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HUMAN ANATOMY AND PHYSIOLOGY – I

UNIT 4

TOPIC :

- **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.

Nervous System

→ Nervous System is a highly advanced network of specialised cells called neurons.

→ With the help of millions of neurons, nervous system coordinates the body functions and transmits signals between the different body parts.

→ A single nerve is a collection of various neurons. These bundles of neurons are covered by a protective layer of connective tissue; and this layer can be divided into

1. Endoneurium
2. Perineurium
3. Epineurium

→ CNS is the main control centre of the whole system.

→ All external and internal stimuli pass to the CNS by means of sense organs and receptors.

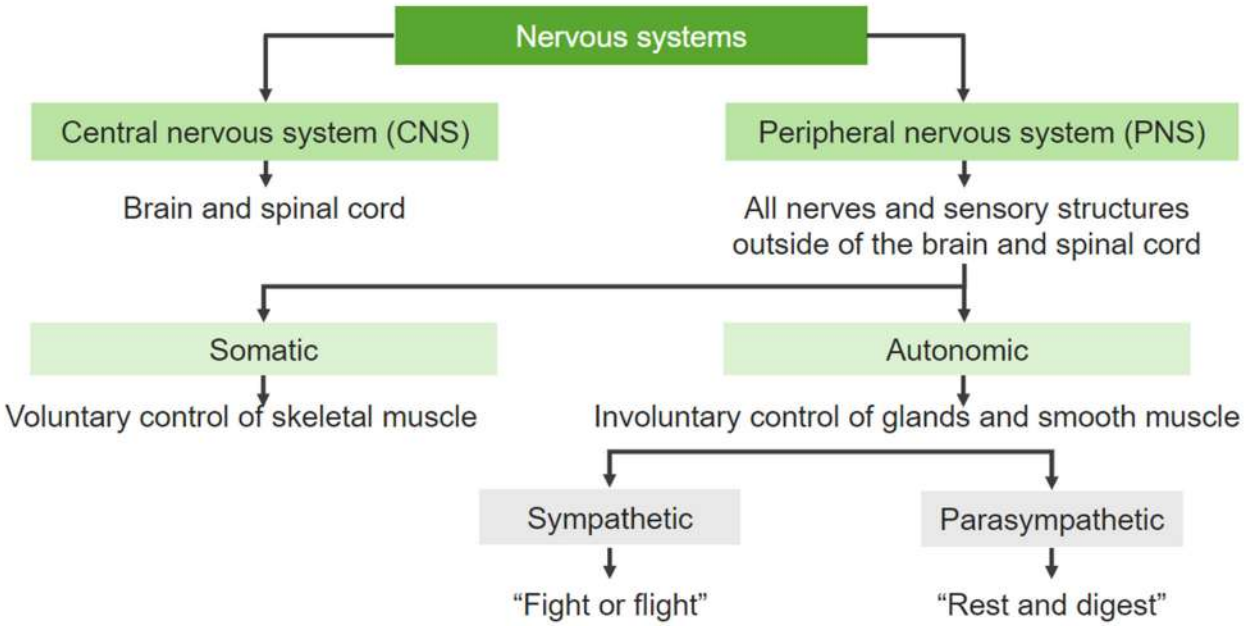
→ CNS interprets these stimuli and if necessary, response to them (e.g., moving away from fire, etc.)

→ The PNS forms the second major part of the nervous system.

→ The PNS is further subdivided into many smaller units.

→ It comprises of all nerves connecting the brain and spinal cord to the sensory receptors, muscles, and glands.

