SPECIAL SENSES

Special senses are senses of hearing, sight, smell, taste and balance. Organs include

1. ***Ears***
2. ***Eyes***
3. ***Nose***
4. ***Tongue***

- All have specialized sensory receptors that collect and transmit information to specific areas of brain
- Incoming nerve impulses from the ears, eyes, nose and mouth are integrated and coordinated within the brain – allows perception of information

EAR

- **Ear** – organ of hearing & involved in equilibrium (i.e maintain balance & orientation in space)
- Supplied by cochlear branch of 8th cranial nerve
- Sound vibrations are converted to electrical signals – then information transmitted to brain

Anatomy

- Ear is divided into 3 main regions

1. The ***outer/ external ear*** – collects sound waves, directs them to middle ear
2. The ***middle ear (tympanic cavity)*** – conveys sound vibrations to oval window/ inner ear
3. The ***inner/ internal ear*** – contains receptors for hearing & equilibrium; converts sound waves into nerve impulses – transmitted to auditory cortex of brain

External (Outer) ear

- Consists of

1. The auricle (pinna)
2. The external acoustic meatus (auditory canal)
3. Eardrum

Auricle

- Visible part of ear, projects from side of head
- Composed of fibroelastic cartilage, covered with skin

- Deeply grooved & ridged
- Most prominent outer ridge/ rim of auricle is called ***helix***
- Inferior portion is called ***lobule/ ear lobe***

External acoustic meatus (auditory canal)

- Slightly 'S' shape/ curved tube – 2.5 cm long
- Extends from auricle to tympanic membrane
- Lies in temporal bone; lined with skin
- Contains few hairs & numerous specialised sweat glands called ***ceruminous glands – secrete cerumen (earwax)***
- Cerumen – sticky material containing protective substances like bactericidal enzyme lysozyme, immunoglobulins
- Prevent dust, foreign objects from entering ear

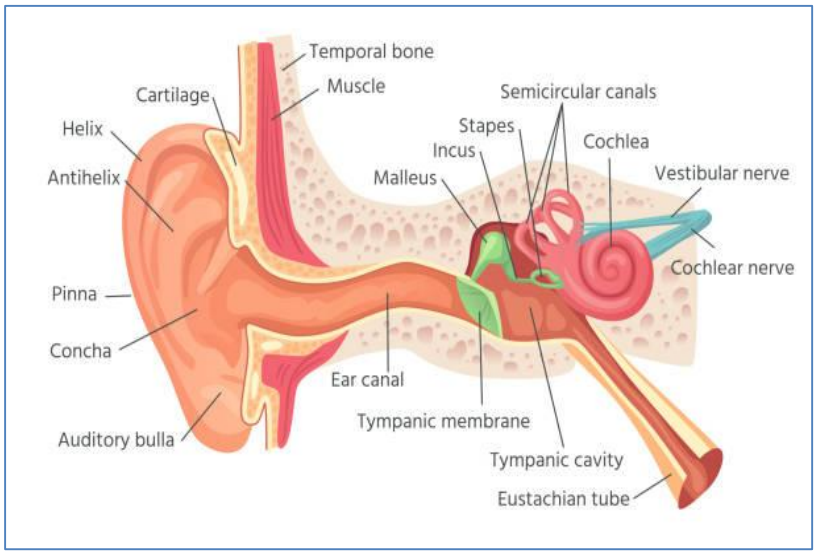
Tympanic membrane (eardrum)

- A thin, semitransparent partition between external auditory canal & middle ear
- Oval shaped & formed by 3 layers of tissue

  Outer – hairless skin

  Middle – fibrous tissue

  Inner – mucous membrane



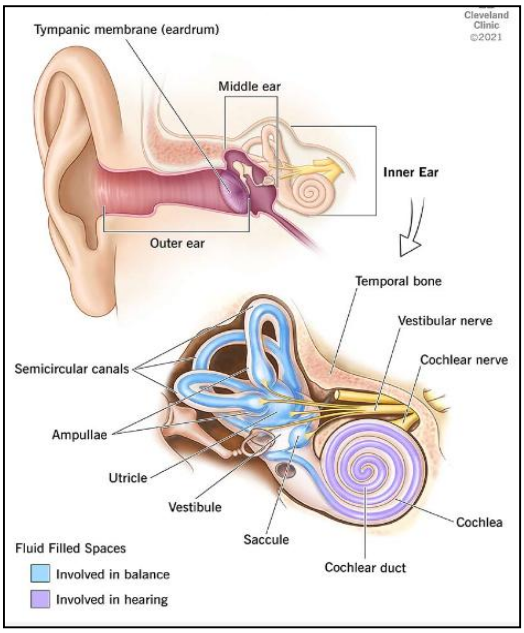
Middle ear (tympanic cavity)

- Small, irregular shaped air filled cavity within petrous portion of temporal bone

- Lined by simple squamous or cuboidal epithelium
- Lateral wall is formed by tympanic membrane
- Medial wall has 2 small openings;

1. ***The oval window &***
2. ***The round window***

- Extends across middle ear are 3 smallest bones in the body called *auditory ossicles* –
    1. Malleus (hammer)
    2. Incus (anvil)
    3. Stapes (stirrup)
- Handle of the malleus attaches to internal surface of tympanic membrane & head articulates with body of incus
- *Incus* articulates with head of stapes
- Base or foot plate of stapes fits into oval window
- Anterior wall of middle ear has an opening that leads directly into ***auditory tube/ pharyngotympanic tube called Eustachian tube***



- Links middle ear with nasopharynx
- During swallowing & yawning, it opens and allows air to enter or leave middle ear until pressure equals with atmospheric pressure – popping sound
- Pressure balanced, tympanic membrane vibrates freely as sound waves strikes it

Inner/ Internal ear

- Also called ***labyrinth*** – contains organs of hearing & balance
- Structurally – 2 divisions

1. Outer bony labyrinth encloses
2. Inner membranous labyrinth (tube inside a tube)

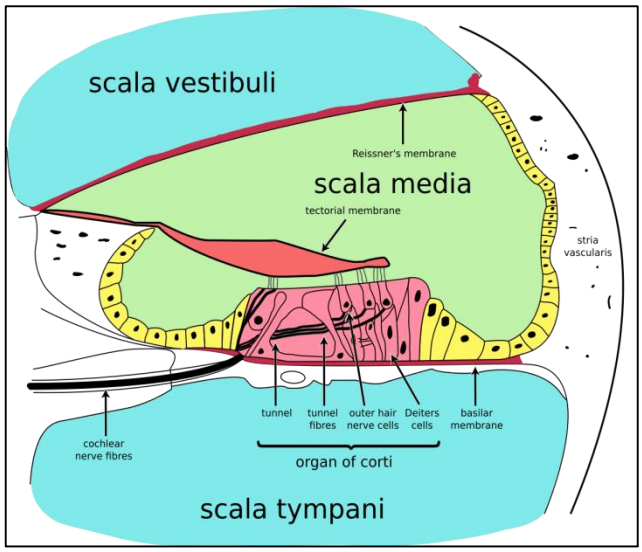
Bony labyrinth

- A series of cavities or network of channels in petrous portion of temporal bone

- Divided into 3 areas

1. *3 semicircular canals*
2. *The vestibule – utricle & saccule*
3. *The cochlea*

- Lined with periosteum & contains watery fluid called ***perilymph***



Membranous labyrinth

- A series of epithelial sacs & tubes inside bony labyrinth
- Has receptors for hearing & equilibrium
- Filled with ***endolymph***

Vestibule

- Oval central portion of bony labyrinth
- Membranous labyrinth consists of 2 sacs – *utricle & saccule* – connected by small duct, important in balance

Semicircular canals

- Bony semicircular canals – project superiorly & posteriorly from vestibule
- One end of each canal has swollen enlargement called *ampulla*
- Continuous with vestibule, also important in balance

Cochlea

- A bony snail-shaped spiral canal
- Broad base & narrow apex, spirals three turns around a central bony column
- Cross-section of cochlea contains 3 components

1. *Cochlear duct/ scala media* – contains organs of hearing; continuation of membranous labyrinth into cochlea – filled with endolymph
2. *Scala vestibuli* – channel above cochlear duct, ends at oval window
3. *Scala tympani* – channel below, ends at round window

