SENSORY ORGANS

Animals possess some specialised structures to perceive the different type of changes (stimuli) occurring in their external environment. These structures are known as sense organs.

After receiving these stimuli, sensory organs transmit these to the central nervous system through the sensory nerve fibres.

A sensory organ is only sensitive to a specific kind of stimulus to which it is specialized like temperature, chemicals, touch, light etc. Based on their location in the body, sensory organs are of three types :

1. **Exteroceptors :** These sense organs receive stimuli from external environment because they remain in contact with the external environment.
   Example- nose, eyes, tongue, ears and skin .
   - Eye, ear and nose are also called "teleoreceptors", because they receive impulse from far places.
2. **Interoceptors :** These sensory organs are associated with internal environment of body and receive the changes taking place in the internal environment.
   Examples- changes in the composition of blood, concentration of carbon-dioxide, hunger, thirst (osmoreceptor), asphyxia etc.
3. **Proprioceptors :** These sensory organs are present in joints, tendons, muscles and connective tissues which perceive the tension and pressure exerted during the activities of equilibrium maintenance and orientations of body.

In human body, five types of exteroceptors are found which are known as sense organs. The main sense organs include skin, eye, nose, ear and tongue.

EYE (Photoreceptor)

- These are photosensitive organs.
- Each eye is an hollow ball like round (Nearly spherical) structure called eye ball. Each eye - ball is situated in the notch of lacrymal bone in the skull. It is called "Eye - orbit". Human eyes are situated in eye orbit lateral to nose.
- Only $1/5^{th}$ part of whole eye is visible from out side in between the eye lashes. Remaining $4/5^{th}$ part is in the eye orbit.

(1) Eye lido or palpebrae :-

- There are two muscular eyelids for the protection of eye. These bear eye lashes at their free surface. Both the eyelids are named according to their situation i.e. upper & lower eyelids.
- There is present one more transparent membrane in the eye. It is called nictitating membrane or third eye lid. It is found constricted at one corner of eye ball, but at the time of need, it may be expanded over entire eye ball.
- Nictitating membrane is vestigeal in human. It is also called "Plica semilunaris" .

(2) Glands :- For the cleaning and for lubrication/moisturising the exposure part of eye.

(3) Muscles of eye balls :-

There are present 6 skeletal muscles in the eyeball which help in rotation of eye ball within the eye orbit. Out of these 4 are rectus muscles and 2 are oblique muscles. They are also called as extra occular muscles.

- Lateral or External rectus muscle rotates the eyeball towards outside i.e. from nose to ear. Medial or Internal rectus muscle rotates the eyeball toward inside i.e. from ear to nose.
- Superior rectus muscle and inferior oblique muscle collectively help the eyeball to rotate upwards.

- Inferior rectus muscle and superior oblique muscle collectively help the eyeball to rotate downwards.
- Rectus and oblique muscles collectively rotate the eye ball to all the sides around its axis.
- Any defect in one of the these eyeball muscles (e.g. muscle may remain small or extra large than required) causes strabismus or squint eyes. In this defect, eye ball remains inclined to any of the one side. Eye muscles are innervated by Oculomotor (III), Trochlear (IV) and Abducens (VI) nerve.

INTERNAL STRUCTURE OF EYE BALL

The wall of remaining eye ball has three layers.

(1) Fibrous tunic :-

It is the outermost covering of eye ball. It is made up of hard and thick connective e tissue.

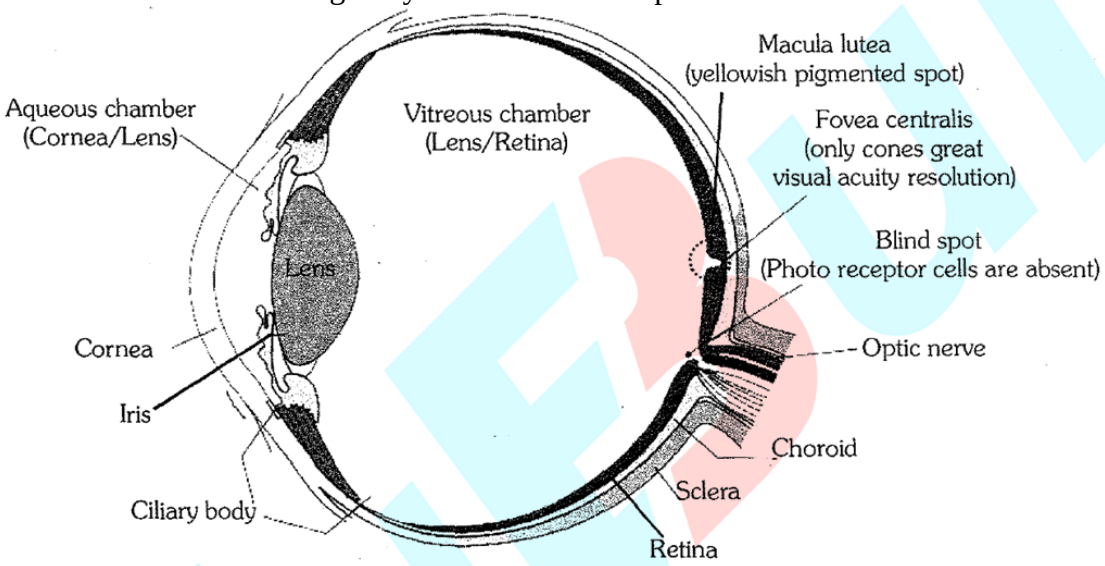


Diagram showing part of an eye

The layer is divided into 2 parts.

(a) Cornea :-

It is the outer visible part of fibrous tunic, covered by Non keratinized stratified squamous epithelium.

- The joint between cornea and sclerotic layer is called "Limbus" or "Sclero - corneal junction". Cornea transplantation is successful because it lacks blood vessels.

(b) Sclerotic layer/Sclera :-

It is made up of white, hard, opaque thick fibrous connective tissue in human. It is the inner portion of eye ball. It is non-vascularised. This layer is of white colour, so it is also called "White of eye".

- Inner layer of eyelids streched over anterior part of sclera is called conjunctiva. Conjunctiva is the thinnest epidermis in animal body.

(2) Vascular tunic :-

It is the middle layer of eyeball. It is coloured part of eyeball. It is richly supplied with blood capillaries. Due to the presence of network of blood capillaries it is highly vascularized.

Melanin pigment is found in this layer. Due to the presence of melanin pigment in man eyes may be brown, black, blue, green according to the melanin present in it.

This layer has three parts :-

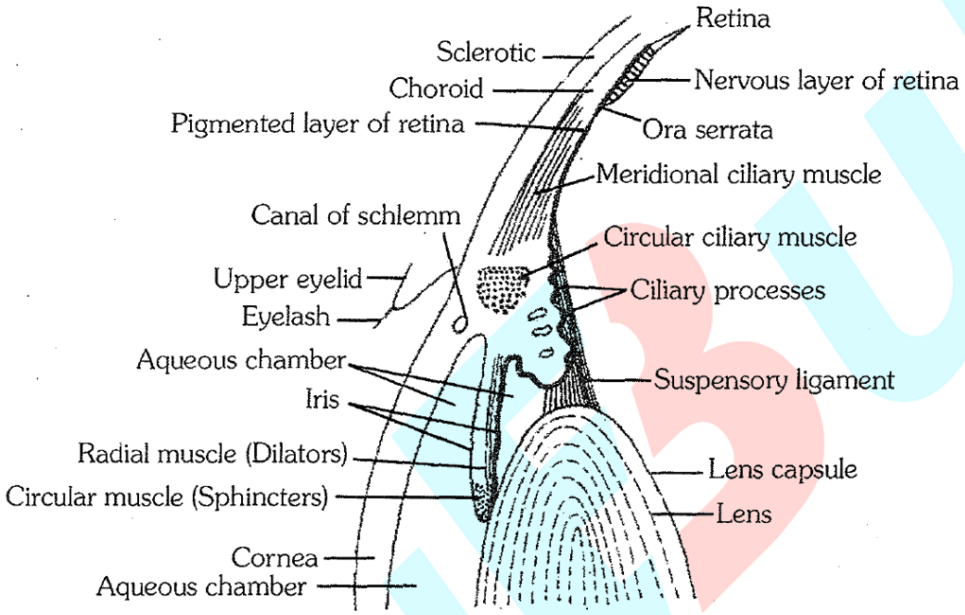
(a) Choroid layer :-

Choroid layer is the part of vascular tunic which lie below the sclerotic layer.
It contains abundant pigment cells, blood vessels and look bluish in colour.
It darkens the cavity of eyeball to prevent internal reflection of light.
It nourishes the retina.

