

Ears

G. Histology

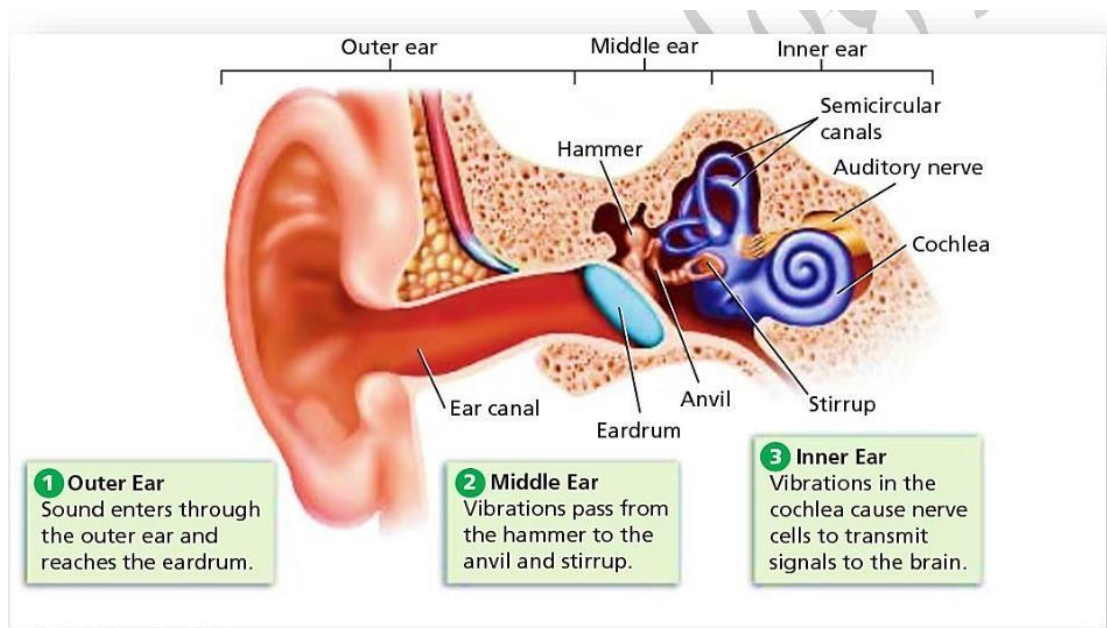
MSC. ALI ALaaraji

Tissues of the ear mediate the senses of equilibrium and hearing.

Each ear consists of three major parts:

1. The external ear, which receives sound waves.
2. The middle ear, in which sound waves are transmitted from air to fluids of the internal ear via a set of small bones.
3. The internal ear, in which these fluid movements are transduced to nerve impulses that pass via the acoustic nerve to the CNS.

In addition to the auditory organ, or cochlea, the internal ear also contains the vestibular organ that allows the body to maintain equilibrium.



1) External Ear

The **auricle**, or **pinna** is an irregular, funnel-shaped plate of elastic cartilage, covered by tightly adherent skin, which directs sound waves into the ear.

Sound waves enter the external acoustic meatus, a canal lined with stratified squamous epithelium that extends from the auricle to the middle ear.

Near its opening hair follicles, sebaceous glands, and modified apocrine sweat glands called ceruminous glands are found in the submucosa.

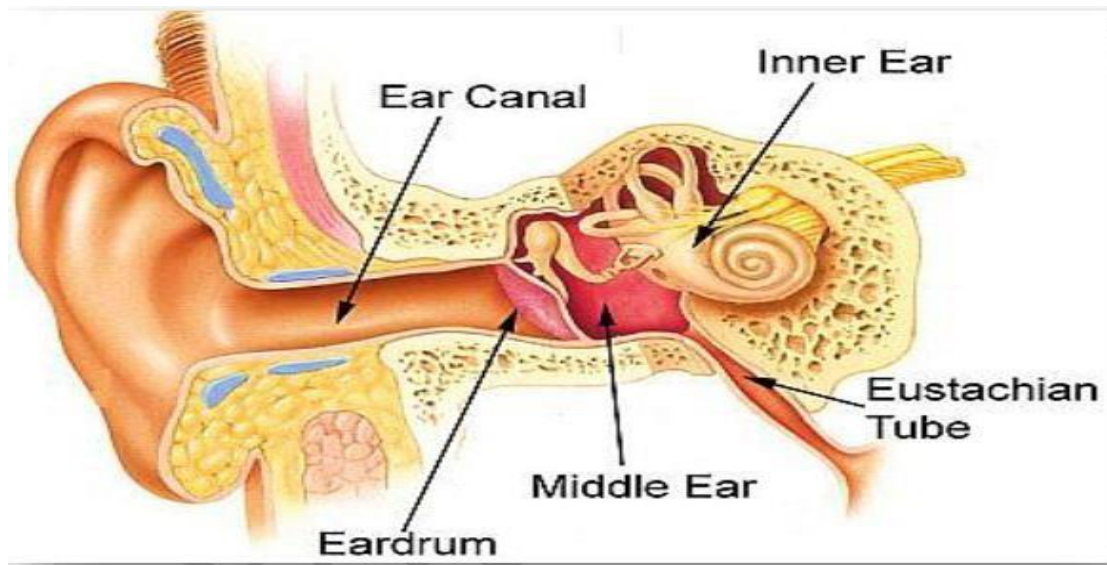
Cerumen, the waxy material formed from secretions of the sebaceous and ceruminous glands, contains various proteins, saturated fatty acids, and sloughed keratinocytes and has protective, antimicrobial properties.