- 2, 3 are part of bony labyrinth – filled with perilymph
- *Vestibular/ Reissner's membrane* – separates cochlear duct from scala vestibuli
- *Basilar membrane* – separates cochlear duct from scala tympani

• There are supporting cells & specialised cochlear hair cells containing auditory receptors

- These cells form the spiral organ or organ of corti, a sensory organ
- Responds to vibration by initiating nerve impulses – in brain, perceived as hearing
- Auditory receptors are the dendrites of sensory nerves combine forming cochlear part of 8th cranial nerve – pass through foramen in temporal bone, then to hearing area in temporal lobe of cerebrum

Physiology of hearing

Sound carried as pressure waves (alternative high pressure & low pressure)

↓

Auricles collect & concentrate sound waves, directs them along external auditory canal

↓

Strike tympanic membrane – vibration

↓

Vibrations transmitted & amplified by middle ear due to movement of ossicles

↓

Stapes move back & forth in oval window

↓

Set up fluid waves in perilymph of scala vestibuli

↓

Scala tympani and eventually to round window

↓

Push vestibular membrane back & forth – pressure waves in endolymph in cochlear duct

↓

Vibration of basilar membrane & stimulation of auditory receptors in hair cells of spiral organs

↓

Generation of nerve impulses

↓

Cochlear portion to vestibulocochlear nerve

↓

Auditory nuclei in medulla

↓

Auditory area in temporal lobe of cerebrum

↓

Perception of SOUND

Physiology of balance

- Semicircular canals have no auditory function
- 3 membranous ducts open into utricle at their dilated ends called ampullae
- Saccule is the part of vestibule & communicates with utricle & cochlea
- Walls of utricle, saccule, ampulla has fine specialised epithelial cells with minute projections called hair cells, among which are the receptors i.e. sensory nerve endings – combine – 8^{th} nerve

Any change of position of head

↓

Movement in endolymph bathing hair cells

↓

Stimulation of receptors in utricle, saccule & ampulla

↓

Generation of nerve impulses

↓

Vestibular nerve – joins cochlear nerve to form vestibulocochlear nerve

↓

Cerebellum – also receives from eyes & receptors in skeletal muscle

↓

Coordination of all

↓

Maintain posture & balance

Disorders of the Ear

Hearing loss

- ***Conductive hearing impairment***

  Otosclerosis

  Serous otitis media

- ***Sensorineural hearing impairment***

  Meniere's disease

  Presbycusis
- ***Mixed***

Ear infections

- ***External otitis***
- ***Acute otitis media***
- ***Chronic otitis media***

Labyrinthitis

Motion sickness

Hearing Loss

Conductive hearing impairment

- Occurs when abnormality of outer or middle ear impairs conduction of sound waves to oval window
- Common causes

1. *Acute otitis media*
2. *Serous otitis media*
3. *Chronic otitis media*
4. *Barotrauma*
5. *Otosclerosis*
6. *External otitis*
7. *Injury of the tympanic membrane*

Otosclerosis

- Abnormal bone develops around footplate of stapes, fuse it to oval window – reduce ability to transmit sound waves across tympanic cavity
- Common cause of progressive conductive hearing loss in young adults

Serous otitis media

- Also called ***'glue ear' or secretory otitis media***
- Collection of fluid in middle ear cavity
- In preverbal children, common causes of hearing impairment – delayed speech and/ or achievement of developmental milestones

Sensorineural hearing impairment

- More prevalent form of hearing impairment
- Result of a disorder of nerves of inner ear or the CNS. ***Ex:*** cochlea, cochlear branch or auditory area of cerebrum
- Common causes

1. *Presbycusis*
2. *Longterm exposure to excessive noise (most common)*
3. *Congenital*
4. *Meniere's disease*
5. *Ototoxic drugs (Ags, diuretics, chemotherapy)*
6. *Infections (mumps, meningitis, syphilis etc.)*

Meniere's disease

- Accumulation of endolymph with destruction of sensory cells in ampulla & cochlea – distension & increase in pressure in membranous labyrinth
- Cause – unknown
- Associated with recurrent episodes of dizziness (vertigo), nausea, vomiting lasting for several hours
- During & between the attacks – continuous ringing sensation in ears (tinnitus)
- Loss of hearing during episodes
- Destruction of spiral organ leads to permanent hearing loss

Presbycusis

- Hearing impairment due to ageing process, common in older adults
- Degenerative changes in sensory cells of spiral organ – sensorineural hearing loss
- High-frequency sound perception impaired first – low frequency

Ear infections

External otitis

- Localised inflammation in auditory canal
- Usual cause is infection by *Staphylococcus aureus*
- Generalised inflammation – prolonged exposure to bacteria or fungi or by an allergic reaction
- ***Ex:*** soaps, hair sprays or hair dyes

Acute otitis media

- Inflammation of middle ear cavity, due to upwards spread of microbes from upper respiratory tract infection via auditory tube
- Very common in children – severe ear ache
- Can spread to external ear through perforation in tympanic membrane
- Bacterial infection – accumulation of pus & outward bulging of tympanic membrane
- May rupture tympanic membrane & pus discharges out

Chronic otitis media

- Recurrent, persistent or untreated acute otitis media, mechanical injury – permanent perforation of tympanic membrane
- Healing – stratified epithelium grows into middle ear – cholesteatoma (collection of desquamated epithelial cells & purulent material)

Labyrynthitis

- It is the inflammation of labyrynth or inner ear
- Complication of middle ear infection
- Accompanied by vertigo, nausea & vomiting, nystagmus

Motion sickness

- Occurs when brain receives conflicting sensory information ***i.e.*** visual information received from eyes do not match information from semicircular canals
- Causes nausea & vomiting in some people – usually associated with travel

EYE

- It is an organ of SIGHT

External Anatomy

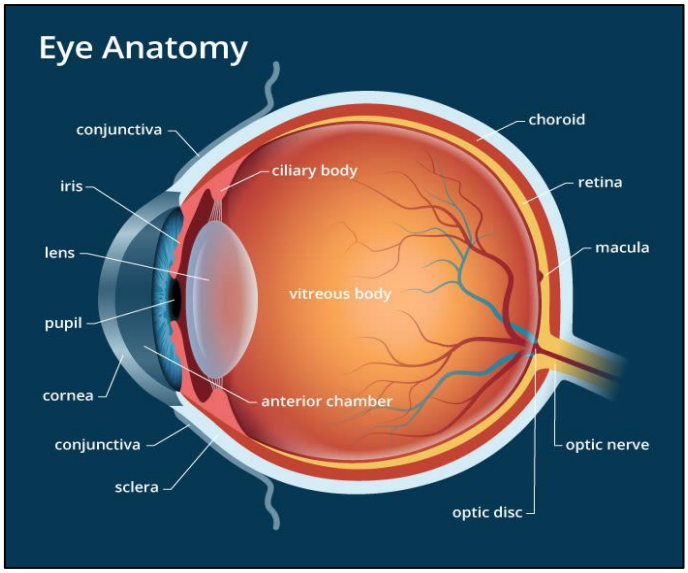
- Eye is situated in the orbital cavity and supplied by optic nerve
- Almost spherical in shape, 2.5 cm in diameter
- Space between the eyes and orbital cavity is occupied by adipose tissue
- Bony walls of orbit, fat – protect the eye from injury

Internal Anatomy

- Internally, eye is divided into 2 chambers

1. ***Anterior chamber***
2. ***Posterior chamber***

- Lens, ciliary body & suspensory ligaments separate both the chambers
- Anterior chamber – filled with clear watery fluid called *aqueous humor*
- Posterior chamber – filled with jelly-like substance called *vitreous humor (vitreous body)*
- Wall of eye is made of 3 layers of tissue



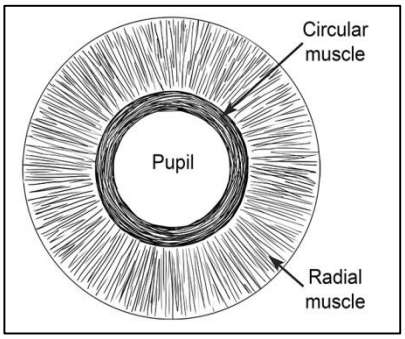
1. Outer ***fibrous layer*** – sclera & cornea
2. Middle ***vascular layer*** or uveal tract – choroid, ciliary body & iris
3. Inner ***nervous tissue layer*** – the retina

