Chapter 44

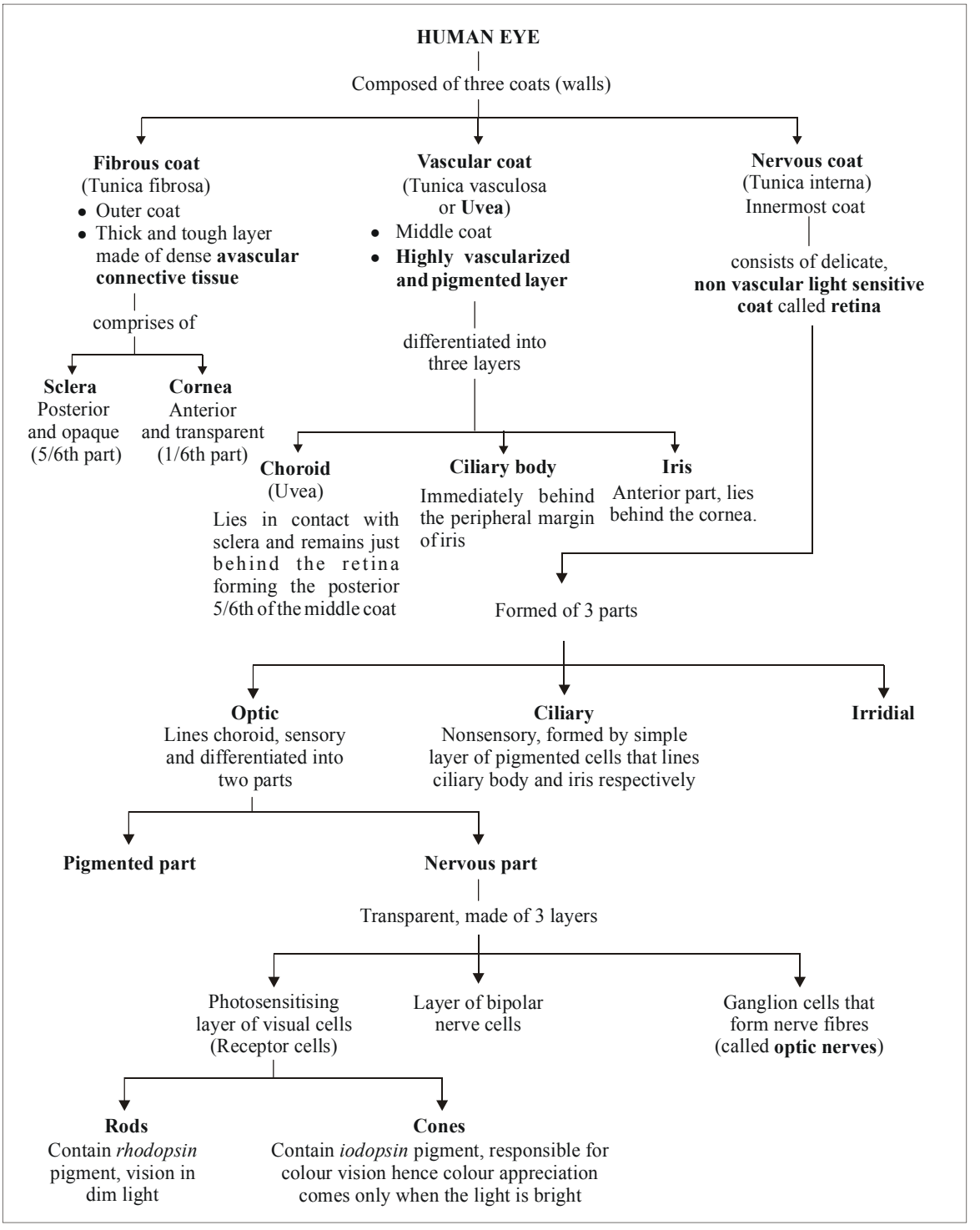
Sense Organs

- **Sense organs** is a part of the body of an animal that contains or consists of a concentration of receptors that are sensitive to specific stimuli.
- Stimuli include **pressure**, **temperature**, **chemical substances**, **vibrations**, **mechanical deformation** and **radiant energy**.
- Receptors **may act directly by opening ion channels in the cell membrane** that are part of the same receptor molecule **or indirectly by inactivating second messenger system** that go on to affect various processes in the cell.
- Stimulation of these receptors initiates the transmission of nervous impulses to the brain, where sensory information is analysed and interpreted.
- The sense of touch/pressure/pain is called **general sense** as its receptor cells lie scattered in the skin & various body parts.
- **On the basis of their location** receptors may be **interoceptors, proprioceptors, extero-receptors**.
- **Interoceptors** or **visceroceptors** receive internal stimuli like hunger, thirst etc.
- The interoceptors are simple and **mostly consists of free nerve endings**.
- **Proprioceptors** are **sensitive to changes** in tendons, muscles & joint movements. They **provide the information about the orientation of the body in space and the position of the limbs**.
- **Exteroreceptors** are somatic receptors located at or close to the body surface to receive external stimuli. Eg. cutaneous receptors & special sense organ.
- **According to type of stimuli** receptors may be **mechanoreceptors** (mechanical stimuli) **chemoreceptors** (sensitive to chemicals or their concentration); **photoreceptors** (sensitive to intensity & wavelength of light, image formation, *eg*., rods, cones & ommatidia); and **thermoreceptors** (sensitive to temperature).
- Thermoreceptors are of two types – **caloreceptors** (sensitive to heat, eg. Ruffini's organs) and **frigidoreceptors** (sensitive to cold, eg. end bulbs of krause).
- **Ampulla of Lorenzini** is a type of thermoreceptors **in scoliodon**.
- Chemoreceptors includes **taste** and **smell**.
- Skin receptors are broadly divisible into two types : free nerve endings & encapsulated nerve endings.
- **Functionally skin receptor** are of the following types– **algesireceptor** (pain); **tactile or tangoreceptors** (touch); **thermoreceptors** (temperature changes) and **vibroreceptors** (vibrations).
- **According** to their **shape & distribution**, types of tangoreceptors are –
  - **Merkels disc** [epidermis of hairless skin (glabrous)].
  - **Meissner's corpuscles** (dermis of skin of finger tip; lips & nipples, sensitive to touch & gentle pressure).
  - **Pacinian corpuscles** (present in subcutaneous tissue of palm, soles of fingers, etc. stimulated by pressure contact).
  - **Corpuscles of Mazzoni** (subcutaneous tissue of fingers, sensitive to heavy touch, pressure, joint, rotation).
  - **Free nerve endings** (present on skin, perceive the sensation of touch, pressure and pain).
  - **Hair and organ** (sensitive to touch & movement of objects).
- Tactile receptors in mammals are **maximum on the face**.
- **Rheoreceptors** detect water current like lateral line sense organ in fishes & amphibian tadpoles.
- **Nociceptors** are **sensitive to deep pain & damage to tissue**.

- **Phonoreceptors** are sensitive to sound, eg. organ of Corti.
- **Statoreceptors** are equilibrium receptors, eg. cristae & maculae.
- The **main human sense organs** are –
  - The **eye** which detects light and colour (different wavelengths of light)
  - The **ear** which detects sound (vibrations of the air) and gravity
  - The **nose** which detects some of the chemical molecules in the air
  - The **tongue** which detects some of the chemicals in food, giving a sense of taste.

