chapter 10

Plant Reproduction

section 1 Introduction to Plant Reproduction

What You'll Learn

- the differences between the two types of plant reproduction
- the two stages in a plant's life cycle

Before You Read

List four things you need to survive. Then circle the items on your list that you think plants also need to survive.

_____

_____

_____

Read to Learn

Mark the Text

Identify Main Ideas
Underline the important ideas in this section. Review these ideas as you study the section.

Types of Reproduction

What do humans and plants have in common? Both need water, oxygen, energy, and food to grow. Like humans, plants reproduce and make similar copies of themselves. Most plants can reproduce in two different ways—by sexual reproduction and by asexual reproduction.

What happens in asexual plant reproduction?

Asexual reproduction does not require the production of sex cells. Instead, one organism produces a new organism that is genetically identical to it. Under the right conditions, an entire plant can grow from one leaf or part of a stem or root. When growers use these methods to start new plants, they must make sure that the plant part has plenty of water and anything else it needs to survive. The stems of lawn grasses grow underground and produce new grass plants asexually along the length of the stem.

What is sexual plant reproduction?

Sexual reproduction in plants requires the production of sex cells—usually called sperm and eggs—in reproductive organs. The organism produced by sexual reproduction is genetically different from either parent organism.

Think it Over

1. **Analyze** A cutting from a plant can be placed in water and roots grow. Is this an example of asexual or sexual reproduction? Explain your answer.

_____

_____

_____

Fertilization An important part of sexual reproduction is fertilization. Fertilization happens when a sperm and egg combine to produce the first cell of the new organism, the zygote. In plants, water, wind, or animals help bring the sperm and the egg together.

What reproductive organs do plants have?

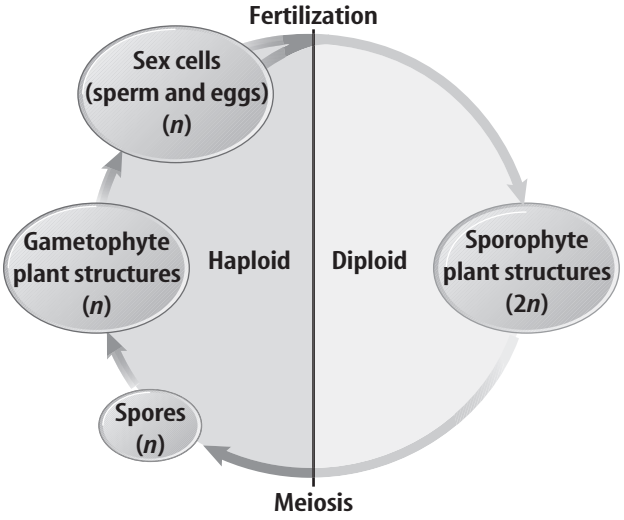
A plant's female reproductive organs produce eggs. The male reproductive organs produce sperm. Some plants have both reproductive organs. A plant with both reproductive organs can usually reproduce by itself. Other plants have either female or male reproductive organs. For fertilization to happen, the male and female plants must be near each other.

Plant Life Cycles

A plant has a life cycle with two stages—the gametophyte (guh MEE tuh fite) stage and the sporophyte (SPOHR uh fite) stage. The figure below shows the two stages.

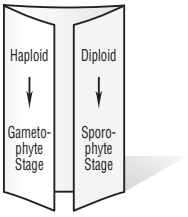
Gametophyte Stage When reproductive cells undergo meiosis and produce haploid cells called **spores**, the **gametophyte stage** begins. Spores divide by cell division to form plant structures or an entire new plant. The cells in these structures or plants are haploid and have half a set of chromosomes. Some of these cells undergo cell division and form sex cells.

Sporophyte Stage Fertilization—the joining of haploid sex cells—begins the **sporophyte stage**. Cells formed in this stage are diploid and have the full number of chromosomes. Meiosis in some of these cells forms spores, and the cycle repeats.



FOLDABLES™

A Explain Make a shutterfold book, as shown below. Explain the two stages of the plant life cycle.



Picture This

2. **Identify** Write the name of the stage that begins with meiosis below the word *Meiosis*. Write the name of the stage that begins with fertilization above the word *Fertilization*.

After You Read

Mini Glossary

gametophyte (guh MEE tuh fite) stage: the stage in plant reproduction when reproductive cells undergo meiosis

spores: haploid cells produced in the gametophyte stage

sporophyte (SPOHR uh fite) stage: the stage in plant reproduction when fertilization begins

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the difference between the gametophyte stage and the sporophyte stage.

2. Choose one of the question headings in the Read to Learn section. Write the question in the space below. Then write your answer to that question on the lines that follow.

Write your question here.

3. Fill in the table below with either "yes" or "no" to compare asexual and sexual reproduction in plants.

	Asexual Reproduction	Sexual Reproduction
a. Requires production of sex cells?		
b. Produces organism that is genetically identical to parent?		
c. Requires fertilization?		

ScienceOnline Visit **life.msscience.com** to access your textbook, interactive games, and projects to help you learn more about the basics of plant reproduction.

End of Section

chapter 10

Plant Reproduction

section 2 Seedless Reproduction

What You'll Learn

- the life cycles of a moss and a fern
- why spores are important to seedless plants
- the structures ferns use for reproduction

Before You Read

Describe what happens when you suddenly open a bag of candy or a bag of chips.

Study Coach

Read and Discuss the main topics of the section with a partner. Read a paragraph and then take turns saying something about what you have learned. Continue until you both understand the main ideas.

Read to Learn

The Importance of Spores

If you want to grow ferns and moss plants, you can't go to a garden store and buy a package of seeds. Ferns and moss plants don't produce seeds. They reproduce by forming spores. The sporophyte stage of these plants produces haploid spores in structures called spore cases.

If you break open a bag of candy, the candy may spill out. In the same way when a spore cases break open, the spores spill out and are spread by wind or water. The spores can grow into plants that will produce sex cells. Seedless plants include all nonvascular plants and some vascular plants.

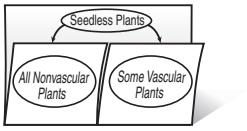
Nonvascular Seedless Plants

A nonvascular plant does not have structures that transport water and materials throughout the plant. Instead, water and materials move from cell to cell. Mosses, liverworts, and hornworts are all nonvascular plants. They cover the ground or grow on fallen logs in damp, shaded forests.

