SECTION 2

Sensing the Environment

Key Concept Your organ systems have specialized structures and functions to sense and gather information.

What You Will Learn

- Pressure, temperature, pain, and vibration are four sensations detected by receptors in the skin.
- A feedback mechanism is a cycle of events in which information from one step controls or affects another step.
- You see an object when it reflects visible light toward your eyes.
- Hearing is the sense that allows you to experience sound energy.

Why It Matters

You respond to the information gathered by your senses.

Vocabulary

- integumentary system
- reflex
- feedback mechanism
- pupil
- retina
- iris
- cochlea

READING STRATEGY

Graphic Organizer In your **Science Journal,** create a Process Chart that shows how your body regulates your temperature.

You feel a tap on your shoulder. Who tapped you? You turn to look, hoping to see a friend. Your senses are on the job! The tap produces impulses in sensory receptors on your shoulder. These impulses travel to your brain.

Once the impulses reach your brain, they create an awareness called a *sensation*. In this case, the sensation is that of being touched on your shoulder. But you still do not know who tapped you. So, you turn around. The sensory receptors in your eyes send impulses to your brain. Now, your brain recognizes your best friend.

Sense of Touch

When you shake hands or feel a breeze, the sensation that you experience is touch. Touch arises from the stimulation of sensory receptors in the skin. Skin is part of the integumentary system. The **integumentary system** is an organ system that protects the body from damage. This system includes hair, skin, and nails. As **Figure 1** shows, skin is not only protective. It also has many kinds of sensory receptors. Each kind of receptor responds mainly to one kind of stimulus. For example, *thermoreceptors* respond to temperature change. Each kind of receptor produces a specific sensation of touch, such as pressure, temperature, pain, or vibration.

Standards Check **What sensations can your skin detect?** 7.5.a

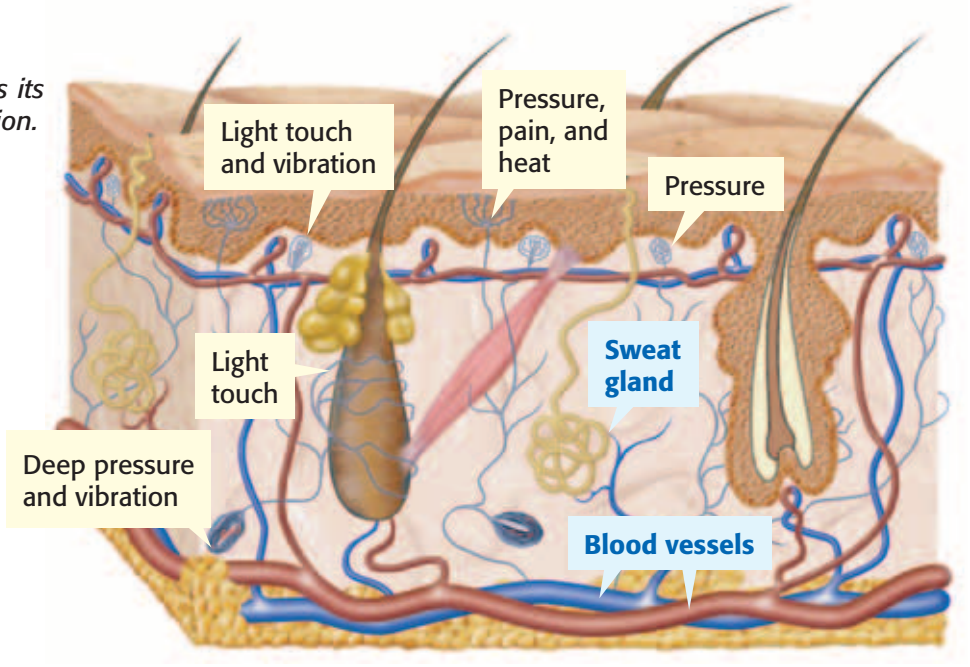


Figure 1 *Each type of receptor in your skin has its own structure and function.*

7.5.a Students know plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.
7.5.b Students know organ systems function because of the contributions of individual organs, tissues, and cells. The failure of any part can affect the entire system.
7.5.g Students know how to relate the structures of the eye and ear to their functions.
7.6.b Students know that for an object to be seen, light emitted by or scattered from it must be detected by the eye.