ORGAN OF SIGHT - EYE

- Eyes are sense organ for **sight (vision)**.
- It is **spherical** in shape and is **located in the orbit-oblong socket of the skull**.
- Movement of eyeball in the eye orbit occurs with the help of **six eye muscles** (also called **extraocular muscles**) namely – superior oblique, inferior oblique, superior rectus, inferior rectus, external rectus and internal rectus.
- These 6 extraocular muscles are **governed by the cranial nerves III** (oculomotor), **IV** (trochlear) and **VI** (abducens).
- Eye movement disturbances can cause images to fail to focus on corresponding portions of the retina, thus resulting in double vision **(diplopia)**.
- **General structure of eye** are the **outer fibrous tunic**, the **middle vascular tunic** and the **inner nervous tunic**.
- **Fibrous coat** consists of sclera and cornea.
- Sclera and uvea are **mesodermal** and rest of the eye is **ectodermal**.
- The white of the eye is called **sclera** which **helps maintain the shape of the eye ball** and **also provides a means of attachment for the muscles that move the eye**.
- Sclera consists of tough white connective tissue.
- In the front of the eye the sclera becomes transparent forming the **cornea**.
- **Cornea** is **transparent because** the collagen fibres in this region are more regularly arranged and do not reflect light.
- Cornea is **non-vascular** (due to which its transplantation is successful) and **convex anteriorly**.
- The cornea admits light to the interior of the eye and bend the light rays and contributes to the formation of a clear image.
- Cornea **receives its nutrients from the tears and aqueous humour that fills the chamber behind it**. The cornea **admits light to the interior of the eye and bends the light rays so that they can be brought to a focus**.
- Cornea and rest of the sclerotic layer is covered by another very thin, vascularized (containing blood vessels) and transparent membrane called **conjunctiva**.
- Conjunctiva is composed of stratified epithelium and is **kept clean by the reflex blink mechanisms**.
- **Vascular coat** (commonly referred as **uveal tract**) is **deeply pigmented with melanin and reduces reflection of stray light within the eye**.
- The vascular tunic is **made up of the choroid** (the thin, dark, blood-vessel containing layer behind the retina), the **ciliary body** (that makes the fluid in the front chamber of the eye and helps to support the lens) and the **iris** (the tissue that makes up the pupil).
- Choroid layer **prevents reflection of light inside the eye**.
- The **choroid coat forms the iris** (a diaphragm) in the front of the eye. This, too, is **pigmented** and **is responsible for eye** "**colour**".
- The **pupil** is the **opening (or black dot) in the centre of the iris that regulates the amount of light received by the retina**.
- The iris has **radial and circular muscles** which allow it to vary the opening to it called the **pupil**.
- Pupil becomes **smallest in bright light** and in **dim lighter it becomes larger**.
- The size of its (**iris**) opening, the **pupil**, is variable and under the control of the autonomic nervous system. **In dim light (or when danger threatens), the pupil opens wider** letting more light into the eye. **In bright light the pupil closes down**. **This not only reduces the amount of light entering the eye but also improves its image-forming ability.**
- **Atropin** is a chemical **used** by doctors **to dilate the pupil**.
- **Ciliary body** immediately behind the peripheral margin of the iris is **thicker and less vascular** than choroid. **Its inner surface is folded to form ciliary processes**.
- Present within the ciliary body are **ciliary muscles**