The sporophyte stage of most nonvascular plants is very small. Moss plants have a life cycle typical of how sexual reproduction occurs in this plant group.

FOLDABLES™

B Compare Make a two-tab concept map Foldable. Write the facts related to all nonvascular plants and some vascular plants.



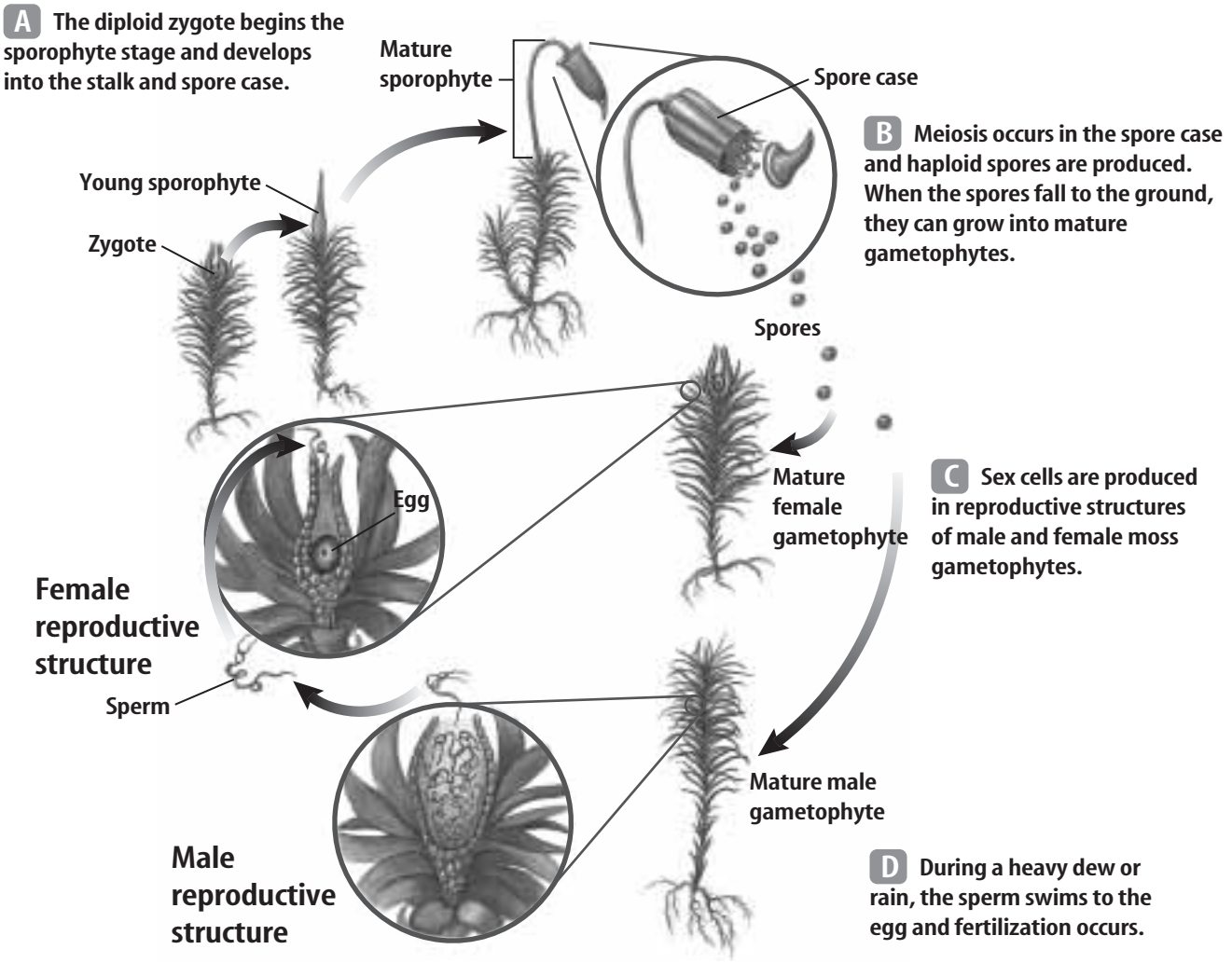
How do nonvascular plants reproduce sexually?

A moss is a green, low-growing plant when in the gametophyte stage. When brownish stalks grow up from the tip of the plant, moss is in the sporophyte stage. The sporophyte stage does not carry on photosynthesis. It depends on the gametophyte for nutrients and water. On the tip of the stalk is a tiny spore case where millions of spores have been produced. Under the right environmental conditions, the spore case opens and the spores are released.

New moss gametophytes can grow from each spore and the cycle repeats. This process is shown in the figure below.

Picture This

1. **Explain** Highlight each of the following words in the captions of the figure: *meiosis, gametophyte, fertilization, sporophyte.* Use each of these words as you explain to a partner the life cycle of a moss.



How do nonvascular plants reproduce asexually?

If a piece of moss gametophyte plant breaks off, it can grow into a new plant. Liverworts can form small balls of cells on the surface of the gametophyte plant. These can be carried away by water and grow into new gametophyte plants.

Vascular Seedless Plants

Vascular plants have tubelike cells that transport water and materials throughout the plant. Most vascular seedless plants are ferns. Horsetails and club mosses are other vascular seedless plants. Unlike nonvascular plants, the gametophyte of a vascular seedless plant is the part that is small.

How do ferns reproduce sexually?

A fern leaf is called a **frond** and grows from an underground stem called a **rhizome**. Roots grow from the rhizome. Roots anchor the plant and absorb water and nutrients.

