EAR: STRUCTURE AND FUNCTION

Introduction:

· Hearing is the process by which humans use their ears to detect and perceive sounds.

· Ears are important for hearing and for controlling a sense of position and balance.

· Ear is advanced and very sensitive organ of the human body, it transmits and transduce sound to the brain through ear.

Structure of Ear:

Each ear is divided into three sections:

I. Outer ear
II. Middle ear
III. Inner ear

OUTER EAR:

· It is the external part of the ear which consists of **pinna, ear canal** and **ear lobe**, all can be seen externally.

i. **Pinna**:

· The pinna or ear shell is shell like part made up of cartilage and covered by skin.

· Its most prominent outer ridge is called helix.

· The lobule is the soft pliable part at its lower end composed of fibrous and adipose tissue richly supplied with blood capillaries.

· The pinna directs sound waves from the outside into the external auditory canal, which in turn channels sound waves to the tympanic membrane known as Ear drum; causing it to vibrate.

ii. External auditory meatus:

· It is tubular passage supported by cartilage in its exterior part and by bone in its inner part. The meatus is internally lined by hairy skin and seruminous gland which later modified into sweat gland; secretes a waxy substance cerumen or ear wax. The function of ear wax is to prevent the entry of foreign pathogen into the ear.

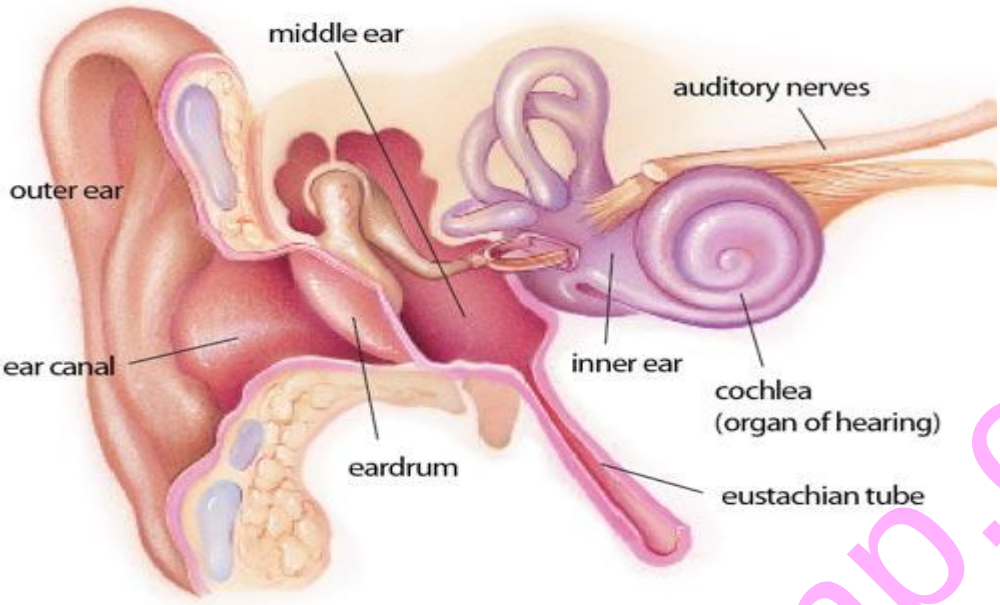
· The ear canal and middle ear is separated by the semi- transparent, flexible membrane which is known as the **tympanic membrane** or **ear drum**.

iii. **Tympanic membrane**:

· This membrane separates the tympanic cavity from the external auditory meatus.

· It is thin and semitransparent, oval and broader from below.

· The central part of the tympanic membrane is called umbo. The handle of the malleus is firmly attached to the membrane internal surface.



MIDDLE EAR:

· It is an air-filled space that is connected with the nasopharynx through the Eustachian tube, which serves to equalize the air pressure in the tympanic cavity with that on outside.

