

6. **Trachoma :-** In this defect of eye, a watery liquid oozes out from eyes in excess amount so eyes become red due to irritation . It is caused by a microbe Chlamydia trachomatis.
7. **Strabismus :-** It is due to loosening or contraction of the any of 6 skeletal muscles which give the proper position to the eye ball in its orbit. Thus eye ball inclines towards one side of orbit. It is strabismus or squint eyes.
Particular muscle may be cured by operation and this defect is cured.
8. **Cataract :-** In this defect, lens becomes more solid, brown or more flat. It occurs in old age mostly . The lens becomes opaque , and reduces its power of accommodation . At this stage person can not see. A new lens is administered in place of defective lens by operation.
9. **Glaucoma :-** If the canal of schlemm is blocked in eyeball , aqueous humour can not return to vein as a result pressure is increased in eye chambers and retina is damaged, and person becomes totally blind.
10. **Photophobia :-** In this defect proper image is not formed in bright light.
11. **Colour blindness :-** It is genetic disorder of X –chromosome. It is due to recessive gene . Colourblind persons can not differentiat in red and green colour.

EAR

SENSE ORGAN – EAR :

(B) Statoacoustic organ ear :- These are also called phonoreceptors.

☞ All the vertebrates have one pair of ears back to the eyes.

There are two main functions of ears :-

- (1) To receive sound waves, hearing
- (2) To maintain body blance. Main function of ear is to maintain the balance of body.

Stucturally ear may be divided into three parts :-

- (a) External ear
- (b) Middle ear
- (c) Internal ear

(a) External ear

It is the outer part of ear. It is well developed in mammals only. External ear may be divided again into 2 parts

- (i) ear pinna,
- (ii) ear canal

(i)

(ii) Ear pinna :- This may be small or large , **fan like** structure , important feature of mammals , but absent in **whale , seal, Ornithorhynchus** etc. The skin of ear pinna is hairy. These are having yellow elastic cartilage in them . A rabbit can move its pinna according to its will, just like dog, cat , cow etc. but a man can not move his pinnae. Muscles of man’s ear are vestigeal . Pinna covers some of the ear canal , this part is called **choncha**.

(ii) Ear canal or External auditory meatus :- It is a 24 mm long canal which is expanded from base of pinna to inner side.

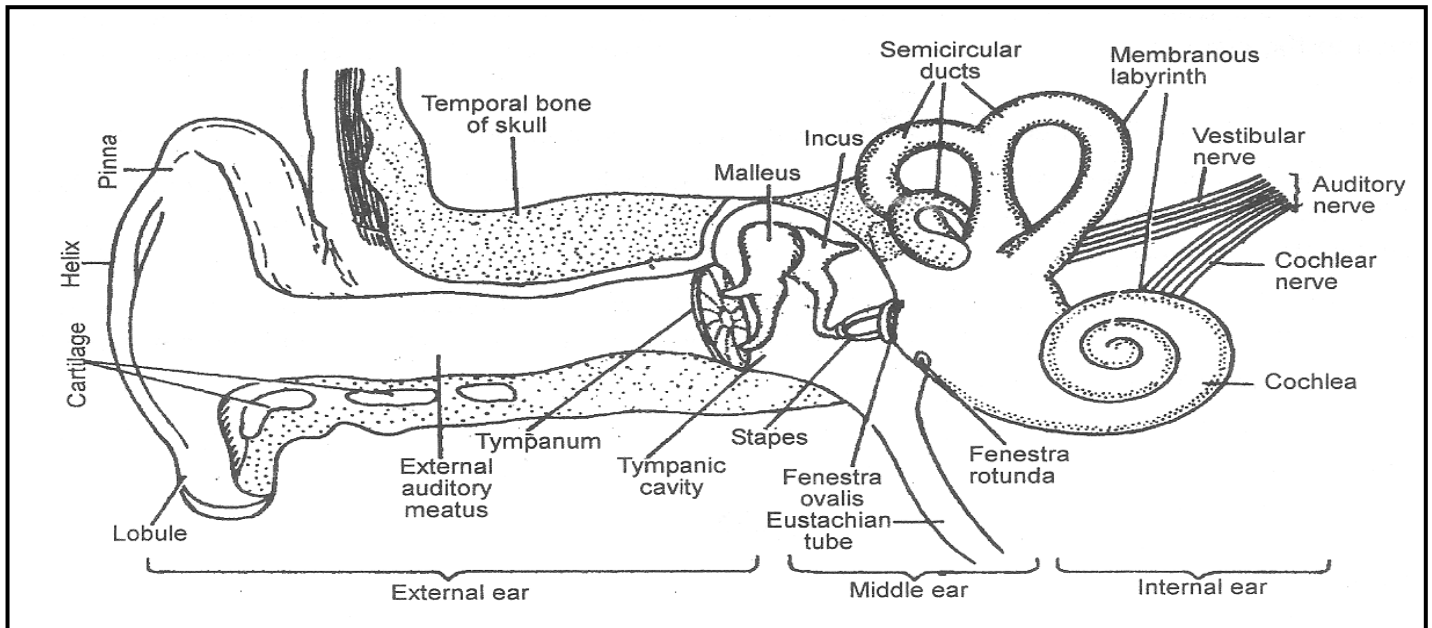
☞ Along with mammals , **birds** and **reptiles** also have ill or less developed ear canal.