Classification



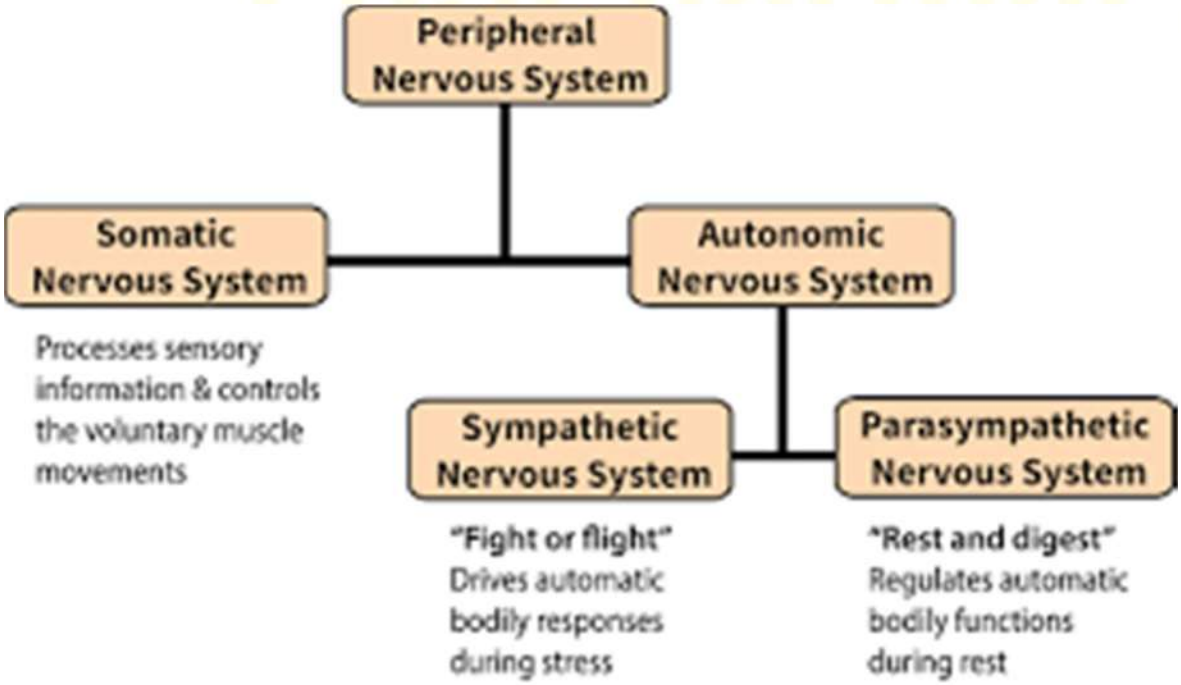
Peripheral Nervous System (PNS)

→ The **Peripheral Nervous System (PNS)** is a part of the nervous system that lies **outside the brain and spinal cord**. It includes all the **cranial nerves**, **spinal nerves**, and their branches. The PNS serves as a communication network between the **Central Nervous System (CNS)** and the **rest of the body** (muscles, glands, skin, and organs).

Functions of PNS:

1. Connects CNS to limbs and organs.
2. Transmits sensory information to the CNS.
3. Sends motor commands from CNS to muscles.
4. Regulates involuntary functions like heartbeat and digestion.
5. Coordinates voluntary movements.

Classification of PNS



Somatic Nervous System (SNS)

→ It is the Part of PNS system responsible for carrying sensory & motor information to form the CNS.

→ SNS name derived from greek word SOMA which means body

→ It is responsible for transmitting sensory information as well as for voluntary movement.

→ SNS Contain two major types of neurons

- Sensory Neurons (Afferent Neurons)
- Motor Neurons (Efferent Neurons)

- Sensory Neurons (Afferent Neurons) : It carry information from the neurons to CNS.
- Motor Neurons (Efferent Neurons) : It carry information from the brain & spinal cord to muscle fibers through out the body.

Autonomic nervous system

Divisions of Autonomic Nervous System :

The autonomic nervous system is separated into two divisions:

✓ Sympathetic (Thoraco lumbar outflow) division

✓ Parasympathetic (Cranio sacral outflow) division

Sympathetic Nervous System (SNS)

→ The Sympathetic Nervous System is a division of the autonomic nervous system responsible for preparing the body to respond to stressful or emergency situations by activating the "fight or flight" response.