Sclera

- It is the ***white of the eye***
- Outermost layer of posterior & lateral aspects of eyeball
- Continuous anterior with cornea
- Firm fibrous membrane – maintains shape of eye & gives attachment to extrinsic muscles of the eye

Cornea

- A clear transparent epithelial membrane
- Convex anteriorly; ***refract (bending) light rays*** to focus them on retina



Choroid

- Lines posterior 5/6th of inner surface of sclera
- ***Rich in blood vessels***, deep chocolate brown in colour
- Light enters eye through pupil, stimulate sensory receptors in retina & then absorbed by the choroid

Ciliary body

- Anterior continuation of choroid
- Consists of ***ciliary muscle (smooth muscle fibers) & secretory epithelial cells***
- Lens attached to ciliary body by radiating suspensory ligaments
- Contraction and relaxation of ciliary muscle fibers determine the size & thickness of the lens
- Epithelial cells – ***secrete aqueous humor***; circulates through anterior chamber to nourish its structures
- Supplied by parasympathetic branches of occulomotor nerve – contraction of muscle & accommodation of eye

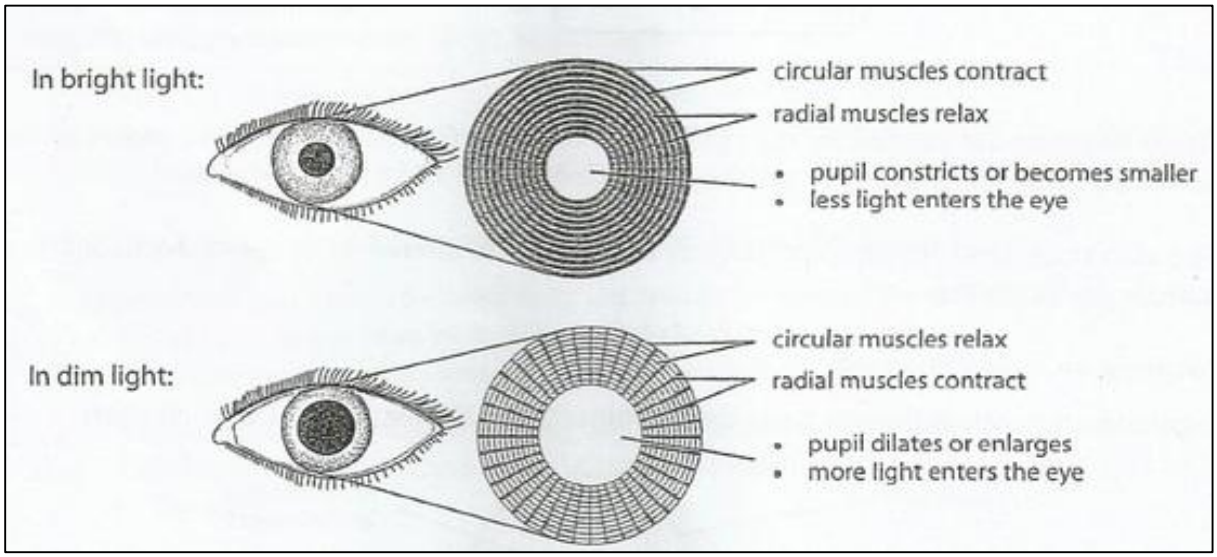
Iris

- Visible ***colored ring at front of eye***
- Extends anteriorly from ciliary body, lies behind cornea and in front of lens
- Divides anterior chamber of eye into anterior & posterior cavities – contain aqueous humor secreted by ciliary body
- ***Anterior cavity*** – between iris & cornea
- ***Posterior cavity*** – between lens & iris
- Composed of pigment cells & 2 layers of smooth muscle fibers called –

1. ***Radial muscles***
2. ***Circular muscles***

- Aperture in the center – ***pupil***
- Parasympathetic supply, constricts the pupil whereas sympathetic supply dilates the pupil

- Color of iris – genetically determined & depends on number of pigment cells



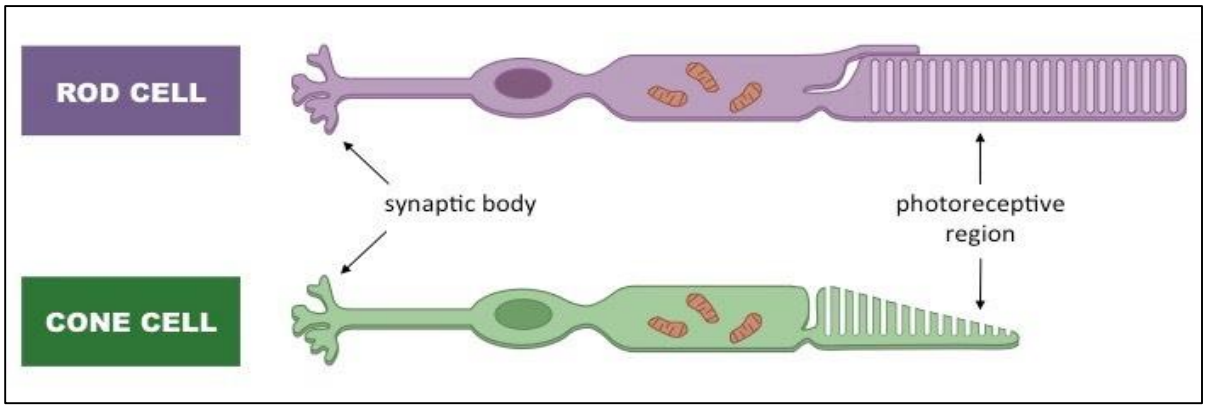
Lens

- A highly elastic circular biconvex body, lying immediately behind pupil
- Consists of fibers enclosed within a capsule & suspended from ciliary body by suspensory ligaments
- Thickness is controlled by ciliary muscle
- Bends/ refracts the light rays reflected into eye from objects in visual field
- Only structure in the eye that can vary its thickness
- Nearer the object being viewed, thicker the lens become to allow focusing

Retina

- Innermost lining of the eye
- Extremely delicate structure composed of several layers of nerve cell bodies & their axons
- ***Light-sensitive layer – has sensory receptor cells called rods & cones***
- Rods & cones contain photosensitive pigments that convert light rays to nerve impulses
- Retina lines 3/4th of eyeball, thickest at back, anteriorly end just behind ciliary body
- Near the center of posterior part – ***macula lutea or yellow spot***
- Center of the yellow spot has little depression called ***fovea centralis***, where only cones are present

- About 0.5 cm to nasal side of macula lutea – all retinal nerve fibers converge to form ***optic nerve***
- Area of retina where optic nerve leaves the eye – ***optic disc or blind spot*** (no light sensitive cells)



Inferior of the eye

- Aqueous humor circulates in front of the lens through pupil into anterior cavity, return to venous circulation through scleral venous sinus (canal of schlemm) in the angle between iris & cornea
- Intraocular pressure – constant between 1.3 & 2.6 K Pa (10 & 20 mm Hg), when production & drainage rates are equal
- Increase in IOP – glaucoma
- Aqueous humor supplies nutrients & removes wastes from transparent structures that do not have blood supply – cornea, lens & lens capsule
- Shape of the eye is because of IOP due to both humors

Functions of the retina

- Retina, photosensitive layer that contains photosensitive cells called rods & cones
- Light rays cause chemical changes in photosensitive pigments – generate nerve impulses – conducted to occipital lobe of cerebrum via optic nerve

Cones

- Sensitive to light & color, responsible for vision at higher light levels
- Gives sharp, clear color vision
- Concentrated at macula lutea & number of rods increase peripheral to macula lutea

