

UNIT 4

Peripheral Nervous System (PNS)

The **Peripheral Nervous System** includes all the **nervous tissue** outside the **brain and spinal cord**. It acts as a communication line between the **Central Nervous System (CNS)** and the rest of the body.

Classification of Peripheral Nervous System

The PNS is functionally and structurally divided into:

1. Somatic Nervous System (SNS)

- Controls **voluntary** movements
- Composed of:
 - **Sensory (afferent) neurons:** Carry information from **skin, skeletal muscles, and joints** to the CNS
 - **Motor (efferent) neurons:** Transmit impulses from CNS to **skeletal muscles**

Key Features:

- Conscious control
 - Involved in reflex arcs and motor activities
 - One motor neuron pathway from CNS to muscle
 - Neurotransmitter: **Acetylcholine**
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2. Autonomic Nervous System (ANS)

- Regulates **involuntary** functions such as **heart rate, digestion, respiration, and glandular activity**
- Consists of:
 - **Visceral sensory neurons:** Carry signals from internal organs to CNS
 - **Visceral motor neurons:** Send signals from CNS to smooth muscles, cardiac muscles, and glands

Subdivisions of ANS:

a) Sympathetic Nervous System

- Prepares the body for "**fight or flight**"
- Increases heart rate, dilates pupils, inhibits digestion
- Neurotransmitters: **Norepinephrine, Epinephrine**

b) Parasympathetic Nervous System

- Promotes "**rest and digest**"
- Slows heart rate, stimulates digestion and gland secretion
- Neurotransmitter: **Acetylcholine**

Structural Differences:

Feature	Sympathetic	Parasympathetic
Origin	Thoracolumbar (T1–L2)	Craniosacral (Cranial + S2–S4)
Ganglia	Near spinal cord	Near or inside organs
Response	Widespread	Localized

3. Enteric Nervous System (ENS)

- Sometimes called the "**brain of the gut**"
- Regulates **GI tract activity independently** of the CNS, though it communicates with the ANS
- Contains **sensory neurons, interneurons, and motor neurons** within the wall of the gastrointestinal tract

Autonomic Nervous System (ANS) Overview

The **Autonomic Nervous System (ANS)** is a part of the **Peripheral Nervous System (PNS)** that controls **involuntary functions** of smooth muscles, cardiac muscles, and glands. It is divided into:

1. **Sympathetic Nervous System (SNS)**
2. **Parasympathetic Nervous System (PNS)**

These systems usually work **antagonistically** to maintain **homeostasis**.

1. Sympathetic Nervous System

Structure:

- Originates from the **thoracolumbar region** of the spinal cord (**T1 to L2**)
- Preganglionic neurons emerge from the lateral horns of spinal cord segments
- Synapse in **sympathetic ganglia**, which are arranged in:
 - **Paravertebral ganglia** (sympathetic chain alongside the spinal cord)
 - **Prevertebral ganglia** (e.g., celiac, superior mesenteric)
- Preganglionic fibers: **short**
- Postganglionic fibers: **long**
- Neurotransmitters:
 - **Preganglionic:** Acetylcholine (ACh)

- **Postganglionic: Norepinephrine (NE)** (except for sweat glands which use ACh)

Functions:

- Prepares body for **emergency or stressful situations** – the "fight or flight" response
 - Increases **heart rate** and **blood pressure**
 - Dilates **pupils** and **bronchi**
 - Inhibits **digestion** and **urination**
 - Stimulates **glucose release** from the liver
 - Redirects blood flow to **skeletal muscles**
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2. Parasympathetic Nervous System

Structure:

- Originates from the **craniosacral region**:
 - **Cranial nerves III, VII, IX, X**
 - **Sacral spinal segments S2–S4**
- Preganglionic neurons synapse in **terminal ganglia**, located **close to or within the target organ**
- Preganglionic fibers: **long**
- Postganglionic fibers: **short**
- Neurotransmitter for both pre- and postganglionic neurons: **Acetylcholine (ACh)**

Functions:

- Promotes **rest, digestion, and energy conservation** – the "rest and digest" state
- Decreases **heart rate** and **blood pressure**
- Constricts **pupils** and **bronchi**
- Stimulates **digestion, salivation, and urination**
- Increases **glandular secretions**
- Promotes **defecation**