☞ At the end of ear canal a stretched, thin , obliquely placed memnbrane is present , it is called **ear drum** or **tympanic membrane**. This separates the ear canal to middle ear.

☞ In the wall of external auditory meatus or ear canal there are found modified aweat glands called **ceruminous** glands. These secrete **Cerumen** or ear wax, which moisten the ear drum and protects it.

☞ Ear drum remains always in stretched position because malleus ear ossicles / bone pulls it towards tympanic cavity by tensor tympani muscle.

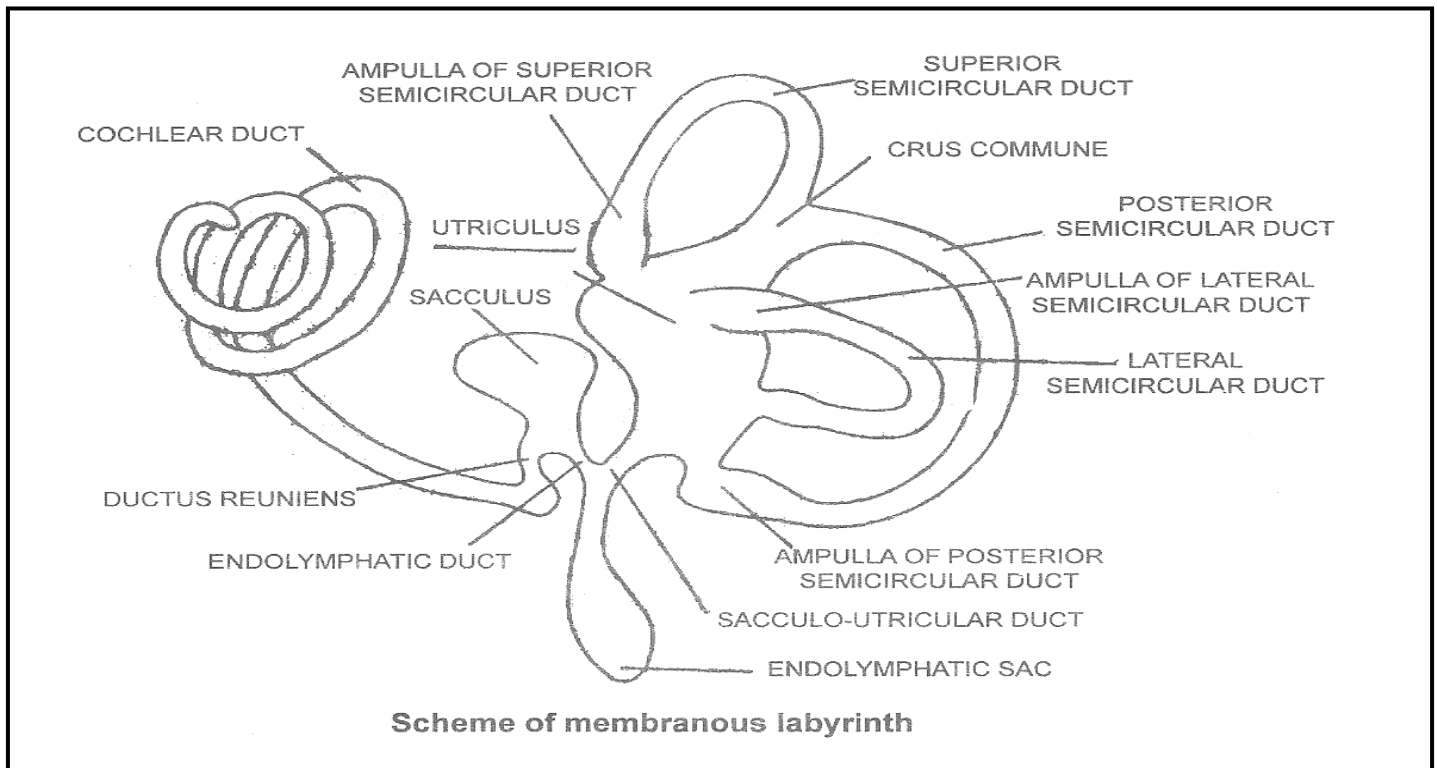
Ear drum is a part of middle ear.



- (b) **Middle ear :-** Middle ear is also called tympanic cavity. It is filled with air. This cavity is covered by a flask like bone called tympanic bulla. This bone is a part of temporal bone of skull. Middle ear cavity is connected by pharyngeal cavity through a canal. It is called **Eustachian duct**. Due to this tube, pressure at both the side of tympanic membrane remains always equal . This duct acts to maintain sound equilibrium. it expels high volume sounds through mouth, to avoid the damage of ear drum. Tympanic cavity is connected by internal ear cavity by two apertures
- (i) Oval aperture fenestra ovalis (oval window) and
 - (ii) Spherical aperture fenestra rotundus (round window) . A thin and firm membrane covers each aperture.
- Three ear ossicles are present arranged in a chain with movable joints connected together in tympanic cavity.
- (a) **Malleus :-**It is situated towards outer ear. It is the largest of three and of hammer shaped malleus is formed by the modification of articular bone of jaw.
- Inner broad part of malleus is connected by incus. Malleus and incus are Joint together by syovial hinge joint.
- (b) **Incus :-** The ossicles is anvil shaped. It is formed by the modification of quadrate bone of jaw. Its outer broad part is connected by malleus and inner thin part is connected by **stapes**. Incus is joined by stapes by **ball ans socket joint**.
- (c) **Stapes :-** It looks like stirrup of horse. It is formed by the modification of hyomandibular **bone of jaw**.
- It is the smallest bone of body
- Stapes is connected to incus at one side and on the other side it is connected to membrane stretched over fenestra ovalis.
- [In the tympanic cavity of frog only one ear ossicles is found it is called **columella auris**. Malleus and incus are absent here.]
- All the three ear ossicles are arranged in ear cavity by ligaments. These carry sound wave from ear drum to internal ear through fenestra ovalis.

