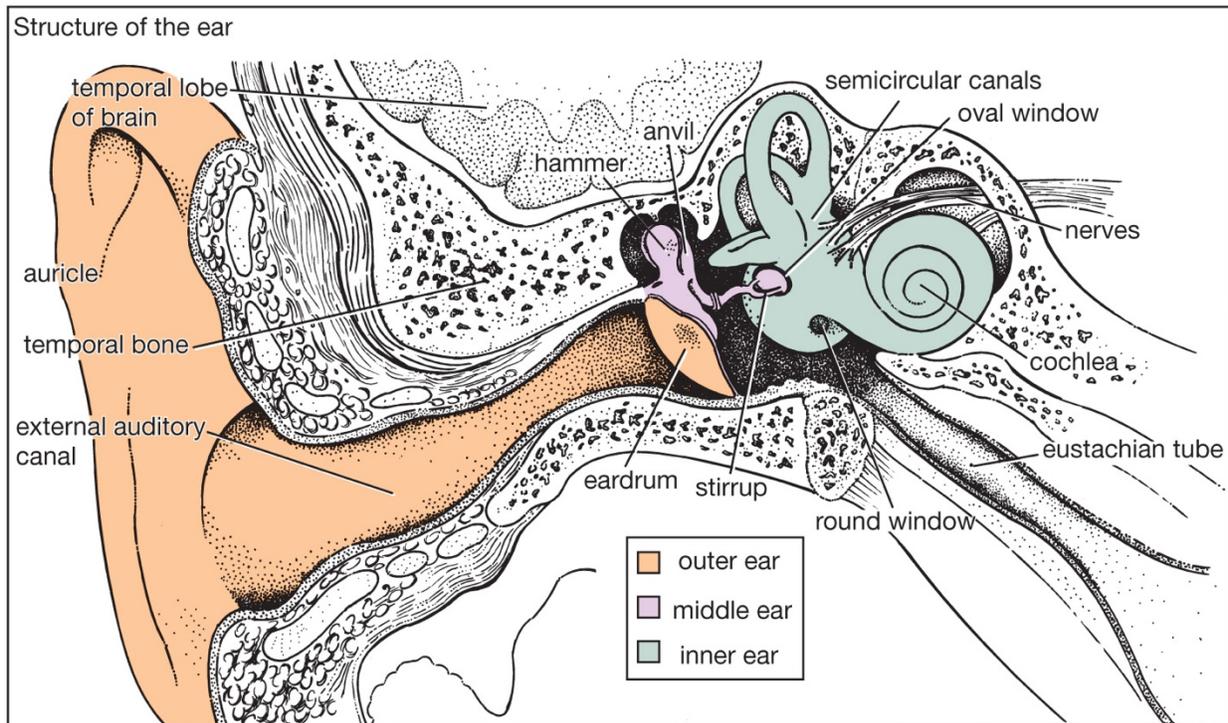


Ear

Introduction

Vibrations of air molecules moving through the air are received and translated into messages that the brain recognizes as sound by a complex organ—the ear. The ear has two important, but different, functions: hearing and sensing the body’s equilibrium, or balance. The mechanisms for these processes are located within a hollow space in the skull’s temporal bone.

Parts of Ear and Hearing



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The ear has three separate sections—the outer ear, the middle ear, and the inner ear. Each section performs a specific function, related to either hearing or balance. The three parts of the outer ear are the auricle (also called the pinna), the external auditory meatus (or ear canal), and the tympanic membrane (or eardrum).

The pinna collects sound waves from the air. It funnels them into a channellike tube, the external auditory meatus. This is a curved corridor that leads to the tympanic membrane.

The eardrum separates the external ear from the middle ear. The middle ear is an irregular-shaped, air-filled space, about 0.75 inch (1.9 centimeters) high and

0.2 inch (0.5 centimeter) wide. A chainlike link of three tiny bones, the ossicles, spans the middle ear.

When sound waves strike the outer surface of the eardrum, it vibrates. These vibrations are mechanically transmitted through the middle ear by the ossicles. The malleus, or hammer, is the first ossicle to receive vibrations from the eardrum. It passes them to the second ossicle—the incus, or anvil. The third ossicle—the stapes, or stirrup—relays the vibrations to a membrane that covers the opening into the inner ear. This opening is the round window.

Like the eardrum, the round window’s membrane transmits vibrations. It directs vibrations into the inner ear, where they enter a fluid that fills a structure called the cochlea. This is a coiled tube that resembles a snail’s shell. If the cochlea were straightened out, it would measure slightly more than 1 inch (2.54 centimeters).

Within the cochlea is housed the true mechanism of hearing, called the organ of Corti. It contains tiny hairlike nerve endings anchored in a basilar membrane, which extends throughout the cochlea. The unattached tips of these nerve endings are in contact with an overhanging “roof membrane,” called the tectorial membrane.

When vibrations pass into the inner ear, they cause waves to form in the cochlear fluid. Receptor nerve cells in the organ of Corti are highly sensitive to these waves. Other specialized nerve cells send the electrochemical impulses produced by the wave motion into the cochlear branch of the acoustic nerve. This nerve carries the impulses to the brain, where sound is identified.