Rods

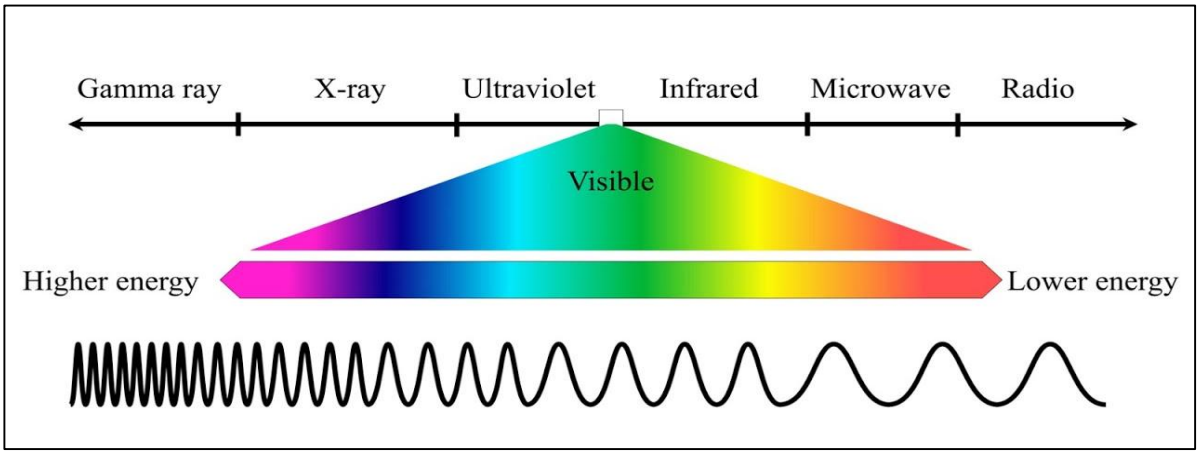
- Much more light sensitive than cones
- Responsible for vision at low light levels
- Stimulation of rods – monochromic (black & white) vision
- Rods : Cones = 16 : 1

Rhodopsins

- Family of light-sensitive pigments found in rods & cones
- Broken down (bleached) when absorb light & generate action potential
- Rods – only 1 type of rhodopsin, absorb single wavelength – gives monochromic vision
- Cones – 3 different rhodopsins, absorb 3 different wavelengths – give rise to red, blue, green cones – combination of 3 – color perception
- Adequate rhodopsin production requires good supply of Vitamin-A

Physiology of Sight

- Light is reflected into eyes by objects within the field of vision
- ElectroMagnetic Radiation (EMR) – energy in the form of waves that radiates from sun



- Eyes are responsible for detection of visible light, part of the EMR – 400-700 nm
- White light is a combination of all colours of visual spectrum & color depends on the wavelength
- Object will appear the color of wavelength that is reflected

Ex: An object appears red when it reflects only red light, white when reflects all wavelengths and blach when absorbs all the light

- To achieve clear vision, light reflected from objects with visual field is focused on to the retina of each eye
- Eyes form images based on

1. ***Refraction/ bending of light by the lens & cornea***
2. ***Accommodation – change in shape of the lens***
3. ***Constriction or narrowing of pupil***

Refraction of light rays

- Light rays entering eye refracted at cornea & further at lens, so that exactly focused on the retina
- Images focused on retina are inverted (upside down). Brain stores the inverted & reversed images early in life – so interprets the visual images correctly
- 75% of total refraction occurs at cornea, remaining 25% at lens
- Light from distant objects needs least refraction and from closer objects need more refraction
- To focus light rays from near objects on retina, refractive power of lens must be increased & is done by accommodation

Accommodation

- ***Process by which the focal length of the eyes is changed to form a clear image on the retina is called accommodation of the eye***
- For distant objects, ciliary muscles relaxes & lens become flatter/ thinner
- For close objects, ciliary muscles contract & ciliary body move towards lens. This lessens pull on suspensory lugaments leading to bulging of the lens - ↑ focusing power – focus light rays on retina

Constriction/ change in size of pupils

- Pupil size contributes to clear vision by controlling amount of light entering the eye
- In bright light, pupils constricted and in dim light they are dilated

Accessory organs of the eyes

1. **Eyebrows**
2. **Eyelids & eyelashes**
3. **Lacrimal apparatus**

Eyebrows

- Two arched ridges of supraorbital margins of frontal bone
- They are numerous & project obliquely from surface of the skin
- Protect eyeball from sweat, dust & other foreign bodies, direct rays of the sun

Eyelids (palpebrae)

- Two movable folds of tissue situated above & below the front of each eye
- On the free edge, short curved hairs called eyelashes are present
- A membrane lining called conjunctiva lines the eyelids & front of eyeball
- Tarsal glands/ meibomian glands embedded in tarsal plates of conjunctiva secrete fluid that keep eyelids from adhering to each other & delays evaporation of tears

Lacrimal apparatus

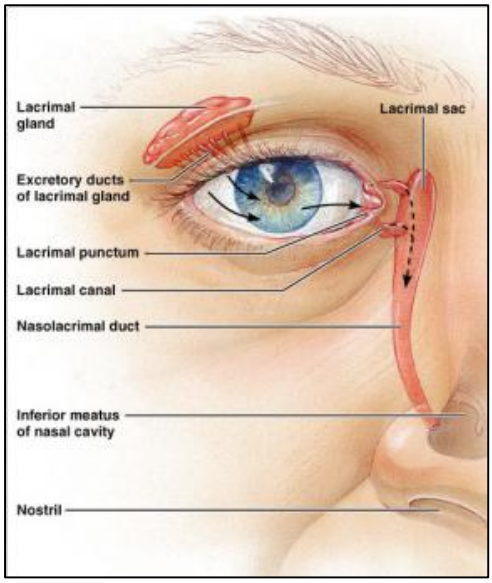
- Consist of structures that secrete tears & drain them from front of eyeball
- Apparatus include

  1 lacrimal gland & its ducts

  2 lacrimal canaliculi

  1 lacrimal sac

  1 nasolacrimal duct



- Lacrimal glands are exocrine glands present on lateral aspect of each eye, secrete tears/ lacrimal fluid
- Tears consist of water, mineral salts, antibodies, lysozyme
- Tears leave glands by small ducts present front of eye under lids to medial canthus – drain into lacrimal canaliculi through opening called punctum
- 2 punctums, one above the other are separated by a small red body called caruncle
- Then drain to lacrimal sac – nasolacrimal duct to nasal sac, opening at the level of inferior conchae

Disorders of Eye

- **With ageing**

Presbyopia

Cataracts

- **Inflammatory conditions**

  Stye

  Blepharitis

  Conjunctivitis (inflammatory, neonatal & allergic)

  Trachoma

  Corneal ulcer

- **Glaucoma**

  Primary – open angle, acute closed-angle & chronic closed-angle

  Secondary – ex: anterior uveitis/ tumor

  Congenital

- **Strabismus** (squint, cross eye)
- **Retinopathies**

  Vascular

  Diabetic

  Retinopathy of prematurity

- **Retinal detachment**
- **Retinitis pigmentosa**
- **Tumors**

  Choroidal malignant melanoma

  Retinoblastoma

- **Refractive errors of the eye**

  Myopia/ near-sightedness/ short sightedness

  Hyperopia/ hypermetropia/ long-sightedness/ far-sightedness

  Astigmatism

With ageing

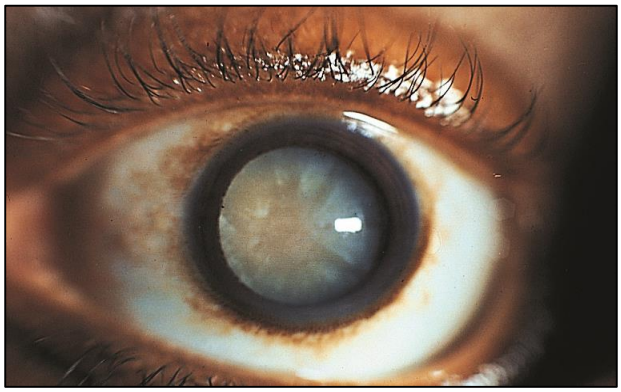
Presbyopia

- Age related changes in the lens leads to loss of accommodation, where lens loses elasticity & becomes firmer
- Prevents focusing of light on retina & causes blurred vision

