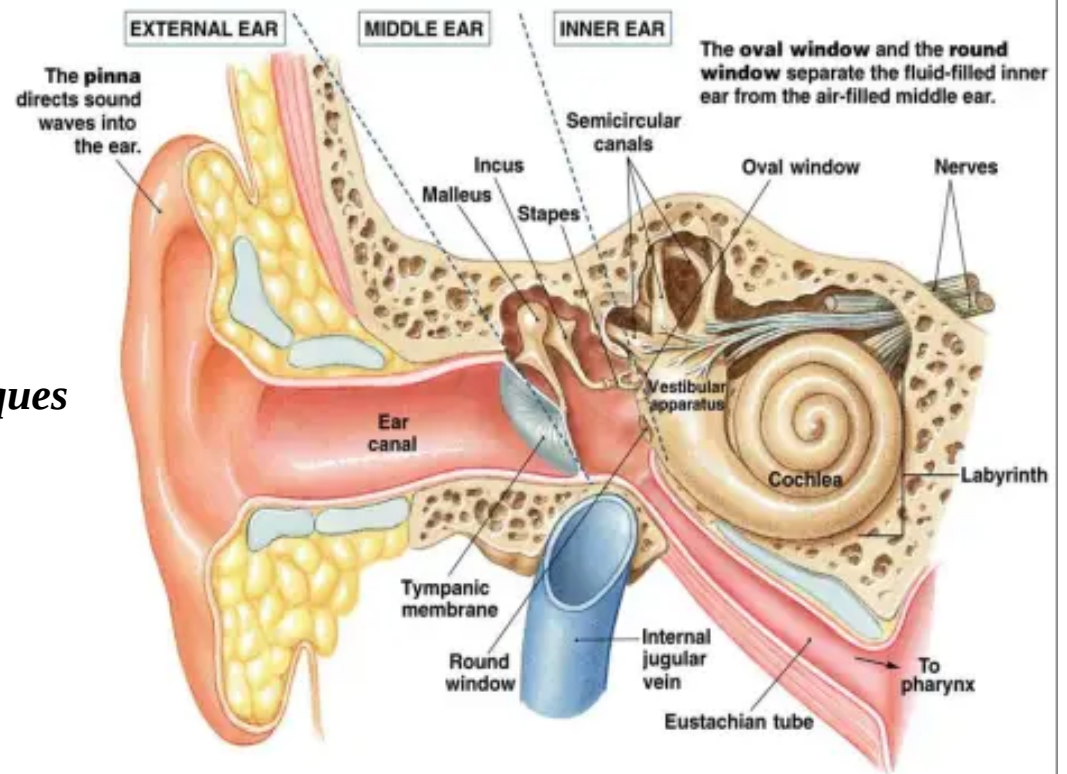


Auditory system
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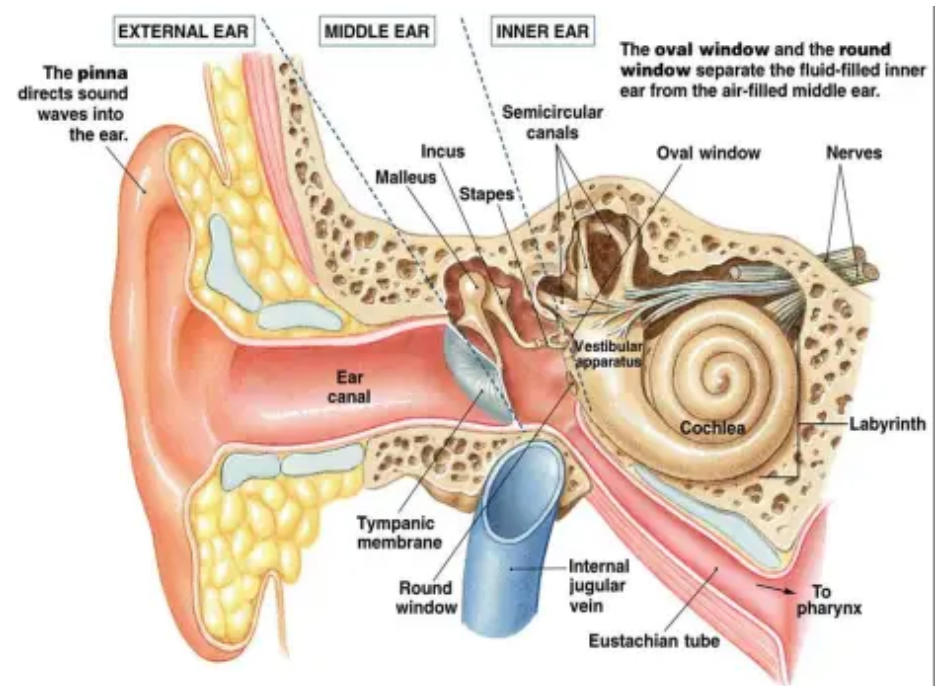


