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HUMAN ANATOMY AND PHYSIOLOGY – I

UNIT 4

TOPIC :

- **Special senses**

  Structure and functions of eye, ear, nose and tongue and their disorders.

Special Sense

- Sense organs have highly specialised nerve cells, which receive stimuli and convert them into appropriate nerve impulses.
- These nerve impulses are carried to the CNS by afferent or sensory nerve fibres.
- sense organs (eyes, ears, tongue, skin, and nose) contain receptors that relay information through sensory neurons to appropriate places within the nervous system.
- Following organs are known as sense organs:
    1) Tongue (Taste Bud of Tongue): To sense the taste.
    2) Nose: For perceiving sense of smell.
    3) Ear: For maintaining equilibrium and sense of hearing.
    4) Eye: To perceive vision/sight.
    5) Skin: To sense touch, pressure, temperature, as well as for thermoregulation.
- Ophthalmology: It is the branch of science that deals with the study of eyes and their disorders.
- Otorhinolaryngology: It is the branch of science that deals with the study and treatment of diseases of the ear, nose and throat.

Eye

→ Eyes are almost spherical in shape having a diameter of about 2.5cm.

→ They are situated in the orbital cavity, receive sense of sight, and are supplied by the optic nerve (llnd cranial nerves).

→ Adipose tissue is present in the space between the eye and orbital cavity.

→ Bony wall of the eye orbit protects the eyes from injury.

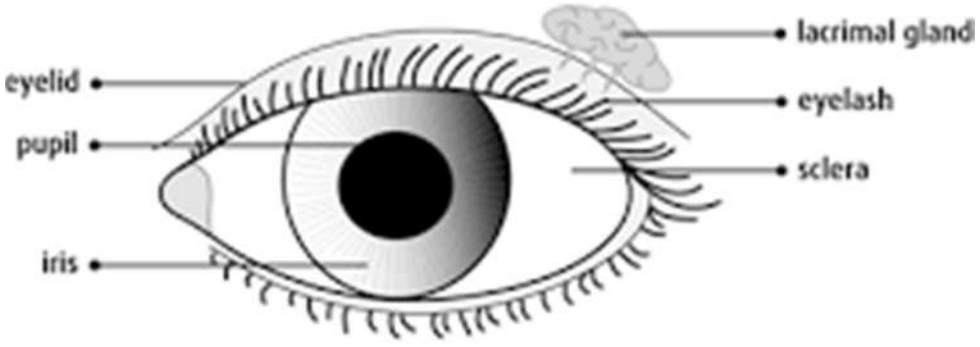
→ Activities of both the eyes are coordinated in such a manner that they function as a pair.

→ It is possible to see only through one eye but in this case three dimensional vision is impaired, especially in the case of judgement of distance.

Accessory Structures of the Eye:

✓ Eyelids
✓ Eyelashes
✓ Eyebrows
✓ Lacrimal apparatus
✓ Extrinsic eye muscles

Front of the Eye



Eyelids:

→ The eyelids are two movable folds of tissue situated above and below the front of each eye. On their free edges there are short, curved hairs called as eyelashes. Various layers of tissue forming the eyelids are:

- A thin covering of skin
- A thin sheet of subcutaneous connective tissue (loose areolar tissue)
- Two muscles: The orbicularis oculi and the levator palpebrae superioris
- A thin sheet of dense connective tissue - Tarsal plate
- Lining of conjunctiva

Functions :

✓ The eyelids and eyelashes protect the eye from injury.
✓ The eyelids protect the front surface of eyes from excessive wind, small particles in the air and from minor mechanical injury.
✓ Blinking at about 3-7 seconds intervals spreads tears and oily secretions over the cornea, preventing injury to eye."

Conjunctiva :

→ It is a thin transparent membrane that lines the eyelids and the front of the eyeball. The corneal conjunctiva consists of avascular stratified epithelium i.e. epithelium without blood vessels. When the eyelids are closed, the conjunctiva becomes a closed sac. It protects the delicate cornea and the front of eye.

Eyebrows :

→ Numerous hairs (eyebrows) projects obliquely from the surface of the skin. They protect the eyeball from sweat, dust and other foreign bodies. Lacrimal Apparatus: It consists of:

✓ 1 Lacrimal gland and its ducts

✓ 2 Lacrimal canaliculi

✓ 1 Lacrimal sac

✓ 1 Nasolacrimal duct

Lacrimal apparatus :

→ The lacrimal apparatus is a structure that produces and drains lacrimal fluid (tears). It has size and shape of an almond.

→ It secrets lacrimal fluid which drains into 6-12 excretory lacrimal ducts that empty tears onto the surface of conjunctiva of the upper lid.