Feature	Sympathetic	Parasympathetic
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Origin	Thoracolumbar (T1–L2)	Craniosacral (Cranial Nerves & S2–S4)
Ganglia location	Near spinal cord	Near or within target organ
Preganglionic fiber	Short	Long
Postganglionic fiber	Long	Short
Neurotransmitter	NE (main), ACh (sweat glands)	ACh
Overall function	Fight or flight	Rest and digest
Effect on heart rate	Increases	Decreases
Effect on digestion	Inhibits	Stimulates
Pupil	Dilates	Constricts
Bronchi	Dilates	Constricts
Blood flow	To muscles	To digestive tract

Spinal and Cranial Nerves

The **Peripheral Nervous System (PNS)** comprises:

- **Spinal nerves** (arising from the spinal cord)
- **Cranial nerves** (arising from the brain)

These nerves connect the **Central Nervous System (CNS)** to various body parts and are involved in **sensory, motor, or mixed** (both) functions.

Spinal Nerves

Origin:

- Originate from the **spinal cord**
- **31 pairs** of spinal nerves:
 - **8 cervical (C1–C8)**
 - **12 thoracic (T1–T12)**
 - **5 lumbar (L1–L5)**
 - **5 sacral (S1–S5)**
 - **1 coccygeal (Co1)**

Each spinal nerve arises from the spinal cord by two roots:

- **Dorsal (posterior) root:** Contains **sensory (afferent)** fibers

- **Ventral (anterior) root:** Contains **motor (efferent)** fibers
These roots join to form a **mixed spinal nerve**.

Functions:

- Carry **motor commands** from the CNS to skeletal muscles
 - Transmit **sensory input** from skin, muscles, and joints to CNS
 - Control **reflex actions**
 - Innervate body regions through **nerve plexuses**:
 - **Cervical plexus:** neck, diaphragm (e.g., phrenic nerve)
 - **Brachial plexus:** upper limbs
 - **Lumbar plexus:** abdominal wall, thigh
 - **Sacral plexus:** buttock, lower limb (e.g., sciatic nerve)
-

Cranial Nerves

Origin:

- Originate from the **brain**, mainly from the **brainstem**
- **12 pairs**, numbered **I to XII**, from anterior to posterior
- May be **sensory, motor, or mixed**

List of Cranial Nerves and Their Functions:

No.	Name	Type	Origin Area	Function
I	Olfactory	Sensory	Cerebrum	Smell
II	Optic	Sensory	Diencephalon	Vision
III	Oculomotor	Motor	Midbrain	Eye movement, pupil constriction
IV	Trochlear	Motor	Midbrain	Eye movement (superior oblique muscle)
V	Trigeminal	Mixed	Pons	Sensation of face, mastication
VI	Abducens	Motor	Pons	Eye movement (lateral rectus)
VII	Facial	Mixed	Pons	Facial expression, taste (anterior 2/3 of tongue), salivation
VIII	Vestibulocochlear	Sensory	Medulla/Pons	Hearing and balance
IX	Glossopharyngeal	Mixed	Medulla	Taste (posterior 1/3), swallowing, salivation
X	Vagus	Mixed	Medulla	Autonomic control of heart, lungs, GI tract; taste
XI	Accessory (Spinal)	Motor	Medulla/Spinal cord	Head and shoulder movement
XII	Hypoglossal	Motor	Medulla	Tongue movement

Eye – Introduction

The **eye** is a specialized **sensory organ** responsible for **vision**. It detects **light**, converts it into **nerve impulses**, and transmits them to the **brain** for image processing.

Structure of the Eye

The eyeball is a **spherical structure** (~2.5 cm in diameter) situated in the **orbital cavity** of the skull and protected by the **eyelids**, **eyelashes**, and **lacrimal apparatus**.