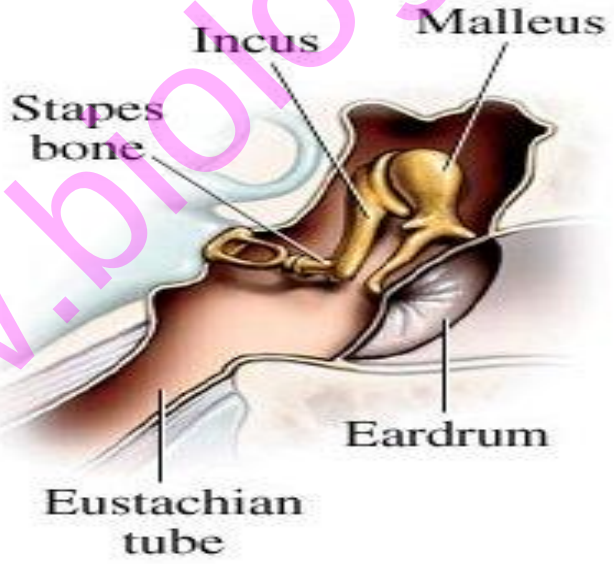
· It contains three tiny bones which are known as ossicles that help in transmitting sound.

· The bones are known individually according to their shape;

a) **Malleus**(hammer)

b) **Incus**(anvil)

c) **Stapes**(stirrup)



· Sound waves that reach the tympanic membrane cause it to vibrate. In turn the eardrum sets into motion.

· The malleus transmits the motion to the incus; finally, the stapes work like a piston to amplify and transforms the sound energy into mechanical energy.

· This mechanical energy is then transmitted from the stapes to the hearing part which is termed as cochlea of the inner ear via the oval window (a thin membrane between the middle ear and inner ear).

· There are two skeletal muscles; tensor tympani attached to the malleus and the stapedium is the smallest muscle in the body.

· The middle ear is connected with the inner ear through two small openings closed by the membrane. These openings are termed as**; fenestra ovalis** and **fenestra rotunda**.

· The fenestra ovalis is covered by foot plate of the stapes. The fenestra rotunda is enclosed by flexible secondary tympanic membrane. The latter is responsible for equalizing the pressure on either side of the tympanic membrane.

INNER EAR:

· Inner ear is the delicate part of the ear which is housed in a bony chamber which is called bony labyrinth.

· There is a body cavity on each side enclosed in the hard-periodic bone which contains the perilymph which corresponds to CSF.

a) Semicircular ducts:

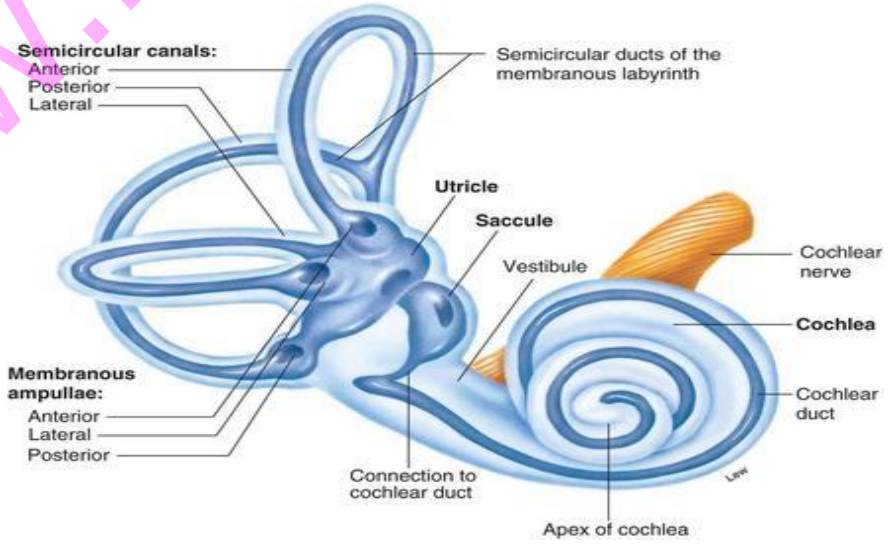
· There are three semicircular ducts, the anterior, posterior and the lateral semicircular ducts.