(b) Ciliary body :-

It is the lower swollen portion below limbus.
It has ciliary processes which project into eyeball.
It has ciliary muscles (i) circular (ii) meridional.

(c) Iris :-



Choroid layer or vascular tunic separates from sclerotic layer (Just after the cornea) inclines towards inner side and forms a coloured screen, it is called iris. Muscles of iris are ectodermal in origin where as the muscles of body are mesodermal in origin. There is present an aperture in the Centre of iris, it is called Pupil. Light rays enter in the eyeball through pupil.
2 types of muscles are related with iris.

(a) Radial dilatory muscles :-

These are outer unstriated muscles, these are expanded in the iris breadth wise. Iris becomes constricted if these muscles contract and diameter of pupil is increased at that time. It happens in dim light, it is called Mydriasis.

(b) Circular sphincter muscles :-

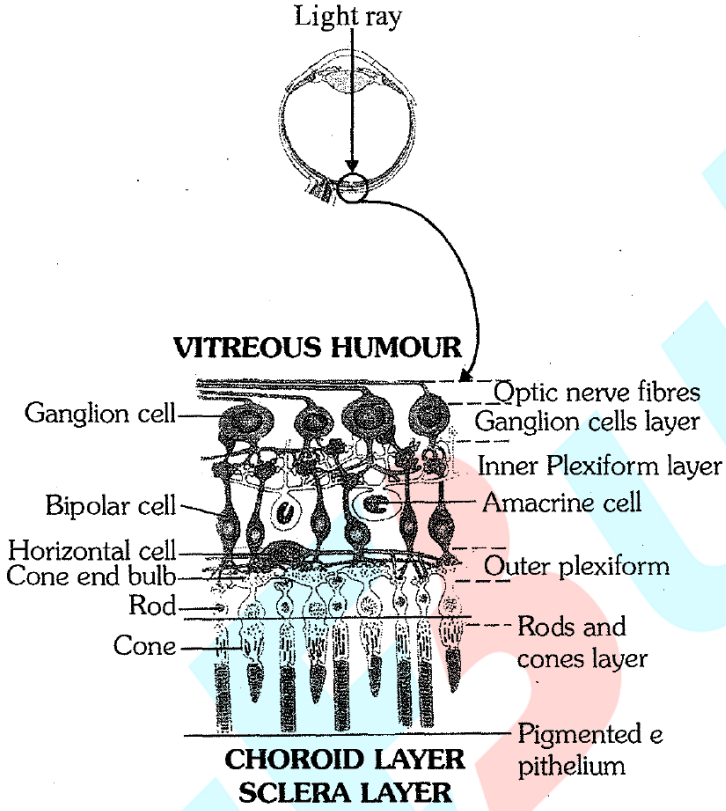
These are scattered in inner part of iris. Due to the contraction (In bright day light or high flashes of light) of these muscles in high light, Iris expands breadth wise and diameter of pupil is decreased. It is called Miosis. Iris controls the intensity of light by increasing or decreasing the diameter of pupil i.e. Iris acts as diaphragm of a camera. Except muscle of iris & ciliary body all vascular tunic of eye ball is mesodermal in origin. The parasympathetic fibres constrict & sympathetic fibre dilate the pupil.

(3) Neurosensory tunic :-

It is the inner most layer of eye ball :-

(a) Pigmented layer :- It is the outer most layer. In the cells of this layer, pigment is found called melanin (receptor cells).

(b) Sensory layer :- This layer is made up of specialized sensory cells. Rods and cones are found in this layer. Receptor cells are also known as photoreceptors/visual cells.



- Rods are long, thin, cylindrical structures/cells. These are numerous in number. **(1200 Lacs)**
- Rods differentiate between light and dark. These are more sensitive than cones.
- A purple coloured pigment is found in rods called **Rhodopsin/Visual** purple.
- Cones are thick and small cells which differentiate among different colours in full light. **(65 Lacs)**
  Iodopsin/Visual violet is present in cones.
- A horizontal neurons layer is present just below the rods and cones, it is called **outer plexiform** layer. This layer connects rods and cones together.
- Then comes the layer of bipolar neurons. Each bipolar neuron has a dendron and one axon. Presence of bipolar neurons is a specialty of retina. Rest parts of body have multipolar neurons. Their dendrites form synapses between rods & cones.
- Axons are jointed together by specific nerve cells, called **Amacrine cells.** Such neurons do not have nerve fibre.
- The layer of amacrine cells is called **"Inner plexiform layer".**
- Between bipolar neurons, supporting cells are found and called **Muller's cells.**

(c) Ganglionic layer :- This layer is made up of nerve ganglia. These nerve ganglia form synapses with axons of bipolar neurons.

Axons of all nerve cells combine to form optic nerve. This optic nerve penetrates the retina and goes to brain.

The optic nerves leave the eye and the retinal blood vessels enter it at a point medial to and slightly above the posterior pole of the eye ball. Photoreceptor cells are not present in that

region and hence it is called the blind spot. At the posterior pole of the eye lateral to the blind spot. there is a yellowish pigmented spot called macula lutea with a central pit called the fovea. The fovea is a thinned-out portion of the retina where only the cones are densely packed. It is the point where the visual acuity (resolution) is the greatest.

- Neurosensory tunic or retina of eye ball is ectodermal in origin.
- **Lens :-** A transparent, ectodermal, biconvex lens is present just after iris. Lens is connected by ciliary body with the help of "Suspensory ligaments" called zonula of zinn" or zonules. These ligaments are flexible and this can slide the lens and can change it's focal length. Lens divides the cavity of eyeball into two chambers.

(a) Aqueous chamber :-

The part of eye ball which lies between cornea and lens is filled with an alkaline fluid, it is called aqueous humor. It is a type of transparent tissue fluid.

Iris divides this aqueous chamber into two parts :-

(i) Anterior chamber :-

This chamber lies between cornea and iris, it is called Venous chamber. Veins carry CO_2, metabolic wastes outside from here.

(ii) Posterior Chamber :-

This chamber lies between iris and lens, it is called arterial chamber. Arteries supply O_2 and nutrients here.

(b) Vitreous chamber :- Cavity of eye ball which lies between lens and retina is called vitreous chamber. A jelly like fluid (transparent and thick like albumin) is filled in this chamber, This is called vitreous humor .

- In this fluid 99% water, some salts, a mucoprotein called vitrin and a mucopolysaccharide-Hyaluronic acid are present. Gelatinous nature of vitreous humor depends upon fibrillar protein & hyaluronic acid. It is form during embryonic stage. In this chamber Hyalocytes cells are found.
- Aqueous humor and vitreous humor both the fluids are secreted by the ciliary body. Aqueous humor leak out by canal of schlemm into blood capillaries and again reach upto their veins.
- Both these fluid maintain proper pressure inside the cavity of eye ball. These check the eye ball from collapsing. If this canal of schlemm is blocked by any reason and fluids do not return back to veins, the fluid is increased in the chambers of eye.
- When amount of this humor is increased in the eye chambers then pressure is increased inside the eye ball. Thus retina pressure is increased. This is known as glaucoma.

GOLDEN KEY POINTS

- Conjuctiva is thin epidermis, vascular and absent at central part of cornea.
- Cornea is avascular part, it obtain oxygen from environment and aqueous humor.

WORKING OF EYES

- Light rays emitted by any object enter the eye. A small, real and inverted image of object is formed at retina. Sensory cells of retina are sensitized, and optic nerve carries this impulse to brain. At this time animal is able to see the object.

- Cornea, aqueous humor and biconvex lens completely refract the light rays coming from object. As a result of this an inverted image is formed at retina.
  Just like diaphragm of a camera, iris of eye decreases or increases the diameter of pupil according to light. Iris expands to decrease the pupil in high intensity of light so a small amount of light touches the retina. When light is dim, iris itself constricts to increase the diameter of pupil.