→ From the upper lid, tear passes to surface of the eyeball to enter two small openings called as lacrimal puncta.

→ Tears then pass into two ducts, the lacrimal canals which lead into the lacrimal sac and then into the nasolacrimal ducts.

→ This duct carries the secretion into the nasal cavity.

→ The lacrimal fluid produced by the gland is a watery solution containing salts, mucous and lysozyme - a protective bactericidal enzyme.

→ The fluid protects, clean, lubricates and moistens the eyeball.

Extrinsic eye muscles :

→ Six extrinsic muscles move the eye together.

- Superior rectus
- Inferior rectus
- Lateral rectus
- Medial rectus
- Superior oblique
- Inferior oblique

Anatomy of the Eyeball :

→ The adult eyeball measures about 2.5 cm in diameter. Only the anterior 1/6th is exposed, the rest is protected in bony socket of the orbit. The wall of eyeball consists of three layers.

- ✓ Fibrous tunic
- ✓ Vascular tunic
- ✓ Retina

Fibrous Tunic :

→ It is the superior layer of eyeball. It consists of anterior cornea and posterior sclera. The cornea is transparent coat that covered the coloured iris. Because it is curved, the cornea helps to focus the light onto the retina. The cornea is about 0.5 to 1 mm thick and consists mainly of the following structure:

- Corneal epithelium
- Substantia propia
- Corneal endothelium

→ **The sclera :** The white of the eye is a layer of dense connective tissue made up of collagen fibres and fibroblasts The sclera covers the entire eyeball except the cornea. It gives shapes to the eyeball, makes it more rigid and protects its inner parts. At the junction of sclera and cornea is an opening known as canal of schlemm. A fluid called aqueous humour drains into the sinus.

Vascular Tunic :

→ The vascular tunic/uvea is the middle layer of eyeball.

→ It is composed of three parts.

- ✓ Choroid
- ✓ Ciliary body

✓ Iris

Retina :

→ The third and inner coat of the eyeball is the retina. It is extremely thin and transparent. The optic disc is the site where the optic (II) nerve exits the eyeball. It consists of :

- Central retinal artery
- Central retinal vein

→ The retina consists of a pigmented layer and neural layer. The pigmented layer is a sheet of melanin-containing epithelial cells. The melanin in the pigmented layer of retina also helps to absorb stray light rays. The neural layer is a multi-layered outgrowth of the brain. It consists of three layers:

- The photoreceptor layer
- Bipolar cell layer
- Ganglion cell layer

Lens

→ The lens is present behind the pupil and iris within the cavity of the eyeball. A crystalline protein, arranged like the layers of an onion, make up the lenses transparent and lacks blood vessels. The lens helps to focus images on the retina to facilitate clear vision.

Inferior of the Eyeball:

→ The lens divides the interior of the eyeball into two cavities:

✓ The anterior cavity
✓ The vitreous chamber

→ The anterior cavity consists of two chambers:

✓ Anterior chamber: It lies between the iris and in front of the lens.
✓ Posterior chamber: It lies behind the iris and in front of the lens.

Functions of Eye

Eye performs two major functions:

1. **Vision:** It is one of the most complex functions of the human body. It requires the cooperation of many small and intricate parts. The functioning of human eye and a camera is similar.
2. Both devices gather, focus, and transmit light through a lens to create an image of the surrounding environment.
    i) Light enters the eye through the cornea, the clear front surface of the eye, which acts like a camera lens.
    ii) The iris of the eye functions like the diaphragm of a camera, controlling the amount of light reaching the back of the eye by automatically adjusting the size of the pupil, which acts like an aperture. In dark conditions, the pupil widens, while in bright conditions, it constricts.
    iii) The eye's crystalline lens, located directly behind the pupil, helps the eye automatically focus on near and approaching objects, like an autofocus camera lens.
    iv) The light then travels through the vitreous. humor, a clear gel-like substance that fills the middle of the eye.
    v) Light then reaches the retina, a sensitive inner lining of the back of the eye. The retina acts like a camera film, converting optical images into electronic signals.
    vi) The image reflected on the retina is upside down. The optic nerve transmits signals to the visual cortex in the brain, which flips the image right side up and creates one composite image.
3. **Production of Tears:** Tears form an important component for maintenance of vision, as the tears nourish and lubricate the surface of the eye and wash away debris as well.

Disorders of the Eye

1. Conjunctivitis (Pink Eye)

- Conjunctivitis is the inflammation or infection of the conjunctiva, the transparent membrane that lines the eyelid and covers the white part of the eyeball.