HUMAN EYE
Composed of three coats (walls)
Fibrous coat
(Tunica fibrosa)
Outer coat
Thick and tough layer made of dense avascular connective tissue
comprises of
Sclera
Posterior and opaque (5/6th part)
Cornea
Anterior and transparent (1/6th part)
Vascular coat
(Tunica vasculosa or Uvea)
Middle coat
Highly vascularized and pigmented layer
differentiated into three layers
Choroid
(Uvea)
Lies in contact with sclera and remains just behind the retina forming the posterior 5/6th of the middle coat
Ciliary body
Immediately behind the peripheral margin of iris
Iris
Anterior part, lies behind the cornea.
Nervous coat
(Tunica interna)
Innermost coat
consists of delicate, non vascular light sensitive coat called retina
Formed of 3 parts
Optic
Lines choroid, sensory and differentiated into two parts
Ciliary
Nonsensory, formed by simple layer of pigmented cells that lines ciliary body and iris respectively
Irridial
Pigmented part
Nervous part
Transparent, made of 3 layers
Photosensitising layer of visual cells (Receptor cells)
Layer of bipolar nerve cells
Ganglion cells that form nerve fibres (called optic nerves)
Rods
Contain rhodopsin pigment, vision in dim light
Cones
Contain iodopsin pigment, responsible for colour vision hence colour appreciation comes only when the light is bright

as circular sheet of smooth muscle fibres that **form bundles of circular and radial muscles which alter the shape of the lens during accomodation**.

