35–4 The Senses

Guide for Reading

Key Concept
- What are the five types of sensory receptors?

Vocabulary
sensory receptor
pupil
lens
retina
rod
cone
cochlea
semicircular canal
taste bud

Reading Strategy: Outlining Before you read, use the headings of the section to make an outline about the five sense organs. As you read, fill in the subtopics and smaller topics. Then, add phrases or a sentence after each to provide key information.

The body contains millions of neurons that react directly to stimuli from the environment, including light, sound, motion, chemicals, pressure, and changes in temperature. These neurons, known as **sensory receptors,** react to a specific stimulus such as light or sound by sending impulses to other neurons, and eventually to the central nervous system. Sensory receptors are located throughout the body but are concentrated in the sense organs. These sense organs include the eyes, the inner ears, the nose, the mouth, and the skin. Sensory receptors within each organ enable it to respond to a particular stimulus.

There are five general categories of sensory receptors: pain receptors, thermoreceptors, mechanoreceptors, chemoreceptors, and photoreceptors. Pain receptors are located throughout the body except in the brain. Pain receptors respond to chemicals released by damaged cells. Pain is important to recognize because it usually indicates danger, injury, or disease. Thermoreceptors are located in the skin, body core, and hypothalamus. Thermoreceptors detect variations in temperature. Mechanoreceptors are found in the skin, skeletal muscles, and inner ears. They are sensitive to touch, pressure, stretching of muscles, sound, and motion. Chemoreceptors, located in the nose and taste buds, are sensitive to chemicals in the external environment. Photoreceptors, found in the eyes, are sensitive to light. **Figure 35–12** shows how photoreceptor cells appear under a scanning electron microscope.

Vision

The world around us is bathed in light. The sense organs that we use to sense light are the eyes. The structures of the eye are shown in **Figure 35–13.** Light enters the eye through the cornea, a tough transparent layer of cells. The cornea helps to focus the light, which then passes through a chamber filled with a fluid called aqueous (AY-kwee-uhs) humor. At the back of the chamber is a disklike structure called the iris. The iris is the colored part of the eye. In the middle of the iris is a small opening called the **pupil.** Tiny muscles in the iris adjust the size of the pupil to regulate the amount of light that enters the eye. In dim light, the pupil becomes larger so that more light can enter the eye. In bright light, the pupil becomes smaller so that less light enters the eye.