- Corrected by using glasses with convex lens for near vision, **ex:** reading

Cataracts

- It is opacity of lens; weak light rays cannot easily pass through cloudy lens
- Vision impairment seen in poor light & darkness
- Most common cause of visual impairment worldwide
- Affects one or both the eyes
- Can be age related, congenital or secondary to ocular trauma, uveitis & diabetes mellitus
- Early treatment prevents permanent loss of sight



Inflammatory conditions

Stye/ hordeolum

- Acute & painful bacterial infection of sebaceous or tarsal glands of eyelid margin i.e. infection of eyelashes
- Most common cause – ***Staphylococcus aureus***
- Infection block the ducts & leads to cyst formation (chalazion) – may cause damage to cornea

Blepharitis

- Chronic inflammation of eyelid margins caused by bacterial infection or allergy
- ***Ex:*** Staphylococcus infection or seborrhoea (excess sebaceous gland secretion)
- Ulcer formation & healing leads to distortion of eyelid margins – prevent complete closure of eyes
- Leads to drying of eye, conjunctivitis & possibly corneal ulceration

Conjunctivitis

- Inflammation of conjunctiva & caused by irritants like smoke, dust, wind, cold or dry air, microbes or antigens
- May be acute or chronic
- It is of 3 types – infectious conjunctivitis, neonatal conjunctivitis & allergic conjunctivitis

Trachoma

- Chronic inflammatory condition caused by *Chlamydia trachomatis*

- Spread by poor hygeine
- ***Ex:*** communal use of contaminated washing water, cross-infection between mother & child or contaminated towels & clothing
- Fibrous tissue deposits in conjunctiva & cornea – eyelid deformity & corneal scarring as eyelashes rub against surface of eye

Corneal ulcer

- Local necrosis of corneal tissue due to corneal infection (keratitis) following trauma (abrasion) or infection spread from conjunctiva or eyelids
- Causes – ***Staphylococci, Streptococci & Herpes Viruses***

Glaucoma

- Group of conditions in which Intraocular Pressure (IOP) rises due to impaired drainage of aqueous fluid through scleral venous sinus (canal of Schlemm) in angle between iris & cornea in anterior chamber
- ↑ IOP – damage optic nerve by mechanical compression or by compression of its blood supply causing ischaemia
- Damage to optic nerve – impairs the vision
- It is of following types -
    1. *Primary open-angle glaucoma*
    2. *Acute closed-angle glaucoma*
    3. ***Chronic closed-angle glaucoma***

Strabismus

- In strabismus – only one eye directed at observed object, other eye diverge (directed elsewhere) – two different images sent to brain – one from each eye
- Cause – one-sided extrinsic muscle weakness or impairment of cranial nerve (III, IV, VI) supply to extrinsic muscle
- Most cases – image from squint eye is suppressed by brain, otherwise there is double vision

Retinopathies

Vascular

- Atheromatous plaques or endocarditis causes embolism that occludes central retinal artery

- Glaucome, diabetes, hypertension - ↑ IOP – occlusion of central retinal vein
- Both causes sudden painless unilateral loss of vision
- Retinal veins distended and retinal haemorrhages occur

Diabetic

- Occurs in both type I & II
- Most common cause of blindness in adults aged between 30 & 65 yrs in developed countries

Retinopathy of prematurity

- Affects premature babies

Retinal detachment

- Occurs when tear or hole in retina allows fluid to accumulate between layers of retinal cells or between retina & choroid
- Visual disturbances, spots before eyes – progressive loss of vision (shadow or curtain)
- Cause – mostly unknown

Retinitis pigmentosa

- Group of hereditary diseases that leads to degeneration of retina that mainly affects rods
- Progressive impairment of peripheral vision, esp. in dim light – usually becomes apparent in early childhood
- Overtime leads to tunnel vision & eventually loss of sight

Tumors

Choroidal malignant melanoma

- Most common ocular malignancy in adults between 40-0 yrs of age
- Normally vision is not affected

Retinoblastoma

- Most common malignant tumor in children
- Evident before age of 4 yrs, usually affects one side
- Presence of squint & enlargement of eye
- Tumor grows – visual impairment & pupil looks pale

Refractive errors

- They are of following types –

Myopia

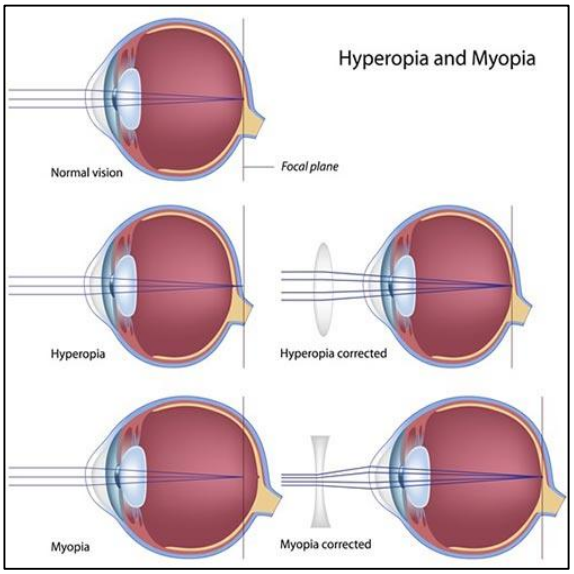
- Called nearsightedness or short-sightedness
- Eyeball is too long – distant objects focused in front of the retina
- Close objects focused normally but distant vision is blurred
- Correction – biconcave lens

Hyperopia

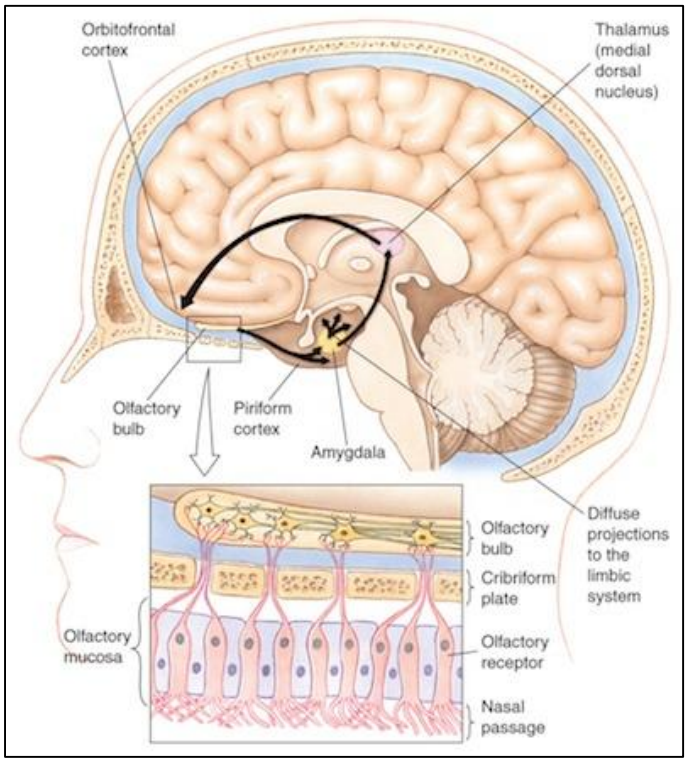
- Farsightedness or longsightedness
- Eyeball is too short, near image focused behind retina
- Distant objects focused normally but close vision is blurred
- Correction – convex lens

Astigmatism

- Abnormal curvature of part of cornea or lens
- Interferes with light path through eye & prevents focusing of light on retina
- Causes blurred distance & near vision
- Very common & coexist with other refractive disorders
- Correction requires cylindrical lenses



OLFACTION – SENSE OF SMELL



Olfaction is the sense of smell.
It originates in the nasal cavity.

The human sense of smell is less acute than in many animals.
In animals, odorous chemicals called **pheromones** play an important role in chemical communication.
In humans, their role is unknown.

Anatomy of Olfactory Receptors

Receptors for the sense of smell are located in the **olfactory epithelium of the nose**, present in the superior part of the nasal cavity.

They originate as **chemoreceptors** in the mucous membrane of the roof of the nasal cavity above the superior nasal conchae.

