

STRUCTURE:-

Human eyeball is approximately globe shaped with a diameter of about 24 mm. Eyeball is made up of two segments, an anterior part which is small and forms $\frac{1}{6}$ of the eyeball, and posterior part is large and forms $\frac{5}{6}$ th of the eyeball.

Orbital cavity:-

Except anterior $\frac{1}{6}$, the eyeball is situated in the bony cavity called orbital cavity or eye socket. A thick layer of areolar tissue is interposed between the bone and the eye. The eyeballs are attached to the orbital cavity by ocular muscles.

Eyelids:- Eyelids protect the eyeball from foreign material & cut off the light during sleep. The margins of eyelids have hairs called cilia which protect dust particles from reaching the eyeballs. Meibomian glands and some sebaceous glands are found in eyelids. The opening between the two eyelids is called palpebral fissure.

Conjunctiva:- It is a thin mucous membrane, which covers the exposed part of the eye where it is called bulbar conjunctiva. Also conjunctiva is reflected on to the inner surface of the eyelids where it is called palpebral conjunctiva. The surface of conjunctiva is lubricated by thin film of tears.

Lacrimal glands:- These are located in the upper, outer portion of each orbit in the frontal bone. From the lacrimal gland, tear flows over the surface of conjunctiva and drains through puncta into the lacrimal sac and then into nose via ^{nasal} lacrimal duct. It keeps the conjunctiva moist and protects it from infection. Tears also contain lysozyme that kills bacteria.

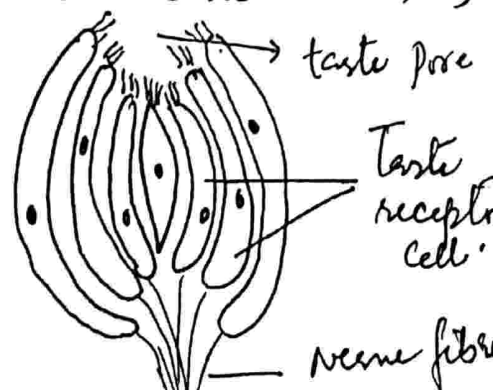
Sense of Taste:-

The organ of taste is tongue. It is a muscular organ that lies in the oral cavity. The surface of tongue bears numerous small projections called papillae on which are present numerous taste buds. The taste buds are ovoid bodies which sense the taste of different foods. In adults about 10,000 taste buds are present on the papillae. Three types of papillae are located on the tongue:-

- 1) Filiform papillae:- These are small, conical shaped papillae situated over the dorsum of tongue. These contain less no. of taste buds.
- 2) Fungiform papillae:- These are round in shape and are situated over the anterior surface of tongue near the tip. The no. of taste buds is moderate in them.
- 3) Circumvallate papillae:- These are large structures present on posterior surface part of tongue. These papillae are arranged in the shape 'V'. Each papilla contains many taste buds.

Structure of taste bud:-

A taste bud is a bundle of taste receptor cells. Each taste bud contains about 40 cells. The taste receptor cells have projections called microvilli. The taste bud has an opening called taste pore.



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Primary taste Sensations:-

The primary taste sensations are of 4 types:-

- 1) Sweet - which is perceived at the tip of the tongue
- 2) Salty - which is perceived at lateral surfaces of the anterior part of the tongue
- 3) Sour - It is perceived at the lateral surfaces of the posterior part of the tongue.
- 4) Bitter - This taste is perceived by the dorsum of the tongue.

Mechanism of taste perception:-

When the food stuffs get dissolved in the mouth by saliva, the dissolved substances act on the microvilli of taste receptor cells in the taste pore. It causes the development of receptor potential in the receptor cells which is carried forward as the nerve impulse to the taste receptor area of the brain where diff. tastes are perceived.

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- 6) Regulation of water and electrolyte balance:- Skin regulates water and electrolyte balance by excreting water and salts through sweat.
- 7) Excretory function:- Skin excretes small quantities of waste materials like urea, salts, fatty substance along with water (sweat).
- 8).

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SENSE OF SMELL:-

The upper part of nostrils ~~are~~^{is} lined by modified mucous membrane called olfactory mucous membrane which contains olfactory receptors. Almost 10-20 million olfactory receptors are present in the nose. The olfactory receptors are dendrites of the olfactory receptor neuron which is present in the mucous membrane.