- **Accomodation** is an **adjustment for distant and close vision** during which contraction of ciliary muscles releases tension in the suspensory ligaments and allows the lens to elastically recoil and bulge out on both of its sides. This **increases the convexity of the lens and increases the level of refraction of light passing through it**.
- The **lens** is a **soft**, **transparent**, **elastic** & **biconcave structure**, **attached by suspensory ligaments** to the ciliary body.
- The lens is **responsible for focussing light coming in through the pupil onto the retina in the back of the eye**.
- The cells that forms the lens contain a protein called **crystalin** which is almost transparent and allows light to pass through.
- The **ciliary muscles of the ciliary body** contract or relax which varies the shape of the lens so that light can be focused on the inner layer – the retina.
- The **lens and the sensory ligament divide** the interior of the **eyeball into two chambers** – **aqueous** and **vitreous chamber**.
- The aqueous chamber itself consists of two chamber– **anterior** and **posterior**.
- **Anterior chamber** is the **space between the iris and cornea**.
- **Posterior chamber** is the **space between lens and iris**.
- Both anterior chamber and posterior chamber are filled with a fluid called **aqueous humour**.
- **Aqueous humour** fills space **between the cornea and the lens**.
- In addition to supplying the cornea and lens with nutrients, the aqueous humour **helps to maintain the shape of the eye**.
- Aqueous humour is **produced and renewed every four hours by the ciliary body**.
- The large space between the lens and the retina is filled with a viscous matrix called **vitreous humor**.
- Aqueous humour a clear fluid produced by the ciliary body **maintains the shape of the cornea and supply nutrition to** both lens and cornea while vitreous humour (a gel-like substance that helps to maintain the round shape of the eye **maintains the shape of the eyeball and contribute to intraocular pressure and also to the focussing of light on the retina**.
- Aqueous and vitreous humors are **rich in vitamin C**.
- A narrow **hyaloid canal** passes through vitreous humor from centre of lens to blindspot (found in rabbit not in man).
- **Canal of Schlemm** drains aqueous humor and passes to blood.
- **Nervous coat** is the innermost ocular coat that **lines the eyeball ending at the margin of the pupil**.
- **Retina** is delicate, inner, non-vascular light sensitive coat of the eyeball.
- It is differentiated into **three parts** – **optic**, **ciliary** and **iridial**.
- Ciliary and iridial parts are **nonsensory** and formed of a single layer of pigmented cells that lines the ciliary body and iris respectively.
- The irregular margin of the pars optica lying internal to the junction of choroid and ciliary body is called **ora serrata retinae**.
- The retina **acts like the film in a camera and transmits electrical images through the optic nerves to the brain**.
- The **retina may be divided into ten layers**, from the outside they are - 1. pigment layer, 2. the photoreceptor layer of rods and cones, 3. external limiting membrane, 4. external nuclear layer (cell bodies of rods and cones), 5. external plexiform layer (synapses of the rods and cones), 6. internal nuclear layer (bipolar cells), 7. internal plexiform layer (synapses of the bipolar cells with the ganglion cells), 8. ganglion cell layer, 9. nerve fibre layer, 10. internal limiting membrane.
- The **retina contains the light receptors** - the **rods** and **cones** (and thus serves as the "film" of the eye).
- The retina also has many interneurons that process the signals arising in the rods and cones before passing them back to the brain.
- The **rods** contain a purple coloured photosensitive pigment **rhodopsin** (formed from vitamin A) and are sensitive even in dim light and dark. The **cones** have a violet coloured photosensitive pigment **iodopsin** and are sensitive to bright light and colour perception.
- The **three types of cones** are– red absorbing cones **(erythrolabe)** which absorb best at the relatively long wavelengths peaking at 565 nm; green absorbing cones **(chlorabe)** with a peak absorption at 535 nm and blue absorbing cones **(cyanolabe)** with a peak absorption at 440 nm.

- The nerve fibres in the retina converge and leave the eye ball to form the **optic nerve** to conduct nerve impulses from the eye ball to the brain.
- The spot at the back of the eye, from where optic nerve fibres leave is free from rods and cones. This **spot is devoid of the ability for vision** and is called the **blind spot**.
- **Macula lutea** or **yellow spot** or **area centralis** is in the exact **centre of the retina**.
- Cones are most densely concentrated in the central **fovea**, a small depression in the centre of macula lutea.
- The **fovea centralis** is the area of **sharpest vision** (or more distinct vision) because of high concentration of cones and they are smaller and more closely packed than elsewhere on the retina. **Ability for vision is highest in the fovea**.
- **Peripheral portion** of retina is **most suitable for detecting motion** *i.e* moving objects.
- Rods are absent in **fovea & macula**.
- **Photopic vision** is associated with cones.
- Light splits rhodopsin (visual purple) into a pigment **retinene (= retinol)**, an aldehyde derivative of vitamin A and a protein **scotopsin (opsin)**. The process of splitting is called **bleaching**. This depolarizes the rod cells to release a neurotransmitter, transmitting the nerve impulse to the bipolar cells, ganglion cells and then to the optic nerves.
- **Vitamin A** is an **important constituent of retinene** so **its deficiency causes deficiency of rhodopsin** inducing **night blindness**. Red green colour blindness is hereditary.
- **Path taken in the eye ball by light rays are** – conjunctiva → cornea → aqueous humour → lens (through pupil) → vitreous humour → retina.
- The retina **converts light energy into electrical signals and sends them to the brain** *via* **the optic nerve**. In the brain the electrical signals are translated into an image that is perceived in an upright position.
- The **eyelids** are extensions of the skin of the face, and they are designed to protect the eye. The outer surface of the eyelid is covered with skin and sometimes contains the cilia (eyelashes). The inside is lined with a pink-white coloured conjunctival membrane.
- The nictitans or **third eyelid** arises from the inside corner of the eye and contains a strong cartilage support and a tear gland. It is also designed as an extra protective mechanism for the eye.
- The **lacrimal system**, which includes the lacrimal (major tear) gland and the gland of the third eyelid, is **responsible for tear production and drainage of tears away from the eye**.
- **Harderian glands**, found in whale, mice, shrew etc., are located close to the inner angle of eye & secrete a lubricant for nictitating membrane.
- **Rabbit and man** do not possess harderian gland.
- **Pecten**, a comblike structure is found in eye of birds.
- **Grandy's corpuscles** is a special type of merkel's corpuscles present in skin of beak & tongue in birds.
- Binocular vision is found in **mammals & birds** (owl).
- Retina of **owl contains only rods** and **fowl contains only cones**.
- **Tapetum lucidum**, made up of crystalline layer with zinc, cystein & guanin, increases sensitivity of vision.

