SENSORY ORGANS

Sense organ/receptor is a specialised body structure having specialised cells which can pick up an external or internal stimulus and transmit the same to the central nervous system as nerve impulse. Only brain can perceive sensations. Sense organs are avenues for receiving stimuli. The sense of taste, smell, sight and hearing are called **special senses** because their receptors occur in specific organs. The sense of touch/pressure/pain is called **general senses** as its receptor cells lie scattered in skin and various body parts.

According to Type of Stimulus.

(1) Mechanoreceptors —Sensitive to mechanical stimuli like pressure, gravity, pain, current, sound, touch.

(2) Chemoreceptors —Sensitive to chemicals or their concentration as in taste, smell, gases, humidity, etc.

(3) Photoreceptors —Sensitive to intensity and wave length of light, image formation.

(4) Thermoreceptors —Sensitive to temperature changes, including heat and cold.

SENSE OF TOUCH – SKIN

Our skin is the largest organ. It covers our entire body and has a surface area of around 2 square metres. Its thickness varies from 0.5mm on our eyelids to 4mm or more on the palms of our hands and the soles of our feet. In total, it accounts for around 16 per cent of our body weight.

ToughPhysical Barrier: Skin consists of two main layers: the outer epidermis and the inner dermis. Cells in the deepest layer of our epidermis divide constantly to make new cells. The new cells are pushed towards the surface of our skin. They eventually die and become filled with keratin, an exceptionally tough protein. Keratin provides our body with a durable overcoat, which protects deeper cells from damage, infection and drying out. Cells on the surface of our skin rub and flake off steadily and are continuously replaced with new ones. About every 30 days, our body produces a totally new epidermis. Inner dermis consists of strong collagen and elastic fibres pierced by blood vessels. It also contains touch, pressure and pain sensors and is packed with hair follicles, sweat and oil glands. The oil glands produce a lubricant that keeps our skin soft and prevents our hair from becoming brittle.

Temperature control: Our skin's blood vessels, sweat glands and hairs play a crucial role in regulating our body temperature. When we need to cool down:

1. blood vessels widen and allow heat to escape through our skin.
2. we start sweating, and as our sweat dries, it uses heat from our skin and cools us down.
3. our hairs lie flat to make sure little warm air doesn't get trapped between our skin and our hairs.

Skin Layers: Skin is the largest organ of the body (18 ft^2.). It regulates body temperature and acts as the organ of touch. It protects the inner organs from infection & injuries.

I. Epidermis

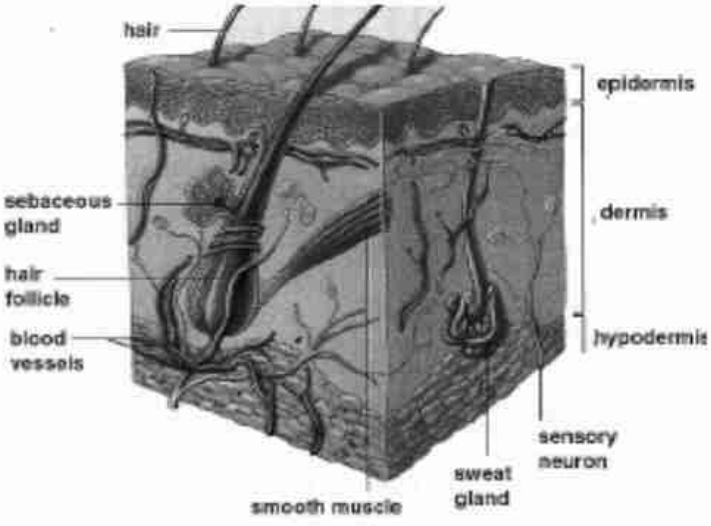
(i) Cornified layer : have dead cells; to cut the loss of water from evaporation & to prevent from microbes.