ACCOMMODATION OR FOCUSSING -

The ability to change the focal length of lens by changing the curvature of lens, is called accommodation power. Only mammals and birds have this accommodation power in their eyes.

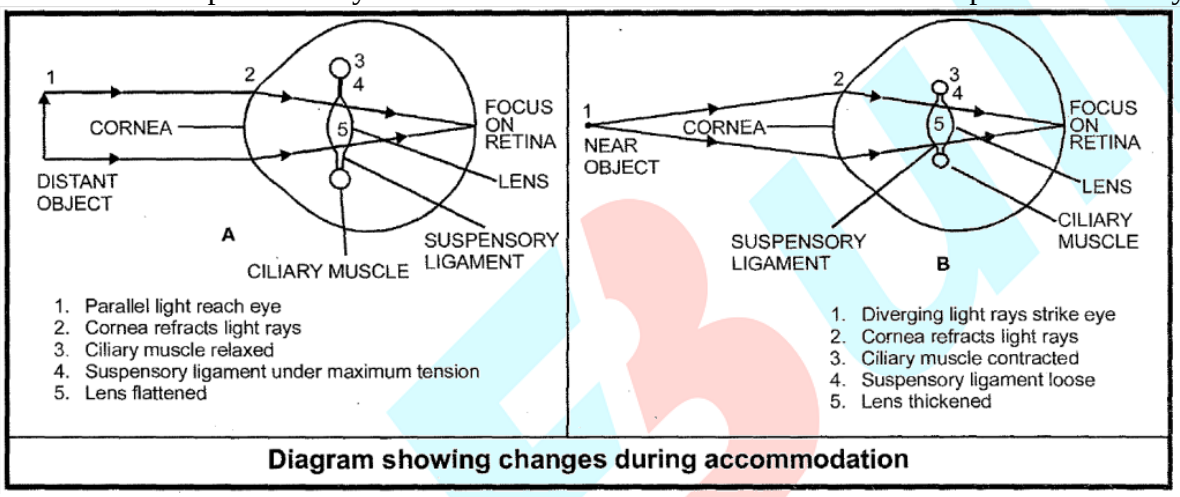


Diagram showing changes during accommodation

- In normal condition muscle fibres of ciliary body remain relaxed and lens is stretched by its suspensory ligaments, and due to this lens is flat. A flat lens has more focal length. As a result of this eye can see long distant objects easily.
- To see near by objects, sphincter muscles of ciliary body contract and ciliary body becomes broad, suspensor ligaments becomes loose and relaxed. As a result of this relaxation of ligament, lens becomes biconvex and now its focal length is reduced. Now animal is able to see near by object easily.

Chemical explanation of vision -

Mechanism of Vision

- The light ravs in visible wavelength focussed on the retina through the cornea and lens generate potentials (imoulses) in rods and cones.
  As mentioned earlier, the photosensitive compounds (photopigments) in the human eves is composed of opsin (a protein) and retinal (an aldehvde of vitamin A).
  Light induces dissociation of the retinal from opsin resulting in changes in the structure of the opsin.
  This causes membrane permeability changes. As a result potential differences are generated in the photoreceptor cells. This produces a signal that generates action potentials in the ganglion cells through the bipolar cells.
  These action potentials (impulses) are transmitted by the optic nerves to the visual cortex area of the brain. where the neural impulses are analvsed and the image formed on the retina is recognised based on earlier memory and experience.

- Retinal is formed by vitamin-A so deficiency of vitamin A causes night blindness.
- Cones able us to differentiate among colours and bright light. Cones have a pigment called Iodopsin in place of rhodopsin of rods. It is decomposed into photopsin and retinal.
  There are three types of cones in retina:-
  (a) Erythrolab - Red cones
  (b) Chlorolab - Green cones
  (c) Cynolab - Blue cones
- We are able to acknowledge different colours due to these three types of cones and their combination.
- Red, Green and Blue are the primary colours.
  Dimlight vision - Scotopic vision (Twilight vision)
  Bright light vision - Photopic vision (Daylight vision)

Some important defects of eye :-

1. Hypermeteropia (far sightedness):-

- In this defect of eye, person is able to see objects placed at far distance but is unable to see objects close to him or her.
- This defect is due to small size of eyeball or flatness of lens. In this defect image is formed behind the retina. To cure this defect person should wear convex lenses in spectacles.
- Sometimes in old age this defect may occur due to reduction in the flexibility of lens or ciliary body, then, it is known as presbyopia.

2. Myopia or Nearsightedness or short sightedness :-

- In this defect of eye, person is able to see objects near/close to him or her but is unable to see objects placed at far distance.
- This is due to enlargement of eyeball or increased convexity of lens.
- In this defect image is formed before the retina because light rays coming from distant objects converge before retina.
- To overcome this; defect person should wear concave lenses in spectacles.

3. Astigmatism :- In this defect curvature of cornea is changed as a result of that light rays do not focus on macula lutea but somewhere else, causing incomplete and blurred vision. This defect may be cured by cylindrical lenses.

4. Night blindness :- This is due to deficiency of vitamin A. In this disorder synthesis of Rhodopsin is reduced, as a result of this person is unable to see in dim light or night.

5. Xerophthalmia :- It is due to keratinisation of conjunctiva and cornea, and conjunctiva becomes solid. It is also due to deficiency of vitamin A.

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 veins again as a result pressure is increased in eye chambers and retina is damaged, and person becomes totally blind.

BEGINNER'S BOX-1

1. The inner layer of eyeball retina and it contains three layers of cells from outside to inside.
(1) Sclera, Choroid, Retina
(2) Photoreceptor, Amacrine, Bipolar
(3) Photoreceptor, Bipolar, Ganglion
(4) Ganglion, Bipolar, Photoreceptor

2. Mark the vitamin present in Rhodopsin
(1) Vitamin A
(2) Vitamin B
(3) Vitamin C
(4) Vitamin D

3. Human eyebal consists of three layers and it encloses
(1) Lens, iris, optic nerve
(2) Lens, aquous humor and vitreous humor
(3) Cornea, lens, iris
(4) Cornea, lens, optic nerve

4. Iris is a part of -
(1) Retina only
(2) Choroid only
(3) Sclera only
(4) Cornea only

5. Sensitive pigmented layer of eye is -
(1) Retina
(2) Cornea
(3) Sclera
(4) None of these

6. Blind spot has -
(1) Cones but no rods
(2) Rods but no cones
(3) No rods and cones
(4) Cones and rods

7. Which of the following statement is correct ?
(1) Rods contain a purplish-red protein called rhodopsin/visual purple
(2) Rhodopsin is a derivative of vitamin-A
(3) The twilight (scotopic) vision is a function of the rods
(4) All the above

8. The path of light enlaring into the eye -
(1) Ganglion cell layer - Horizontal cell - Amacrine cell - Photoreceptor cell
(2) Ganglion cell layer - Bipolar cell layer - Photoreceptor cell
(3) Bipolar cell layer - Ganglion cell layer - Photoreceptor cell
(4) Photoreceptor cell - Bipolar cell layer - Ganglion cell layer

EAR (Stato - Acoustic organ)

These are also called phonoreceptors.

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

Functions of ears :-

(1) To receive sound waves (hearing)

(2) To maintain body balance, main function of ear is to maintain the balance of body.

Structurally, ear may be divided into three parts :-

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

(a) External ear

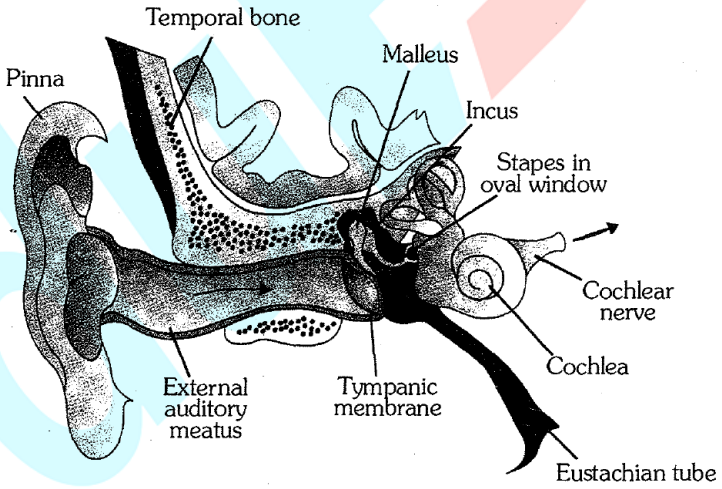
It is the outer part of ear. It is well developed in mammals only. External ear may be divided again into 2 parts

(i) Ear pinna (ii) Ear canal

(i) Ear pinna :- These may be small or large, fan like structure, important feature of mammals, nut absent in whale, seal, Ornithorhynchus etc. the skin of ear pinna is hairy. These are having yellow elastic cartilage. A man can not move his pinna. Muscles of man's ear pinna are vestigial. Pinna covers some of the ear canal, this part is called choncha.