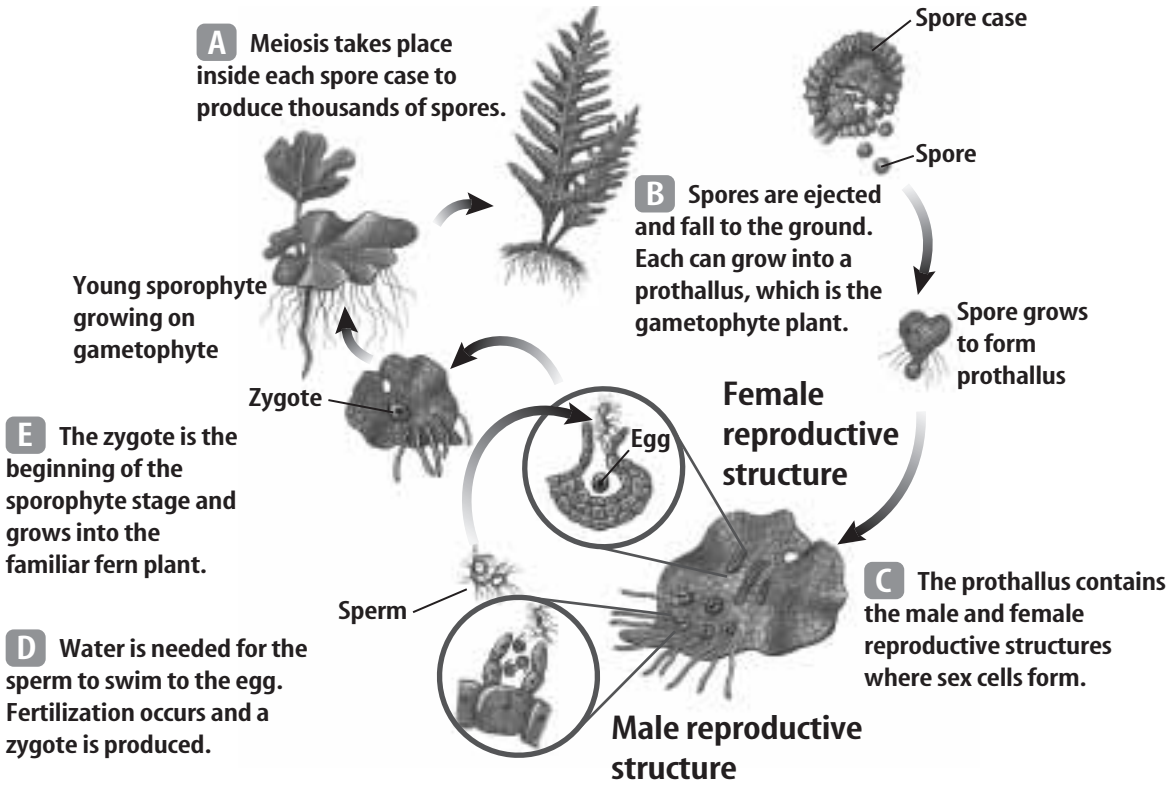
Fern sporophytes make their own food by photosynthesis. Fern spores are produced in a spore case called a **sorus** (plural, *sori*). Sori are dark colored bumps on the underside of a frond. A spore that falls on the ground can grow into a small, green, heart-shaped gametophyte plant called a **prothallus** (proh THA lus). It contains chlorophyll and can make its own food. The life cycle of a fern is shown below.

How do ferns reproduce asexually?

Fern rhizomes grow and form branches in asexual reproduction. New fronds and roots develop from each branch. The new rhizome branch can be separated from the main plant. It can grow on its own and form more fern plants.

Picture This

2. **Identify** Highlight the name of the structure that contains the male and female reproductive structures.



After You Read

Mini Glossary

frond: a fern leaf

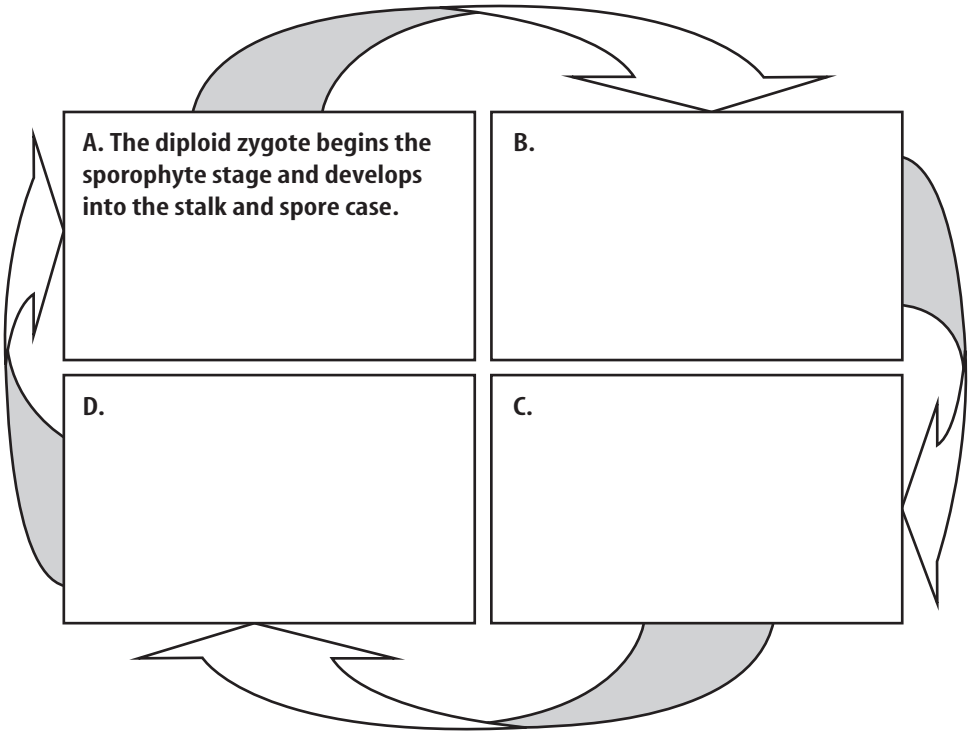
prothallus (proh THA lus): a small, green, heart-shaped gametophyte fern plant

rhizome: underground stem of a fern

sorus: a spore case where fern spores are produced

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the relationship between a frond and a sorus.

2. Complete the flow chart below to show the life cycle of a moss.



3. How does discussing what you have read help you remember the important ideas?

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End of Section

chapter 10

Plant Reproduction

section 3 Seed Reproduction

What You'll Learn

- the life cycles of most gymnosperms and angiosperms
- the structure and function of the flower
- the ways seeds are scattered

Before You Read

On the lines below, write the names of three fruits or vegetables. Next to each name, describe its seed.

_____

_____

_____

Study Coach

Define Terms Skim the text and write each key term on an index card. As you read the section, write the definition of each term on another index card. Use the cards to match the terms to their definitions as you review the important words in this section.

Read to Learn

The Importance of Pollen and Seeds

All plants described so far have been seedless plants. However, the fruits and vegetables that you eat come from seed plants. Oak, maple, and other shade trees also are produced by seed plants. All flowers are produced by seed plants. In fact, most plants on Earth are seed plants. Reproduction that involves pollen and seeds helps explain why seed plants are so successful.

What is pollen?

In seed plants, some spores develop into small structures called pollen grains. A **pollen grain** has a waterproof covering and contains male gametophyte parts that can produce sperm. The waterproof covering of a pollen grain can be used to identify the plant that the pollen grain came from.

The sperm of seed plants are part of a pollen grain. Pollen grains are carried by gravity, wind, water, or animals. The transfer of pollen grains of a species to the female part of the plant of the same species is called **pollination**.

After the pollen grain reaches the female part of the plant, a pollen tube is produced. The sperm moves through the pollen tube, then fertilization can happen.

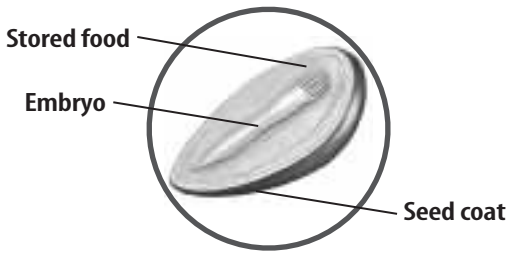
Reading Check

1. **Identify** one way a pollen grain reaches the female part of the plant.

_____

What are the three main parts of a seed?

After fertilization, the female part of a plant can develop into a seed. As shown in the figure below, a seed has three main parts, an embryo, stored food, and a protective seed coat. The embryo will grow to become the plant's stem, leaves, and roots. The stored food gives the embryo energy when it begins to grow into a plant. Because a seed contains an embryo and stored food, a new plant develops faster from a seed than from a spore.



Gymnosperms and Angiosperms Gymnosperms (JIHM nuh spurmz) and angiosperms are the two groups of seed plants. In gymnosperms, seeds usually develop in cones. In angioperms, seeds develop in flowers and fruit.

Gymnosperm Reproduction

Cones are the reproductive structures of gymnosperms. Gymnosperm plants include pines, firs, cedars, spruces, cycads, and ginkgoes. Each kind of gymnosperm has a different cone.

A pine tree is a gymnosperm. The way pines produce seeds is typical of most gymnosperms. The pine is a sporophyte plant that produces both male cones and female cones. Male and female gametophyte structures are produced in the cones, but they are very small. A mature female cone is made up of woody scales on a short stem. At the base of each scale are two ovules. The egg is produced in the **ovule**. Pollen grains are produced in the smaller male cones. In the spring, clouds of pollen are released from the male cones.

How are gymnosperm seeds produced?

Pollen is carried from the male cones to the female cones by the wind. The pollen must land between the scales of a female cone to be useful. There it can be trapped in the sticky fluid given off by the ovule. If the pollen grain and the female cone are the same species, fertilization can take place. It can take from two to three years for the seed to develop.

Picture This

2. Infer Circle the part of the seed that will become a plant.

FOLDABLES™

Categorize Make a folded chart, as shown below. Write facts in each block to describe the reproduction of gymnosperms and angiosperms.

Seed Reproduction	Reproductive Organs	Seeds
Gymnosperm Reproduction		
Angiosperm Reproduction		

Angiosperm Reproduction

Most seed plants are angiosperms. All angiosperms have flowers, which are the reproductive organs. Flowers have gametophyte structures that produce sperm or eggs for sexual reproduction.

Most flowers have four main parts—petals, sepals, stamen, and pistil, as shown in the figure below. The petals usually are the most colorful parts of the flower. Sepals often are small, green, leaflike parts. In some flowers, the sepals are as colorful and as large as the petals.

Inside the flower are the reproductive organs of the plant. The **stamen** is the male reproductive organ of the plant. The stamen has a thin stalk called a filament. On the end of the filament is an anther. Pollen grains form inside the anther. Sperm develop in each pollen grain.

The **pistil** is the female reproductive organ. It consists of a stigma, a long stalklike style, and an ovary. Pollen grains land on the stigma and move down the style to the ovary. The **ovary** is the swollen base of the pistil where the ovules are found. Eggs are produced in the ovules. Not all flowers have both male and female reproductive parts.

Reading Check

3. **Identify** the four main parts of a flower.

_____

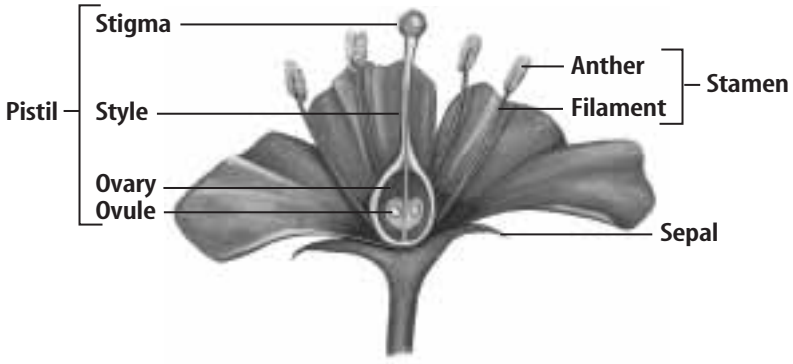
_____

_____

_____

Picture This

4. **Locate** Highlight the male reproductive structure. Circle the female reproductive structure.



Scarlet pimpernel

How is pollen spread?

Insects and other animals eat the flower, its nectar, or pollen. As insects and other animals move about the flower, they get pollen on their body parts. These animals spread the flower's pollen to other plants they visit. Some flowers depend on the wind, rain, or gravity to spread their pollen. Following pollination and fertilization, the ovules of flowers can develop into seeds.

How do angiosperm seeds develop?

A flower is pollinated when pollen grains land on a pistil. A pollen tube grows from the pollen grain. The pollen tube enters the ovary and reaches an ovule. The sperm then travels down the pollen tube and fertilizes the egg in the ovule. A zygote forms and grows into a plant embryo.

Parts of the ovule develop into the stored food and the seed coat that surround the embryo, and a seed is formed. The seeds of some plants, like beans and peanuts, store food in structures called cotyledons. The seeds of other plants, like corn and wheat, store food in a tissue called endosperm.

Reading Check

5. Identify Where is the egg fertilized?

_____

_____

Seed Dispersal

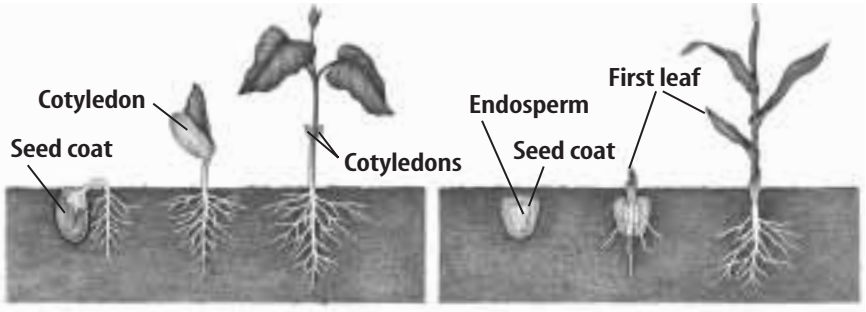
Some plant seeds are spread by gravity. They fall off the parent plant. Other seeds have attached structures, like wings or sails, which help the wind carry them.

Some seeds are eaten by animals and spread after the seeds are digested. Other seeds are stored or buried by animals. Raindrops can knock seeds out of dry fruit. Some fruits and seeds float on flowing water or ocean currents.

What is germination?

A series of events that results in the growth of a plant from a seed is called **germination**. Seeds will not germinate until the environmental conditions are right. Conditions that affect germination include temperature, light, water, and oxygen. Germination begins when seed tissues absorb water. This causes the seed to get larger and the seed coat to break open.

As you can see in the figure below, a root eventually grows from the seed. Then a stem and leaves grow. Once the plant grows above the soil, photosynthesis begins. Photosynthesis provides food as the plant continues to grow.



In beans, the cotyledons rise above the soil. As the stored food is used, the cotyledons shrivel and fall off.

In corn, the stored food in the endosperm remains in the soil and is gradually used as the plant grows.

Picture This

6. Locate Highlight the structure in each plant that stores food.

After You Read

Mini Glossary

germination: a series of events that result in the growth of a plant from a seed

ovary: the swollen base of the pistil where ovules are found

ovule: the place where eggs are produced

pistil: the female reproductive organ in the flower of an angiosperm

pollen grain: a small structure in seed plants that has a waterproof covering and that contains gametophyte parts that can produce sperm

pollination: the transfer of pollen grains to the female part of the plant

stamen: the male reproductive organ in the flower of an angiosperm

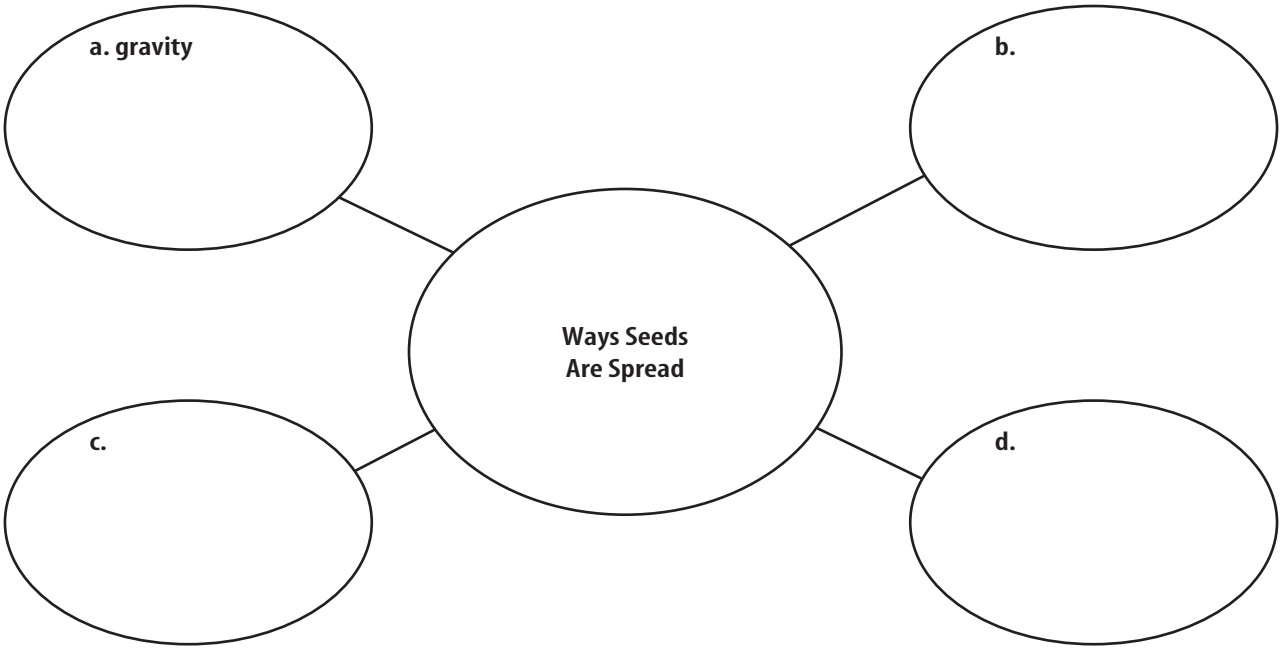
1. Review the terms and their definitions in the Mini Glossary. Write a sentence that describes either the male or the female reproductive organs of a flower.

_____

_____

_____

2. Complete the concept web below to identify the ways seeds are spread.



End of Section

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chapter 11

Plant Processes

section 1 Photosynthesis and Respiration

Before You Read

Name the parts of a plant that you have seen recently. For one of the parts, describe its function.