Responding to Sensory Messages

When you step on something sharp, as the man in **Figure 2** did, pain receptors in your foot or toe send impulses to your spinal cord. Almost immediately, a message to move your foot travels back to the muscles in your leg and foot. Without thinking, you quickly lift your foot. This immediate, involuntary action is called a **reflex.** Your brain is not telling your leg to move. In fact, by the time that the message reaches your brain, your leg and foot have already moved. If you had to wait for your brain to act, your toes could get seriously hurt!

Standards Check **Why are reflexes important?** 7.5.b

integumentary system (in TEG yoo MEN tuhr ee SIS tuhm) the organ system that forms a protective covering on the outside of the body

reflex (REE FLEKS) an involuntary and almost immediate movement in response to a stimulus

feedback mechanism (FEED BAK MEK uh NIZ uhm) a cycle of events in which information from one step controls or affects a previous step

Feedback Mechanisms

Most of the time, the brain processes information from skin receptors. For example, on a hot day, heat receptors in your skin detect an increase in your temperature. The receptors send impulses to the brain. Your brain responds by sending messages that cause your sweat glands to make sweat. As sweat evaporates, it cools your body. Your brain also tells the blood vessels in your skin to dilate (open wider). Blood flow increases. Thermal energy from the blood in your skin moves to your surroundings. This process also cools your body. As your body cools, it sends messages to your brain. The brain responds by sending messages that cause sweat glands to reduce their activity and blood vessels to constrict.

This cooling process is one of your body's feedback mechanisms. A **feedback mechanism** is a cycle of events in which information from one step controls or affects a previous step. The temperature-regulating feedback mechanism helps keep your body temperature within safe limits. This cooling mechanism works like a thermostat on an air conditioner. Once a room reaches a certain temperature, the thermostat sends a message that causes the air conditioner to stop blowing cold air.

Figure 2 *A reflex, such as lifting your foot when you step on something sharp, is one way in which your nervous system responds to your environment.*

Sense of Sight

Cameras capture images of objects that reflect visible light. Sight is the sense that allows you to see the size, shape, motion, and color of objects around you. You see an object when your eyes, like a camera, receive visible light that is scattered, reflected, or emitted by the object. Once your eyes detect the light, your brain can form visual images. Your eyes are complex sensory organs, as **Figure 3** shows. A clear membrane called the *cornea* covers the front of the eye. The cornea protects the eye but allows light to enter. Light from an object enters the front of your eye through an opening called the **pupil.** Then, the light travels through the lens to the back of the eye. There, the light strikes the **retina,** a layer of light-sensitive cells.

pupil (PYOO puhl) the opening that is located in the center of the iris of the eye and that controls the amount of light that enters the eye

retina (RET 'n uh) the light-sensitive inner layer of the eye, which receives images formed by the lens and transmits them through the optic nerve to the brain

The retina is packed with retinal cells called *photoreceptors*. A photoreceptor is a special neuron that responds to light energy by causing other cells in the retina to create electric impulses. The brain perceives these impulses as light. The retina has two kinds of photoreceptors: rods and cones. Rods are very sensitive to dim light. They are important for night vision. Impulses from rods are interpreted as black-and-white images. Cones are very sensitive to bright light. Impulses from cones allow you to see fine details and colors. Impulses from the rods and cones travel along axons. The impulses leave the back of each eye through an optic nerve. The optic nerve carries the impulses to your brain, where the impulses are interpreted.