Internal ear :-

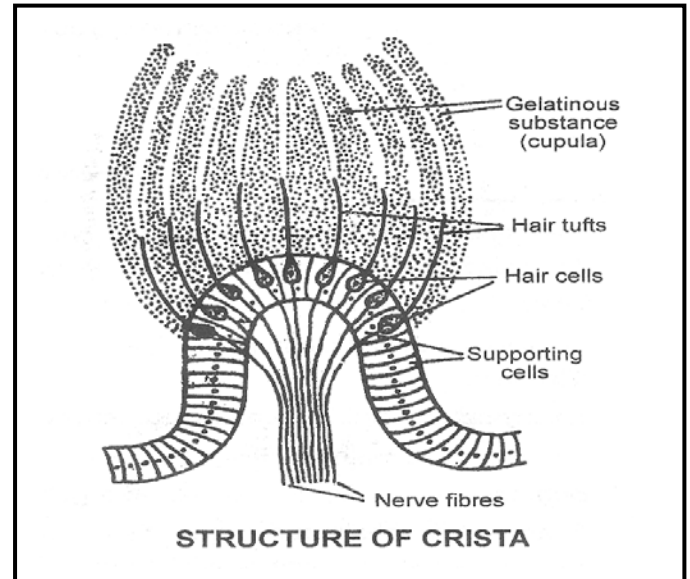
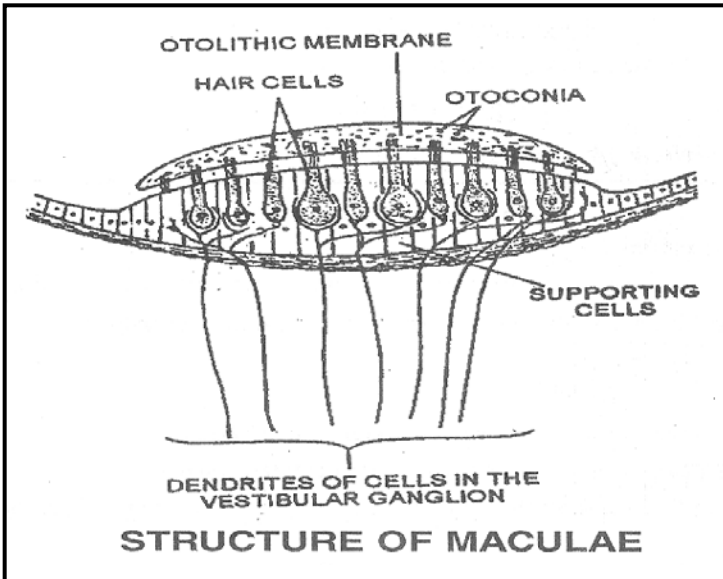
It consist of (1) Bony Labyrinth (2) Membranous Labyrinth.



- ☞ Internal ear enclosed in the petrous part temporal bone which form a bony capsual out side the internal ear it is called bony labyrinth. It is the cavity of hearing apparatus.
- ☞ Internal ear is a complex structure made up of semi transparent membrane. It is called membranous labyrinth.
- ☞ Bony labyrinth and membranous labyrinth are connected by a cavity called perilymph cavity. Perilymph liquid is filled in it.
- ☞ Endolymph is filled in membranous labyrinth.
- ☞ There are two main bag like chambers in membranous labyrinth, **utricle and saccule**. Both these chambers are connected together by a thin canal called **sacculo – utricular duct**.
- ☞ A thin endolymphatic duct opens into sacculo – utricular duct. This endolymphatic duct opens into **endolymphatic sac** situated at back side of skull on the other side. Utricle is comparatively large. Three semicircular canal arise from utricle at 90° angle to each other and open into utricle again these are called
 - (i) Anterior or superior semicircular canal
 - (ii) Posterior semicircular canal
 - (iii) External or lateral or horizontal semicircular canal.
- ☞ Anterior and posterior canals arise in the form of a single canal called “**Crus commune**”
- ☞ The distal end of each semicircular canal is some what swollen, called **Ampulla**.
- ☞ Saccule is smaller than utricle . Its back side is coiled like spring . It is called **cochlear canal** . It is also known as **largeta**.
- ☞ The length of cochlear canal of human, rabbit and whale are $2\frac{3}{4}$, $2\frac{1}{2}$ and $1\frac{1}{2}$ coils respectively.
- ☞ Cochlear canal is connected by saccule by a small duct called **ductus reunions**.
- ☞ All the coils of cochlear canal are connected together by flexible ligaments .
- ☞ In the centre of coils of cochlea in human, there are present a pillar like structure called **modiolus**.