_____

_____

_____

What You'll Learn

- how plants take in and give off gases
- the differences and similarities between photosynthesis and respiration
- why photosynthesis and respiration are important

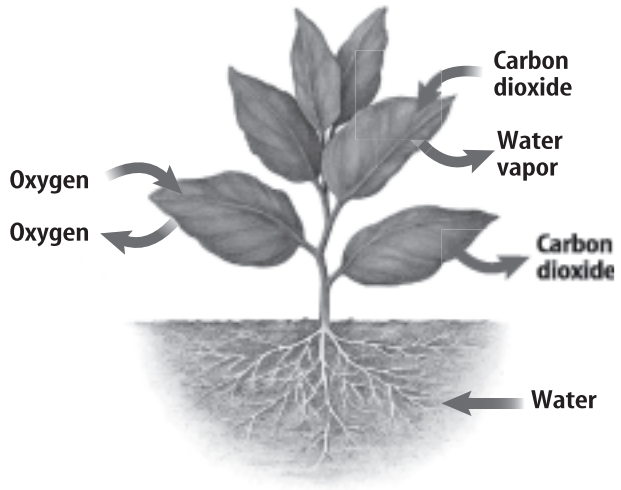
Read to Learn

Taking in Raw Materials

Plants make their own food using the raw materials water, carbon dioxide, and inorganic chemicals in the soil. Plants also produce wastes.

Which plant structures move water into the plant?

The figure below shows the plant structures that take in raw materials. Most of the water used by plants is taken in through the roots and moves through the plant to where it is used.



Study Coach

Summarize Main Ideas
Read the section. Recall and write down the main ideas. Go back and check the main ideas to make sure they are accurate. Then use your notes to summarize the main ideas of this section.

Picture This

1. **Identify** Circle the raw materials that a plant takes in.

What is the function of a leaf?

Gas is exchanged in the leaves. Most of the water taken in by the roots of a plant exits the plant through its leaves. Carbon dioxide, oxygen, and water vapor enter and exit the plant through openings in the leaves.

What is the structure of a leaf?

A leaf is made up of many different layers. The outer layer of the leaf is called the epidermis. The epidermis is nearly transparent and allows sunlight, which is used to make food, to reach the cells inside the leaf.

The epidermis has many small openings called **stomata** (stoh MAH tuh) (singular, *stoma)*. Raw materials such as carbon dioxide, water vapor, and waste gases enter and exit the leaf through the stomata. Many plants have stomata on their stems. Guard cells surround each stoma to control how much water enters and exits the plant. Stomata close when a plant is losing too much water.

As you can see in the figure below, the inside of a leaf is made up of a spongy layer and a palisade layer. Carbon dioxide and water vapor fill the spaces of the spongy layer. Most of the plant's food is made in the palisade layer.

Picture This

2. Identify Circle the part of the leaf where most of the plant's food is made.

Why are chloroplasts important?

Some cells of a leaf contain small green structures called chloroplasts. Chloroplasts are green because they contain a green pigment, or coloring, called **chlorophyll** (KLOR uh fihl). Chlorophyll is important to plants because the light energy that it absorbs is used to make food. This food-making process, photosynthesis (foh toh SIHN thuh suhs), happens in the chloroplasts.

Reading Check

3. Describe What happens in the chloroplasts?

The Food-Making Process

Photosynthesis is the process during which a plant's chlorophyll traps light energy and sugars are produced. In plants, photosynthesis occurs only in cells with chloroplasts. For example, photosynthesis occurs only in a carrot plant's green leaves. The carrot's root cells do not have chlorophyll, so they cannot perform photosynthesis. But excess sugar produced in the leaves is stored in the root. The familiar orange carrot you eat is the root of the carrot plant. When you eat a carrot, you benefit from the energy stored as sugar in the plant's root.

Plants need light, carbon dioxide, and water for photosynthesis. The chemical equation for photosynthesis is shown below.

$$6CO_2 + 6H_2O + \text{light energy} \xrightarrow{\text{chlorophyll}} C_6H_{12}O_6 + 6O_2$$

carbon dioxide — water — glucose — oxygen

What are light-dependent reactions?

Chemical reactions that occur during photosynthesis that need light are called the light-dependent reactions. During light-dependent reactions, chlorophyll and other pigments trap light energy that will be stored in sugar molecules. Light energy causes water molecules, which were taken up by the roots, to split into oxygen and hydrogen. The oxygen exits the plant through the stomata. This is the oxygen that you breathe. The hydrogen produced when water is split is used in light-independent reactions.

What are light-independent reactions?

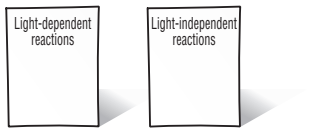
Chemical reactions that occur during photosynthesis that do not need light are called light-independent reactions. The light energy trapped during the light-dependent reactions is used to combine carbon dioxide and hydrogen to make sugars, such as glucose. The chemical bonds that hold glucose and other sugars together are stored energy.

What happens to the oxygen and glucose that are made during photosynthesis?

Most of the oxygen produced during photosynthesis is a waste product and is released through the stomata. Glucose is the main form of food for plant cells. A plant usually produces more glucose than it can use. The extra glucose is stored in plants as other sugars and starches. When you eat carrots or potatoes, you are eating the stored product of photosynthesis.

FOLDABLES™

A Describe Use two quarter-sheets of notebook paper, as shown below, to take notes about photosynthesis.



Think it Over

4. **List** two other foods that are stored products of photosynthesis.

How does a plant use glucose?

Glucose also is the basis of a plant's structure. Plants grow larger by taking in carbon dioxide gas and changing it to glucose. Cellulose, an important part of plant cell walls, is made from glucose. Leaves, stems, and roots are made of cellulose and other materials produced using glucose.

Why is photosynthesis important?

Photosynthesis produces food. Photosynthesis uses carbon dioxide and releases oxygen. This removes carbon dioxide from the atmosphere and adds oxygen to it. Most organisms need oxygen to live. About 90 percent of the oxygen in the atmosphere today is a result of photosynthesis.

Reading Check

5. **Determine** What does photosynthesis add to Earth's atmosphere?

_____

The Breakdown of Food

Cellular respiration is a series of chemical reactions that breaks down food molecules and releases energy. Cellular respiration uses oxygen and breaks down food chemically. The overall chemical equation for cellular respiration is shown below.

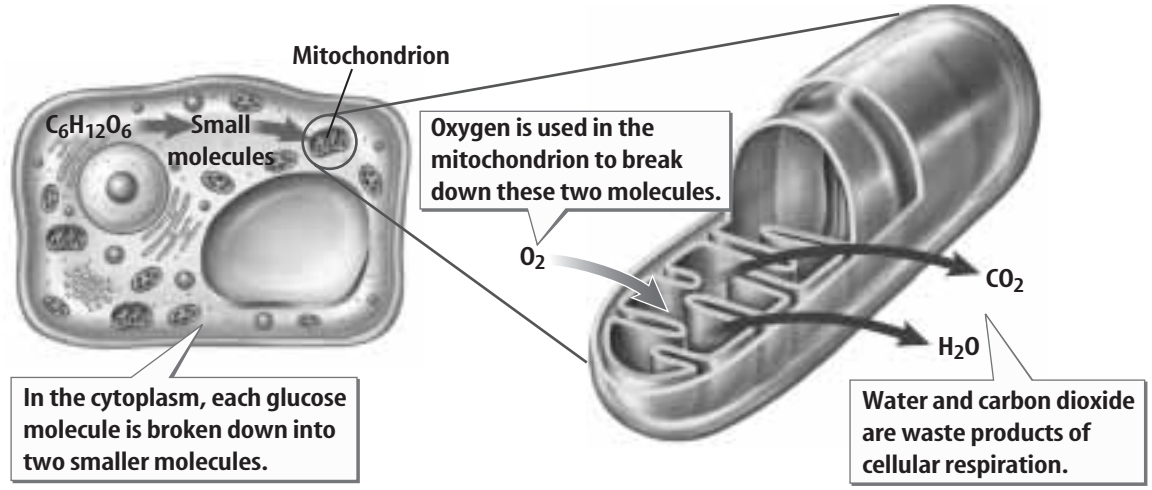
$$\underset{\text{glucose}}{C_6H_{12}O_6} + \underset{\text{oxygen}}{6O_2} \rightarrow \underset{\text{carbon dioxide}}{6CO_2} + \underset{\text{water}}{6H_2O} + \text{energy}$$

Where does cellular respiration occur?

Before cellular respiration begins, glucose molecules in the cytoplasm are broken down into two smaller molecules. These molecules enter a mitochondrion, where cellular respiration takes place. Oxygen is used and molecules break down into water and carbon dioxide and energy is release. The figure below shows cellular respiration in a plant cell.

Picture This

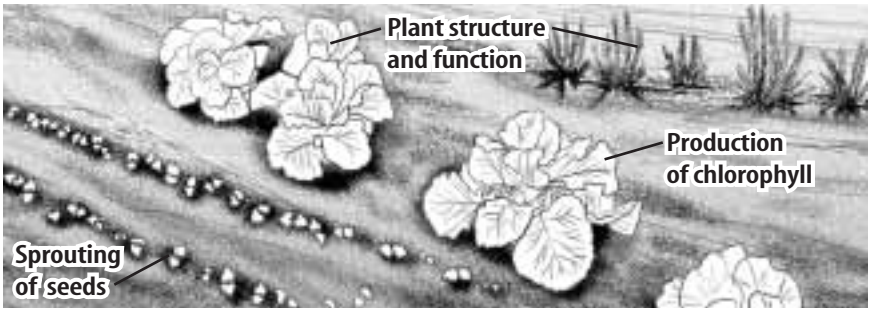
6. **Identify** Circle the part of the cell where aerobic respiration occurs. Highlight the waste products of cellular respiration.



Why is cellular respiration important?

Food contains energy. But it is not in a form that can be used by cells. Cellular respiration changes food energy into a form that cells can use. This energy drives the life processes of almost all organisms on Earth.

Plants use energy produced by cellular respiration to transport sugars, to open and close stomata, and to produce chlorophyll. When seeds sprout, they use energy from the respiration of stored food in the seed. The figure below shows some uses of energy in plants.



The waste product carbon dioxide also is important. Cellular respiration returns carbon dioxide to the atmosphere, where plants and some other organisms use it for photosynthesis.

Comparison of Photosynthesis and Cellular Respiration

Cellular respiration is almost the reverse of photosynthesis. Photosynthesis combines carbon dioxide and water by using light energy. The end products are glucose (food) and oxygen. Cellular respiration combines oxygen and food to release the energy in the chemical bonds of the food. The end products of cellular respiration are energy, carbon dioxide, and water. Look at the table below to compare the differences between photosynthesis and cellular respiration.

Comparing Photosynthesis and Cellular Respiration

	Photosynthesis	Cellular Respiration
Energy	stored	released
Raw materials	water and carbon dioxide	glucose and oxygen
End products	glucose and oxygen	water and carbon dioxide
Where	cells with chlorophyll	cells with mitochondria

Picture This

7. **List** two uses of energy produced by cellular respiration in plants.

Picture This

8. **Compare and Contrast** Highlight water and carbon dioxide for each process in one color and glucose and oxygen in another color.

After You Read

Mini Glossary

chlorophyll (KLOR uh fihl): a green pigment found in chloroplasts

photosynthesis (foh toh SIHN thuh suhs): the process during which a plant's chlorophyll traps light energy and sugars are produced

respiration: a series of chemical reactions that breaks down food molecules and releases energy

stomata (stoh MAH tah): small openings in the leaf epidermis, which act as doorways for raw materials to enter and exit the leaf

1. Review the terms and their definitions in the Mini Glossary. Write one or two sentences that explain the difference between photosynthesis and respiration.

2. Choose one of the question headings in the Read to Learn section. Write the question in the space below. Then write your answer to that question on the lines that follow.

Write your question here.

3. How did your notes help you summarize what you read in this section?

End of Section

ScienceOnline Visit **life.msscience.com** to access your textbook, interactive games, and projects to help you learn more about photosynthesis and respiration.

chapter 11

Plant Processes

section 2 Plant Responses

Before You Read

Have you ever been suddenly surprised? On the lines below, describe what surprised you and how your body responded to the surprise.

_____

_____

_____

What You'll Learn

- the relationship between a stimulus and a tropism in plants
- about long-day and short-day plants
- how plant hormones and responses are related

Read to Learn

What are plant responses?

A stimulus is anything in the environment that causes a response in an organism. A stimulus may come from outside (external) or inside (internal) the organism. An outside stimulus could be something that startles or surprises you. An inside stimulus is usually a chemical produced by the organism. Many of these chemicals are hormones. Hormones are substances made in one part of an organism for use somewhere else in the organism. The response to the stimulus often involves movement toward or away from the stimulus. All living organisms, including plants, respond to stimuli.

Tropisms

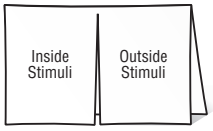
Some plant responses to external stimuli are called tropisms (TROH pih zumz). A **tropism** can be seen as movement caused by a change in growth. It can be positive or negative. A positive tropism would be growth toward a stimulus. A negative tropism would be growth away from a stimulus. You may have seen plants responding to touch, light, and gravity. Plants also can respond to electricity, temperature, and darkness.

Study Coach

Create a Quiz Write a quiz question for each paragraph. Answer the question with information from the paragraph.

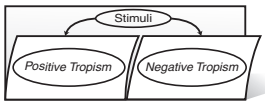
FOLDABLES™

B Compare Make a two-tab Foldable, as shown below, to compare inside and outside stimuli.



FOLDABLES™

C Explain Make a two-tab concept map Foldable, as shown below, to describe and list positive and negative tropisms.



Touch If a pea plant touches a solid object, it responds by growing faster on one side of its stem than on the other side. As a result, the stem bends and twists around any object it touches.

Light When a plant responds to light, the cells on the side of the plant opposite the light get longer than the cells facing the light. Because of this, the plant bends toward the light. The leaves turn and can absorb more light. This positive response to light is called positive phototropism.

Gravity Plants respond to gravity. The downward growth of plant roots is a positive response to gravity. A stem growing upward is a negative response to gravity.

Plant Hormones

Plants have hormones that control the changes in growth that result from tropisms and affect other plant growth. These hormones include ethylene, auxin, gibberellin, cytokinin, and abscisic acid.

How does ethylene affect plants?

Many plants produce the hormone ethylene (EH thuh leen) gas and release it into the air around them. This hormone helps fruits ripen. Ethylene also causes a layer of cells to form between a leaf and the stem. The cell layer causes the leaf to fall from the stem.

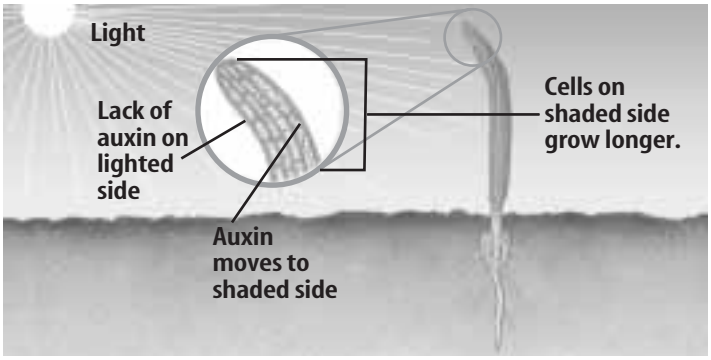
What is auxin?

The plant hormone **auxin** (AWK sun) causes a positive response to light in stems and leaves. The figure below shows the effect of auxin.

When light shines on a plant from one side, the auxin moves to the shaded side of the stem where it causes a change in growth. Auxin causes plants to grow toward light.

Picture This

1. **Describe** Use the figure to describe to a partner how auxin affects a plant's response to light.



How do gibberellins and cytokinins affect plant growth?

Two other groups of plant hormones also affect a plant's growth. Gibberellins (jih buh REH lunz) can be mixed with water and sprayed on plants and seeds to stimulate plant stems to grow and seeds to germinate. Cytokinins (si tuh KI nunz) promote growth by causing faster cell mitosis and division. Cytokinins can keep stored vegetables fresh longer.

How does abscisic acid affect plant growth?

Abscisic (ab SIH zihk) acid is a plant hormone that keeps seeds from sprouting and buds from developing during the winter. This hormone also causes stomata to close in response to water loss on hot summer days.

Photoperiods

A plant's response to the number of hours of daylight and darkness it receives daily is called **photoperiodism** (foh toh PIHR ee uh dih zum). Because Earth is tilted about 23.5° from a line perpendicular to its orbit, the hours of daylight and darkness change with the seasons. These changes in the hours of daylight and darkness affect plant growth.

How does darkness affect flowers?

Many plants must have a certain number of hours of darkness to flower. Plants that need less than 10 h to 12 h of darkness to flower are called **long-day plants.** These plants include spinach, lettuce, and beets. Plants that need 12 or more hours of darkness to flower are called **short-day plants.** These plants include poinsettias, strawberries, and ragweed. If a short-day plant receives fewer hours of darkness than it needs to flower, it will produce larger leaves instead of flowers.

What are day-neutral plants?

Plants that do not need a set number of hours of darkness to flower are called **day-neutral plants.** They can flower within a range of hours of darkness. These plants include dandelions and roses. Knowing the photoperiods of plants helps farmers and gardeners know which plants will grow best in the area where they live.

Reading Check

2. **Explain** How does abscisic acid affect plants?

Think it Over

3. **Infer** Why could you produce long-day flowering plants in a greenhouse during winter months?

After You Read

Mini Glossary

auxin (AWK sun): a plant hormone that causes plant stems and leaves to exhibit positive response to light

day-neutral plant: a plant that does not have a specific photoperiod to flower

long-day plant: a plant that needs less than 10 h to 12 h of darkness to flower

photoperiodism (foh toh PIHR ee uh dih zum): a plant's response to the number of hours of daylight and darkness it receives daily

short-day plant: a plant that needs 12 h or more of darkness to flower

tropism (TROH pih zum): a response of a plant to an external stimulus

1. Review the terms and their definitions in the Mini Glossary. Write one or two sentences to explain the differences among the long-day, short-day, and day-neutral plants.

2. Complete the cause-and-effect chart below to show how plant hormones affect plant growth.

Cause	Effect
Ethylene	
Auxin	
Gibberellin	
Cytokinin	

End of Section

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