

Human Physiology Presentation No. 2

Neurophysiology Physiology of the Nervous System

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Functions

- The nervous system **coordinates** all body functions, enabling a person to adapt to changes in the internal and external environment. It:
 1. **Coordinates** the activity of the muscles,
 2. **Monitors** the organs,
 3. **Constructs** and **stops input** from the senses, and
 4. **Initiates actions.**

Functional Mechanisms

1. Sensory input (Gathers Information or data)

The nerves **conduct impulses** from sensory receptors to the brain and spinal cord .

2. Integration of data (Data Process)

The data is then processed by way of integration of data, which occurs only in the brain.

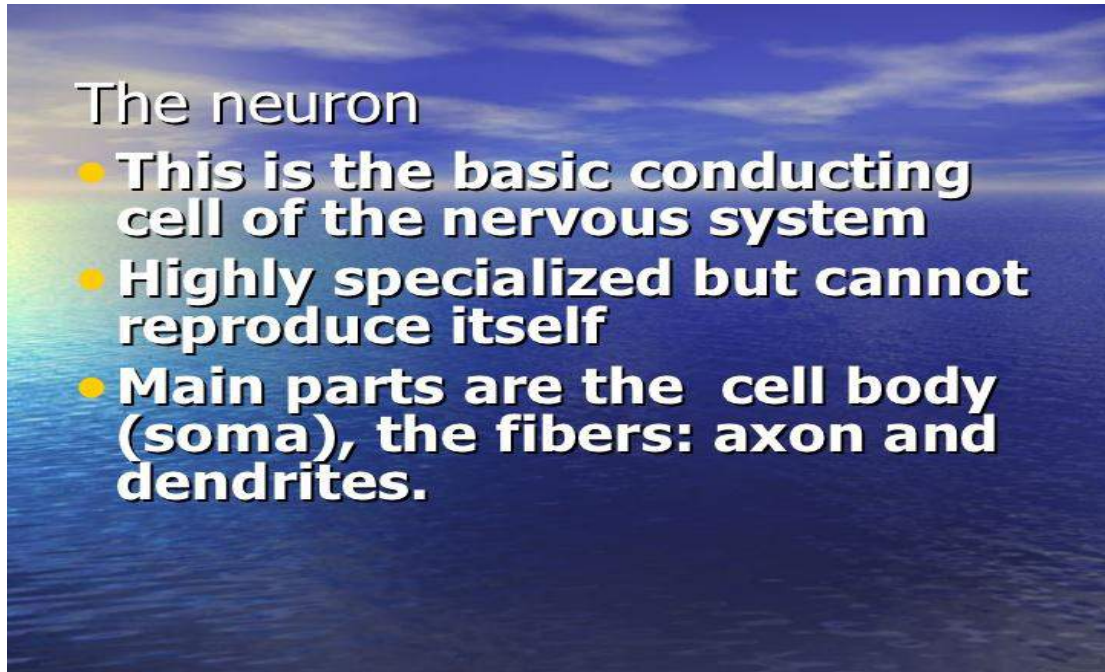
3. Motor output (Impulse Conduction)

Impulses are then conducted from the brain and spinal cord to muscles and glands, which is called **motor output**.

The nervous tissue consists of two types of cells.