(ii) Malpighian layer : colour, contain malpighism cells which secrete 'Melanin' which protect the inner cells from ultra-violet radiations. When more melanin is secreted, the skin colour becomes 'tan'. White-men have more possibility of skin cancer. Skin cancer may be of two types: (a) Localised Skin Cancer- can be treated, not fatal, less harmful (b) Melonoma- most serious, known as skin cancer, fatal, pigment cell are affected, most common in Southern Hemisphere due to erosion of ozone layer.

II. Dermis (inner layer)

It is more thicker, true skin, regulates the body temperature through capillary vassels & sweat glands, have millions of capillary blood vessels, sweat glands, nerve endings, sebaceous glands and hair follicles. If temperature increases the capillary vessels expand & sweat glands help in evaporation; air conditioner of the body; sweat glands also remove the waste products; sebaceous glands- kills bacteria & keeps the skins soft & the body hair lustrous; found at the root of the hair follicles.

- When we need to retain heat, the opposite happens, our blood vessels narrow, we produce less sweat and our hairs stand up on end to trap warm air around our body.



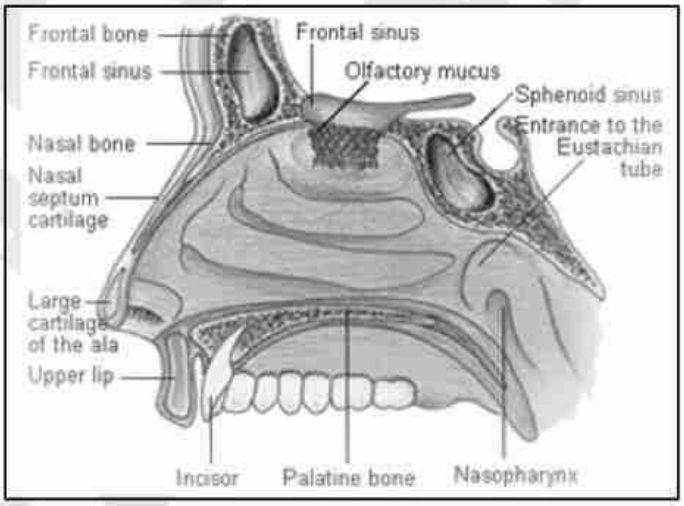
- **Skin colour:** Our skin contains specialised cells called melanocytes. They produce melanin, a brown substance, which absorbs some of the Sun's harmful ultraviolet rays. Fair-skinned people only have melanin in the lower layers of their epidermis. People with dark skin have larger amounts of melanin in all layers. Freckles and moles are nothing else but small patches of skin with more melanin than in the surrounding area.
- **Wrinkles:** As we age, the number of collagen and elastic fibres in our dermis decreases. Additionally, we lose fat from the tissue under our skin. As a result, our skin becomes less elastic and begins to sag and wrinkle.
- **Skin Receptors** : Pressure, Pain, Touch/Tactile, Temperature Receptors.
- **Meissner's Corpuscles** (Tactile Corpuscles): Low frequency vibrations and movements of objects, also pain.
- **Free Nerve Endings:** Touch, pressure and pain.
- **Hair End Organs** (Basket Nerve Endings): Touch and movement of objects.
- **Merkel's Corpuscles** (Merkel's Discs): Tactile receptors, constant touch.
- **Pacinian Corpuscles:** Pressure, tension and tissue vibrations.
- **Golgi-Mazzoni Organs** (Organs of Golgi): Heavy touch, pressure, joint rotation.
- **End Bulbs of Krause/Krause's Corpuscles:** Cold.
- **Ruffini's Organs or Corpuscles:** Warmth
- Maximum number of tactile corpuscles occur in figner tips and lips.
- Cold sensation is more developed in fore-head region.

