University of Al-Mustaqbal
College of Science
Department of Medical Physics

Neurophysics

Fourth Stage

Nerve Fiber Structure

Second Licture

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Nerve Cell (or **Neuron**)

Is A nerve cell, known as a neuron, is a fundamental component of the nervous system responsible for transmitting information around the body in the form of electrical impulses. It comprises a cell body (soma), axon, and dendrites, each playing a crucial role in receiving, processing, and transmitting signals to other nerve cells, muscles, or glands. Neurons enable essential functions including cognition, sensation, and motor activities.

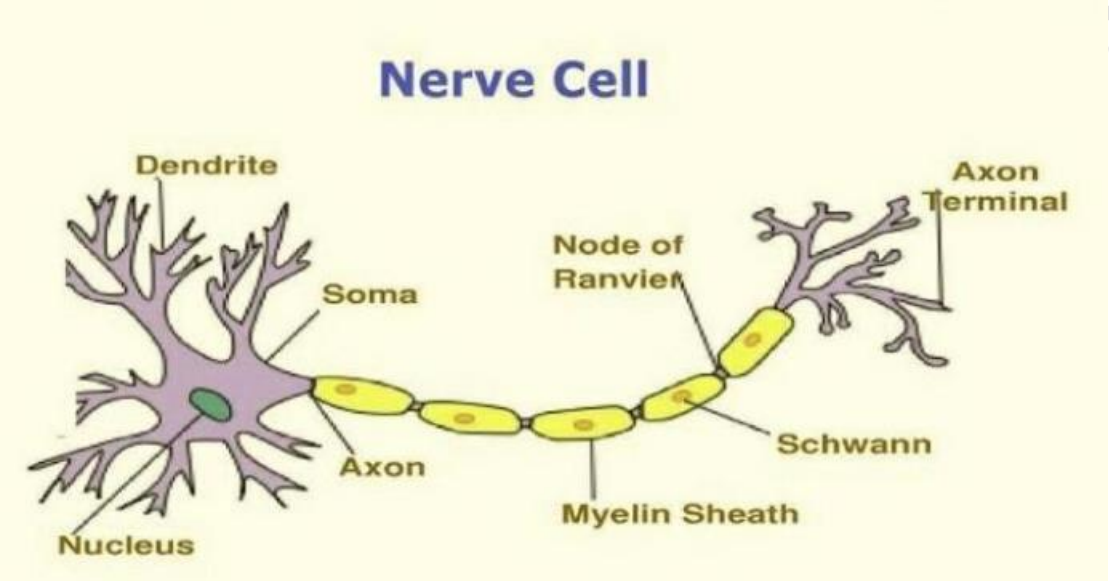
What are neurons or nerve cells?

At its most fundamental level, a neuron, also commonly known as a nerve cell, is an electrically excitable cell that communicates with other cells via specialized connections called synapses.

These cells are the nervous system's primary components, including the brain, spinal cord, and peripheral nerves. They are responsible for receiving sensory input from the external world, sending motor commands to our muscles, and transforming and relaying the electrical signals at the foundation of our thoughts, memories, and feelings .

Nerve Cell Structure

The neuron is an incredibly specialized cell, equipped with unique structures that enable it to perform its vital role in the nervous system. A neuron is composed of several essential parts, each playing an indispensable role in transmitting and receiving information.



Its consists from many parts:-

1-Cell body (soma)

The cell body, or soma, is the life center of the neuron. It houses the nucleus, which contains the cell's genetic material, and the cytoplasm, where the cell's metabolic reactions occur. The cell body is responsible for the neuron's overall health and functionality, maintaining the cell's structure and carrying out protein synthesis.

2-Dendrites

These are short, branch-like structures that extend from the cell body. They are akin to the "antennae" of the neuron, receiving signals from other neurons and transmitting them to the cell body. The signals they receive can either stimulate the neuron to initiate an electrical response (excitatory signals) or inhibit it from doing so (inhibitory signals).

3-Axons

The axon is a long, slender projection that extends from the cell body and ends in multiple branches. Unlike dendrites, which receive signals, the axon's primary function is to transmit electrical signals away from the cell body to other neurons or cells. The point where an axon connects with another cell is called a synapse.

4-Myelin sheath and Nodes of Ranvier

Many axons are insulated by a fatty layer known as the myelin sheath. The myelin sheath acts as an electrical insulator, increasing the speed at which electrical impulses (action potentials) travel along the axon.