1. **Neurons**

2. **Neuroglia cells**



a. Soma

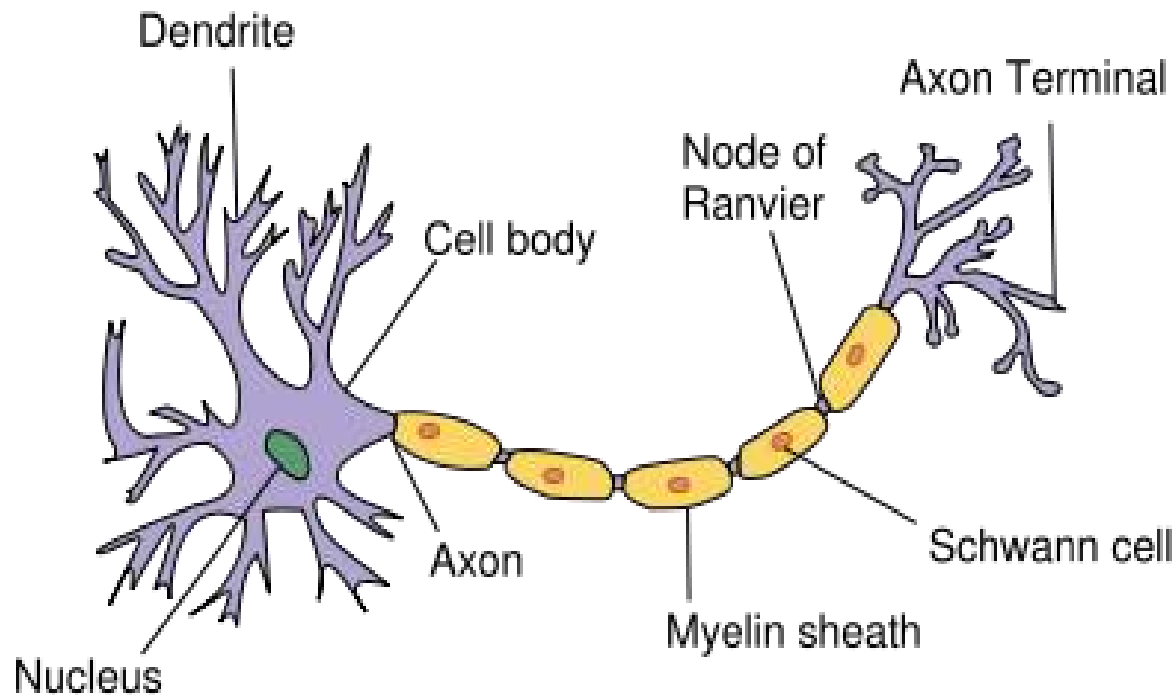
The soma (cell body) is the central part of the neuron. It contains the nucleus of the cell, and therefore is where most protein synthesis occurs.

b. Axon

- **The axon** is a long process with myelin sheath. It **carries nerve signals** away from the soma. It consists of:
 1. **Axon Hillock:** The part of the axon where it emerges from the soma. It is involved in **information outflow**.
 2. **Axon terminal :** A specialized structure at the end of the axon that is used to **release neurotransmitter chemicals** and **communicate with target neurons**.

- **The dendrites (dendritic tree):**

They are short, thick, branching cellular extensions that **receive impulses and conduct them towards the cell body.**



The neuroglia

- **The supporting cells**
- **They supply nutrients to the neurons and help maintain the electrical potential**
- **They also form part of the blood-brain barrier**
- **They are made up of macroglia, microglia and ependymal cells**

Myelin Sheath

- **Schwann cells** contain a **lipid** substance called myelin in their plasma membranes. When schwann cells wrap around axons, a myelin sheath forms.
- There are gaps that have no myelin sheath around them; these gaps are called **Nodes of Ranvier** (important in Saltatory transmission)
- Myelin sheathes make excellent **insulators**.
- The disease **multiple sclerosis** is an autoimmune disease where the body attacks the myelin sheath of the central nervous system.

The neuroglia

- **Oligodendrocytes produce myelin sheath in the CN**
- **Schwann cells or lemmocytes produce myelin sheath in the peripheral NS**