SENSE OF TASTES –TONGUE

Taste is a sense connected with feeling about food taken in mouth. It determines selection of food, its palatability and stimulation of reflexes for secretion of saliva, gastric juices and pancreatic juices. There are four basic tastes — sweet (sugars, glycerol), saltish (sodium), sour (acidic substance) and bitter (e.g., quinine, nicotine). Chillies and pepper give burning sensation. Gustatorceptros are chemoreceptors. They are located on the tongue, a few on palate, pharynx and tonsillar pillars. Organs of taste are **taste buds.** Some 10,000 of them occur on tongue in or around papillae with a papilla having 1 to 100 taste buds. Though a taste bud can be sensitive to two or more basic tastes, it is specialised for one only. The taste buds for sweet taste are located at tip and anterior surface of tongue, saltish antero-laterally, sour on sides and bitter towards base (posterior side).

- Sensation of taste is collected by facial (VII cranial, glossopharynegeal (IX cranial and vagues (X cranial taken to brain stem and then taste centre in temporal lobes of cerebrum for interpretation. However, the sense of taste is imparied in bad cold (when the sense of olfaction or smell is lost) indicating that most of our taste is actually related to smell.
- **Metallic Taste** spreads all over the tongue; tastes are in the form of chemical impulses; for tastes, tongue must be moist; well developed in man.
- Our sense of taste also helps us maintain a consistent chemical balance in our body. Like sugar and salt for example, satisfies our body's need for carbohydrates and minerals, similarly, eating sour foods such as oranges and lemons supplies our body with essential vitamins like vitamin C.

SENSE OF SMELL – NOSE



Sense of smell is the ability to perceive chemicals diffusing through air. It is well developed in mammals and in humans too who can distinguish many odours. Dogs, cats, rats and rabbits have very well developed olfactoreceptors. The olfactory sense is useful in search of food, selection of food, detection of enemies, preys, predators and mates. Nose is the organ of olfaction or smell. There are some 100 million olfactory cells which are actually bipolar neurons.

Mucus present over olfactory epithelium picks up particles and molecules present in the inhaled air. An impulse is generated in the nerve-fibre which is taken by olfactory nerve to olfactory bulb of fore-brain and then transmitted to olfactory area of temporal lobe of cerebrum for interpretation. However, continuous perception of a smell does not occur. Olfactory centre of brain gets fatigued of a smell within 2.5 –10/0 minutes. This is helpful to human beings in living and working in premises having odorous chemicals. The ability to condition one self in an odorous environment is known as olfactory adaptation. Perfume sprayed over one's clothes will stop smelling to that person after some time while other persons will be able to smell the same.

- Our sense of smell warns of dangers such as smoke and poisonous gases. It also helps appreciate the full flavours of food and drink.
- Our sense of smell is 10,000 times more sensitive than the sense of taste.
- When our olfactory receptors are stimulated, they

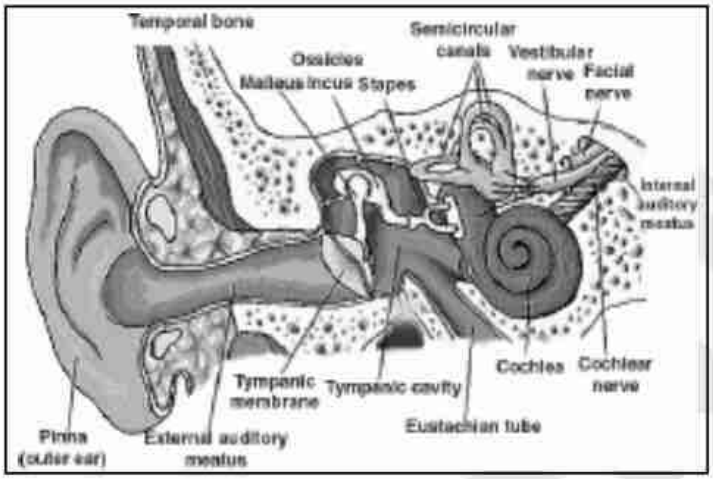
transmit impulses to our brain. This pathway is directly connected to our limbic system, the part of our brain that deals with emotions.