(D) **Internal structure of inner ear :-**

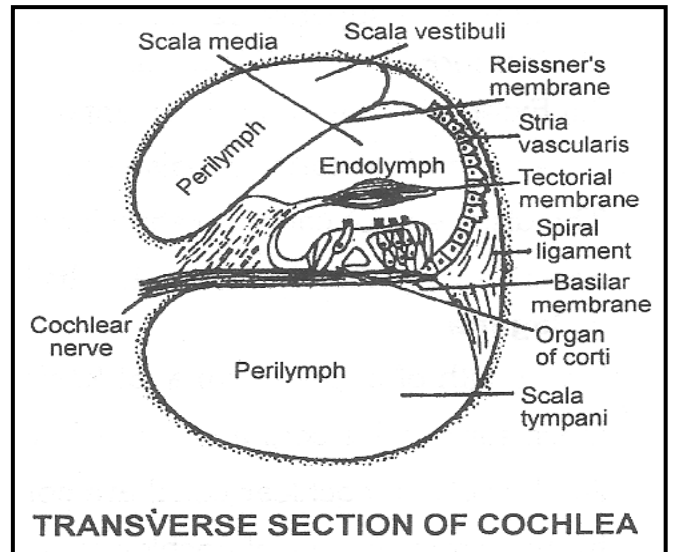
- ☞ The inner wall of membranous labyrinth is lined by cuboidal epithelium and outer wall is lined by connective tissue richly supplied with blood capillaries.
- ☞ Membranous labyrinth is empty inside. Its cavity is filled by endolymph which is a milky, mucillagenous fluid.
- ☞ Distal end of each semicircular canal becomes swollen swollen called ampulla. In this ampulla, internal cuboidal epithelium forms a ridge like projection called **acoustic ridge** small immovable microvilli are found at the free edges of sensory cells of acoustic ridge. These microvilli are numerous in number. These are called stereocilia, along with these there are found single movable cilium called **kinocilium** . Otoconia are absent in crista of ampulla. All the microvilli of ridge are bind together like a bag and form **cupula**.
- ☞ One structure each is present in utriculus and one in sacculus , these are called **Maculae**. Numerous CaCO₃ particles are found in endolymph these are called **Otoconia**.
- ☞ These sensory cells situated in internal ear are in contact with small nerves. All these thin nerve combine to form **vestibular nerve (branch of auditory nerve)**.
- ☞ Sensory crista and maculae are related with equilibrium of body
- ☞ Cristae control and maintain body equilibrium at the time of movement and maculae regulate this at static position.

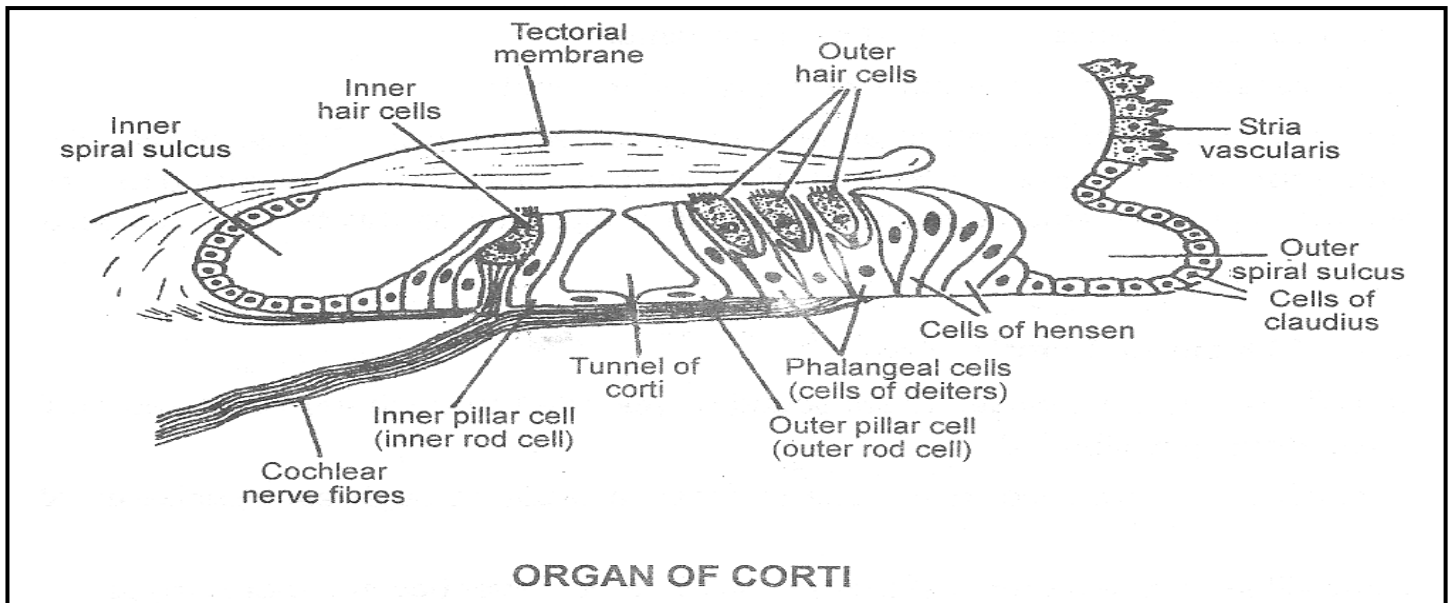


(E) **Internal Structure of Cochlea & Cochlear canal**

Cochlear duct is connected by bony labyrinth in such a way that it divides the cavity of labyrinth into dorsal and ventral chambers. So in a transverse section of cochlea following three chambers are seen clearly.