· They arise from the utricle. Each semicircular duct is enlarged at one end to give rise to a small rounded ampulla. The anterior and lateral semicircular ducts bear ampulla at their anterior ends while the posterior ducts contain an ampulla at its posterior end.

· Each ampulla contains a sensory patch of cells, the cristae. Each cristae consists of two kinds of cells, sensory and supporting cells. The sensory cells bear long sensory hairs at their free ends and nerve fibers at another end.

· Sensory hairs are partly embedded in a gelatinous mass, capsule. The cristae are concerned with balance of the body.

· The vestibular apparatus are semicircular canals which also contain cilia.



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b) Utricle, Endolymphaticus and Saccule:

· Utricle is dorsally placed structure to which all the three semicircular ducts are connected.

· The saccule is a ventrally situated structure which is joined with the utricle by a narrow utriculosaccular ducts. From this duct a long tube, the ductus endolymphaticus arises which ends blindly as the saccus endolymphaticus.

· Both utricle and saccule contain sensory patches, the maculae. Maculae comprise sensory and supporting cells similar to those of the cristae.

· The hair is not actually motile and is embedded in a gelatinous membrane, the otolith membrane in which there are also found very small crystals $CaCO_3$ in the otolith.

· The cristae and maculae are concerned with balance.

c) Cochlea:

· The cochlea is spiral shaped that resembles a snail shell in appearance and contains many hair cells with projections called cilia.

· It is the main hearing organ which is connected with saccule by short ductus reunions leading from the saccule.

· It tapers from a broad base to utmost pointed apex. Internally, it consists of three fluid filled chambers, the upper scala vestibule, lower scala tympani and the middle scala media.

· Both scala vestibuli and scala tympani are filled with perilymph. However scala media is filled with endolymph. Both the scala tympanii and scala vestibule are connected with each other at the apex of the cochlea by small canal; helicoterma.

· The cilia in the cochlea are responsible for hearing whereas those that are present in the vestibular apparatus are meant for maintaining balance.

Function of Ear:

i. **Hearing**:

Main function of ear is hearing which involves many steps; external sound is channelized from the outer ear into the auditory canal where it reaches the tympanic membrane to produce vibrations. These vibrations are transferred via the ossicles present in the middle ear to the cochlea causing waves in the inner ear. The waves are sent as signals to the brain by auditory nerve. Brain interprets the vibration as sound.

Ø **Mechanism of Hearing**: Sound waves are collected by external ear and to some extent pass it to external auditory meatus to the tympanic membrane which is caused it to vibrate. The vibrations are transmitted across the middle ear by malleus, incus and to the stapes bone, it fits into the fenestra ovalis. The perilymph of the inner ear receives the vibrations through the membrane covering the fenestra ovalis. From the perilymph the vibrations are transferred to the scala vestibule of cochlea and then to the scala media through Reissner's membrane. The movements of endolymph and tectorial membranes stimulate the sensory hairs of the organ of corti. The impulses thus received by the hair cells are carried to the brain through the auditory nerve where the sensation of hearing is felt. It is evident that the

external and the middle ear serve to transmit sound waves to the internal ear. In the internal ear transfer motion of the vibrations into nerve impulses for relay to the brain take place. From scala tympani the sound waves are transmitted to the tympanic or middle ear cavity through the membrane covering the fenestra rotunda. From the tympanic cavity the sound waves are transferred to the pharynx through the eustachian tube.

ii. **Equilibrium:** The vestibular apparatus function to maintain balance and positions of the body. The semicircular canals, utricle and saccule of the membrane labyrinth are the structures of equilibrium whenever the animal gets bled or displaced of the hair cell of the cristae and maculae are stimulated by the movement of the endolymph and otolith. The stimulus is carried to the brain through the auditory nerve and the change of position is detected by the medulla oblongata of the brain. After that, brain sends impulses to the muscles to regain the normal condition.

iii. The Eustachian tube helps in draining the fluid collected in the middle ear into the pharynx.

iv. Frequencies perceive by the ear:

Ear perceives sound ranging from 20 hz to about 20,000 hz. The minimum threshold of human hearing is 0 db and the threshold at which hearing becomes painful is 120 db.