male cone to the female cone, and the sperm in the pollen fertilizes the egg in the pine cone and forms a zygote. After fertilization, a seed forms around the zygote. Once the seed is formed, it is released from the cone and grows into a mature sporophyte plant. Keep in mind that the when you look at a "pine tree," you are looking at a plant that is in the sporophyte phase.



13.7 PLANT REPRODUCTION: ANGIOSPERMS AND FLOWERS

Flowers are the reproductive structures of angiosperms. Angiosperms are classified into the Anthophyta division. Anthophyta is further divided into the classes Magnoliopsida (dicots) and Liliopsida (monocots). Even though flowers are unique in appearance, they do share a common form. In order to understand how angiosperms reproduce, the flower structure must be understood. Like all plants, angiosperms alternate between a gametophyte phase and a sporophyte phase. The sporophyte phase is the organism that we are familiar with as "plants." Like the conifers, the gametophyte phase of angiosperms is small and grows in the sporophyte.

The bottom of the flower is called the **flower base**. Structures are attached to the base—**sepals**, **petals**, **stamens**, and **pistils**. See Figure 13.7.1 for details. Stamens are the male reproductive structure; they make pollen. Pistils are the female reproductive structure; they form eggs in the ovary.

Recall that pollination is the transfer of pollen from the male part of the flower to the female part. Or, pollination is the transfer of pollen from the stamen to the pistil. The way in which the flower is pollinated determines the flower's actual structure. Some flowers are pollinated by the wind. They tend to be open and dull in color. The lack of petals allows the wind to blow through the flower and carry away pollen. Having no petals, or small petals and sepals, allows pollen carried by the wind to land on the stigma. Other flowers are pollinated by insects and other animals, called **pollinators**. These flowers tend to be brightly colored to attract the insect. Also, most flowers pollinated by insects contain **nectar**, a sweet-smelling, sugary substance that further attracts the insect. Nectar is a sweet reward for the pollinators and, in the case of bees, is what they use to make honey.

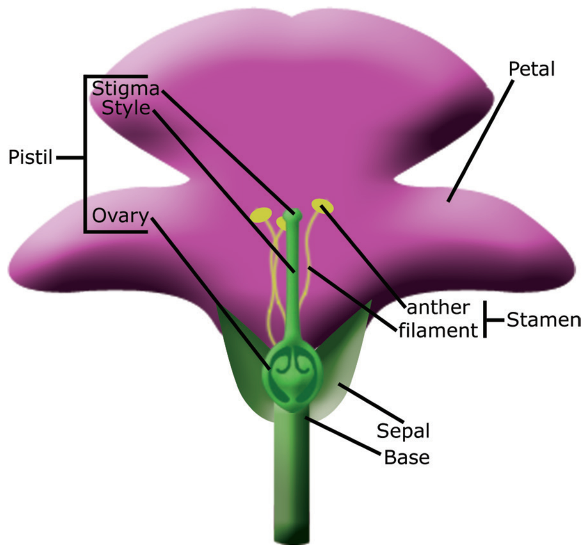


Figure 13.7.1

Flower Structure
The flower structure is shown here. The male part of the flower is the stamen. The anther is where the male spore forms and develops into the male gametophyte. Sperm is then encased into a grain of pollen to be transferred from the anther to the stigma. The female part of the flower is the pistil. The ovary at the bottom of the pistil is where the female spore forms and develops into the female gametophyte. The female gametophyte produces an egg which remains in the ovary. Fertilization of the egg occurs in the ovary. The seed also develops and forms in the ovary.

Figure 13.7.2

Flower Types
Flowers that are pollinated by the wind, like grains and grasses (left), are open flowers with little color. Flowers that rely on pollinators, like the lily (right), are brightly-colored and fragrant. They also reward the pollinator with nectar.