Standards Check **Explain what happens when light enters the eye.** 7.6.b

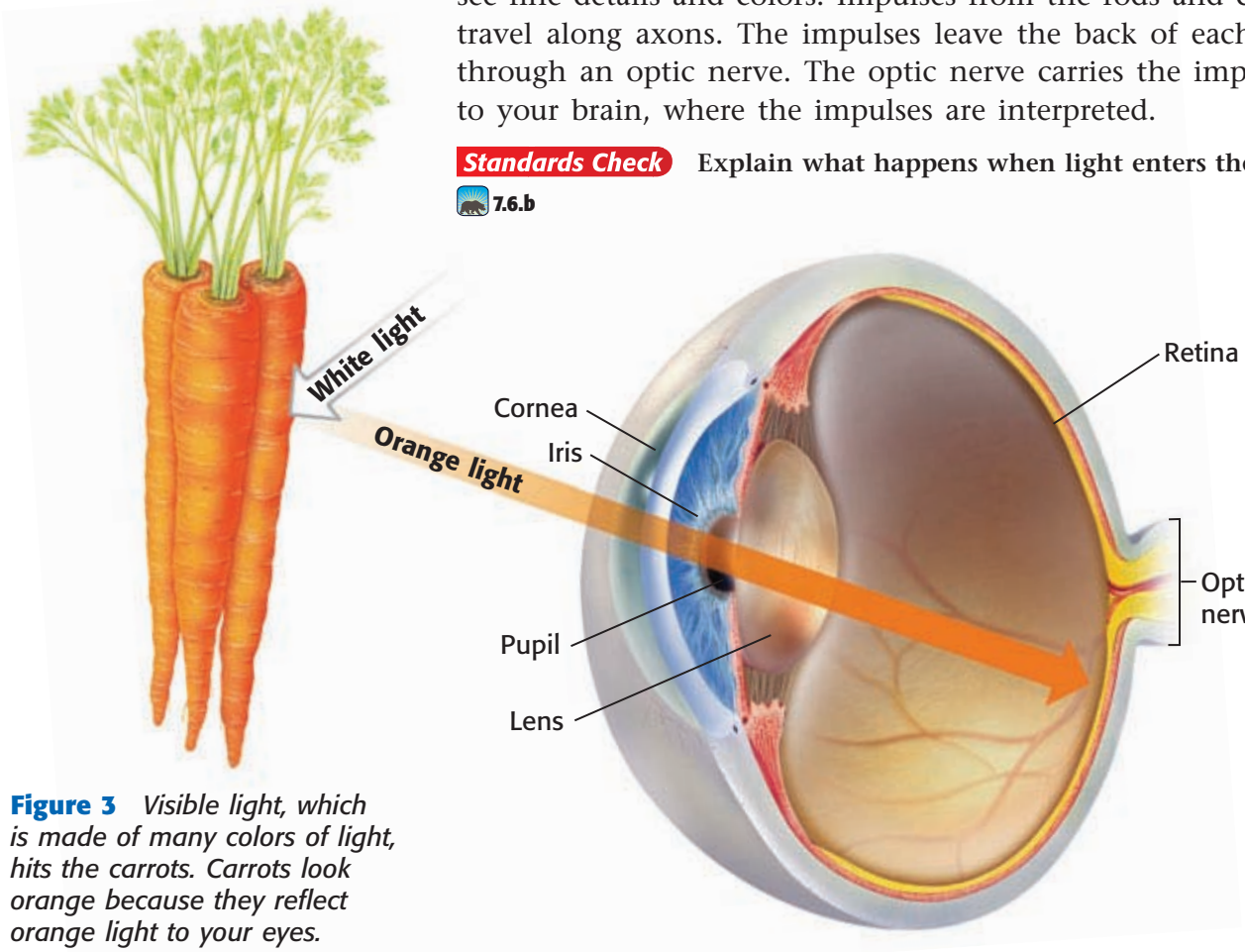


Figure 3 *Visible light, which is made of many colors of light, hits the carrots. Carrots look orange because they reflect orange light to your eyes.*

Reacting to Light

Your pupil looks like a black dot in the center of your eye. In fact, it is an opening that lets light enter the eye. The pupil is surrounded by the **iris,** a ring of muscle. The iris controls the amount of light entering the eye and gives the eye its color. In bright light, the iris contracts, which makes the pupil smaller in diameter. A smaller pupil reduces the amount of light entering the eye and passing onto the retina. In dim light, the iris relaxes, which dilates the pupil to let in more light.