It consists of **three layers (tunics)**:

1. Fibrous Tunic (Outer layer)

This is the tough, protective outer coat of the eye.

a) Sclera:

- White, opaque portion (posterior 5/6 of the eye)

- Maintains **shape** of the eye
- Provides **attachment** for eye muscles

b) Cornea:

- Transparent, curved anterior portion (anterior 1/6)
 - Allows **light entry**
 - Responsible for **refraction** of light (major refractive surface)
-

2. Vascular Tunic (Middle layer)

This layer is rich in blood vessels and pigment.

a) Choroid:

- Pigmented layer lining the sclera
- Prevents **light scattering**
- Provides **nutrition** to retina

b) Ciliary Body:

- Contains **ciliary muscles** and **ciliary processes**
- Secretes **aqueous humor**
- Adjusts **lens shape** for focusing (accommodation)

c) Iris:

- Colored portion of the eye
 - Contains circular and radial muscles that regulate **pupil size**
 - Controls amount of **light entering** the eye
-

3. Nervous Tunic (Inner layer)

Retina:

- Contains **photoreceptor cells**:
 - **Rods**: Dim light, black-and-white vision
 - **Cones**: Bright light, color vision
 - Contains the **macula lutea** (high cone density) and **fovea centralis** (sharpest vision)
 - **Optic disc (blind spot)**: No photoreceptors; where optic nerve exits the eye
-

Internal Structures

1. Lens:

- Transparent, biconvex, avascular structure
- Focuses light on the **retina**
- Changes shape for **accommodation** (near/far vision)

2. Aqueous Humor:

- Clear fluid in **anterior chamber**
- Maintains **intraocular pressure**
- Provides **nourishment** to lens and cornea

3. Vitreous Humor:

- Gel-like substance in **posterior chamber**
 - Maintains **shape** of eyeball
 - Keeps retina in place
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Accessory Structures of the Eye

- **Eyelids:** Protect the eye and spread tears
 - **Eyelashes:** Prevent dust from entering the eye
 - **Conjunctiva:** Thin membrane lining eyelids and eyeball
 - **Lacrimal apparatus:** Produces and drains tears to keep eye moist and free of debris
 - **Extraocular muscles:** Control eye movements (6 muscles per eye)
-

Functions of the Eye

1. Vision:

- Detects and focuses light onto retina
- Transmits electrical signals via the **optic nerve** to the **visual cortex** of the brain

2. Light Regulation:

- **Iris** adjusts pupil size to control light entry

3. Refraction and Accommodation:

- Cornea and lens bend light to focus images
- **Ciliary muscles** adjust lens shape for near/far vision

4. Protection:

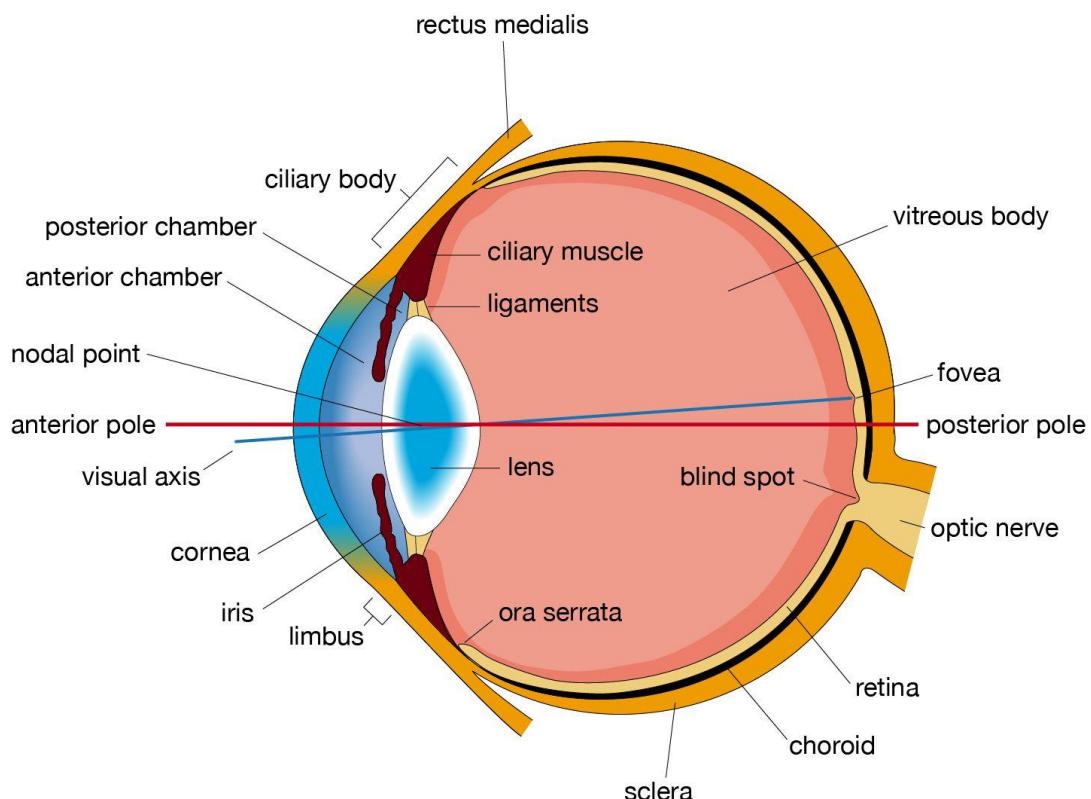
- Eyelids, eyelashes, and tears protect from injury and infection