Functional Types of Neurons

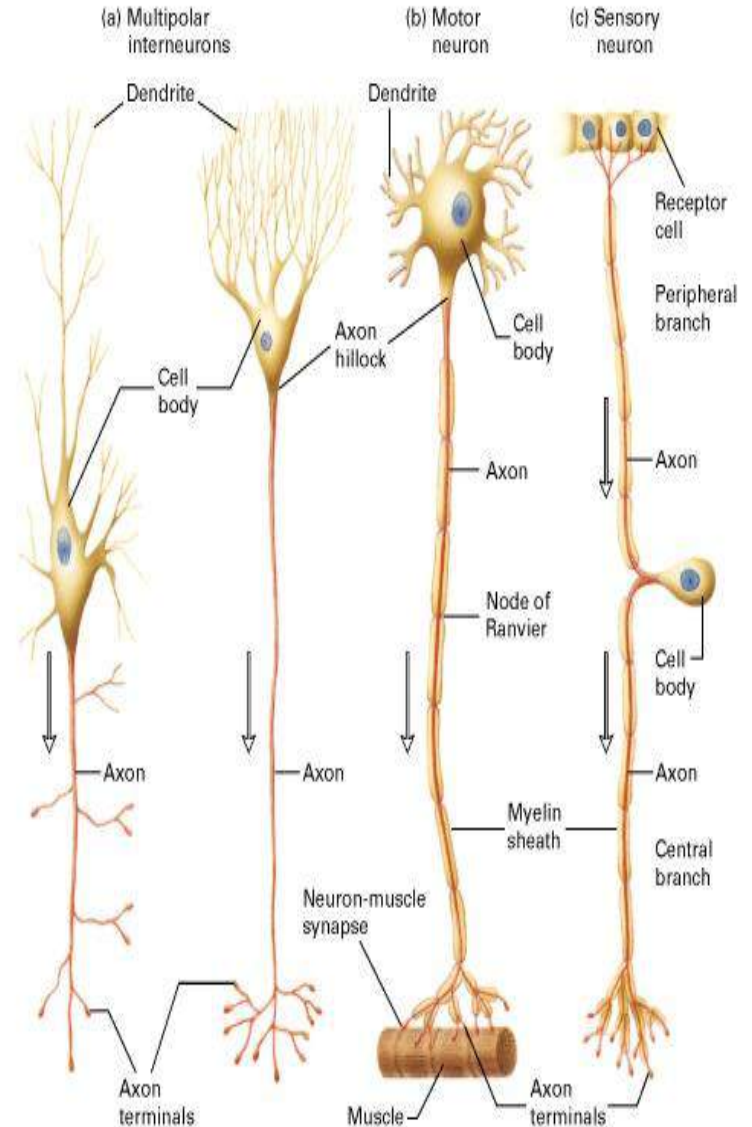
- **Sensory afferent neurons** convey information from tissues and organs into the central nervous system.
- **Efferent neurons** transmit signals from the central nervous system to the effector cells and are sometimes called **motor neurons**.
- **Interneurons** connect neurons within specific regions of the central nervous system.

Classification on basis of Processes

1. Unipolar (usually sensory neurons): Cell body gives rise to a single process (Axon) which split into two branches. One returns sensory information from the peripheral branch, whereas the other branch convey this information to CNS.

2. Bipolar (specialized sensory neurons- Retina & Olfactory epithelium): Cell body gives rise to two processes, one convey information from periphery and the other (axon) travels to CSN.

3. Multipolar (most CSN neurons): Cell body gives rise to a single axon and numerous dendritic branches. They can be further subcharacterized based on size and complexity of dendritic tree.



The Organization of the Nervous System

- The nervous system is divided functionally and structurally into 2 parts
- 1. Central Nervous System- the Brain and the spinal cord
- 2. Peripheral Nervous System- the cranial nerves and spinal nerves

Central Nervous System (CNS)

Function

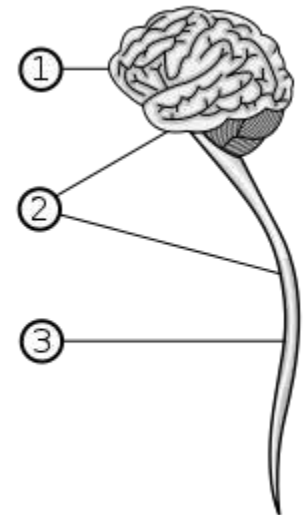
1. It is the control center for the body.
2. It regulates organ function, higher thought, and body movement.

Structure

The **central nervous system** includes:

1. **Brain**
2. **Brain stem**
3. **Spinal cord.**

The brain and spinal cord are protected by bony structures, membranes and fluid.



The Brain: Structure & Functions

The brain consists of:

1. Cerebrum
2. Cerebellum
3. Brain stem
4. Diencephalon

It contains the **higher nerve centers** responsible for **coordinating the sensory and motor systems** of the body (forebrain).

