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GRADE 8 • VOLUME 2



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5 Mirrors and Lenses

The BIG Idea
Mirrors and lenses form images by causing light rays to change direction.



LEARNING

5.1 Mirrors

- How do different types of mirrors form images?
- What are real images and virtual images?
- What are some examples of plane, convex, and concave mirrors?



LEARNING

5.2 Lenses

- In what ways do convex lenses and concave lenses bend light rays?
- What types of images do convex lenses and concave lenses form?
- How are lenses used to correct vision problems?



LEARNING

5.3 Optical Instruments

- What is the difference between a refracting telescope and a reflecting telescope?
- How does a microscope magnify images?
- How does a camera work?



Explore Activity

Experiment with Focal Lengths

Procedure

1. Read the procedure and safety information, and complete the lab form.
2. Fill a glass test tube with water, and seal it with a lid or a stopper.
3. Type or print the compound name SULFUR DIOXIDE in capital letters on a piece of paper or a note card.
4. Set the test tube horizontally over the words, and observe them. What do you notice?
5. Hold the tube 1 cm over the words, and observe them again. Record your observations. Repeat, holding the tube at several other heights above the words.

Analysis

1. Describe your observations of the words at the different distances.
2. Identify whether the image that you see at each height is real or virtual.

Essential Questions

- How do different types of mirrors form images?
- What are real images and virtual images?
- What are some examples of plane, convex, and concave mirrors?

Review Vocabulary

Reflection: the return of waves or particles from a surface

Vocabulary

- plane mirror
- virtual image
- concave mirror
- optical axis
- focal point
- focal length
- real image
- convex mirror

The BIG Idea

Reflections in a Mirror Ask students to describe how a typical bathroom mirror is different from a store security mirror. **A bathroom mirror is flat, but a store security mirror is curved outward. The store security mirror shows a wider, more distorted view than a bathroom mirror.** Then ask students how a makeup mirror is different from either of these other mirrors. **The makeup mirror can produce magnified reflections.** Tell students that they will study how different types of mirrors reflect light in this section.

LESSON **5.1** Mirrors

INQUIRY
Light from the lamp reflects off the book and into the person's eyes. People see objects when their eyes detect light emitted or reflected from those objects.

Write your response in your interactive notebook.



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Figure 1 Light from the lamp reflects off the book and into the person's eyes. People see objects when their eyes detect light emitted or reflected from those objects.

Mirrors

Light and Vision

Have you ever tried to find an address on a house or an apartment at night on a poorly lit street? It is harder to do those activities in the dark than it is when there is plenty of light. Your eyes see by detecting light, so when you can see something, it is because light came from that object to your eyes. Light is emitted from a light source, such as the Sun or a light bulb, and then reflects off an object, such as the page of a book, as shown in **Figure 1**.

When light travels from an object to your eye, you see the object. Light can reflect more than once. For example, light can reflect off an object into a mirror and then reflect into your eyes. When no light is available to reflect off objects and into your eyes, you cannot see anything. This is why it is hard to see an address in the dark.

Light rays Light sources send out light waves that travel in all directions. These waves spread out from the light source, just as ripples on the surface of water spread out from the point of impact of a pebble.

You could also think of the light coming from the source as traveling in narrow beams. Each narrow beam travels in a straight line and is called a light ray. Even though light rays can change direction when they are reflected or refracted, your brain interprets images as if light rays travel in a straight line.

Plane Mirrors

Greek mythology tells the story of a handsome young man named Narcissus who noticed his image in a pond and fell in

1 Focus

Tie to Prior Knowledge

Reflection Distortion Ask students whether they have ever looked at a rounded, shiny surface, such as a doorknob, and noticed that their reflection is distorted. In this section, students will learn how the shape of a mirror determines the type of reflection they see.

Set a Purpose Have students scan the text to find the new vocabulary terms. Be sure they look carefully at figures and headings for clues to meanings. Using ideas gleaned from scanning, have students develop questions that incorporate the vocabulary terms. As students read the text, they should answer each other's questions.

Two-Way Mirrors Psychologists and police sometimes secretly observe people using a two-way mirror, a coated window that only partially transmits light. If one side is in an illuminated room and the other is in a darkened room, the window acts as a mirror on the illuminated side and as a window on the darkened side. Have students debate whether use of this technology is an invasion of privacy. ■

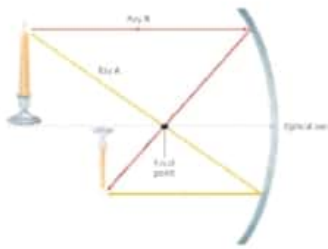


Figure 5 Ray A first passes through the focal point and then reflects parallel to the optical axis. Ray B is first parallel to the optical axis and then reflects through the focal point. An image of the candle forms where the two rays converge. Diagram how other points on the image of the candle are formed.

Ray tracing for concave mirrors You can diagram how concave mirrors form images by tracing some of the light rays involved. Suppose that the distance between an object, such as the candle in **Figure 5**, and the mirror is greater than the focal length. Light rays bounce off the candle in all directions. One light ray, labeled Ray A, starts from a point on the flame of the candle and passes through the focal point on its way to the mirror. Ray A is then reflected parallel to the optical axis.

Another ray, Ray B, starts from the same point on the candle's flame, but it travels parallel to the optical axis as it moves toward the mirror. The mirror then reflects Ray B through the focal point. The place where Ray A and Ray B meet after they are reflected is a point on the reflected image of the flame.

More points on the reflected image can be located in this way. From each point on the candle, one ray can be drawn that passes through the focal point and is reflected parallel to the optical axis. Another ray can be drawn that travels parallel to the optical axis and then reflects through the focal point. The point where the two rays meet is on the reflected image.

Real images The image that is diagrammed in **Figure 5** is not virtual. Rays of light pass through the location of the image. A **real image** is an image that is formed when light rays converge to form the image. You could hold a sheet of paper at the location of a real image and see the image projected on the paper.

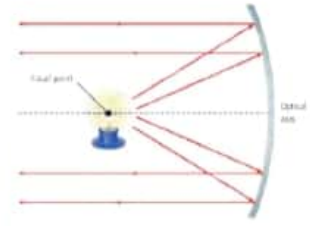
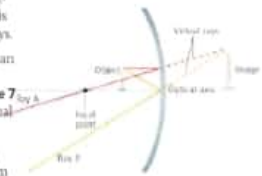


Figure 6 A light beam forms whenever someone places a light source at a concave mirror's focal point. Explain why the reflected rays of light in the diagram are parallel to each other.

Spotlights What happens when you place an object exactly at the focal point of a concave mirror? **Figure 6** shows that when the object is at the focal point, the mirror reflects all light rays parallel to the optical axis. The rays never meet, and no image forms. Even the virtual rays that extend behind the mirror do not meet. Therefore, a light placed at the focal point is reflected in a beam. Car headlights, flashlights, spotlights, and other devices use concave mirrors in this way to produce light beams with nearly parallel rays.

Mirrors that magnify A concave mirror magnifies an object when you place that object between the concave mirror and that mirror's focal point. **Figure 7** shows that the reflected rays diverge and a virtual image forms.



Just as it does with a plane mirror, your brain interprets the diverging rays as if they came from one point behind the mirror. You can find this point by imagining virtual rays that extend behind the mirror. The resulting image is magnified. Shaving mirrors and makeup mirrors are concave mirrors that are used for magnification. They form enlarged, upright images of a person's face so that it is easier to see small details.

Visual Learning

Figure 5 Have students work in pairs and take turns explaining to each other how rays from all parts of the candle are reflected off the concave mirror to form an image.

■ Caption Question Figure 5

Check students' answers. Student diagrams should show how light rays diverge from another point on the object and then converge at a corresponding point on the image.

Guiding Questions

- OL** How would the reflection of light from a concave mirror be different if the surface of the mirror were rough rather than smooth?
- At each individual point, the light rays would be reflected so that the angle of incidence equaled the angle of reflection. If the surface were rough, these angles would change from point to point, and the rays would be scattered. You would not see a clear image.

■ Caption Question Figure 6

The light source is located at the focal point.

Activity

Flashlight Study Have students open the top of a flashlight to see the shape of the reflector. Explain that if the flashlight had a spherical mirror, the light rays coming out from it would not be completely parallel. A parabolic reflector has a definite focal point for all rays, so it produces a narrower beam of light.

■ Caption Question Figure 7

The light rays do not converge to a point.

Quick Demo

Light Beams

Materials flashlight that has a rotating head to adjust the divergence of the light beam

Estimated Time 10 minutes

Procedure In a darkened room, show students that as you rotate the head, the beam spreads out. Explain that rotating the head moves the lightbulb back and forth about the focal point of the reflecting mirror, varying the divergence of the beam.

Science Journal

Solar Furnace Concave mirrors are used in solar furnaces, in which sunlight heats objects. Have students describe how they think a solar furnace works in their Science Journals. Students should include a description of where the object to be heated must be located. The rays from the Sun that strike the mirror are parallel. By the law of reflection, the rays reflect to the focal point, which becomes intensely hot. Therefore, the object to be heated should be located at the focal point.

Compare Science Words Many of the vocabulary terms in this section come in pairs: *real image* and *virtual image*, *focal point* and *focal length*, *concave mirror* and *convex mirror*. Have students write summaries of the similarities and differences between each pair of terms as they read the relevant sections.

Visualize It!



You see an object because your eyes detect the light reflected from that object.



Plane mirrors are smooth and flat.



A convex mirror curves outward.

Summarize It!

1. Why can't light rays pass through the location of a virtual image?

2. Describe the features of a concave mirror.

Use Vocabulary

1. **Diagram** how both concave mirrors and convex mirrors form images.

Critical Thinking

5. An object is less than one focal length from a concave mirror. How does the size of the image change as the object gets closer to the mirror?

Understand Key Concepts

2. **Identify** at least one example of a plane mirror, one example of a concave mirror, and one example of a convex mirror.

Math Skills

Finding the Mean

6. **Calculate Distance** If you stand 2 m away from a plane mirror, how far away does your reflection appear to be from you?

3. **Describe** the image of an object that is 38 cm from a concave mirror that has a focal length of 10 cm.

4. **Infer** whether a virtual image can be photographed.



1. Diagrams for the concave mirror should show light rays from a single point on the object bending inward after being reflected from the mirror. Diagrams for the convex mirror should show light rays from a single point on the object diverging after being reflected from the mirror.
2. Answers will vary. A typical wall mirror is a plane mirror. A makeup or shaving mirror is a concave mirror. A store security mirror is a convex mirror.
3. The image will be real, inverted, and smaller than the object.
4. Yes, the virtual image formed by the convex mirror in **Figure 8** has been photographed.
5. The image gets smaller.



LESSON 5.2 Lenses

INQUIRY
Lenses form images by refracting light rays.

Explore Activity

Water Lenses

Have you ever used a magnifying glass, a camera, a microscope, or a telescope? If so, you were using a lens to create an image. A lens is a transparent material that bends rays of light and forms an image. In this activity, you will use water to create a lens.

Procedure

1. Describe what you see when the pencil is inside the water cup.
2. Identify if the image that you see at each height is virtual or real.

Real-World Reading Link Anyone who wears glasses uses lenses to improve their vision. Without lenses, even people who do not wear glasses or contacts could not see. Each human eye contains a pair of lenses to help bring images into focus.

Explain

Essential Questions

In what ways do convex lenses and concave lenses bend light rays?

- What types of images do convex lenses and concave lenses form?
- How are lenses used to correct vision problems?

Review Vocabulary

Transparent: material that transmits light without scattering so that objects are clearly visible through it

New Vocabulary

convex lens
concave lens
cornea
retina

ExploreActivity

Water Lenses



Preparation Bring samples of printed texts to class, including some that have very small print, for students to observe.

Materials 10-cm × 10-cm piece of plastic wrap, printed text, water, dropper

Procedure Have students read and complete the lab safety form and follow the procedure below.

1. Set the plastic wrap on a page of printed text.
2. Place a small drop of water on the plastic. Look at the text through the drop. What do you observe?
3. Make your water drop larger, and observe the text through it again.
4. Carefully lift the piece of plastic wrap a few centimeters above the text, and look at the text through the water drop again.

Critical Thinking

5. Describe how the text looked in steps 2, 3, and 4. Why do you think water affects the way the text looks? What other materials might you use to change the appearance of the text?

In step 2, the text appeared enlarged and upright. In step 3, it appeared larger and still upright. In step 4, the text flipped and appeared upside down. As the light reflected from the text moves from the water to the air, it is refracted. Other possible materials include plastic, glass, and other transparent liquids and solids.

Introduce the Chapter

Investigate Lenses Divide the class into small groups, and give each group a magnifying lens. Have students look through the lens at a text page. Tell students to describe how the image of the text changes as the lens moves closer to and farther from the page.



The Reflection of Light When light waves strike a material, the light waves interact with the atoms in the material. As a result, light waves of the same frequency are re-emitted from the material's surface so that some of the incident wave energy is reflected. Each point on the surface of the material can be considered as a source of waves traveling away from the material. Alternatively, each point can also be considered as a source of light rays that travel in straight lines outward from the surface in all directions.

Use the Photo

Mirrors in Design Mirrors are used for artistic design as well as for functional technologies. Here, the interior dome of the German Parliament dome in Berlin (equivalent to the US Capitol dome) is shown. Ask students to estimate the number of mirrors in the German Parliament dome. **Estimates between 300 and 600 mirrors are reasonable.**



Assessment

Oral Ask students to make an events chain to describe the path of a light ray from the time it leaves a light source to the time it enters their eyes after passing through the drop of water. **The ray moves straight through the air from the light source. The light ray refracts toward the normal when it reaches the curved surface of the water. The light ray then passes through the water and reflects off the page. The light ray refracts again when it passes from the water back into the air. After this second refraction, the light ray travels straight to the students' eyes.**

1 Focus

Tie to Prior Knowledge

Eyeglasses Many students wear corrective lenses, either as eyeglasses or contact lenses. Ask students how eyeglasses work. **They cause light rays to refract before they enter your eyes.**

Predict Ask students what they think *convex lenses* and *concave lenses* are and how they interact with light. Have students preview the text to see whether their predictions are correct.

MAIN Idea

Lenses vs. Mirrors Ask students to brainstorm ideas of how a lens is different from a mirror. **Answers will vary. A mirror works by reflection, but a lens does not.** Ask students how a lens is similar to a mirror. **Answers will vary. Both lenses and mirrors redirect light.** Tell students that they will be learning about how lenses refract light in this section and that their prior knowledge of mirrors and reflections will help their understanding.

Visual Learning

Figure 9 You can point out two additional effects here: spherical aberration and chromatic aberration. For spherical aberration, a convex lens or a concave mirror fails to focus light to an exact point. This is due to imperfections in the shape of the mirror or lens. For chromatic aberration, a convex lens converges the different colors of visible light to different points. The resulting rainbow effect is visible in the figure.

■ Caption Question Figure 9


The focal point of the lens is at the point where the light rays converge.

2 Teach


Discussion

Reflection vs. Refraction What is the primary difference between lenses and mirrors? **Mirrors are designed to reflect light, but lenses are designed to refract light.**

Use Science Words

Word Origin Lenses were named because of the resemblance of an eye's lens to a small legume called a lentil. The Latin word for *lentil* is *lenticula*. Bring lentils to class so students can see the resemblance in shape. 

Activity

Convex Lenses Distribute to your class some convex lenses of varying focal lengths. Show students how to find the focal length of a lens by focusing the clearest possible image of an overhead light on a white piece of paper (held by a partner) and measuring the distance from the paper to the .

Discover

Before reading this lesson, write down what you already know in the first column. In the second column, write down what you want to learn. After you have completed this lesson, write down what you learned in the third column.

What I Know	What I Want to Learn	What I Learned
-------------	----------------------	----------------

Lenses

What is a lens?

What do your eyes have in common with cameras and eyeglasses? Each of these things contains at least one lens. A lens is a transparent material with at least one curved surface that causes light rays to bend, or refract, as those rays pass through the lens. The image that a lens forms depends on the shape of the lens. Like curved mirrors, a lens can be convex or concave.

All light rays traveling parallel to the optical axis in **Figure 9** are refracted so they pass through a single point, which is the focal point of the lens. The focal length of the lens depends on the shape of the lens. If the sides of a convex lens are less curved, light rays are bent less. As a result, lenses with flatter sides have longer focal lengths. **Figure 9** also shows that light rays traveling along the optical axis are not bent at all.

Convex Lenses

A **convex lens** is a lens that is thicker in the middle than at the edges. Its optical axis is an imaginary straight line that is perpendicular to the surface of the lens at its thickest point. When light rays approach a convex lens traveling parallel to its optical axis, the rays are refracted toward the center of the lens, as shown in **Figure 5**.



Figure 9 A convex lens bends light inward, toward the optical axis. A light ray that passes straight through the center of the lens does not refract. **Identify the focal point of the lens.**

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Forming images with convex lenses

The type of image that a convex lens forms depends on where the object is relative to the focal point of the lens, as shown in the bottom panel of **Figure 10**. If an object is more than two focal lengths from the lens, the image is virtual because the light rays from the object are not converging after they have passed through the lens. When you use a magnifying glass, the object is between one and two focal lengths from the lens. Now the image is larger than the object but is still inverted.

As the object moves closer to the lens, the image gets larger. The middle panel of **Figure 10** shows the image formed when the object is between one and two focal lengths from the lens. Now the image is larger than the object but is still inverted.

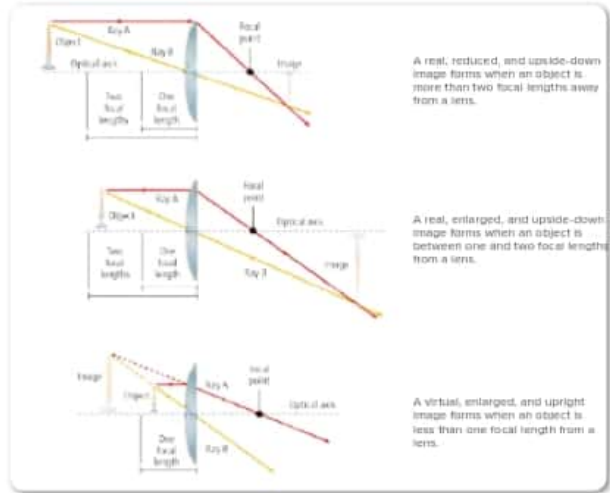


Figure 10 The image that a convex lens forms depends on the relative positions of the lens and the object. **Identify the type of mirror that produces images that are similar to the images produced by a convex lens.**

Lesson 5.2 Lenses 179

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Visual Learning

Figure 10 Have students make sketches of the candle and lens with the candle at various distances from the lens. Suggested distances include more than two focal lengths, exactly two focal lengths, between one and two focal lengths, exactly one focal length, and less than one focal length. For each sketch, have students draw in a ray diagram to determine the size, position, and orientation of the candle's image.

■ Caption Question Figure 10

A concave mirror produces images that are similar to the images produced by a convex lens.

