Unit-4

Human Anatomy and Physiology-I

B.Pharma 1st Sem Notes

UNIT-IV

- **Peripheral nervous system:**
  Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves.

- **Special senses**
  Structure and functions of eye, ear, nose and tongue and their disorders.

Peripheral Nervous System (PNS)

- The Peripheral Nervous System consists of all nerves and ganglia outside the brain and spinal cord.
- It connects the Central Nervous System (CNS) with different parts of the body and helps in receiving sensory information and sending motor commands.

Classification of Peripheral Nervous System

The PNS is broadly classified into:

1. **Somatic Nervous System (SNS)**
2. **Autonomic Nervous System (ANS)**

1. Somatic Nervous System

The main function of the somatic nervous system is to transfer impulses from CNS to skeletal muscles.

It consists of

- Cranial Nerves
- Spinal Nerves

Cranial nerves are 12 pairs and they emerge from the brain. Some of the examples of cranial nerves are optic, olfactory, etc.

Spinal nerves have their point of emergence as the spinal cord. There are 31 pairs of spinal nerves. They emerge from the spinal cords into dorsal and ventral roots. At the junction of these two roots, the sensory fibres continue into the dorsal root and the motor fibres into the ventral root.

2. Autonomic Nervous System

The autonomic nervous system relays impulses from the central nervous system to the involuntary organs and smooth muscles of the body.