(ii) Ear canal or External auditory meatus :- It is a 2.5 cm long canal which is expanded from base of pinna to inner side.

- Apart from mammals, birds and reptiles also have ill or less developed ear canal.
- At the end of ear canal a stretched, thin, obliquely placed membrane is present, it is called ear drum or tympanic membrane. It separates the ear canal there are found sebaceous glands and modified sudoriferous 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 ossicle/ bone pulls it towards tympanic cavity by tensor tympani muscle.
- Ear drum is a part of middle ear.



Diagrammatic view of ear

(b) Middle ear

Middle ear consists of tympanic cavity, which is filled with air. This cavity is covered by a flask like bone called tympanic bulla. This bone is a part temporal bone of skull.

- Middle ear cavity is connected by phyaryngeal 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 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 (ovalis (oval window) and
(ii) Spherical aperture fenestra rotundus (round window). A thin and firm membrane covers each aperture.

- Three ear ossicles (small bones) are present and arranged in a chain with movable joints connected together in tympanic cavity. These ear ossicles are :-

(i) Malleus :-

- It is situated towards outer ear.
- It is the largest of three bones and of hammer shaped.
- Malleus and incus are joint together by synovial hinge joint.

(ii) Incus :-

- The incus is anvil shaped.
- Its outer broad part is connected by malleus and inner thin part is connected by stapes.
- Incus is joined by stapes by ball and socket joint.

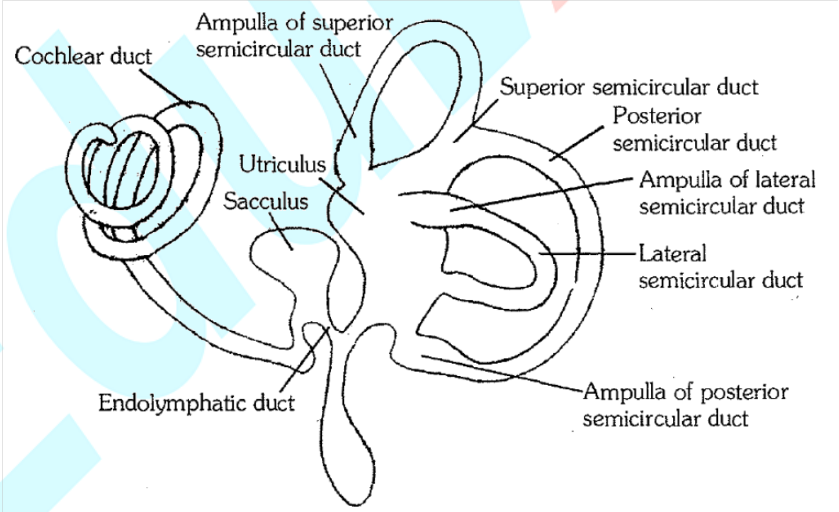
(iii) Stapes :-

- It looks like stirrup of horse.
- 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.
- 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.

(c) INTERNAL EAR

The fluid-filled inner ear called labyrinth consists of two parts, the bony and the membranous labyrinths. The bony labyrinth is a series of channels. Inside these channels lies the membranous labyrinth, which is surrounded by a fluid called perilymph. The membranous labyrinth is filled with a fluid called endolymph.



Scheme of "Membranous Labyrinth"

INTERNAL STRUCTURE OF VESTIBULAR AND COCHLEAR APPARATUS

Vestibular apparatus

- It is sensory part for balancing, located above the cochlea.
- It is consist of (i) three semi-circular canal (sec)
  (ii) one utriculus

(iii) one sacculus

- Each semi-circular canal lies in different plane at right angle to each other.
- The base of canal is swollen structure called Ampulla which contain projecting ridge called crista Ampullaris (Crista) which has hair cells.

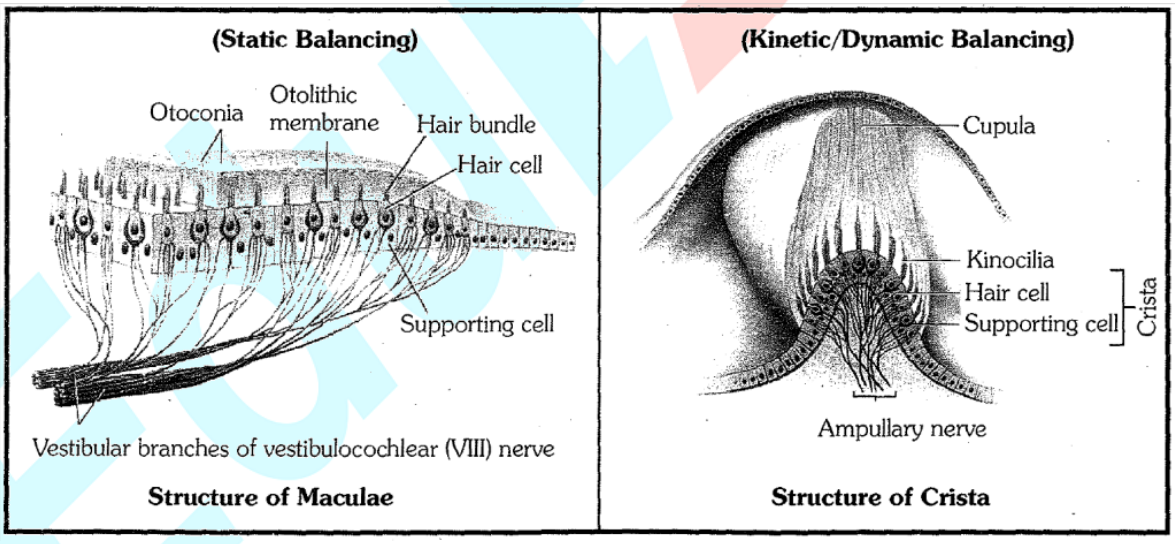
Internal Structure of Ampulla

In this ampulla, internal cuboidal epithelium forms a ridge like projection called acoustic ridge. It is formed of small immovable microvilli found at the free edges of sensory cells of acoustic ridge. These are called stereocilia. Along with these, there are found single movable cilium called kinocillium.

Otoconia are absent in crista of ampulla. All the microvilli of ridge are bind together like a bag and form cupula.

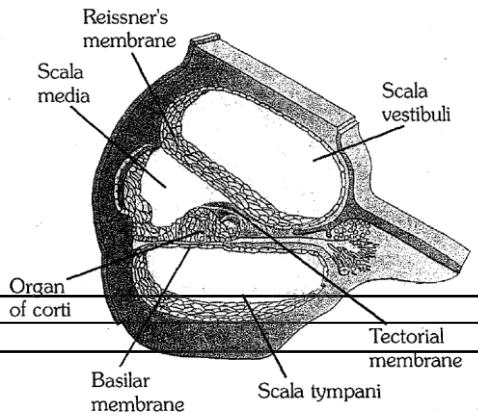
Internal Structure of Macula

- The utricules and sacculus contain a projecting ridge called Macula.
- One structure each is present in utriculus and one in sacculus, these are called Maculae. Numerous $CaCO_3$ particles are found in endolymph these are called Otoconia.
- These sensory cells situated in internal ear are in contact with small nerves. All these nerve combine to form vestibular nerve (branch of auditory nerve).
- The crista and macula are the specific receptors of the vestibular apparatus responsible for maintenance of balance of the body and posture.
- Cristae control and maintain body equilibrium at the time of movement and maculae regulate this at static position.