13.8 PLANT REPRODUCTION: ANGIOSPERMS AND FERTILIZATION

Following pollination, fertilization occurs. For plants, fertilization cannot occur unless pollination has. Fertilization begins when a pollen grain lands on the stigma. A tube quickly forms from the pollen grain. The tube grows from the pollen through the style to the ovary. A sperm cell moves through this passage to the egg in the ovule. Fertilization occurs as the sperm unites with the egg and the chromosomes from the male parent are combined with those of the female parent. This forms the zygote which is then wrapped inside of a seed coat for protection. If the plant species is a monocot, a seed with one cotyledon is formed. If the species is a dicot, the seed will have two cotyledons. As the ovary matures, it develops into a **fruit**. When you eat an apple, you are eating the matured ovary of an apple flower. When you eat an orange, you are eating the matured ovary of the orange flower. What is inside of the fruit? The seeds!

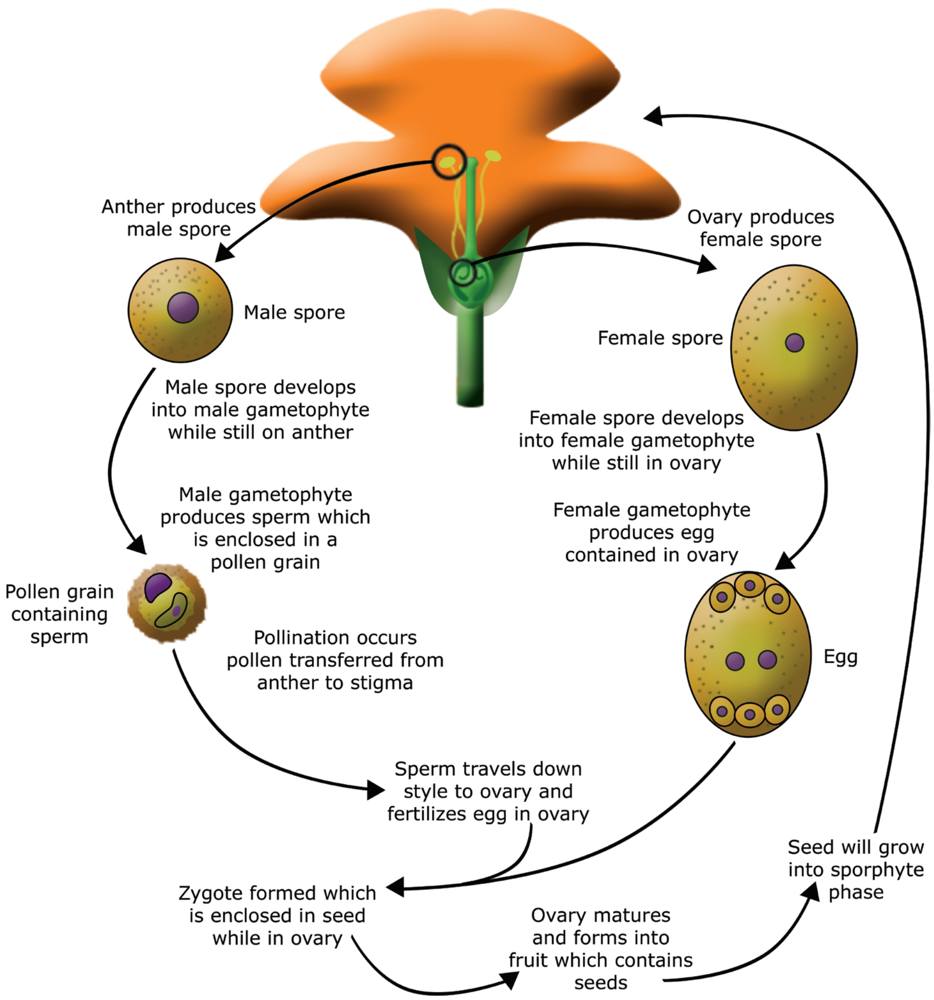


Figure 13.8.1

Angiosperm Life Cycle
Like all the other plants discussed, angiosperms have two forms—gametophyte and sporophyte. The sporophyte is the form we are familiar with. Like conifer gametophytes, angiosperm gametophytes are small and live inside the sporophyte. The sporophyte phase—the large "plant" that produces a flower, produces spores. Male spores are produced in the anther and female spores are produced in the ovary. The male spore grows into a male gametophyte and, just like the conifers, this gametophyte is small and contained in a grain of pollen. While in the grain of pollen, the gametophyte produces sperm. The female spore develops into a female gametophyte in the ovary. This produces the egg, which stays in the ovary. Pollination occurs and a tube grows from the stigma, down the style to the ovary. Sperm move down the tube and fertilize the egg in the ovary. This forms an embryo, which is the "mini-plant" that is contained in a seed. A seed forms which will grow into a sporophyte.