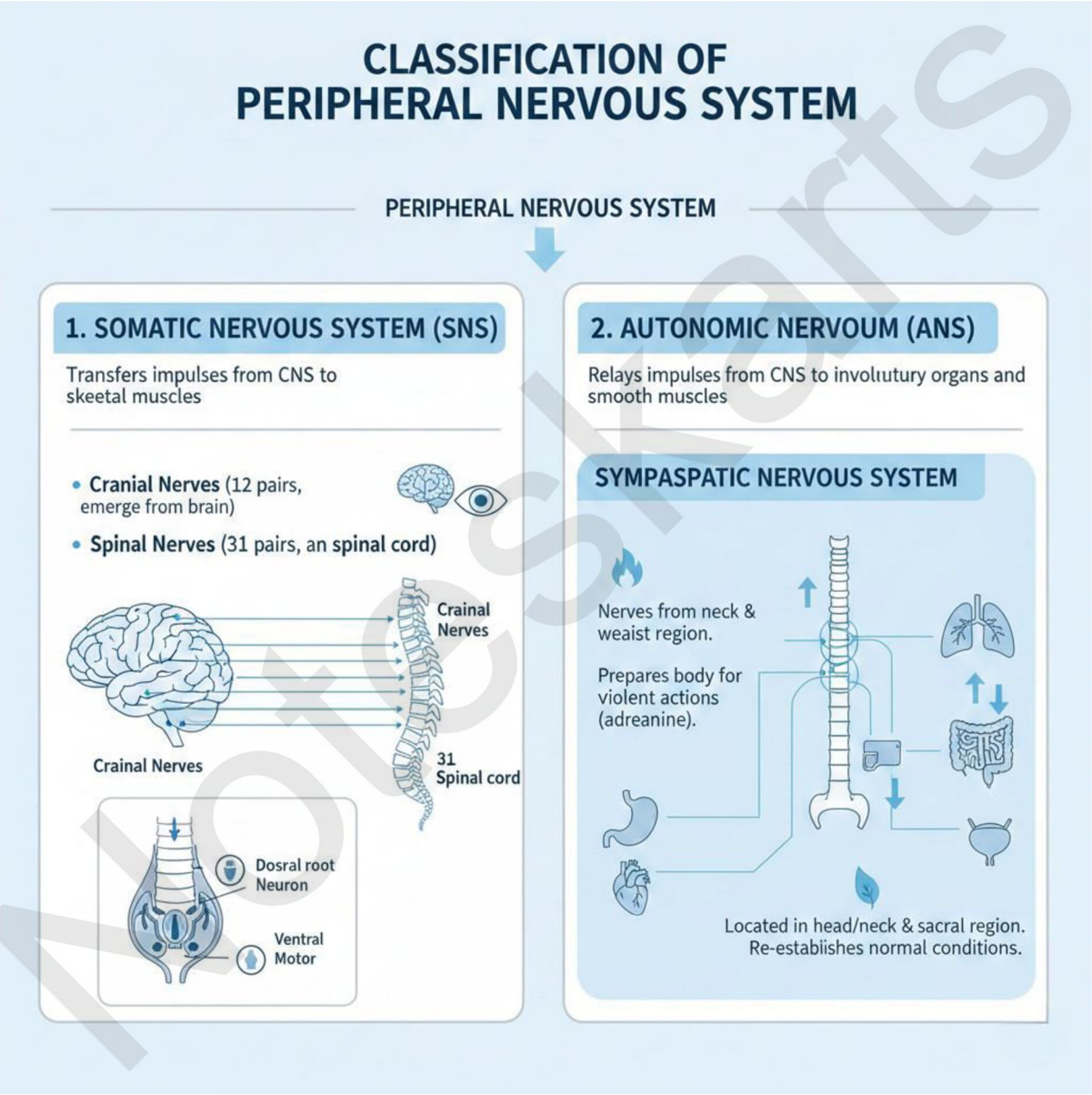
It is divided into two parts –

1. Sympathetic Nervous System
2. Parasympathetic Nervous System

1. **Sympathetic nervous system** consists of nerves arising from the spinal cord between the neck and waist region. It prepares the body for violent

actions against abnormal conditions and is generally stimulated by adrenaline.

2. **Parasympathetic nervous system** is located anterior in the head and neck and posterior in the sacral region. It is mainly involved in the re-establishment of normal conditions when violent action is over.



Peripheral Nervous System Functions

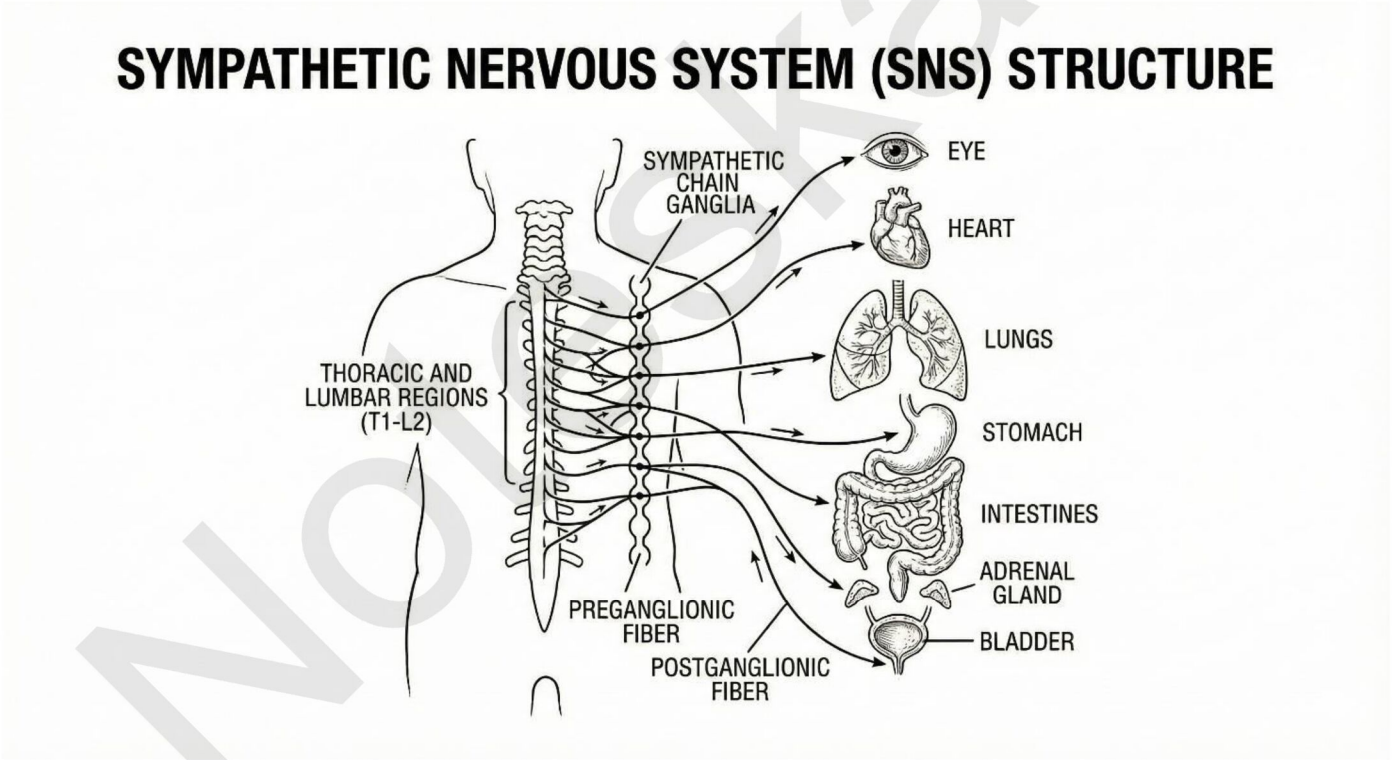
Following are the important functions of the peripheral nervous system:

1. The peripheral nervous system connects the brain and the spinal cord to the rest of the body and the external environment.
2. It regulates internal homeostasis.
3. It can regulate the strength of muscle contractility.
4. It controls the release of secretions from most exocrine glands.