The Cerebrum

- This is the largest part of the brain
- Consists of right and left hemisphere connected by the corpus callosum
- Each cerebral hemisphere is composed of different lobes- frontal, temporal, parietal and occipital
- Embedded in the cerebrum is the BASAL ganglia

The right hemisphere is responsible for the left side of the body while the opposite is true of the left hemisphere.

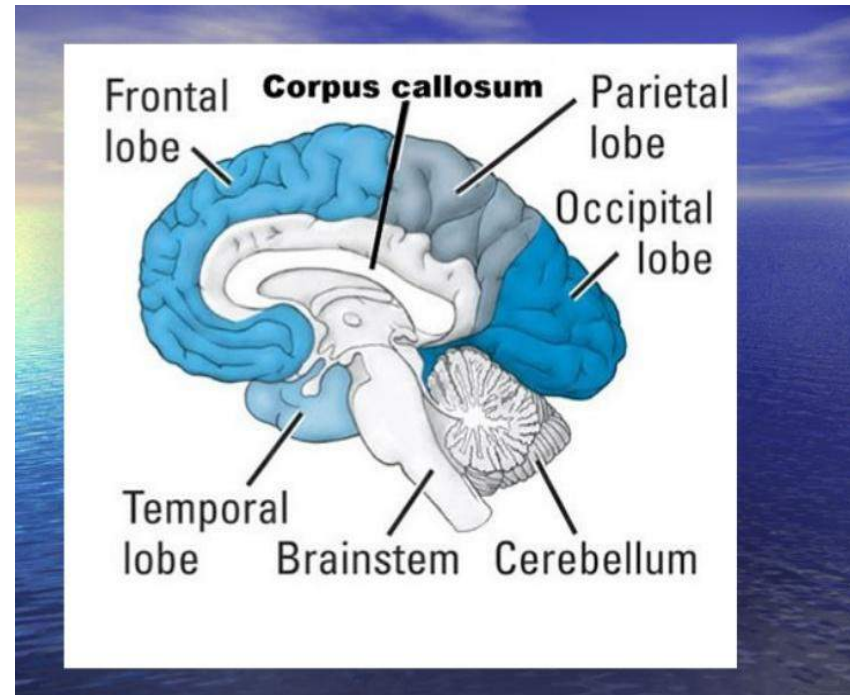
Cerebrum Lobes

Frontal in control of specialized motor control, learning, planning and speech, social behaviour.

Parietal integrates the sensory inputs like touch, temperature and pain. It interprets size, shape, distance and texture.

Occipital in control of vision;

Temporal lobes which consists of hearing centers and some speech, storage and recall of memories.



The Cerebellum

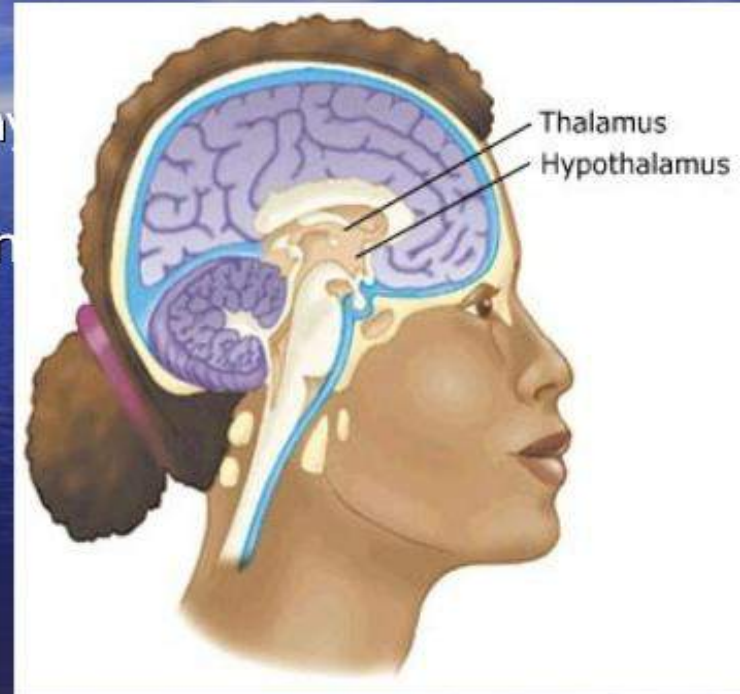
- The second largest brain region
- Has also two hemispheres
- Functions to maintain muscle tone, coordinate muscle movement, posture and control balance/equilibrium
- If this is damaged, muscle tone decreases and fine motor movements become very clumsy