Axons of the olfactory receptor neuron pierce the cribriform plate of the ethmoid bone and reach the olfactory bulb. From there, the fibres form as ~~the~~ olfactory tract which runs backwards and ends in olfactory cortex of the temporal lobe.

The mechanism of Smell:-

The odoriferous substance first dissolves in the mucus covering the olfactory mucous membrane and stimulates the olfactory receptors. This generates the action potential in the receptors which is transmitted forwards in the form of nerve impulses of the smell to the olfactory cortex of the temporal lobe. In this way the cortex perceives different smells.

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SKIN

Skin is the largest organ of the body. The average thickness of the skin is about 1-2 mm. In the sole of the foot, palm of the hand it is 5 mm in thickness whereas over the eyelids and penis it is only 0.5 mm thick.

Skin is made up of two layers (Structure of skin)

- i). Outer Epidermis (ii) Inner Dermis.

EPIDERMIS:-

The epidermis of the skin is formed by stratified epithelium, which consists of 5 layers:-

- Stratum Corneum:- Also known as horny layer. It is the outermost layer and consists of dead cells called corneocytes. Their cytoplasm is filled with fibrous protein called keratin.
- Stratum lucidum:- It is made up of flattened epithelial cells. These cells have shiny character i.e., why it is called Stratum lucidum (lucid = clear).
- Stratum Granulosum:- It is a thin layer. The cytoplasm of these cells contain granules of protein called keratohyalin. The keratohyalin is the precursor of keratin.
- Stratum Spinosum:- Also called prickly cell layer because the cells of this layer possess some spine like protoplasmic projections. By these projections, the cells are connected to one another.
- Stratum Germinativum:- The cells in this layer divide constantly and the newly formed cells move continuously towards Stratum Corneum. Melanocytes are scattered between the cells of this layer. From this layer, some projections called rete ridges extend down upto dermis. These projections

provide anchoring and nutritional function.

DERMIS:-

It is a connective tissue layer made up of dense collagen fibres, fibroblasts and histiocytes. The dermis is rich in blood vessels, lymphatics and nerve fibres. Dermis also contains hair follicles, sweat glands and sebaceous glands. Lots of smooth muscles called arrector pili are also found in skin around the hair follicles.

Functions of skin:-

- 1) Sensory function: Skin has many nerve endings which form specialised cutaneous receptors. These are stimulated by the sensations of touch, pain, pressure or temperature and are conveyed to the brain via afferent nerves. At the different levels in brain the perception of different sensations occurs.
- 2) Protective function: Skin forms the covering of all the organs of the body and protects these organs from bacteria and toxic substances, mechanical blow, UV rays.
- 1) Storage function: Skin stores fat, water, sugar etc.
- 1) Synthetic function: Vitamin D_3 is synthesized in the skin by the action of UV rays on cholesterol.
- 5) Regulation of body temperature: Skin plays an important role in the regulation of body temp. Excess heat is lost from body through skin. Sweat glands of the skin play an active part in heat loss by secreting sweat.

Walls of the eye ball:-

The wall of the eyeball is composed of three layers:-

- 1) outer layer which includes Cornea and Sclera.
- 2) Middle layer which includes choroid, ciliary body and iris.
- 3) Inner layer which includes retina.

OUTER LAYER / TUNICA FIBROSA

Sclera:- It is formed by the white fibrous tissue and elastic fibers. It is opaque and white in colour. It forms posterior $5/6$ of the eye layer.

Cornea:- It is the anterior $1/6$ of outer layer. Cornea is transparent ~~also~~, but it appears coloured due to the underlying iris. The transition between Sclera and Cornea is called limbus. Cornea is formed by 5 layers. The superficial layer is formed of stratified epithelium. Cornea is sensitive to pain, touch, pressure and cold.

MIDDLE LAYER / TUNICA VASCULOSA

Choroid:- It forms the posterior $5/6$ th of the middle layer. Choroid is separated from sclera by perichoroidal space. It has a rich supply of capillary plexus, small arteries and veins. It provides oxygen and nourishment to the outer layers of retina.

Ciliary body:- Choroid is extended anteriorly to form ciliary body. It consists of ciliary muscles which control the shape of the lens with the help of suspensory ligament (zonules) and ciliary epithelium which produces aqueous humor which is responsible for providing oxygen, nutrients and removal of metabolic waste.