Causes:

- Viral or bacterial infections
- Allergies or irritants (smoke, dust)

Symptoms:

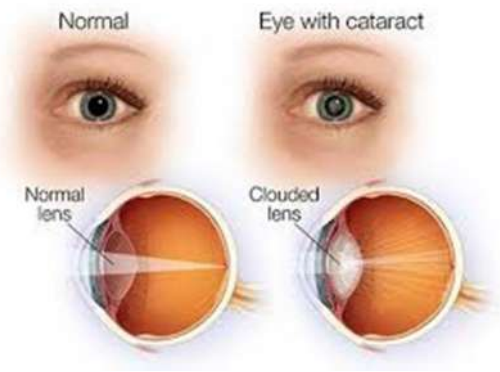
- Redness, itching, watery or pus-like discharge, crusting on eyelids

Treatment:

- Antibiotic or antiviral eye drops
- Antihistamines for allergic type
- Maintaining eye hygiene

2. Cataract

A cataract is the clouding or opacity of the eye's natural lens, leading to blurry or reduced vision.



Causes:

- Aging (most common), UV exposure, diabetes, smoking

Symptoms:

- Cloudy or foggy vision, glare sensitivity, faded colors

Treatment:

- Surgical removal of the cloudy lens and replacement with an artificial lens (IOL)

3. Glaucoma

→ Glaucoma is a group of eye disorders characterized by increased intraocular pressure (IOP) that can damage the optic nerve, causing permanent vision loss.

Causes:

- Blocked drainage of aqueous humor
- Hereditary factors

Symptoms:

- Slow loss of peripheral vision, eye pain, halos around lights (in acute cases)

Treatment:

- Eye drops to reduce pressure
- Laser treatment or surgery

Ear

→ Human beings have a pair of ears, each present laterally on either side of the head.

→ The primary function of ears is to maintain body equilibrium as well as they are also responsible for hearing.

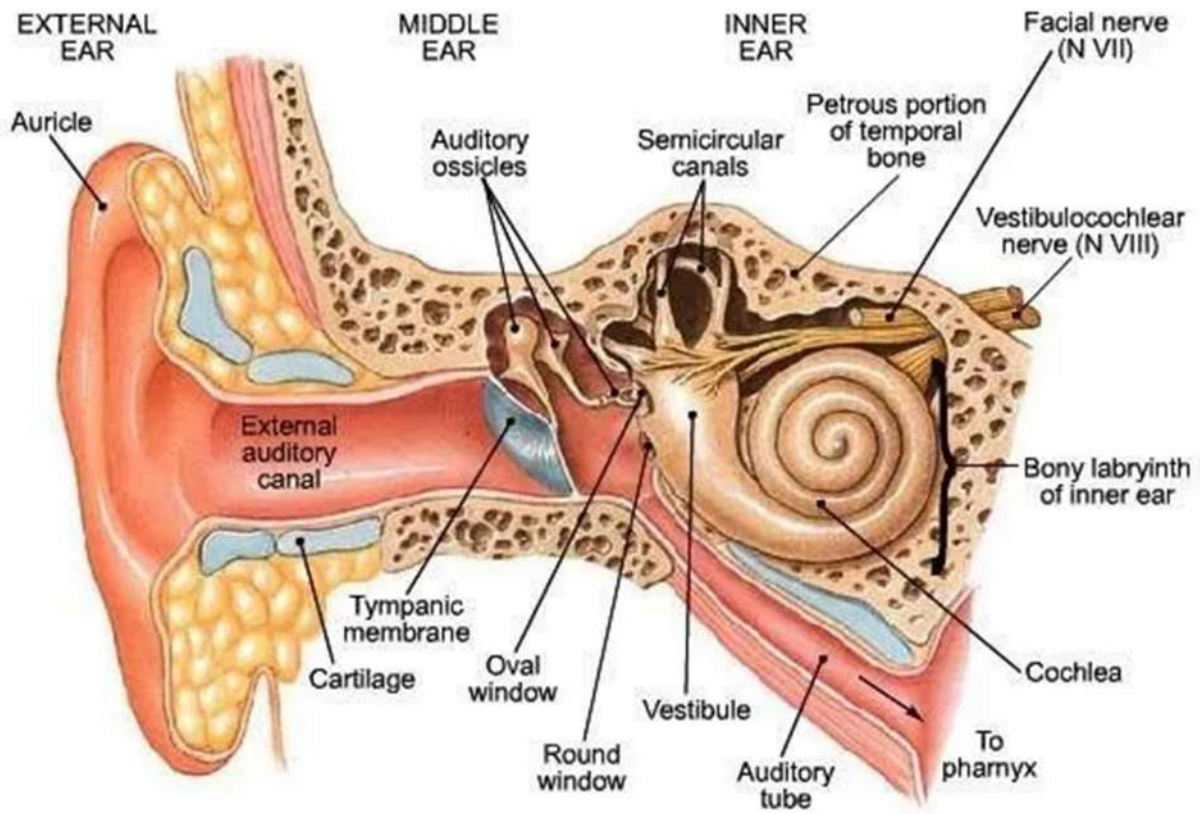
→ Thus, ears not only help in perceiving sound but also play a pivotal role in balancing different positions of the body.