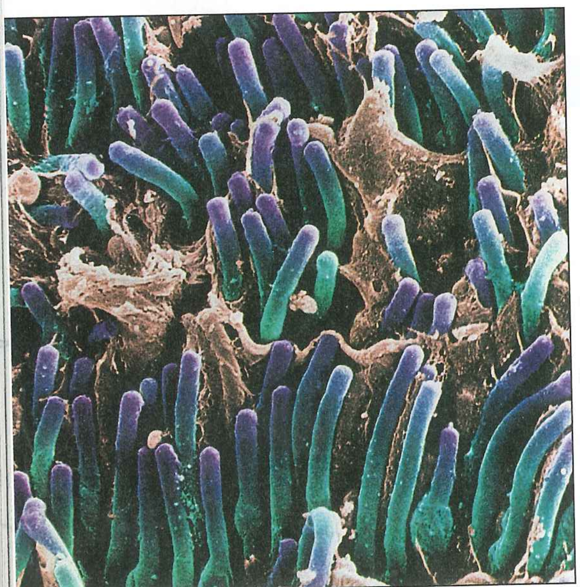

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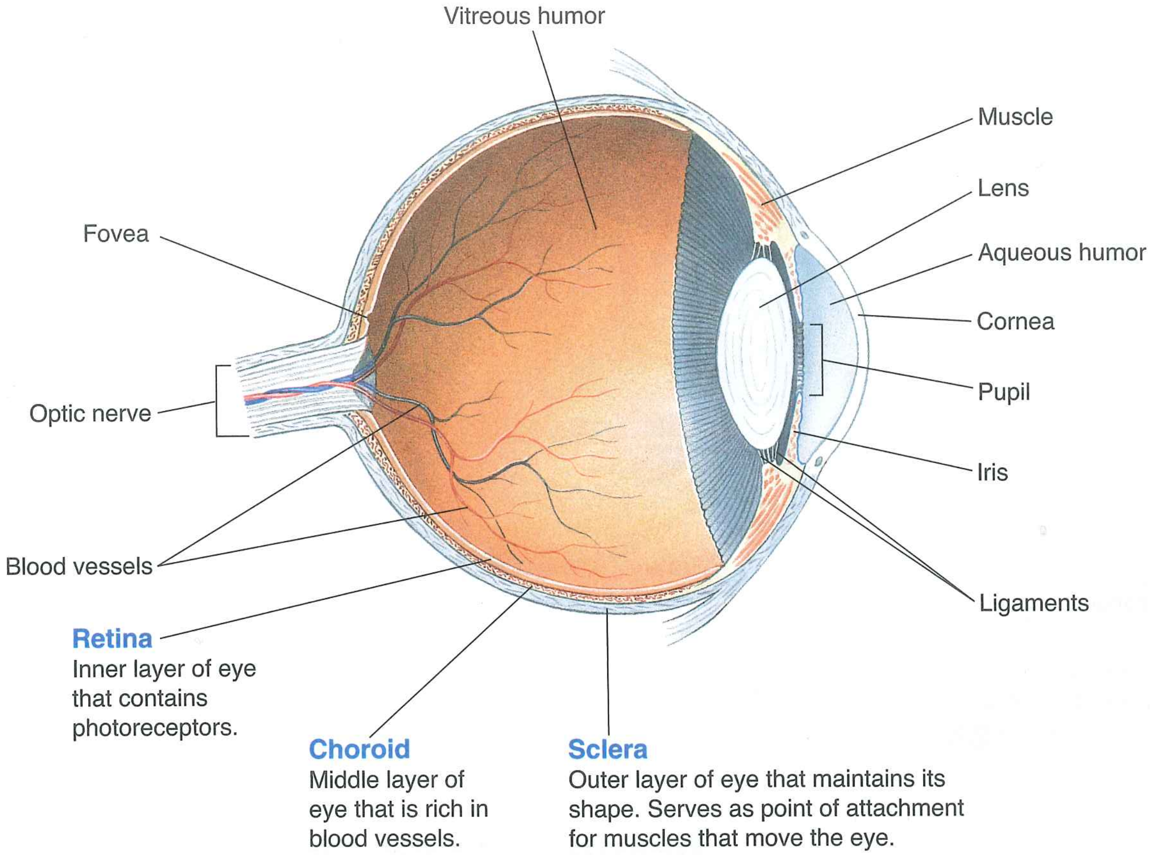
Figure 35–12 **There are two types of light-sensitive photoreceptor cells in the retina—rods and cones.** This color-enhanced scanning electron micrograph shows the rod cells of an eye.



▲ **Figure 35–13** The eye is a complicated sense organ. The sclera, choroid, and retina are three layers of tissue that form the inner wall of the eyeball. **Interpreting Graphics** *What is the function of the sclera?*

Just behind the iris is the **lens.** Small muscles attached to the lens change its shape to help you adjust your eyes' focus to see near or distant objects. Behind the lens is a large chamber filled with a transparent, jellylike fluid called vitreous (VIH-tree-uhs) humor.

The lens focuses light onto the **retina.** Photoreceptors are arranged in a layer in the retina. The photoreceptors convert light energy into nerve impulses that are carried to the central nervous system. There are two types of photoreceptors: rods and cones. **Rods** are extremely sensitive to light, but they do not distinguish different colors. **Cones** are less sensitive than rods, but they do respond to light of different colors, producing color vision. Cones are concentrated in the fovea. The fovea is the site of sharpest vision. There are no photoreceptors where the optic nerve passes through the back of the eye. This place is called the blind spot.

The impulses assembled by this complicated layer of interconnected cells leave each eye by way of an optic nerve. The optic nerves then carry the impulses to the appropriate regions of the brain. The brain interprets them as visual images and provides information about the external world.