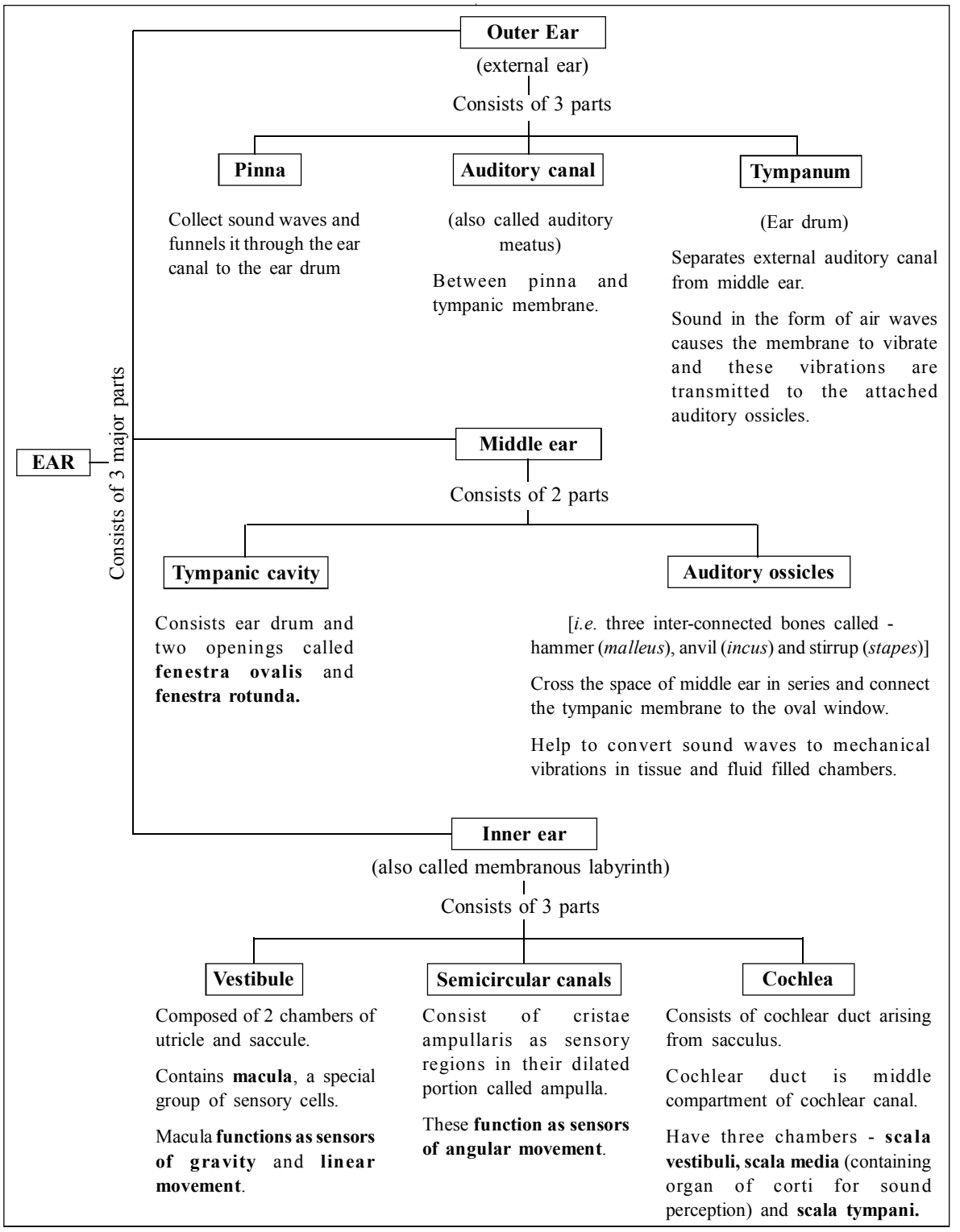
Disorders of eye

- **Myopia**, also called **short sightedness** is characterized by longer eye ball & focal point in front of retina.
- **Hypermetropia**, also called **long sightedness**, is characterized by short eye ball in anterior-posterior direction and focal point behind the retina.
- **Presbyopia** is inability to focus on nearby objects due to loss of elasticity of crystalline lens.
- **Cataract** is loss of transparency of the lens.
- **Trachoma** is a chronic contagious conjunctivitis caused by infection of a bacterium *Chlamydia trachomatis*.
- **Astigmatism** is a condition in which irregular lens or cornea produce a blurred image.
- Deficiency of any cone pigment result in **colourblindness**.
- **Protanopia** is red colour blindness.
- **Deuteronopia** is green colour blindness.
- **Tritanopia** is blue colour blindness.
- **Glaucoma** is a condition in which loss of vision occurs because of an abnormally high intraocular pressure in the eye may be due to blockage of canal Schlemm [a venous channel at the junction between the iris and the cornea (anterior chamber angle)]. It may cause blindness.
- Squint results in **diplopia or two images**. It occurs