Structure :

- **O**rigin: Arises from the thoracolumbar region of the spinal cord (T1 to L2).
- Neurons:
  - Preganglionic neurons originate in the spinal cord.
  - They synapse in sympathetic ganglia (either in the paravertebral chain or prevertebral ganglia).
  - Postganglionic neurons extend from ganglia to the target organs.
- Neurotransmitter:
  - Acetylcholine (ACh) in preganglionic fibers.
  - Norepinephrine (NE) in postganglionic fibers (except sweat glands which use ACh).

Functions:

- **Increases heart rate and force of contraction** – to improve blood flow to muscles.
- **Dilates bronchi** – allows more oxygen into the lungs.
- **Dilates pupils** – improves vision.
- **Inhibits gastrointestinal motility and secretions** – redirects energy to muscles.
- **Stimulates glucose release** from liver – increases energy supply.
- **Inhibits urination and defecation** – conserves energy for vital functions.
- **Stimulates sweating** – helps in thermoregulation.

Parasympathetic Nervous System (PNS)

→ The Parasympathetic Nervous System is the division of the autonomic nervous system responsible for conserving energy and promoting "rest and digest" activities during normal, relaxed states.

Structure :

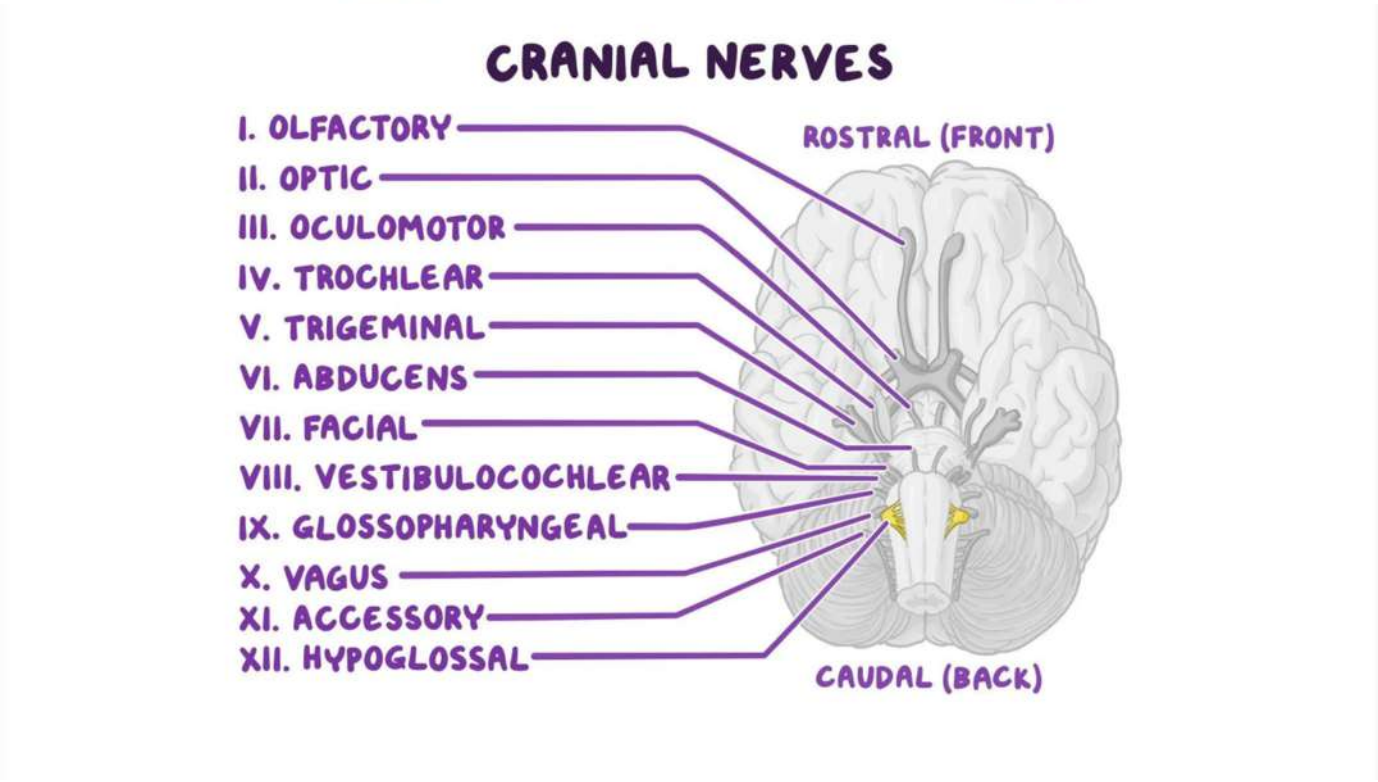
- Also part of the autonomic nervous system (ANS).
- Originates from the craniosacral region:
  - Cranial nerves: III (oculomotor), VII (facial), IX (glossopharyngeal), X (vagus).
  - Sacral spinal nerves: S2 to S4.
- Has long preganglionic and short postganglionic fibers.
- Ganglia are located near or within the target organs.