- (i) **Scala vestibule :-** It is situated at dorsal side and is filled with perilymph.
- (ii) **Scala tympani :-** It is situated at the ventral side below the cochlear duct. It is also filled by perilymph.





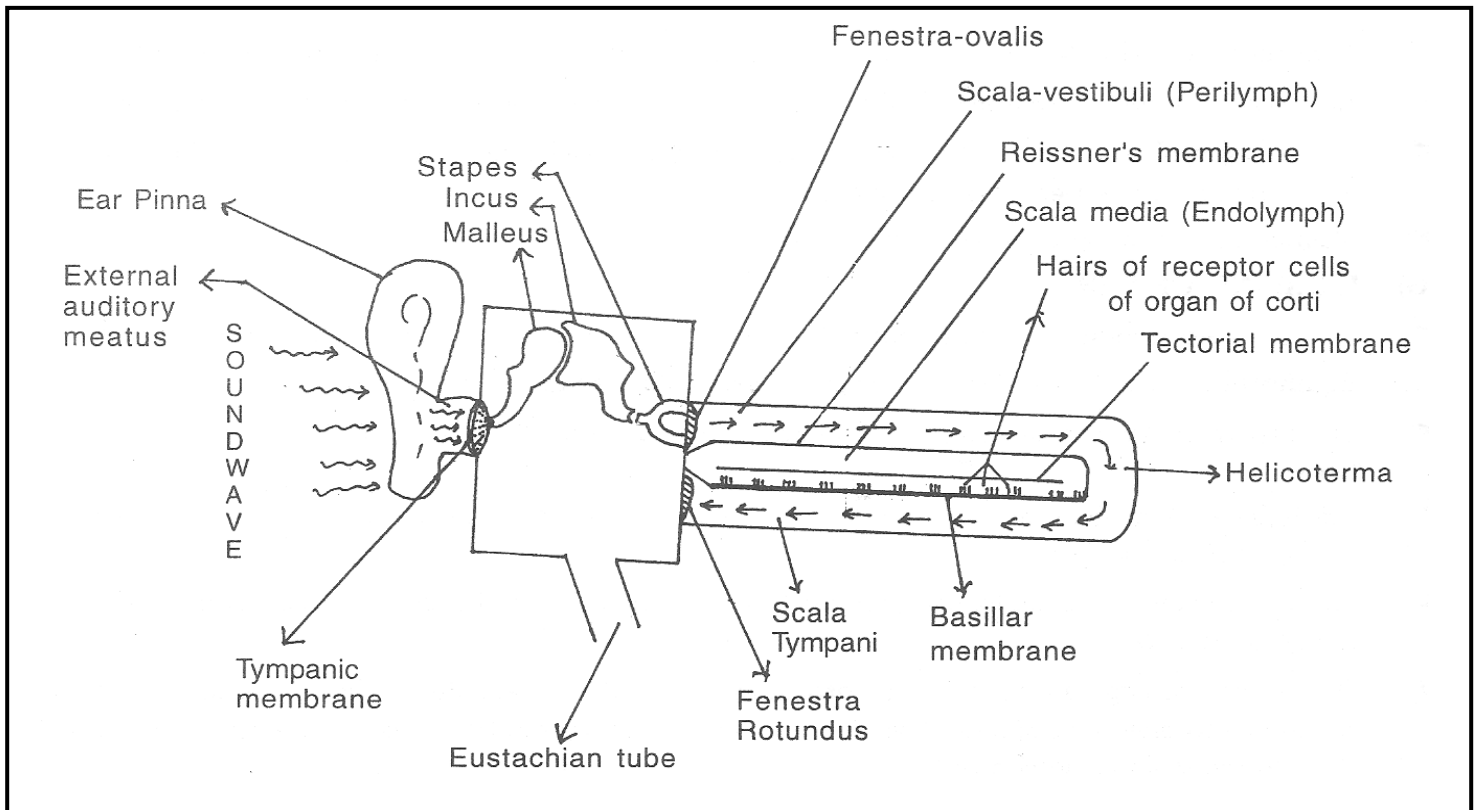
- (iii) **Scala media :-** It is the triangular cavity of cochlear duct that is situated between scala vestibule and scala tympani. It is filled with endolymph.
- ☞ Thin dorsal wall of cochlear duct is called vestibular membrane or Reissner's membrane.
 - ☞ Ventral wall of scala media is thick it is called basilar membrane. Scala vestibule and scala tympani are connected through a small aperture at the free edge of cochlea . This aperture is called **helicotrema**.
 - ☞ Scala media is blind (closed) at its both the sides.
- (F) **Organ of Corti :-** A sensory ridge is present at the whole length of line at epithelium lining of basilar membrane of scala media. It is called organ of corti. It has two types of cells (i) Sensory cell (ii) Supporting or suspensory cell. & three type of suspensory cell
- (i) Cells of Dieter's or basal cells (ii) Pillar cells or rod cells (iii) Hensen's cells or rectangular.
 - ☞ In between the empty spaces of sensory and suspensory cells a lymph like fluid cortilymph is filled . This space is called tunnel of corti.
 - ☞ Numerous microvilli called stereocilia (sensory hair) are present at the free surface of each sensory cell.
 - ☞ At the ventral surface of sensory cells there are present thin fibres of auditory nerve that form cochlear branch.
 - ☞ At the organ of corti a thin jelly like membrane is inclined called tectorial membrane. In this membrane, all the sensory hair's free edges are embedded.
 - ☞ Main credit of hearing goes to "Organ of corti".
- (G) **WORKING OF EAR:-**
- ☞ Ears are stato- acoustic organs of body. Thus these help the body to hear and balanching the body.
- (a) **Static balancing :-** The first and basic function of ears is to maintain balance of body.
- ☞ This act is done by utriculus, sacculus and three semicircular canals. Equilibrium impulse /sensation is of two types :-
- (i) **Static balancing :-** Its relation is from the point of view of gravity and position of head in static conditions of body and its changes.
- ☞ The senses of these changes (of head) are produced and carried mainly by utriculus, sacculus and their sensory Cristae i.e. maculae.
 - ☞ Sensory hair of ridge are sensitized by **otoconia or otolith or ear dust**. These sensations or impulses are carried to brain by auditory nerve After it messages of appropriate reactions are send through motor fibres to the skeletal muscles of body.