5. Color Vision:

- **Cones** detect colors (red, green, blue)

6. Night Vision:

- **Rods** help in low light and peripheral vision



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Disorders of the Eye

1. Conjunctivitis (Pink Eye)

- **Cause:** Bacterial, viral, or allergic infection of the **conjunctiva**
- **Symptoms:** Redness, itching, watery or purulent discharge, eyelid swelling
- **Treatment:**
 - Antibiotic or antiviral eye drops (if infectious)
 - Antihistamines (if allergic)
 - Good hygiene to prevent spread

2. Cataract

- **Cause:** Clouding of the **lens** due to aging, trauma, UV exposure, diabetes
 - **Symptoms:** Blurred vision, glare sensitivity, faded colors, poor night vision
 - **Treatment:** Surgical **removal of cloudy lens** and replacement with **intraocular lens (IOL)**
-

3. Glaucoma

- **Cause:** Increased **intraocular pressure** due to impaired drainage of **aqueous humor**
 - **Types:**
 - Open-angle (chronic)
 - Angle-closure (acute)
 - **Symptoms:** Gradual peripheral vision loss, eye pain, halos around lights
 - **Complication:** Can lead to **optic nerve damage** and **blindness**
 - **Treatment:**
 - Eye drops to reduce pressure (beta-blockers, prostaglandin analogs)
 - Laser surgery or conventional surgery
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4. Myopia (Nearsightedness)

- **Cause:** Eyeball too long or cornea too curved
 - **Effect:** Distant objects appear blurry; light focuses **in front of retina**
 - **Treatment:**
 - **Concave lenses** (minus power)
 - LASIK surgery (laser-assisted correction)
-

5. Hypermetropia (Farsightedness)

- **Cause:** Eyeball too short or cornea too flat
 - **Effect:** Nearby objects appear blurry; light focuses **behind retina**
 - **Treatment:**
 - **Convex lenses** (plus power)
 - LASIK surgery
-

6. Astigmatism

- **Cause:** Uneven curvature of **cornea or lens**
 - **Effect:** Blurred or distorted vision at all distances
 - **Treatment:**
 - Cylindrical corrective lenses
 - Refractive surgery
-

7. Presbyopia

- **Cause:** Age-related loss of **lens elasticity**
 - **Effect:** Difficulty in focusing on near objects (common after 40 years)
 - **Treatment:** **Bifocal or progressive lenses**
-

8. Color Blindness (Color Vision Deficiency)

- **Cause:** Inherited defect in **cone cells**
 - **Types:**
 - Red-green (most common)
 - Blue-yellow
 - Total color blindness (rare)
 - **Effect:** Difficulty distinguishing certain colors
 - **Treatment:** No cure; color-filter lenses may help
-

9. Night Blindness (Nyctalopia)

- **Cause:** Deficiency of **vitamin A**, retinal disorders, or genetic defect
 - **Effect:** Difficulty seeing in low light
 - **Treatment:** Vitamin A supplementation, treat underlying cause
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10. Retinal Detachment

- **Cause:** Separation of **retina** from underlying tissues due to injury, aging, or diabetic retinopathy
 - **Symptoms:** Flashes of light, sudden vision loss, "curtain" over visual field
 - **Treatment:** **Emergency surgery** (laser or cryotherapy) to reattach retina
-

11. Diabetic Retinopathy

- **Cause:** Damage to retinal blood vessels due to **chronic diabetes**
 - **Symptoms:** Blurred vision, floaters, visual field loss
 - **Treatment:**
 - Blood sugar control
 - Laser photocoagulation
 - Vitrectomy in advanced cases
-

12. Macular Degeneration

- **Cause:** Degeneration of **macula lutea** (central part of retina), common in elderly
- **Types:**
 - Dry (common)
 - Wet (severe, with abnormal blood vessels)
- **Symptoms:** Central vision loss, straight lines appear wavy
- **Treatment:**
 - Antioxidant supplements (dry type)
 - Anti-VEGF injections (wet type)

Introduction

The **ear** is a complex **sensory organ** responsible for two major functions:

1. **Hearing (Audition)**
2. **Balance (Equilibrium)**

It is divided into **three main parts**:

1. **External ear**
 2. **Middle ear**
 3. **Internal (inner) ear**
-

1. External Ear

a) Auricle (Pinna):

- Visible, cartilaginous part
- Collects **sound waves** and directs them into the **external auditory canal**

b) External Auditory Canal (Meatus):

- Tubular passage (~2.5 cm long)
- Lined with **ceruminous glands** (produce wax to trap dust)
- Conducts sound to **tympanic membrane**

c) **Tympanic Membrane (Eardrum):**

- Thin, semitransparent membrane
 - Vibrates in response to **sound waves**, converting them into **mechanical vibrations**
-

2. Middle Ear

a) **Tympanic Cavity:**

- Air-filled space in the temporal bone

b) **Auditory Ossicles (three tiny bones):**

1. **Malleus (hammer)** – attached to tympanic membrane
 2. **Incus (anvil)** – connects malleus to stapes
 3. **Stapes (stirrup)** – base fits into **oval window** of cochlea
- These bones **amplify** and **transmit vibrations** from the eardrum to the inner ear

c) **Eustachian Tube (Auditory Tube):**

- Connects middle ear to the **nasopharynx**
 - Equalizes pressure between middle ear and atmosphere
 - Important during swallowing or yawning
-

3. Inner Ear (Labyrinth)

Located within the **petrous part of the temporal bone**, the inner ear consists of:

a) **Bony Labyrinth (filled with perilymph):**

- **Cochlea** (hearing)
- **Vestibule** (balance)
- **Semicircular canals** (balance)

b) **Membranous Labyrinth (filled with endolymph):**

- Lies within the bony labyrinth
 - Contains **sensory receptors**
-

Parts of Inner Ear:

i) Cochlea (for hearing):

- Spiral-shaped (like a snail shell)
- Contains **Organ of Corti**, the actual **hearing receptor**
- Converts **vibrations** into **nerve impulses**
- **Sound pathway:** Oval window → Scala vestibuli → Basilar membrane → Organ of Corti → Cochlear nerve → Brain

ii) Vestibule (for balance):

- Central chamber
- Contains **utricle and saccule** with receptors for **linear acceleration** and **head position**

iii) Semicircular Canals (for balance):

- Three canals: anterior, posterior, and lateral
 - Each has an expanded end called **ampulla**
 - Detect **rotational/angular movements** of the head
 - Contains **crista ampullaris**, the sensory organ
-