SENSE OF SOUND –EAR

Organ of hearing; organ of maintenance of equilibrium of body; audible range of human- 20 to 20000 fr/sec. (hertz). An ear has three parts — external, middle and inner.

1. **External Ear.** It consists of pinna, external auditory canal and tympanum.

(a) **Pinna:** It is the funnel-shaped oval projecting part which



consists of elastic cartilage covered by skin and having muscles (not functional in humans). It is meant for collecting sound waves.

(b) **External Auditory Canal/Meatus:** The canal is oblique S-shaped irregular passage from outside to tympanum. External auditory meatus is covered by skin having **hair** in the outer part and **ceruminous** or **wax glands** in the inner part. Secretion of ceruminous glands is called creumen or ear wax. Hair and ear wax trap dust particles and microbes. Ear wax also lubricates tympanum.

(c) **Tympanum** (Ear Drum): It is an oval, bluish grey, tight, stretchable membrane capable of vibrating, that lies at the end of external auditory canal. Tympanum is made of fibrous connecting tissue covered by stratified epithelium on external side and mucous membrane on the inner side.

2. **Middle Ear:** It has an irregular air-filled **tympanic cavity** lined by mucous membrane and enclosed inside temporal bone of skull. Tympanic cavity leads to Eustachian tube that opens into pharynx through a valve for equalising air pressure. A ligament supported chain of three bones or **ear ossicles** occurs between tympanum and oval window — outer hammer shaped **malleus** (in contact with tympanum,) middle anvil-shaped **incus** and inner stirrup-shaped **stapes** (in contact with oval window). The ear ossicles are meant for transmitting as well as amplifying vibrations received from ear drum.

2. **Internal Ear:** It is an irregular endolymph filled organ called **membraneous labyrinth** that occurs inside a **perilymph** filled **bony labyrinth.** Membranous labyrinth is differentiated into three parts — vestibule, semicircular canals and cochlear duct.

- **Vestibule** consists of an epithelium having sensory cells and supporting cells.
- **Semicircular Canals** are three semicircular ducts borne over the utriculus at right angles to one another. One end of each semicircular canal is swollen to form ampulla having a sensory spot known as **crista.**
- **Cristae** maintain dynamic equilibrium of the body.
- **Cochlear Duct** is a spirally coiled tube of 21/2 turns. The coils of cochlear duct are held by ligaments. Cochlear duct lies in a coiled part of bony labyrinth called cochlear bone. The two are collectively called cochlea. They have receptor organ for hearing called organ of Corti. There are some eight types of sensory cells specialised to perceive different sound vibrations. The sensory cells or organ of Corti are also called phonoreceptors.

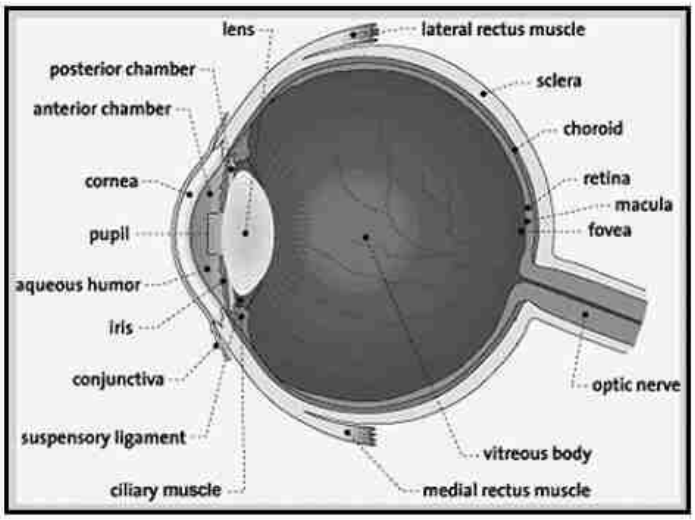
Our ear flap funnels sound waves into our outer ear canal. The waves travel along this passage until they hit our eardrum and cause it to vibrate. As a result, our ossicles start moving. They, in turn, pass on vibrations to a thin layer of tissues at the entrance of our inner ear called the oval window. The movement of the oval window then sets off wave-like motions in the fluid in our cochlea.