(ii) **Dynamic equilibrium :-**

- ☞ It is the action to maintain balance of body during movement.
- ☞ This act is done by sensory ridges of ampula of semicircular canals.
- ☞ At the time of movement the endolymph of ampula produces waves in it. Cupula of ampula are effected by these waves and sensory cells cupula are irritated . This sensation or stimulation is carried to brain by auditory nerve and proper messages are send to muscle of legs in reply . Due to this body is balanced at the time of walking.

(b) **Hearing :-**

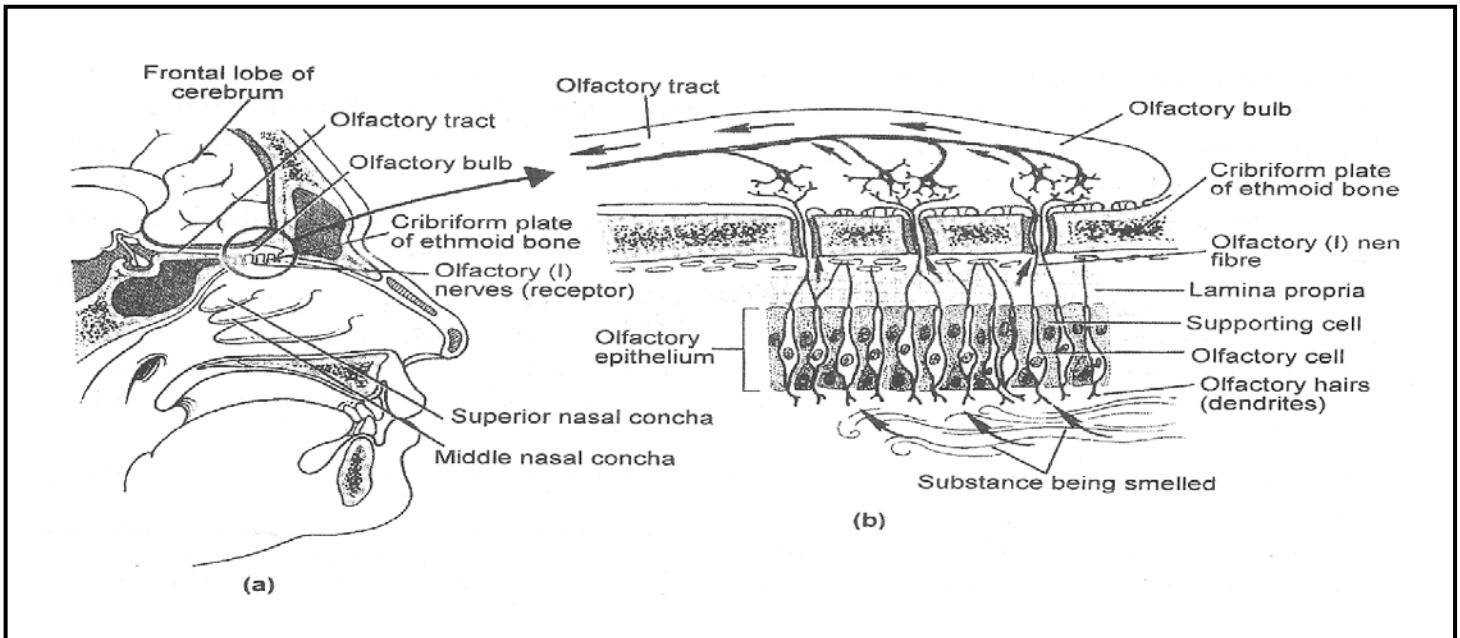
- ☞ This act is done by “Organ of Corti “.
- ☞ Sound waves are collected by ear pinnae. These sound waves travel through ear canal and hit the ear drum as a result of it ear drum get vibrated.
- ☞ These vibrations reach up to stretched membrane of fenestra ovalis through ear ossicles ear ossicles work as lever/
- ☞ As a result of this traveling (from ear drum to fenestra ovalis) sound waves become more strong.
- ☞ When the membrane of fenestra ovalis starts vibrating, perilymph of scala vestibule also starts vibrating , some vibrations reach up to scala tympani (fenestra rotundus) and its perilymph.
- ☞ Due to these vibrating waves , reissner membrane and basilar membrane of the walls of scala media also start vibrations. These vibration travel through endoymph reach upto organ of corti. The organ of corti also starts vibrating.
- ☞ At this place, sensory hair of sensory cells (cells of organ of corti) hit by the tectoreal membrane. Now stimulation of hearing takes place.
- ☞ Cochlear nerve carries this impulse to brain through auditory nerve. Appropriate messages are send to receptor organs by brain accordingly.
- ☞ Vibrations / waves produced by cochlea travel through perilymph , reach up to membrane stretched at fenestra Rotandus and are destroyed.
- ☞ Some sound waves are also destroyed, when coming from helicotrema.