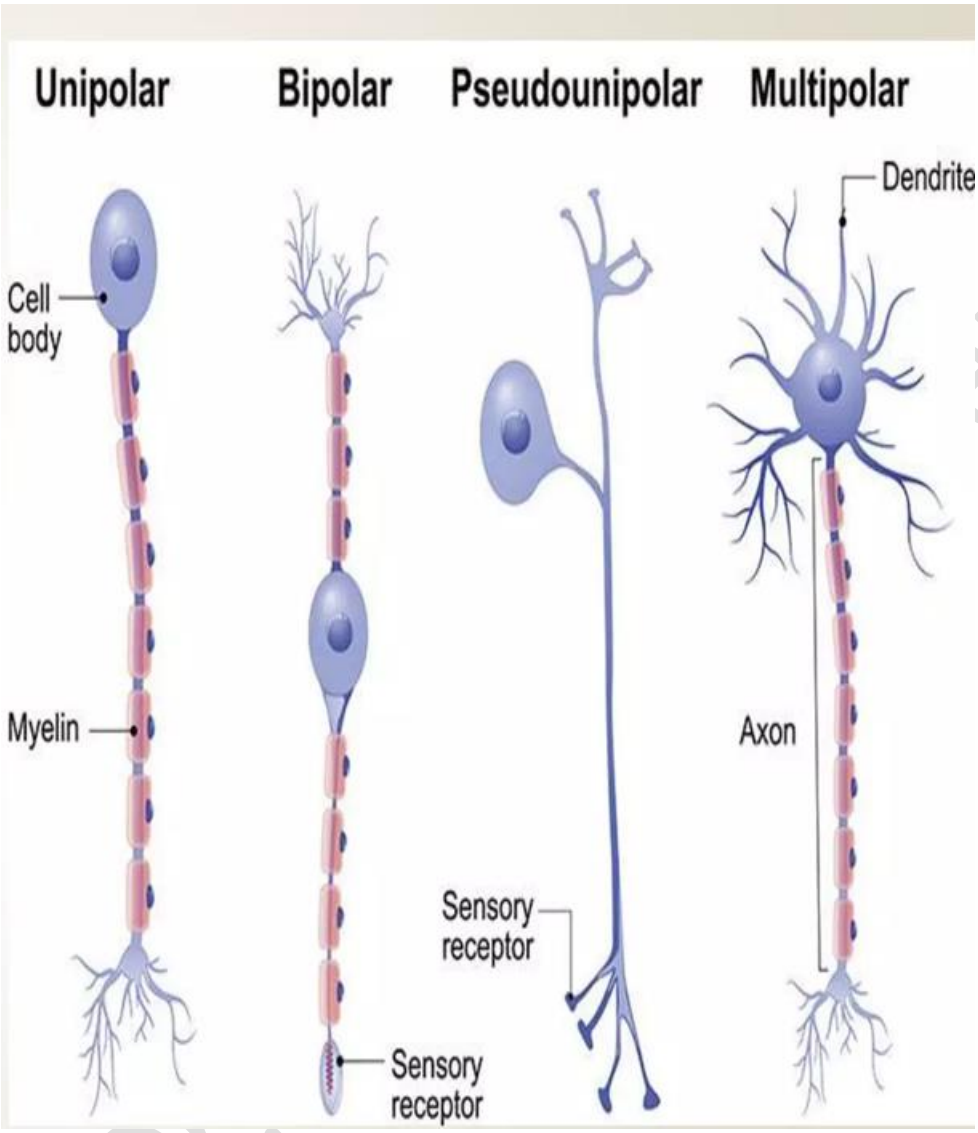
The myelin sheath is not continuous and has small gaps known as Nodes of Ranvier. These nodes play a crucial role in speeding up the transmission of electrical signals along the axon, allowing for rapid and efficient communication between neurons.

Different types of neurons

While all neurons share some core characteristics, not all are the same. There are several types of neurons, each with its unique structure and function within the nervous system. Here's a closer look at some of the primary types.

Two basic classes of neurons

A.Based on structure



1.Unipolar

Unipolar neurons have only one structure that extends away from the soma. These neurons are not found in vertebrates but are found in insects where they stimulate muscles or glands.