Standards Check How does your iris react to bright light? 7.5.g

iris (IE ris) the colored, circular part of the eye

INTERNET ACTIVITY

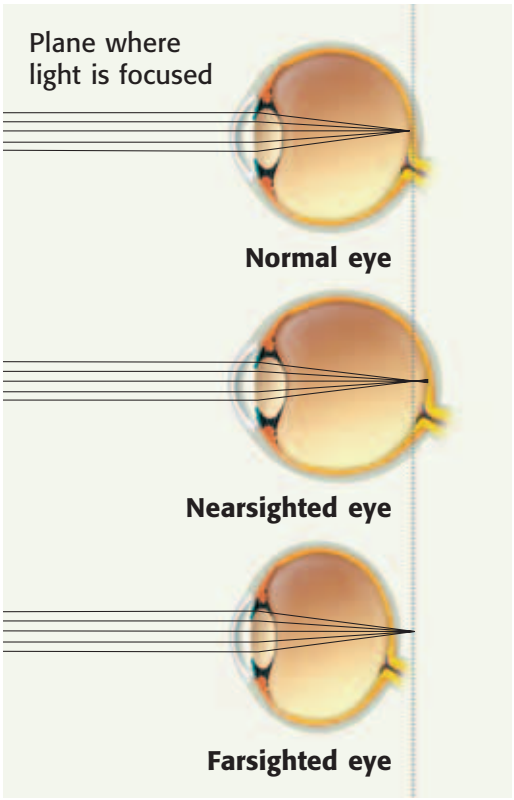
Brain Brochure

How does the brain keep track of various activities? Develop a brochure that discusses the structure and function of the human brain. Go to **go.hrw.com,** and type in the keyword HY7BD4W.

Focusing the Light

Light travels in straight lines until it passes through the cornea and the lens. The *lens* is an oval-shaped piece of clear, curved material behind the iris. The lens refracts, or bends light. Muscles in the eye change the shape of the lens in order to focus light onto the retina. When you look at objects that are close to the eye, the lens becomes more curved. When you look at objects that are far away, the lens gets flatter.

Figure 4 shows some common vision problems. In some eyes, the lens focuses the light in front of the retina, which results in nearsightedness. If the lens focuses the light just behind the retina, the result is farsightedness. Glasses, contact lenses, or surgery can usually correct these vision problems.



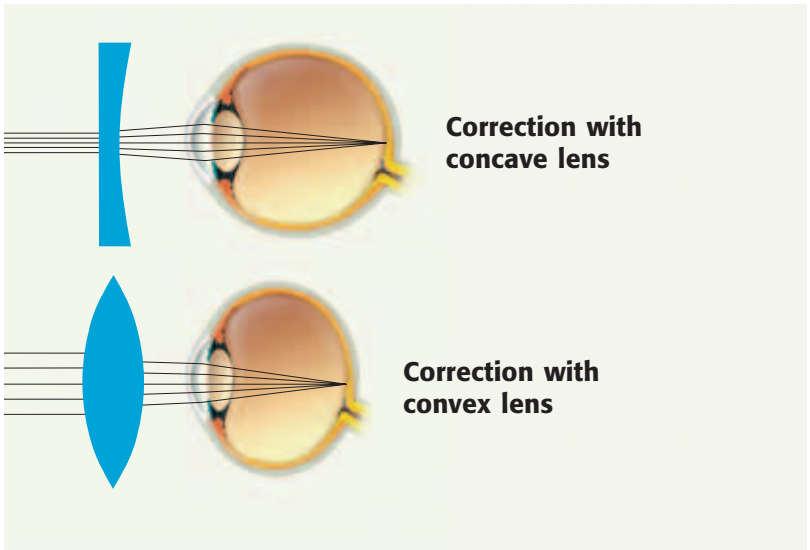


Figure 4 *A concave lens bends light rays outward to correct nearsightedness. A convex lens bends light rays inward to correct farsightedness.*

Sense of Hearing

Sound is produced when something, such as a drum, vibrates. Vibrations push on nearby air particles, which push on other air particles. The vibrations create waves of sound energy. Hearing is the sense that allows you to experience sound energy.

Ears are organs that are specialized for hearing. Each ear has an outer, middle, and inner portion, as shown in **Figure 5.** The outer ear consists of the ear canal. The middle ear includes the *tympanic membrane,* or eardrum. The middle ear also includes the three ear bones: the hammer, anvil, and stirrup. The inner ear includes the cochlea and the auditory nerve.

cochlea (KAHK lee uh) a coiled tube that is found in the inner ear and that is essential to hearing

Sound waves reaching the outer ear are funneled into the middle ear. There, the waves make the eardrum vibrate. The eardrum is a thin membrane separating the outer ear from the middle ear. The vibrating eardrum makes three small bones in the middle ear vibrate. One of these bones, the stirrup, vibrates against the **cochlea,** a fluid-filled organ of the inner ear. Inside the cochlea, vibrations make waves that are just like the waves you make by tapping on a glass of water. Neurons in the cochlea respond to the waves by creating electric impulses. These impulses travel along the *cochlear nerve,* or auditory nerve, to the area of the brain where sound is interpreted.