Ear:

The ear is the primary organ for hearing and body balance. Hearing is the process by which the ear transforms sound vibrations in the external environment into nerve impulses that are conveyed to the brain, where they are interpreted as sounds

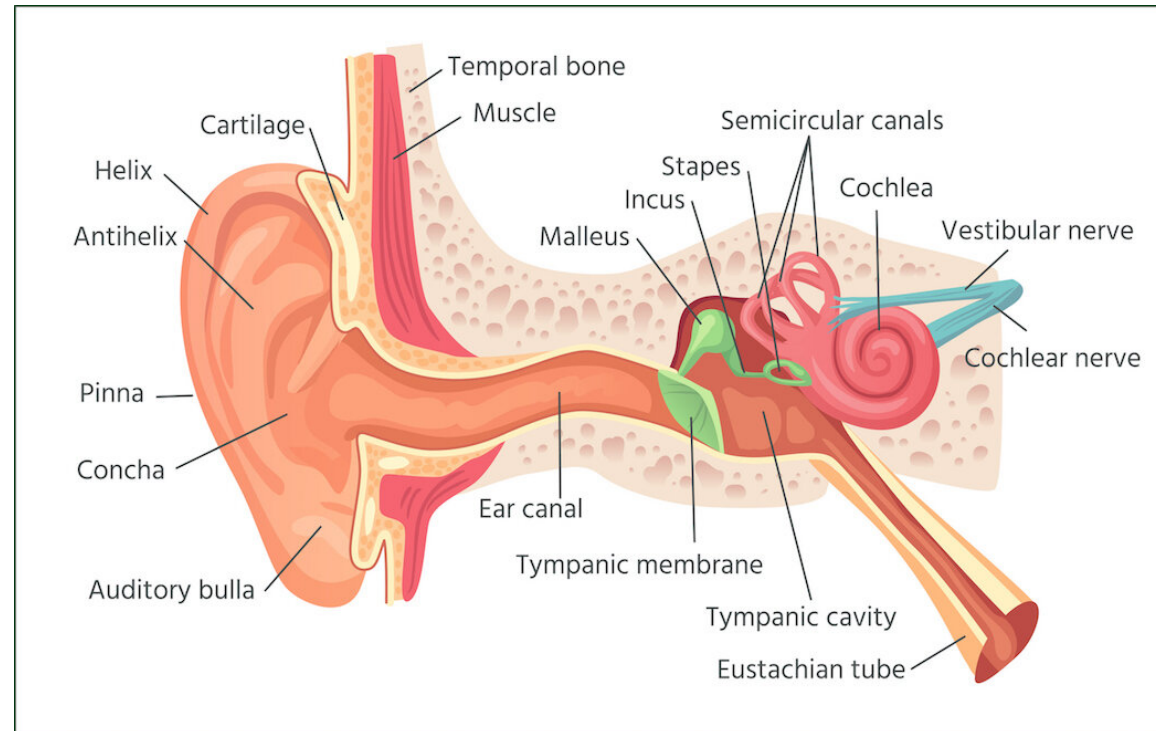
The ear is divided into three main regions:

1. the external ear, which collects sound waves and channels them inward.
2. the middle ear, which conveys sound vibrations to the oval window.
3. the internal ear, which houses the receptors for hearing and equilibrium.