1. Sympathetic Nervous System (SNS)

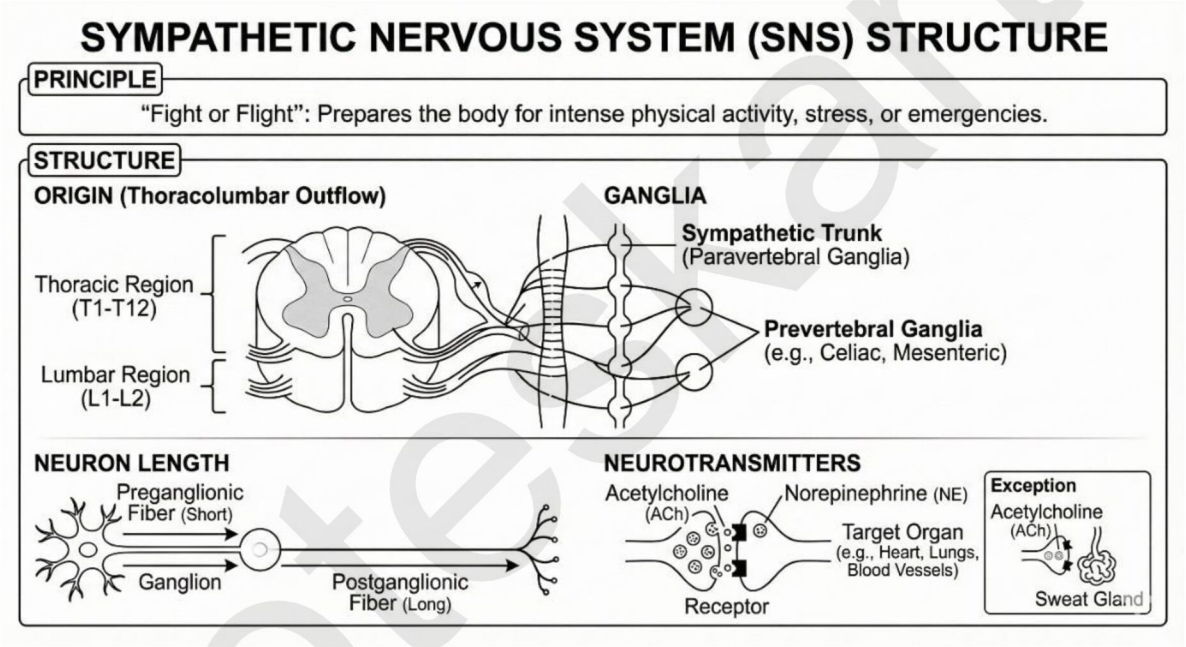
Principle: "Fight or Flight" This system prepares the body for intense physical activity, stress, or emergencies.

Structure:



- **Origin (Thoracolumbar Outflow):** The nerves of the sympathetic system originate from the thoracic and lumbar regions of the spinal cord (specifically T1 to L2).
- **Ganglia:** The ganglia (clusters of nerve cell bodies) are located close to the spinal cord in a chain called the **Sympathetic Trunk** (paravertebral ganglia).