due to **weakness in ocular muscle** or due to **defect in position of the two eyes**.

ORGAN OF HEARING - EARS

- Ears are **statoacoustic organs** meant for both balancing & hearing.
- Ear **contains** both **receptors that respond to movements of the head** and **receptors that convert sound waves into nerve impulses**. Impulses from both types of receptors are transmitted *via* the vestibulocochlear (VIII) cranial nerve to the brain for interpretation.
- The ear of a human adult consists of **three structural and functional divisions** : the **external ear, the middle ear**, and **the inner ear**.
- External ear consists of **pinna (auricle)**, **auditory canal** & **tympanic membrane**.
- **Pinna** is **non-functional (vestigial)** in human.
- It is an **immovable cartilaginous** structure that lead into the auditory canal.
- In case of mammals like cats, dogs & elephant, **pinna is movable**.
- Pinna, the outer visible part of the outer ear, is meant for **collecting sound waves**.
- The pinna consists of a cartilaginous framework of elastic connective tissue covered with skin. The **lower flexible lobe** (called **lobule**) **is the only part of the pinna which is not supported by cartilage**.
- The **external auditory meatus** is a S-shaped, short canal extending from the pinna to the ear drum (tympanic membrane or tympanum).
- Deeper within the meatus are **ceruminous glands** (wax-secreting glands), which keeps the tympanum soft and waterproof and together with the hairs prevent foreign objects from reaching the ear drum.
- **Tympanic membrane** (also **called ear drum**) is a thin, delicate membranous structure that **vibrates in response to the sound waves tapping on its outer surface**.
- Tympanum is composed of an outer concave layer of stratified squamous epithelium and an inner, convex layer of low columnar epithelium.
- It is **innervated by the auriculotemporal nerve** [a branch of the mandibular portion of the trigeminal (V) cranial nerve] and the auricular nerve (a branch of the vagus (X) cranial nerve].
- The **middle ear** is a narrow air filled cavity **(tympanic cavity)** located in the temporal bones of the skull. It is separated from the external auditory meatus of the outer ear by the tympanic membrane.
- Middle ear is connected to pharynx by an air filled tube called **eustachian canal**.
- The eustachian canal **maintains the balance in air pressure between two sides of the eardrum** thus allows it to vibrate freely when sound wave strike it.
- The pharyngeal opening of eustachian tube is closed by **tensor palati**.
- Middle ear consists of **three tiny bones** (called **ear ossicles**) that vibrate in response to the vibrations of the ear drum.
- **Three ear ossicles** are : hammer shaped **malleus**, anvil shaped **incus** and stirrup shaped **stapes**.
- **Stapes** bone and its muscle **'stapedius'** are the **smallest in the human body**.
- There are **two small skeletal muscles** - the **tensor tympani** which attaches to the malleus; and the **stapedius** which attaches to the stapes. They contract reflexly and very quickly to protect the ear against loud noises.
- The tensor tympani **pulls the malleus away from the tympanic membrane** while the stapedius **pulls the stapes away from the oval window** and changes its orientation 90 degrees.
- The auditory ossicles **transmit sound induced vibrations of the ear drum to the fluid called endolymph**, **filling the internal ear**.
- Tympanic cavity is connected with auditory capsule by **two apertures – oval window** (fenestra ovalis) and **round window** (fenestra rotundus).
- The **internal ear or inner ear** is called labyrinth consisting of two parts – **bony labyrinth**, **membranous labyrinth**.
- Bony labyrinth is filled with a fluid called **perilymph**.
- Membranous labyrinth contains a fluid called **endolymph**.
- Membranous labyrinth is divided into **three parts – vestibule, semicircular canal** & **cochlear duct**.
- **Vestibule** is a central sac having larger upper **utriculus** & a smaller lower **sacculus** sac containing granules of calcium carbonate called **otolith** (ear stones).
- Both utricle and saccule **contain receptors which are sensitive to gravity and linear movements of the head**.
- Utriculus and sacculus, connected by a small narrow **sacculo-utricular duct**, are often called **otolith organ**.