■ Caption Question Figure 11

A concave lens behaves more like a convex mirror.

Use an Analogy

Prisms Convex and concave lenses refract light much like two prisms joined together. When the prisms are joined at the base so that they are thick at the middle, a beam of light will be refracted downward by the upper prism and upward by the lower prism. In this case, the two prisms act like a convex lens. When the two prisms are joined at the apex, a beam of light will be refracted upward by the upper prism and downward by the lower prism, producing the effect of a concave lens. ■

Teacher FYI

Converging and Diverging Lenses Convex lenses are also often called converging lenses because they cause light to converge to a focal point. Concave lenses are also often called diverging lenses because they cause light to diverge.

Demonstration

Image Formation



Purpose to observe images with convex and concave lenses

Materials convex and concave lenses, optical bench with lens holders, tape, pencil

Estimated Time 10 minutes

Procedure Place a convex lens in a holder on the bench. Using tape, mark one and two focal lengths from the lens. Hold a pencil more than two focal lengths from the lens, between one and two focal lengths from the lens, and less than one focal length from the lens. At each position, have students look through the lens. Repeat using a concave lens.

Expected Outcome Students should see images similar to those in **Figure 10**.

Assessment Ask students to explain why the image flips as the pencil moves closer to the lens when the convex lens is used. **When the image flips, the light rays have gone from truly converging below the optical axis (producing a real image) to appearing to converge above the optical axis (producing a virtual image).**

Concave Lenses

A **concave lens** is a lens that is thinner in the middle and thicker at the edges. As shown in **Figure 11**, light rays that pass through a concave lens bend outward, away from the optical axis. The rays spread out and never meet at a focal point, so they never form a real image. However, a concave lens can form virtual images. These virtual images are always upright and smaller than the actual object. Notice that concave lenses and convex mirrors both produce the same types of images.

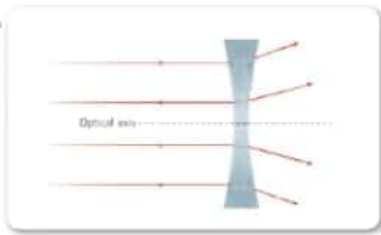


Figure 11 A concave lens causes light rays to diverge.
Classify Does a concave lens behave more like a concave mirror or a convex mirror?

Concave lenses are used in some types of eyeglasses and in some microscopes. Concave lenses are usually placed in combination with other lenses. A summary of the images formed by concave and convex lenses is shown in **Table 2**.

Lens Shape	Location of Object	Virtual/Real	Type of Image Upright/Inverted	Size
Convex	object beyond 2 focal lengths from lens	real	inverted	smaller than object
	object between 1 and 2 focal lengths	real	inverted	larger than object
	object within 1 focal length	virtual	upright	larger than object
Concave	object at any position	virtual	upright	smaller than object

Apply Science

How do object distance and image distance compare?

The size and orientation of an image formed by a lens depends on the location of the object and on the nature of the lens. Convex lenses form both real images and virtual images. Concave lenses can form only virtual images. What happens to the location of the image formed by a lens as the object moves closer to or farther from the lens? The distance from the lens to the object is the object distance, and the distance from the lens to the image is the image distance. How are the focal length, object distance, and image distance related to each other?

Identify the Problem

A 5-cm-tall object is placed at different lengths from a convex lens with a focal length of 15 cm. The table at the right shows the different object and image distances. How are these two measurements related?

Focal Length (cm)	Object Distance (cm)	Image Distance (cm)
15.0	45.0	22.5
15.0	30.0	30.0
15.0	20.0	60.0

Solve the Problem

1. Describe the relationship between the object distance and the image distance.
2. The lens equation describes the relationship between the focal length and the image and object distances.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

f: focal length d_o: object distance d_i: image distance

Using this equation, calculate the image distance when the object is placed at a distance of 60.0 cm from the lens.

Describe

List the main ideas from this section in the box below.



Apply Science

1. Given the same focal length, as the object distance increases, the image distance decreases.

2. $\frac{1}{\text{image distance}} = \frac{1}{15.0} - \frac{1}{60.0}$
 $0.067 - 0.017 = 0.05$;
 image distance = $\frac{1}{0.05}$
 = 20 cm

Identify Misconceptions

Human Corneas Students might assume that rays of light pass through the cornea unaffected. In fact, the cornea does about two-thirds of the focusing and is responsible for many human vision problems. The flexible lens does the fine focusing.

Reflection Tell students to suppose that they are rays of light from a distant object. Ask them to write a description of their journey through the human eye.

Visual Learning

Figure 12 Have students visit connected.mcgraw-hill.com to view an animation on how the eye works.

Fun Fact

Vertebrates, cephalopods, and some spiders have camera-like eyes with variable focusing. Worms, mollusks, and some crustaceans and insects have simple eyes that can distinguish light and dark. Most arthropods have compound eyes, with many separate lenses, each of which forms its own image.

Reading Check

1. The cornea causes the light rays entering your eye to bend so that they converge.

Demonstration

Explore an Eye

Purpose to explain how the human eye works

Materials model of a human eye

Estimated Time 20 minutes

Procedure Allow students to explore the model and study the cornea, lens, and retina. Have students explain how light enters through the cornea and is refracted onto the retina. Point out the muscles that adjust the size of the lens, and note the optic nerve, which carries information about images to the brain.

Expected Outcome Students will explain that light enters the eye through the cornea, which does most of the refraction. The eye lens then performs the fine focusing to project a real image onto the retina.

Assessment What would happen if a person could not adjust the shape of his or her eye lens? **He or she would not be able to focus on objects.**

The Invention of Spectacles Have students investigate the invention and history of eyeglasses. **The first eyeglasses seem to have been developed over 700 years ago in Italy. By the early fourteenth century, the Venetian Glassmakers Guild had imposed regulations forbidding the use of glass instead of quartz crystal to make spectacles. For hundreds of years eyeglasses were extremely expensive, but their use slowly became more widespread. By the middle of the twentieth century, plastic lenses had been developed. These replaced the thick, heavy glass lenses that had been in use for centuries.**

Fun Fact

Eyeglasses were used as early as the thirteenth century. The Greeks and Arabs used crystals as natural magnifying glasses even earlier.

Use Science Words

Word Meaning Have students break the word *astigmatism* into its parts, then find out what each part means and what it contributes to the meaning of the whole word. **A-**, without; **stigma**, point; **-ism**, state or condition **A** stigmatism is the condition of not having a point or a focus. **A**

Differentiated Instruction

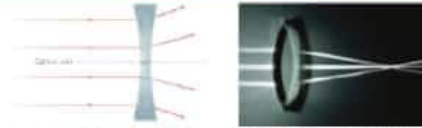
BL Struggling Learners If students have trouble remembering which type of curved surface is concave and which is convex, tell them to remember that a concave surface is curved inward like a cave. To practice using this mnemonic, have them name some curved surfaces and identify them as concave or convex.

My Notes

Lined area for taking notes.

LESSON 5.2 Review

Visualize It!



A concave lens is thinner in the middle and thicker at the edges. Light rays are refracted away from the optical axis. A convex lens is thicker in the middle than at the edges. Light rays are refracted toward the optical axis.

Summarize It!

1. What does the image formed by a convex lens depend upon?

Blank lines for answering question 1.

2. What two parts of the eye focus light onto the retina?

Blank lines for answering question 2.

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1. Check student sketches. A convex lens should cause light rays to converge. A concave lens should cause light rays to diverge.
2. The image less than one focal length from the lens is enlarged, upright, and virtual. The image more than two focal lengths from the lens is reduced, inverted, and real.
3. A concave lens forms a virtual, upright, reduced image.
4. Vision problems occur when the cornea and eye lens do not form images on the retina. The lenses in eyeglasses refract light so that images form on the retina.

5. Light rays from the light source will be refracted by the lens so they travel parallel to the optical axis. A beam of light will be formed.

Math Skill

6. A real, inverted, enlarged image is formed when the object is between one and two focal lengths from the lens. The maximum distance from the lens would be two focal lengths (30 cm).

5.3 Optical Instruments

INQUIRY

Optical instruments, such as cameras, telescopes, and microscopes allow us to see things that we could not see without them.

Write your response in your interactive notebook.



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الرحمن
2018

Explore Activity

Optical instruments

Lenses and mirrors are used to make objects easier to see.

Analysis

- Optical instruments, such as cameras, telescopes, and microscopes allow us to see things that we could not see without them.
- Identify if the image that you see at each height is virtual or real.

Real-World Reading Link With a good digital camera, you can zoom in on distant objects, bring them into focus, and record images to view later.

Explain

Essential Questions

- What is the difference between a refracting telescope and a reflecting telescope?
- How does a microscope magnify images?
- How does a camera work?

Review Vocabulary

Refraction: the change in direction of a wave when it changes speed as it moves from one medium to another

Vocabulary

refracting telescope
reflecting telescope
microscope

1 Focus

Tie to Prior Knowledge

Blurry Pictures Ask students whether they have ever taken a blurry picture with a digital camera or cell phone camera. Have them suggest why this might have happened. **The camera or object might have moved, or the image might not have been focused on the image sensor.**

Activate Background Knowledge Ask students if they have ever used a telescope, microscope, or digital camera. Then have students describe how each of these devices works. Tell students that they will learn more about each of these devices in this section.

MAIN Idea

Telescopes and Microscopes

Ask students how a telescope makes objects easier to see. **A telescope makes faraway objects appear to be much closer.** Ask students how a microscope makes objects easier to see. **A microscope makes small objects appear to be much larger.**

Guiding Questions

OL What kinds of knowledge might scientists gain from telescopes?

Possible answers: how the universe began and how old it is; how stars form; the dynamics of pulsars, quasars, and black holes; information about planets outside our solar system

Teacher FYI

Telescope Inventors The identity of the inventor of the first true telescope is uncertain, but credit is often given to Hans Lippershey of Holland. Galileo heard of Lippershey's "looker" and made an improved version that he used to study the sky. Among Galileo's discoveries were sunspots, four moons of Jupiter (called the Galilean Moons), and the phases of Venus.

Optical Instruments

Telescopes

You know from your experience that it is difficult to see faraway objects clearly. When you look at an object, only some of the light reflected from its surface enters your eyes. As you move farther away from the object, the amount of light entering your eyes decreases, as shown in **Figure 16**. As a result, the object appears dimmer and less detailed.

A telescope uses a lens or a concave mirror that is much larger than your eye to gather more of the light from distant objects. The largest telescopes can gather more than a million times more light than the human eye. As a result, objects such as distant galaxies appear much brighter. Because the image formed by a telescope is so much brighter, more detail can be seen when the image is magnified.

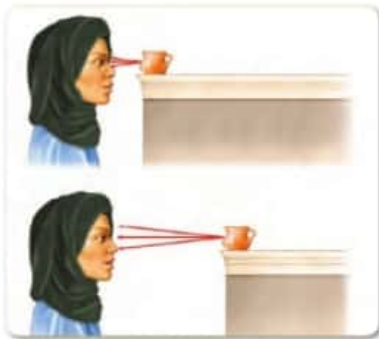


Figure 16 All three of the light rays reflected off the mug enter the girl's eye in the top panel, but only one of those light rays enters the girl's eye in the bottom panel. As the girl gets farther away, fewer light rays reflected from the mug enter the girl's eyes.



Figure 17 A refracting telescope uses an objective lens and an eyepiece lens to gather light from distant objects so that scientists can observe and study those objects.

Refracting telescopes One common type of telescope is the **refracting telescope**. A telescope that uses lenses to gather light from distant objects is called a refracting telescope. A simple refracting telescope, shown in **Figure 17**, uses two convex lenses to gather and focus light from distant objects.

Incoming light from distant objects passes through the first lens, called the objective lens. Light rays from distant objects are nearly parallel to the optical axis of the lens. As a result, the objective lens forms a real image at the focal point of the lens, within the body of the telescope.

The second convex lens, called the eyepiece lens, magnifies this real image. When you look through the eyepiece lens, you see an enlarged, inverted, virtual image of the real image formed by the objective lens.

In order to form detailed images of distant objects, the objective lens of a refracting telescope must be as large as possible. A telescope lens can sag or flex due to its own weight, distorting the image that it forms. Another class of telescopes, called reflecting telescopes, do not have this problem.

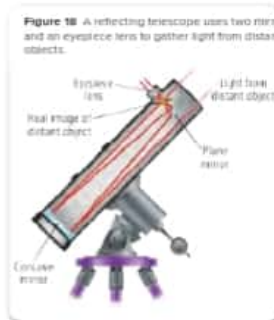


Figure 18 A reflecting telescope uses two mirrors and an eyepiece lens to gather light from distant objects.

Reflecting telescopes A telescope that uses mirrors and lenses to collect and focus light from distant objects is a **reflecting telescope**. Mirrors, unlike lenses, can be supported from behind. This additional support for mirrors prevents mirrors from sagging inside reflecting telescopes. As a result, reflecting telescopes can be much larger than refracting telescopes. **Figure 18** shows a reflecting telescope.

For this reflecting telescope, light from a distant object enters one end of the telescope and strikes a concave mirror at the opposite end. The light reflects off this mirror and converges. Before it converges at a focal point, the light hits a plane mirror inside the telescope tube. The light is then reflected from the plane mirror toward the telescope's eyepiece. The light rays converge at the focal point, creating a real image of the distant object. Just like a refracting telescope, a convex lens in the eyepiece then magnifies this image.

2 Teach

Demonstration Telescopes

Purpose to observe distant objects through both a refracting telescope and a reflecting telescope

Materials refracting telescope, reflecting telescope, several telescope eyepieces

Estimated Time 30 minutes

Procedure Allow students to look through both a refracting telescope and a reflecting telescope at a distant object. Change the eyepiece in each telescope and allow students to look again. **WARNING: Never look at the Sun or other bright objects through a telescope.**

Expected Outcome If the reflecting telescope is significantly larger than the refracting telescope, then students might notice that the image is significantly sharper and brighter in the reflecting telescope. Students should also note that changing the telescope eyepiece changes the magnification of the image.

Assessment Is it more useful for a telescope to magnify images or for a telescope to produce sharp (not blurry) images? **It is more useful for a telescope to produce sharp images. The magnification of the image can be changed by changing the eyepiece or processing the image on a computer. However, increasing the magnification of an image will not increase the sharpness of that image.**

Science Journal Mystery Element

The reflective coating on many telescope mirrors used to be made of a valuable metallic element. Have students write the name of this element, its chemical symbol, and its atomic number in their Science Journals. **silver, Ag, atomic number 47**

Teacher FYI

Types of Reflecting Telescopes There are many types of reflecting telescopes. The reflecting telescope described on this page is called a Newtonian telescope after its inventor, Isaac Newton. Other types of reflecting telescopes are Schmidt-Cassegrain telescopes and Gregorian telescopes. All reflecting telescopes employ concave mirrors to gather and focus light from distant objects.

It forms a real, enlarged image of the object because the distance from the object to the lens is between one and two focal lengths. The real image is then magnified again by the eyepiece lens (another convex lens) to create a virtual, enlarged image. This final image can be hundreds of times larger than the actual object, depending on the focal lengths of the two lenses. The total magnification is the magnification of the objective times the magnification of the eyepiece.

Cameras

With the click of a button, you can capture a beautiful scene in a photo. How does a digital camera make a reduced image of a life-sized scene? **Figure 21** shows the path that light follows as it enters a camera from a distant object. The light rays from distant objects are almost parallel to each other. When you take a picture with a camera, a shutter opens to allow light to enter the camera for a specific length of time.

The light reflected off the object enters the camera through an opening called the aperture. The camera lens focuses the image onto an image sensor, which converts light into electric signals. A computer then processes these signals into an image that can be displayed on a screen or printed.

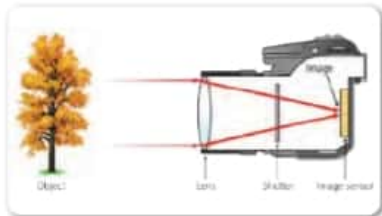


Figure 21 A camera's lens focuses an image onto the image sensor. An image sensor converts the light from an image into a set of electric signals. Compare a digital camera with the human eye.

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■ Caption Question Figure 20

The light source is positioned so that it shines through the bug, up through the microscope tube, and into the eye of someone looking in the microscope.

Visual Learning

Figure 20 Point out that the eyepiece is typically a system of multiple lenses although it performs as a single convex lens. Similarly, the objective is actually a combination of lenses that performs as a single convex lens. Although a single lens is possible for each, the combination of lenses provides clearer images.

■ Caption Question Figure 21

The lens of a digital camera functions like the cornea of a human eye. The image sensor of a digital camera functions like the retina of a human eye. Focusing is similar to how the eye lens focuses.

How SCIENCE Works

Light from distant stars and galaxies reaches Earth day and night. Telescopes capture this light, helping astronomers study the universe. The next generation of telescopes might be able to detect Earth-like planets and uncover secrets of the ancient universe. Three teams are racing to build the world's next giant telescope.

Telescope	Area of Primary Mirror (m ²)
Gran Telescopio Canarias	85 (This is about the area of six parking lot spaces.)
Giant Magellan Telescope	470 (This is about the area of a basketball court.)
Thirty Meter Telescope	700 (This is about the area of a baseball infield.)
European Extremely Large Telescope	1,400 (This is about the area of five tennis courts.)

Light buckets Telescopes are light buckets, and telescope builders want to catch as much light in their buckets as possible. The larger the telescope's mirror, the more light that the telescope catches. The more light captured, the fainter the objects that the telescope can detect.

Instead of collecting light from a single, continuous mirror, the next generation of telescopes will have mirrors made from many segments, as shown in **Figure 1**. A segmented mirror is more stable than a continuous mirror. As a result, a telescope with a segmented mirror can be much larger than a telescope with a continuous mirror.

Possible new telescopes The largest optical telescope in operation today is the Gran Telescopio Canarias. The primary mirror for this telescope has an area of 85 m². The smallest candidate for the world's next great telescope is the Giant Magellan Telescope (GMT), which would have a segmented mirror with a total area of 470 m². **Table 1** summarizes the properties of the GMT as well as other possible future telescopes.

Figure 1 The next generation of giant telescopes will use carefully fitted, segmented mirrors rather than a single, continuous mirror to reflect ancient light.



Race to first light The first of the new telescopes to peer into the sky will open a new universe of discovery. The race is not so much to be the biggest but to be first. Even the smallest of these new telescopes would be large enough to be the first to spot planets circling nearby stars, as well as spot the oldest and most distant objects ever seen.

Writing Draft a persuasive letter to a prospective donor, describing why your giant telescope deserves the tens of millions of dollars in funding needed for construction and operation.

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Summarize Have students write summaries that describe how refracting telescopes, reflecting telescopes, microscopes, and digital cameras work. Students should include a sketch or diagram for each device.

3 Assess

Check for Understanding

Interpersonal Have students look through a microscope and then discuss how the adjustments they make to the microscope focus affects the positions of the lenses inside the microscope tube.