The wall of the external auditory meatus is supported by elastic cartilage in its outer third, while the temporal bone encloses the inner part.

Across the deep end of the external acoustic meatus lies a thin, somewhat transparent sheet called the tympanic membrane or eardrum.

This membrane consists of fibroelastic connective tissue covered externally with epidermis and internally by the simple cuboidal epithelium of the mucosa that lines the middle ear cavity.

Sound waves cause vibrations of the tympanic membrane, which transmit energy to the middle ear.



2) Middle ear (tympanic cavity)

The tympanic cavity contains the three bony ossicles (malleus, incus, and stapes), which transmit movements of the tympanic membrane (eardrum) to the oval window (a membrane-covered opening in the bony wall of the cochlea).

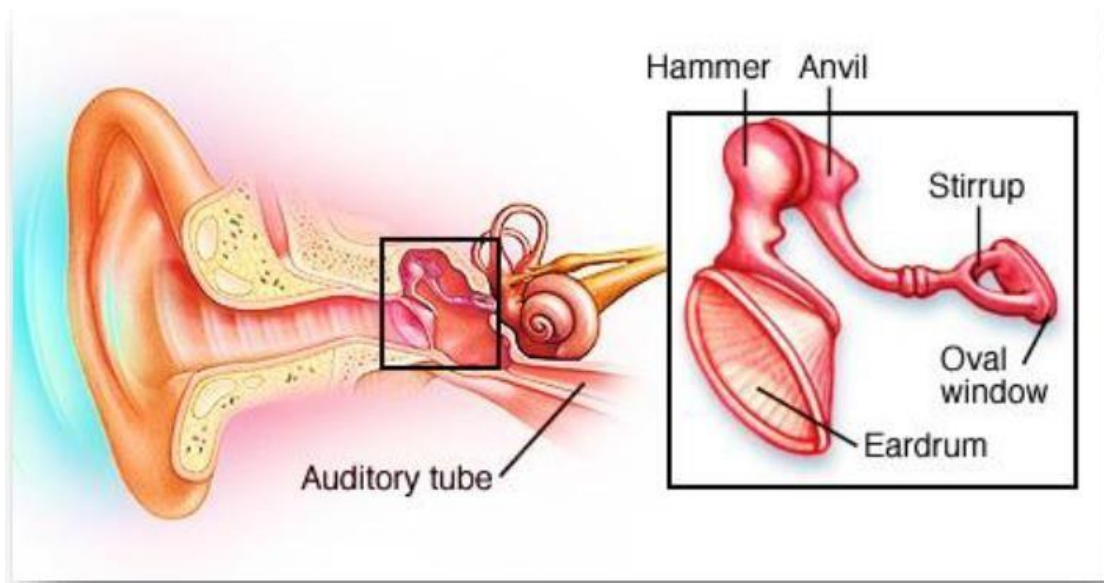
The bony ossicles, malleus, incus, and stapes, are attached to each other in a chain-like formation between the tympanic membrane and the oval window, a membrane-covered opening in the bony labyrinth.

The malleus (or Hammer) is attached to the tympanic membrane, whereas the stapes (or stirrup) is attached to the membrane of the oval window.

The middle ossicle, the incus (or Anvil), is interposed between the malleus and the stapes. The bony ossicles, as a group, function in modulating movements of the tympanic membrane and in amplifying the sound waves by applying pressure on the membrane covering the oval window in the cochlea.