Iris: It is a coloured structure and is placed in front of the lens. It has a circular opening in the centre called pupil. Iris is a muscular structure and has two muscles - Constrictor pupillae, - Dilator pupillae.

These muscles control the ~~op~~ dilatation and constriction of pupil and controll the amount of light entering the lens.

INNER LAYER / TUNICA NERVOSA:-

Retina is the innermost which has receptors of vision. It is made up to 10 layers. The outermost layer called pigment epithelium absorbs light and prevents reflection of light rays back from retina. Another layer is that of rod and cone cells which help to see in ~~dark~~ and bright light. The ~~rod~~ retina has visual receptors which convert the light energy into nerve impulse and is then carried to the brain through optic nerve originating from retina.

CHAMBERS OF EYE

The eye has three chambers - anterior, posterior & vitreous.

Anterior chamber:- It is present between cornea and iris.

It is filled with a fluid called aqueous humor.

Posterior chamber:- It is present between iris and lens. It is also filled with aqueous humor. Aq. humor is secreted by ciliary epithelium. Both anterior and posterior chamber are connected by pupil. Aq. humor provides nutrients, oxygen and removes metabolic waste from lens and cornea. It also maintains the intra ocular pressure.

Vitreous chamber:- It is a space between lens and retina. It is filled with vitreous humor formed by albumin & hyaluronic acid. It maintains shape of the eyeball.

Lens: It is biconvex, transparent, crystalline structure situated behind the retina. It is an avascular structure. Lens refracts light rays and helps focus the image of objects on retina. Lens is supported by suspensory ligaments which are attached to the ciliary bodies.

VISUAL PROCESS:-

Visual process is a series of actions that take place during visual perception. During visual process, the image of an object seen by the eyes is focused on retina resulting in visual perception of that object. There are three separate processes that make up the visual process:-
(A) Mechanical, (B) Chemical, (C) Electrical.

The mechanical process:- The light passes through cornea, from an object and enters through pupil to the lens. The cornea's shape focuses incoming light slightly before it enters the lens. The size of the pupil is determined by iris. In bright light, the iris shrinks the pupil, which lets in less light while in dim light, iris expands the pupil and allows more light. The light then passes through the lens which bends (refracts) it & focuses it onto the photoreceptors. The shape of the lens is changed by ciliary muscles and ligaments, which allows the lens to focus light from both distant and nearby objects onto the retina.

The chemical process:- The photoreceptors i.e. rods & cones receive the light and convert it into electrical signals. The cones are active in dim bright light, & detect and interpret colours. The rods are active

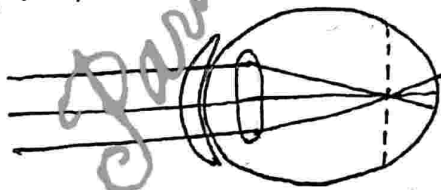
in dim conditions. There are about 6 million cones and 1.2 million rods in the human eye.

The electrical process:- Once the photoreceptors convert the light into electrical signals, the nerve cells that are on the top of rods & cones pick up the signals and carry them to the optic nerve, which in turn takes the signals to the visual cortex of the occipital lobe where the brain interprets the signal as what we are seeing.

Refractive errors

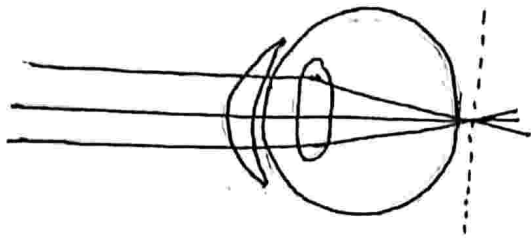
Those defects of vision which occur because of the change in the shape of the eyeball are called refractive errors:- They are of following types:-

- 1) Myopia:- Also known as short sightedness because the person can see the nearby objects clearly but not the far objects. It is because of the ^{increase} in the anteroposterior diameter of the eyeball, as a result, the image of the object is formed in front of the retina. So the image of the object is blurred. It is corrected by using concave lens.



- 2) Hypermetropia: Also known as hypermetropia because one can see the distant objects clearly but not the near objects. It is due to decreased anteroposterior diameter of the eyeball, as such image is formed beyond the retina which causes blurred image of the near objects. It is corrected by using convex lens.