Reteach

Convex Lenses Refracting telescopes, microscopes, and digital cameras all rely on convex lenses in order to function. Point out that convex lenses produce real images, but concave lenses do not.

Assessment

Process Show students sketches of the light paths for the optical instruments described in this section. For each light path sketched, have students identify the device that would produce that light path. Then have students describe the types of images produced by each device.

Differentiated Instruction

OL **AL** **Challenge** Ask students to describe what you would have to do to change a microscope into a refracting telescope. You would have to make the objective lens bigger so it could gather more light. Having done that, you would have to lengthen the distance between the objective and the eyepiece to accommodate the longer focal distance of the larger objective lens.



My Notes

Lined area for taking notes.

LESSON

5.3 Review

Visualize It!



Reflecting telescopes use two convex lenses to gather light and focus it. A camera lens focuses light to gather an image sensor. A microscope uses two convex lenses with short focal lengths to magnify small, close objects.

Summarize It!

1. How do reflecting telescopes collect, reflect, and focus light?
2. In order to avoid the distorting effects of Earth's atmosphere, what can be done with a telescope?



1. More light enters the lens, making the images brighter and more detailed.
2. The image will be real, enlarged, and inverted.
3. It is easier to make very large concave mirrors than convex lenses because mirrors need be polished only on one surface. Mirrors can also be supported from the back so they don't bend under their own weight.
4. A camera; both adjust to focus on near and far objects, control the amount of light that enters, form real and inverted images, and focus an image on a light-sensitive surface.

Math Skill

5. $1,000 \times$

Grid area for math calculations.

Optical Instruments

Use Vocabulary

1. **Identify** the advantage to making the objective lens larger in a refracting telescope.

Understand Key Concepts

2. **Describe** the image formed by the objective lens in a microscope.

3. **Explain** why the largest telescopes are reflecting telescopes instead of refracting telescopes.

Critical Thinking

4. **Think Critically** Which optical instrument—a telescope, a microscope, or a camera—forms images in a way most like your eye? Explain.

Math Skills

Finding the Mean

5. **Calculate Magnification** Suppose the objective lens in a microscope forms an image that is 100 times the size of an object. The eyepiece lens magnifies this image 10 times. What is the total magnification?

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LESSON

5 Chapter Review

Use Vocabulary

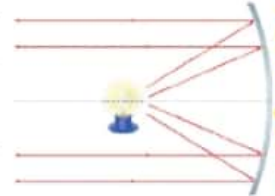
Complete each sentence with the correct term from the Study Guide.

1. A flat, smooth surface that reflects light and forms an image is a(n) _____.
2. A(n) _____ uses two convex lenses to magnify small, close objects.
3. Every light ray that travels parallel to the optical axis before hitting a concave mirror is reflected such that it passes through the _____.
4. A(n) _____ is thicker in the middle than at the edges.
5. The inner lining of the eye that converts light images into electric signals is called the _____.

Check Concepts

6. Which best describes image formation by a plane mirror?
 - A) A real image is formed in front of the mirror.
 - B) A real image is formed behind the mirror.
 - C) A virtual image is formed in front of the mirror.
 - D) A virtual image is formed behind the mirror.
7. Which can form an enlarged image?
 - A) convex mirror
 - B) plane mirror
 - C) convex lens
 - D) concave lens
8. Which is NOT part of a reflecting telescope?
 - A) plane mirror
 - B) concave mirror
 - C) convex lens
 - D) concave lens

Use the figure below to answer question 26.



9. Which is being used in the figure above?
 - A) concave lens
 - B) convex lens
 - C) concave mirror
 - D) convex mirror
10. What do lenses do?
 - A) reflect light
 - B) refract light
 - C) diffract light
 - D) interfere with light

Use the figure below to answer question 28.



The BIG Idea

11. Which way does the lens shown bend light that is parallel to the optical axis?
 - A) toward its optical axis
 - B) toward its focal point
 - C) away from its optical axis
 - D) away from its edges
12. What type of lens is used to correct farsightedness?
 - A) flat lens
 - B) convex lens
 - C) concave lens
 - D) plane lens

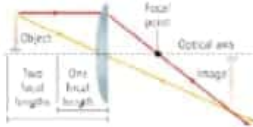
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Mirrors and Lenses

Standardized Test Practice

Interpret Graphics

Use the figure below to answer question 30.



- Suppose the image of the candle moves away from the focal point. How did the position of the candle change?
- Copy and complete the following table about image formation by lenses and mirrors.

Image Formation by Lenses and Mirrors

Type of Lens or Mirror	Position of Object	Type of Image
Concave lens	all positions of object	virtual, upright, reduced
Convex lens	closer than one focal length	a.
	between one and two focal lengths	b.
Concave mirror	farther than two focal lengths	real, inverted, reduced
	closer than one focal length	c.
Convex mirror	object placed at focal point	d.
	farther than two focal lengths	e.
Convex mirror	all positions of object	f.

Think Critically

- Infer** Could a person who is nearsighted use his or her glasses to focus light and start a fire?
- THINK-FOCUS** Compare and contrast a refracting telescope and a microscope.
- Infer** why a convex mirror and a concave lens can never produce a real image.
- Explain** The top half of a bifocal lens helps a person to focus on distant objects. The bottom half of a bifocal lens helps a person to focus on nearby objects. Why might a person need glasses with bifocal lenses?
- Infer** why it would be easier to make a concave mirror for a reflecting telescope than an objective lens of the same size for a refracting telescope.
- Compare** A concave lens made of plastic is placed in a liquid. Light rays traveling in the liquid are not refracted when they pass through the lens. Compare the speed of light in the plastic and in the liquid.

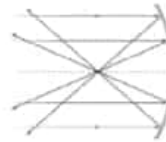
Apply math

- Calculate Magnification** The magnification of a refracting telescope can be calculated by dividing the focal length of the objective lens by the focal length of the eyepiece lens. If an objective lens has a focal length of 1 m and the eyepiece has a focal length of 1 cm, what is the magnification of the telescope?
- Infer Object Distance** You hold an object in front of a concave mirror with a 30-cm focal length. You don't see a reflected image. How far from the mirror is the object?

Multiple Choice Aligned with TIMSS Study

- How far is an object from a concave mirror if the image formed is upright?
 - one focal length
 - less than one focal length
 - more than two focal lengths
 - two focal lengths

Use the figure below to answer questions 2 and 3.



- Which describes a light ray that passes through the focal point and then is reflected by the mirror?
 - It travels parallel to the optical axis.
 - It forms a real image.
 - It is reflected back through the focal point.
 - It forms a virtual image.
- If the mirror becomes flatter and the focal point moves farther from the mirror, which best describes the reflection of the parallel rays shown in the figure?
 - They pass through the old focal point.
 - They do not pass through either the old or the new focal point.
 - They pass through the new focal point.
 - They reverse direction.

- Which describes the image formed by a convex mirror?
 - real
 - enlarged
 - inverted
 - virtual
- What is an advantage to increasing the diameter of the concave mirror in a reflecting telescope?
 - The mirror forms brighter images.
 - The mirror forms larger images.
 - The mirror forms more magnified images.
 - The focal length increases.

Use the table below to answer questions 6-8.

Object Distance (cm)	Image Distance (cm)	Magnification
250.0	62.5	0.25
200.0	66.7	0.33
150.0	75.0	0.50
100.0	100.0	1.00
75.0	150.0	2.00

- How does the image change as the object gets closer to the lens?
 - It gets larger.
 - It gets smaller.
 - It gets closer.
 - It becomes real.
- Which is the best estimate of the magnification if the object is 225 cm from the lens?
 - 0.20
 - 0.30
 - 64
 - 68
- What should the object distance be if the lens is to be used as a magnifying glass?
 - 150 cm
 - 100 cm
 - greater than 250 cm
 - less than 100 cm

Use Vocabulary

- plane mirror
- microscope
- focal point
- convex lens
- retina

Check Concepts

- D
- C
- D
- C
- B
- C
- B

Interpret Graphics

- The candle moved closer to the lens.
- a. virtual, upright, enlarged
b. real, inverted, enlarged
c. virtual, upright, enlarged
d. No image forms.
e. real, inverted, reduced
f. virtual, upright, reduced

Think Critically

- No. The eyeglasses for a nearsighted person are concave lenses. Concave lenses cause light to diverge, not converge.
- Both use two convex lenses to form an image. A refracting telescope forms images of distant objects and uses a large objective lens. The object is more than two focal lengths away. A microscope forms images of nearby objects and uses a small objective lens. The object is between one and two focal lengths from the lens.
- Both a convex mirror and a concave lens cause light rays that strike them to always diverge.
- A person might be unable to focus on distant objects when his or her eye lens is relaxed. However, his or her eye lens might have also hardened, making it impossible for that person to focus on nearby objects as well. Such a person would need glasses for both nearsightedness and farsightedness.
- The concave mirror needs to be carefully polished on only one side instead of two. Also, the concave mirror can be made much thinner because it can be supported from the back, so less glass is required.
- If no refraction occurs, the speed of light is the same in both materials.

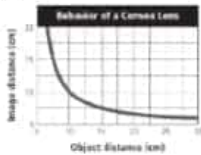
Math Skill

- $1 \text{ m} = 100 \text{ cm};$
magnification = $100 \text{ cm} / 1 \text{ cm} = 100$
- 30 cm

Standardized Test Practice

9. Describe how you could determine whether the image formed by a lens or a mirror is a real image or a virtual image.
10. The objective lens in a microscope has a magnification of 20. What is the magnification of the microscope if the eyepiece lens has a magnification of 20?
11. Describe how the focal length of a convex lens changes as the lens becomes more curved.

Use the figure below to answer questions 12 and 13.

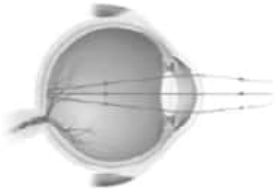


12. Determine how far the image is from the lens when the object is 15 cm from the lens.
13. At what object distance are the image distance and the object distance equal?

Think Critically

Record your answers on a sheet of paper.

Use the figure below to answer questions 14 and 15.



14. Describe the vision problem shown in the figure. Why does this vision problem become more serious as people age?
15. Explain how the vision problem shown in the figure can be corrected.
16. Predict whether a camera that uses a concave lens to focus light onto the image sensor would work.
17. Describe the change in the lenses in your eyes when you look at this book and then look out the window at a distant object.
18. Explain why objects become dimmer and less detailed as they move farther away.

Need Extra Help

If You Missed Question ...	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Review Section ...	1	1	1	1	3	2	2	2	2	3	2	2	2	2	2	3



My Notes

Standardized Test Practice

Multiple Choice

1. B
2. A
3. C
4. D
5. A
6. A
7. B
8. D

Short Response

9. If the image can be projected onto a screen or a piece of paper, it is a real image. Otherwise, the image is a virtual image.
10. $30 \times 20 = 600$
11. The focal length decreases as the lens becomes more curved.
12. 7.5 cm
13. 10 cm

Extended Response

14. This problem is farsightedness, which is the inability to focus on nearby objects. As people age, the lens in the eye becomes less able to be curved enough to produce a sharp image of nearby objects.
15. A convex lens in front of the eye converges light rays so the lens in the eye is able to focus nearby objects onto the retina.
16. Such a camera would not work. A concave lens causes light to diverge, not converge.
17. The lens in your eye becomes less convex as you look away from a close object to a more distant object.
18. Fewer light rays from each point on the object enter the eye as an object moves farther away. Because less light enters the eye, the object appears dimmer and less detail can be seen.



The BIG Idea

How do the digestive and excretory systems help maintain the body's homeostasis?



LESSON

6.1 Nutrition

- Why do you eat?
- Why does your body need each of the six groups of nutrients?
- Why is eating a balanced diet important?



LESSON

6.2 The Digestive System

- What does the digestive system do?
- How do the parts of the digestive system work together?
- How does the digestive system interact with other systems?



LESSON

6.3 The Excretory System

- What does the excretory system do?
- How do the parts of the excretory system work together?
- How does the excretory system interact with other body systems?

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Digestion and Food

The cells in our body need a source of energy to carry out their cell functions. They also need building blocks for growth and repair of tissues. The energy and building blocks come from food digested by the digestive system. Put an X next to all the things that our cells get from the digestive system to use for energy and building blocks.

- | | |
|---|---|
| <input type="checkbox"/> water | <input type="checkbox"/> banana |
| <input type="checkbox"/> molecules of sugar | <input type="checkbox"/> carbon dioxide |
| <input type="checkbox"/> bread | <input type="checkbox"/> hamburger |
| <input type="checkbox"/> vitamins | <input type="checkbox"/> molecules of fat |
| <input type="checkbox"/> calcium | <input type="checkbox"/> peanuts |
| <input type="checkbox"/> molecules of protein | <input type="checkbox"/> carrots |
| <input type="checkbox"/> diet soda | <input type="checkbox"/> rice |

Explain your thinking. What rule or reasoning did you use to decide what cells use for energy and building blocks?

How do the digestive and excretory systems help maintain the body's homeostasis?



The BIG Idea

There are no right or wrong answers to these questions. Write student-generated questions produced during the discussion on chart paper and return to them throughout the chapter.

Guiding Questions

- AL** Why do people eat food? *Use this question to begin a discussion about the meaning of nutrition and the importance of good nutrition.*
- QL** What organs make up your digestive and excretory systems? *Have students generate a list of organs they think make up these two body systems.*
- BL** Where does digestion happen? *This question initiates discussion about the role of different organs in digestion.*

Get Ready to Read

What do you think?

Use this anticipation guide to gauge students' background knowledge and preconceptions about digestion and excretion. At the end of each lesson, ask students to read and evaluate their earlier responses. Students should be encouraged to change any of their responses.

Anticipation Set for Lesson 1

- 1. An activity such as sleeping does not require energy.**
Disagree. All activities, including sleeping, require energy.
- 2. All fats in food should be avoided.**
Disagree. The human body needs fat to be healthy. Cell membranes are made up mostly of lipids.

Anticipation Set for Lesson 2

- 3. Digestion begins in the mouth.**
Agree. The first step of digestion is mechanical digestion in the mouth.
- 4. Energy from food stays in the digestive system.**
Disagree. Energy from food is distributed via the circulatory system and used by all body systems.

6.1 Nutrition



INQUIRY

Time for Lunch? This photo shows fried moth larvae. It might not look appetizing, but it contains nutrients your body needs for energy and growth. Nutrients are in many different foods, from a cheeseburger to a fried insect.

Write your response in your interactive notebook.

Explore Activity

How much energy is in an almond?

Food contains energy. Is there enough energy in an almond to boil water?

Procedure Food allergy

1. Read and complete a lab safety form.
2. Place a small amount of **clay** in a **shallow baking dish**. Straighten a **metal paper clip**. Insert one end into an unshelled **almond**. Anchor the other end in the clay.
3. Place a **25-mL test tube** in a **test-tube clamp**. Add 10 mL of **water** to the test tube.
4. Have your partner light the almond with a **long wooden match** until the almond starts burning on its own.
5. Gently **swirl** the test tube at an angle over the flame until the almond completely burns. Record your observations in your Science Journal.

Point the test tube away from fellow students.

Think About This

1. What happened to the water? Why did this happen?

2. What do you think happens to your body when you eat an almond?



Essential Questions

- Why do you eat?
- Why does your body need each of the six groups of nutrients?
- Why is eating a balanced diet important?

Vocabulary

- Calorie
- protein
- carbohydrate
- fat
- vitamin
- mineral

INQUIRY

About the Photo Time for Lunch? Crunchy? Nutty? Although a pile of fried larvae might not appeal to many Americans, insects and insect larvae are high in protein and other nutrients. What people like to eat depends to a large extent on the culture in which they are raised. In many tropical countries a serving of fried larvae might be considered as a treat.

Guiding Questions

- | | |
|---|--|
| <p>QL Why do you eat?</p> | <p><i>You eat to get the energy and nutrients your body needs to function.</i></p> |
| <p>BL Why might it be healthier to eat insects than to eat meat?</p> | <p><i>Insects are low in fat. In addition, they feed on wild plants and have not been treated with hormones or antibiotics. The one concern is that insects from areas that have been sprayed with pesticides could have pesticide residues in them.</i></p> |

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Clearing Up Some Caloric Confusion

1. Write the word *calorie* on chart paper or on the board.
2. Explain that calorie has two different meanings. A calorie, as defined by scientists, is the amount of energy required to raise the temperature of 1 g of water 1°C. The calories used in food labeling are kilocalories—1,000 calories. A kilocalorie is the amount of energy required to raise the temperature of 1 kg (1 L) of water 1°C. To confuse matters, kilocalories are usually just called calories.

LAB Manager

All the labs for this lesson are indicated at point of use. Labs can be found in the *Student Resource Handbook* and the *Activity Lab Workbook*.

6.1 Review

Table 2 Daily Recommended Amounts of Each Food Group for 9–13-Year-Olds

Food Group	Daily Amount males, 9–13 years old	Daily Amount females, 9–13 years old	Examples of Foods
Grains	170 grams	142 grams	whole-wheat flour, rye bread, brown rice
Vegetables	2 1/2 cups	2 cups	broccoli, spinach, carrots
Fruits	1 1/2 cups	1 1/2 cups	apples, strawberries, oranges
Fats	5 teaspoons or less	5 teaspoons or less	canola oil, olive oil, avocados
Milk	3 cups	3 cups	milk, cheese, yogurt
Meat and beans	142 grams or less	142 grams or less	fish, beans, lean beef, lean chicken

Key Concept Check

6. Why is eating a balanced diet important?

Visual Check

7. List the nutrients in this food product.



A Balanced Diet

A healthful diet includes carbohydrates, proteins, fats, vitamins, minerals, and water. But how do you know how much of each food group you should eat? **Table 2** lists the daily recommended amounts of each food group for 9–13-year-olds.

The nutrient-rich foods that you choose might be different from the nutrient-rich foods eaten by people in China, Kenya, or Mexico. People usually eat foods that are grown and produced regionally. Regardless of where you live, eating a balanced diet ensures that your body has the nutrients it needs to function.

Food Labels

What foods would you buy to follow the recommended guidelines in **Table 2**? Most grocery stores sell many varieties of bread, milk, meat, and other types of food. How would you know what nutrients these foods contain? You can look at food labels, such as the one in **Figure 3**. Food labels help you determine the amount of protein, carbohydrates, fats, and other substances in a food.



Figure 3 A food label lists a food's nutrients per serving, not per container.

Visualize It!



People eat food to obtain the energy their bodies need to function.



Proteins are one of the six groups of nutrients.



Evaluating food labels can help you eat a balanced diet.

Summarize It!

1. Why do you eat?
2. Why does your body need each of the six groups of nutrients?
3. Why is eating a balanced diet important?

A Balanced Diet

Emphasize that eating a balanced diet, one with adequate amounts of all the required nutrients, is one of the best ways to stay in good health. Point out that a balanced diet can be obtained in a variety of ways, no matter where you live in the world.

