CONCEPT MAP

THE EAR

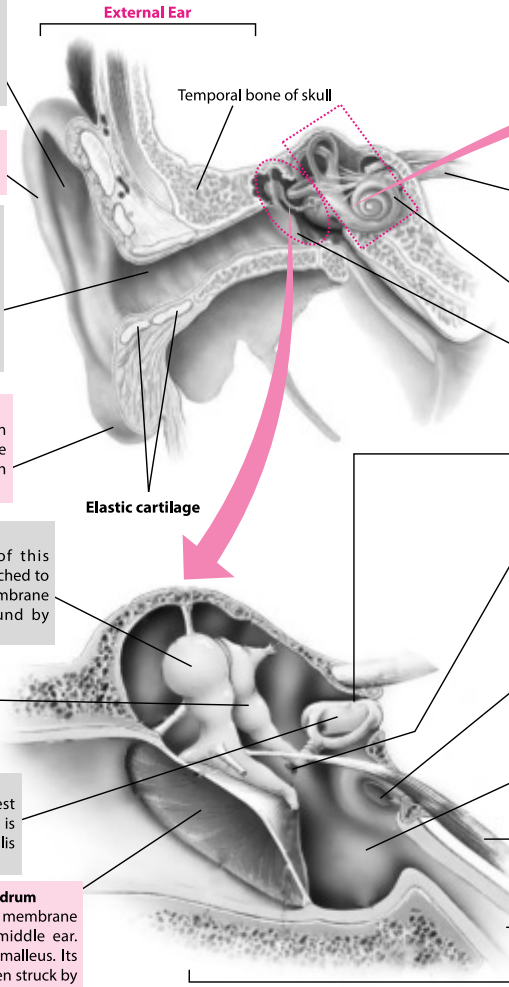
Ears are a pair of sense organs that are situated on the either sides of the head to produce a sensation of hearing and to maintain body's equilibrium and balance. Anatomically, human ear is divided into three regions - external ear, middle ear and inner ear.

Pinna (Auricle)
It is a cartilaginous structure which help to amplify (detect) and direct the sound waves towards auditory canal.

Helix
The outer prominent ridge of auricle.

External acoustic meatus
It is a tubular passage supported by cartilage in its external part and by bone in the inner part. Internally it is lined by stratified epithelium and ceruminous gland that secretes cerumen (ear wax).

Lobule
It is a soft, pliable flap of skin composed of fibrous and adipose tissue. It is richly supplied with blood capillaries.



Vestibulocochlear or auditory nerve
Transmits sound and equilibrium information from inner ear to brain.

Cochlea
Spirally coiled, main hearing organ.

Tympanic membrane

Fenestra ovalis (Oval window)
It is covered by foot plate of the stapes.

Stapedius muscle
Smallest muscle of the body.

Fenestra rotunda (Round window)
Flexible structure. It equalises pressure on either side of the tympanic membrane.

Tympanic cavity
Air filled cavity connected to nasopharynx through Eustachian tube.

Tensor tympani muscle

Eustachian tube
Equalises the air pressure in the tympanic cavity with that on the outside.