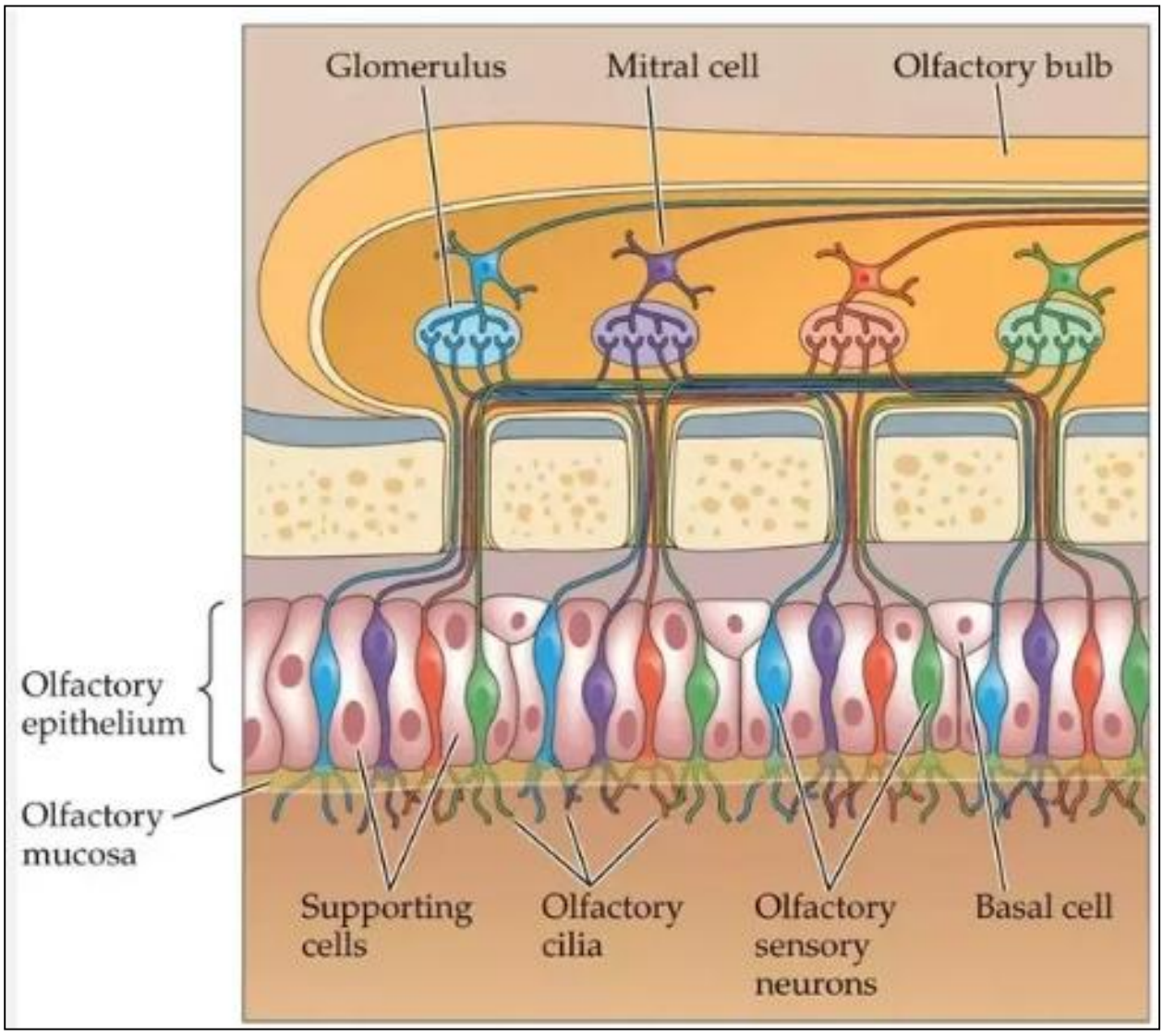
On each side of the nasal septum, nerve fibers form the **right and left olfactory nerves**.

These nerves pass through the **olfactory foramina of the cribriform plate of the ethmoid bone** and extend to the **olfactory bulb**.

Interconnections and synapses occur in the bulb.

From the bulb, bundles of nerve fibers form the **olfactory tract**, which passes backward to the **primary olfactory area in the temporal lobe of the cerebral cortex**.

Here, impulses are interpreted and **odour is perceived**.



Physiology of Smell (Olfaction)

Odorous materials give off **volatile molecules**.
These are carried to the nose with inhaled air.

Even very low concentrations, when dissolved in mucus, stimulate olfactory chemoreceptors.

Odorant binds with receptor → stimulates G-proteins (membrane proteins).

This activates the enzyme **adenylyl cyclase**, leading to production of **cAMP**.

cAMP opens **cation channels**, allowing Na^+ and Ca^{2+} ions to enter the cytosol.

This causes depolarization → threshold → action potential.

The human nose contains about **10 million olfactory receptors** with nearly **400 different functional types**.

Relationship Between Smell and Taste

The senses of smell and taste are closely related and may affect appetite.

Pleasant odours increase appetite.

Sight of food produces appetising smell, salivation, and stimulation of the digestive system.

The sense of smell can create powerful and long-lasting memories, such as hospital smells or favourite foods.

Adaptation

With continuous exposure to an odour, perception decreases and usually stops within a few minutes.

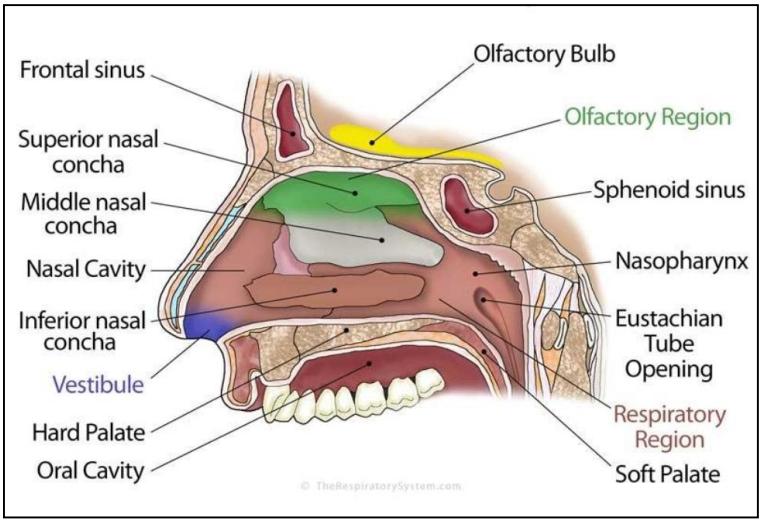
NOSE

Nostrils (Nares)

Nostrils are the openings into the nose and are the main route of air entry into the respiratory system.

Behind each nostril are large cavities.

The right and left nasal cavities are separated by the **nasal septum**, a perpendicular sheet of bone and cartilage formed by the vomer, ethmoid bone, and cartilage forming the anterior part of the nose.



Bones Forming the Nasal Cavity

- **Roof:** Cribriform plate of ethmoid bone, sphenoid bone, frontal bone, nasal bones
- **Floor:** Roof of mouth — hard palate in front and soft palate behind
- **Medial wall:** Septum
- **Lateral wall:** Maxilla, ethmoid bone, inferior conchae
- **Posterior wall:** Posterior wall of pharynx

Lining of Nasal Cavity

The nasal cavity is lined with very vascular **ciliated columnar epithelium** containing mucus-secreting goblet cells.

Anteriorly, the epithelium has coarse hairs covered with sticky mucus which filter air passing towards the back of the nose.