External (Outer) ear: consist of:

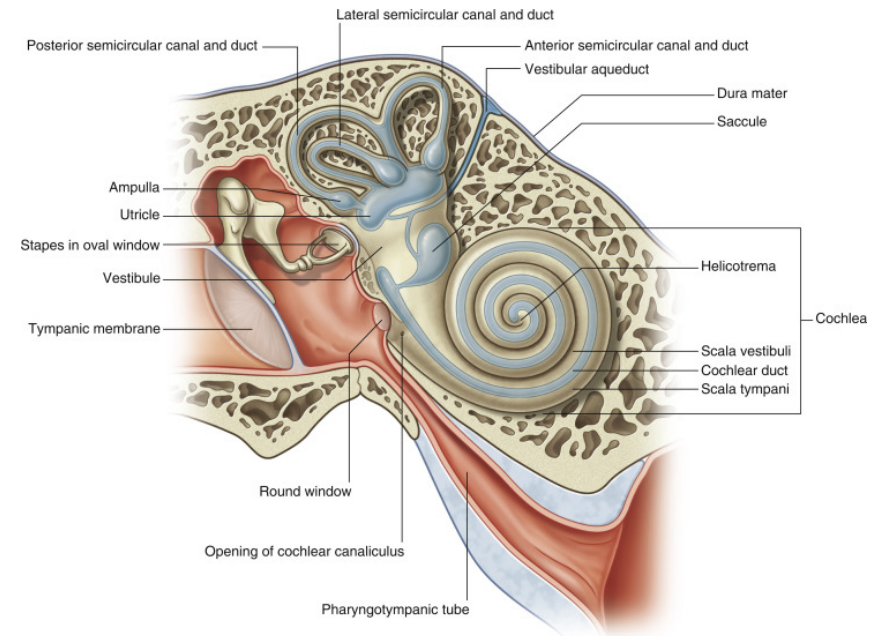
- ❖ **The auricle or pinna:** is a flap of elastic cartilage shaped like the flared end of a trumpet and covered by skin.
- ❖ **The external auditory canal:** is a curved tube about 2.5 cm (1 in.) long that lies in the temporal bone and leads to the eardrum.
- ❖ **The tympanic membrane or eardrum:** is a thin, semitransparent partition between the external auditory canal and middle ear.



Near the exterior opening, the external auditory canal contains a few hairs and specialized sweat glands called ceruminous glands that secrete earwax or cerumen. The combination of hairs and cerumen helps prevent dust and foreign objects from entering the ear. Cerumen also prevents damage to the delicate skin of the external ear canal by water and insects.

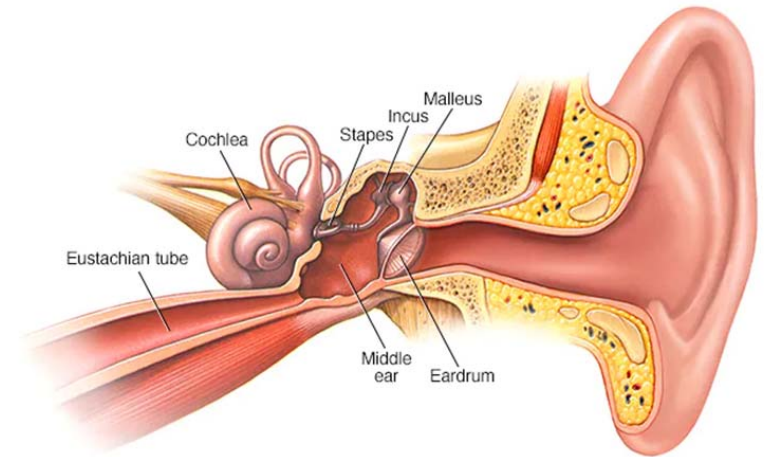
Middle Ear:

- ❖ The middle ear is a small, air-filled cavity in the petrous portion of the temporal bone that is lined by epithelium. It is separated from the external ear by the tympanic membrane and from the internal ear by a thin bony partition that contains two small openings: the oval window and the round window.
- ❖ Extending across the middle ear and attached to it by ligaments are the three smallest bones in the body, the auditory ossicles, which are connected by synovial joints. The bones, named for their shapes, are the malleus, incus, and stapes.
- ❖ The “handle” of the malleus attaches to the internal surface of the tympanic membrane. The head of the malleus articulates with the body of the incus. The incus, the middle bone in the series, articulates with the head of the stapes.
- ❖ The base or footplate of the stapes fits into the oval window. Directly below the oval window is another opening, the round window, which is enclosed by a membrane called the secondary tympanic membrane.



❖ Two tiny skeletal muscles also attach to the ossicles:

- **The tensor tympani muscle**, which limits movement and increases tension on the eardrum to prevent damage to the inner ear from loud noises.
- **The stapedius muscle**, which is the smallest skeletal muscle in the human body. By dampening large vibrations of the stapes due to loud noises, it protects the oval window, but it also decreases the sensitivity of hearing.



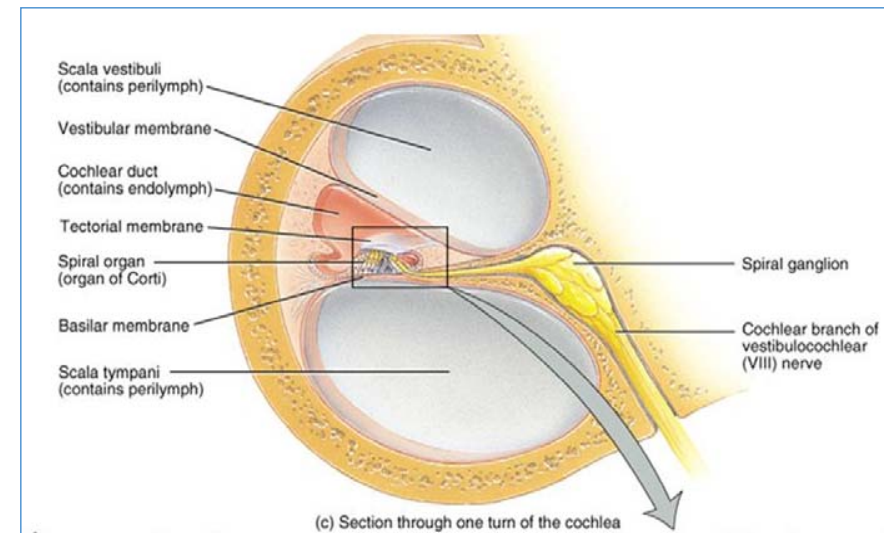
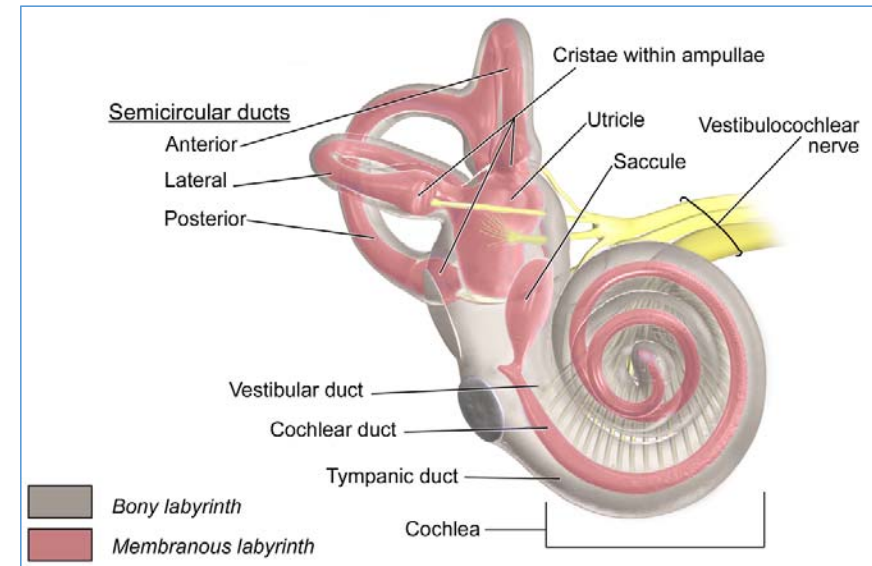
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- ❖ The anterior wall of the middle ear contains an opening that leads directly into the auditory tube or **pharyngotympanic tube**, commonly known as the **eustachian tube**. connects the middle ear with the nasopharynx (superior portion of the throat).
- ❖ During swallowing and yawning, it opens, allowing air to enter or leave the middle ear until the pressure in the middle ear equals the atmospheric pressure.
- ❖ Most of us have experienced our ears popping as the pressures equalize. When the pressures are balanced, the tympanic membrane vibrates freely as sound waves strike it. If the pressure is not equalized, intense pain, hearing impairment, ringing in the ears, and vertigo could develop.