(d) COCHLEA

- It is sensory structure for hearing.
- It is coiled structure present below vestibular apparatus.
- The cochlea in cross section show 3-canals :
  (i) Scala vestibuli - It is situated at dorsal side and filled with Perilymph.



Diagrammatic representation of the sectional view of "Cochlea" (NCERT)

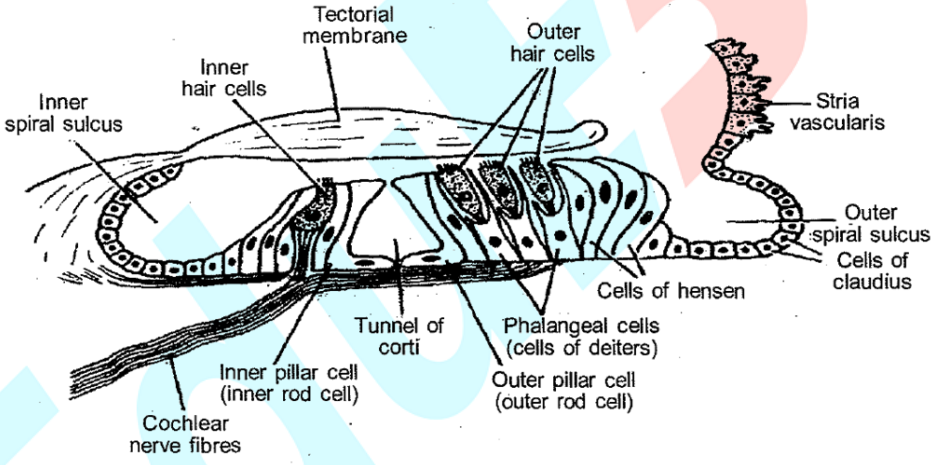
(ii) Scala media - It is situated between the scala vestibuli and scala tympani. It is filled with Endolymph.

(iii) Scala tympani - It is situated at the ventral side below the scalamedia. It is filled with Perilymph.

- The membrane of the roof of scala media which separates scala vestibuli from scala media is call Reissner's membrane. The membrane at the floor of scala media, which separates scala media from scala tympani is called basilar membrane of the base.
- At the base of the cochlea, the scala vestibuli ends at the oval window, while the scala tympani terminates at the round window which opens to the middle ear.

Internal Structure of Cochlea & Cochlear Canal

- The organ of corti is a structure located on the basilar membrane which contains hair cells that act as auditory receptors.
- The hair cells are present in rows on the internal side of the organ of corti.
- The basal end of the hair cell is in close contact with the afferent nerve fibres that forms cochlear nerve branch.
- A large number of processes called stereo cilia are projected from the apical part of each hair cell.
- Above the rows of the hair cells (organ of cortil is a thin elastic membrane called tectorial membrane.
- Main credit of hearing goes to " Organ of corti".



ORGAN OF CORTI

(e) WORKING OF EAR :-

♦ Ears are stato - acoustic organs of body. Thus these help the body to hear and balancing the body.

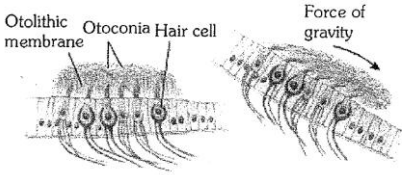
(a) Equilibrium :- The first and basic function of ears is to maintain balance of body .

♦ 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



Static Balancing

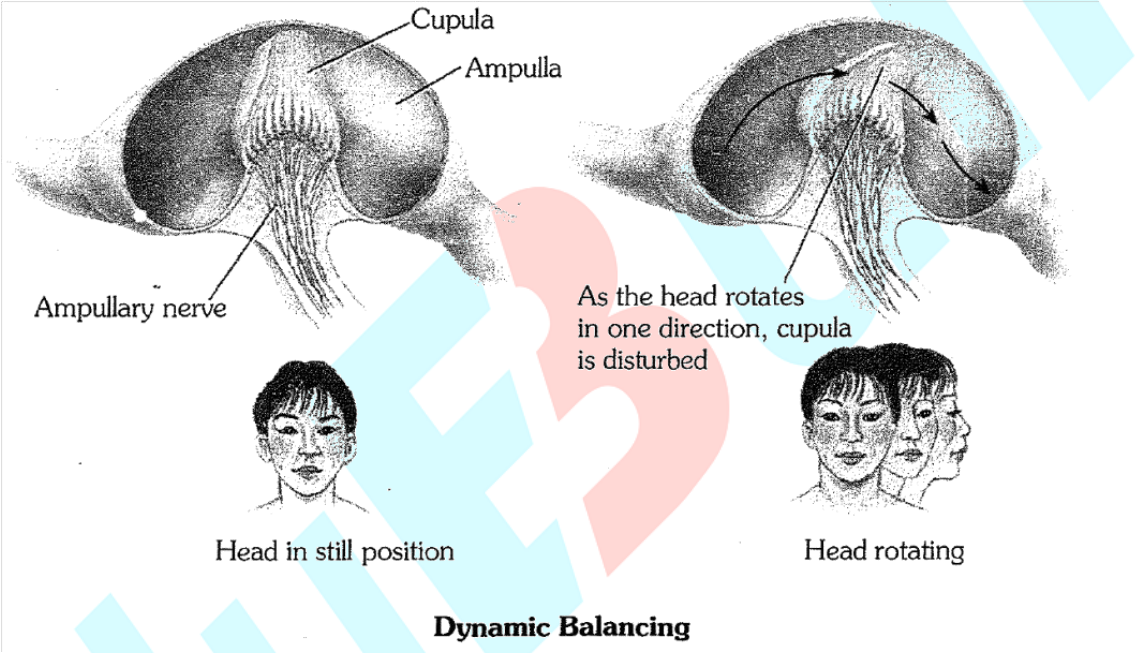
♦ Sensory hair of ridge are sensitized by otoconia or otolith or ear dust. These sensations or impulses are carried to brain by auditory nerve After this, messages of appropriate reactions are send through motor fibres to the skeletal muscles of the body.

(ii) Dynamic balancing :-

♦ It is the action to maintain balance of body during movement.

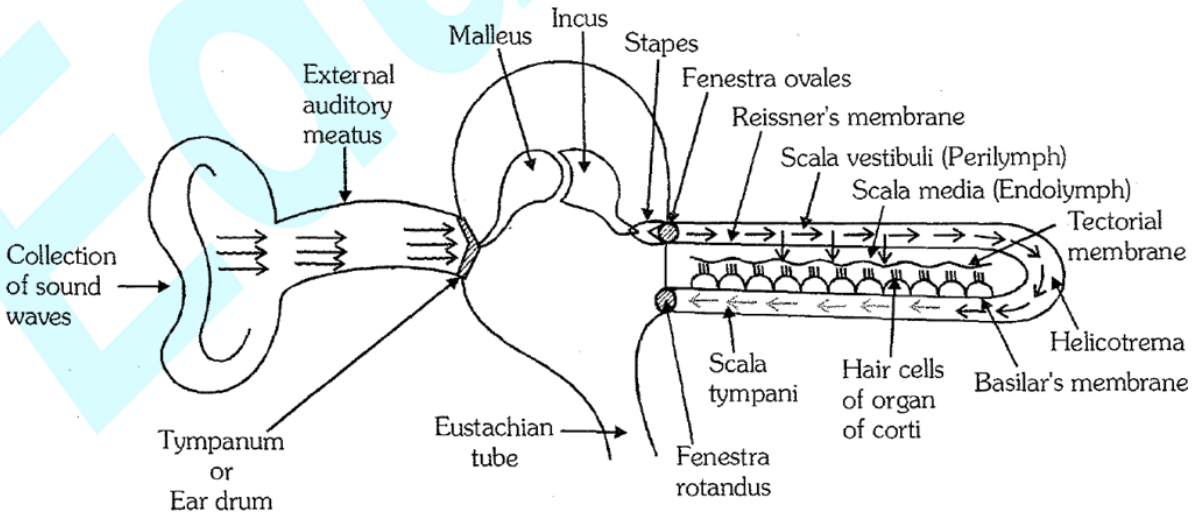
♦ This act is done by sensory ridges of ampula of semicircular canals.

♦ At the time of movement the endolymph of am pula produces waves in it. Cupula of am pula 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.



Dynamic Balancing

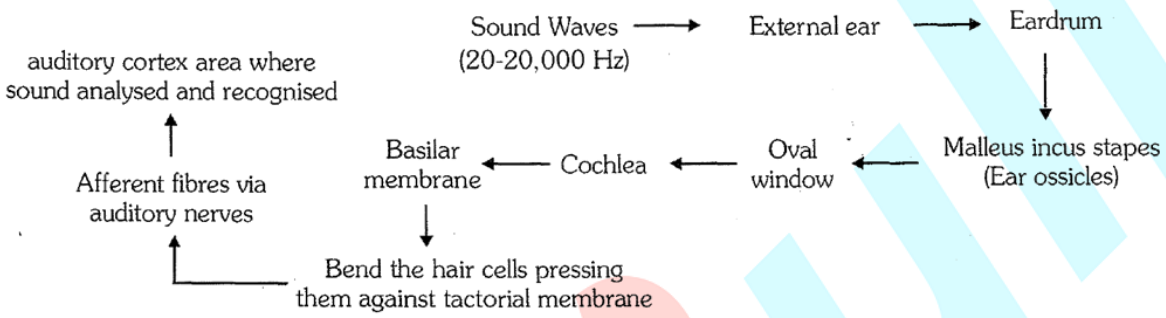
(b) Hearing :-



♦ 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. These ossicles increase the efficiency of transmission of sound waves to the inner ear.
- As a result of this travelling (from ear drum to fenestra ovalis) sound waves become more strong.

Mechanism of hearing



- When the membrane of fenestra ovalis starts vibrating, perilymph of scala vestibuli 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 vibrating. These vibrations travel through endolymph 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 tectorial membrane. Now timulation of hearing takes place.
- Cochlear nerve carries this impulse to brain through auditory nerve. Appropriate massages are send to receptor organs by brain accordingly.
- Vibrations I 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.

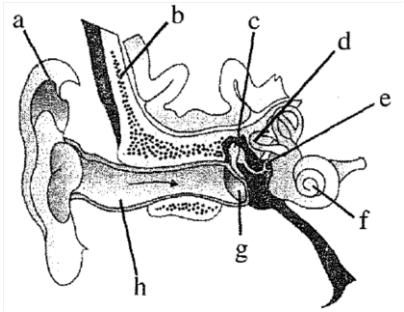
BEGINNER'S BOX-2

1. Wax gland present in the ear canal is called
(1) Sweat gland (2) Prostate gland
(3) Cowper's gland (4) Sebaceous gland/cercuminous gland

2. The part of internal ear responsible for hearing is
(1) Cochlea (2) Semicircular canal (3) Utriculus (4) Sacculus

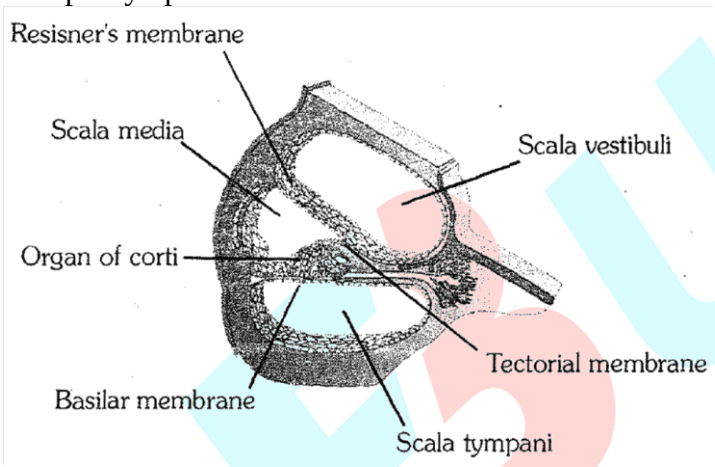
3. The organ of corti is a structure present in
(1) External ear (2) Middle ear (3) Semi circular canal (4) Cochlea

4. In the given figure identify the part of ear which is responsible for hearing and contains organ of corti



(1) c, d, and e (2) Only g (3) Only f (4) All of these

5. The given figure describes the sectional view of cochlea. In th given figure identify the parts which are filled with perilymph.



(1) Scala media (2) Scala vestibule (3) Scala tympani (4) Both (2) and (3)

6. Dancers and sports person are able to mintain their proper body position by using their internal sense of balance. Sensing of this sort of body's internal condition and position is performed by:-
(1) Organ of corti (2) Crista (3) Macula (4) Otolighic organ

7. The base of membraous canals is swollen and is called ampulla which contains a projecting ridge called:-
(1) Otilith (2) Otoconia (3) Macula (4) Crista ampullaris

8. "Organ of Corti" is found in -
(1) Scala rotundes (2) Scala media (3) Scala vestibule (4) Scala tympani

SPECIAL POINTS

1. The best colour differentiation is found in primates (Advanced mammals).
2. In the retina of man's eyes there are found 1110 - 1125 lacs rods and 65 lacs cones.
3. Image of object is formed on retina and it is always inverted & real.
4. Ciliary body secretes aqueous humor and vitreous humor.
5. The largest eyes are found in deers in vertebrates with respect to body surface area.
6. Atropine, Beladona and Cocane medicines are used to dilate the pupil.
7. Cornea and lens of eye lack blood supply.
8. Eyes are most sensitive to the light having approx 5000 Å wavelength.
9. From the fovea to the periphery, cones diminish and rods increase in number.

10. Electrical activity of retina is record in sequence of potential change known as electroretinogram.

11. The eyes of some animals shine at night, because in the eyes of these animals, there is a pigment just outside the retina in the choroid layer of eyeball, which reflects the light rays coming from retina. This layer is called Tapetum. Due to this layer, these animals are capable to see in dark also.

- Kangaroo, hoofed mammals, elephants, whales etc. are having a silver shining layer of fibrous connective tissue called Tapetum fibrosum.
- In Elasmobranch fishes a reflecting colour pigment called Guanine is present in tapetum layer so it is called tapetum lucidum.
- Hunters and carnivorrus mammals like dogs, cats, tiger etc. have a layer in their retina called tapetum cellulosum.

12. In the eyes of birds pecten is found, which help in accomodation.

13. **TYPES OF VISION :**

(a) **Monocular vision or panoramic vision :-** Most of the vertebrates have their eyes situated on the lateral sides of head and due to this animal is capable to see large area of both the sides. It is called monocular vision. e.g. rabbit, frog, horse (Most of the herbivorous animals have this type of vision)

(b) **Binocular vision :-** Most of the carnivorous mammals have eyes in front of their heads and side by side, so as to focus on one object by both the eyes. It is called binocular vision. e.g. Man, monkeys and apes.

(c) **Stereoscopic vision :-** It is three dimensional vision found in human.

(d) **Telescopic vision :-** This is found in birds due to presence of pecten.

ANSWER KEY

BEGINNER'S BOX-1

1.	(3)	**2.**	(1)	**3.**	(2)	**4.**	(2)	**5.**	(1)	**6.**	(3)	**7.**	(4)
8.	(2)												

BEGINNER'S BOX-2

1.	(4)	**2.**	(1)	**3.**	(4)	**4.**	(3)	**5.**	(4)	**6.**	(2)	**7.**	(4)
8.	(2)												

EYE

1. Aperture of an eye can be changed by:-
(1) Aquous humor (2) Vitreous humor
(3) Ciliary muscles (4) Iris

2. Which is responsible for colour detection ?
(1) Cones (2) Rodls (3) Rods and cones (4) Choroid

3. Pigmented layer in eye is called :-
(1) Cornea (2) Sclerotic (3) Retina (4) All

4. Rhodopsin is a constituent of :-
(1) Cornea (2) Choroid (3) Rods (4) Cones

5. If the source of bright light in front of eye suddenly become bright :-
(1) Pupil contract (2) Focus of lens changes
(3) Vitreous humor becomes liquid like (4) Retina blood supply is cut-off

6. Retina of the vertebrates eye consists of :-
(1) Neurons and neuroglia (2) Rods, cones, neurons and neuroglia
(3) Rods, cones and neuroglia (4) Rods and cones

7. The focal length of the lens in eye is controlled by
(1) Vitreous humor (2) Ciliary muscles
(3) Iris muscles (4) Pupil

8. Night blindness is caused due to :-
(1) Hypermatropia (2) Myopia
(3) Defective cornea (4) Deficiency of rhodopsin in rods

9. During night when the intensity of light is low, it is detected by :-
(1) Rods (2) Cones (3) Both (4) Crystalline lens

10. To correct myopia vision one should use :-
(1) Convex lens (2) Concave lens (3) Plane lens (4) None

11. Where is the cavity of vitreous humor found ?
(1) Between sclerotic and choroid (2) Infront of lens
(3) Behind lens (4) Between choroid and retina

12. Function of iris is to :-
(1) Alter diameter of pupil (2) Close eye lids
(3) Secrete aqueous humor (4) Move the lens

13. The pigment found in rods is :-
(1) Rhodopsin (2) Melanine (3) Photosin (4) Keratin

14. Which pigment helps some nocturnal animal to see at night?
(1) Haemoglobin (2) Porphyrin (3) Guanine (4) Heparin

15. Eye is most sensitive to :-
(1) 20 Å (2) 1000 Å (3) 5000 Å (4) 7000 Å

16. Area of most active vision in eye where sharp image is formed is called :-
(1) Blind spot (2) Yellow spot (3) Lens (4) Pupil

17. Blind spot in the eye is located :-
(1) In the center of pupil
(2) In the center of lens
(3) In fovea centralis
(4) Where optic nerves leaves retina

18. Lens and retina of vertebrate eye develop from :-
(1) Mesoderm
(2) Ectoderm
(3) Endoderm
(4) Partly from ectoderm and partly from endoderm

19. The common defect of eye which develops in old age is:-
(1) Glaucoma (2) Astigmatism (3) Presbyopia (4) Myopia

20. Ciliary muscles are found in :-
(1) Junction of choroid and iris in eye ball
(2) Inside larynx toregulate tension in eye ball
(3) Between ribs to assist in breathing movement
(4) At base of cilia in ciliated epithelium

21. The aperture controlling the light entering in eye is called:-
(1) Iris (2) Pupil (3) Blind spot (4) Sclerotic layer

22. Myopia is a defect in human eyes in which the image is formed:-
(1) Behind retina and can be corrected by using convex lens.
(2) Behind retina and can be corrected by using concave lens.
(3) Infront of retina and can be corrected by using concave lens.
(4) Infront of retina and can be corrected by using convex lens.

23. All bones provide support and protection to body parts which bone is different in it's function:-
(1) Ribs (2) Atlas vertebra (3) Malleus (4) Radius

24. Convex lens is used to correct:-
(1) Hypermatropia (2) Myopia (3) Cataract (4) Glaucoma

25. Owls moves freely during night since they have :
(1) Adjustable pupil
(2) Only cones in retina
(3) Only rods in retina
(4) Vitamin a deficiency

26. Which one of the following diseases in man belongs to the same category as haemophilia ?
(1) Hypermatropia (2) Rabies

(3) Night blindness (4) Colour blindness

27. Transmission of light into nerve impulse is a :-
(1) Mechanical process (2) Physical process
(3) Chemical process (4) Biochemical process

28. Colour blindness in human being is due to:
(1) Vitamin A deficiency (2) Sex linked inheritance
(3) Over activity of adrenal gland (4) Excessive drinking of alcohol

29. How many oblique and rectus muscles are found to move the eye ball in various direction inside the eye orbit?
(1) Two (2) Four (3) Six (4) Eight

30. A small region on the retina of the eye which contains only cones is called :-
(1) Area centralis (2) Fovea centralis
(3) Blind spot (4) Ora serrata

31. In man, nictitating membrane is :-
(1) Absent (2) Vestigeal (3) Non-functional (4) Functional

32. For the synthesis of rhodopsin, which of the following food is needed ?
(1) Mango (2) Rice (3) Carrot (4) Tomatoes

33. No image formation occurs on blind-spot of retina because:-
(1) It is not present of the optical axis of the eye
(2) Here cones and rods are absent
(3) On this part only cones are present
(4) The nerve fibres of this region do not contribute in the formation of optic chiasma

34. "Telescopic vision" found in :-
(1) Amphibians (2) Mammals
(3) Birds (4) None of these

35. Binocular vision found in :-
(1) Man (2) Monkey (3) Apes (4) All the above

36. Highly vascular and pigmented layer of human eyes is:-
(1) Retina (2) Sclerotic (3) Choroid (4) None of these

37. The part of human eye which acts like diaphragm of camera is :-
(1) Pupil (2) Iris (3) Lens (4) Cornea

38. Which of the following medicine is used to dilate pupil is?
(1) Atropine (2) Cocain (3) Belladona (4) All of the above

39. A circular canal which found in limbus part of eyes is called :-
(1) Hyaloid canal (2) Canal of Schlemm
(3) Canal of Croquet (4) Eustachian tube

40. Three layers in eye ball from inside to out side are-
(1) Retina, choroid, sclerotic (2) Choroid, retina, sclerotic
(3) Sclerotic, choroid, retina (4) Sclerotic, retina, choroid

41. In eyes the image which is formed on the retina is-
(1) Erect and real (2) Erect and virtual
(3) Inverted and real (4) Inverted and virtual

42. Aqueous humor and vitreous humor are secreted by:-
(1) Iris (2) Ciliary body (3) Lens (4) Cornea

43. Pecten, a comb like structure is found in the eye of
(1) Amphibians (2) Reptiles
(3) Birds (4) Mammals

44. Aqueous humour & vitreous humour are separated by:-
(1) Cornea (2) Conjunctiva (3) Lens (4) All

45. In Glaucoma:-
(1) Eye ball elongates (2) Eye ball shortened
(3) Fluid pressure increase in eye (4) Cornea become opaque

46. Space between cornea & lens is :-
(1) Aqueous chamber (2) Vitreous chamber
(3) Fovea centralis (4) Canal of schlemm

47. Colour blindness is due to :-
(1) Deficiency of Vitamin A (2) Deficiency of Vitamin D
(3) Deficiency of Vitamin E (4) None of these

48. Cavity of aqueous humour is :-
(1) Behind the lens (2) lnfront of lens
(3) Between choroid and sclerotic (4) None of these

49. Trachoma disease is due to infection of bacteria:-
(1) Chlamydia trachomatis (2) Bassilus
(3) E. Coli (4) Salmonella

50. The eye defect, Astigmatism can be corrected by using:-
(1) Convex lens (2) Concave lens (3) Cylindrical lens (4) Surgery

51. Mucoprotein which found in vitreous humour is :-
(1) Albumin (2) Vitrin (3) Globulin (4) Lysozyme

52. Conjunctiva of eye is derived from:-
(1) Epidermis (2) Dermis (3) Mesoderm (4) Endoderm

53. " Miosis" in eye refers to :-

(1) Reduction in diameter of pupil (2) Increased diameter of pupil
(3) Reduction division in retina (4) Shrinkage of eye ball

54. What is the cause of sterioscopic vision in human?
(1) Refraction power of eye is high (2) Well developed retina
(3) Highly developed cerebral cortex (4) Presence of biconvex lens

55. Astigmatism is developed when –
(1) Lens become opaque (2) Curvature of conjunctiva is changed
(3) Lens become nonflexible (4) Curvature of cornea is changed

56. What conditions are developed after deficiency of vitamin A-
(1) Night blindness (2) Keratinization of cornea
(3) Keratinization of conjunctiva (4) All the above

57. Function of vitreous humor is -
(1) Nutrition to lens (2) Maintain intraocular pressure
(3) Reflection (4) All the above

58. Which of the following structure of eye is artificially implanted?
(1) Cornea (2) Lens
(3) Retina (4) Cornea & lens both

59. When the human comes in bright light then what will happen ?
(1) Synthesis of rhodopsin (2) Mydriasis
(3) Miosis (4) None of the above

60. Which structure of eye is related to focussing of eye?
(1) Lens (2) Cornea
(3) Retina (4) Aqueous and vitreous humor

61. Which statement is wrong about conjunctiva ?
(1) Ectodermal origin (2) Presents on the central part of cornea
(3) Vascular (4) Covers the anterior part of sclera

62. When the canal of schlemm is blocked then what condition is developed ?
(1) Intraocular pressure is increased (2) Retina start damage
(3) Person may become blind (4) All the above

63. Which one of the following is the correct difference between Rod Celis and Cone Cells of our retina?

		Rod Cells	**Cone Cells**
(1)	Overall function	Vision in poor light	Colour vision and detailed vision in bright
(2)	Distribution	More concentrated in centre of retina	Evenly distributed all over retina
(3)	Visual acuity	High	Low
(4)	Visual pigment	Iodopsin	Rhodopsin

	contained		

64. Cornea transplant in humans is almost never rejected. This is because:-
(1) It is composed of enucleated cells
(2) It is a non-living layer
(3) Its cells are least penetrable by bacteria
(4) It has no blood supply

65. Maximum refraction of light takes place at:
(1) cornea (2) lens (3) iris (4) aqueous humour

66. Vitreous humor contains :
(1) mucoprotein (2) water
(3) mucoid connective tissue (4) all of the above

67. Only rods are present in the eyes of one of the following animals
(1) Pigeon (2) Squirrel (3) Fowl (4) Owl

EAR

68. Organ of cortisis found in:-
(1) Kidneys (2) Heart (3) Nasal chamber (4) Internal ear

69. The fluid found in semicircular annals internal ear of rennin is **:-**
(1) Perilymph (2) Endolyhl (3) Haemolymph (4) Lymph

70. Chief function of semicircular canals of internal ear-
(1) Balancing and hearing
(2) to perceive sound wibrations of high frequency
(3) To maintain dynamic equilibrium of the body while the body is inbalance
(4) To transmit sound vibration to the auditory

71. In Mammals organ Cochlear corit occurs in :-
(1) Main canal (2) Ear canal (3) Cochlear canal (4) Tympanum

72. "Organ of corti" is connected with the sense of :-
(1) Smell (2) Hearing
(3) Taste (4) Equilibrium

73. Which structure helps a person to maintain equilibrium ?
(1) Cochlea (2) Eustachian tube
(3) Semicircular canals (4) Hammer like bone

74. Cochlea of mammalian ear is concerned with :-
(1) Balancing of body (2) Hearing
(3) Pereception of atmospheric pressure (4) Both (1) and (2)

75. All bones provide support and protection to body parts. Which bone is different in it's function?
(1) Ribs (2) Atlas vertebra
(3) Malleus (4) Radius

76. External ear are characteristic of:-
(1) Mammals (3) Amphibians
(2) Reptiles (4) Fishes

77. Our ear can hear sound waves of the frequency :
1) Above 20,000 cycles/sec. (2) 5-100 cycles/ sec.
(3) 50-20,000 cycles/sec. (4) 20-20,000 cycles/sec.

78. The fluid surrounding the membranous labyrinth of human is called :-
(1) Perilymph (2) Endolymph
(3) Haemolymph (4) Cerebrospinal fluid

79. Cochlea contains:
(1) Scala vestibule (2) Scala tympani
(3) Scala media (4) All the above

80. By the stimulation of which structure of human ear, the soimd waves are perceived by brain :-
(1) Basilar membrane (2) Tectorial membrane
(3) Meissner's membrane (4) Sensory hair cells of organ of corti

81. Which of the following is not an ear ossicle?
(1) Incus (2) Malleus (3) Humerus (4) Stapes

82. Cochlea arises from :
(1) Utriculus (3) Middle ear
(2) Sacculus (4) Semicircular canals

83. The other name of internal ear is :
(1) Utriculus (2) Membranous labyrinth
(3) Sacculus (4) Ductus endolymphaticus

84. External auditory meatus contains the following gland:-
(1) Ceruminous gland (2) Lachrymal gland
(3) Harderian gland (4) Meibomian gland

85. Which of the following statement is correct regarding "Structure of ear" ?
(1) The ear ossicles increase the efficiency of transmission of sound wave.
(2) Malleus is attached with oval window.
(3) Eustachian tube connects middle ear cavity with larynx.
(4) Middle ear contain three ear ossicles called malleus, incus and sphenoid.

86. Otolith (otoconia) are $CaCO_3$ particles found in:-
(1) Perilymph (2) Endolymph (3) Bones (4) Vitreous humor

87. Which of the following is anvil shaped ear ossicle ?
(1) Incus (2) Malleus (3) Stapes (4) Humerus

88. Which of the following is stirrup shaped ear ossicle?
(1) Incus (2) Stapes (3) Malleus (4) Humerus

89. Fenestra ovalis is the opening of:-
(1) Cranium (2) Tympanum (3) Tympanic cavity (4) Brain

90. In man the muscles which move the pinnae are :-
(1) Absent (2) Vestigeal (3) Functional more (4) Functional

91. The ear ossicles of man lie in the:
(1) Auditory capsules (2) External auditory meatus
(3) Tympanic cavity (4) Tympanic bulla

92. The middle ear and internal ear of mammals are enclosed in which of the following bones ?
(1) Mastoid
(2) Ethmoid
(3) Tympanic bulla
(4) Tympanic bulla and periotic bone (temporal bone)

93. The scala vestibuli communicates with scala tympani through narrow canal called :-
(1) Ductus endolymphaticus (2) Helicotrema
(3) Ductus utriculi (4) Sacculo utricular canal

94. Between malleus & incus is found :
(1) Synovial hinge joint (2) Synovial ball socket joint
(3) Pivot joint (4) Glinding joint

95. Eye and ear are the example of :-
(1) Teleoreceptor (2) Gustato receptor
(3) Extero receptor (4) Intero receptor

96. The tympanic cavity is :-
(1) Columella auris (2) Middle ear
(3) Eustachian tube (4) Internal ear

97. One of the following is correct :
(1) Semicircular canal-balancing (2) Cochlea - hearing
(3) Utriculus -& sacculus - balancing (4) All of the above

98. In the tympanic cavity there is an aperture in which the stapes is fitted it is :-
(1) Foramen rotundus (2) Foramen triosseum
(3) Fenestra ovalis (4) Fenestra rotandus

99. Cochlea is mainly responsible for :
(1) Balance only (2) Hearing only
(3) Both balancing and hearing (4) Perception of colour

100. The bone which is in contact with fenestra ovalis is:-
(1) Malleus (2) Incus (3) Stapes (4) None

101. Ear ossicle from inner side of middle ear are:
(1) Malleus, Incus, stapes (2) Stapes, Incus, Malleus
(3) Incus stapes & malleus (4) Malleus, stapes, incus

102. Endolymph contains white crystals of $CaCO_3$ called:-
(1) Otoconia (2) Otolith (3) Ear dust (4) All of the above

103. Which of the following is part of middle ear?
(1) Cochlea (2) Utriculus
(3) Sacculus (4) Malleus

104. "Tensor tympani" & "Stapedius muscles" are found in:-
(1) External ear (2) Middle ear
(3) Internal ear (4) Exterrial auditory meatus

105. The organ of corti is a modification of:-
(1) Tectorial membrane (2) Reissner's membrane
(3) Basilar membrane (4) Meissner's membrane

106. Function of eustachian tube is to:
(1) Provide air to the ear ossicles
(2) Remove dirt from the middle ear
(3) Keep middle ear in proper shape
(4) To maintain proper air pressure in middle earand internal em for protecting them from damage by loud sound

107. The damage to ear by sudden explosion (loud sound) is prevented by :-
(1) Eustachian tube (2) Tensor tympani muscles
(3) Stapedius muscles (4) All of the above

108. The structure in the internal ear which resembles "snail shell" is called ;-
(1) Organ of corti (2) Membranous labirynth
(3) Cochlea (4) Ear ossicles

109. The sound vibration are finally exhausted in:
(1) Organ of corti (2) Fenestra rotundus
(3) Fenestra ovalis (4) Tympanic membrane

110. Which of the following structure is not related to body balance ?
(1) Maculae (2) Crista (3) Organ of corti (4) Ampulla

111. Scala media is present in -
(1) Part of middle ear (2) Cochlear canal
(3) Chamber of semicircular canal (4) Chamber which is related to perilymph

112. Ear dust is not situated in endolymph of -
(1) Utriculus (2) Ampulla
(3) Sacculus (4) Endolymphatic sac