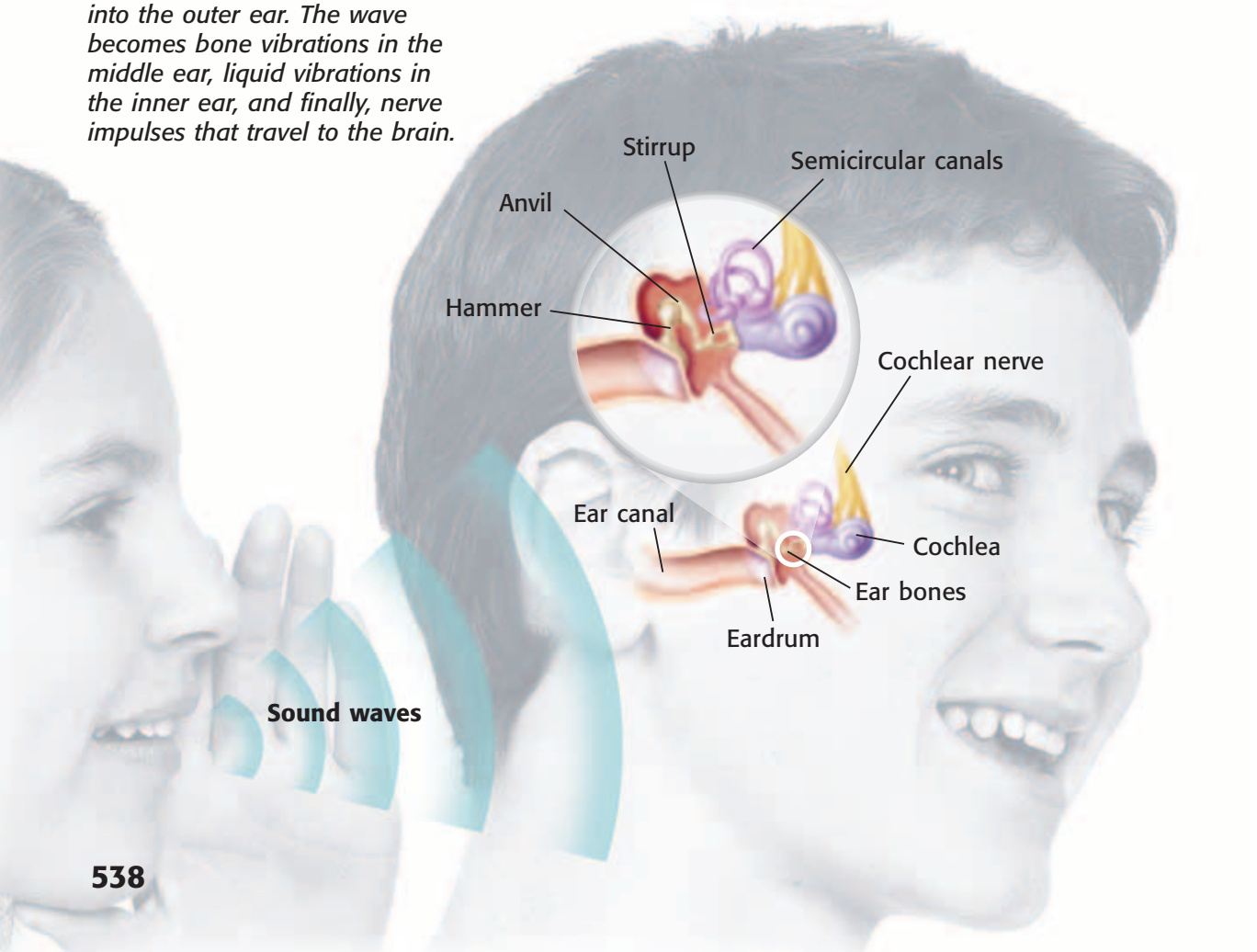


Figure 5 *A sound wave travels into the outer ear. The wave becomes bone vibrations in the middle ear, liquid vibrations in the inner ear, and finally, nerve impulses that travel to the brain.*

Quick Lab

What Does the Ear Drum Do?

7.5.g
7.7.d

In this activity, you will use simple materials to model the human ear. This model will help you understand how the ear functions.

Try It!

1. Stretch a **piece of plastic wrap** over one end of a **cardboard tube.** Secure the edges of the plastic with a **rubber band.**
2. Use a **piece of paper** to make a cone. Tape the cone together so that it does not unroll.
3. Place the small end of the cone into the open end of the cardboard tube.
4. Use **modeling clay** to place an **index card** vertically on the table.
5. Point a **flashlight** at the plastic wrap–covered end of the tube so that the light reflects onto the index card.