CHECKPOINT *Where are the photoreceptors located in the eye?*

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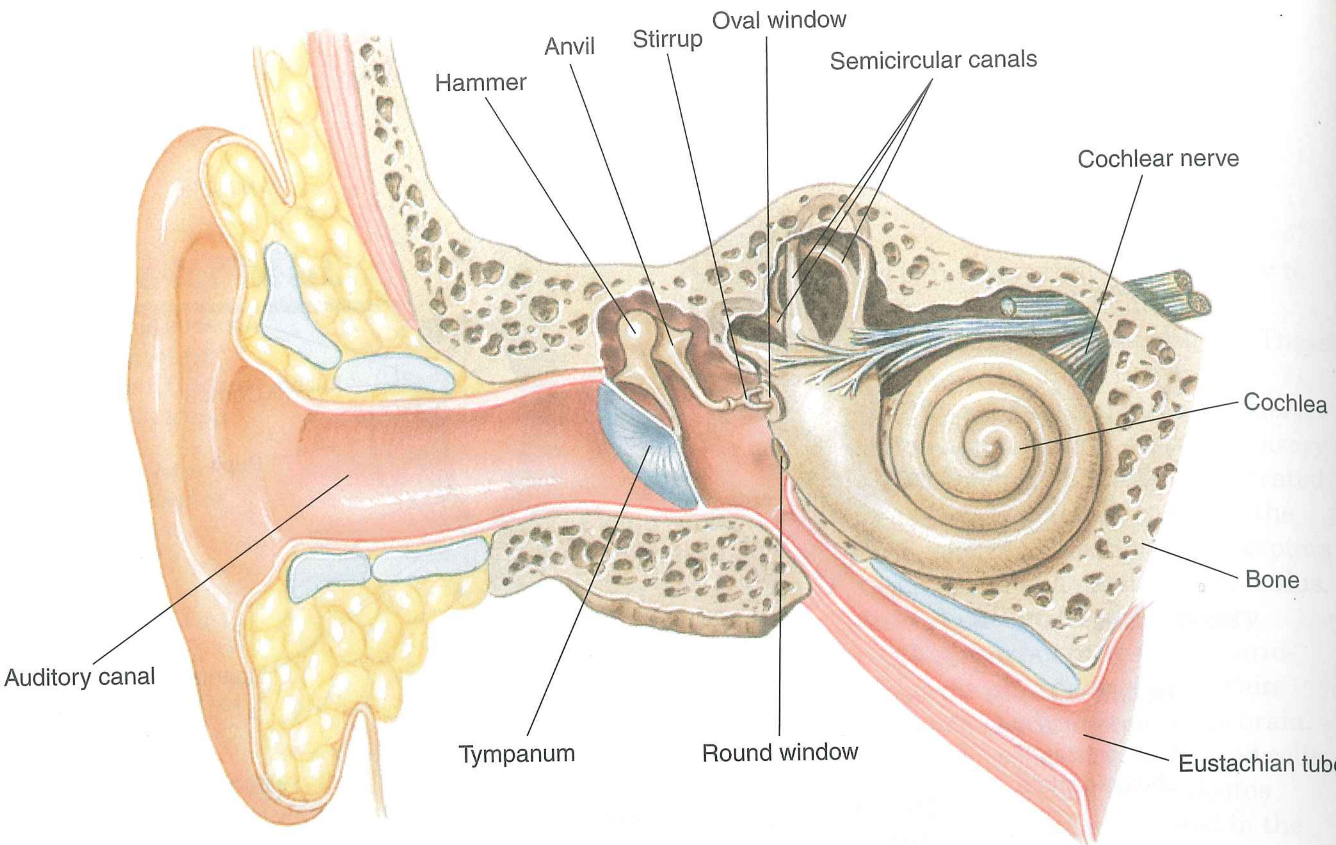

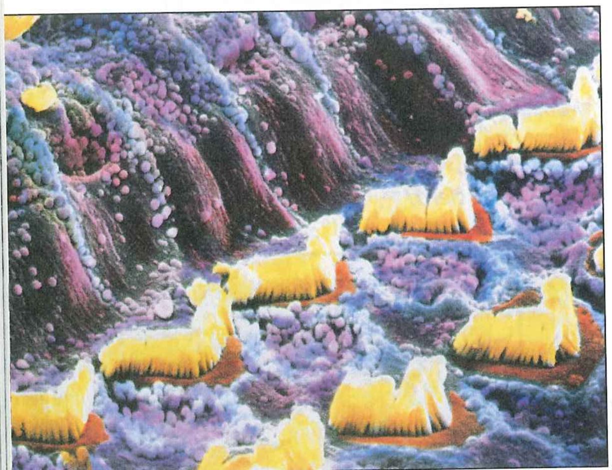

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Figure 35–14 The diagram (top) shows the structures in the ear that transmit sounds. The scanning electron micrograph shows hair cells (yellow) in the inner ear. The motion of these hairs produces nerve impulses that travel to the brain through the cochlear nerve. **Predicting** *How would frequent exposure to loud noise affect a person's threshold for detecting sound?*

Hearing and Balance

The human ear has two sensory functions. One of these functions is hearing. The other function is detecting positional changes associated with movement.