→ The auditory nerve (8th cranial nerve) is divided into two parts, namely vestibular nerve, responsible for equilibrium of the body and cochlear nerve, responsible for hearing, which detects vibrations of the sound wave.

Structure of Ear

→ Parts of ear:

1. External ear
2. Middle ear
3. Internal ear



External Ear:

- The external ear collects sound waves and channels them inwards.
- External ear consists of following parts:
  - ✓ Auricle (Pinna)
  - ✓ External auditory canal
- Auricle is a sheet of elastic cartilage covered with skin.
- The rim of auricle is the helix and the inferior portion is called as lobule.
- Muscles and ligaments attach the auricle to the 2.5 cm long. Pinna opens into the external auditory canal.
- The external auditory canal extends from pinna to eardrum. External auditory canals contain many specialized sebaceous glands which secrete wax called as ceremonious glands.

- Hairs are present in this canal and along with earwax; they prevent the entry of dust and foreign particles inside the ear.
- The external auditory canal ends at the tympanic membrane which is called as eardrum.
- The eardrum or tympanic membrane is a thin, semitransparent partition between the external auditory canal and middle ear.
- It is covered by epidermis and is lined by simple cuboidal epithelium.

Middle Ear:

→ It coveys sound vibrations to the oval window. The middle ear is also called as tympanic cavity. The middle ear is a small, air-filled cavity in the temporal bone that is line by epithelium. It is separated from the external ear by a thin bony partition that contains two small membrane covered openings.

- ✓ Oval window
- ✓ Round Window

→ Three tiny ligaments attached bones are present in the middle ear. These bones are called as auditory ossicles. These are named according to their shapes.

- ✓ The malleus or the hammer
- ✓ The incus or the anvil
- ✓ The stapes or the stirrup

- **The Malleus :** The handle of malleus attaches to the internal surface of the eardrum. The head of the malleus articulates with the body of the incus.
- **The Incus :** The middle bone in the series articulates with the head of the stapes.

- **The Stapes :** The base or footplate of the stapes fit into the oval window. Directly below the oval window is another opening the round window which is enclosed by a membrane called as secondary tympanic membrane. The middle ear also filled with air.The middle ear is connected to pharynx through a tube called as eustachian tube. It helps maintain equal air pressure on the two sides of the eardrum.

Internal Ear :

→ The internal ear is also called as labyrinth.

→ Structurally, it consists of two parts.

- Bony labyrinth: Outer part of labyrinth
- Membranous labyrinth: Inner part of labyrinth It is divided into three parts:
  - The semi-circular canals
  - The vestibule
  - The cochlea

Functions

Functions of ear include:

- ✓ **Motor and Reflex Effects:** Position of the eyes and head, and maintain balance.
- ✓ **Effects on Higher Functions:** Thought, memory, language, body language, and emotions.
- ✓ **Sensory Effects:** Position and movement of the head.
- ✓ **Sensorial Effects:** Perception of sound.
- ✓ **Effects on State of Consciousness and Vigilance:** Triggering of sleep and waking phases. Maintaining alertness

Disorders of the Ear

1. Hearing Loss (Deafness)

→ Hearing loss refers to a partial or total inability to hear sounds.

Types:

- **Conductive Hearing Loss** – blockage in outer or middle ear
- **Sensorineural Hearing Loss** – damage to inner ear or auditory nerve
- **Mixed Hearing Loss** – combination of both

Causes:

- Aging, noise exposure, infections, genetic defects, trauma

Symptoms:

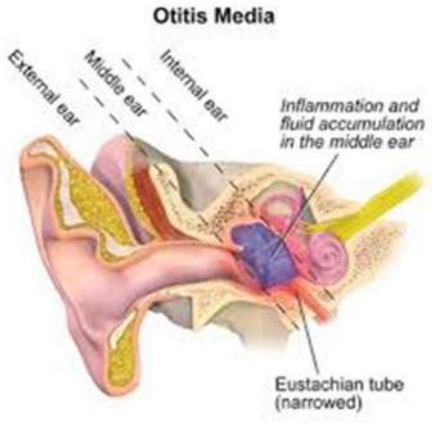
- Muffled hearing, inability to understand speech

Treatment:

- Hearing aids, cochlear implants, surgery (for conductive loss)

2. Otitis Media

→ Otitis media is an infection or inflammation of the middle ear, often due to bacterial or viral infections.