Our organ of hearing, the spiral organ of Corti, runs through the inside of our cochlea. It consists of thousands of sensory hair cells, attached to a membrane. Tiny sensory hairs emerge from each sensory hair cell and pierce into a second, gel-like membrane above. Whenever the fluids in our cochlea are in motion, the first membrane vibrates and squashes the sensory hairs against the second membrane. The movement of our sensory hairs is then translated into nerve impulses, which travel along our cochlear nerve to our brain.

Because we have two ears, we are able to locate the source of a sound. If a sound comes from the right, for instance, it will reach our right ear slightly sooner than our left ear. Or it will be slightly louder in our right ear. As a result, we will recognise the sound as coming from our right.

SENSE OF SIGHT–EYE

Organs of sight are a pair of eyes lodged in eyes sockets or **orbits** of skull having cushion of fat for frictionless movement and protection from shock. Each eye is rounded and called **eye ball.** It is 2–5 cm in diameter . It can move in the orbit by six strap– shaped occular muscles: Eyes are protected by eye lids and tear glands. **Eye brows** are supra-orbital arched eminences bearing obliquely projecting hair. They can be brought down to protect the eye ball from dust, sweat and rain. **Eye lids** are a pair of movable skin folds supported by stiff connective tissue plates which lie above and below the 'eye' and cover the same at intervals by coming together in the process of blinking, closing of eyes during sleep or rest. Eye lids bear stiff hair or **eye lashes** at the edges. They are lubricated by **glands of Moll.** Margins of eye lids posses **Meibomian** or **tarsal glands** (modified sebaceous glands).



The inner surface of eye lids is lined by mucous membrane called **palpebral conjuncntiva.** Secretion of Meibomian glands helps in frictionless blinking and holding tears over the exposed part of eye ball. Eye lashes and blinking are protective against dust particles, flies, rain, etc. A small reddish patch on the inner corner of eye is called **plica semilunaris** (may be vestigial third eye lid or nictitating membrane). **Tear gland** (**lacrimal = lacrymal = lachrymal gland**) is an almond shaped racemose gland lying in the upper part of orbit that secretes a watery fluid or tear having antibacterial **lysozyme** (water + sugar + amino acid + proteins + minerals + salt + urea). It is poured over the exposed part of eye ball by 6 — 10 tear ducts. The lacrimal secretion or tear moistens and cleanses the eye ball and eye lids, provides protection from microbes and nourishes the cornea.

Wall of eye ball has three concentric layers — fibrous tunic, uvea and retina. Out of these only fibrous tunic is complete.

Fibrous Tunic (Sclerotic): It is the outermost covering of eye ball. The coat is made of fibroelastic connective tissue. 5/6th of it is opaque and bluish white, largely hidden but a part present in front as white of eye. It is called **sclera,** has blood vessels and provides attachment to eye muscles. The front part (1/6th) of fibrous tunic is thicker, transparent, bulged out **cornea** which is devoid of blood vessels. Cornea is nourished by aqueous humour and partly by lacrimal secretion. Cornea and the exposed sclera is covered by a transparent membranous epidermis called **conjunctiva** (bulbar conjuctiva). It provides protection and lubrication. Cornea admits light and helps in rough focussing.

Uvea (Choroid): It is middle pigmented and vascular coat which is differentiated into three parts — choroid, ciliary body and iris.

(i) **Choroid** : It lines the sclera. Because of its pigmented nature, choroid prevents internal reflection. It provides nourishment and oxygen to retina.