Functions :

- **Decreases heart rate and cardiac output** – conserves energy.
- **Constriction of pupils** – reduces light entry for relaxation.
- **Stimulates digestion** – increases enzyme secretion and intestinal movement.
- **Stimulates salivation and lacrimation** – helps in food digestion and eye lubrication.
- **Promotes urination and defecation** – supports waste removal.
- **Contracts bronchial muscles** – decreases airway diameter during rest.

CRANIAL NERVES

- There are 12 pairs of cranial nerves originating from the nuclei in the inferior surface of the brain.
- Some are sensory, some are motor and some are mixed.
- Their names and numbers are as follows:



→ **Olfactory Nerves:** It is sensory type of nerve with afferent fiber. It originates in the olfactory lobe i.e. root of nose and terminates in the temporal lobe of cerebrum. It is associated with sense of smell.

→ **Optic Nerves:** It is sensory type of nerve with afferent fibre. It originates in the retina of eyes and terminates in the vision area of occipital lobe of cerebrum. It is related with sense of vision

→ **Oculomotor Nerves:** It is mixed type of nerve with efferent as well as afferent fiber, but primarily it is motor originates in the mid-brain.

✓ Efferent (motor) portion: It innervates skeletal muscles it moves the eyeball and innervates smooth muscles that constrict pupil and lens shape for far and near vision.

✓ Afferent (sensory) portion: It is related to movement of eyeball and regulating the size of pupil.

→ **Trochlear Nerves:** It is mixed type of nerve but primarily motor and originates in the midbrain. It is the smallest of the 12 cranial nerves. The motor portion is related to movement of eyeball and sensory vision carries information from muscles of eye to midbrain.

→ **Trigeminal Nerves:** It is a mixed type of nerve fibre. It is the largest among all the cranial nerves. The motor portion originates from pons and innervates the muscles of mastication (skeletal chewing muscles).The sensory portion consists of three branches:

- Ophthalmic nerve: It contains axons from skin of eyelids, eyeball, lacrimal glands, nasal cavity, nose, and forehead.
- Maxillary nerve: It contains axons from the mucosa of nose, parts of pharynx, upper teeth, upper lip, and lower eyelid.
- Mandibular nerve: It contains axon from tongue, lower teeth, skin over mandible, cheek.

→ **Abducens Nerve:** A mixed type of nerve, but 1° motor that originates in the pons. The motor portion innervates the skeletal muscles that move eyeball. The sensory portion transmits information from proprioceptors in muscles. It is related to the movement of eyeball and muscles sense (proprioception).