13.9 GERMINATION

Germination is the process of a seed sprouting and beginning to grow into a new plant. Seeds cannot grow just anywhere. In order for a seed to sprout and grow, the right conditions need to be met. Since seed coats are hard, there needs to be enough water present to soften the coat. Once water enters the coat, enzymes and the seed embryo are activated inside the seed. The seed embryo starts to grow and break out of the coat. In order for the seedling to continue to grow well, it needs to have a good supply of nutrients and soil conditions that will allow the roots to penetrate.

Figure 13.9.1

Germination
The sprout on the left has recently germinated and is trying to break its first leaves out from under the soil. The right seedling is older and has two leaves.

13.10 WATER: PHOTOSYNTHESIS

Not only is water important to start a plant's life, it is also important in maintaining it. Water is critical for many processes of a plant to function correctly. Recall from our discussion on photosynthesis that water is used during this process. If there is not adequate water supply, then photosynthesis will not occur. The guard cells open and close the stoma on the undersurface of the leaf depending on water conditions. If water is in short supply, the guard cells close the stoma so photosynthesis cannot occur. This saves water so the plant does not dry out. When water is plentiful, the guard cells open the stoma again. By doing so, carbon dioxide can enter the leaf so photosynthesis can occur.

13.11 WATER: TURGOR PRESSURE

Turgor pressure is pressure that builds up inside of a cell due to water. The more water a cell contains, the higher the turgor pressure it has. Turgor pressure forms inside plant cells because of the large vacuole in the cell, which stores water. In fact, the vacuole can hold so much water that the other organelles are pushed to the side of the cell. Turgor pressure exerts a pressure from inward to outward in all plant cells. Since the plant cells are all packed close together, turgor pressure results in all of the cells "pushing" against one another. This maintains leaves and herbaceous stems in the right posture.

You may have noticed that when a house plant is not watered for a while it gets limp, or wilts. Maybe you have noticed leaves on a bush or tree get wrinkled and soft when it is dry for a long period of time. These things happen because the plant has lost turgor pressure. When the plant does not have enough water, the vacuoles get smaller and smaller. As this happens, the cells do not push against one another, and the plant wilts. Usually once the plant is watered, it does not take long for the water to be taken up into the plant and restore normal turgor pressure.

13.12 WATER: NASTIC MOVEMENTS

Changes in turgor pressure are also responsible for nastic movements. **Nastic movements** of a plant are physical movements in a plant that occur repeatedly throughout the day or the plant's entire life. Nastic movements occur as a result of changes in turgor pressure. Nastic movements are responsible for the opening of some flower petals during the daytime, then closing during the night time. Nastic movements are also responsible for the property of sunflowers following the sun. If you notice that sunflower flowers seem to be facing different directions during a sunny day, it's because they *are*. As a result of changes in turgor pressure in the plant, a sunflower changes the way the flower is facing so that it receives the maximal amount of light.

Figure 13.12.1

Nastic Movements

Nastic movements are responsible for morning glories closing at night (left), then opening again when the sun comes out (right). Changes in turgor pressure cause the petals to move open and close.

13.13 WATER: TRANSPORTATION

Water is also responsible for moving nutrients, hormones, and glucose through the plant. Whether the plant is vascular or nonvascular, transport cannot occur without water. Contrary to common belief, leaves do not absorb water. In fact, some plants can die if their leaves are too wet. In nonvascular plants, water enters into the plant through the rhizoids by diffusion. Water then moves from one area of the nonvascular plant to another by diffusion.