Internal (Inner) Ear:

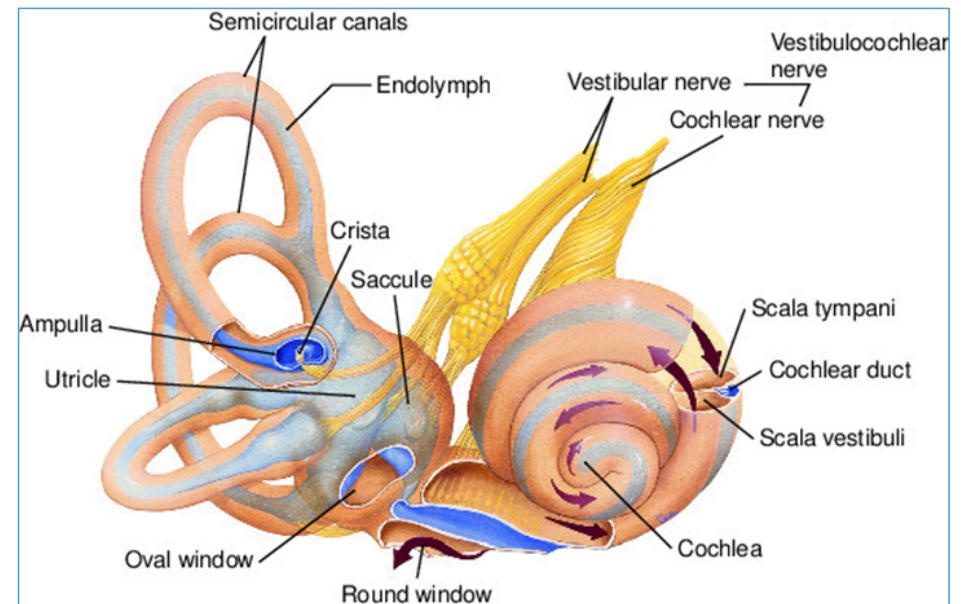
- ❖ **The internal (inner) ear** is also called the labyrinth because of its complicated series of canals.
- ❖ **Structurally**, it consists of two main divisions:
 - an outer bony labyrinth** that encloses an **inner membranous labyrinth**. It is like long balloons put inside a rigid tube.
- ❖ **The bony labyrinth** is a series of cavities in the petrous portion of the temporal bone divided into three areas:
 1. the semicircular canals.
 2. the vestibule.
 3. the cochlea: a bony spiral canal that resembles a snail's shell and makes almost three turns around a central bony core called the modiolus. The three channels in the cochlea are the scala vestibuli, the scala tympani, and the cochlear duct.

The bony labyrinth is lined with periosteum and contains perilymph. This fluid, which is chemically similar to cerebrospinal fluid (high sodium, low potassium). Surrounds the membranous labyrinth, a series of epithelial sacs and tubes inside the bony labyrinth that have the same general form as the bony labyrinth and house the receptors for hearing and equilibrium.



The membranous labyrinth It comprises 3 distinct, but joined, sensory sacs and ducts supplied by the vestibulocochlear nerve (CN VIII):

1. **cochlear duct (scala media) in the cochlea:** responsible for hearing.
2. **utricle and saccule in the vestibule:** responsible for static balance.
3. **semicircular ducts in the semicircular canals:** responsible for kinetic balance



Summary of Structures of the Ear:

Function

1. External (outer) ear:

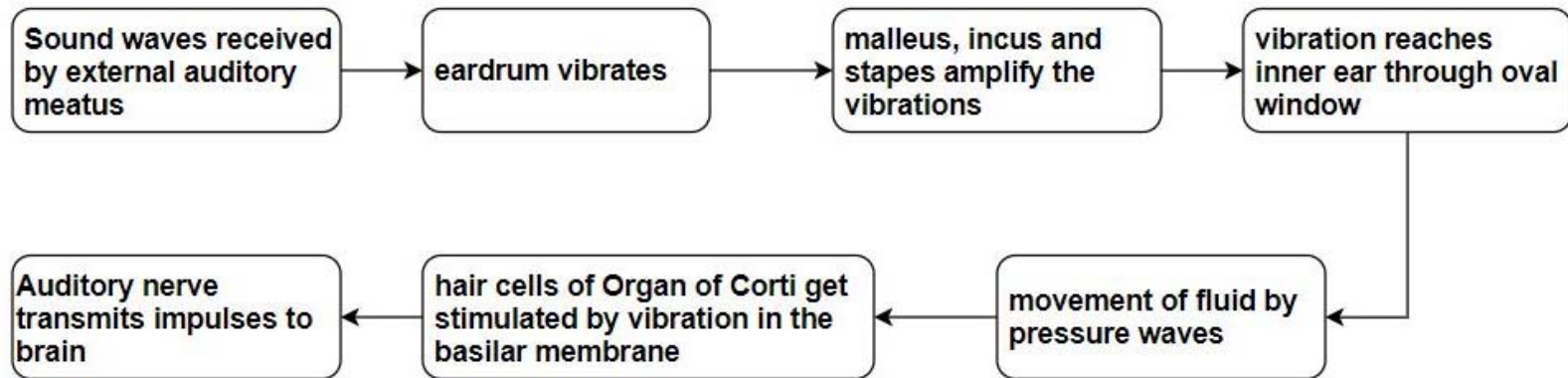
- o **Auricle (pinna):** Collects sound waves.
- o **External auditory canal (external auditory meatus):** Directs sound waves to eardrum.
- o **Tympanic membrane (eardrum):** Sound waves cause it to vibrate, which in turn causes malleus to vibrate.

2. Middle ear

- o **Auditory ossicles:** Transmit and amplify vibrations from tympanic membrane to oval window.
- o **Auditory tube (eustachian tube):** equalizes air pressure on both sides of tympanic membrane.
- o **Cochlea:** Contains a series of fluids, channels, and membranes that transmit vibrations to spiral organ (organ of Corti), the organ of hearing; hair cells in spiral organ produce receptor potentials, which elicit nerve impulses in cochlear branch of vestibulocochlear (VIII) nerve.

3. Internal (inner) ear

- o **Vestibular apparatus:** Includes semicircular ducts, utricle, and saccule, which generate nerve impulses that propagate along vestibular branch of vestibulocochlear (VIII) nerve.
- o **Semicircular ducts:** Sense rotational or angular acceleration and deceleration of the head, such as turning or tilting the head from side to side.
- o **Utricle:** Detects linear acceleration and deceleration in the horizontal plane (like moving forward in a car), as well as detecting static head tilt.
- o **Saccule:** Detects linear acceleration and deceleration in the vertical plane (like riding in an elevator)



Physiology of Hearing:

The following events are involved in hearing