Openings of Nasal Cavity

- **Anterior nares (nostrils):** Open from exterior into nasal cavity
- **Posterior nares:** Open from nasal cavity into pharynx

Functions of Nose

- **Respiratory function:** Air is warmed, moistened, and filtered
- **Humidification:** Air is saturated with water vapour

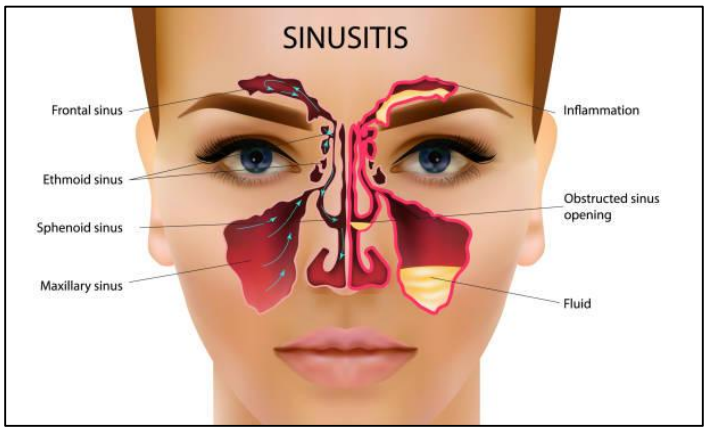
- **Sense of smell:** Receptors are stimulated by airborne odours

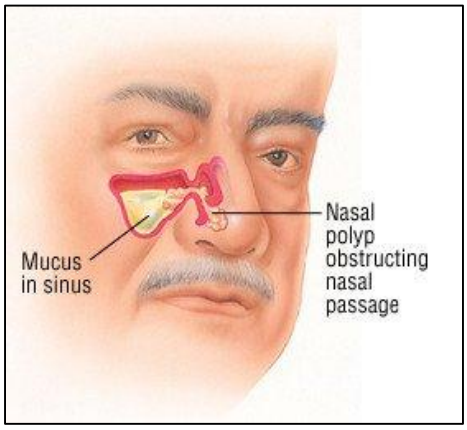
DISORDERS OF NOSE

Inflammation of nasal mucosa prevents odorous substances from reaching the olfactory area, causing loss of smell (**anosmia**).

Common cause: cold.

Sinusitis





Inflammation of the cavities around the nasal passages.

- Can be acute or chronic
- Acute: triggered by cold or allergies
- Chronic: lasts up to 8 weeks

Symptoms:
Headache, facial pain, runny nose, nasal congestion.

Nasal Polyps

Soft, painless, noncancerous growths on the lining of nasal passages or sinuses.

Causes:
Chronic inflammation due to infection, allergies, drug sensitivity, or immune disorders.

Symptoms:
Runny nose, nasal stuffiness, post-nasal drip.

Smell and Taste Disorders

May be due to chronic rhinosinusitis, nasal polyps, allergic rhinitis, upper respiratory tract infection, tumors, etc.

Rhinitis (Stuffy Nose)

Irritation and swelling of the nasal mucous membrane.

Common causes include pollen, dust mites, animal dander, fumes, odours, and smoke.

May be allergic or non-allergic.

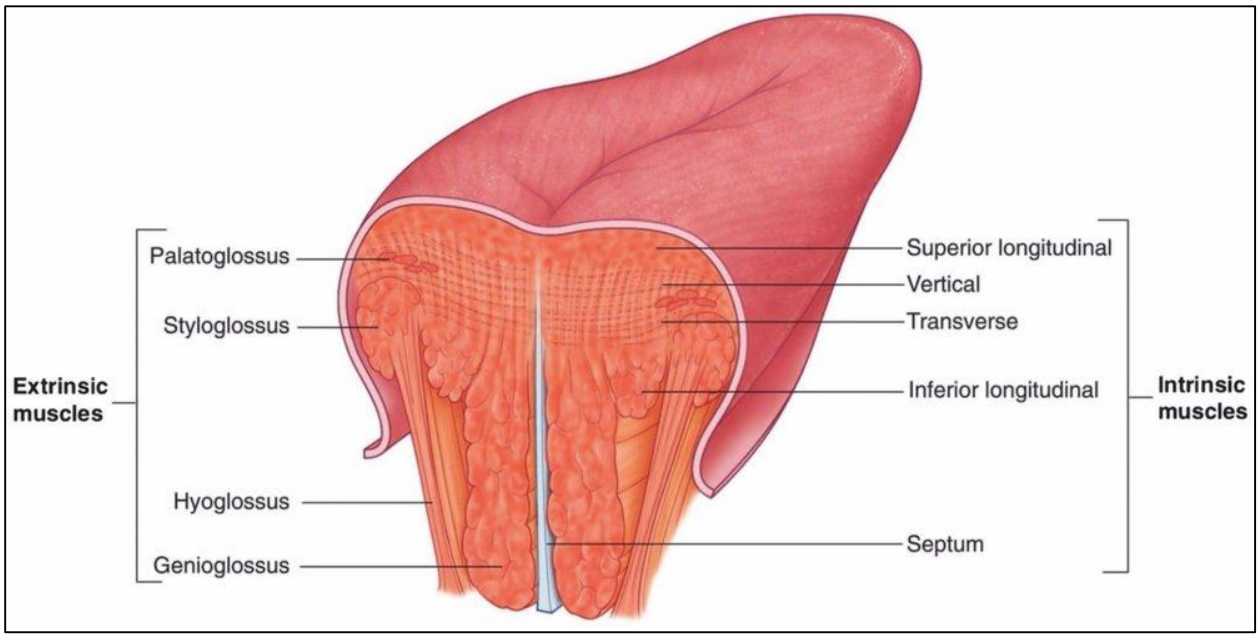
GUSTATION – SENSE OF TASTE

The tongue is composed of voluntary muscle and forms the floor of the oral cavity.

It is attached inferiorly to the hyoid bone, styloid process of temporal bone, and mandible.

A fold of mucous membrane in the midline of the undersurface is called the **lingual frenulum**, which limits posterior movement of the tongue.

The tongue is divided into symmetrical lateral halves by a median septum.



Muscles of Tongue

Two types of muscles are present:

Extrinsic muscles

- Move tongue from side to side
- Move tongue in and out
- Maneuver food for chewing
- Shape food into rounded mass

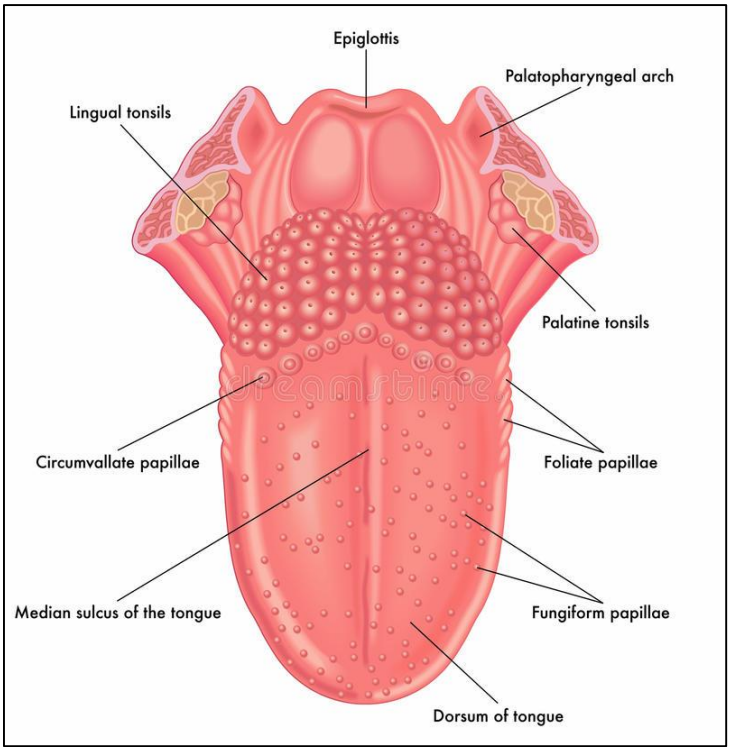
Intrinsic muscles

- Alter shape and size of tongue
- Important for speech and swallowing

Surface of Tongue

The superior surface consists of stratified squamous epithelium with numerous projections called **papillae**.

Many papillae contain **taste buds**, which are receptors for gustation (taste).