Causes:

- Cold, sore throat, or respiratory infections
- Blocked Eustachian tube

Symptoms:

- Ear pain, fever, fluid discharge, temporary hearing loss

Treatment:

- Antibiotics or pain relievers
- Myringotomy (draining fluid) in chronic cases

3. Otitis Externa (Swimmer's Ear)

→ Otitis externa is an infection of the external auditory canal, usually caused by moisture trapped in the ear.

Causes:

- Bacterial or fungal infection
- Water exposure, injury, or use of cotton buds

Symptoms:

- Itching, ear pain, swelling, foul-smelling discharge

Treatment:

- Antibiotic or antifungal ear drops
- Keep the ear dry

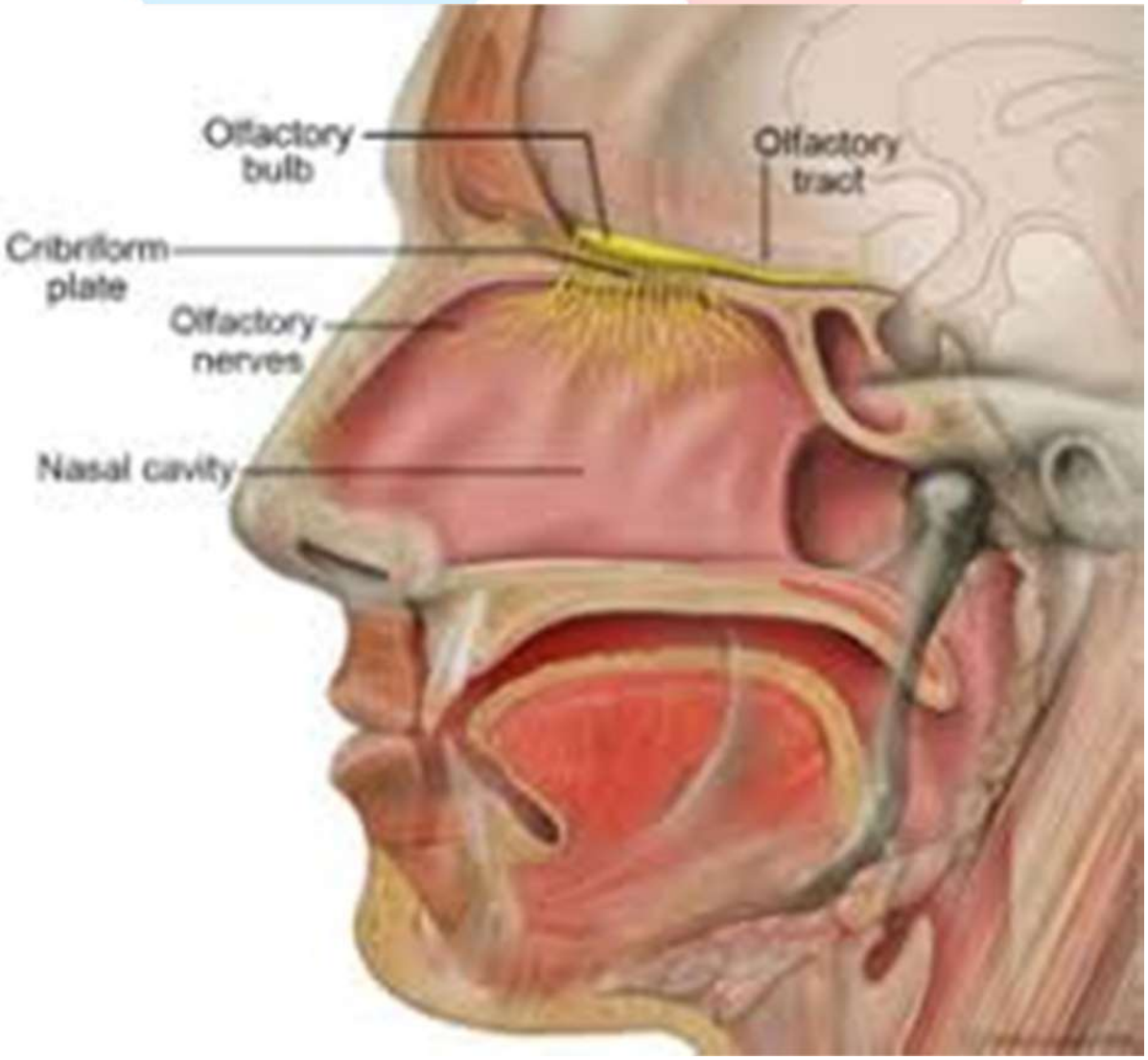
Organ of Smell (Nose)

→ The nose is centrally located in human beings whereas it is on the upper snout tip, in most of the mammals.