2. Bipolar

Abipolar neuron has one axon and one dendrite extending from the soma. An example of a bipolar neuron is a retinal bipolar cell, which receives signals from photoreceptor cells that are sensitive to light and transmits these signals to ganglion cells that carry the signal to the brain.

3. Multipolar

Multipolar neurons are the most common type of neuron. Each multipolar neuron contains one axon and multiple dendrites. Multipolar

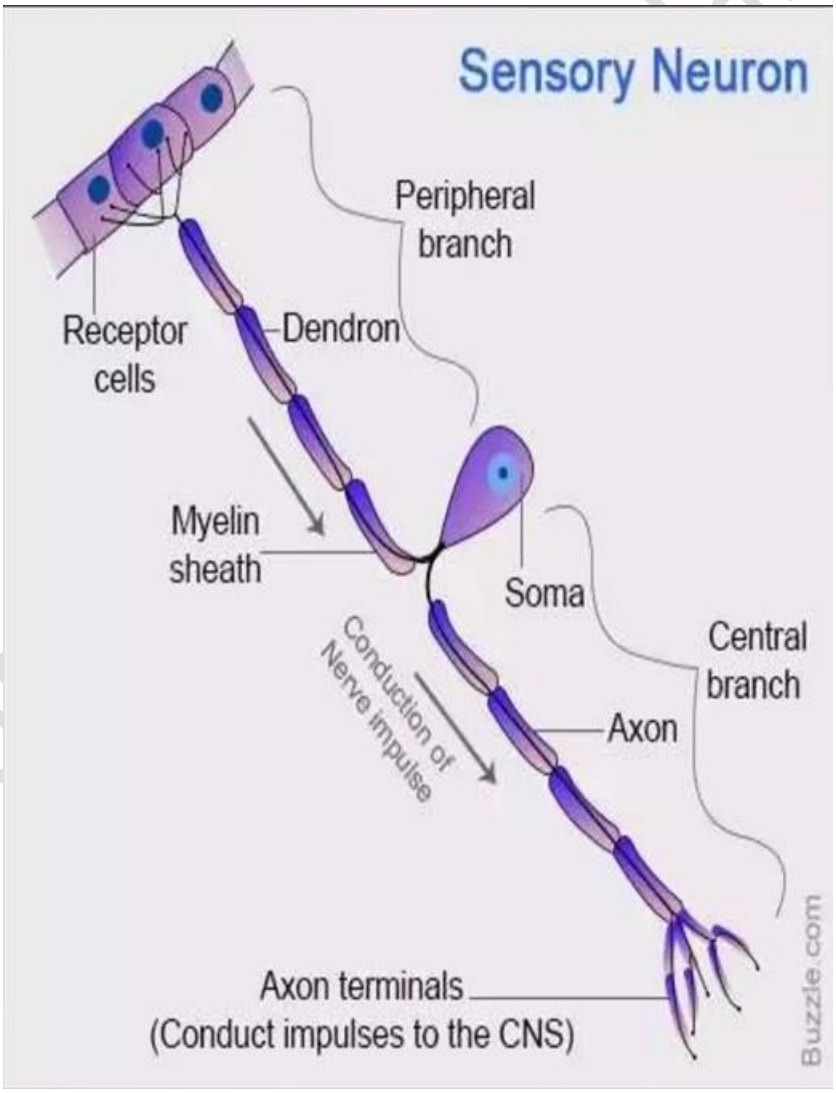
neurons can be found in the Cell- central nervous system (brain and spinal body cord). The Purkinje cell, a multipolar neuron in the cerebellum, has many branching dendrites, but only one axon.

4. Pseudounipolar

Pseudounipolar cells share characteristics with both unipolar and bipolar cells. Most sensory neurons are pseudounipolar and have an axon that branches into two extensions: one connected to dendrites that receives sensory information and another that transmits this information to the spinal cord.