The middle ear is connected to the nasopharynx via the auditory tube (eustachian tube). It is lined by a simple squamous epithelium, which changes to pseudostratified ciliated columnar epithelium near its opening to the auditory tube.

It has a lamina propria composed of dense connective tissue tightly adherent to the bony wall.



3) Internal ear

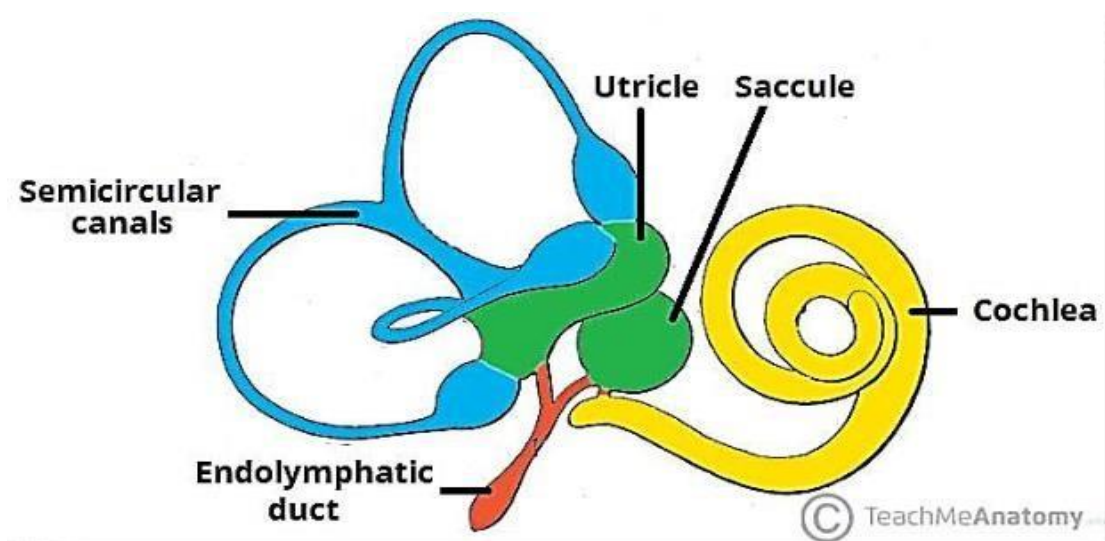
The internal ear is located completely within the temporal bone, where an intricate set of interconnected spaces, the bony labyrinth, houses the smaller membranous labyrinth, a set of continuous fluid-filled, epithelium-lined tubes and chambers.

The entire membranous labyrinth is within the bony labyrinth, which includes the following regions:

a) Vestibule

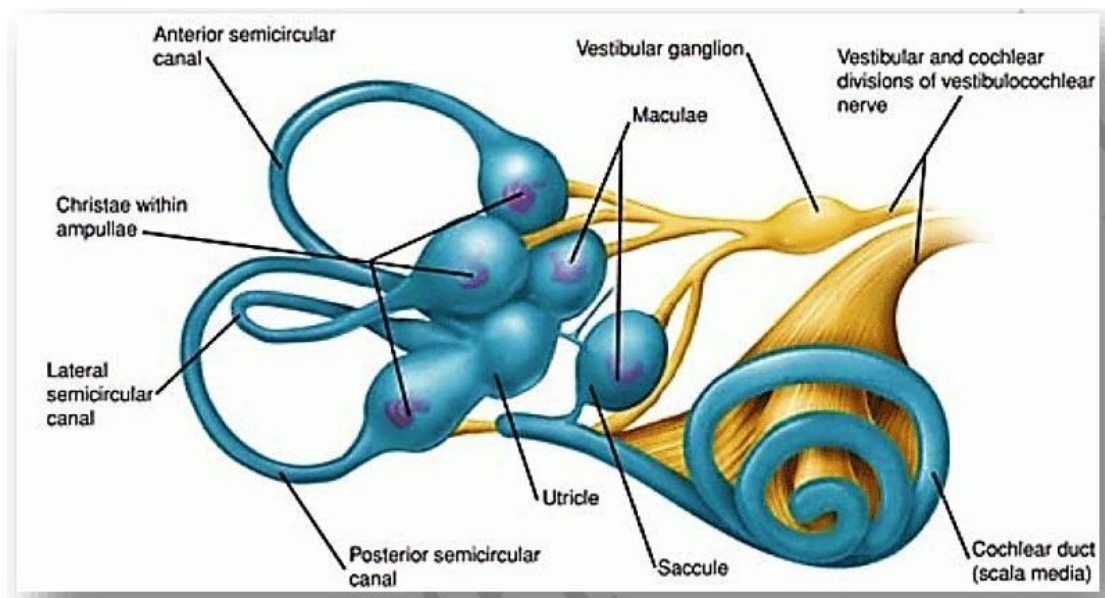
An irregular central cavity, the vestibule houses the saccule and the utricle. The interconnected, membranous utricle and the saccule are composed of a very thin connective tissue sheath lined with simple squamous epithelium and are bound to the periosteum of the bony labyrinth by strand of connective tissue containing microvasculature.