In vascular plants, water enters the plant through the roots. Water then enters the root xylem. Also, any minerals and nutrients dissolved in the water enter the xylem.

How does the water move through the plant? Animals have a muscular heart and muscles in their vessels to move blood. Plants do not have muscles. Instead, plants rely on transpiration to cause the movement of water from the roots through the stem to the leaves. **Transpiration** is the loss of water from the leaves of a plant. All plants lose water through the leaf stoma. As that water is lost, the rest of the water is "pulled" upward through the xylem. In this way, there is a constant flow of water and nutrients from the roots to the stem and leaves. Plants can turn this process off, though, if it is too dry. The guard cells close the stoma and transpiration stops. The water sits in the xylem until the leaf stoma are opened again, then the flow resumes. This is similar to what happens when you drink from a straw. The sucking force you provide to make the liquid rise is like the force that transpiration provides. Water is also responsible for moving materials in phloem, but it does this through a different process.

13.14 PLANT HORMONES

Plants and animals produce hormones. Hormones are chemicals that are produced in one area of an organism and affect the growth or chemical reactions in another area of the organism. There are several different types of plant hormones—**auxin**, **gibberellin**, **ethylene**, **cytokinins**, and **abscisic acid**. Some of the effects of these hormones are not well understood. Others, like auxin, gibberellin, and ethylene, are used commercially on plants. In general, plant hormones regulate how much or how little plant tissues grow.

When auxin is present, plant tissues grow. When auxin is absent, plant tissues do not grow. Auxin causes cells to elongate. As cells elongate, the stem and other plant tissues grow. Auxin is used by farmers to help their crops grow and produce fruit more quickly. Gibberellin also causes growth, mainly in the stem. When plants are given gibberellin, they grow very tall.

Ethylene is normally produced by the plant to cause fruit to ripen and leaves to fall off. Now it is common to pick fruit when it is not ripe. Unripened fruit tolerates shipping much better than ripened fruit. Before the unripened fruit is placed on store shelves, it is treated with ethylene. In this case, the ethylene is a gas. The fruit is exposed to ethylene, and it ripens.

13.15 TROPISMS

Tropism is the directional movement of a plant in response to some type of stimulus. Although tropism and nastic movements are both forms of plant movement, they are different. Tropisms occur due to the effects of hormones, and nastic movements occur due to the effects of turgor pressure.

There are several different types of tropisms. Auxin is responsible for causing the plant growth seen with tropisms. **Phototropism** is the growth of plants toward a light source. When sunlight strikes one side of a plant, the light causes plant cells in the stem which is in the light to stop producing auxin. Cells on the dark side of the stem continue to produce auxin. This results in the cells on the dark side growing, while the cells on the light side do not. This has the effect of causing the stem to "bend" toward the light because of the difference in cell growth on the dark and light side of the stem.

Gravitropism is the growth of a plant against gravity. This means that plants have some way to sense which way gravity is acting upon them. If a plant is grown normally for a while, then laid on its side, over several days the plant stem will begin to grow upward. Auxin is not produced in the part of the stem that is facing up. The auxin produced in the part of the stem facing down causes the cells in that area of the stem to grow. This results in the plant stem bending upward so the plant will, once again, grow upward. It is not known how the plant knows which way is up.

Figure 13.15.1

Gravitropism
Plants have the natural ability to grow up against gravity. These trees show an excellent example of gravitropism. They started out growing parallel to the ground but, over time, gravitropism caused them to grow straight up against gravity. This is controlled by the plant hormone auxin.

13.16 PHOTOPERIODISM

Photoperiodism relates to certain processes of a plant responding to the amount of light it receives. Many plant processes, such as flowering, are responsive to the amount of light a plant receives. For example, some plants, such as apples and violets, require small periods of light during the day to simulate them to produce flowers. Other plants, such as wheat, barley, corn, and lettuce require a lot of light to stimulate them to flower. Plants such as dandelions and roses produce flowers all the time. These plants can bloom regardless of the amount of light they receive.