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Astigmatism:- It is also a common optical defect. The light rays are not brought to a sharp point upon retina. It occurs as a result of irregularity of curvature of lens. Astigmatism is corrected by using cylindrical glass lens.

Presbyopia:- It is the gradual reduction in the ~~some~~ power of accommodation. It starts developing after middle age. In this disorder, the distant vision is unaffected, only near vision is affected. It is corrected by convex lens.

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EAR:-

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The ear consists of three parts namely external ear, middle ear and internal ear.

External ear It is formed of two parts:-

- 1) Auricle or Pinna:- It is the external visible portion of the eye and consists of fibrocartilage plate covered by connective tissue and skin. The plate is folded and ridged & contains many fine hairs and sebaceous glands. The depression of auricle, which forms the orifice of external auditory meatus is called Concha.
- 2) External auditory meatus / Canal:- It starts from Concha & extends inside as a slightly curved canal to a length of 55mm. The outer portion of the meatus is cartilaginous and inner portion is bony. The auditory canal is covered by skin and contains a no. of sebaceous glands and ceruminous glands. The secretions of these glands and dead epithelial cells form the ear wax. Ear wax is protective in nature and traps all the dust, dirt and foreign bodies.

MIDDLE EAR:-

The middle ear consists of tympanic cavity, tympanic membrane, ear ossicles and Eustachian tube.

- 1) Tympanic cavity:- Also called tympanum is present within the temporal bone. The tympanic cavity is separated from external auditory meatus by tympanic membrane. It contains the ear ossicles.
- 2) Tympanic membrane:- It is a semitransparent structure which separates the middle ear from external auditory canal. It vibrates when the sound waves strike it.

- 3) Auditory ossicles:- These are three miniature bones, which are arranged in the form of a chain extending from tympanic membrane to the oval window. The three bones are - Malleus, Incus, Stapes.

Malleus:- Also called hammer bone. It has a head, neck and handle. The handle is attached to the tympanic membrane and head articulates with body of incus.

Incus:- Also known as Anvil. It resembles the premolar tooth. It has a body, one long process and one short process. Body articulates with malleus head, short process is attached to a ligament and long process articulates with next bone.

Stapes:- Also called Stirrup. It is the smallest bone of the body. It has a head, neck and footplate. The head articulates with incus and footplate fits into the oval window.

- 4) Auditory tube / Eustachian tube:- It is a small canal extending from middle ear to the nasopharynx. It forms a passage of air b/w middle ear and nose thus pressure on both sides of tympanic membrane is equalised.

INNER EAR:- Also called labyrinth and consists of a bony labyrinth and membranous labyrinth. Inner ear consists of sense organ of hearing and equilibrium. Inner ear is made up of semicircular canals and cochlea:-

Cochlea:- It is a coiled structure like a snail's shell. The body of cochlea encloses a membranous duct. Cochlea is the organ of hearing. It has a neuroepithelial structure which acts as a receptor for sound waves called Organ of Corti. The cochlear duct is filled with endolymph. From the organ of Corti arises the cochlear division of vestibulocochlear N.

3/ Semi-circular Canals:- There are three semicircular canals present in the ear which are filled with endolymph. The canals are responsible for equilibrium and balance in the body. The space between the membranous and the bony labyrinth is filled with perilymph. From these canals arises the vestibular branch of vestibulocochlear nerve.

Mechanism of hearing and balance:-

The sound waves travel through the external auditory meatus which are focussed towards the meatus by pinna or external ear. Due to the pressure changes produced by sound waves, the tympanic membrane vibrates. From the tympanic membrane, sound waves are transmitted to the ear ossicles i.e., malleus, incus and stapes which causes to and fro motion of stapes against oval window. This motion causes vibratory motion in the perilymph, which in turn cause movement of the endolymph. This stimulates the sensory cells of organ of Corti leading to the generation of receptor potential or nerve impulse. This nerve impulse is taken to the auditory centres in the temporal lobe where this sound impulse is perceived.

The balance system consists of three semicircular canals that contain endolymph and sensors that detect rotational movement of the head like up and down, side to side, and tilting from side to side. The semicircular canals contain sensory hair cells that are activated by movement of the endolymph. As the head moves, hair cells send nerve impulse via vestibular branch of VC nerve to the cerebellum where position of head and movement of head is perceived thus maintaining the balance.