→ Anatomically, the nose consists of nostrils or nares that expel and admit the respired air along with the mouth.

→ The sinuses and the olfactory mucosa are present behind the nose.

→ The air passes from the nasal cavity to the pharynx (shared with the digestive system) which then moves into the rest of the respiratory system.



Structure of the Nose

1. External Nose (Visible Part)

Structure :

The **external nose** is the **protruding portion** located on the front of the face. It is made up of:

- **Bone**: The upper portion includes the nasal bones and the frontal process of the maxilla.
- **Cartilage**: The lower portion is made of hyaline cartilage, giving the nose its flexible shape.
    - Includes lateral cartilage, septal cartilage, and alar cartilages (shaping the nostrils).
- **Skin and Muscles**: The external nose is covered by skin with sebaceous glands and small facial muscles for movement.

Openings:

- **Nostrils (Nares)**: Two openings at the base of the external nose that allow air entry into the nasal cavities.

2. Nasal Cavity (Internal Nose)

Location and Boundaries:

The nasal cavity lies behind the external nose and is divided into two equal halves by the nasal septum.

- **Roof**: Formed by the ethmoid bone, sphenoid bone, and part of the frontal bone.
- **Floor**: Formed by the hard palate (palatine and maxilla bones), separating the nose from the mouth.
- **Lateral Walls**: Have bony projections called nasal conchae or turbinates.

- **Medial Wall**: Formed by the nasal septum (made of cartilage and bone).

Main Regions of the Nasal Cavity:

a. Nasal Septum:

- A vertical wall dividing the nasal cavity into right and left halves.
- Made of both cartilage (anterior) and bone (posterior).

b. Nasal Conchae (Turbinates):

- Three curved bony shelves on each lateral wall:
  - **Superior**, **Middle**, and **Inferior conchae**.
- These increase surface area and help in warming, moistening, and filtering the air.

c. Meatuses:

- Spaces located beneath each concha:
  - **Superior**, **Middle**, and **Inferior meatuses**.
- Serve as **passageways** for airflow and **drainage of sinuses**.

d. Olfactory Region:

- Located in the upper part of the nasal cavity.
- Contains olfactory receptors for the sense of smell.

e. Respiratory Region:

- Lined with ciliated pseudostratified columnar epithelium and goblet cells.
- Warms, moistens, and filters inhaled air.

Lining and Glands:

- The nasal cavity is lined with mucous membrane rich in capillaries, cilia, and mucous glands.
- Cilia move mucus and trapped particles towards the throat.
- Goblet cells secrete mucus that traps dust and microbes.

Openings into the Nasal Cavity:

- **Anterior nares (nostrils)**: Allow air to enter.
- **Posterior nares (choanae)**: Open into the nasopharynx.
- **Openings for paranasal sinuses** and **nasolacrimal duct** drain into the nasal cavity.

Accessory Structures:

Paranasal Sinuses:

- Air-filled spaces within the skull bones that open into the nasal cavity.
- Include:
  - **Frontal sinus**
  - **Ethmoidal sinus**
  - **Maxillary sinus**
  - **Sphenoidal sinus**
- Functions:
  - Lighten the skull.
  - Warm and moisten air.
  - Enhance voice resonance.

Nasolacrimal Duct:

- Drains tears from the lacrimal sac (from the eyes) into the inferior meatus of the nasal cavity.

Functions

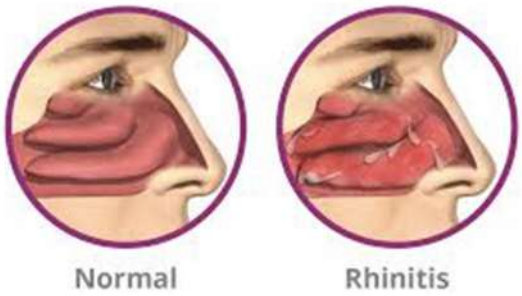
Nose performs the following functions:

(1) **Smell:** The smell sense is accommodated by the nose due to the presence of special neuro-epithelium.)
(2) **Respiration:** It is the primary function of nose.)
(3) **Air-Conditioning:** Nose helps in the moistening of dry and cold air inhaled by the human beings even on the coldest day of winters. This air is transformed into the 'tropical' air before reaching the lungs.)
(4) **Detoxification:** The nasal mucous membrane secretes the viscous mucous layer that helps to intercept and exclude the solid matter such as dust, bacteria, pollen, viruses, etc. present in the air inhaled by human beings. The membrane surface is covered with the countless tiny hair-like ilia.) structures known as cilia."