The **maculae** in the walls of the utricle and saccule are small areas of columnar neuroepithelial cells innervated by branches of the vestibular nerve. The macula of the saccule lies in a plane perpendicular to that of the utricle, but both are similar histologically. Each consists of a thickening of the wall containing several thousand columnar hair cells, each with surrounding supporting cells and synaptic connections to nerve endings.



b) semicircular canals

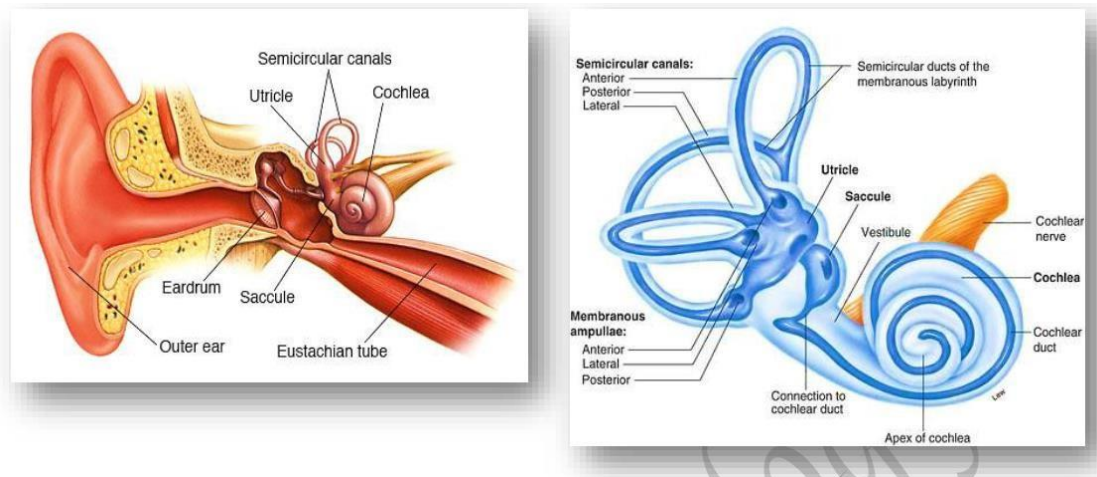
Three osseous semicircular canals enclose the semicircular ducts extend from and return to the wall of the utricle. They lie in three different spatial planes, at approximately right angles to one another. Each semicircular duct has one enlarged ampulla end containing hair cells and supporting cells on a crest of the wall called the crista ampullaris. Each crista ampullaris is perpendicular to the long axis of the duct.



c) Cochlea

The cochlea is about 35 mm long and makes $2\frac{3}{4}$ turns around a bony core called the modiolus. The modiolus contains blood vessels and surrounds the cell bodies and processes of the acoustic branch of the eighth cranial

nerve in the large spiral or cochlear ganglion. The cochlear duct, this duct is one of three parallel compartments, which coil $2\frac{3}{4}$ turns within the cochlea. The cochlear duct itself forms the middle compartment, filled with endolymph. It is continuous with the saccule and ends at the apex of the cochlea.



The bony and membranous labyrinths contain two different fluids. The separation and ionic differences between these fluids are important for inner ear function.

1) Perilymph fills all regions of the bony labyrinth and has an ionic composition similar to that of cerebrospinal fluid and the extracellular fluid of other tissues, but it contains little protein. Perilymph emerges from the microvasculature of the periosteum and drains via a perilymphatic duct into the adjoining subarachnoid space. Perilymph suspends and supports the closed membranous labyrinth, protecting it from the hard wall of the bony labyrinth.

2) Endolymph fills the membranous labyrinth and is characterized by a high- K^+ and low- Na^+ content, similar to that of intracellular fluid.

Endolymph is produced in a specialized area in the wall of the cochlear duct and drains via a small endolymphatic duct into venous sinuses of the dura mater.