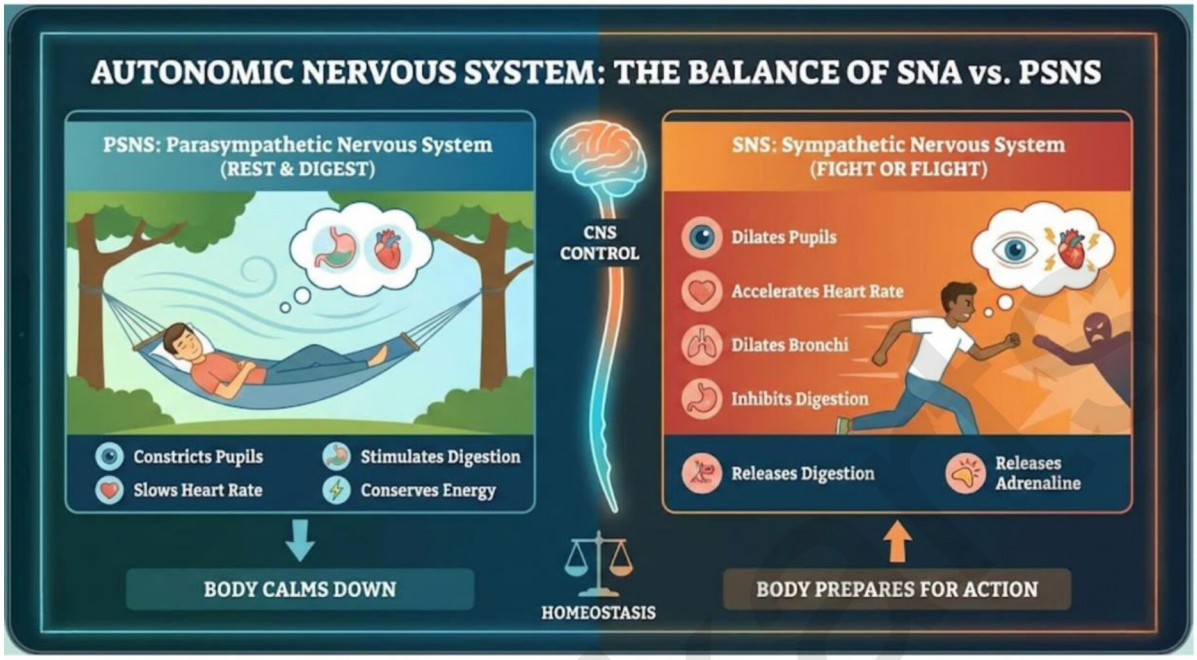
- **Neuron Length:**
  - **Preganglionic fibers:** Short (they travel from the spine to the nearby ganglia).
  - **Postganglionic fibers:** Long (they travel from the ganglia to the target organs).
- **Neurotransmitters:**
  - Releases **Acetylcholine (ACh)** at the preganglionic synapse.
  - Releases **Norepinephrine (NE)** at the target organ (postganglionic synapse). *Exception: Sweat glands use Acetylcholine.*



Functions

- **Eyes:** Dilates pupils (Mydriasis) to let in more light for better vision.
- **Heart:** Increases heart rate and force of contraction to pump more blood to muscles.
- **Lungs:** Dilates bronchioles (bronchodilation) to allow more oxygen intake.
- **Digestion:** Inhibits peristalsis (movement) and secretions; diverts blood away from the stomach to skeletal muscles.
- **Liver:** Stimulates the breakdown of glycogen into glucose (glycogenolysis) for a quick energy burst.
- **Bladder:** Relaxes the bladder muscle (detrusor) and constricts the sphincter to prevent urination.

Different between SNA and PSNS



Origin and Functions of Spinal Nerves

Origin of Spinal Nerves

Spinal nerves originate from the **spinal cord**, which extends from the medulla oblongata to the lumbar region of the vertebral column. There are **31 pairs of spinal nerves**, each emerging through the intervertebral foramina.

Region	Number of Pairs
Cervical (C)	8
Thoracic (T)	12
Lumbar (L)	5
Sacral (S)	5
Coccygeal (Co)	1
Total	**31 pairs**

Each spinal nerve is formed by the union of two roots:

1. **Dorsal (Posterior) Root**
    - Contains sensory (afferent) nerve fibers.
    - Has a **dorsal root ganglion** that contains sensory neuron cell bodies.
    - Carries impulses from receptors to the spinal cord.
2. **Ventral (Anterior) Root**

- Contains motor (efferent) nerve fibers.
- Carries impulses from the spinal cord to muscles and glands.

Functions of Spinal Nerves

Spinal nerves perform three major functions:

1. **Sensory Function**
   - Transmit sensory impulses from skin, muscles, joints, and internal organs to the spinal cord and brain.
   - Sensations include:
     - Touch
     - Pain
     - Temperature
     - Pressure
     - Proprioception
2. **Motor Function**
   - Carry motor impulses from the spinal cord to:
     - Skeletal muscles (voluntary movements)
     - Smooth muscles and glands (through autonomic fibers)
   - Responsible for muscle contraction and body movement.
3. **Reflex Function**
   - Participate in **spinal reflexes**, which are rapid, automatic responses to stimuli.
   - Example: Withdrawal of hand from a hot object.

Branches of a Typical Spinal Nerve

After emerging, each spinal nerve divides into:

- **Dorsal ramus**: Supplies skin and muscles of the back.
- **Ventral ramus**: Supplies limbs and anterior body wall; forms nerve plexuses.
- **Meningeal branch**: Supplies meninges of the spinal cord.
- **Communicating rami**: Connect spinal nerves to the sympathetic chain.

Origin and Functions of Cranial Nerves

Cranial nerves arise directly from the **brain and brainstem**, unlike spinal nerves which arise from the spinal cord. There are **12 pairs of cranial nerves**, numbered I to XII according to their order of origin from the brain.

They may be:

- Sensory
- Motor
- Mixed (both sensory and motor)

Origin of Cranial Nerves

Cranial Nerve	Name	Origin
I	Olfactory	Forebrain (olfactory bulb)
II	Optic	Forebrain (diencephalon)
III	Oculomotor	Midbrain
IV	Trochlear	Midbrain
V	Trigeminal	Pons
VI	Abducens	Pons–medulla junction
VII	Facial	Pons–medulla junction
VIII	Vestibulocochlear	Pons–medulla junction
IX	Glossopharyngeal	Medulla oblongata
X	Vagus	Medulla oblongata
XI	Accessory	Medulla oblongata and spinal cord
XII	Hypoglossal	Medulla oblongata

Functions of Cranial Nerves

No.	Nerve	Type	Main Functions
I	Olfactory	Sensory	Sense of smell
II	Optic	Sensory	Vision
III	Oculomotor	Motor	Eye movements, pupil constriction
IV	Trochlear	Motor	Eye movement (downward and inward)
V	Trigeminal	Mixed	Facial sensation, chewing
VI	Abducens	Motor	Lateral movement of eye
VII	Facial	Mixed	Facial expressions, taste (anterior 2/3 of tongue), salivation
VIII	Vestibulocochlear	Sensory	Hearing and balance
IX	Glossopharyngeal	Mixed	Taste (posterior 1/3 of tongue), swallowing, salivation
X	Vagus	Mixed	Controls heart, lungs, digestion; voice
XI	Accessory	Motor	Shoulder and neck movements
XII	Hypoglossal	Motor	Tongue movements

Classification Based on Function

Type	Cranial Nerves
Sensory	I, II, VIII
Motor	III, IV, VI, XI, XII
Mixed	V, VII, IX, X

General Functions of Cranial Nerves

1. **Sensory Functions**
   - Smell, vision, hearing, taste, and balance.
   - Sensations from face and head.
2. **Motor Functions**
   - Control of eye movements.
   - Facial expressions.
   - Chewing and swallowing.
   - Movement of tongue, neck, and shoulders.
3. **Autonomic Functions**
   - Regulation of heart rate.
   - Control of digestion.
   - Glandular secretions (salivary and lacrimal glands).

Special senses

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

Sensory organs biologically identify sensations and are essential organs that participate in day-to-day activities. The sensory organs function by the transmission of signals to the brain in response to the environment, and the brain helps interpret the signals.

A human body is embodied with five sensory or sense organs-

- Eyes- gives the sense of sight,
- Nose- gives the sense of smell,
- Skin- gives the sense of touch,
- Tongue- gives the sense of taste,
- Ear- gives the sense of hearing.

In cellular organisms, the sensory organs are made up of sensory cells that respond to a specific type of stimuli. These sensory receptor cells transduce the physical stimuli to nerve signals that are interpreted by the brain cells.
The optimum functioning of these sensory organs is crucial. And so, Keeping them healthy is imperative. This article talks about the five sense organs, their functioning, and ways to keep them in a healthy condition.

1. The Eye (Vision)

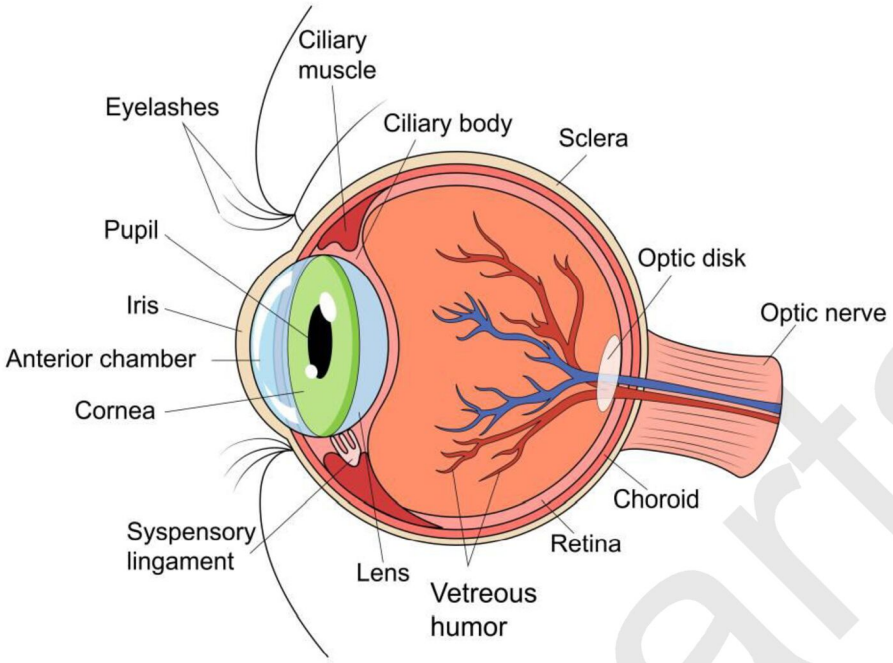
The eye is a complex optical instrument that focuses light onto a photosensitive surface.

Structure

- **Fibrous Layer:** Includes the **Sclera** (the white of the eye) and the **Cornea** (the clear front "window" that refracts light).
- **Vascular Layer (Uvea):** Contains the **Iris** (controls pupil size), **Ciliary Body** (adjusts lens shape), and **Choroid** (provides blood supply).
- **Inner Layer (Retina):** The neural layer containing **photoreceptors**:
  - **Rods:** Responsible for vision in low light.
  - **Cones:** Responsible for color vision and high detail.

Functions

- **Refraction:** Light is bent by the cornea and lens to focus on the retina.
- **Accommodation:** The lens changes shape to focus on near or far objects.
- **Phototransduction:** Photoreceptors convert light into nerve impulses sent via the **Optic Nerve**.



Common Disorders

- **Myopia (Nearsightedness):** Eyeball is too long; light focuses in front of the retina.
- **Hyperopia (Farsightedness):** Eyeball is too short; light focuses behind the retina.
- **Cataracts:** Clouding of the lens, leading to blurry vision.
- **Glaucoma:** Increased intraocular pressure that can damage the optic nerve.

2. The Ear (Hearing & Equilibrium)

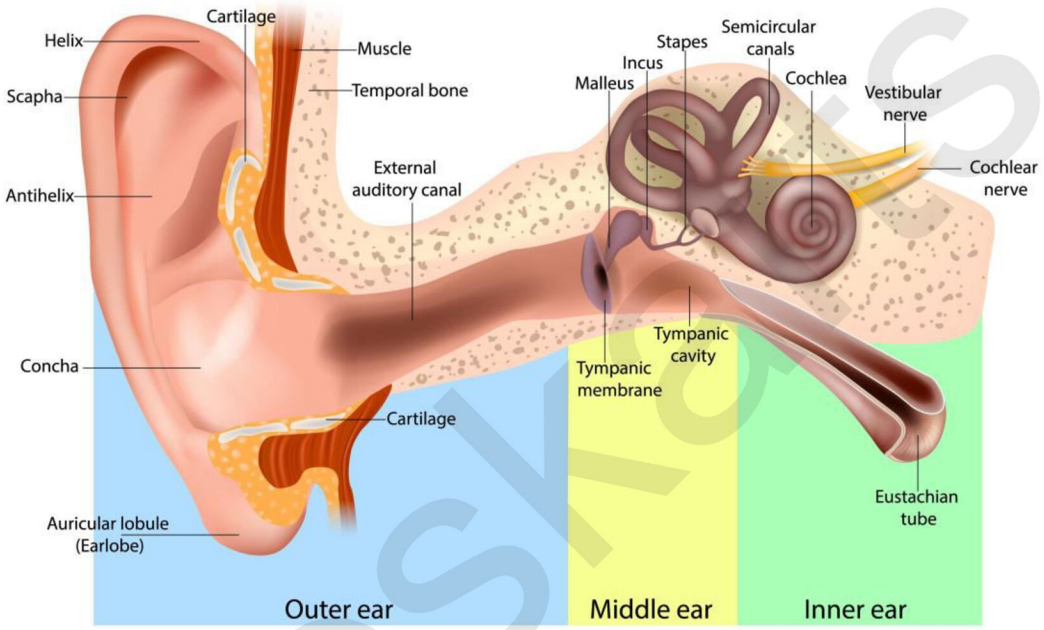
The ear serves a dual purpose: collecting sound waves and maintaining balance.

Structure

- **Outer Ear:** Auricle (Pinna) and External Acoustic Meatus.
- **Middle Ear:** Contains the **Ossicles** (Malleus, Incus, Stapes) which amplify sound.
- **Inner Ear:** * **Cochlea:** Snail-shaped structure for hearing.
    - **Semicircular Canals:** Responsible for dynamic equilibrium (balance).

Functions

- **Hearing:** Sound waves vibrate the eardrum, moving the ossicles, which creates fluid waves in the cochlea. These waves stimulate hair cells to send signals via the **Auditory Nerve**.
- **Balance:** Fluid movement in the canals detects head position and movement.