Disorders of the Nose

1. Rhinitis

→ Rhinitis is the inflammation of the nasal mucous membrane, which may be allergic or non-allergic.



Causes:

- Allergens (pollen, dust, animal dander)
- Viruses (common cold)

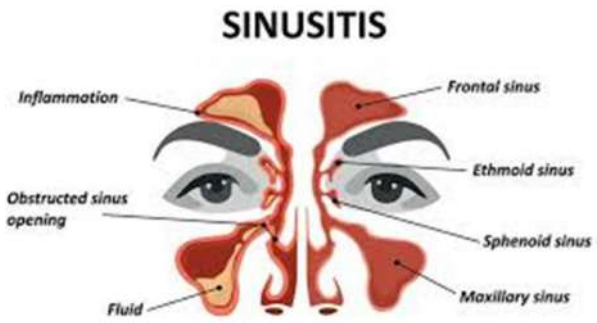
Symptoms:

- Sneezing, nasal congestion, runny nose, itching

Treatment:

- Antihistamines, nasal decongestants
- Avoidance of allergens

2. Sinusitis



→ Sinusitis is the inflammation or infection of the paranasal sinuses, often following a cold or allergy.

Causes:

- Viral, bacterial, or fungal infection
- Nasal polyps, deviated septum

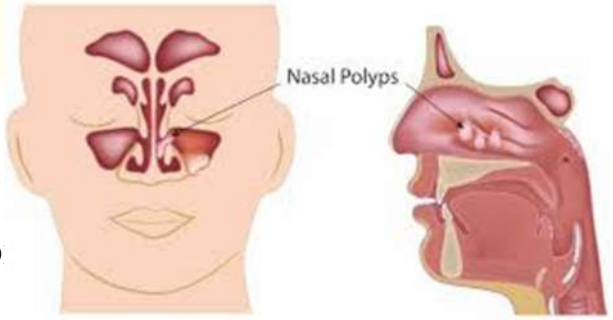
Symptoms:

- Facial pain or pressure
- Nasal congestion, headache, fever, post-nasal drip

Treatment:

- Antibiotics (if bacterial), nasal corticosteroids, steam inhalation
- Surgery in chronic cases

3. Nasal Polyps



→ Nasal polyps are soft, noncancerous growths of the nasal or sinus lining that result from chronic inflammatio

Causes:

- Asthma, allergies, chronic sinus infections

Symptoms:

- Blocked nose, reduced or lost sense of smell, snoring

Treatment:

- Nasal steroids, antihistamines
- Surgical removal if large

Organ of Taste (Tongue)

→ Tongue is a muscular organ situated on the floor of the mouth, which helps in chewing and swallowing of food (deglutition).

→ Since the surface of tongue is covered with the papillae and taste buds, it is considered as the chief organ for taste perception.

→ Speech is another function supported by tongue.

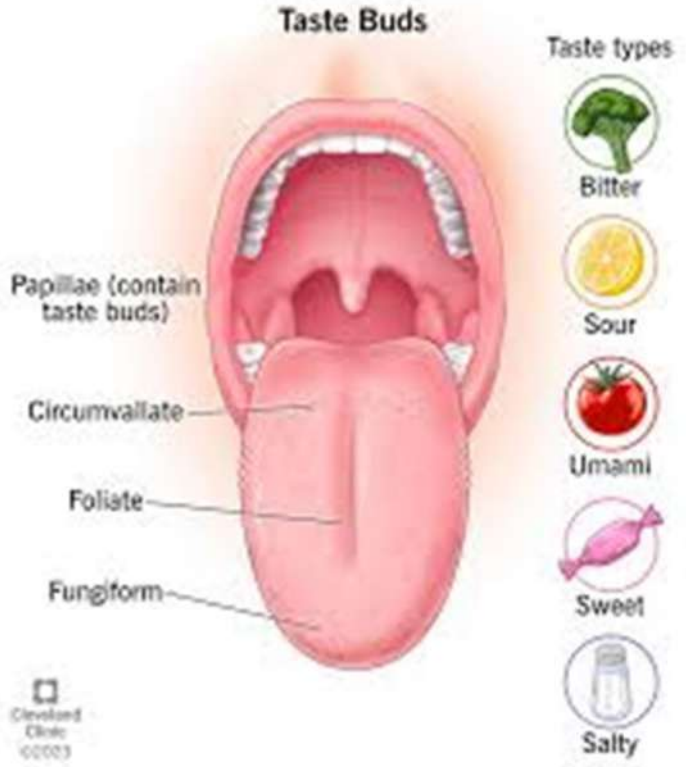
→ Tongue is a very sensitive organ which remains moistened with the saliva.