(ii) **Ciliary Body** : It is ring-shaped thick muscular structure occuring at the junction of choroid and iris. Its epithelium secretes aqueous humor.

(iii) **Iris** : It is an opaque muscular pigmented and perforated diaphragm having radial (dilator) and circular (sphincter) smooth muscles which are operated by sympathetic and parasympathetic nerves respectively. The iris provides colour to eyes. It can be blue (only at the back), grey, brown (dark, light) or black (depending upon layers having pigment). The central perforation of iris is called **pupil.** Its size is controlled by radial (contraction dilates pupil) and circular (contraction constricts pupils) muscles in response to dim and strong light respectively.

Lens: It is transparent, elastic, biconvex structure which is suspended in the cavity of eye ball behind the pupil by means of suspensory ligaments. Lens is made of layers of non-nucleated elongated cells and intercellular proteins. It is covered by a thin transparent membrane called **lens capsule.** The convexity of lens is slightly more on the back as compared to the front. Stretching and relaxation of suspensory ligaments changes the focal length of the lens for accomodation.

Cavity of Eye Ball: Lens and suspensory ligaments divide the cavity of eye ball into anterior **aqueous chamber** and posterior **vitreous chamber.** Aqueous chamber is filled with clear watery fluid or aqueous humor secreted by ciliary body. It nourishes lens and cornea. Aqueous humor also maintains shape and pressure in the front part of eye. The posterior vitreous chamber (between lens and posterior part of eye ball) contains a non-replaceable jelly-like transparent substance called **vitreous humor/**vitreous body. It maintains shape of eye ball and provides pressure for keeping the lens in position. Vitreous chamber contains a lymphoid hyaloid canal from lens to blind spot.

Retina: It is the delicate inner non-vascular light sensitive coat of the eye ball . It is sensory and differentiated into two parts, outer **pigmented part** and inner **nervous part.** The pigmented part is made of cuboidal cells with dark brown granules and fringe-like protoplasmic processes. It continues beyond ora serrata. The inner nervous part is transparent and made of three layers —

(i) Outer photosensitive layer of visual/photoreceptor cells called rods and cones.

(ii) Middle layer of bipolar nerve cells.

(iii) Inner layer of ganglion cells that form nerve fibres.

Glowing of eyes in cats and dogs is **due** to presence of reflecting layer of **tapetum** behind the retina. The area of retina where optic nerve and blood vessels enter and leave the eye ball is called **blind spot** (optic disc) as it does not contain visual cells. An area lateral to blind spot is the spot of image formation. It is called **yellow area** or **muscular lutea.** A depression in the yellow area is called **yellow spot** or **fovea centralis.** It lies on optical axis, has maximum density of cone cells and forms the sharpes vision.

- Human eye has about 120 million rod cells and 7 million cone cells. Cone cells are more abundant in the yellow area. Yellow spot has exclusively cone cells.The animals which can see in dark have very high number of rod cells (e.g., Owl, Bat).
- A **rod cell** has an outer pigment part drawn out as a rod, the inner end contains a nucleus. The pigment present in rod cells is called **visual purple** or **rhodopsin**. It consists

of protein and vitamin A. Rods produce a blurred grey white image in dim light. In twilight a coloured flower will appear only black due to rod-mediated vision. Rhodopsin is bleached in strong light but is reformed in dim-light with the help of vitamin. A. Deficiency of Vitamin A leads to **night blindess** (no vision in dim light) because of little rhodopsin.

- A **cone cell** has a conical outer pigmented part and a branched inner part. The pigment is known as **visual violet** or **iodospin**. It is actually of three types corresponding to three basic colours — green sensitive **chlorolabe,** blue sensitive **cyanolabe** and red sensitive **erythrolabe.** Cone cells produce sharp, coloured image is bright light. Alongwith humans, colour vision is present in paes, monkeys, birds, lizards, snakes, fresh water fishes, cray fishes, etc. Other animals have black-white vision. In humans colom blindness is caused by a defect in the colom sensitive cells (Cones).