Hearing Sound is nothing more than vibrations in the air around us. The ears are the sensory organs that can distinguish both the pitch and loudness of those vibrations. The structure of the ear is shown in **Figure 35–14.**

Vibrations enter the ear through the auditory canal. The vibrations cause the tympanum (TIM-puh-num), or eardrum, to vibrate. These vibrations are picked up by three tiny bones, commonly called the hammer, anvil, and stirrup. The last of these bones, the stirrup, transmits the vibrations to the oval window. Vibrations of the oval window create pressure waves in the fluid-filled **cochlea** (KAHK-lee-uh) of the inner ear.

The cochlea is lined with tiny hair cells that are pushed back and forth by these pressure waves. In response to these movements, the hair cells produce nerve impulses that are sent to the brain through the cochlear nerve.

Balance Your ears contain structures that help your central nervous system maintain your balance, or equilibrium. Within the inner ear just above the cochlea are three tiny canals at right angles to one another. They are called **semicircular canals** because each forms a half circle. The semicircular canals and the two tiny sacs located behind them monitor the position of your body, especially your head, in relation to gravity.

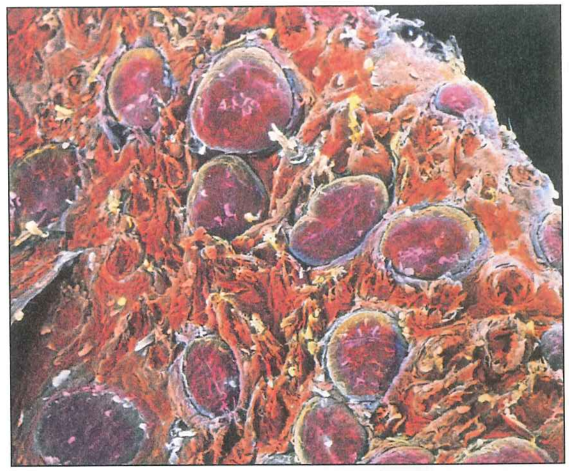
The semicircular canals and the sacs are filled with fluid and lined with hair cells. As the head changes position, the fluid in the canals also changes position. This causes the hair on the hair cells to bend. This action, in turn, sends impulses to the brain that enable it to determine body motion and position.

Smell and Taste

You may never have thought of it this way, but your sense of smell is actually an ability to detect chemicals. Chemoreceptors in the lining of the nasal passageway respond to specific chemicals and send impulses to the brain through sensory nerves.

Your sense of smell is capable of producing thousands of different sensations. In fact, much of what we commonly call the "taste" of food and drink is actually smell. To prove this to yourself, eat a few bites of food while holding your nose. You'll discover that much of the taste of food disappears until you open your nose and breathe freely.

Like the sense of smell, the sense of taste is a chemical sense. The sense organs that detect taste are the **taste buds.** Most of the taste buds are on the tongue, but a few are found at other locations in the mouth. The surface of the tongue is shown in **Figure 35–15.** The tastes detected by the taste buds are classified as salty, bitter, sweet, and sour. Sensitivity to these different categories varies on different parts of the tongue.



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▲ **Figure 35–15** This color-enhanced scanning electron micrograph shows the surface of the tongue. The large pink objects are the taste buds. **Chemoreceptors found in the taste buds are sensitive to chemicals in food.**

Touch and Related Senses

The sense of touch, unlike the other senses you have just read about, is not found in one particular place. All of the regions of the skin are sensitive to touch. In this respect, your largest sense organ is your skin. Skin contains sensory receptors that respond to temperature, touch, and pain. Not all parts of the body are equally sensitive to touch, because not all parts have the same number of receptors. The greatest density of touch receptors is found on your fingers, toes, and face.

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35–4 Section Assessment

1. **Key Concept** Name the five types of sensory receptors and list where they are found in the body.
2. Identify the functions of the cornea, pupil, lens, retina, and optic nerve.
3. What are the four basic tastes detected by the tongue?
4. Explain why you can't "taste" food when you have a bad cold.
5. **Critical Thinking Applying Concepts** If you spin around for a time, the fluid in your semicircular canals also moves. When you stop suddenly, you feel as though you are still moving. Why do you think you might feel dizzy?

Writing in Science

Creative Writing
Imagine that you have to do without your sense of taste for one day. How would this influence your food choices? Write a 3- to 4-paragraph essay describing how the absence of this sense organ would affect your day.