The Brainstem

- Lies inferior to the cerebrum
- Continuous with the cerebrum and the spinal cord
- It is composed of the midbrain, the pons and the medulla oblongata
- Functions: houses the center for respiration and cardiovascular system

The Diencephalon

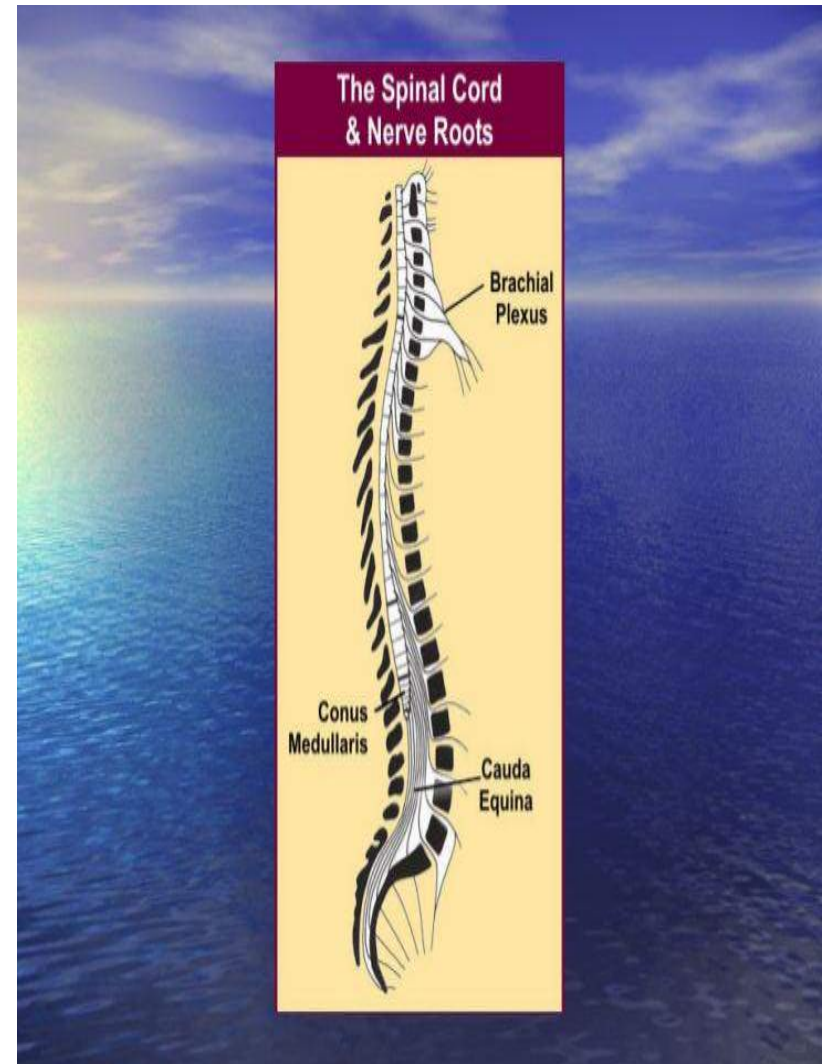
- The thalamus and the hypothalamus
- The thalamus is the relay station of all sensory stimuli towards the brain
- The hypothalamus controls body temperature, appetite, water balance, pituitary secretions and sleep-wake cycle



The Spinal Cord

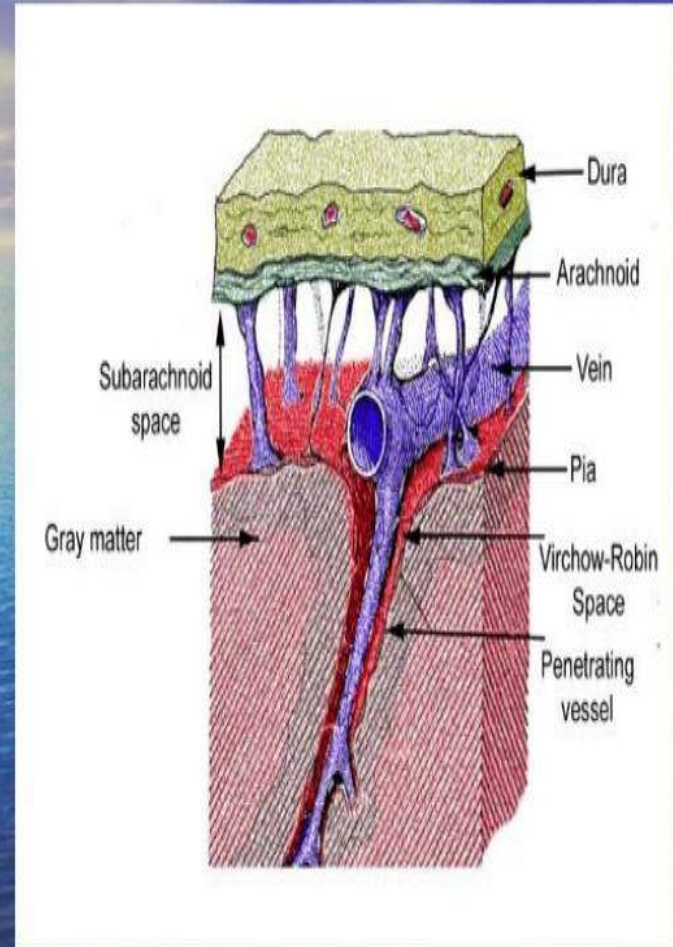
The spinal cord is continuous with the medulla oblongata of the lower brain stem.

It is specially designed to allow two-way conduction of nerve impulses, with sensory (afferent) fibers carrying signals from sensory receptors to the brain, while motor (efferent) fibers originate in the brain and transmits action potentials to end organs



The Meninges

- These are 3 connective tissue layers surrounding the brain and spinal cord.
- 1. DURA MATER- the superficial, thickest layer. The area above the dura mater is called epidural space
- 2. ARACHNOID- second layer, thin and wispy.
- 3. PIA MATER- the deepest layer, adhered to the brain and spinal cord substance



The Peripheral Nervous System

- The **PNS** is a vast network of spinal and cranial nerves that are linked the brain and the spinal cord to the rest of the body.
- The PNS is subdivided into :
- The **autonomic** has involuntary control of internal organs, blood vessels, smooth and cardiac muscles.
- The **somatic** has voluntary control of skin, bones, joints, and skeletal muscle.
- The **peripheral nervous system** includes:
12 cranial nerves 31 pairs of spinal nerves

Spinal nerves

Spinal nerves take their origins from the spinal cord.

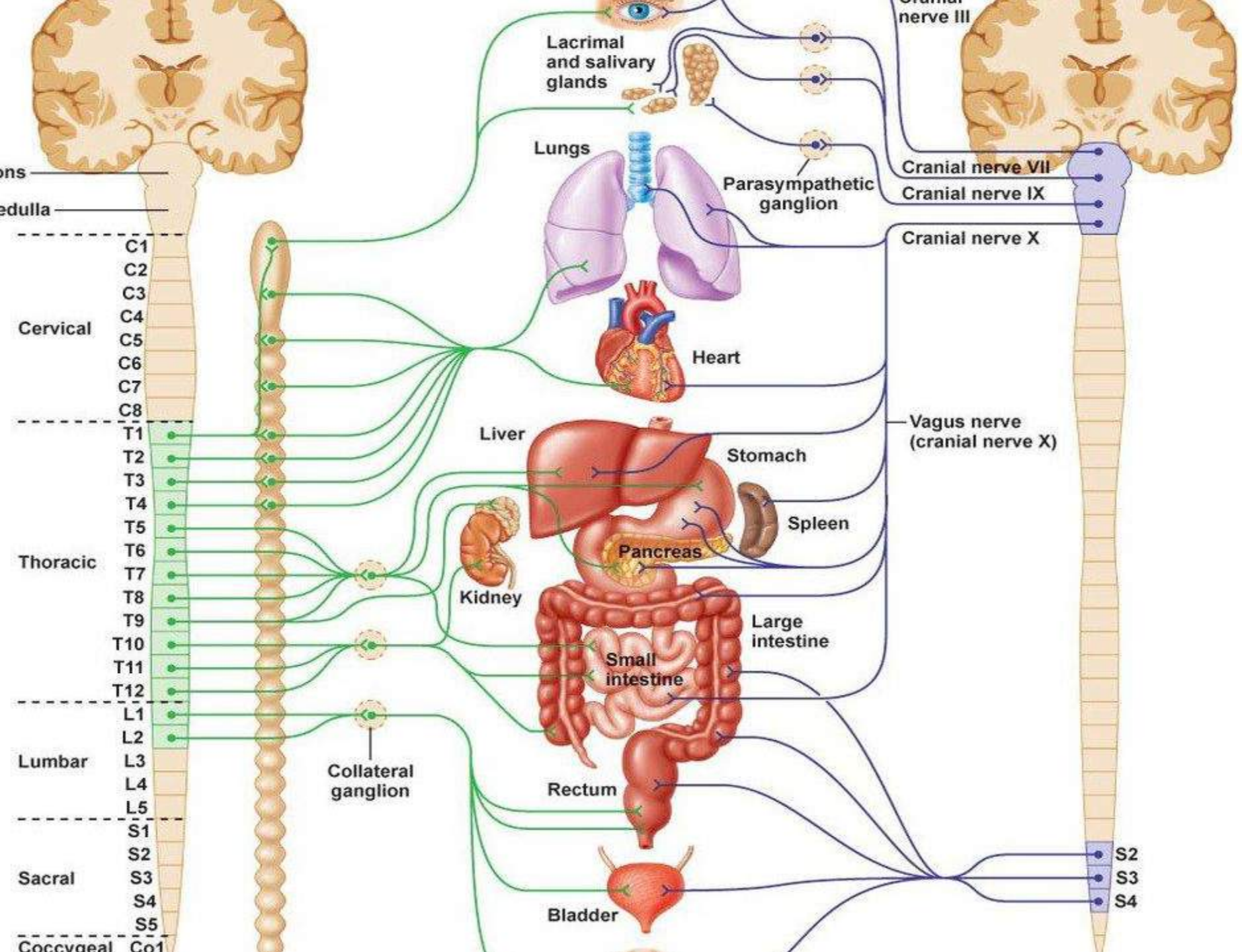
They control the functions of the rest of the body.

In humans, there are 31 pairs of spinal nerves:

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- Cervical segments= 8 pairs
 - Thoracic segments=12 pairs
 - Lumbar= 5 pairs
 - Sacral=5 pairs
 - Coccygeal=1 pair

cranial nerves

- I **Olfactory Nerve** for smell
- II **Optic Nerve** for vision
- III **Oculomotor** for looking around
- IV **Trochlear** for moving eye
- V **Trigeminal** for feeling touch on face
- VI **Abducens** to move eye muscles
- VII **Facial** to smile, wink, and help us taste
- VIII **Vestibulocochlear** to help with balance, equilibrium, and hearing
- IX **Glossopharyngeal** for swallowing and gagging
- X **Vagus** for swallowing, talking, and parasympathetic actions of digestion
- XI **Spinal accessory** for shrugging shoulders
- XII **Hypoglossal** for tongue more divided into different regions as muscles



The Autonomic System

- The **Autonomic system** deals with the visceral organs, like the heart, stomach, gland, and the intestines. It regulates systems that are unconsciously carried out to keep our body alive and well, such as breathing, digestion (peristalsis), and regulation of the heartbeat.
- The Autonomic system consists of the **sympathetic** and the **parasympathetic** divisions. Both divisions work without conscious effort, and they have similar nerve pathways, but the sympathetic and parasympathetic systems generally have opposite effects on target tissues (they are antagonistic).
- By controlling the relative input from each division, the autonomic system regulates many aspects of homeostasis.
- One of the main nerves for the parasympathetic autonomic system is Cranial Nerve X, the Vagus nerve.