Think About It!

6. Shout, sing, and talk into the open end of the cone. Record your observations.
7. Draw the model that you created. Label the part of the human ear that the model represents and describe the function of that part.
8. Why did the light vibrate?
9. How are the parts of the ear specialized to perform their jobs?

30 min

The External Ear and Sound

You have just read that the human ear is structured to efficiently transfer sound waves into electric impulses. But how is sound gathered and delivered to the ear? The external ear, the part of the ear that you can see, gathers sound waves. It also directs those sound waves into your ear canal. The external ear of a human is fixed in place, but many animals can adjust the position of their external ears to listen to faint sounds. Being able to change the position of the external ear also helps some animals, such as rabbits, determine the direction from which a sound is coming.

Standards Check **Describe the role that the external ear plays in hearing.** 7.5.g

Keeping Your Balance

Your ears enable you not only to hear but also to maintain your balance. The *semicircular canals,* special fluid-filled canals in your inner ear, are filled with hair cells. These hair cells respond to changes in the position of your head with respect to gravity. The hair cells help your brain determine the orientation and position of your head.

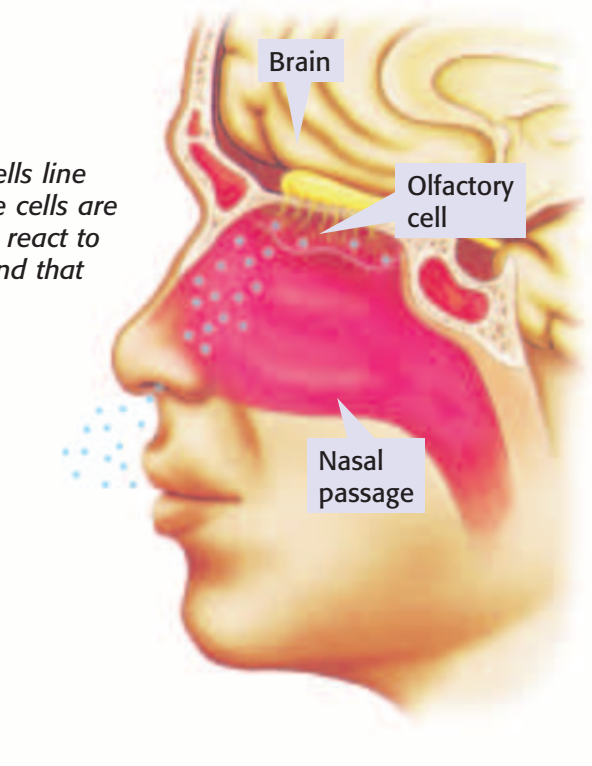


Figure 6 *Olfactory cells line the nasal cavity. These cells are sensory receptors that react to chemicals in the air and that allow you to smell.*

Sense of Taste

Taste is the sense that allows you to detect chemicals and to distinguish flavors. Your tongue is covered with tiny bumps called *papillae* (puh PIL ee). Most papillae contain taste buds. Taste buds contain clusters of *taste cells,* the receptors for taste. Taste cells respond to dissolved-food molecules. Taste cells react to five basic tastes: sweetness (sugar), sourness (lemon), saltiness (salt), savoriness (meats and cheeses), and bitterness (some medicines). When the brain combines information from all of the taste buds, you taste a "combination" flavor.

Sense of Smell

As you can see in **Figure 6,** receptors for smell are located on *olfactory cells* in the upper part of your nasal cavity. An olfactory cell is a nerve cell that responds to chemical molecules in the air. You smell something when the receptors react to molecules that have been inhaled. The molecules dissolve in the moist lining of the nasal cavity and trigger an impulse. Olfactory cells send those impulses to the brain, which interprets the impulses as odors.

Taste buds and olfactory cells both detect dissolved molecules. Your brain combines information from both senses to give you sensations of flavor.

Standards Check **How do your taste cells and olfactory cells communicate with your nervous system?** 7.5.a

SCHOOL to HOME

Disorders of the Senses

With a parent or guardian, research a disorder of one of the five senses discussed in this section. What causes this disorder? What technology is used to help people who are affected by this disorder? Create a poster that illustrates your research.

ACTIVITY