EAR
Consists of 3 major parts
Outer Ear
(external ear)
Consists of 3 parts
Pinna
Collect sound waves and funnels it through the ear canal to the ear drum
Auditory canal
(also called auditory meatus)
Between pinna and tympanic membrane.
Tympanum
(Ear drum)
Separates external auditory canal from middle ear.
Sound in the form of air waves causes the membrane to vibrate and these vibrations are transmitted to the attached auditory ossicles.
Middle ear
Consists of 2 parts
Tympanic cavity
Consists ear drum and two openings called fenestra ovalis and fenestra rotunda.
Auditory ossicles
[i.e. three inter-connected bones called - hammer (malleus), anvil (incus) and stirrup (stapes)]
Cross the space of middle ear in series and connect the tympanic membrane to the oval window.
Help to convert sound waves to mechanical vibrations in tissue and fluid filled chambers.
Inner ear
(also called membranous labyrinth)
Consists of 3 parts
Vestibule
Composed of 2 chambers of utricle and saccule.
Contains macula, a special group of sensory cells.
Macula functions as sensors of gravity and linear movement.
Semicircular canals
Consist of cristae ampullaris as sensory regions in their dilated portion called ampulla.
These function as sensors of angular movement.
Cochlea
Consists of cochlear duct arising from sacculus.
Cochlear duct is middle compartment of cochlear canal.
Have three chambers - scala vestibuli, scala media (containing organ of corti for sound perception) and scala tympani.

- **Macula**, a group of sensory cells are found in both sacs.
- Macula **takes part in maintaining static equilibrium**.
- The **sense organ of the utricle** is called the **macula triculi** which is an oval thickened area in which fibres of the vestibular branch of the acoustic nerve terminate. It is covered with hair cells which respond to movement of the endolymph.
- The saccule has openings into the endolymphatic duct and the cochlear duct.
- The sense organ of saccule is the **macula sacculi**.
- **Crus commune** is the **dorsal part of utriculus**. Anterior and posterior semicircular canals arise from crus commune.
- **Semicircular canals** are three semicircular ducts borne over the utriculus at right angles to one another.
- Three semicircular canals are – **anterior vertical**, **posterior vertical** and **lateral horizontal**.
- The lower end of each semicircular canal has a swelling called **ampulla** containing a group of sensory hair cells called **cristae**.
- **Cristae**, covered by a mass of gelatinous material (**cupula**) **has longer sensory hairs** & **lacks otolith** (particle of calcium carbonate).
- Cristae **maintains dynamic equilibrium of the body**.
- There are two types of equilibria – **static equilibrium** and **dynamic equilibrium**.
- **Static equilibrium** refers to orientation of the body (mainly head) relative to gravity.
- **Dynamic equilibrium** is the maintenance of the body position in response to sudden movements.
- The **receptor organs for equilibrium** are the **sacculus**, **utriculus** and **semicircular canals**. All of these are known as **vestibular apparatus**.
- Vestibular apparatus is a type of **proprioceptor**.
- Utriculus and sacculus are considered to be sense organs of **static equilibrium**. The three semicircular canals maintain **dynamic equilibrium**.
- Semicircular canals **responds to rotatory movement of head**. The crista is stimulated by movement of endolymph. This movement causes distortion of hair cells and effect neural impulse from ampulla. The direction and rate of displacement of the cupula (which is bent in the opposite direction to head movement) are both detected by the receptor cells. Linear acceleration is detected by both the maculae and cupulae.
- The **utricle responds to vertical movements of the head and the otoconia** (regions of the walls of utricle and saccule, called maculae, contain receptor cells which have their hair like process embedded in a gelatinous mass that contain $CaCO_3$ granules, this mass is called an otoconium) **produce maximum stimulation when pulling the receptor hairs downwards when the body is upside down**.
- The saccule **responds to sideways movement of the head**.
- **Cochlea** (auditory region of internal ear) is a long coiled tubular and blind outgrowth of sacculus.
- Cochlea is **divided into 3 chambers – scala vestibuli**, **scala media** & **scala tympani**.
- **Scala media** is also known as **cochlear duct**.
- Scala media **contains endolymph** while the other two chambers contain **perilymph**.
- Two partitions in cochlea are dorsal vestibular membrane, also called **Reissner's membrane**, between scala media and scala vestibuli & ventral **basilar membrane** between scala media and scala vestibuli.
- **Helicotrema**, a small whole or narrow passage permits continuity between scala vestibuli & scala tympani.
- Scala media **has receptor organ for hearing** called **organ of corti** containing **receptor hair cells**, **Deiter's cell** & **cells of Hensen** etc.
- **Organ of Corti** (also called **spiral organ**) rests on the basilar membrane.
- **Tectorial membrane** is a thin, gelatinous ribbon-like sheet of connective tissue.
- Tectorial membrane overhangs the hair cells in close contact with tissue.
- The organ of Corti is stimulated by sound waves or nerve impulse of hearing starts from organ of Corti.
- Organ of Corti is **associated with hearing**.
- The perception of sound by a mammal involves the stimulation of mechanoreceptors located on organ of corti.
- The **measuring unit of sound** is **decibel**.
- Ear is most sensitive to frequency **1000-3000 cycles/sec**.