→ A large amount of nerves and blood vessels innervates the tongue, there by helping in its movement.

→ Separated by a V-shaped groove Which makes the terminal sulcus, the dorsal layer (upper Surface) of the tongue has two parts:

→ An oral part, lying in the mouth (anterior two-thirds of the tongue), and

→ A pharyngeal part, facing backward to the oropharynx (posterior third part of the tongue)



Anatomy of Taste Buds and Papillae :

→ The receptors for sensations of taste are located in the taste buds. Nearly 10,000 taste buds are present on the tongue of a young adult, but some are found on the soft palate, pharynx and epiglottis. The number of taste buds declines with age.

→ Each taste bud is an oval body consisting of three kinds of epithelial cells:

(a) Supporting cells : The supporting cells surround about 50 gustatory receptor cells in each taste bud.

(b) Gustatory receptor cells : A single, long microvillus, called a gustatory hair, projects from each gustatory receptor cell to the external surface through the taste pore (opening in the taste bud).

(c) Basal cells : Basal cells, stem cells found at the periphery of the taste bud near the connective tissue layer, produce supporting cells, which then develop into gustatory receptor cells. Each gustatory receptor cell has a life span of about 10 days.

→ At their base, the gustatory receptor cells synapse with dendrites of the first-order neurons that form the first part of the gustatory pathway.

→ Taste buds are found in elevations on the tangue called papillae which provide a rough texture to the upper surface of the tongue.

→ Four types of papillae contain taste buds.

(a) Circumvallate papillae: It form an inverted V-shaped row at the back of the tongue. Each of these papillae houses 100-300 taste buds.

(b) Fungiform papillae: These are mushroom-shaped elevations scattered over the entire surface of the tongue that contain about 5 taste buds each.

(c) Foliate papillae: These are located in small trenches on the lateral margins of the tongue, but most of these taste buds degenerate in early childhood.

(d) Filiform papillae: In addition, the entire surface of the tongue has filiform papillae.

→ These pointed, threadlike structures contain tactile receptors but no taste buds. They increase friction between the tongue and food, making it easier for the tongue to move food in the oral cavity

Functions

Tongue performs three main functions:

- ✓ The taste buds cover the surface of the tongue and inform the brain regarding the nature of the eaten food. Tongue not only acts as a sense organ of taste for recognising the delightful taste of food but also acts as a protective guard for rejecting the unpalatable food.
- ✓ It also assists in digestion as it allows the eaten food to move inside the mouth and reach a position where it can easily be crushed by the molar teeth. After this process, when the food is ready for swallowing, the tongue converts the crushed food into a ball (bolus) and directs it towards the pharynx in order to swallow the bolus.
- ✓ It also promotes speech by attaining different positions within the mouth. This change in position, changes the shape of the air passage; thereby, producing variations in sound (by vibrating the vocal cords).

Disorders of the Tongue

1. Glossitis

→ Glossitis is the inflammation of the tongue, which may cause swelling, redness, smoothness, and pain.

Causes:

- Nutritional deficiencies (iron, B12, folic acid)
- Infections, allergies, irritants, dry mouth

Symptoms:

- Red, swollen, smooth tongue
- Pain or burning sensation
- Difficulty eating or speaking

Treatment:

- Treat underlying cause (e.g., supplements, antibiotics)
- Good oral hygiene

2. Geographic Tongue (Benign Migratory Glossitis)

→ A harmless condition where map-like red patches with white borders appear on the tongue due to loss of papillae.

Causes:

- Unknown (possibly genetic, stress-related)

Symptoms:

- Red, smooth patches on the tongue that change location
- Mild burning or sensitivity

Treatment:

- No specific treatment needed
- Avoid spicy or acidic foods

3. Black Hairy Tongue

→A condition where the filiform papillae become elongated and discolored, giving the tongue a dark, hairy appearance.

Causes:

- Poor oral hygiene
- Smoking, antibiotic use, excessive coffee/tea

Symptoms:

- Black or brown discoloration
- Bad breath (halitosis), abnormal taste

Treatment:

- Proper oral hygiene, tongue brushing
- Avoid causative substances