Photoperiodism is used by flower growers to ensure there are supplies of almost every type of flower all year. They expose the plants to the specific amount of light required to stimulate flower production.

13.17 KEY CHAPTER POINTS

- All plants are capable of asexual reproduction.
- All plants show two separate phases during their reproductive cycles. One phase is a spore-producing (sporophyte) phase, the other is a gamete-producing (gametophyte) phase.
- Spores are small cells capable of developing and growing into a gametophyte.
- The male gametes (sperm) need to fuse with a female gamete (egg) to form a new organism. This new organism grows into a sporophyte.
- Flowers are specialized angiosperm reproductive structures.
- The male reproductive structure of a flower is the stamen; the female reproductive structure is the pistil.
- Pollination is the process of transferring pollen from the anther to the style. This can occur by wind or pollinators.
- Fertilization is the process of the male gamete fusing with the female gamete and combining their chromosomes to form a new organism.
- Germination is the process of a seed embryo breaking through the seed coat and starting to grow.
- Water is responsible for maintaining turgor pressure and for xylem flow.
- Plants produce hormones that control various processes and growth.
- There are two types of plant movements—nastic and tropisms. Water is responsible for nastic movements and hormones for tropisms.

13.18 DEFINITIONS

abscisic acid
A plant hormone.

auxin
A plant hormone.

cytokinins
A plant hormone.

ethylene
A plant hormone.

fertilization
The process of the DNA of the sperm combining with the egg.

flower base
The bottom of a flower to which the sepals, petals, etc., attach.

fruit
The seed-containing mature ovary of a dicot.

gamete phase
The plant phase in which the plant lives as a gamete-producing plant.

gibberellin
A plant hormone.

grafting
A stem from one tree being placed into a notch cut into the trunk of another tree.

gravitropism
The growth of a plant against gravity.

nastic movements
Plant movements caused by changes in turgor pressure.

nectar
A sweet-smelling, sugary substance that attracts insects and causes pollen to stick to them for the purpose of improved pollination.

petals
The usually brightly colored parts of a flower.

photoperiodism
The process of a plant responding to the amount of light it receives.

phototropism
The growth of plants toward a light source.

pistils
The female reproductive structure; they form eggs in the ovary.

pollen
The male reproductive structure that contains the male gametophyte and sperm.

pollination
The transfer of pollen from the male part of the plant to the female part.

pollinators
Insects and other animals that pollinate flowers.

sepals
The outer layer of structures attached to the flower base.

sporophyte
A plant that produces spores.

sporophyte phase
The plant phase in which the plant lives as a spore-producing plant.

stamens
The male reproductive structure; they make pollen.

stem cutting
A common way to grow many of the same types of plant starting from one plant.

stolons
Shoots sent out from the main plant along the top of the ground.

transpiration
The loss of water from the leaves of a plant.

tropism
The directional movement of a plant in response to some type of stimulus; controlled by hormones.

turgor pressure
Pressure inside of a cell due to water.

vegetative reproduction
The formation of a new plant from a part of a plant that does not normally reproduce; a form of asexual reproduction.

STUDY QUESTIONS

1. What is stem cutting and grafting a form of?
2. What reproductive structure does a sporophyte produce?
3. What reproductive structure does a gametophyte produce?
4. True or False? Most plants live either as a sporophyte or gametophyte.
5. True or False? Fern gametophytes are quite large and are the plant structures we see when we look at a fern.
6. What phase does a spore grow into?
7. What phase does a fertilized female gamete (zygote) grow into?
8. In a flower, the __________ contains the male reproductive structures, and the ___________ contains the female.
9. Describe the process of angiosperm fertilization, beginning with pollination.
10. What is turgor pressure, and why is it important for plants?
11. Describe the process of materials moving through xylem.
12. True or False? Auxin is the hormone responsible for gravitropism and phototropism.
13. How are tropisms and nastic movements different?
14. What is photoperiodism?

PLEASE TAKE TEST #6 IN TEST BOOKLET