Common Disorders

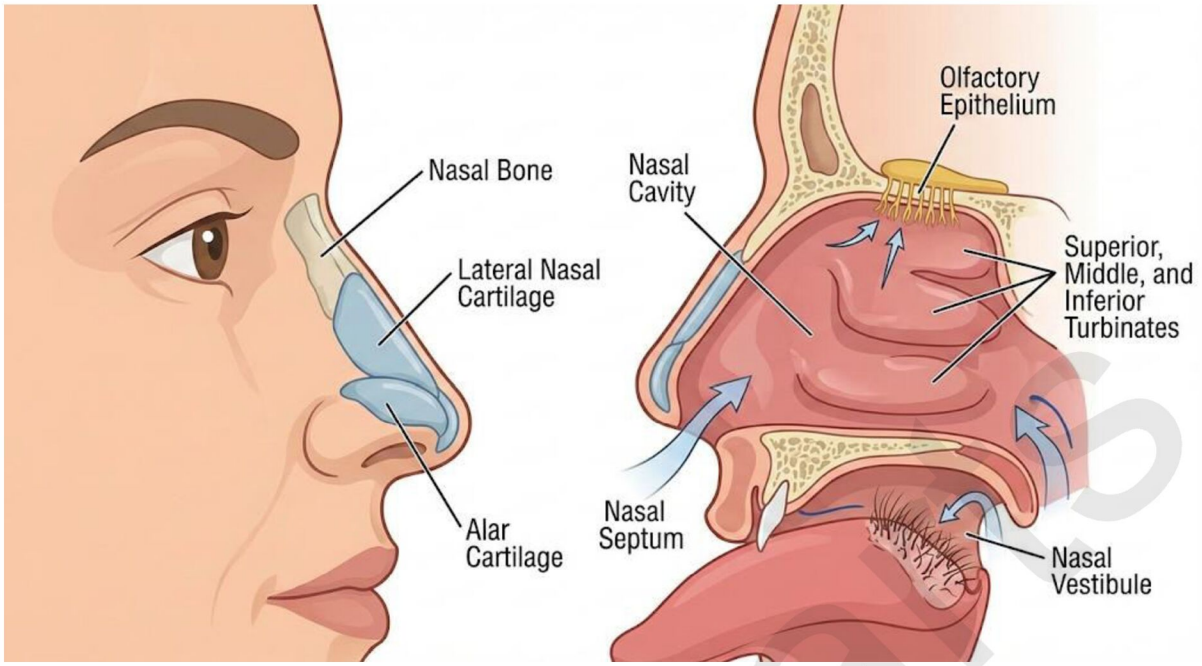
- **Otitis Media:** Inflammation or infection of the middle ear.
- **Tinnitus:** A persistent ringing or buzzing sensation in the ears.
- **Vertigo:** A sensation of spinning caused by inner ear issues.

3. The Nose (Olfaction)

The sense of smell is a chemical sense triggered by airborne molecules.

Structure

- **Olfactory Epithelium:** Located in the roof of the nasal cavity.
- **Olfactory Receptors:** Bipolar neurons with "hairs" that detect chemicals.
- **Olfactory Bulb:** The brain structure where signals are processed before traveling to the cortex.



Functions

- **Odor Detection:** Chemicals dissolve in nasal mucus and bind to receptors.
- **Flavor Contribution:** Much of what we perceive as "taste" is actually smell.

Common Disorders

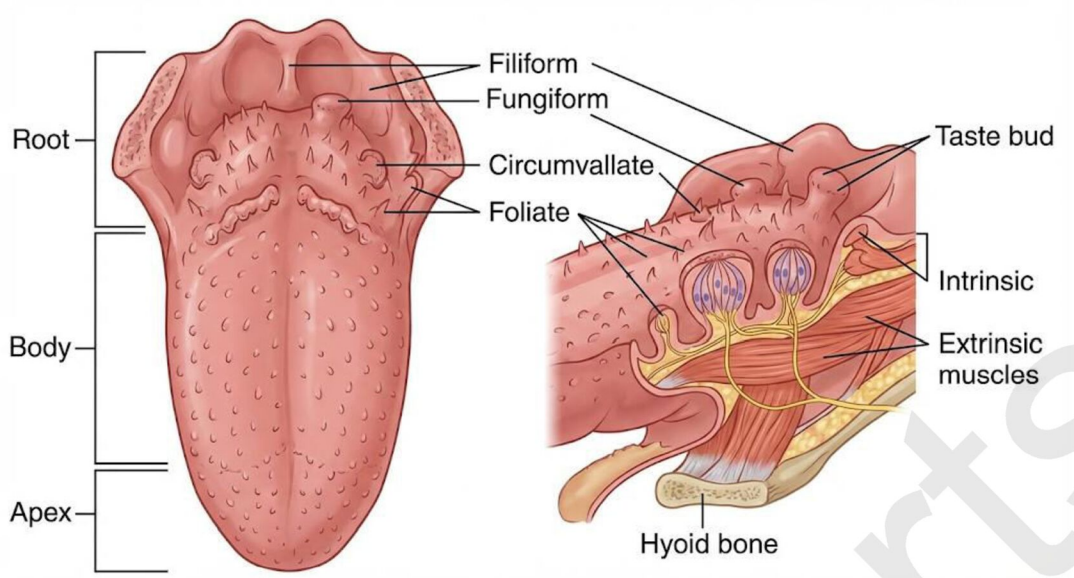
- **Anosmia:** Total loss of the sense of smell (often due to head injury or infection).
- **Rhinitis:** Inflammation of the nasal mucous membranes (allergies/colds).