DIFFERENCES OF RECEPTORS BETWEEN RABBIT AND MAN

RABBIT	MAN
Eye : 1. Monocular vision is present. 2. Both eyes are located on the dorsal and lateral side of head. 3. Nictitating membrane is present. 4. Eye is red coloured.	1. Binocular vision is present. 2. Both eyes are located at anterior part of face. 3. Nictitating membrane is vestigial which is called as plica-semilunaris. 4. Eye is black, blue, brown coloured.
Ear 1. Ear pinna are funnel shaped 2. Ear pinna are motile 3. No. of coiling of cochlear canal is $2\frac{1}{2}$	1. Ear pinna kidney shaped. 2. Ear pinna are non-motile 3. No. of coiling of cochlear canal is $2\frac{3}{4}$

NOSE



Olfactoreptor :

- Olfactoreceptors are situated in the upper part of nasal chamber in olfactory epithelium.
- This membrane is called as **schneiderian membrane**.
- Olfactoreceptors are related with olfactory bulb. It is the extension of limbic system.
- This bulb is situated below the frontal lobe cerebral hemisphere and above the ethmoid bone of nasal chamber.
- Three types of cells are found in the olfactoreceptors. These are -
 - (i) Bipolar olfactory nerve cells
 - (ii) Columnar epithelial cells
 - (iii) Mucous glands

- (1) **Bipolar olfactory cells** : It is special types of nerve cells
- Sensory hair and found at the anterior end of olfactory cells. They contact with external environment in nasal chamber.
 - Sensory hair are related with dendrites of bipolar nerve cells.
 - Middle part of olfactory cell is cyton.
 - Posterior part of olfactory cell is axon which is nonmyelinated.
- (2) **Columnar epithelial cells** : It is also as supporting cells . They are present arounds the bipolar olfactory cells .
- They provides support to the olfactory cells .
 - Some small conical cells are also found at the basal part of olfactoreceptor and provide base to the olfactoreceptor .
 - A layer of connective tissue lies below the olfactoreceptor. It is also called as Lamina propria.
- (3) **Mucous gland** : It is called as **Bowman's gland** . It is situated in the Lamina propria. It opens at the outer part of olfacto receptor through fine duct. Their secretory mucous substance dissolve the smell particle and carry to the sensory hair of olfactory cells. Unmyelinated axons of all olfacto sensory cells makes the synapse with dendrites of Multipolar neurone of olfactory bulb . The number of receptors stimulated indicates the strength of smell .
- * In addition to smell receptor , a network of nerves is found in the nose , mouth and tongue. The network formed by trigeminal nerve of V cranial nerve. It is also known as Dentists' nerve, reacts to messagesd of pain of teeth. It also convey the message of smell to brain. Such as ammonia , vinegar etc.
- The trigeminal can protect by warning about harmful chemical in the air. Bowman's glands inside the nose release mucous fluid to get rid of the irritating substances.
- Loss of the sense of smell is known as **anosmia**. It occur due to congenital abnormalities of Olfactory bulbs or nerves.

TONGUE OR ORGAN OF TASTE

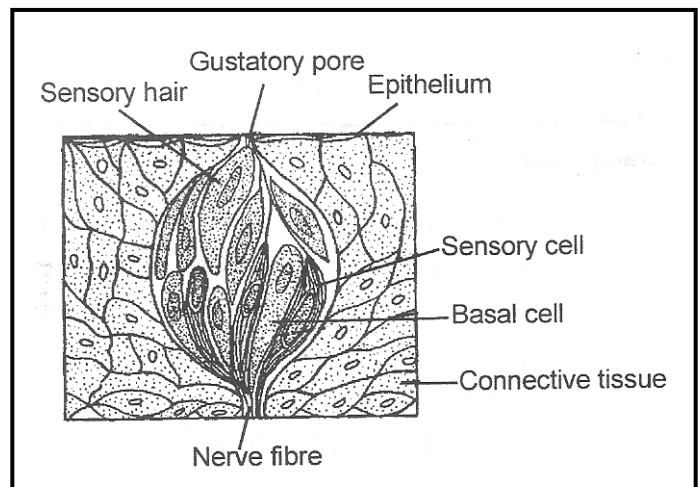
A thick, muscular and movable organ, the tongue is found in the mouth cavity. Tongue bears four types of small papillae which are provided with taste buds. Taste buds are much numerous in the circumvallate and foliate papillae. Taste buds are formed by the transformation of epithelial cells of the tongue. A taste bud possesses two types of cells -

1. **Supporting Cells** : These cells are elongated in middle region they do not bear sensory hairs at their free ends.