Functions of Tongue

- Chewing (mastication)
- Swallowing (deglutition)
- Speech
- Taste

ANATOMY OF TASTE BUDS AND PAPILLAE

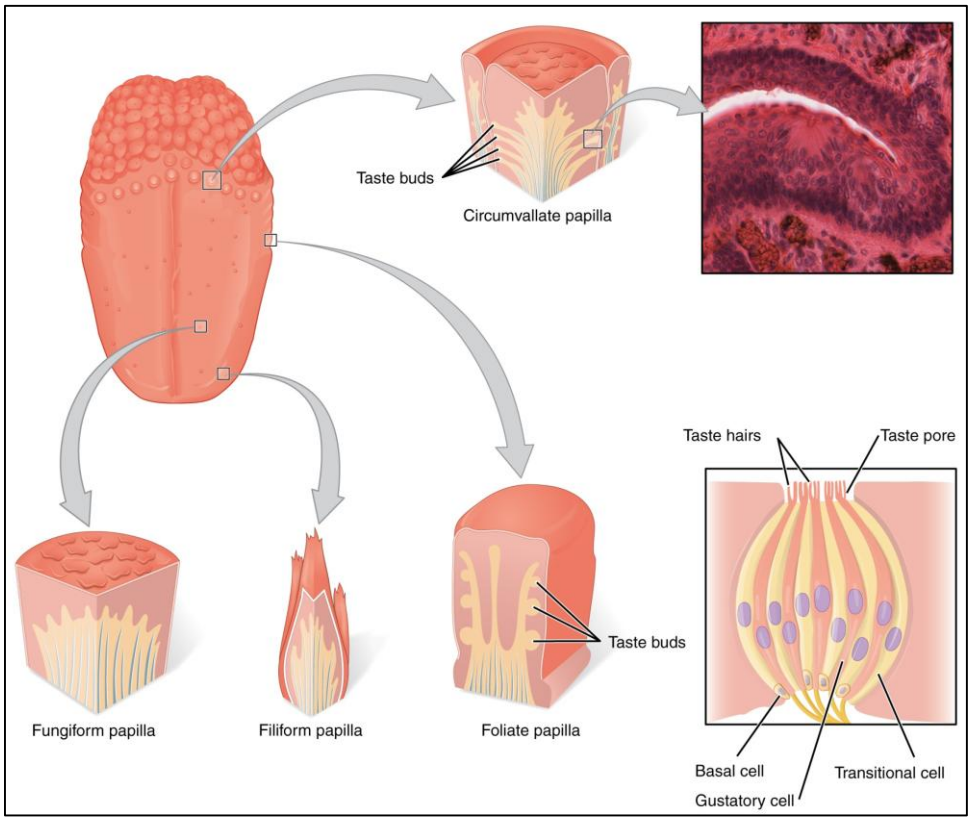
The sense of taste is closely linked with smell.

Both involve stimulation by dissolved chemicals.

Taste receptors are located in **taste buds**.

Each taste bud is an oval structure made of three kinds of epithelial cells.

Taste buds are present in papillae.



Types of Papillae

- **Vallate (circumvallate):** Largest; arranged in inverted V-shaped row at back of tongue
- **Fungiform:** Mushroom-shaped; scattered over surface, mainly tip and edges
- **Foliate:** On lateral margins; most taste buds degenerate in early childhood
- **Filiform:** Smallest and most numerous; present on anterior two-thirds; do not contain taste buds

PHYSIOLOGY OF TASTE

Five fundamental tastes are distinguished:

- Salty

- Sweet
- Sour
- Bitter
- Umami (savory or meaty)

All taste buds can be stimulated by all tastes.

Taste-stimulating chemicals are called **tastants**, dissolved in saliva.

Taste buds contain sensory nerve endings of cranial nerves VII, IX, and X.

Stimulation produces nerve impulses that travel to the medulla and thalamus, then to the **primary gustatory area in the parietal lobe of cerebral cortex**, where taste is perceived.

Role of Taste and Smell

Taste and smell are closely linked.

Example: during cold, food tastes bland and unappealing.

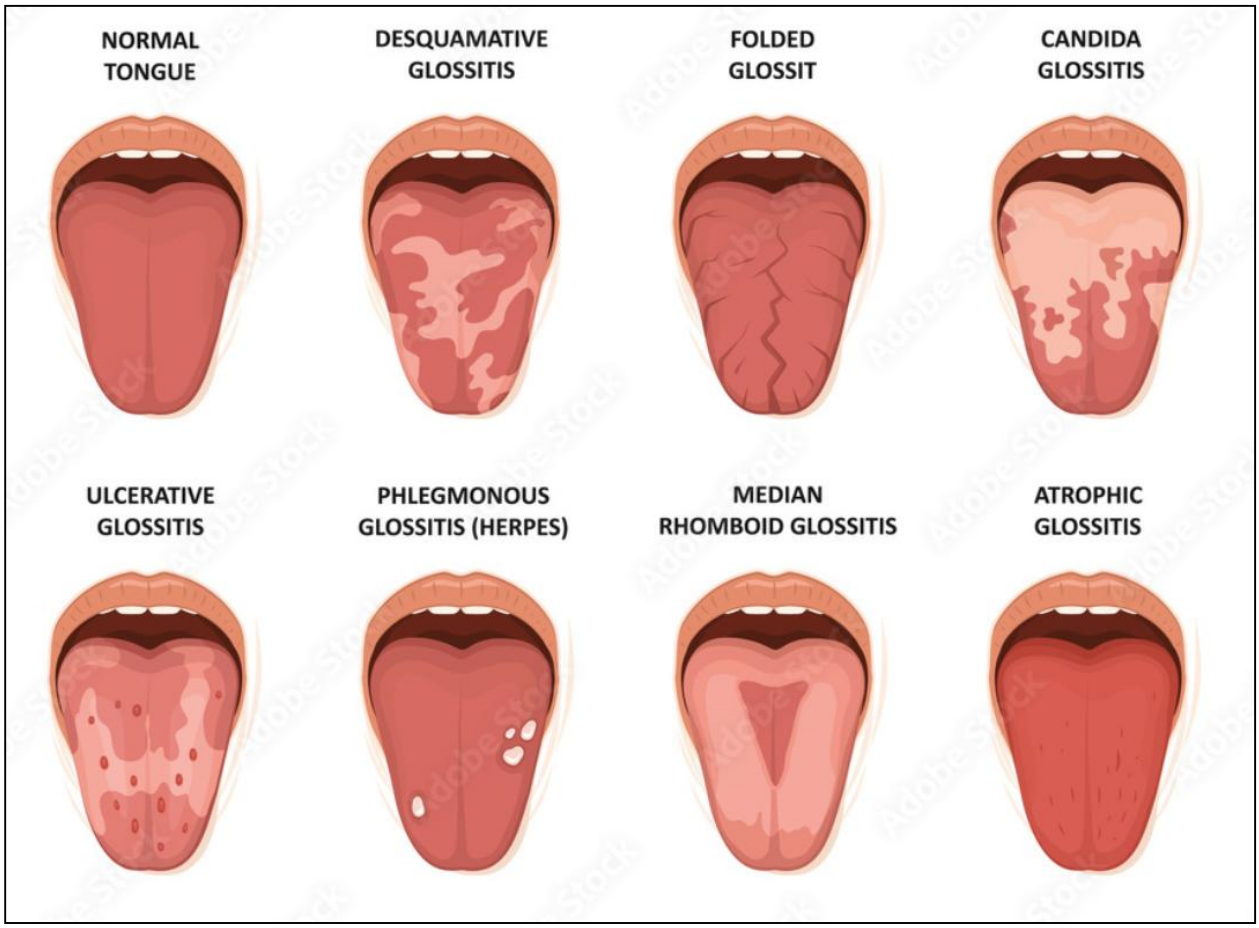
Taste stimulates salivation and gastric juice secretion.

Taste also has a protective role — foul-tasting food can trigger vomiting reflex.

TONGUE DISORDERS

Common disorders include:

- **Black hairy tongue:**
  Due to poor oral hygiene; dead cells accumulate giving dark furry appearance.
- **Glossitis:**
  Swollen, inflamed, or discolored tongue caused by various factors.
- **Oral thrush:**
  White patches on tongue caused by yeast infection; treated with prescribed medication.
- **Burning mouth syndrome:**
  Burning sensation of tongue; relief depends on accurate diagnosis.
- **Oral cancer:**
  Symptoms include pain, difficulty in tongue movement, and abnormal spotting.


NORMAL TONGUE
DESQUAMATIVE GLOSSITIS
FOLDED GLOSSIT
CANDIDA GLOSSITIS
ULCERATIVE GLOSSITIS
PHLEGMONOUS GLOSSITIS (HERPES)
MEDIAN RHOMBOID GLOSSITIS
ATROPHIC GLOSSITIS