Equilibrium and the Inner Ear

The inner ear also functions, independently of hearing, as the organ of equilibrium. In addition to the cochlea, the inner ear contains special structures that sense equilibrium. These are the utricle, the saccule, and the three semicircular canals.

The saclike utricle and saccule sense the body’s relationship to gravity, or its static equilibrium. A person knows that the body is right side up because these structures relay messages about the body’s position to the brain.

Both sacs are hollow. Hairlike nerve endings are anchored into the inner surface of each structure. The free ends of the nerve endings project into the hollow

space. Tiny particles of limestone, known as otoliths, rest against the bottom of each sac. If the head moves, the otoliths change position. In shifting, they pass over sensitive nerve endings. These send immediate impulses to the brain. Notified of a change in body position, the brain triggers the reflex mechanisms to correct the position of the body.

Each of the three semicircular canals of the inner ear forms about two thirds of a circular loop. This loop begins and ends in the utricle. The canals are positioned at right angles to each other, similar to the way that the front wall, side wall, and floor of a room are at right angles to each other. The semicircular canals are fluid-filled tubes. If straightened out, each tube would be from about 0.4 inch (1 centimeter) to 0.8 inch (2 centimeters) long. Each canal is also lined with hairlike nerve endings. When the head turns, the fluid flows through these canals. As it passes over the nerve endings, impulses are triggered to the brain. At this time, appropriate reflex action immediately occurs.

Examination

At the beginning of an ear examination, a physician first checks the cerumen, or earwax, that is in the external auditory meatus. Cerumen is secreted by glands lining the passage to the eardrum. The sticky, waxy substance protects the eardrum from damage by attracting such substances as dust and dirt before they can pass through the meatus to damage the eardrum.

The eardrum is examined with an instrument called an otoscope. As viewed through the otoscope, the eardrum appears as a pearly-gray, oval-shaped membrane. Its longest diameter is about 0.5 inch (1.3 centimeters). A cross section of the eardrum looks like a shallow funnel.

The drum is divided into four separate parts, or quadrants. One of these is called the cone of light. Through it can be seen the handle of the malleus, the hammerlike ossicle. If its position is normal, the ear is probably capable of hearing. If the cone of light appears cloudy or blurred, it may be a sign of a common infection of the middle ear known as acute otitis media. Bacteria causing such an infection may enter the middle ear by way of the eustachian tube, a duct that connects the middle ear to the throat.

The eustachian tube helps to insure that there is equal air pressure on both sides of the eardrum. Going down too rapidly in an elevator, for example, often causes an uncomfortable feeling of fullness in the ear. The same thing happens to passengers in a descending aircraft. This occurs because air pressure pushing in on

the ear is greatly increased as the elevator descends. The pressure bends the eardrum inward, causing discomfort. When swallowing occurs, the throat muscles open the eustachian tube's outlet into the throat. Air is able to pass upward into the middle ear. Pressure inside the middle ear pushes the eardrum back to normal.

Disease

Each of the ear's three sections can be affected by diseases that relate to the structure, tissues, and function of that particular part of the ear. Diseases of the outer ear affect the skin, cartilage, and the glands and hair follicles in the outer ear canal. The sound-transmitting function of the outer ear is damaged when the ear canal becomes filled with a tumor, earwax, or infected material. When these conditions occur, sound cannot reach the eardrum.

There are several common diseases of the outer ear. Frostbite is a condition in which the exposed part of the ear becomes frozen and numb, resulting in a temporary loss of skin sensation. An injury that causes bleeding between the cartilage and the skin may produce a hematoma, which is a smooth, rounded, non-tender, purplish swelling. External otitis is an infection of the outer ear canal caused by molds or microorganisms. It occurs most often in warm humid climates and among swimmers. A greenish or brownish, musty, foul-smelling discharge develops in the outer ear canal, and the outer ear becomes tender, red, and much thicker than usual.

A common middle ear infection is secretory otitis media, in which the middle-ear cavity becomes filled with a clear, pale-yellowish, noninfected fluid. This develops when not enough air comes into the cavity from the eustachian tube. A painless impairment of hearing results. Head colds, allergic reactions of the membranes of the eustachian tube, and an enlarged adenoid are common causes of this condition.

A common inner-ear disease is congenital nerve deafness, which is caused by a defect of the hearing nerves in the cochlea. This may be present at birth or develop during or soon after birth. Usually both inner ears are affected to a similar degree. A severe impairment of hearing generally occurs but not always.

Ototoxic, or ear-poisoning, drugs can cause temporary and even permanent damage to the hearing-nerve function. Large doses of such salicylates as aspirin may cause ringing in the ears of some persons, followed by a temporary decrease in hearing. When a person stops taking the drug, hearing returns to normal. Certain antibiotics may cause permanent damage to the hearing-nerve function.

Exposure to various degrees of noise may cause temporary or permanent hearing damage. A single exposure to such an extremely intense sound as an explosion may produce a severe and permanent loss of hearing. Repeated exposures to sounds that reach more than 80 to 90 decibels may cause gradual loss of hearing. This happens because the hair cells of the inner ear, and sometimes even the nerve fibers, may be destroyed. The levels of noise produced by rock music bands is frequently more than 110 decibels. In the United States there are laws that require workers who are exposed to sound levels higher than 90 decibels to wear some form of protection. Earplugs or earmuffs are often used.

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