B.Based on functions

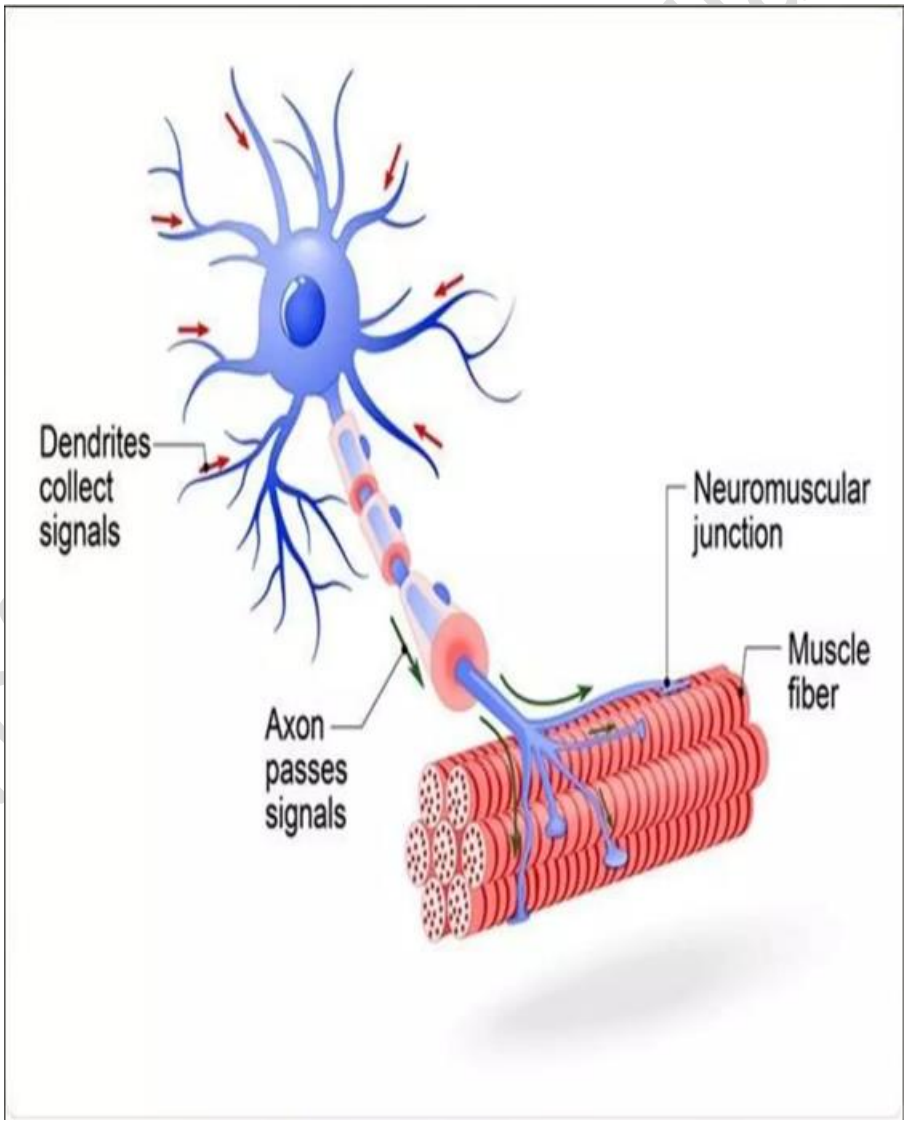
1. Sensory neurons



Sensory neurons are neurons responsible for converting external stimuli from the environment into corresponding internal stimuli.They are activated by sensory input and send projections to other elements of the nervous system, ultimately conveying sensory information to the brain or spinal cord.