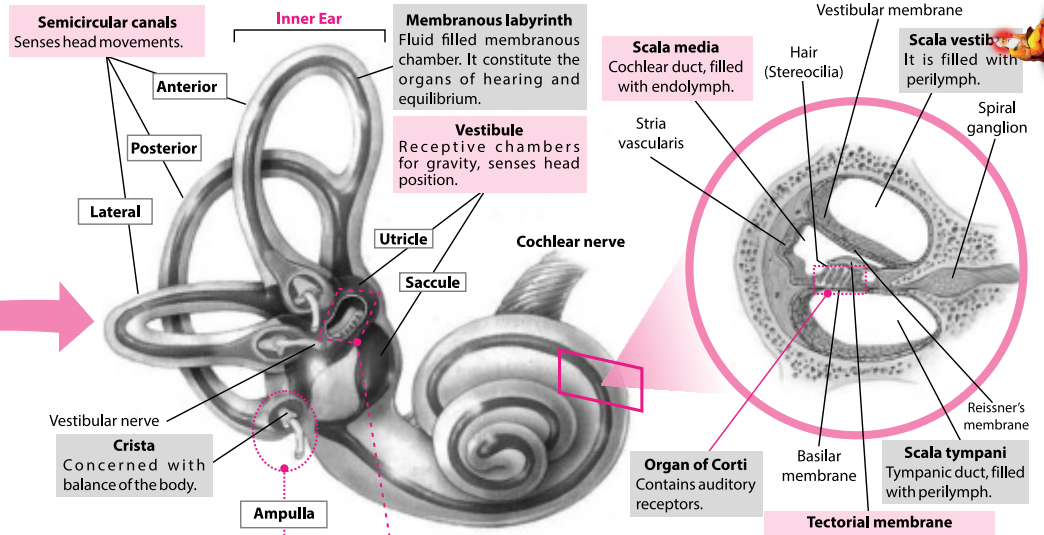
Ear ossicles

Malleus
Largest ossicle. Handle of this hammer shaped bone is attached to inner side of tympanic membrane and its head is firmly bound by ligaments to incus.

Incus
Middle, anvil shaped bone. It is connected to malleus on one side and the stapes on other.

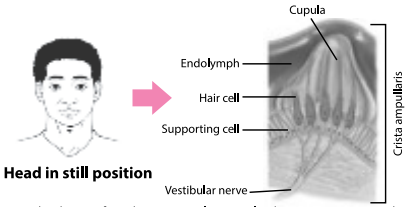
Stapes
Smallest ossicle and smallest bone of the human body. It is attached to the fenestra ovalis (oval window).

Tympanic membrane/ Eardrum
Oval, thin and semi-transparent membrane that separates external and middle ear. Internally it is attached to the malleus. Its central part umbo, vibrates when struck by sound waves.



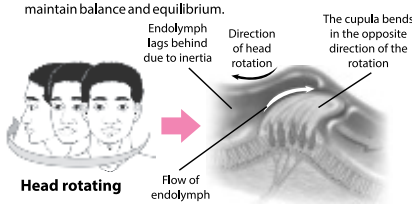
EQUILIBRIUM

Rotational Movement



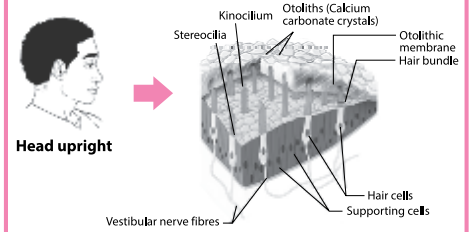
Head in still position

- The base of each semicircular canal where it meets vestibule, connects to a region called ampulla. The ampulla contains hair cells that respond to rotational movement of the head.
- The fluid in each canal will move slowly in the direction of motion of cupula bending the stereocilia within it.
- When the head rotates, the fluid (endolymph) inside the semicircular canals pushes against the cupula and causes the cilia and cupula to bend opposite to direction of head rotation.
- This bending either depolarise or hyperpolarise the hair cells depending on the direction in which they are bent. This stimulates the production of action potential in associated neurons to maintain balance and equilibrium.



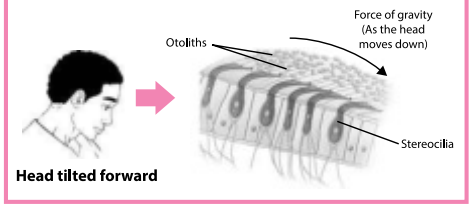
Head rotating

Linear Movement



Head upright

- Utricle and saccule are parts of balancing apparatus that detect linear accelerations. The hairlike processes called stereocilia are embedded within a gelatinous membrane containing calcium carbonate crystals (otoliths).
- The utricle is more sensitive to horizontal acceleration (as in a moving car) and the saccule to vertical acceleration (as in an elevator).
- When the head moves forward or tilts, otoliths move forward slowly and the inertia bends the stereocilia on the hair cells and depolarise them. Electrical signals are sent to the brain which interprets the signals.
- Brain sends impulses to muscle to regain normal condition.



Head tilted forward

MECHANISM OF HEARING

Sound waves are collected from an external source by the help of ear pinna and are transmitted to tympanic membrane through an external auditory meatus.

Tympanic membrane (eardrum) stretches; and as the air molecules push the membrane, they cause it to vibrate at the same frequency as the sound wave.

Tympanic membrane bows inwards and transmits the sound waves to the ear ossicles.

Perilymph of inner ear receives the vibrations through fenestra ovalis.

Vibrations are further transferred to scala vestibuli and then to scala media through Reissner's membrane of cochlea.

Movements in fluid (endolymph) of scala media and tectorial membrane stimulate the sensory hair of the organ of Corti.

Hair cells receive the impulses and transmit it to brain through auditory nerve and finally sound is detected by the brain.