- Motor function: Movement of eyeball
- Sensory function: Proprioception

→ **Facial Nerve :** It is a mixed type of nerve. The motor fibre originates from pons and innervates skeletal muscle of face, nose, palate, lacrimal and salivary gland. The sensory fibre transmits information from taste buds in the tongue and mouth.

- Motor function: Facial expression
- Sensory function: Proprioception and taste

→ **Vestibulocochlear Nerve:** It is sensory type of nerve transmits information from receptor in ear. It consists of two nerves:

- Vestibular nerve: It arises from semicircular canals of the inner ear and conveys impulses to the cerebellum. They are associated with maintenance of posture and balance.
- Cochlear nerve: It originates in the spiral organ in the inner ear and conveys impulses to the hearing area of cerebral cortex. Cochlear nerve is responsible for hearing.

→ **Glossopharyngeal Nerve:** It is a mixed type of nerve.The motor fibres originate from medulla oblongata and innervate the tongue andpharynx. The sensory fibres originate from salivary glands and terminate in medulla oblongata.

- Motor function: Elevates the pharynx during swallowing and speech.
- Sensory function: Taste sensations, touch, pain and temperature sensations, monitoring of blood pressure.

→ **Vagus Nerve:** It is a motor type of nerve.The motor fibres originates in the medulla and innervates the smooth muscles of pharynx, larynx, trachea, heart oesophagus, stomach, intestine, pancreas, gall bladder, bile duct, spleen, kidney, ureter, blood vessels in thoracic and abdominal cavities.The sensory fibres convey impulses from same organs to brain.

- Motor function: Swallowing, coughing and voice production.
- Sensory function: Taste, touch, pain and temperature sensations, monitoring of blood pressure

→ **Accessory Nerve:** It is mixed type of nerve, primarily motor nerve. It originates from medulla oblongata and in the spinal cord. It originates from medulla oblongata and innervates the voluntary muscles of pharynx and skeletal muscle of neck.

- Motor function: Neck controls swallowing movements and movement of head and shoulders.

→ **Hypoglossal Nerve:** It is mixed type of nerve but primarily motor nerve. It originates in the medulla and supplies to the muscle of tongue. The sensory function is gives sensation to tongue.

- Sensory function: Proprioception
- Motor function: Movement of tongue during speech and swallowing

SPINAL NERVES

→ There are 31 pairs of spinal nerves that leave the vertebral canal by passing through the intervertebral foramina formed by adjacent vertebrae. They are named and grouped according to the vertebrae with which they are associated.

- 8 Cervical
- 12 Thoracic
- 5 Lumbar
- 5 Sacral
- 1 Coccygeal

→ Even though there are only seven cervical vertebrae, eight cervical nerves are present because the first pair leaves the vertebral canal between the occipital bone and the atlas and the eighth pair leaves beneath the last cervical vertebra.

→ The lumbar, sacral and coccygeal nerves leave the spinal cord near its termination at the level of first lumbar vertebra, and extend downwards inside the vertebral canal in the subarachnoid space, forming horse's tail like structure called as Cauda equina.

→ A typical spinal nerve has two connections to the cord: Posterior root and anterior root.

Functions of spinal nerves

- ✓ Transmit sensory information from skin, muscles, and joints to the spinal cord.
- ✓ Carry motor signals from the spinal cord to skeletal muscles.
- ✓ Control voluntary movements of limbs and trunk.
- ✓ Regulate reflex actions like the knee-jerk reflex.
- ✓ Conduct autonomic signals to smooth muscles and glands.
- ✓ Support posture and balance through proprioceptive feedback.
- ✓ Innervate skin for touch, pain, and temperature sensation.
- ✓ Form nerve plexuses to supply large body areas (e.g., arms, legs).
- ✓ Coordinate muscle actions for walking, lifting, and other activities.
- ✓ Protect the body by initiating quick withdrawal from harmful stimuli.