Nerve Supply

- The **Vestibulocochlear nerve (Cranial Nerve VIII)** has two divisions:
 1. **Cochlear nerve** – for hearing
 2. **Vestibular nerve** – for balance
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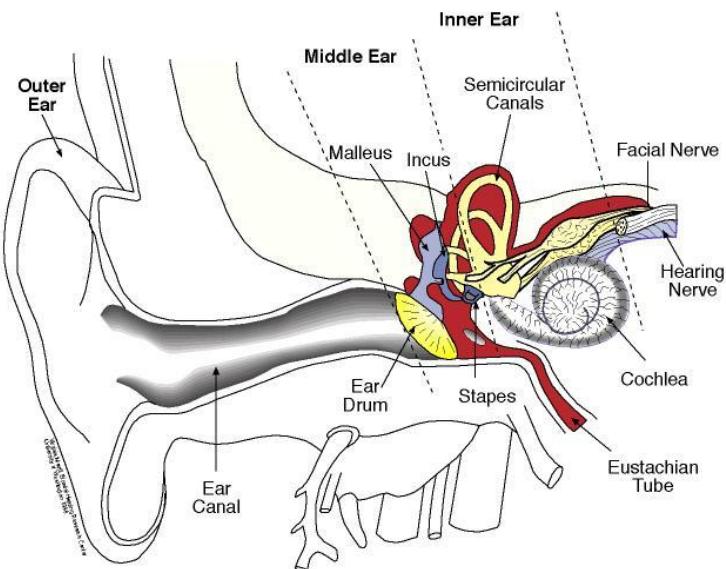
Functions of the Ear

1. Hearing:

- Sound waves → mechanical vibrations → fluid waves in cochlea → electrical impulses → interpreted by brain

2. Equilibrium (Balance):

- **Static equilibrium:** Maintained by utricle and saccule (head position)
- **Dynamic equilibrium:** Maintained by semicircular canals (movement)



Common Disorders of the Ear

1. Otitis Media (Middle Ear Infection)

Cause:

- Bacterial or viral infection spreading from the **nasopharynx** via the **Eustachian tube**
- Common in children due to shorter Eustachian tubes

Symptoms:

- Ear pain
- Fever
- Hearing loss
- Fluid or pus discharge (if eardrum ruptures)

Treatment:

- Antibiotics
 - Pain relievers
 - Myringotomy (surgical drainage in severe cases)
-

2. Otitis Externa (Swimmer's Ear)

Cause:

- Infection of the **external auditory canal**, often due to moisture or trauma
- Common after swimming

Symptoms:

- Ear canal pain and itching
- Redness and swelling
- Discharge

Treatment:

- Antibiotic/antifungal ear drops
 - Avoid water exposure
 - Ear canal cleaning
-

3. Tinnitus

Cause:

- Exposure to loud noise, aging, ear injury, or inner ear damage
- Often associated with **sensorineural hearing loss**

Symptoms:

- Ringing, buzzing, or humming sound in ears (without external source)

Treatment:

- Treat underlying cause
 - Use of **masking devices** or hearing aids
 - Avoid triggers like loud noise or caffeine
-

4. Hearing Loss

a) Conductive Hearing Loss

Cause:

- Blockage or damage in **external/middle ear** (e.g., wax, otitis media, perforated eardrum)

Symptoms:

- Reduced sound volume
- Muffled hearing

Treatment:

- Removal of blockage
- Surgery (e.g., tympanoplasty)
- Hearing aids

b) Sensorineural Hearing Loss

Cause:

- Damage to **inner ear (cochlea)** or **auditory nerve**
- Causes: aging (presbycusis), loud noise, infections, ototoxic drugs

Symptoms:

- Distorted or reduced hearing
- Often irreversible

Treatment:

- Hearing aids
 - Cochlear implants (in severe cases)
-

5. Vertigo

Cause:

- Inner ear disorders affecting balance (e.g., **vestibular neuritis, labyrinthitis**)
- Benign paroxysmal positional vertigo (BPPV)

Symptoms:

- Spinning sensation
- Nausea
- Loss of balance

Treatment:

- Antivertigo medications (e.g., betahistidine)
 - Vestibular rehabilitation exercises
-

6. Meniere's Disease

Cause:

- Excess **endolymph fluid** in the inner ear

Symptoms:

- Episodic vertigo
- Tinnitus
- Fluctuating hearing loss
- Fullness in the ear

Treatment:

- Diuretics
 - Low-salt diet
 - Antiemetics
 - Surgery in chronic cases
-

7. Ear Wax Impaction (Cerumen Impaction)

Cause:

- Accumulation of hardened wax blocking the **ear canal**

Symptoms:

- Hearing loss
- Fullness in the ear
- Itching or pain

Treatment:

- Wax softening drops (cerumenolytics)
 - Irrigation or manual removal by a healthcare provider
-

8. Tympanic Membrane Perforation (Eardrum Rupture)

Cause:

- Trauma, infections, sudden pressure change (barotrauma)

Symptoms:

- Sharp ear pain
- Sudden hearing loss
- Blood or discharge

Treatment:

- Usually heals on its own
 - Surgery (tympanoplasty) if large or persistent
-

9. Barotrauma

Cause:

- Sudden change in **atmospheric pressure** (e.g., during flights, diving)
- Eustachian tube dysfunction

Symptoms:

- Ear pain
- Fullness
- Temporary hearing loss

Treatment:

- Yawning or swallowing to equalize pressure
- Nasal decongestants
- Avoid flying when congested

Nose – Structure and Functions

The **nose** is the primary organ of the **olfactory system (sense of smell)** and a vital part of the **respiratory system**. It is responsible for filtering, humidifying, warming incoming air, and detecting odors.

1. External Nose

- Visible portion on the face
- Composed of:
 - **Nasal bones**
 - **Hyaline cartilage**
 - **External nares (nostrils)** – openings for air entry

2. Internal Nose (Nasal Cavity)

A large cavity located behind the external nose, divided into two halves by the **nasal septum**.

Parts of the Internal Nose:

- **Nasal septum:** Divides the nasal cavity into right and left portions; made of bone and cartilage.
- **Nasal conchae (turbinates):** Three bony projections on lateral walls:
 - **Superior**
 - **Middle**
 - **Inferior**
These increase the surface area and create turbulence for better filtration and humidification.

Openings:

- **Anterior nares (nostrils):** Entry point

- **Posterior nares** (choanae): Connects nasal cavity to **nasopharynx**

Lining:

- The entire nasal cavity is lined with **mucous membrane**:
 - **Ciliated pseudostratified columnar epithelium**
 - **Goblet cells** secrete mucus to trap dust and microbes
-

3. Olfactory Region

Located in the **roof of the nasal cavity**, includes:

- **Olfactory epithelium**: Contains **olfactory receptor neurons**
 - **Olfactory nerve endings** (cranial nerve I): Transmit smell signals to the brain
-

Paranasal Sinuses

Air-filled cavities in surrounding bones:

- **Frontal**
- **Maxillary**
- **Ethmoid**
- **Sphenoid**

Functions:

- Lighten skull weight
 - Contribute to voice resonance
 - Produce mucus that drains into the nasal cavity
-

Blood Supply

- Rich vascular supply from branches of:
 - **Facial artery**
 - **Ophthalmic artery**
 - **Maxillary artery**

This rich blood supply warms the incoming air.

Nerve Supply

- **Olfactory nerve (CN I)** – smell

- **Trigeminal nerve (CN V)** – general sensation
 - **Autonomic nerves** – regulate glandular secretions
-

Functions of the Nose

1. Respiratory Function

- **Passage for inhaled air to reach lungs**
- **Filters dust** and microbes via nasal hairs and mucus
- **Humidifies** the air using mucus and glandular secretions
- **Warms** the air via extensive blood vessels

2. Olfactory Function

- Contains **receptors for smell**
- Detects **volatile chemicals** in air and sends signals to the **olfactory bulb**, then to the **olfactory cortex** in the brain

3. Resonance for Voice

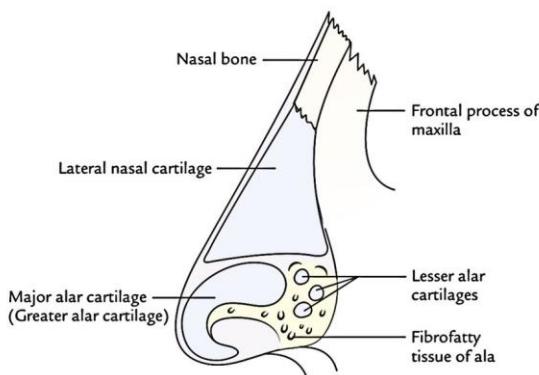
- Nasal cavity and sinuses contribute to **voice quality and resonance**

4. Protection

- Sneezing reflex expels irritants
 - Mucociliary clearance transports mucus and trapped debris toward the throat for swallowing
-

Clinical Conditions of the Nose (Brief Overview)

- **Rhinitis:** Inflammation of nasal mucosa (common cold, allergies)
- **Deviated nasal septum:** Causes breathing difficulty
- **Nasal polyps:** Non-cancerous growths in the mucosa
- **Epistaxis:** Nosebleed, common due to rich blood supply



Tongue – Structure and Functions

The tongue is a **muscular organ** located in the **oral cavity**, essential for:

- Taste
- Speech
- Swallowing (deglutition)
- Mastication (chewing)

It is highly flexible and covered with a **mucous membrane**.

Gross Anatomy of the Tongue

The tongue is divided into:

1. Anterior two-thirds (oral part):

- Lies in the **oral cavity**
- Responsible for most of the **taste perception**
- Mobile and visible

2. Posterior one-third (pharyngeal part):

- Lies in the **oropharynx**
- Contains **lymphoid tissue** (part of **lingual tonsils**)

3. Dorsal surface:

- **Top** surface
- Covered with **papillae** (projections that may contain taste buds)

4. Ventral surface:

- **Underside** of the tongue
 - Smooth, shows blood vessels
-

Muscles of the Tongue

A. Intrinsic muscles (within the tongue):

- Alter the **shape** of the tongue (e.g., curling, flattening)

B. Extrinsic muscles (attach tongue to surrounding structures):

1. **Genioglossus** – protrudes tongue
2. **Hyoglossus** – depresses tongue
3. **Styloglossus** – retracts and elevates
4. **Palatoglossus** – elevates posterior part

All muscles are innervated by the **hypoglossal nerve (cranial nerve XII)**, except palatoglossus (**vagus nerve CN X**).

Papillae on the Dorsum of the Tongue

Type	Location	Function	Taste Buds Present?
Filiform	Most numerous; anterior 2/3	Tactile sensation	<input checked="" type="checkbox"/> No
Fungiform	Scattered among filiform	Taste perception	<input checked="" type="checkbox"/> Yes
Circumvallate	V-shaped row near back	Bitter taste	<input checked="" type="checkbox"/> Yes
Foliate	Lateral margins	Taste (mainly in infants)	<input checked="" type="checkbox"/> Yes

Taste Buds

- Located mainly on **fungiform, circumvallate, and foliate papillae**
 - Each taste bud has **gustatory receptor cells** with **microvilli** (taste hairs)
 - These detect chemicals dissolved in saliva
-

Basic Tastes

1. **Sweet** – tip of tongue
 2. **Salty** – sides and tip
 3. **Sour** – sides
 4. **Bitter** – back of tongue
 5. **Umami** – overall distribution
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Nerve Supply of the Tongue

Function	Nerve	Area
General sensation (touch, temperature)	Trigeminal nerve (CN V - mandibular branch)	Anterior 2/3
Taste	Facial nerve (CN VII)	Anterior 2/3
Taste and sensation	Glossopharyngeal nerve (CN IX)	Posterior 1/3
Motor supply	Hypoglossal nerve (CN XII)	All muscles except palatoglossus
Taste/sensation from pharyngeal region	Vagus nerve (CN X)	Root of tongue & epiglottis

Blood Supply

- **Lingual artery** (branch of external carotid artery)
 - Venous drainage via **lingual vein**
-

Lymphatic Drainage

- Drains into **submental, submandibular, and deep cervical lymph nodes**
-

Functions of the Tongue

1. **Taste perception** through taste buds
 2. **Manipulation of food** during chewing (mastication)
 3. Helps in **swallowing (deglutition)**
 4. Essential for **speech articulation**
 5. Helps in **cleaning** the oral cavity
 6. Contains part of the **immune system** (lingual tonsils)
-

Clinical Conditions

- **Glossitis** – Inflammation of the tongue (due to vitamin B12 deficiency or infections)
- **Geographic tongue** – Irregular patches on surface, benign
- **Tongue-tie (ankyloglossia)** – Short lingual frenulum, may impair speech
- Oral cancer-tobacco chewing