4. The Tongue (Gustation)

Taste is another chemical sense, primarily used to distinguish between nutrients and toxins.

Structure

- **Papillae:** Small bumps on the tongue surface (fungiform, circumvallate, foliate).
- **Taste Buds:** Located within papillae, containing **gustatory cells**.



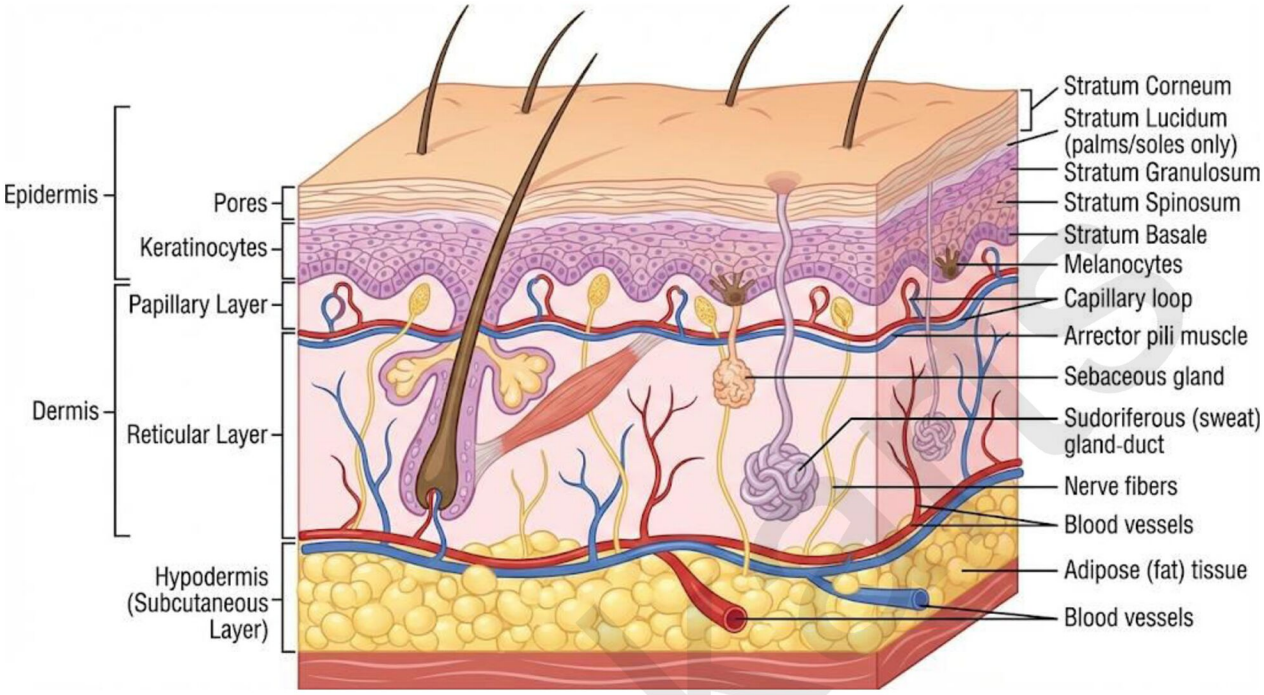
Functions

- **Primary Tastes:** Detection of Sweet, Sour, Salty, Bitter, and Umami (savory).
- **Chemoreception:** Saliva dissolves food chemicals so they can bind to receptor cells.

Common Disorders

- **Ageusia:** Loss of taste functions.
- **Glossitis:** Inflammation of the tongue, often causing it to appear smooth and red.

SKIN: Sense of Touch



- Skin is the largest sensory organ. It is the most sensitive and natural defence against many external predators.
- According to an article by Stanford Encyclopaedia of Philosophy, the sensation of touch through the skin is one of the first senses a human develops.
- The specialised neurons of the skin transmit distinct sensations of touch-pressure, vibration, light touch, pain, tingle, texture, and temperature change to the brain.
- The sensation of touch is tied to abstract concepts of compassion, pain, laughter, mood change, and even decision-making.
- Ageing can affect your skin while impacting the sensation of touch, causing hypoesthesia (reduced sensitivity or loss of touch)

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