2. **Sensory cells** : - These cells are elongated, buldge in middle part, they bear sensory hair at their free ends.

Each taste bud is flask or barrel shaped. It's upper part opens at the epithelial surface of the tongue through a fine pore. These sensory hairs , exposed to outside through the gustatory pore are stimulated by the food substances. The sensory cells are chemoreceptor in nature and taste the food while it is dissolved in saliva. Food substances get mixed with saliva to enter into the pores of taste buds (Fig.).

In human different regions ns of the tongue are sensitive to different taste. Anterior and free end of the tongue are sensitive to sweet and salty, lateral sides to soury taste, while the posterior part is particularly sensitive to bitter taste.



Types of receptors

General Senses -

Touch	—	Tangoreceptors (Thigmoreceptor)
Temperature	—	Thermoreceptor
Heat	—	Caloreceptors
Cold	—	Frigidoreceptors
Pain	—	Algesireceptors
Current of water	—	Rheoreceptors
Electric current	—	Galvanoreceptors
Gravity	—	Georeceptors
Muscle position	—	Proprioreceptors
Equilibrium	—	Statoreceptors
Hunger, thirst etc.	—	Interoceptors
Blood pressure	—	Baroreceptors
Osmotic pressure	—	Osmoreceptors
Chemical changes	—	Chemoreceptors
Vibration	—	Vibroreceptors

Special Senses

Vision	—	Photoreceptors
Hearing	—	Phonoreceptors
Smell	—	Olfactoreceptors
Taste	—	Gustatoreceptors

- (1) Receptors of vision, hearing and smell receive stimuli from distance, hence called teloreceptors.
- (2) Tangoreceptors or mechanoreceptors
 - (i) Merkel's disc (Corpuscles) : Epidermis of non hairy (glabrous) skin, shallow cup shaped disc.
 - (ii) Meissner's corpuscle : Dermis of skin of the finger tip, lips and nipples . Sence of touch and gentle pressure.
 - (iii) Pacinian corpuscle : Present in subcutaneous tissue of palm, sole of finger etc. stimulated by strong pressure contact.
 - (iv) Corpuscles of Golgi : Subcutaneous tissue of fingers.
 - (v) Corpuscles of mazzoni : Sub cutaneous tissue of fingers.
 - (vi) Grandy's corpuscles : Beak of birds
 - (vii) Herbst corpuscles : Mouth part of birds
 - (viii) Free nerve ending : Present of skin, perceive the sensation of touch.
- (3) Thermoreceptors
 - (i) Ampullae of lorenzini : Scoliodon (Fishes)
 - (ii) Organ of ruffini : Caloreceptor - Heat
 - (iii) End bulb of Krause : Fridoreceptor – cold
- (4) Tactile receptors in mammals are maximum on face
- (5) Current of water : Rheoreceptors lateral line sense organ in fishes and amphibian of tadpole detect the water current

Misc. Point :

1. Minimum distance for proper vision of eyes is **25 cm**.
2. Anterior – posterior diameter of eyeball is **17.5mm** at the time of birth normally and in adults it is **20-21mm**.
3. The best colour differentiation is found in **primates** (Advanced mammals)
4. In the retina of man's eyes there are found **1110 -1125 lacs rods** and **65 lacs cones**.
5. Healthy eye of a person can see clearly from **12 inch** to **20 feet**.
6. Image of object is formed on retina and it is always **inverted & real**
7. Hyalocytes cells are found in vitreous humor.
8. Ciliary body secretes aqueous humor and vitreous humor.
9. In frog and other amphibians sclerotic layer of eyeball is **Cartilaginous**
10. The largest eyes are found in **deers** in vertebrates with respect to body surface area.
11. The lens of man's eye ball has its diameter of **11 mm**.
12. Circular canal present in limbus is called **Canal of Schlemm**.
13. Atropine , Beladona and Cocaine medicines are used to **dilate** the **pupil**
14. In a newborn child , eye balls are very small, i.e. babies are always very much hypermetropic.
15. Cornea and lens of eye lack blood supply.
16. Eyes are most sensitive to the light having approx 5000 Å **wavelength**.
17. Internal or inner ear of rabbit is originated by **ectoderm** of embryo and middle ear (Bony part-mesodermal) and Eustachian tube are originated by **endoderm** layer of embryo.
18. Frog's vision is **hypermetropic** in **water** and **myopic** on **land**.
19. Light sensitive organ was discovered by **Steven**.
20. Gland of moll are modified sweat gland.
21. **Stye** is infection of gland of **zeis**
22. The relationship of receptor to bipolar cells to ganglion cells is **1:1:1** within the fovea.
23. From the fovea to the periphery , cones diminish and rods increase in number.
24. Electrical activity of retina is recorded in sequence of potential change known as electroretinogram.
25. The horizontal cells which transmit signals horizontally in the outer plexiform layer from the rods and cones to the bipolar cell dendrites.
26. The bipolar cells which transmit signals from the rods, cones and horizontal cells to the inner plexiform layer where they synapse with ganglion cell and Amacrine cells.
27. The Amacrine cells which transmit signals in two directions directly from bipolar cells to ganglion.