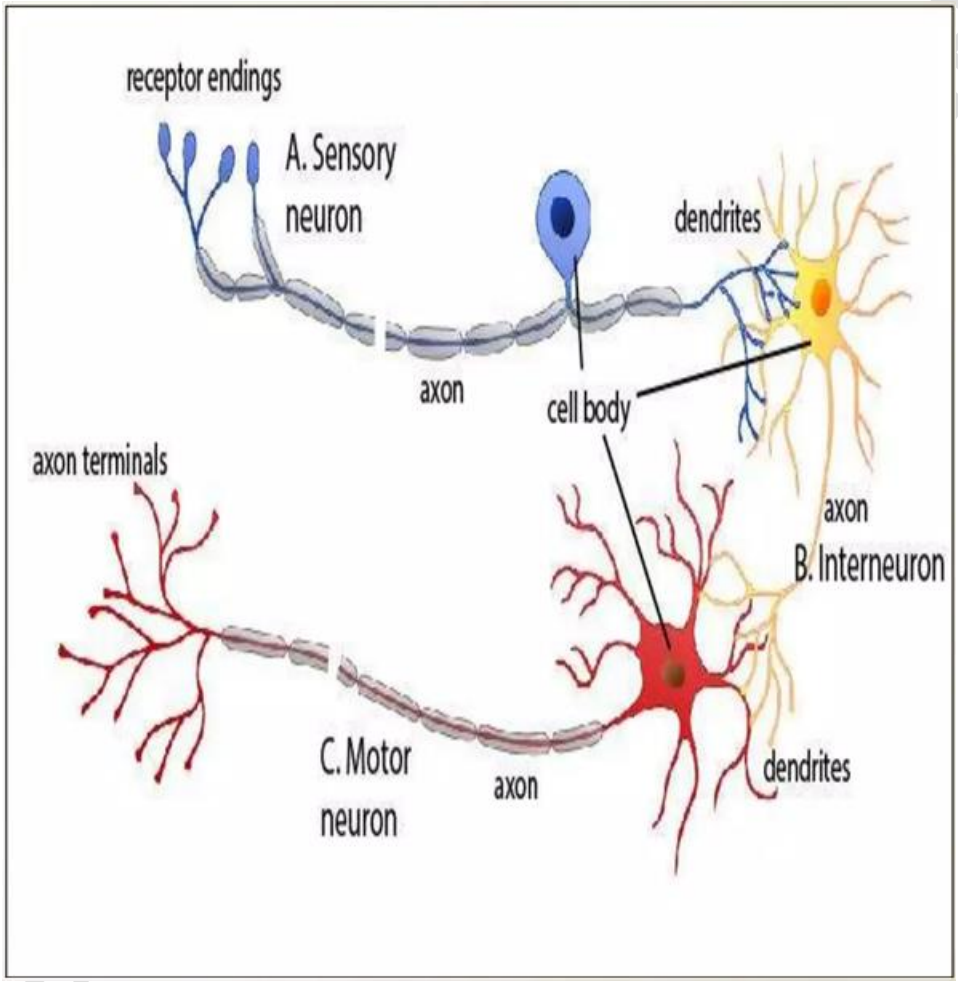
Sensory neurons are activated by physical modalities (such as visible light, sound, heat,physical contact, etc.) or by chemical signals (such as smell and taste). Most sensory neurons are pseudounipolar, meaning they have an axon that branches into two extensions-one connected to dendrites that receive sensory information and another that transmits this information to the spinal cord.

2. Motor neurons



Motor neurons are neurons located in the central nervous system, and they project their axons outside of the CNS to directly or indirectly control muscles.The interface between a motor neuron and muscle fiber is a specialized synapse called the neuromuscular junction.The structure of motor neurons is multipolar, meaning each cell contains a single axon and multiple dendrites.

3- Relay Neurons



Interneurons are neither sensory nor motor; rather, they act as the "middlemen" that form connections between the other two types.

Located in the CNS, they operate locally, meaning their axons connect only with nearby sensory or motor neurons. Interneurons can save time and therefore prevent injury by sending messages to the spinal cord and back instead of all the way to the brain. Like motor neurons, they are multipolar in structure.

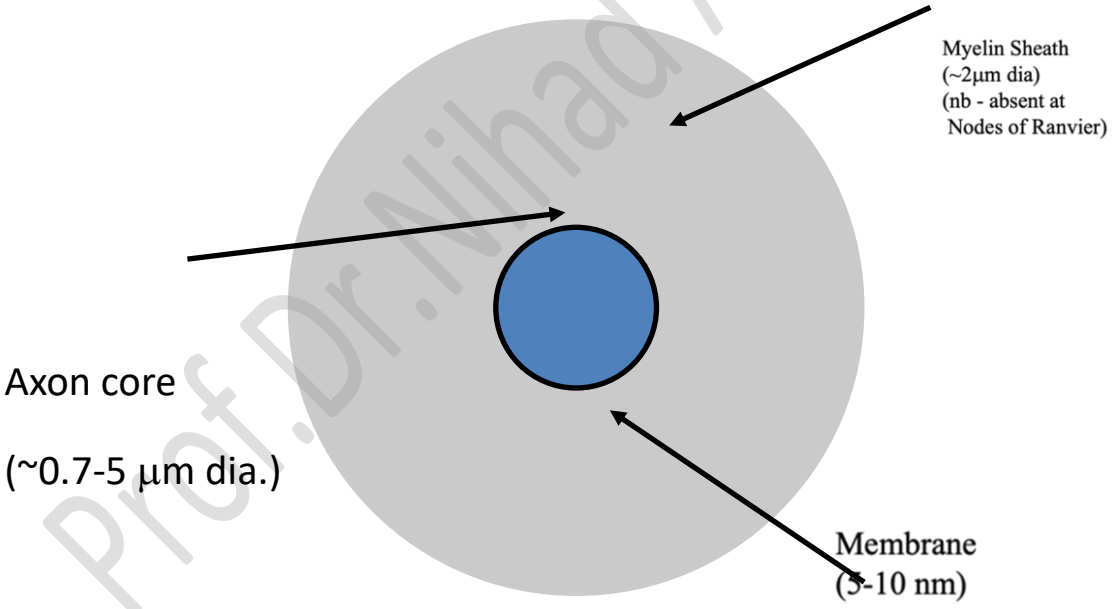
What is the main function of a nerve cell?