Guiding Questions

- OL** Why is eating a balanced diet important? *Eating a balanced diet ensures that your body has the nutrients it needs to function.*
- BL** What grain do you think is common in both Mexican and Asian diets? *Mexican and Asian diets include high amounts of rice.*

Food Labels

Explain that food labels are an important resource for shoppers. They provide valuable information about the nutritional content of foods.

Guiding Questions

- OL** List the nutrients in the food product shown in **Figure 3**. *The nutrients in the food include carbohydrates, protein, vitamin A, vitamin C, calcium, and iron.*
- BL** What is meant by "percentage of daily value" for each nutrient? *It is the percentage of the recommended dietary allowance (formerly called the recommended daily allowance, or RDA), of each nutrient for the average person.*

Summarize It!

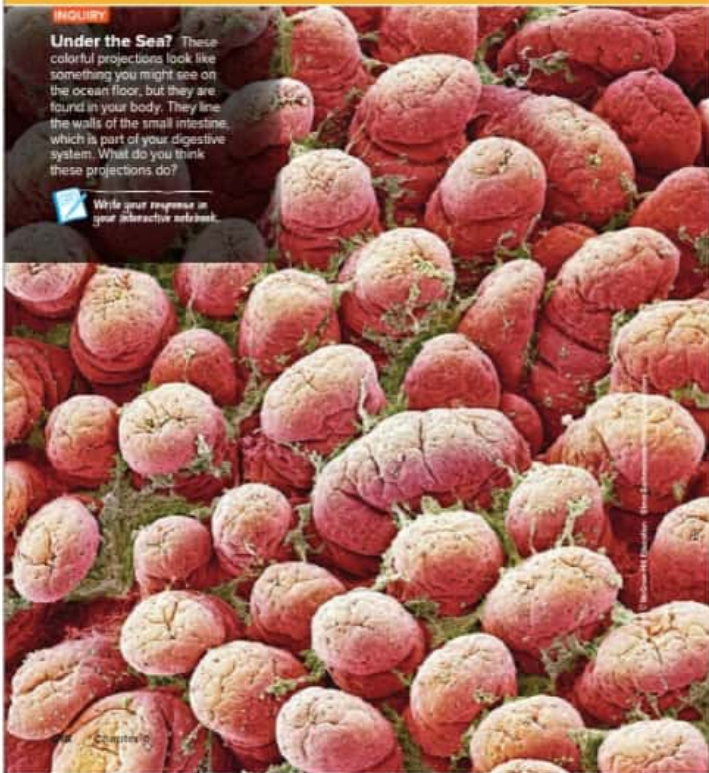
Answers may vary. The information needed to complete this graphic organizer can be found in the following sections:

6.2 The Digestive System

INQUIRY

Under the Sea? These colorful projections look like something you might see on the ocean floor, but they are found in your body. They line the walls of the small intestine, which is part of your digestive system. What do you think these projections do?

Write your response in your interactive notebook.



Explore Activity

Which dissolves faster?

Has anyone ever told you to take small bites and chew your food thoroughly? The size of chewed food particles can affect how quickly food is digested. Similarly, the size of a sugar particle can affect how fast it dissolves in water.

Procedure

1. Read and complete a lab safety form.
2. Add the contents of one serving package of **granulated sugar** to a **500-mL beaker** containing 300 mL of **warm water**.
3. Gently stir the contents of the beaker with a **plastic spoon**. Have your partner use a **stopwatch** to time how long it takes the sugar to dissolve. Record the time in your Science Journal.
4. Add **sugar cubes** to another **500-mL beaker** containing 300 mL of warm water.
5. Repeat step 3.

Think About This

1. Which dissolved faster—the granulated sugar or the sugar cube?

2. Why do you think particle size affects the rate at which sugar dissolves?

3. How might food particle size affect how quickly food is digested?

Essential Questions

- What does the digestive system do?
- How do the parts of the digestive system work together?
- How does the digestive system interact with other systems?

Vocabulary

- digestion
- mechanical digestion
- chemical digestion
- enzyme
- esophagus
- peristalsis
- chyme
- villi

INQUIRY

About the Photo Under the Sea? Have students study the projections in the photo. Read the caption. Have students speculate on what the green matter is between the projections. Have students speculate on why the projections are red. Explain that most digestion and absorption of nutrients takes place in the small intestine, which has an extensive blood supply.

Guiding Questions

- AL** What do you think the projections in the photo do? *Use this question to begin a discussion on functions of the digestive system.*
- OL** What happens to your body if your digestive system is not working properly? *Use this question to help students recognize the importance of digestion to total well-being.*
- BL** What happens if food is not properly digested? *Students may speculate that there is a loss of nutrients to the body and, eventually, poor health.*

LAB Manager

Labs can be found in the *Student Resource Handbook* and the *Activity Lab Workbook*.

Essential Questions

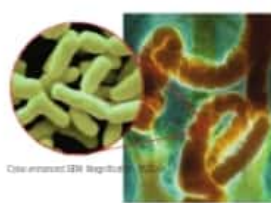
After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary Making Observations

1. Write the words *mechanical* and *chemical* on chart paper or the board. Explain that these words describe processes. Give an example of a mechanical process (cutting an apple into pieces) and a chemical process (the cut surface changes color and texture after awhile). Help students recognize that in a mechanical process, the material changes shape but not composition. In a chemical process, there is a chemical reaction and new products form.
2. **Ask:** What is the first thing that happens when you eat an apple? *bite down and chew* **Is this a mechanical or a chemical process?** *mechanical; The shape changes but a chemical change does not occur.* **Ask:** What do you think happens to the apple after it is chewed and swallowed? **How does your body gain energy from an eaten apple?** *Students should note some type of change must take place to release energy.* **Is that a mechanical or chemical process?**

Visual Check

1. Cocci bacteria are spherical, bacilli bacteria are rod-shaped, and spirilla bacteria are spiral-shaped. Which type of bacteria is shown in the photo?



© iStockphoto.com/Robert H. Schmitt

Key Concept Check


2. What might happen to other body systems if the digestive system did not function properly?

Math Skills


Use Percentages
A percentage is a ratio that compares a number to 100. For example, the total length of the intestines is about 8.5 m. That value represents 100%. If the rectum is 0.12 m long, what percentage of the intestines is made up of the rectum?
The ratio is $\frac{0.12 \text{ m}}{8.5 \text{ m}}$.
Find the equivalent decimal for the ratio.
 $\frac{0.12 \text{ m}}{8.5 \text{ m}} = 0.014$
Multiply by 100.
 $0.014 \times 100 = 1.4\%$

Practice
The total length of the intestines is about 8.5 m. If the small intestine is 7.0 m long, what percentage of the intestines is made up of the small intestine?


6.2 Review



Enzymes in the digestive system break down food so nutrients can be absorbed by your body.



Food moves through the digestive tract by waves of peristalsis.



The liver and the pancreas produce substances that help with chemical digestion.

Summarize It!

- What does the digestive system do?
- How do the parts of the digestive system work together? How do the parts of the digestive system work together?
- How does the digestive system interact with other systems?

The Large Intestine, Bacteria, and Digestion

Compare the absorption that occurs in the small intestine with what occurs in the large intestine. Students should understand that not all bacterial are harmful. Discuss the role of beneficial bacteria found in the digestive system.

Guiding Questions

- AL** What happens to water in the large intestine?

Some of it gets absorbed by the large intestine.
- AL** Why is it important to have certain types of bacteria in the intestine?

They help to digest food and produce important vitamins.
- OL** Which materials pass through the large intestine?

The waste products of digestion pass through the large intestine.
- BL** What might happen if a person lacks beneficial bacteria in his or her intestine?

Sample answer: The person might experience difficulty digesting food.
- BL** How do the small and large intestines maximize opportunity to absorb nutrients?

Sample answer: Between the small and large intestines, digested food travels almost 9 m before waste is expelled from the body.

Visual Literacy: Figure 8

Direct students' attention to the **Figure 8** photographs and point out the magnified image showing bacteria of the large intestine. Use the question below to help students analyze the photographs and to understand the important role of bacteria in digestion.

Ask: Cocci bacteria are spherical, bacilli bacteria are rod-shaped, and spirilla bacteria are spiral-shaped. Which type of bacteria is shown in the photo? *bacilli bacteria*

Summarize It!

Answers may vary. The information needed to complete this graphic organizer can be found in the following sections:

226 Chapter 6

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The Digestive System

Use Vocabulary

1. Define enzyme in your own words.

2. Distinguish between absorption and digestion.

Understand Key Concepts

3. Where is the first place digestion occurs?

- A. mouth C. large intestine
B. stomach D. small intestine

4. Compare the functions of the stomach and the small intestine.

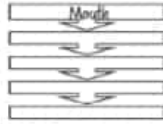
5. Give an example of how the digestive system affects other body systems.

Interpret Graphics

6. Explain how do structures like the one to the right affect digestion?



7. Organize Information Copy and fill in the graphic organizer below to show how food moves through the digestive tract.



Critical Thinking

8. Infer what would happen if food passed more quickly than normal through the digestive system.

Math Skills

9. If the total length of the intestines is 8.5 m and the large intestine is 1.5 m long, what percentage of the intestines is made up of the small intestine?

My Notes



Use Vocabulary

- Possible answer: An enzyme is a protein that helps to break down food. Some responses might include that enzymes help speed up reactions. **DOK 1**
- Absorption occurs when the cells of the digestive system take in digested food particles. Digestion occurs when food is broken down into small particles. **DOK 2**

Understand Key Concepts

- A. mouth **DOK 2**
- The stomach stores food and aids in chemical digestion. The small intestine chemically digests food and absorbs nutrients. **DOK 2**
- Sample Answer: The blood in the circulatory system absorbs the products of digestion. **DOK 2**

Interpret Graphics

- Villi help move nutrients out of the small intestine and into the blood. **DOK 3**
- mouth, esophagus, stomach, small intestine, large intestine **DOK 2**

Critical Thinking

- Answers may vary. Food might not have time to be fully digested, leaving fewer nutrients available for absorption. **DOK 2**

Math Skills

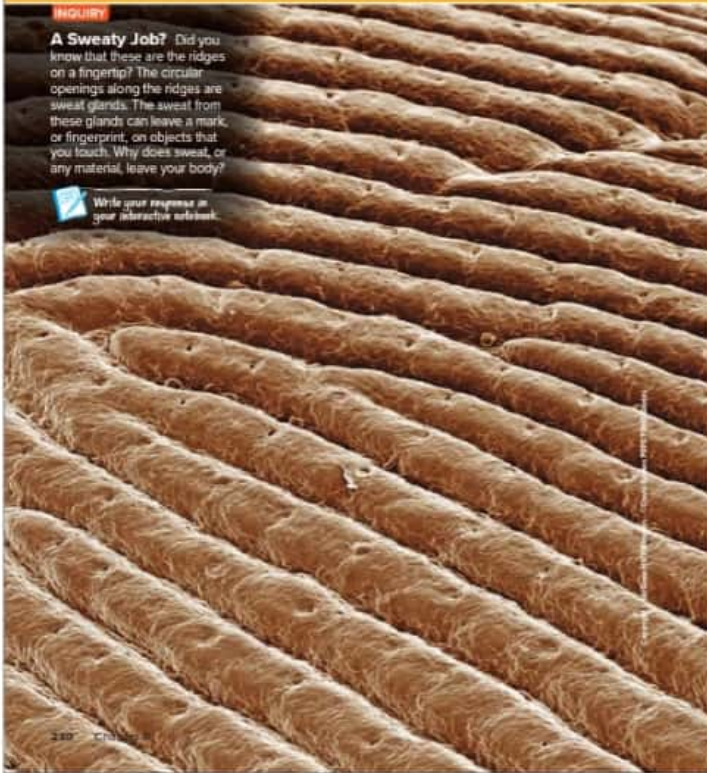
- 82.4 percent **DOK 1**

6.3 The Excretory System

INQUIRY

A Sweaty Job? Did you know that these are the ridges on a fingertip? The circular openings along the ridges are sweat glands. The sweat from these glands can leave a mark or fingerprint, on objects that you touch. Why does sweat, or any material, leave your body?

Write your response in your interactive notebook.



Explore Activity

What happens when you breathe out?

Look again at the photo of the fingertip on the previous page. The sweat glands in your skin are one way substances leave your body. Do substances also leave your body when you breathe out?

Procedure

1. Read and complete a lab safety form.
2. Take a deep breath and hold it.
3. Breathe out through your mouth into a **plastic bag**. Leave a small opening to allow some of the air to leave the bag as you blow into it.
4. Remove the bag from around your mouth. Let the air escape from the bag, but do not push the sides of the bag together.
5. Using the same plastic bag, repeat steps 2–4 three more times.
6. Observe the contents of the bag. Record your observations in your Science Journal.

Think About This

1. Did the plastic bag look different after you breathed into it? Explain.

2. What do you think was in the plastic bag at the end of the activity?

3. Based on your observations, do you think the respiratory system is part of the excretory system? Explain.

Essential Questions

- What does the excretory system do?
- How do the parts of the excretory system work together?
- How does the excretory system interact with other body systems?

Vocabulary

- excretory system
- kidney
- nephron
- urine
- ureter
- bladder
- urethra

INQUIRY

About the Photo A Sweaty Job? The magnified ridges on the fingertip in the photo illustrate the role of skin in the excretory system. The sweat glands, which are small circular openings along the ridges, are difficult to see. Sweat glands are found almost everywhere on the skin. Although the main purpose of perspiration is to cool the body and help maintain the body's temperature, it also contains waste products, such as salt and urea, from cellular activities.

Guiding Questions

- AL** Do you think a person's sweat glands can make sweat without a person being aware of it? *Explain that sweat may not be noticeable unless a lot of it is being produced. Other organs of the excretory system are also working without a person being aware of them.*
- QL** Why does perspiration, or any material, leave your body? *To rid the body of waste products.*
- BL** What other organs are involved in removing wastes from the body? *Students might mention the lungs, the large intestine, the kidneys, or other organs of the urinary system.*

LAB Manager

Labs can be found in the *Student Resource Handbook* and the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary Be a Word Detective

1. Write the words *excrete*, *excretion*, and *excretory* on chart paper or the board. Add descriptions as students answer the questions.
2. Have students look up the words in a dictionary. **Ask: What part of speech is each word? What does each word mean?** *Answers will vary depending on the dictionary. Sample answer: Excrete is a verb that means "to discharge waste matter from the body." Excretion is a noun that means "the waste matter that is discharged from the body." Excretory is an adjective that means "involved in or used in excretion."*

LESSON 6.3 Review

Visualize It!



The excretory system collects and eliminates wastes from the body and regulates the level of fluid in the body.



The respiratory system is one of the body systems that make up the excretory system.



The organs of the urinary system process, transport, collect, and excrete waste.

Summarize It!

1. What does the excretory system do?
2. How do the parts of the excretory system work together?
3. How does the excretory system interact with other body systems?

Use Vocabulary

1. Define the word *nephron* in your own words.
2. Distinguish between ureter and urethra.
3. Use the term *bladder* in a sentence.

Understand Key Concepts

4. The kidneys filter wastes from the
 - A. blood.
 - B. intestine.
 - C. lungs.
 - D. skin.
5. Construct a diagram of the urinary system showing the production and flow of urine.
6. Distinguish between the excretory functions of the respiratory system and the integumentary system.

Interpret Graphics

7. Identify the function of the highlighted portion of the diagram to the right.



8. Organize Information Copy and fill in the table below with details about each organ of the urinary system.

Organ	Structure and Function

Critical Thinking

9. Hypothesize What might happen if urine did not go through a second filtration?
10. Evaluate the role of the hypothalamus in maintaining the level of fluid in the body.



Visual Summary

Concepts and terms are easier to remember when they are associated with an image. Ask: Which Key Concept does each relate to?

Use Vocabulary

1. Answers will vary. Possible answer: A nephron is a network of capillaries and small tubes that filter blood in the kidneys. **DOK 1**
2. Ureters are tubes that connect the kidneys to the bladder. The urethra is the tube through which urine leaves the bladder. **DOK 2**
3. Answers will vary. Possible answer: The bladder is like a balloon that expands and contracts as urine is stored and excreted. **DOK 1**

Understand Key Concepts

4. A. blood **DOK 1**
5. Diagrams should show production of urine in the kidney. Urine moves from the kidney to the ureter, to the bladder, to the urethra, and out of the body. **DOK 2**
6. The excretory function of the respiratory system is to eliminate carbon dioxide and water during breathing. The excretory function of the integumentary system is to eliminate water and salts during perspiration. **DOK 2**

Interpret Graphics

7. Wastes are being filtered from the blood. **DOK 2**
8. **DOK 1**

Organ	Structure and Function
Kidney	bean-shaped organ that filters wastes from blood
Ureters	tubes through which urine leaves the kidneys
Bladder	muscular sac that holds urine until the urine is excreted
Urethra	tube through which urine leaves the bladder

Critical Thinking

9. Too much water would be excreted and nutrients would be lost. This could lead to dehydration and nutrient deficiency. **DOK 3**
10. The hypothalamus controls hormones that cause the kidneys to absorb or retain water. If this function was not working properly, the body might have too much or too little fluid. **DOK 3**

6 Study Guide

The BIG Idea

The digestive and excretory systems move materials through the body and remove waste. The digestive system also absorbs nutrients.

Key Concepts Summary

6.1: Nutrition

- People eat food to obtain the energy their bodies need to function. The amount of energy in food is measured in **Calories**.
- The types and amounts of nutrients a person needs depend on age, gender, and activity level.
- The six groups of nutrients are **proteins, carbohydrates, fats, vitamins, minerals**, and water.
- A balanced diet provides **nutrients** and energy for a healthful lifestyle.



Vocabulary

Calorie
protein
carbohydrate
fat
vitamin
mineral

6.2: The Digestive System

- The function of the digestive system is to break down food and absorb nutrients for the body.
- Organs of the digestive system include the mouth, **esophagus**, stomach, small intestine, and large intestine.
- The digestive system interacts with other body systems to maintain the body's internal balance.



digestion
mechanical digestion
chemical digestion
enzyme
esophagus
peristalsis
chyme
villi

6.3: The Excretory System

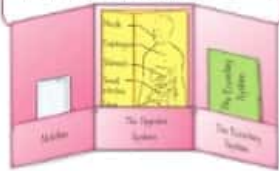
- The function of the **excretory system** is to collect and eliminate wastes from the body and regulate the levels of fluids in the body.
- The excretory system is made up of the digestive system, respiratory system, urinary system, and the integumentary system.
- The excretory system works with other body systems, including the nervous system, to maintain homeostasis.



excretory system
kidney
nephron
urine
ureter
bladder
urethra

FOLDABLES Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

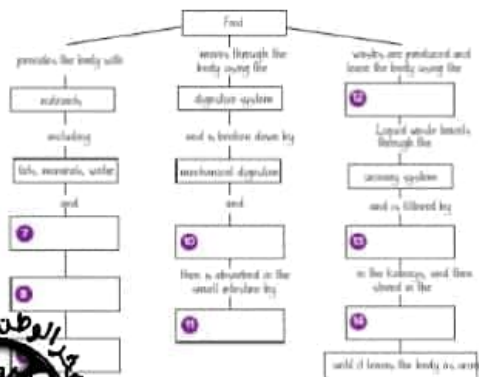


Use Vocabulary

- 1 About 25–35 percent of your total daily should be from fats.
- 2 One type of nutrient, _____, is made of long chains of sugars.
- 3 Food moves down the esophagus by _____.
- 4 The breakdown of fo _____ food into small particles and molecules is called _____.
- 5 A tube that _____ contracts a kidney to the bladder is called the _____.
- 6 Urine is stored in the _____.

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.



Key Concepts Summary

abc Vocabulary

Study Strategy: Bulleted Lists

Students often complete a reading without realizing they failed to understand it. Self-assessment helps students practice metacognition, increasing their awareness of their understanding.

1. Have students write a question from each lesson heading. For example, the question for **Lesson 1** could be *What is nutrition?*
2. Students should reread each lesson to create a bulleted list below the lesson question. For example:

What is nutrition?

- Proteins: protect against disease, relay signals between cells, provide support to cells, speed up chemical reactions
- Carbohydrates: body's major source of energy
- Fats: major part of cell membranes, help insulate against cold temperatures

3. You may want to have students work individually or in small groups to complete their bulleted lists.
4. An alternative approach would be to divide the class into three groups and assign each group one lesson. Groups can then share bulleted lists for the other lessons.

Study Strategy: Categorizing


Ask students to put vocabulary words into categories. Placing vocabulary words into categories promotes understanding.

1. Have students use plain paper to create the following chart.

Nutrients My Body Uses to Stay Healthy	Body Parts Used to Process Food	Body Processes	What My Body Produces

2. Have students work individually to place the vocabulary words from each lesson into the chart. **Ask:** In which column would you place the word *protein*? Where would you place *esophagus*? Have students continue independently.
3. Have students meet in small groups to compare their charts and discuss why they chose to place words in particular columns.

Understand Key Concepts

- What are proteins made of?
 - amino acids
 - minerals
 - sugars
 - vitamins
- Which would be considered a grain?
 - black beans
 - brown rice
 - canola oil
 - lean chicken
- What is the main source of energy for your body?
 - carbohydrates
 - minerals
 - proteins
 - water
- Look at the diagram below. Where does most absorption of nutrients occur?
 
 - A
 - B
 - C
 - D
- What is the correct order for how food is processed in the digestive system?
 - absorption, digestion, ingestion, elimination
 - elimination, ingestion, absorption, digestion
 - ingestion, absorption, digestion, elimination
 - ingestion, digestion, absorption, elimination

- What organ is shown below?
 
 - bladder
 - hypothalamus
 - kidney
 - ureter
- What organ produces a substance that neutralizes acid from the stomach?
 - esophagus
 - gallbladder
 - liver
 - pancreas
- What fluid produced in the mouth contains digestive enzymes?
 - bile
 - blood
 - chyme
 - saliva
- Carbon dioxide is eliminated by which body system?
 - digestive system
 - integumentary system
 - respiratory system
 - urinary system
- What is produced by the urinary system?
 - blood
 - feces
 - perspiration
 - urine
- The bladder is most similar to which object?
 - a balloon
 - a tube
 - a folded paper
 - a rigid container

Critical Thinking

- Distinguish between minerals and vitamins.
- Hypothesize why a child might have different nutritional needs than an adult over the age of 60.
- Select Study the nutrient information below. Select the snack that would be a better choice as part of a healthy lifestyle. Explain your choice.

Nutrient information	Tortilla Chips	
	Fried	Baked
Calories	150	110
Calories from fat	60	5
Total fat (g)	7	1
Saturated fat (g)	1	0
Sodium (mg)	135	200
Total carbohydrate (g)	22	24
Sugars	3	0
Protein	3	2

- Differentiate Suppose your teacher showed you a diagram of a small intestine and a diagram of a large intestine. How might you distinguish between them?
- Hypothesize How might digestion be affected if a person swallowed his or her food without first chewing it?
- Critique the following statement: "Bacteria are harmful and should not be in the digestive system."
- Compare the excretions of the urinary system and the digestive system.

Write a Scenario

- Create a commercial to encourage people to eat a healthy amount from each food group. Include a setting and dialogue for your commercial.

The BIG Idea

- Give examples of how the digestive system and excretory system help to maintain homeostasis.
- What is the function of the small intestine?



Math Skills

Use Percentages

Use the table below to answer questions 22–24.

Location of food	Time in location (hrs)
Stomach	4
Small intestine	6
Large intestine	24

- What percentage of the total digestive time does food spend in the stomach?
- What percentage of the total digestive time does food spend in the large intestine?
- What percentage of the total digestive time does food spend in the stomach and the small intestine combined?



Understand Key Concepts

- A. amino acids
- B. brown rice
- A. carbohydrates
- C. small intestine
- D. ingestion, digestion, absorption, elimination
- C. kidney
- D. pancreas
- D. saliva
- C. respiratory system
- D. urine
- A. a balloon

Critical Thinking

- Vitamins aid in growth, regulate body functions, and prevent some diseases. Minerals are elements that regulate many chemical reactions in the body.
- Answers will vary. A child is still growing, while an adult over 60 has stopped growing. Young children require diets that are higher in fat, while an adult may need a diet rich in calcium to support bone health. Also, their activity levels are likely different.
- Baked tortilla chips would be a better choice. They have fewer calories from fat, less saturated fat, and less sugar.
- The small intestine is longer in length and smaller in diameter than the large intestine. It is also lined with villi.
- Chewing breaks up food into smaller pieces. If food were not chewed, it would take longer to digest or might not digest completely.
- The statement is false because certain bacteria are needed for digestion of food.
- The urinary system produces urine that contains wastes from the blood. The digestive system produces solid wastes mostly from undigested food.

Writing in Science

19. Answers will vary. Commercials should include the nutrients and food groups discussed in **Lesson 1**. They should also include a setting and a dialogue.



The **BIG** Idea

20. Answers will vary. The digestive system provides the nutrients other body systems need to function. The excretory system removes potentially harmful waste from the body.
21. The main function of the small intestine is the absorption of nutrients.

Math Skills

Use Percentages

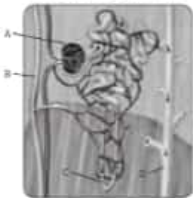
22. 11.8 percent
23. 70.6 percent
24. 29.4 percent

Teacher Notes

Multiple Choice Aligned with TIMSS Study

- 1 Which process depends on enzymes?
A chemical digestion
B elimination
C mechanical digestion
D respiration

Use the diagram below to answer questions 2.



- 2 Where does the first filtration process occur in the nephron shown above?
A A
B B
C C
D D
- 3 Which factor does NOT influence how much energy a person needs?
A age
B gender
C height
D weight

Use the diagram below to answer questions 4 and 5.



- 4 In which part of the system pictured above does chemical digestion begin?
A 1
B 2
C 3
D 4
- 5 In the diagram above, from which organ are nutrients absorbed into the bloodstream?
A 2
B 3
C 4
D 5
- 6 What is a main function of the excretory system?
A fight diseases
B move limbs
C pump blood
D remove wastes

- 7 Which part of the brain works with the urinary system to help maintain homeostasis?
A cerebellum
B cerebrum
C hypothalamus
D medulla

Use the diagram below to answer question 8.



- 8 In the diagram above, where is urine produced?
A 1
B 2
C 3
D 4
- 9 Which system works with the digestive system to carry nutrients to the cells of the body?
A circulatory
B excretory
C lymphatic
D respiratory

Constructed Response Aligned with TIMSS Study

Use the table below to answer questions 10 and 11.

Nutrient	Example of Food
Carbohydrates	
Fats	
Minerals	
Proteins	
Vitamins	
Water	

- 10 In the table above, the six main groups of nutrients are provided. What is an example of a food that contains each nutrient? What is the function of each nutrient in the body?
- 11 Explain how the nutrients in the table above are related to eating a balanced diet.

Use the table below to answer question 12.

Process	Description
Ingestion	
Digestion	
Absorption	
Elimination	

- 12 When a person eats food, the food undergoes four processes in the digestive system. Briefly describe each process provided in the table above.



Question	1	2	3	4	5	6	7	8	9	10	11	12
Points	2	3	1	2	2	3	3	3	2	1	1	2

Multiple Choice

- 1 **A—Correct.** B, C, D—Enzymes are not part of the elimination of solid or liquid wastes from the body. Mechanical digestion is the breakdown of food into smaller pieces by chewing. Respiration involves breathing in and out through the lungs. **DOK 2**
- 2 **A—Correct.** B, C, D—During the first filtration, water, sugar, wastes, and salt pass from the glomerulus into small tubes. Other structures take part in the second filtration and collection of urine. **DOK 2**
- 3 **C—Correct.** A, B, D—The types and amounts of energy people need depend on factors such as their gender, age, and weight. **DOK 1**
- 4 **A—Correct.** B, C, D—Chemical digestion begins in the mouth and is continued in the stomach and small intestine. No digestion takes place in the large intestine. **DOK 2**
- 5 **C—Correct.** A, B, D—All other organs are used for processing food or moving it along. **DOK 2**
- 6 **D—Correct.** A, B, C—Disease is fought mainly by the lymphatic and immune systems. Limbs are moved when muscles in the muscular system pull on the bones of the skeletal system. The heart pumps blood. **DOK 1**

- 7 **C—Correct.** A, B, D—The hypothalamus produces a hormone that causes tubules in the kidneys to absorb more water. The cerebellum controls balance and coordination. The cerebrum processes language, learning, memory, and voluntary muscle movement. The medulla controls blood pressure and breathing and heart rates. **DOK 1**
- 8 **A—Correct.** B, C, D—When the kidney (1) filters blood as it passes through, it produces urine. Ureters carry urine to the bladder where it is stored until it leaves the body through the urethra. **DOK 2**
- 9 **A—Correct.** B, C, D—Organs that are part of the excretory system carries away the body's wastes. The lymphatic system works to fight disease and keep tissue fluid balanced. The respiratory system supplies oxygen but also has an excretory function as it carries away carbon dioxide. **DOK 2**

Constructed Response

10

Nutrient	Example of Food
Carbohydrates	rice, wheat, corn, potato
Fats	olive oil, avocado
Minerals	vegetables, whole grains, milk, meat
Proteins	fish, beans, beef, chicken
Vitamins	oranges, broccoli
Water	water, juices

Carbohydrates are the body's major source of energy. Proteins are in all cells and speed up chemical reactions. Fats provide energy, help absorb vitamins, and form cell membranes. Body fat provides insulation against cold temperatures. Vitamins promote growth, regulate body functions, and prevent some diseases. Minerals help build parts of the body, such as bones and teeth, and regulate many chemical reactions. Water makes up most of blood, is needed for chemical reactions and transports wastes and other materials. **DOK 2, 3**

11 Answers will vary. Possible answer: A healthful diet includes carbohydrates, fats, minerals, proteins, vitamins, and water. Your body needs each type of nutrient because each performs a unique function. To get each type of nutrient, you have to eat a balanced diet. **DOK 1**

12 Answers will vary. Possible answers:



DOK 3

Answer Key

Question	Answer
1	A
2	A
3	C
4	A
5	C
6	D
7	C
8	A
9	A
10	See extended answer.
11	See extended answer.
12	See extended answer.

Circulatory and Respiratory Systems



The BIG Idea

How do the Oscillatory and Respiratory Systems help in maintaining homeostasis?



LESSON

7.1 Circulatory System

- What are the main functions of the circulatory system?
- How does the blood flow through the heart and body?
- What are the similarities and differences between the major components of the blood?



LESSON

7.2 Respiratory System

- What is the difference between internal and external respiration?
- What is the path of the air through the respiratory system?
- What changes occur in the body during breathing?

What changes take place in the body during exercise?

Body systems, including the respiratory and circulatory systems, function together to meet the demands of exercise and to maintain homeostasis. For example, red blood cells circulate throughout the body to deliver oxygen to cells, where it is used to help produce the energy required for exercise. In this lab, you will investigate how body system responses to exercise might be related to each other.

- | | |
|--|---|
| <input type="checkbox"/> light exercise | <input type="checkbox"/> heavy exercise |
| <input type="checkbox"/> Breathing movements | <input type="checkbox"/> Carbon Dioxide |
| <input type="checkbox"/> Oxygen | <input type="checkbox"/> Water |
| <input type="checkbox"/> Vitamins | <input type="checkbox"/> Lipids |
| <input type="checkbox"/> Calcium | <input type="checkbox"/> Carotenoids |

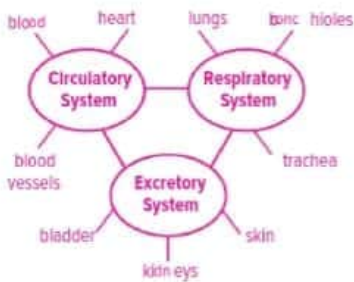
Explain your perception. Which rule or logic you adopted to determine how likely organ system' responses are related with body exercising? How does your diet help you?



The BIG Idea

Concept Map Have students make a concept map showing the relationships among the circulatory, respiratory, and excretory systems, including the major components of each system.

Sample concept map:



Guiding Questions

Why do you think it is important to maintain these systems?

These systems provide materials or processes needed to sustain life.

7.1 Circulatory System

INQUIRY

These systems function together to maintain homeostasis by delivering important substances to the body's cells while removing wastes.

Write your response in your interactive notebook.



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248 Chapter 7

Explore Activity

Investigate Blood Pressure

How does blood pressure change in response to physical activity? Blood pressure changes from day to day and throughout the day. It is affected by physical, psychological, behavioral, and inherited factors.

Procedures

1. Identify the safety concerns of this lab before work begins.
2. Watch the instructor demonstrate how to safely measure blood pressure. Practice using a **blood-pressure cuff** to measure a partner's blood pressure. Refer to a **blood-pressure chart** to interpret the reading.
3. Predict how exercise will affect systolic and diastolic blood pressure.
4. Take the resting blood-pressure reading of one of your classmates.
5. Have the person whose blood pressure you took do a rhythmic exercise for one minute.
6. Take a second blood-pressure reading and compare it to the resting blood-pressure reading.

Analysis

1. Identify the experimental constants, the independent and dependent variables, and the control in your experiment.
2. Conclude whether your prediction was supported. Explain.

Essential Questions

- What are the main functions of the circulatory system?
- How does the blood flow through the heart and body?
- What are the similarities and differences between the major components of the blood?

Review Vocabulary

Muscle contraction: muscle cells or fibers shorten in response to stimuli

Vocabulary

artery
capillary
vein
valve
heart
pacemaker
plasma
red blood cell
platelet
white blood cell
atherosclerosis

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INQUIRY

About the Photo Body systems, including the respiratory and circulatory systems, function together to meet the demands of exercise and to maintain homeostasis. For example, red blood cells circulate throughout the body to deliver oxygen to cells, where it is used to help produce the energy required for exercise. In this lab, you will investigate how body system responses to exercise might be related to each other.

Discuss

Before reading this lesson, write down what you already know in the first column, in the second column, write down what you want to learn. After you have completed this lesson, write down what you learned in the third column.

What I Know	What I Want to Learn	What I Learned

Reading Check

2. How does your body get oxygen to produce energy?

Functions of the Circulatory System

Cells must have oxygen and nutrients and must also get rid of waste products. This exchange is accomplished by the circulatory system—the body's transport system. The circulatory system consists of blood, the heart, blood vessels, and the lymphatic system. Blood carries important substances to all parts of the body. The heart pumps blood through a vast network of tubes inside your body called blood vessels. The lymphatic system is considered part of the circulatory and immune systems. All of these components work together to maintain homeostasis in the body.

The circulatory system transports many important substances, such as oxygen and nutrients. The blood also carries disease-fighting materials produced by the immune system. The blood contains cell fragments and proteins for blood clotting. Finally, the circulatory system distributes heat throughout the body to help regulate body temperature.

Blood Vessels

Highways have lanes that separate traffic. They also have access ramps that take vehicles to and from roads. Similarly, the body has a network of channels—the blood vessels. Blood vessels circulate blood throughout the body and help keep the blood flowing to and from the heart. The fact that there are different kinds of blood vessels was first observed by the Greek physician Praxagoras, as noted in Figure 1. The three major blood vessels are arteries, capillaries, and veins, as illustrated in Figure 1.

Key Concept Check

2. Why does your body need a circulatory system?

Arteries

Oxygen-rich blood, or oxygenated blood, is carried away from the heart in large blood vessels called **arteries**. These strong, thick-walled vessels are elastic and durable. They are capable of withstanding high pressures exerted by blood as it is pumped by the heart.

As shown in Figure 2, arteries are composed of three layers: an outer layer of connective tissue, a middle layer of smooth muscle, and an inner layer of endothelial tissue. The endothelial layer of arteries needs to be thicker because blood is under higher pressure when it is pumped from the heart into the arteries.

Capillaries

Arteries branch into smaller vessels called arterioles, which become smaller in diameter as they grow farther away from the main vessel. The smallest branches are **capillaries**. **Capillaries** are microscopic blood vessels where the exchange of important substances and wastes occurs. Capillary walls are only one cell thick, as illustrated in Figure 1. This permits the easy exchange of materials between the blood and body cells through the process of diffusion. Capillaries are so small that red blood cells move single-file through these vessels.

The diameter of blood vessels changes in response to the needs of the body. For example, when you are exercising, muscle capillaries expand, or dilate. This increases blood flow to working muscles, which brings more oxygen to cells and removes extra wastes from cells.

Veins

After blood moves through the tiny capillaries, it enters the

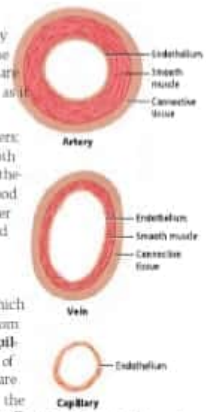


Figure 1 The three major blood vessels in the body are arteries, veins, and capillaries.

Figure 1 Check

Predict by what process it is you think materials cross the walls of capillaries?

CAREERS IN BIOLOGY

Exercise Physiologist Scientists who study the effects of exercise on the human body. They advise athletes, fitness enthusiasts, and medical professionals. They recommend exercise programs and monitor heart rate and breathing blood.



BL O! AI

Transporting Material

ASK STUDENTS: How do your cells obtain nutrients and dispose of waste products? Blood carries important material, such as oxygen, to cells and removes wastes, such as carbon dioxide, from the cells. Inform students that Section 1 will help them understand how these transactions take place.

Guiding Questions

- OL** What do you recall about the definition of homeostasis? *regulation of an organism's internal environment to maintain conditions needed for life*
- AL** What benefits do you think are derived when the body maintains homeostasis? *Homeostasis maintains stability in the body and allows the body to survive. Then cells can carry out life processes.*

Develop Concepts

BL O! AI COOP LEAR

Analogy Have pairs of students think of an analogy of the circulatory system, such as a pool, a radiator heating system, or a water and sewage treatment system. Have them draw a diagram of their analogy. A successful analogy will demonstrate a complete cycle.

Content Background

Teacher FYI Today, stents are used to open arteries narrowed by plaque build up. A stent is a small, meshlike, metal tube that acts like scaffolding once inserted into the artery. The stent is inserted into the body using a tiny balloon catheter that enters through a blood vessel in the groin area or the arm. The catheter, balloon, and stent travel through the blood vessels to the spot where the stent is needed. Once at the correct spot, the balloon pushes the plaque away, and the stent is put into place. The stent holds the artery open so that blood can flow through.

Skill Practice

OL AL

Compare and Contrast

Have students construct a three-column chart comparing and contrasting blood vessel types. Have them label the columns *Arteries*, *Veins*, and *Capillaries*. Tell students to identify the structure, function, type of blood carried, and other unique features in each row. Student charts should be organized to allow students to easily compare and contrast the structure and function of different blood vessels.

Critical Thinking

BL OL AL Evaluate

ASK STUDENTS: *Why do arteries contain smooth muscle and not skeletal or cardiac muscle? Smooth muscles allow for involuntary control of the arteries. Skeletal muscle would be inefficient for monitoring the blood flow because it is so energy consuming. Cardiac muscle is located only in the heart.*

■ **Caption Question Fig. 2** *Materials move across the walls of capillaries by diffusion.*

Differentiated Instruction

Above Level When introducing a chapter, connect what will be learned to the broader themes of science. Gifted students will perform at a higher level when they understand the larger context into which facts fit.

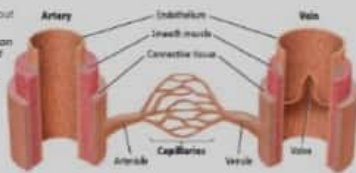
Teacher Toolbox

Reading Strategy

BL OL Take Notes As students read, have them write questions about any concepts they do not understand. Have a class discussion using these questions as a guide. Possible question: *What is the relationship between arteries and capillaries?*



Figure 2 Blood circulates throughout the body inside blood vessels. Hypertension (high blood pressure) can be regulated by the diameter of blood vessels.



larger vessels called **venules**, and then enters the largest blood vessels, called **veins**. **Veins** carry oxygen-poor blood, or deoxygenated blood, back to the heart. The endothelial walls of veins are much thinner than the walls of arteries. The pressure of the blood decreases when the blood flows through capillaries before it enters the veins. By the time blood flows into the veins, the heart's original pushing force has less effect on making the blood move. So how does the blood keep moving? Many veins are located near skeletal muscles, and the contraction of these muscles helps keep the blood moving. Larger veins in the body also have flaps of tissue called **valves**, such as the one in **Figure 2**, which prevent blood from flowing backward. Lastly, breathing movements exert a squeezing pressure against veins in the chest, forcing blood back to the heart.

Reading Check

4. Describe the differences in structure among arteries, capillaries, and veins.

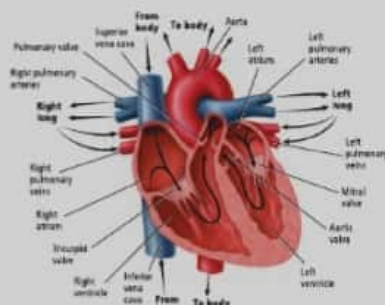


Figure 3 The arrows map the path of blood as it circulates through the heart. **Diagram** the path of blood through the heart.

The right and left atria have thinner muscular walls and do less work than the ventricles. Notice the **islands** in **Figure 3** that separate the atria from the ventricles and keep blood flowing in one direction. **Valves**, such as the aortic valve shown in a closed position in **Figure 3**, are also located between each ventricle and the large blood vessels that carry blood away from the heart.

Blood flow in the body

If you follow the flow of blood shown in **Figure 4**, you will notice that it flows in two loops. First, the blood travels from the heart to the lungs and back to the heart. Then, the blood is pumped in another loop from the heart through the body and back. The right side of the heart pumps deoxygenated blood to the lungs, and the left side of the heart pumps oxygenated blood to the rest of the body.

Key Concept Check

3. Why does the body need a heart?

The Heart

The **heart** is a muscular organ that is about as large as your fist and is located at the center of your chest. This hollow organ pumps blood throughout the body. The heart performs two pumping functions at the same time. The heart pumps oxygenated blood to the body, and it pumps deoxygenated blood to the lungs.

Structure of the heart

Recall that the heart is made of cardiac muscle. It is capable of conducting electrical impulses for muscular contractions. The heart is divided into four compartments called **chambers**, as illustrated in **Figure 3**. The two chambers in the top half of the heart, the **right atrium** and the **left atrium** (plural, **atria**), receive blood that is returning to the heart. Below the atria are the **right ventricle** and **left ventricle**, which pump blood away from the heart. A strong muscular wall separates the left side of the heart from the right side of the heart.



To the lungs and back When blood from the body flows into the

Describe the main ideas of this lesson.

Develop Concepts

BL OI AI COOP LEAR

Scaffolding Have students work in groups of four to generate answers.

ASK STUDENTS: *When giving blood, is an artery or vein used? vein Why? the larger supply of blood in the veins, thinner walls, less pressure What color is the blood? dark red If you bleed from the same area, what indicates you cut a vein? Blood flow from a cut vein is steady. A cut artery will spurt blood.*

Develop Concepts

BL OI

Clarify a Misconception

ASK STUDENTS: *Where in your chest is your heart located? What does it look like?* Students might think that the heart is located on left side and has a "heart" shape. *The heart is actually located in the center of the chest, using the sternum for protection. The stronger pumping ventricle is on the left side, hence we can feel the beat on the left side.* Emphasize that the heart, while resembling the commonly seen heart shape, is not symmetrical. You might want to obtain a beef heart from a butcher to show the class.

■ Caption Question Fig. 3 Blood vessels that have a large diameter have a large surface area from which to radiate and lose heat from the blood. This can cool the body. Blood vessels that have a narrow diameter have a smaller surface area and cannot radiate heat from the blood and body as effectively.

Reading Check Veins are the largest blood vessels, but have thinner endotheliums than arteries. The largest veins contain valves to prevent blood from flowing backward. Arteries are large blood vessels with thick endotheliums to withstand high blood pressure. Capillaries are microscopic blood vessels with walls that are only one cell thick.

Skill Practice

BL OI AI Visual Literacy

Have students review Figure 4 and then diagram the heart, labeling each major area and denoting blood flow with arrows.

Develop Concepts

BL OI AI Discuss

ASK STUDENTS: *Why is it important for both atria to beat at the same time and for both ventricles to contract together?* This provides consistent flow of blood through the heart.

Writing Support

BL OI AI Technical Writing

Have pairs or small groups of students write a product guide and give instructions for the heart. This guide should detail the heart's functions to someone unfamiliar with how the heart works. Illustrations may be used. *Sample guide should be similar to product*

instructions. Items might include a diagram with labeled parts, flow

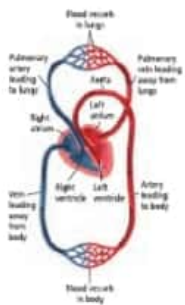


Figure 4 Blood flow through the body consists of two different circulatory loops.

right atrium, it has a low concentration of oxygen but a high concentration of carbon dioxide. This deoxygenated blood is dark red. The blood flows from the right atrium into the right ventricle and is pumped into the pulmonary arteries that lead to the lungs, as shown in **Figure 4**.

Eventually, blood flows into capillaries in the lungs that are in close contact with the air that enters the lungs. The air in the lungs has a greater concentration of oxygen than the blood in the capillaries does, so oxygen diffuses from the lungs into the blood. At the same time, carbon dioxide diffuses in the opposite direction—from the blood into the airspace in the lungs. Oxygenated blood, which is now bright red, flows to the left atrium of the heart to be pumped out to the body.

To the body and back The left atrium fills with oxygenated blood from the lungs, beginning the second loop. As shown in **Figure 4**, the blood then moves from the left atrium into the left ventricle. The left ventricle pumps the blood into the largest artery in the body called the aorta. Eventually, blood flows into the capillaries that branch throughout the body. Importantly, the capillaries are in close contact with body cells. Oxygen is released from the blood into the body cells by diffusion, and carbon dioxide moves from the cells to the blood by diffusion. The deoxygenated blood then flows back to the right atrium through veins.

Blood Components

Blood is the fluid of life because it transports important substances throughout the body. Blood is made up of a liquid medium called plasma, red blood cells, platelets, and white blood cells.

Plasma

The clear, yellowish fluid portion of blood is the **plasma**. More than 50 percent of blood is plasma. Ninety percent of plasma is water, and nearly 10 percent is dissolved materials. Plasma carries the broken-down products of digested food, such as glucose and fats. Plasma also transports vitamins, minerals, and chemical messengers including hormones that signal body activities, such as the uptake of glucose by the cells. In addition, waste products from the cells are carried away by plasma. There are three groups of plasma proteins that give plasma its

yellow color. One group helps to regulate the amount of water in blood. The second group, produced by white blood cells, helps fight disease. The third group helps to form blood clots.

Red blood cells

The **red blood cells** carry oxygen to all of the body's cells. Red blood cells resemble discs with pinched-in centers, as shown in **Figure 5**. Recall that red blood cells develop in the marrow—the center portion of large bones. Red blood cells have no nuclei and live for only about 120 days.

Red blood cells mostly consist of an iron-containing protein called hemoglobin. Hemoglobin chemically binds with oxygen molecules and carries oxygen to the body's cells.

Platelets

Have you ever cut your finger? If so, you probably noticed that in a short while, the blood flowing from the cut slowed down and then stopped as a blood clot formed. A **scab**. **Platelets** are cell fragments, shown in **Figure 7**, that are important in forming blood clots.

When a blood vessel is cut, platelets collect and stick to the vessel at the site of the wound. The platelets then release chemicals that produce a protein called fibrin. Fibrin weaves a network of fibers across the cut that traps blood platelets and red blood cells, as shown in **Figure 6**. As more and more platelets and blood cells are trapped, a blood clot forms.

White blood cells

The body's disease fighters are the **white blood cells**. Like red blood cells, white blood cells are produced in bone marrow. Some white blood cells recognize disease-causing organisms, such as bacteria, and alert the body that it has been invaded. Other white blood cells produce chemicals to fight the invaders. Still, other white blood cells surround and kill the invaders.

White blood cells are different from red blood cells in important ways. Many white blood cells move from the marrow to other sites in the body to mature. Unlike red blood cells, there are fewer white blood cells—only about one white blood cell for every 500 to 1000 red blood cells. Also, white blood cells have nuclei. Finally, most white blood cells live for months or years.

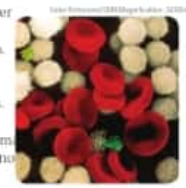


Figure 5 Blood is composed of liquid plasma, red blood cells (biconcave discs), white blood cells (irregularly shaped cells), and platelets (flat fragments). **Inter:** What might be occurring if there are too many white blood cells?

Reading Check

Explain what could happen if the number of white blood cells is high?

Skill Practice

BL OI AI Visual Literacy Have students examine Figure 7.

ASK STUDENTS: Why are red blood cells concave in shape?

This shape allows a maximum surface area for the transfer of gases and to give them the flexibility they need to travel and fit through capillaries.

Critical Thinking

BL OI AI Hypothesize

ASK STUDENTS: What is the advantage of the red blood cell not having a nucleus? A nucleus decreases the space available for gas transport. Having more space leaves more room for hemoglobin to transport oxygen. A nucleus also adds cell mass. Tell students that this increases the heart's workload by about 20 percent. If every red blood cell had a nucleus, the heart would have to work 20 percent harder.

Develop Concepts

BL OI AI Discuss

ASK STUDENTS: Have you ever bitten your lip and noticed that your blood had a specific taste? Some will say yes. Why do you think this is? The iron of hemoglobin within the red blood cell is responsible for the specific taste.

Writing Support

OI AI Creative Writing Have students imagine they are a red blood cell and write an autobiography entitled *120 Days of Life*.

Writing Support

BL OI AI Technical Writing Have students write an ingredient label for a vial of blood. **Sample label:** plasma (10 percent is dissolved materials—glucose, fats, vitamins, minerals—and 90 percent is water), red blood cells, white blood cells, and platelets

Reading Check Plasma transports vitamins and carries waste products away from cells.

■ Caption Question Fig. 7 A high number of white blood cells might indicate an infection.



Figure 6 A scab forms as fibrin threads trap blood cells and platelets.

Circulatory System Disorders

Several disorders of the blood vessels, heart, and brain are associated with the circulatory system. Blood clots and other matter, such as fat deposits, can reduce the flow of oxygen-rich and nutrient-rich blood traveling through arteries. Physicians refer to the condition of blocked arteries as **atherosclerosis**. When blood flow is reduced or blocked, the heart must work even harder to pump blood, and vessels can burst. **Figure 6**

My Notes



Going Further On the back of their Foldables, have students list the type of marker associated with each blood type.

Critical Thinking

BL O! A! Infer

ASK STUDENTS: *Why is it difficult to pull a gauze strip away from a cut?* Blood clots within the gauze, making the gauze part of the clot. The blood uses the gauze network much like the fibrous structure it forms on its own.

Develop Concepts

BL O! A! Discuss

ASK STUDENTS: *Why can people who have type O blood donate blood to people who have other types of blood?* Type O blood does not have the marker molecules that would cause rejection in the recipient. Recently researchers have discovered that the immune response to blood transfusions is increasingly complicated. Type O blood is given when blood type is unknown, but type-specific blood is preferred over type O if the patient is not type O.

Research Citation

Question Educational research indicates that good questioning challenges students to think beyond simple recall. As suggested on this page, students should be asked to use higher level thinking skills when considering the main ideas of a lesson in order to deepen their understanding. (Heibert et al., 1997)

Writing Support

OL A! **Technical Writing** Have students research and write a brochure about preventing heart disease. Have students present their finished piece to the class.

Formative Assessment

Evaluation Give students two diagrams of the circulatory system with blood flow labeled. One diagram will be labeled correctly, the other will be labeled incorrectly.

ASK STUDENTS: *Which diagram is correct? What is incorrect on the other diagram?* Answers should demonstrate correct understanding of how blood flows through the circulatory system.

Remediation Provide students with an unlabeled diagram of the circulatory system. Have them use the diagrams in the book to label the direction of blood flow on the diagram which you have given them.

LESSON 7.1 Review

Visualize It!



The human body contains a network of tubes called blood vessels.



Red blood cells circulate throughout the body to deliver oxygen to cells.

Summarize It!

1. What are the main functions of the circulatory system?
2. How does blood flow between the heart and the body?
3. What are the similarities and differences of the main blood components?

Checking the main ideas

1. Explain the main functions of the circulatory system.
2. Create a diagram of the path of blood through the heart and body.
3. Compare and contrast the structure of arteries and the veins.
4. Calculate the average number of red blood cells per 100 white blood cells in the human body.
5. Summarize the functions of the four blood components.

Critical Thinking

6. **Cause and Effect** What would happen if the stopmaker received wrong signals from the brain?
7. **Form a hypothesis** about why exercise helps maintain heart health?

MATH in Science

8. **Count** the number of your heart beat in 15 seconds. What is the rate of your heart beat in a minute?



Assessment

1. The circulatory system supplies the cells of the body with oxygen and nutrients, and it removes wastes such as carbon dioxide.
2. Diagrams will reflect Figures 4 and 6.
3. Arteries have a thicker endothelial wall than veins have. Veins have valves and arteries do not.
4. For every 100 white blood cells, there would be 50,000–100,000 red blood cells.
5. Plasma is the liquid portion of the blood. Red blood cells carry oxygen to cells and carry carbon dioxide away from cells. White blood cells defend the body from disease. Platelets are cell fragments that help form blood clots.
6. The heart might beat irregularly.
7. People who exercise strengthen their cardiac muscle.
8. Students should multiply their count by four to calculate their heart rate per minute.

LESSON 7.2 Respiratory System

EXPLORE

Air filter separates dust and other particles from the air before it flows to the car engine. This in turn leads to the avoidance of troubles in the engine, and also helps guarantee the flow of air. Your respiratory system has features that guarantee the flow of enough clear air to your lungs.



Explore Activity

Does Exercise Affect Metabolism?

Metabolism is the result of most of the chemical reactions that take place in your body cells. In this experiment, you will explore the effect of exercises on the circulatory and respiratory systems. You can also find out how this affects metabolism.

Procedures

1. Identify the safety risks of this experiment before starting.
2. Record the rate of heart beats and the rate of breathing per minute for 10 of your class mates.
3. Ask the students to walk around their places for 5 minutes. At the end of 5 minutes record the number of heart rate and number of breathing rate per minute for each of the students.
4. After a break of 5 minutes ask the student to jump slowly and walk briskly around their places. Record their heart and breathing rates per minute.
5. Represent the results in a graph. Each point should indicate the breathing rate per minute on the horizontal axis, and heart rate beat per minute on the vertical axis.

Analysis

1. Explain the relationship between the two variables: the heart rate and the breathing rate.
2. Find out if exercise affects metabolism and why?
3. Form a hypothesis about the variation of the heart rate and the breathing rate per minute among the students, despite the fact that all of them jumped or run for the same duration.

Essential Questions

- What is the difference between internal and external respiration?
- What is the path of the air through the respiratory system?
- What changes occur in the body during breathing?

Review Vocabulary

ATP: biological molecule that provides the body's cells with chemical energy

Vocabulary

breathing
external respiration
internal respiration
trachea
bronchus
lung
alveolus

The BIG Idea

BL OI AL Respiratory System

ASK STUDENTS: How does oxygen reach a car engine to mix with an energy source, providing energy for the car? Possible answers: through the air intake, carburetor, or in the fuel injection.
SAY TO STUDENTS: Powering a car takes oxygen and fuel. Your body also requires oxygen and fuel for cellular respiration.

Reading Strategy

BL OI

Monitor Comprehension Help students practice monitoring their comprehension as they read. As they read the text on this page, remind them to slow down and make note of any concepts that they do not understand. Help them practice the habits of rereading or reviewing to clarify what is unclear.

Guiding Questions

BL How would the two processes of respiration be affected if you were running a 400-m race?	Breathing and respiration rates would increase.
QL What if you were sleeping?	They would slow down.
AL Walking to school?	They would increase.

■ **Caption Question** Fig. 10 Inhaled air has more O₂; exhaled air has more CO₂.

Content Background

Real-World Connection Irritants enter the respiratory system daily, and the body has protective reflexes, such as coughing and sneezing, to fight them. Both involve a temporary period of apnea, which is a period when respiration is suspended. Sneezing is triggered by the irritation of the nasal cavity wall, while coughing is triggered by irritation of the larynx, trachea, or bronchi. The air forced out of the larynx during a sneeze can travel up to 160 km/h, carrying mucus, foreign particles, and the irritant out of the respiratory tract.

The lab at the end of the chapter can be used at this point in the lesson.

GOING GREEN

If you bring your lunch to school, place items in reusable containers. Encourage students to do the same. Also be conscious of the packaging used for single serving snack-sized packages.

Critical Thinking

BL OL A Hypothesize

ASK STUDENTS: *What role does mucus play when you have a cold? Mucus is the body's first line of defense against foreign particles. Often, more mucus is developed during a cold in an attempt to rid the body of the invaders in the respiratory system.*

Develop Concepts

BL OL A

Clarify a Misconception

ASK STUDENTS: *When you get a cold, can you visit the doctor and obtain medication to cure the cold? Some students might say yes. Colds are a respiratory infection caused by viruses, not by bacteria. Medication does not exist to cure the cold but medication can be used to treat its symptoms. Antibiotics are often prescribed to fight secondary bacterial infections resulting from the cold. Overuse and unnecessary use of antibiotics might lead to resistant strains of bacteria.*

■ **Caption Question** **Fig. 11** Air travels into the body through the mouth and nose, past the pharynx, down the trachea, down the bronchi, through the bronchioles, and into the alveoli.



Demonstration

BL OL **Circulation and Respiration** Use a fish tank, water, and an aquarium pump with a filter to demonstrate how a circulatory system and respiratory system work together. Fill the aquarium with water and hook up the filter/pump system. Turn the pump on and have the water pass through the filter. **ASK STUDENTS:** *Where are the gases being exchanged? The gases are exchanged as the water passes over the edge back into the aquarium.* Point out that the filter acts like cilia in the respiratory tract, the water acts similar to the blood, and the pump acts like the heart. Est. time: 10 min

Discover

Before reading this lesson, write down what you already know in the first column. In the second column, write down what you want to learn. After you have completed this lesson, write down what you learned in the third column.

What I Know	What I Want to Learn	What I Learned

Respiratory System

The Importance of Respiration

Your body's cells require oxygen. Recall that oxygen and glucose are used by cells to produce energy-rich ATP molecules needed to maintain cellular metabolism. This process is called cellular respiration. In addition to releasing energy, cellular respiration releases carbon dioxide and water.

Breathing and respiration

The respiratory system sustains cellular respiration by supplying oxygen to body cells and removing carbon dioxide waste from cells. The respiratory system can be divided into two processes: breathing and respiration. First, air must enter the body through breathing. **Breathing** is the mechanical movement of air into and out of your lungs. **Figure 8** illustrates air being released from the lungs into the air. Second, gases are exchanged in the body. **External respiration** is the exchange of gases between the atmosphere and the blood, which occurs in the lungs. **Internal respiration** is the exchange of gases between the blood and the body's cells.

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Figure 8 Exhaled air from a person's lungs can be seen on a chilly evening. **Infer** how the air that you inhale is different from the air that you exhale.

Breathing

The brain directs the rate of breathing by responding to internal stimuli that indicate how much oxygen the body needs. When the concentration of carbon dioxide in the blood is high, the breathing rate increases because cells need more oxygen.

Inhalation is the act of taking air into the lungs. During inhalation, as shown in **Figure 9**, the diaphragm contracts. This causes the chest cavity to expand as the diaphragm moves down, allowing air to move into the lungs. During exhalation, the diaphragm relaxes and returns to its normal resting position. This reduces the size of the chest cavity as the diaphragm moves up. Air naturally flows out from the greater pressure of the lungs. Follow **Figure 11** to learn how circulation and respiration work together to supply the needed oxygen and to get rid of carbon dioxide.

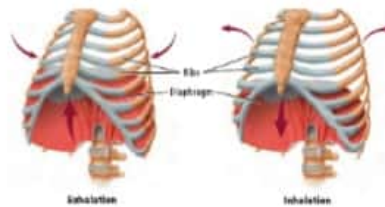


Figure 9 Rib and diaphragm muscles contract and relax during breathing. **Analyze** how air pressure is involved in breathing.

Key Concept Check

1. Explain the difference between the air you breathe in and the air you breathe out?

Assess Content Development Assess how understanding has developed when students revisit the Launch Lab analysis questions.

Skill Practice

BLQA Sequence

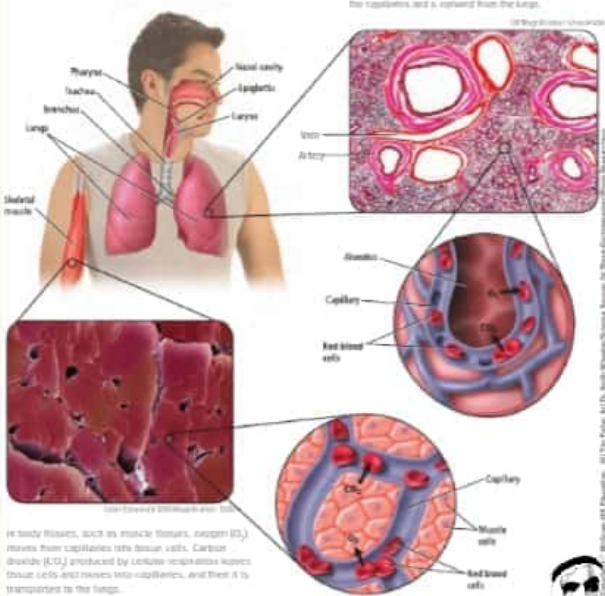
TELL STUDENTS: Create a list of events that take place when a force "knocks the air out of you." Force hits the abdominal region, forcing the diaphragm up, which in turn compresses the lungs and releases the air inside the lungs.

■ **Caption Question** **Fig. 13** Air flows from areas of greater to lesser pressure during inhalation and exhalation.

Visualizing Gas Exchange

Figure 11

Gases are exchanged in the capillaries and in the tissue cells of the body.



In body tissues, such as muscle fibers, oxygen (O_2) moves from capillaries into tissue cells. Carbon dioxide (CO_2) produced by cellular respiration moves from tissue cells and moves into capillaries, and then it is transported to the lungs.

In the lungs, oxygen (O_2) that is inhaled moves into capillaries and is transported to body cells. Carbon dioxide (CO_2) leaves the capillaries and is removed from the lungs.

Visualize It!



Cellular breathing produces carbon dioxide and water.



Each bronchi branches out into smaller tubes called bronchioles.

Summarize It!

1. Distinguish between internal and external respiration.
2. Sequence the path of air in the respiratory system.
3. Describe the changes that occur in the body concurrent with breathing movements.



Purpose

Students will understand organisms accommodate the need for obtaining, transforming, and transporting the matter and energy used to sustain the organism.

Skill Practice

Visual Literacy Have students review the figure on this page **examining the gases exchanged within the lungs.**

ASK STUDENTS: *What part of the figure is responsible for gas exchange in the respiratory and circulatory systems? alveoli, capillaries, and blood. Are they similar? Yes, both alveoli and capillaries contain one thin layer of tissue. What is the mechanism for gas exchange? diffusion.*

Writing Support

BLQA

Narrative Writing

SAY TO STUDENTS: *Suppose you are an oxygen molecule travelling into a human body. Write a narrative describing what you see and what is happening to you as you travel to the alveoli. Then write a sentence describing each stage. A possible narrative may include the following chain of events: An oxygen molecule might pass into the nose, passing cilia and mucus, through the trachea, passing dust and other foreign particles into the bronchi, to a bronchiole, to an alveolus, and into a red blood cell.*

Research Citation

Formative Assessment Educational research indicates that assessment should be ongoing, strategic, and purposeful. The results can then benefit students by allowing the teacher to adapt curriculum and instruction to meet individual needs. (Bredenkamp and Cople, 1997)

The BIG Idea
 These systems function together to maintain homeostasis by delivering important substances to the body's cells while removing wastes.

Key Concepts Summary

7.1: Circulatory System

- Blood vessels transport important substances throughout the body.
- The top half of the heart is made up of two atria, and the bottom half is made up of two ventricles.
- The heart pumps deoxygenated blood to the lungs, and it pumps oxygenated blood to the body.
- Blood is made up of plasma, red blood cells, white blood cells, and platelets.
- Blood is classified by the following four blood types: A, B, AB, and O.

Vocabulary

- artery
- capillary
- vein
- valve
- heart
- pacemaker
- plasma
- red blood cell
- platelet
- white blood cell
- atherosclerosis

7.2: Respiratory System

- Alveoli in the lungs are the sites of gas exchange between the respiratory and circulatory systems.
- The pathway of air starts with the mouth or nose and ends at the alveoli located in the lungs.
- Inhalation and exhalation are the processes of taking in and expelling air.
- Respiratory disorders can inhibit respiration.

Vocabulary

- breathing
- external respiration
- internal respiration
- trachea
- bronchus
- lung
- alveolus

FOLDABLES Unit Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.

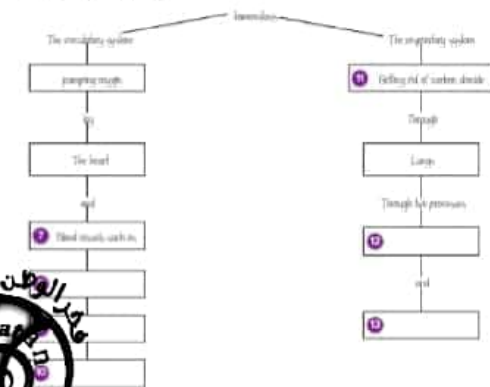


Use Vocabulary

- Cause and Effect** What would happen if the pacemaker received wrong signals from the brain?
- Form a hypothesis about why exercise helps maintain heart health.
- Blood is made of red blood cells and white blood cells.
- The circulatory system transports blood to deliver vital substance such as supplying oxygen to cells and getting rid of waste.
- Breaking in and _____ are two processes to take in and take out air.
- Muscular disorders could hamper breathing.

Link Vocabulary and Key Concepts

Draw this concept map, and then use vocabulary terms from the previous page to complete the concept map.



Est. Time 90 min

Content Background

Information can be effectively presented using a variety of formats, including posters, pamphlets, and multimedia presentations.

Safety Precaution Discuss the safety concerns of this lab before work begins.

Teaching Strategy Students may need help narrowing the scope of information in their presentations.

Alternative Teaching Demo

Students could examine prepared pamphlets, videos, and posters from a variety of health organizations and evaluate their effectiveness in communicating information using the rubric provided.

Analyze and Conclude

1–5. Answers will vary based on presentations. Students' presentations should demonstrate solid research skills and original work, should be well organized and accessible to the target audience. The presentation rubric below may help in your evaluations.

***RUBRIC Presentation Evaluation Rubric:** Rate each category according to the following scale: *excellent*–9–10 points; *very good*–7–8 points; *good*–5–6 points; *satisfactory*–3–4 points; *poor*–1–2 points; and *unsatisfactory*–0 points.

Categories	Points Possible	Self-Assessment	Target Audience Member Assessment
The presentation flows well from one topic to another and is easy to follow.	10		
The presentation includes diagrams and photographs that provide visual interest.	10		
The presentation provides information about the importance of making positive health choices.	10		
The presentation conveys the interconnected nature of body systems.	10		
Information in the presentation is helpful to someone who is trying to establish and/or follow a healthy lifestyle.	10		

Section 1
Vocabulary Review

Match each of the following definitions with the correct vocabulary term from the Study Guide page.

- a vessel carrying oxygen-rich blood
- involved in blood vessel repair

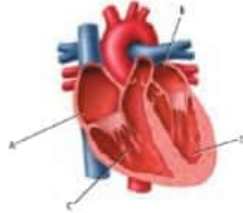


- What part of the respiratory system contains hair that purifies air of particles?
A. 1
B. 2
C. 3
D. 4
- In which of the numbered areas in the diagram gas exchange takes place?
A. 1
B. 2
C. 3
D. 4

Use this diagram to answer question 3 and 4

- When blood leaves the heart, where does it exit?
A. the aorta
B. the capillaries
C. the lungs
D. the pulmonary vein

Use the diagram below to answer questions 6 and 7



- Which represents the right ventricle?
A. A
B. B
C. C
D. D
- Into what part of the heart does oxygen-rich blood enter?
A. A
B. B
C. C
D. D
- When a small blood vessel in your hand is cut open, which plays an active defensive role against possible disease?
A. plasma
B. platelets
C. red blood cells
D. white blood cells
- Which process occurs inside the tissue cells in your legs?
A. filtration
B. breathing
C. external respiration
D. internal respiration

Understand Main Ideas

Use the diagram below to answer questions 10 and 11



- Which process is shown above?
A. inhalation
B. exhalation
C. cellular respiration
D. filtration
- Which structure moves down as its muscles contract?
A. trachea
B. diaphragm
C. pharynx
D. ribs
- How many breaths will a person take in one day if he or she takes 12 breaths per minute?
A. about 1000
B. about 10,000
C. about 17,000
D. about 1,000,000

- Which gas is needed by all cells?
A. sulfur
B. hydrogen
C. carbon dioxide
D. oxygen

Writing in Science

- Create a diagram similar to the circulatory system based on a highway route in your city or rural area.

Constructed Response

- Short Answer** Differentiate between asthma, bronchitis, and emphysema.
Use the photo below to answer question 16.



- Short Answer** Describe the function of the structures above. Where would these structures be found?

Constructed Response

- $180 \text{ L}/24 \text{ hr} = 7.5 \text{ L/hr}$

Think Critically

- Questions will vary, but should reflect realistic concerns about urinary and reproductive health.

Summative Assessment

- The respiratory and circulatory systems deliver oxygen and nutrients. Oxygen is important for cellular respiration; nutrients are important for energy and cell function. The excretory system removes carbon dioxide and excess salt.
- Answers may include comparisons of arteries and veins to highways, and red blood cells to cars.

Document-Based Questions

Macey, R. 1968. *Human Physiology*. Englewood Cliffs, NJ, Prentice Hall.

- most likely Subject C because his or her hemoglobin content of the blood is the lowest
- most likely Subject B because the oxygen content of Subject B's blood in the arteries is the lowest (except for Subject C, whose low oxygen content is due to another reason)

- most likely Subject E because the difference between the oxygen content of his or her arteries and veins is the smallest

Standardized Test Practice

Multiple Choice

- A
- B
- A
- D
- B
- A
- A
- B

Short Answer

- When the biceps muscle contracts, the lower arm is moved upward. When the triceps muscle contracts, the lower arm is pulled downward.
- Muscles only do work when they contract. Muscles need to be in pairs that work against each other to create movement.
- Answers can vary depending on the drug chosen.

12. Answers may vary.

	Autonomic nervous system	Somatic nervous system
Type of response	Involuntary	Voluntary and involuntary
Systems affected	Internal organs and glands	Skeletal muscles
Example	CNS sends impulses to digestive system to proceed with digestion	Brain sends a signal to move leg muscles when running

13. Monotreme characteristics that are reptilian: webbed feet, lay eggs, and lower body temperature than most mammals. Monotreme characteristics that are mammalian: hair and fur on the body and mammary glands that provide milk to young.
14. Since myelin provides insulation on neurons, early symptoms would be related to the loss of control of muscles, for example, trouble with walking, moving, picking up things.
15. Blood enters nephron units in the kidney through the renal artery. The renal artery enters the kidney and branches into smaller and smaller blood vessels, eventually ending in the tiny capillaries in the glomerulus. The walls of the capillaries are very thin. As a result, water and substances dissolved in the blood, and the waste product urea, pass through the capillary walls into the Bowman's capsule. Larger molecules and red blood cells are too large to pass through the capillary walls and remain in the bloodstream.

Extended Response

16. Blood from each atrium flows into the ventricle below, and then is pumped either to the lungs, or to the body. A four-chambered heart separates oxygen-rich and oxygen-poor blood, making it possible to pump highly oxygenated blood to the body.
17. Both types of meristems are regions in a plant that have rapidly dividing cells. Apical meristems occur at the tips of roots and stems. These tissues cause roots and stems to grow longer. Lateral meristems occur along roots and stems. They are responsible for the lateral growth, or increase in diameter, of roots and stems.
18. Inventing microscopes was an advance in technology because the microscope is a tool that is useful for seeing tiny objects that are invisible to the unaided eye. The discovery of hundreds of microscopic organisms was an advance in science that came from observations by many researchers using microscopes. That advance in science could not have happened without an advance in technology.

Essay Question

19. The involuntary responses involved with "fight or flight" responses may seem useless today because they include pupil dilation, decreased activity of the digestive system, and faster heart rate. In the past, these responses have been useful

Teacher Notes



for survival when humans often were hunting for food or in danger from predatory animals. These responses are not typically needed by humans in today's high-stress activities, such as having to perform in front of other people, that might still stimulate the "fight or flight" response. Other involuntary responses, however, include reflexes that cause a person to pull away from a hot stove. This response is useful because it occurs much faster than a voluntary response could. Moreover, the processes of whole organ systems such as digestion, respiration, and circulation are controlled by involuntary actions of the nervous system. This control is important so that these systems can work constantly together

8.1 Inheritance and Traits

INQUIRY

Dyed Blue? No, due to a genetic mutation, about 1 in 5 million lobsters are naturally blue. What is a mutation? How do you think mutations affect traits?

Write your response in your interactive notebook.



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Explore Activity

What role does chance play in inheritance?

You probably look like your parents in many ways, but you are not identical to them. For instance, you might have blue eyes like your father, but brown hair like your mother. Inheriting traits is a matter of chance.

Procedure

1. Obtain two dice of different colors. With a partner, roll the dice 10 times. Make a data table in your Science Journal to record the number of dots on each die for each roll.
2. Discuss with your partner how this activity might model reproduction. What do the colors represent? What do the dots represent?

Think About This

1. Did you get the same combination for any of your rolls?

2. What if each die had 12 faces, or 100 faces? How do you think these changes would affect your chances of getting the same combination?

3. **Key Concept** In what ways do you think rolling dice models how traits are inherited? What role does chance play in inheritance?

Essential Questions

- What is inheritance?
- What is the role of genes in inheritance?
- How do environmental factors influence traits?
- How do mutations influence traits?

Vocabulary

- trait
- inheritance
- gene
- genotype
- phenotype
- mutation



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INQUIRY

About the Photo Dyed Blue? Lobsters live in saltwater environments and come in many colors, including yellow, greenish-brown, and orange. Very rarely, a genetic mutation produces the blue color. All lobsters turn red when placed into hot water for cooking. This is because the red pigment in the lobster's shell is stable at high temperatures, unlike the other color pigments that are present.

Guiding Questions

- AL** If a lobster's parents are brown, do you think the lobster is more likely to be brown or another color? *Use this question to initiate a discussion about inherited traits. Students may have prior knowledge that offspring inherit some traits, such as color, from their parents.*
- QL** What is a mutation, and how might a mutation affect traits? *Use this question to begin a discussion about mutations as permanent changes in genes that can change traits in organisms.*

LAB Manager

All the labs for this lesson can be found in the *Student Resource Handbook* and the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential questions and be able to answer these questions. Have students write each question in their Science Journals. Revisit each question as you cover its relevant content.

Vocabulary Using Word Origins

1. Write *genotype* and *phenotype* on the board or chart paper. Circle *geno* and *pheno*. Write *genea* next to *genotype* and *phaein* next to *phenotype*.
2. **Ask:** Which part of these two words is the same? *type*
Ask: What can we use to remember the difference between these two scientific terms? *the meaning of the first part of each word; the word origin*
3. Explain that *genea* is Greek for *generation*, while *phaein* comes from the German language and means "to show." An organism's genotype is the entire set of genes—what has

8.1 Review

Visualize It!



Traits are either inherited or acquired. Inherited traits are passed from one generation to the next.

An organism's phenotype can be influenced by factors in the environment, such as light, nutrients, or social interactions.

One result of a mutation could be a change in appearance, such as a change in feather color.

Summarize It!

1. What is inheritance?
2. What is the role of genes in inheritance?
3. How do environmental factors influence traits?
4. How do mutations influence traits?

Inheritance and Traits

Use Vocabulary

1. A distinguishing characteristic of an organism is a(n) _____.
2. A permanent change in the sequence of DNA in a gene is a(n) _____.
3. **Distinguish** between phenotype and genotype.

Interpret Graphics

7. **Organize Information** Copy the graphic organizer below and use it to list *gene*, *chromosome*, *cell*, and *DNA* from smallest to largest.



Critical Thinking

8. **Propose** an explanation for why this wallaby lacks normal coloration in its fur.



Understand Key Concepts

4. Which is an inherited trait?
 - A. learning to strig
 - B. losing a claw
 - C. having a hooked beak
 - D. learning a new trick
5. **Design an experiment** to determine the environmental factors that cause adult flamingos to turn pink.
6. **Compare and contrast** sexual reproduction and asexual reproduction.

Math Skills

9. The common hamster has 20 chromosomes. How many different types of hamster offspring could form?



Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask:** Which Key Concept does each image relate to?

Summarize It!

Use Vocabulary

1. trait **DOK 1**
2. mutation **DOK 1**
3. Phenotype is the collection of observable traits in an organism that results from the interaction of genes and the environment. Genotype is the entire collection of genes in an organism's cells. **DOK 2**

Understand Key Concepts

4. C. having a hooked beak **DOK 2**
5. Answers will vary. Students could vary the diet of the birds or choose other variables to test, such as temperature or nutrients in the water. **DOK 4**

6. In asexual reproduction, the offspring are identical to a parent. In sexual reproduction, the offspring are all different from their parents because each receives a slightly different set of genes from each parent. **DOK 3**

Interpret Graphics

7. DNA → genes → chromosome → cell **DOK 2**

Critical Thinking

8. There is a mutation in one of the genes. **DOK 3**

Math Skills

9. $\frac{20}{2} = 10$; $2^{10} = 1024$ **DOK 3**

8.2 Adaptations in Species

INQUIRY

Why Blend In? This snake, called an eyelash viper, blends in well with its environment. How does this adaptation help the snake survive? What are some other adaptations that help organisms survive?

Write your response in your interactive notebook.



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Explore Activity

How alike are members of a population?

It is easy to see the differences among people, but what about plants or animals? Are all robins alike? What about sunflower seeds?

Procedure

1. Read and complete a lab safety form.
2. Place 10 sunflower seeds on a paper towel. Number the seeds 1–10 by writing on the paper towel below each seed.
3. Use a magnifying lens to examine the seeds, focusing on how their coloration is alike and/or different. Record your observations in your Science Journal.
4. Copy the table on the right in your Science Journal. Perform the following steps and record your observations.
 - Use a metric ruler to measure the length of each seed.
 - Measure the thickness of each seed at its thickest point.
5. Compare the length and thickness of your 10 seeds with those of other teams.

Think About This

1. Do all sunflower seeds have the same length and thickness? Why do you think the seeds differed in so many ways?

2. If you were a bird, do you think you would be more or less attracted to any of the seeds? How might this affect the reproduction of the sunflowers?

Essential Questions

- How do mutations cause variations?
- How does natural selection lead to adaptations in species?
- What are some ways adaptations help species survive in their environments?

Vocabulary

- variation
- adaptation
- natural selection
- selective breeding
- camouflage
- mimicry

INQUIRY

About the Photo Why Blend In? Eyelash vipers vary in color, depending on where they live. These snakes can be yellow, green, red, brown, or gray. Eyelash vipers' habitats range from the southwestern United States through the northernmost parts of South America. In addition to their coloring, the eyelash vipers have scales above each eye. These "eyelashes" may help them blend in with their environments, making their eyes less noticeable. Ask students to closely note the details of the photo as you discuss adaptations.

Guiding Questions

- AL** Why might you not notice the snake when you first glance at the photo? *It blends in with the branch because it is a similar color.*
- QL** How does the snake's adaptation help it survive? *Use this question to launch a discussion of the importance of blending in for the purpose of hiding from predators—and hiding to await prey.*
- BL** What are some other adaptations that help organisms survive? *Answers will vary. Students may cite other ways animals camouflage with color or patterns, how some animals hunt at night or migrate, how some animals spray venom or shed their coats. All are adaptations for survival.*

LAB Manager

Labs can be found in the *Student Resource Handbook* and the *Activity Lab Workbook*.

Essential Questions

After this lesson, students should understand the Essential Questions and be able to answer them. Have students write each question in their interactive notebooks. Revisit each question as you cover its relevant content.

Vocabulary

Using Prior Knowledge to Understand Vocabulary

Ask students to talk about when they have used mimicry to imitate a singer, a dancer, or someone else. Write *mimic* on the board, making sure students understand that to *mimic* is to "imitate." Point out that the meaning of *mimicry* is a bit different in the natural world; it is an adaptation in which one species looks like another. Explain that in this lesson, students will learn more about mimicry in nature and about the difference between camouflage and mimicry.



Woodpeckers use their long, thin beaks to search for insects in tree bark.

Parrots have strong beaks that help them crack nuts and seeds.

The condor uses its long, powerful beak to tear the flesh from dead organisms.

Figure 12 Though all birds have wings, beaks, and feathers, each species is adapted to a different environment. Each uses its beak in a different way to gather food.

Visual Check

How is a condor's beak adapted for the food it eats?

FOLDABLES

Make a vertical four-tab book, and label it as shown. Use it to organize your notes on benefits of adaptations.



Food Gathering

As you have just read, camouflage and mimicry protect species from predators. These same adaptations also can help species find food. The camouflaged stonefish in **Figure 11** is hidden not only from predators, but also from its prey. Many other kinds of adaptations help species gather and eat food. An anteater has a long nose and a long tongue for gathering ants. Each of the birds shown in **Figure 12** has a beak that helps it gather a different type of food. Some plants also have adaptations that enable them to store food. Potatoes, onions, and tulips all have modified underground stems that store food for the plants.

As predators develop adaptations for hunting their prey, the species they hunt develop adaptations for avoiding them. A cheetah is a fast runner. But so are the gazelles it chases as prey. Over time, cheetahs might become even faster due to chance variations and natural selection. But faster gazelles also might arise from the same process. In this way, species adapt to each other.

Movement

Cheetahs and gazelles have long, powerful legs adapted for running fast. Legs, wings, flippers, fins, and even tails are adaptations that help species move. Movement helps species seek food, avoid predators, and escape unpleasant stimuli. Even trees have adaptations for movement. Their leaves turn to face the Sun as it moves across the sky.

Visualize It!



Variations in populations occur because of mutations. Variations can lead to adaptations.



Through natural selection, a variation that helps organisms survive and reproduce eventually is inherited by most members of the population.



Adaptations may be structural, behavioral, or functional. Structural adaptations help organisms blend in with their environments.

Summarize it!

1. How do mutations cause variations?
2. How does natural selection lead to adaptations in species?
3. What are some ways adaptations help species survive in their environments?

Food Gathering

While students recognize the need of food for survival, they might not have carefully considered adaptations related to acquiring food. Use the **Visual Literacy** below and **Figure 12** to guide their understanding.

Visual Literacy: Figure 12

Students should study the photographs in **Figure 12** and then answer the following questions.

Ask: How is a condor's beak adapted to the food it eats? *Its long, powerful beak is used to tear the flesh of the carcasses.*

Ask: How is a woodpecker's beak adapted to the food it eats? *Its long, thin beak helps it hammer into tree bark to find insects.*

Ask: How is a parrot's beak adapted to the food it eats? *Its strong beak is shaped for cracking open nuts and seeds.*

Movement

Use the Guiding Questions to help students understand adaptations that help species move.

Guiding Questions

- AL** What are five adaptations that help species move? *legs, wings, flippers, fins, and tails*
- OL** How are adaptations related to movement alike for animals and plants? *These adaptations enable animals and plants to obtain what they need for survival.*
- BL** Suppose a fish's fins were damaged during an attack by a predator. What would be the effect on movement for the fish? *Use this question to launch a discussion regarding the importance of movement to a fish. Students should discuss survival issues as they recognize that if the fins are badly damaged, the fish will not be able to move—or will not be able to control direction of movement.*

Visual Summary

Concepts and terms are easier to remember when they are associated with an image. **Ask:** Which Key Concept does each image relate to?

Summarize it!

Adaptations in Species

Use Vocabulary

1. Slight differences in inherited traits are _____.
2. Describe natural selection in your own words.

3. Distinguish between mimicry and camouflage.

Understand Key Concepts

4. A nonpoisonous butterfly has coloration and markings similar to a poisonous butterfly. This is an example of
 - A. camouflage.
 - B. mimicry.
 - C. behavioral adaptation.
 - D. functional adaptation.
5. Compare and contrast natural selection and selective breeding.

6. Explain how two species might trigger adaptive changes in each other.

Interpret Graphics

7. Identify the type of adaptation the insect at right exhibits, and explain how the insect might benefit from the adaptation.



8. Organize Information Copy the graphic organizer below. Use it to list three ways that an organism you choose is adapted to its environment. Classify each adaptation as structural, behavioral, or functional.



Critical Thinking

9. Evaluate the role of the environment in natural selection.

10. Assess the role of mutations in adaptations.

My Notes

Use Vocabulary

1. variations, variations **DOK 1**
2. Answers will vary but should convey that natural selection is the process by which variations that help organisms survive and reproduce more become common in a population. **DOK 2**
3. In camouflage, a species looks like something in its environment, usually nonliving. In mimicry, one species resembles another species. Usually this calls attention to the species. **DOK 2**

Understand Key Concepts

4. **B** mimicry **DOK 1**
5. Natural selection is a naturally-occurring process in which variations that help an organism survive are passed to offspring. Selective breeding is similar except people—not nature or the environment—select variations that are passed to offspring. **DOK 2**
6. Answers will vary but might include two species that are known to be predator and prey, such as a fox and a rabbit. As the environment selects variations that make the fox faster, similar variations in the rabbit are selected to make the rabbit faster. If the predator didn't get faster, the environment would not be as likely to select variations to make the prey faster. There is more chance that a variation will be passed to offspring if it increases survival. **DOK 3**

Interpret Graphics

7. This is an example of camouflage. Because the insect is hard to see against its background, it avoids being eaten and survives longer in its environment. **DOK 1**
8. Answers will vary but should be traits common to a species, not an individual. **DOK 2**

Critical Thinking

9. The environment plays a critical role in natural selection. Only the variations that help an organism survive in its environment will be selected. These variations will then be passed to offspring. **DOK 3**
10. Without mutations, there would be no variations in individuals. If there were no variations, the environment would have nothing to "select." Therefore, mutations help organisms—and their offspring and the offspring's offspring, and so on—adapt to changes in their environments. **DOK 4**

The BIG Idea

Inherited mutations can lead to variations, which can become adaptations through natural selection over many generations.

Key Concepts Summary

8.1 Inheritance and Traits

- The passing of **traits** from generation to generation is **inheritance**.
- Information about traits is passed from parents to offspring on **genes**.
- An organism's **phenotype** can be influenced by environmental factors, such as temperature, nutrients, and social interaction.
- Only traits affected by **mutation** can be passed to offspring.



Vocabulary

trait
inheritance
gene
genotype
phenotype
mutation

8.2 Adaptations in Species

- Variations** in the when mutations cause changes in the sequence of an organism's DNA.
- Natural selection** explains how variations that help organisms survive are passed to offspring and eventually become **adaptations**.
- Adaptations help animals, plants, and microorganisms survive, protect themselves from predators, gather food, and move.



variation
adaptation
natural selection
selective breeding
camouflage
mimicry

FOLDABLES Chapter Project

Assemble your lesson Foldables as shown to make a Chapter Project. Use the project to review what you have learned in this chapter.



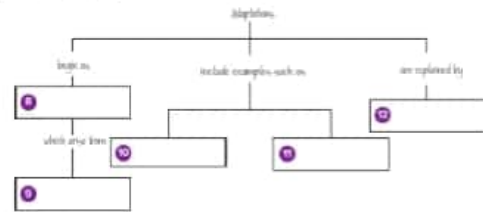
Use Vocabulary

Choose the vocabulary term that best matches the descriptions below.

- slight differences in inherited traits
- a distinguishing characteristic of an organism
- all of an organism's genes
- how a trait appears, or is expressed
- adaptation that helps an organism blend in with its surroundings
- the human practice of breeding organisms with desired characteristics
- resembling another species

Link Vocabulary and Key Concepts

Copy this concept map, and then use vocabulary terms from the previous page to complete the concept map.



Key Concepts Summary

Vocabulary

Study Strategy: Questions and Answers

Self-assessment helps students practice metacognition, increasing their awareness of their understanding.

- Ask students to create a chart similar to the one below.
- Have students list the Key Concept questions in the first column, their answer in the second column, and their self-assessment in the third column. **Example:**

Lesson KC Questions	My Answers	My Self-Assessment
What is inheritance?	Inheritance is the passing of inherited traits from parents to offspring.	I left out the part about passing the traits from generation to generation, but it means the same thing as passing the traits from parents to offspring. I understand the concept.

Study Strategy: In Your Own Words

Ask students to work in pairs to write vocabulary definitions in their own words. Connecting vocabulary words to students' own language promotes understanding more effectively than memorizing.

- Have students create a two-column table like the one below in their Science Journals.
- Have them write the vocabulary words in the Study Guide in the left column.
- Ask students to review the definition of each word in the chapter.
- Then have students use their own words to write a definition for each vocabulary word, including any notes that will help them remember its meaning.

Example:

Vocabulary Word	My Definition
trait	A trait is a characteristic that an organism has. Inherited traits are passed on from parents to offspring. Acquired traits are not passed on to offspring.

Use Vocabulary

- 1 variations
- 2 trait
- 3 genotype
- 4 phenotype
- 5 camouflage
- 6 selective breeding
- 7 mimicry

Link Vocabulary and Key Concepts

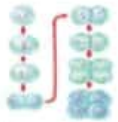
- 8 variations
- 9 mutations
- 10 camouflage
- 11 mimicry
- 12 natural selection

Teacher Notes




Understand Key Concepts

- In which way does asexual reproduction differ from sexual reproduction?
 - Genes are not involved in asexual reproduction.
 - No traits are passed to offspring in asexual reproduction.
 - Offspring are identical to the parent in asexual reproduction.
 - There are no mutations in asexual reproduction.
- Which is a source of variations?
 - adaptations
 - mutations
 - phenotype
 - traits
- Which is the sequence by which natural selection works?
 - selection → adaptation → variation
 - selection → variation → adaptation
 - variation → adaptation → selection
 - variation → selection → adaptation
- Which adaptation is functional?
 - a lizard playing dead
 - a monkey swinging by its tail
 - a skunk spraying a predator
 - a wolf hunting in a pack
- Which process is illustrated below?



- meiosis
- mutation
- asexual reproduction
- natural selection

298 Chapter 8 Review

- Which trait cannot be inherited?
 - scars
 - shyness
 - big feet
 - red hair
- The photo below is a leaf butterfly. Which explains how the butterfly came to resemble a leaf?
 




- The butterfly's shape is the result of an exchange of genes with plants over many generations.
 - The butterfly's shape is the result of the environment causing mutations over many generations.
 - The butterfly's shape is the result of the environment influencing its phenotype over many generations.
 - The butterfly's shape is the result of the environment selecting variations over many generations.
- Graffes range in color from orange to yellow. Which explains these color differences?
 - adaptations
 - variations
 - natural selection
 - selective breeding



2018



Critical Thinking


- Design an organism adapted to a murky lake with many plants. The organism's major predator is a large fish that swims slowly.
- Assess how mutations can be beneficial.
- Differentiate among mutation, variation, and adaptation, and explain how they are related to one another.
- Classify the following adaptations as structural, behavioral, or functional: robins migrating, llamas spitting, bats hibernating, a beetle's color, wolves hunting in packs.
- Predict what might happen to a species of ground plants over many generations when leaf-eating tortoises move into its range.
- Design an experiment to test whether a trait in an animal is inherited or the result of an environmental factor.
- Interpret Graphics The seal on the right has normal coloration. The seal on the left does not. What could explain why the seal on the left has abnormal coloration?
 



Writing in Science

- Write Scientists have determined that all dogs were bred from wolves. Think about how wolves might have become tame enough to be pets. Then write a paragraph explaining how dogs became so different over time. Include a main idea, supporting details, and a concluding sentence.

The BIG Idea

- Adaptations help species survive in their environments. Choose two species that live near you, and list at least three ways—one structural, one behavioral, and one functional—that each is adapted to its environment. Explain how each adaptation helps the species survive.
- In what ways does the juvenile mountain goat look like its mother? In what ways might the offspring be different from its mother? Explain how differences in individual mountain goats could help the species survive if its environment suddenly changed.
 



Math Skills

Use Probability

- Human has 24 chromosomes. How many possible combinations of chromosomes can form in a sperm?
- Human has 46 chromosomes. How many different combinations of chromosomes can be formed during reproduction?
- Human has 46 chromosomes. How many possible combinations can the chromosomes make during reproduction?

Chapter 8 Review 299

Understand Key Concepts

- Offspring are identical to the parent in asexual reproduction.
- mutations
- variation → selection → adaptation
- a skunk spraying a predator
- meiosis
- scars
- The butterfly's shape is the result of the environment selecting variations over many generations.
- variations

Critical Thinking

- Answers will vary but should reflect the conditions of the lake. The organism may have dark coloration, move quickly, and feed on plants.
- Mutations can lead to variations in individuals within a population. Some variations might give an organism an advantage in a particular environment.
- A mutation is a permanent change to a gene. A variation is a difference in inherited traits among individual members of a species. An adaptation is a trait that helps a species survive in its environment. Variation within a species occurs because of mutations in genes. Variations can lead to adaptations if the variation enables individuals to survive and reproduce.
- behavioral; functional; behavioral; structural; behavioral
- The plants might be eaten to extinction. If some plants have a variation that enables them to grow taller, they might survive and reproduce. Eventually, most or all of the surviving plants would be taller.