Disorders of ear

- **Labyrinth** is an infection or inflammation of the inner ear causing dizziness and loss of balance.

- **Meniere's disease** is an inner ear fluid balance disorder that causes episodes of vertigo, fluctuating hearing loss, tinnitus (a raging or roaring in the ears), and sensation of fullness in the ear.
- **Otitis media** is an infection or inflammation of the middle ear. This inflammation often begins when infections that cause sore throats, colds, or other respiratory or breathing problems spread to the middle ear.
- **Presbyacusis** is a hearing loss occurring with age. It occurs due to decreased blood supply to the inner ear possibly due to heart disease, high blood pressure or arteriosclerosis or hereditary factors.
- **Tinnitus** is a ringing sensation in the ears caused by irritative stimulation of either the inner ear or the vestibulocochlear nerve. In this the person hears when there is no real sound. It is usually accompanied by hearing loss.
- Ear is most sensitive to frequency **1000-3000 cycles/sec**.
- Inflammation of ear drum is called **myringitis**.
- **Deafness** means impairment of hearing. It can occur at any age.
- Deafness is **classified principally as being of two types** : conductive loss of hearing and sensorineural deafness.
- **Conductive loss** occurs when the ossicular chain (the bones in the middle ear – the hammer, anvil and stirrup) do not function properly. This type of loss can be surgically treated.
- **Sensorineural deafness** (or **nerve deafness**) occurs from damaged nerves in the inner ear and can generally be treated only by the use of a hearing aid (if there is residual hearing). Sensorineural deafness can result from long exposure to excessive noise levels, diseases such as whooping cough or measles, or the ageing process.

ORGAN OF SMELL–NOSE

- The nose may be called the sense organ for olfaction (smell).
- Receptors for smell occur in a modified form of pseudostratified epithelium covering a part of the nasal mucosa. It is called **olfactory epithelium**.
- The olfactory receptor cells function as **chemoreceptors**. They are **stimulated by specific chemical substances and produce impulse of smell**.
- Olfactory receptor cells are **bipolar neurons**.
- **Jacobson organ** is concerned with smell, present in the anterior part of nasal cavity. This organ is **well developed** in dogs and snakes & **less developed** in birds and mammals.
- Continuous smelling of an odour make the receptor cells immune to the odour and the receptor cells fail to respond to the sensation. It is called **olfactory adaptation**. This is the reason that a person cease to smell the perfume on his dress after sometime.

ORGAN OF TASTE–TONGUE

- **Taste buds** are the **organs for taste sensation** (gustatory receptors).
- They are present on the papillae of mucous membrane on the surface of tongue. The human tongue bears about 10,000 taste buds. Some taste buds occur in hard palate, pharynx and epiglottis also.
- Papillae containing taste buds are of **four types** - foliate, fungiform, filiform & circumvallate.
- **Foliate** is **absent in man**.
- **Filiform** does not contain taste buds and are located near centre & most of them on the upper surface of tongue. Hence nongustatory in function.
- **Foliate** is present on the posterior part of tongue, anterior to circumvallate papillae and found in rabbit & other mammals.
- **Circumvallate** (largest type) form an inverted V shaped row at the posterior **part of the tongue**.
- Types of taste buds corresponding to the taste are – **sweet**, **sour**, **bitter** & **salt**.
- **Sweet taste** are produced by various class of organic molecules including sugar, glycols & aldehydes.
- **Salt taste** is associated with anions of ionizable salt.
- **Sour taste** is produced by weak acid like the one present in unripened fruits etc.
- **Bitter taste** refers to the taste of alkaloids (little quinine, caffeine).
- Moth & butterflies have their chemoreceptors on **antennae**.
- A taste bud has **taste receptor cells** or **gustatory cells** which act as **chemoreceptors**.
- These cells bear sensory hair at free ends, which are connected to nerve fibres at other end. The taste bud communicates to the surface of the tongue by a narrow taste pore.
- The anterior part of the tongue is most sensitive to **sweet taste**, back to the bitter and sides to **salty** and **sour**. The taste of chillies is a sensation of burning pain of the pain receptors of the tongue.

End of the Chapter