- **Working:** Eye, like photographic (camera, has to parts — diopteric or focussing and sensory/receptor

(a) **Focussing —** It is carried out by cornea (rough focussing) and lens (fine focussing) so that image is formed on fovea centralis or yellow spot. Aqueous and vitreous humors help in keeping the light rays on proper path. For focussing at nearer objects, the ciliary muscles contract, the suspensory ligaments are loosened and the lens becomes more convex. Human beings have **binocular** (monocular in Frog) and ***s*sterescopic** (3-dimensional) **vision,** because both the eyes are focussing an the same object with very slight variation of angle. It gives clearer image with better idea of distance.

(b) **Reception —** An inverted but real image is formed over the retina. A black and white blurred image is formed in dim light due to perception by rods. A sharp coloured image is produced in day light due to perception by conces in the area of fovea centralis. The stimulus perceived by rods and cones is converted into impulses which are transferred to bipolar ganglion cells and then nerve fibres of optic nerve to be carried to visual area of occipital lobe of cerebrum for interpretation.

Common Refractive Eye Defects

1. **Myopia** (Short Sightedness). Common in young persons/ students due to either higher convexity of lens or longer eye ball which results in image of distant objects (writing on black board, bird on a tree) being formed in front of the retina. It is corrected by wearing (spectacles with) concave or convergent lenses.

2. **Hypermetropia** (Far or Long Sightedness). The image of nearer objects (words in a book) is blurred due to its being formed beyond retina due to eye ball being short or lens being flattened (with low convexity). It is corrected by wearing (spectacles with) convex or divergent lenses.

3. **Astigmatism**. Cornea or lens is curved unequally in different regions so as to produce a blurred image (foccusing at different points in different regions). Complementary lenses (cylindrical lenses) are prepared to correct astigmatism.

4. **Presbyopia.** It is old age (after 40 years) far sightedness due to loss of elasticity in the eye lens so that near objects (e.g., written or printed words) are not correctly visible. Convex/bifocal lenses correct the vision.

5. **Cataract.** In older persons (60 years and above) the eye lens becomes opaque reducing visibility. Cataract can be nuclear (central portion capacity) or cortical (peripheral opacity). Cataract is corrected by (i) Removing or opaque lens and wearing special spectacles. (ii) Replacing opaque lens with artifical infraocular lens. (iii) Laser treatment of opacity.

TRIVIA

- **Koths, Butterfiles:** Chemoreceptors occur on antennae.
- **Chillies:** Not bitter taste but produce burning pain.
- **Vibrations to which Human Ear is Most Sensitive:** 1000 cycles/sec.
- **Pinna:** Absent in certain mammals like Platypus,. and many aquatic forms like Whale, Seal, Sirenian.
- **Colour Blindness:** Sex linked recessive. Three types — protanope (red), tritanope (blue) and deuteranope (green).
- **Glaucoma:** It is an eye defect in which intra-ocular pressure becomes different in the two chambers causing acute pain leading to damaged retina and hence blindness.
- **Squint/Strabismus, Diplopia** or two images: Correct surgically.
- **Binocular Vision:** Found in mammals and some birds.
- **Stereoscopic/Three Dimensional Vision:** Occurs in primates.
- **Cones:** Absent in Owis, Shrews, Moles, Hedge Hogs, Bats, etc. Pure cone retina occurs in squirrels.
- **Harderian Glands:** Present at the angle of eye, secrete lubricant for nictitating membrane in animals where the latter is present.
- **Eye Size:** Diameter at birth is about 17.5 mm and at puberty 20-21 mm. In relation to body size, Deer possess the largest eyes.
- **Colour Vision:** Occurs in bees, reptiles, birds, monkeys, apes and humans. Absent in most domesticated animals.
- **Eye-Lids:** Absent in snakes and fishes. ■■