The primary function of a nerve cell, or neuron, is to transmit information through electrical and chemical signals. This enables communication within the nervous system, facilitating sensory perception, motor function, and complex cognitive processes such as learning and memory.

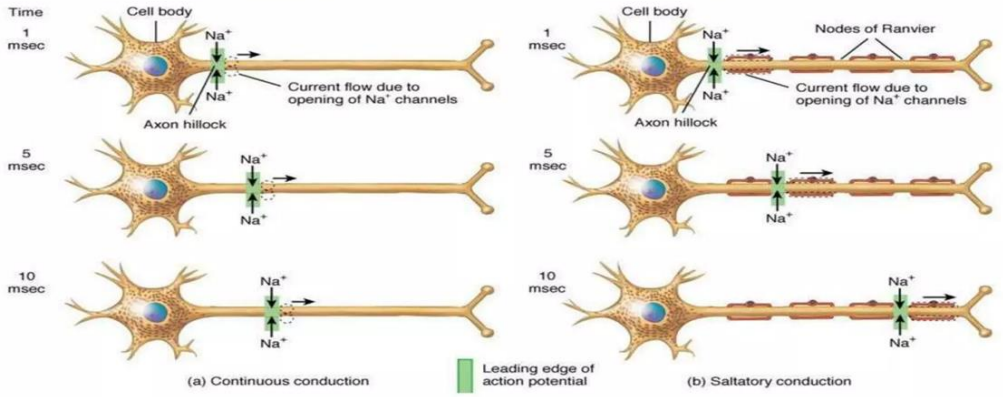
Myelinated and Non- Myelinated Nerve Fibres

Many axons are insulated by a fatty layer known as the myelin sheath. The myelin sheath acts as an electrical insulator, increasing the speed at which electrical impulses (action potentials) travel along the axon.

The myelin sheath is not continuous and has small gaps known as Nodes of Ranvier. These nodes play a crucial role in speeding up the transmission of electrical signals along the axon, allowing for rapid and efficient communication between neurons.



MYELINATED AND NON - MYELINATED NERVE FIBRES



Myelinated	Non- Myelinated
Myelinated nerve fibers contain a myelin sheath around the nerve fiber	Unmyelinated nerve fibers do not contain a myelin sheath
White in color	Grey in color
Consist of nodes of Ranvier	Do not consist of nodes of Ranvier
Since transmission occurs only through nodes of Ranvier, the speed of transmission of nerve impulses is high	The speed of the transmission of the nerve impulses is low since these do not contain myelin sheaths
Include most peripheral nerves	Include small-axon neurons in the central nervous system and postsympathetic nerve fibers in the peripheral nervous system
Long axon nerve fibers are myelinated	Short axon nerve fibers are unmyelinated
Myelin sheath prevents the loss of the impulse during conduction	Can lose the nerve impulse during conduction

How different types of neurons work together in the nervous system?

Neurons form the basic building blocks of the nervous system, which is divided into two main parts: the central nervous system (CNS) and the peripheral nervous system (PNS). Each system relies on neurons to transmit information and perform their functions.

Comprising of the brain and the spinal cord, the CNS serves as the processing center for the nervous system, interpreting inputs from the body and coordinating appropriate responses. It comprises motor neurons, interneurons, and specialized neurons in different brain regions. The PNS then, connects the CNS to the rest of the body. It comprises all the nerves and neurons outside the brain and spinal cord.

Neurons transmit electrical and chemical signals, allowing communication between different body parts, enabling us to react to our environment, regulate bodily functions, perceive the world, and even think and create memories.

Here's how sensory neurons, motor neurons, and interneurons work together to enable our bodies to function seamlessly: