Ashur University
College of Medicine

Grade 2
Neuroscience

Physiology of the Nervous System II

Neuron



Ass. Professor Internal Medicine

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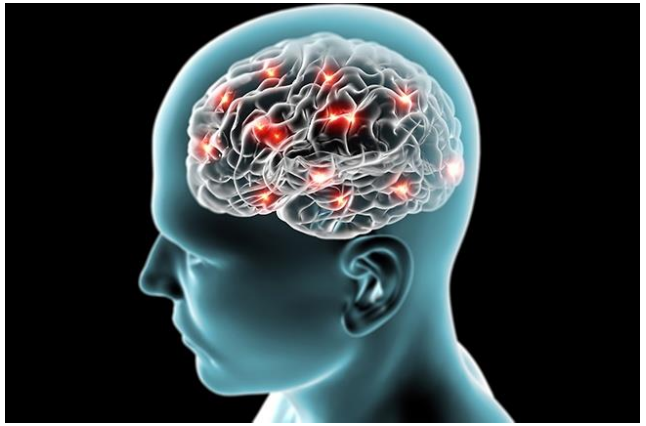


Objectives

- Recognize the functional and structural organization of the neuron.
- Compare between the mylinated and the unmyelinated nerve fibers.
- Define myline sheath and its origin.
- Differentiate between the types of neural communication.
- Classify the nerve fibers according to their basic properties.

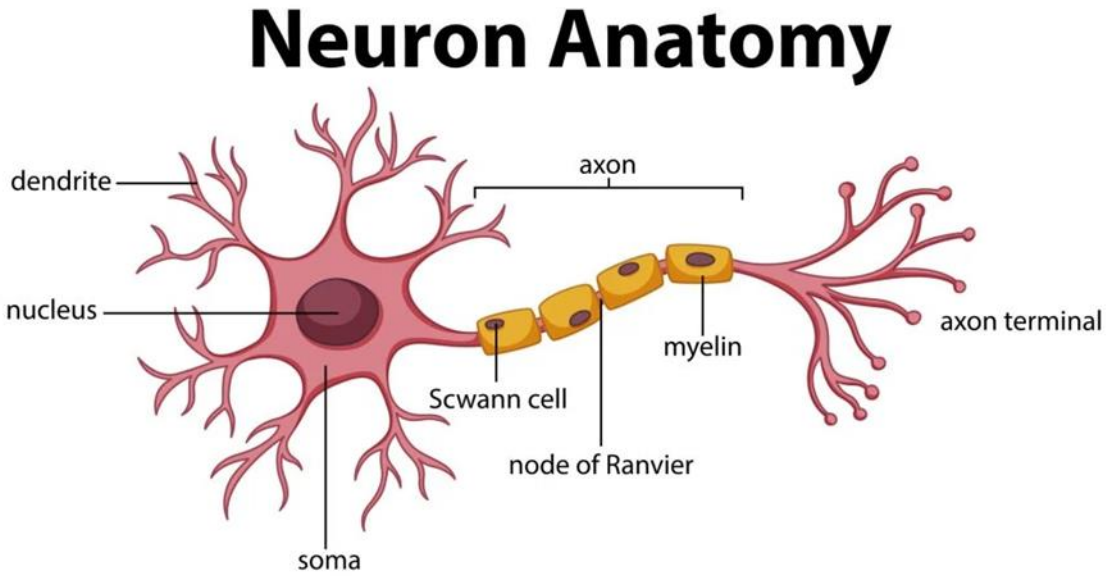
Neuron anatomy and structure

- All neurons have **three** different parts

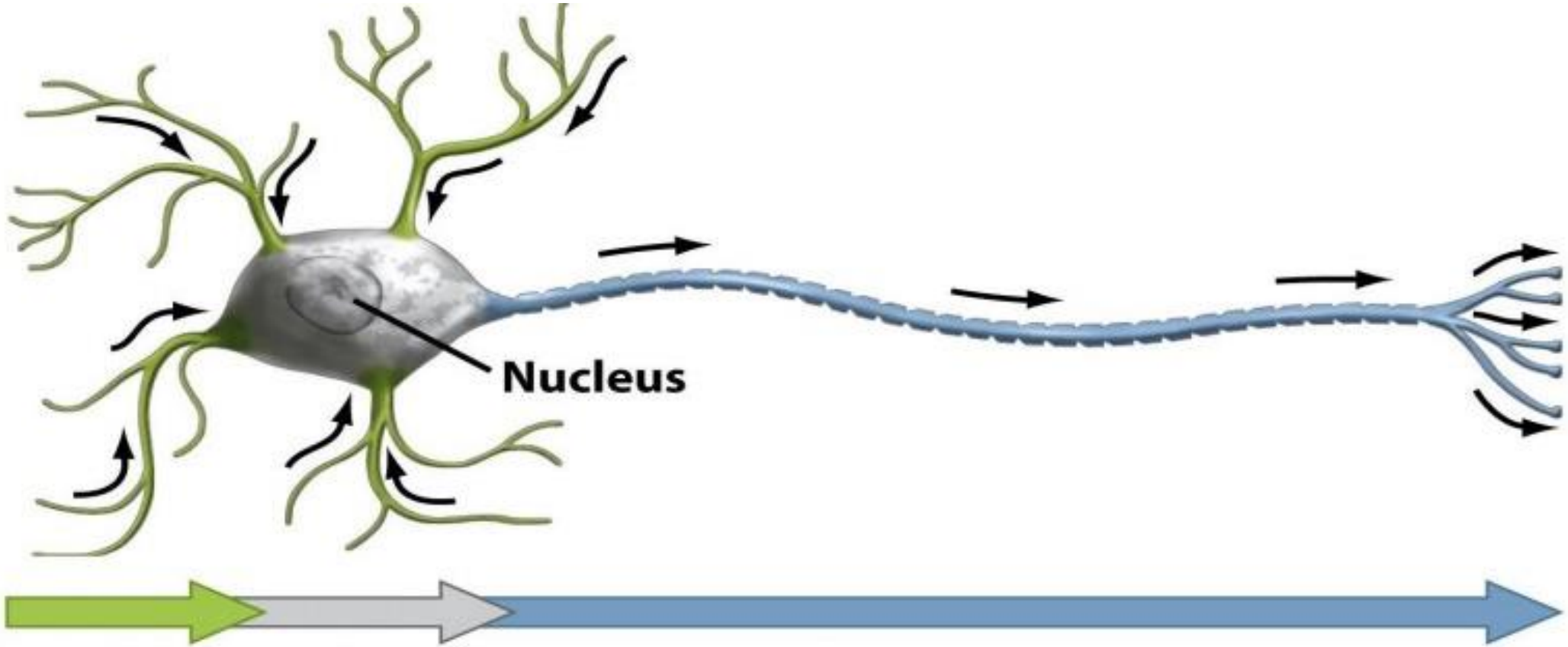
(1) Dendrites : Dendrites are the “arms of the neuron”, they form branch extensions that come out of different parts of the neuron.

(2) Cell body (Soma): The main body of the neuron,contains specialized cytoplasm, single nucleus.

(3) Axon : The axon is main part of the neuron. It is a fine and long nerve fiber that is responsible for transmitting electrical signals from the soma of the neuron to the terminal buttons.



Neuron



Dendrites
Collect electrical signals

Cell body
Integrates incoming signals and generates outgoing signal to axon

Axon
Passes electrical signals to dendrites of another cell or to an effector cell

Types of Neurons

- Scientists classify neurons **based on function** into three broad types:

(1) Sensory

(2) Motor

(3) Interneurons

- These three neuron types are separated into two categories based on whether or not they are protected by **myelination**:

(1) Myelinated axons

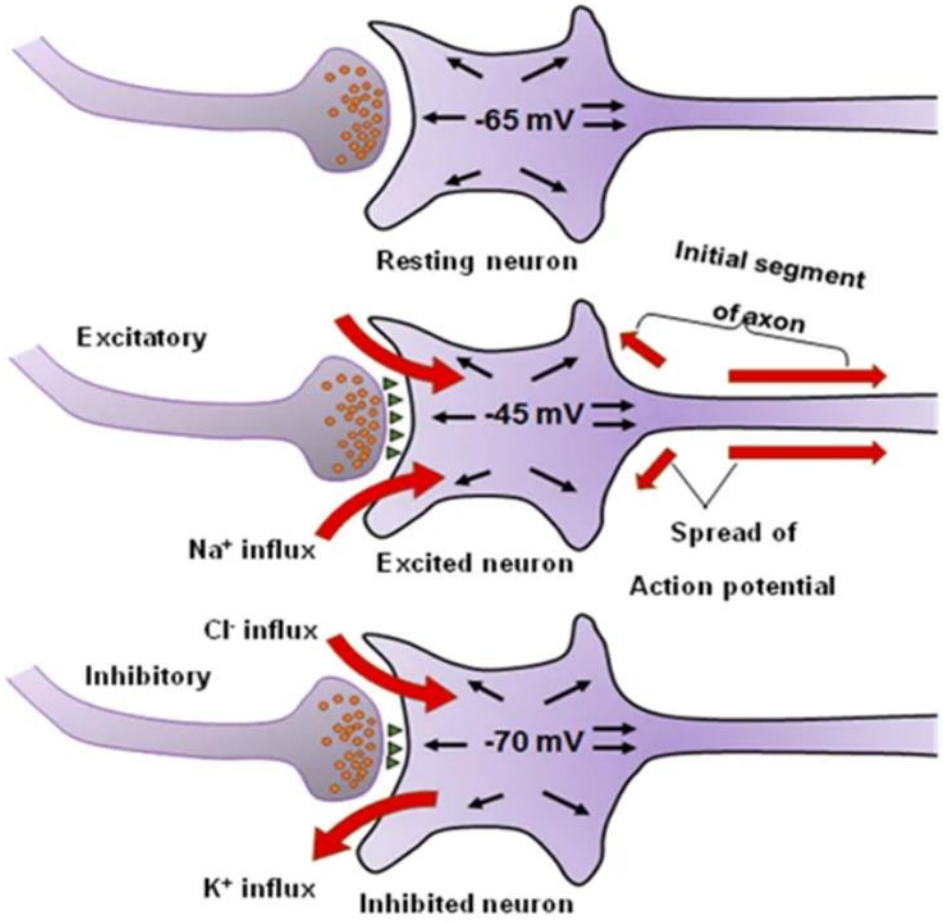
(2) Unmyelinated axons

Myelinated axons are present in sensory neurons and motor neurons.

Most neurons that carry signals regarding movement and higher-level functions, such as thinking and reading, are myelinated.

States of Neuron:

1. **Resting Neuron**: In its resting state, the neuron maintains a stable membrane potential of -65 millivolts.
2. **Excited Neuron**: When excited, the membrane potential becomes less negative, reaching about -45 millivolts, mainly due to the inflow of sodium ions.
3. **Inhibited Neuron**: In an inhibited state, the potential becomes more negative, around -70 millivolts, caused by the outflow of potassium ions, the inflow of chloride ions, or both.



Types of Neurons:

(1) Sensory

conduct impulses from sensory receptors into the CNS.

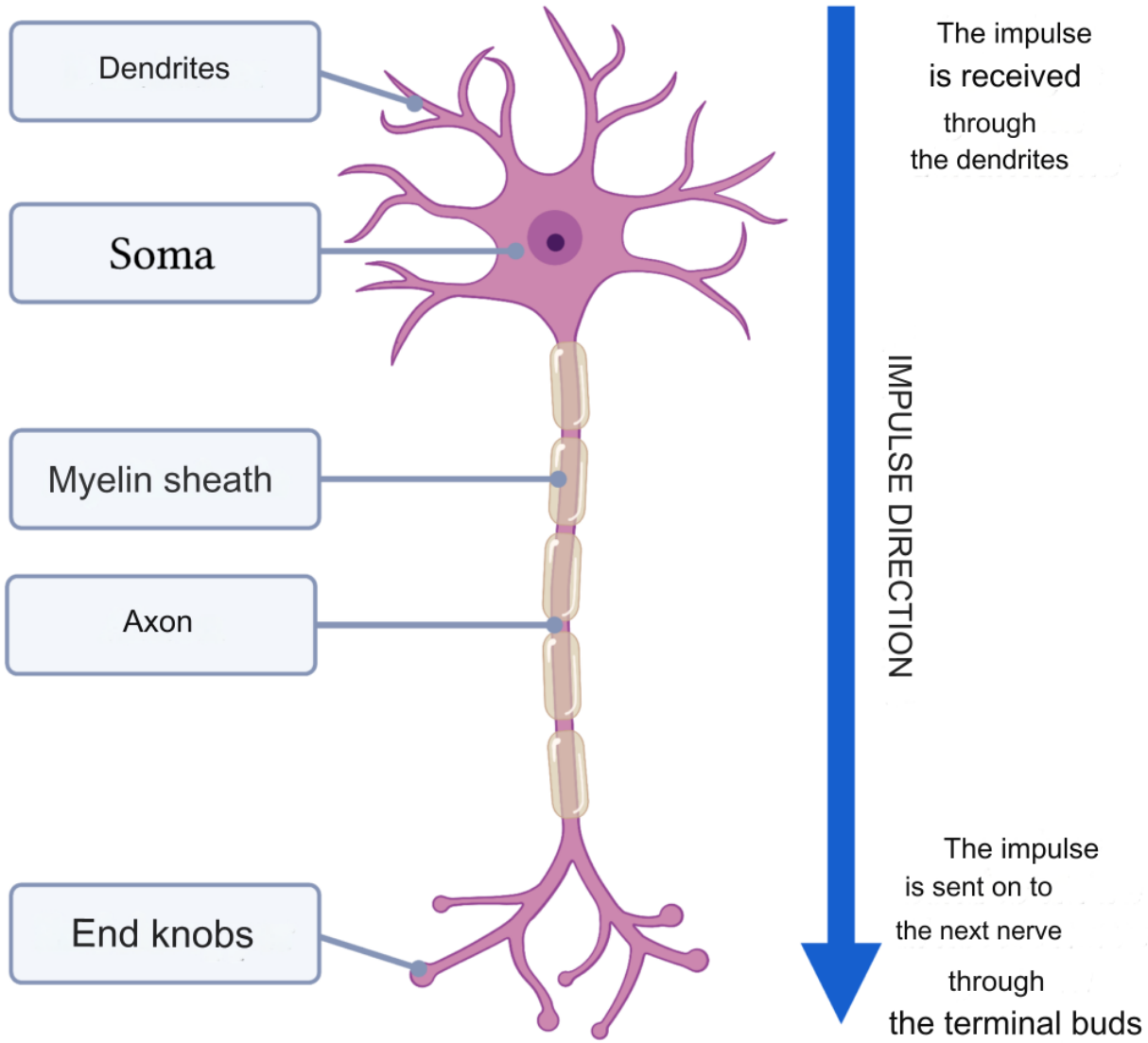
(2) Motor

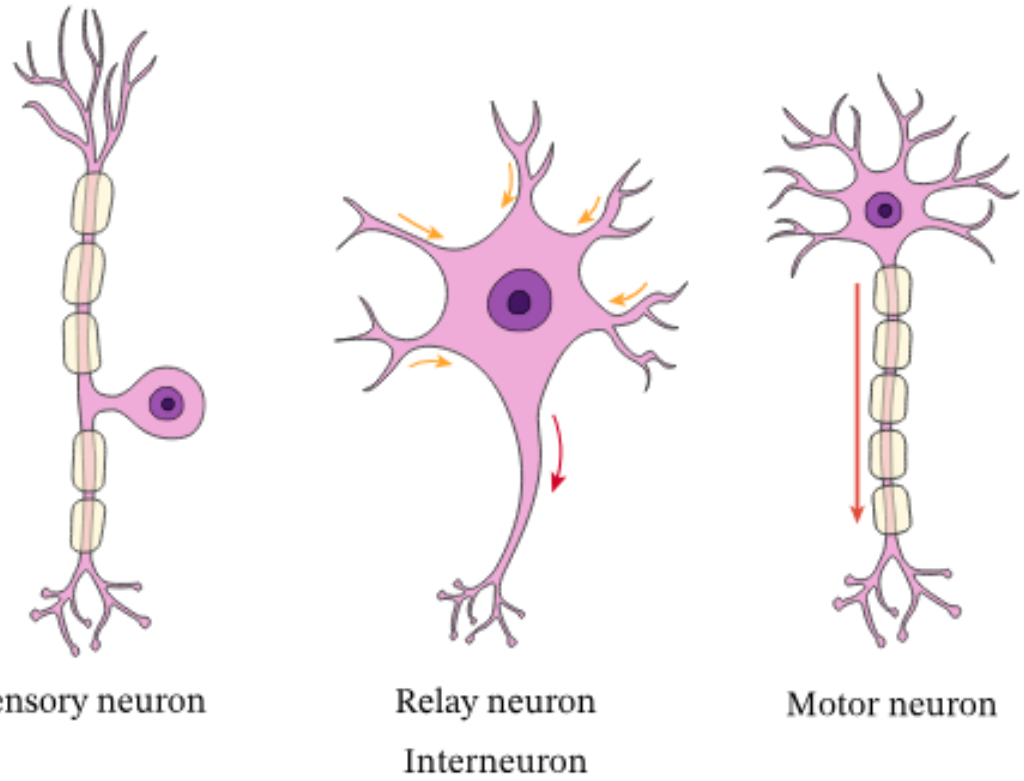
conduct impulses out of the CNS to the organs (muscles and glands).

They are **2 types somatic motor** (are responsible for both reflex and voluntary control of skeletal muscles, and autonomic motor (innervate the involuntary effectors: smooth muscle, cardiac muscle, and glands)

(3) Interneurons

are **located entirely within the CNS** and serve the associative, or integrative, functions of the nervous system


Dendrites
Soma
Myelin sheath
Axon
End knobs
The impulse is received through the dendrites
IMPULSE DIRECTION
The impulse is sent on to the next nerve through the terminal buds


Sensory neuron
Relay neuron
Interneuron
Motor neuron

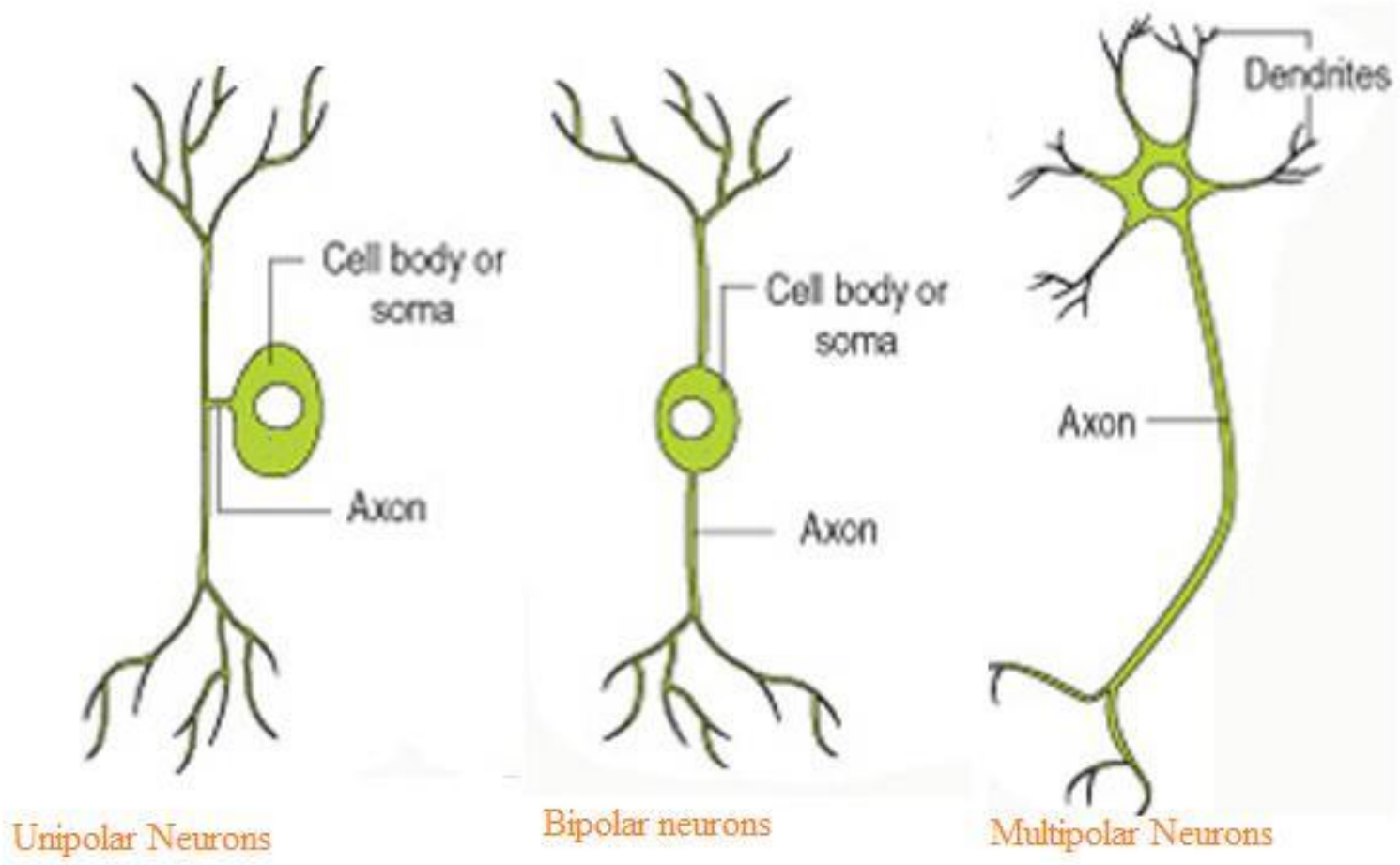
Neurons classified into 3 groups based on structural differences:

(Based on the number of processes extending from the soma)

(1) Unipolar

(2) Bipolar

(3) Multipolar



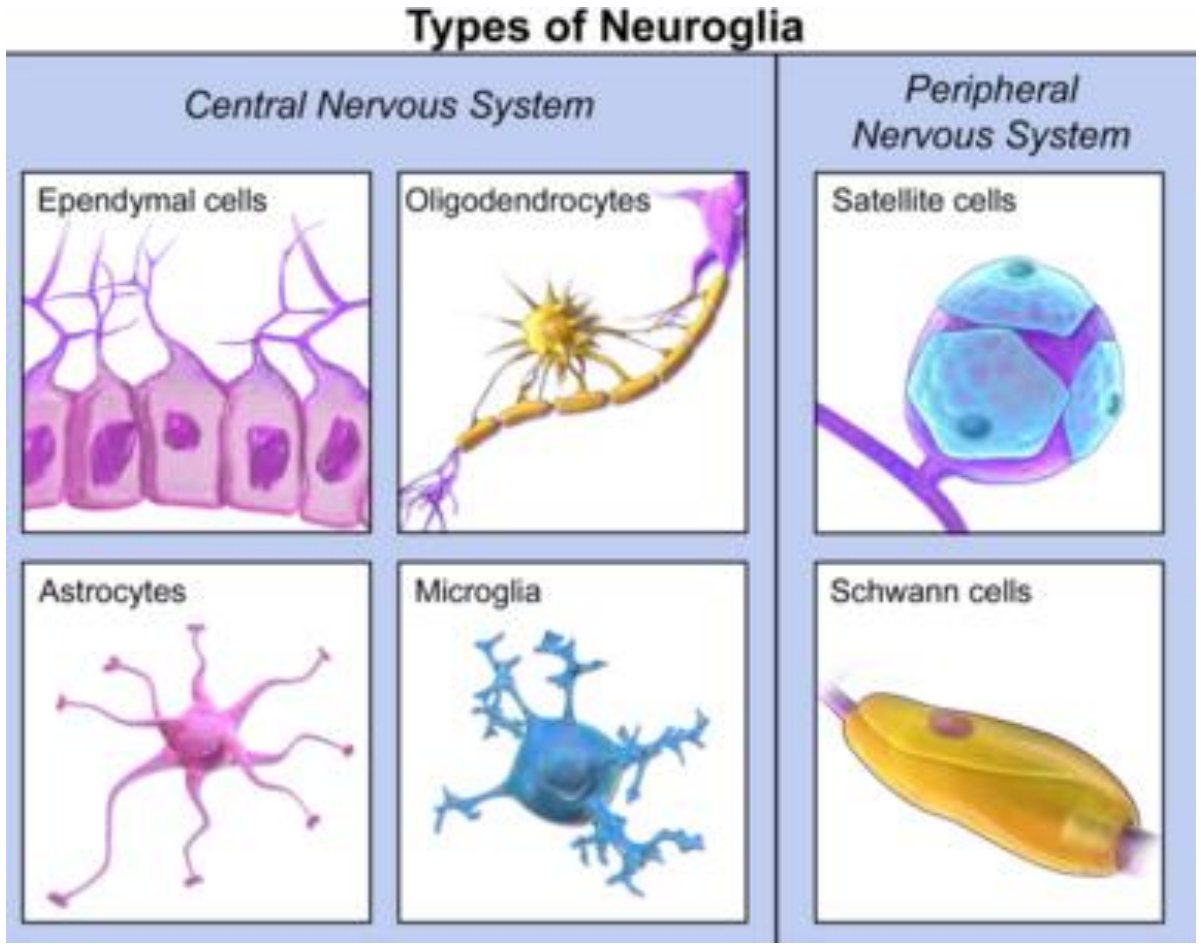
Neuroglia (supporting cells)

In the CNS, supporting cells are collectively called **neuroglia** or **glial cells**. glia means "glue" in Greek

(glia = glue).

Unlike neurons, which typically do not undergo mitosis, **glial cells can divide**, explaining why brain tumors in adults are often composed of glial cells rather than neurons.

There are **6 types of glial cells.**

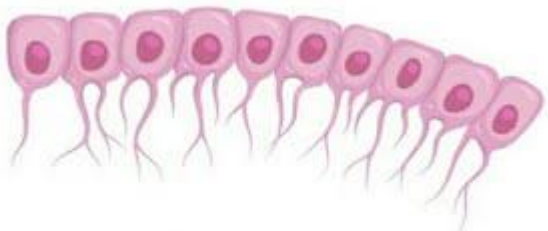


Types of Glial Cells

Cell Type	Location	Functions
Astrocytes	CNS	Provide structural support, regulate blood flow, maintain the blood-brain barrier, and interact metabolically with neurons.
Oligodendrocytes	CNS	Form the myelin sheath around axons, producing "white matter" and speeding up signal transmission.
Schwann Cells	PNS	Myelinate axons in the peripheral nervous system (PNS), enhancing signal transmission, and support neuron functions in sensory and autonomic ganglia.
Satellite Cells	PNS	Surround neurons in sensory and autonomic ganglia, supporting their functions.
Microglia	CNS	Act as immune cells, phagocytosing pathogens and clearing debris.
Ependymal Cells	CNS	Line the ventricles of the brain and the central canal of the spinal cord, forming the choroid plexuses that produce cerebrospinal fluid (CSF).

Astrocytes

Recent research highlights a new, exciting role **for ependymal cells**, which line the brain's ventricles, and the adjacent **astrocytes**. These cells can act as **neural stem cells**, **capable of dividing and giving rise to specialized cells**, including new neurons and neuroglial cells. While the ability to generate new neurons throughout life has been recognized in reptiles and birds, this capacity has only recently been discovered in mammalian brains, including those of humans.

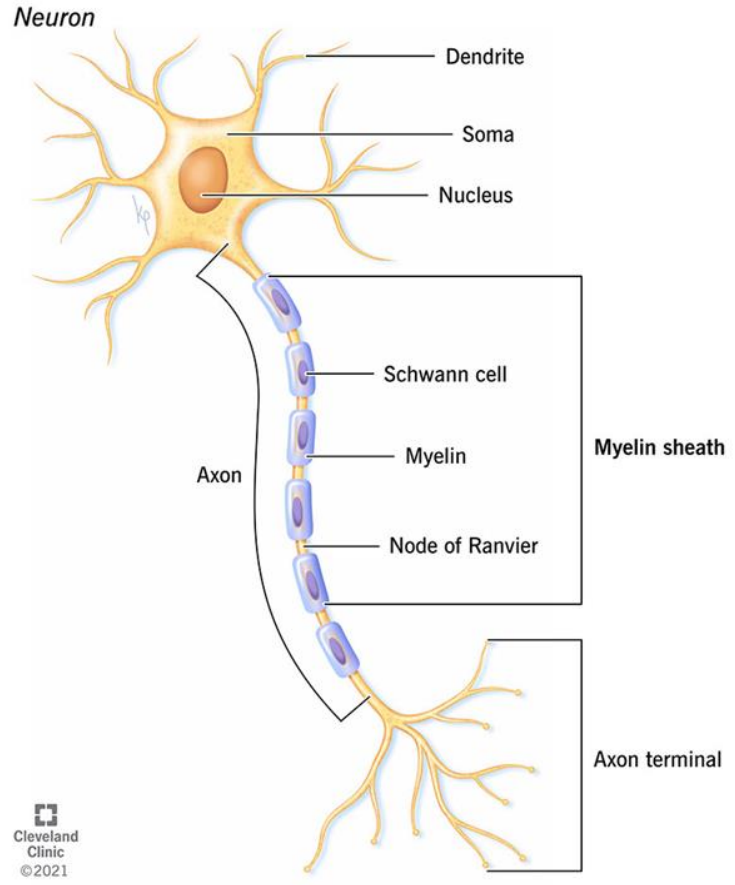




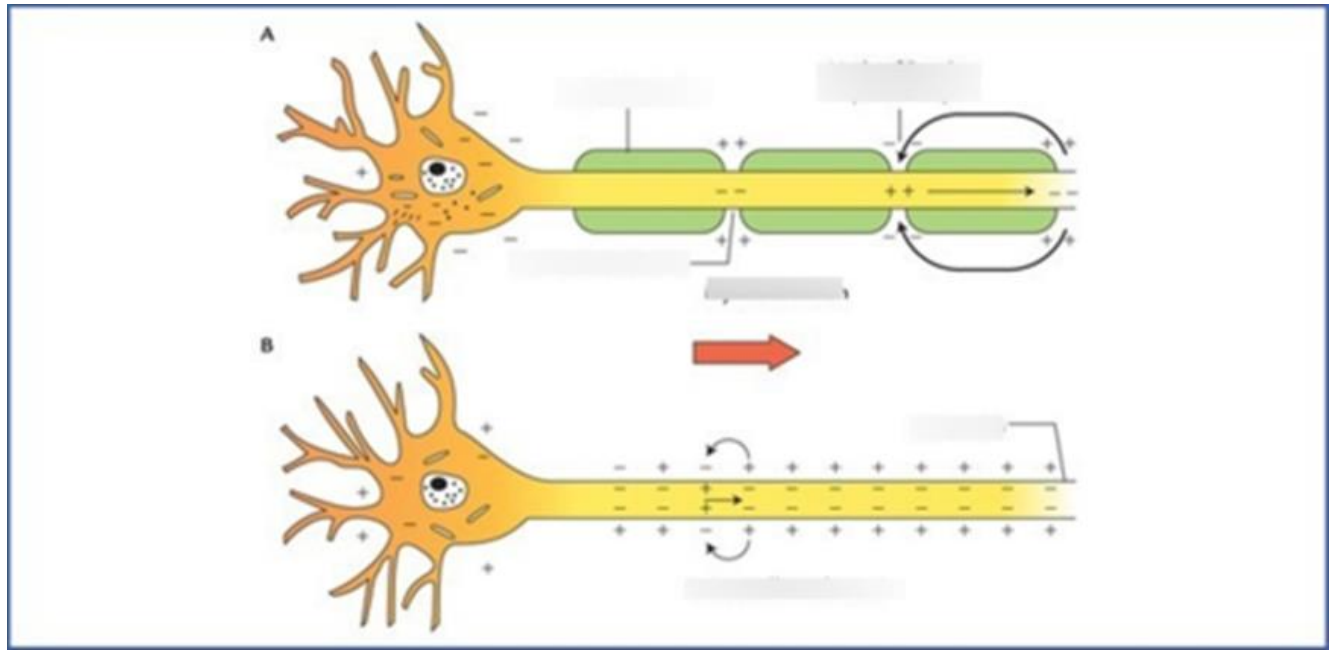
Myelin Sheath

The myelin sheath, a protective layer of insulation, is formed by successive wrappings of **Schwann cell membranes in the PNS** and by **oligodendrocytes in the CNS**.

In the **peripheral nervous system (PNS)**, all axons, whether myelinated or unmyelinated, are surrounded by a continuous layer of **Schwann cells** called the **neurilemma**, or **sheath of Schwann**. In contrast, axons in the **central nervous system (CNS) lack a neurilemma**, as **Schwann cells are only found in the PNS**.



The myelin sheath serves to increase the speed of nerve impulse conduction by allowing electrical signals to travel faster along the axon. Axons smaller than 2 micrometers (µm) in diameter are typically unmyelinated, while larger axons are likely to be myelinated. Myelinated axons conduct impulses significantly more rapidly than unmyelinated ones due to the insulation provided by the myelin sheath.

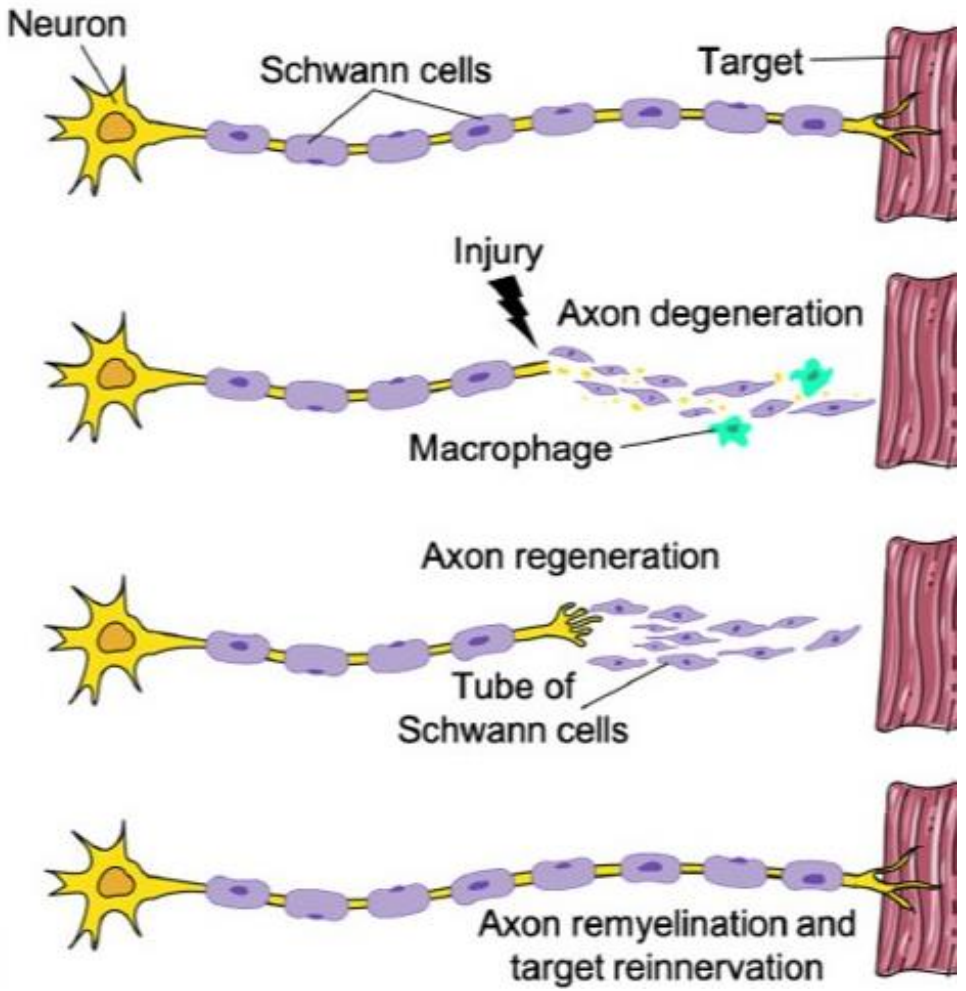


A) Myelinated Axon

B) Unmyelinated Axon

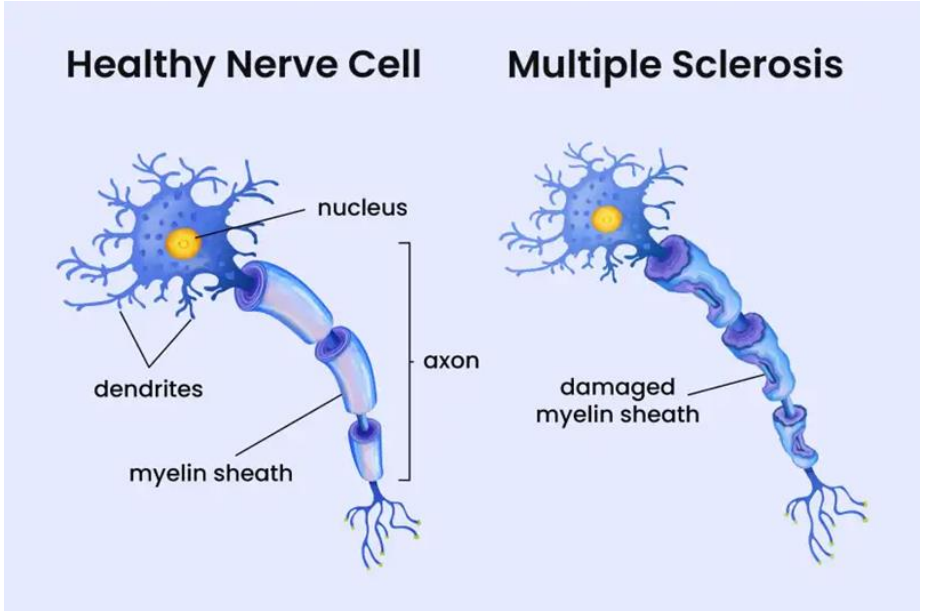
Regeneration of a Cut Axon

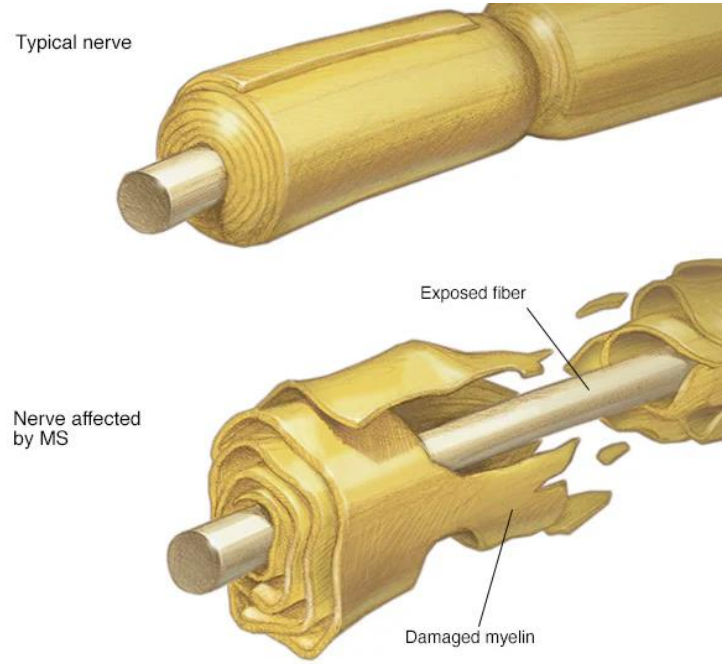
- After peripheral nerve injury, axons readily regenerate. **The distal portion of the axon, which is disconnected from the cell body, undergoes Wallerian degeneration**. This active process results in fragmentation and disintegration of the axon. Debris is removed by glial cells, predominantly macrophages.
- When a peripheral nerve axon is cut, the portion of the axon that is disconnected from the cell body, called the distal part, begins to break down. Schwann cells in the area help by engulfing and removing this damaged portion. Afterward, the **Schwann cells form a structure known as a regeneration tube**, which is surrounded by a basement membrane.



Multiple sclerosis (MS)

- Multiple sclerosis (MS), an **autoimmune disease** in which the immune system **attacks the myelin** that covers nerve fibers, disrupting nervous system communication.
- MS occurs usually at ages of 20 and 40. It is a chronic, degenerating**, remitting and relapsing disease**. The lesions form on the myelin sheaths and soon develop into hardened **scleroses, or scars (from the Greek word sklerosis, meaning "hardened")**.
- MS has a **wide variety of symptoms** than any other neurological disease.
- **There's no cure for multiple sclerosis**





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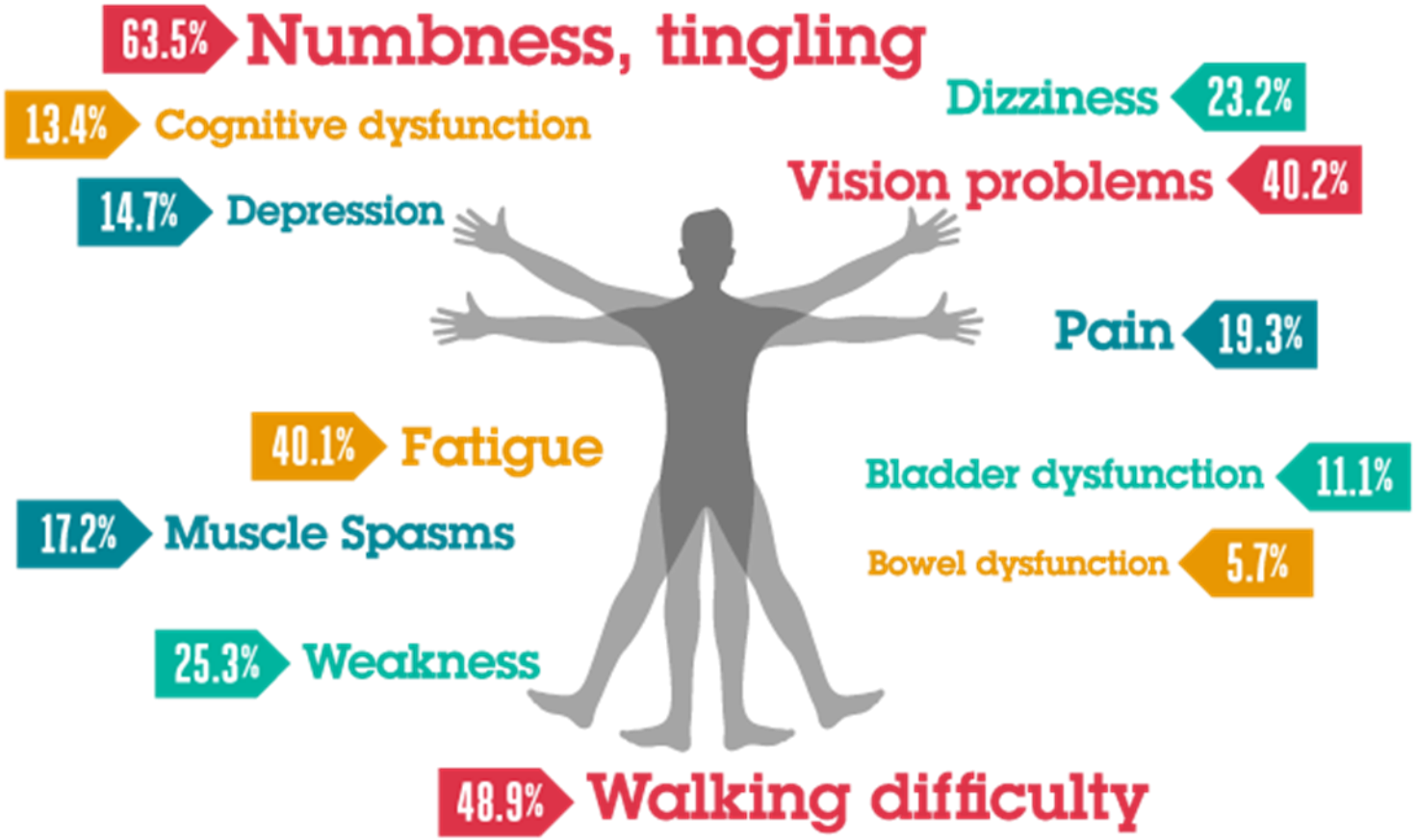
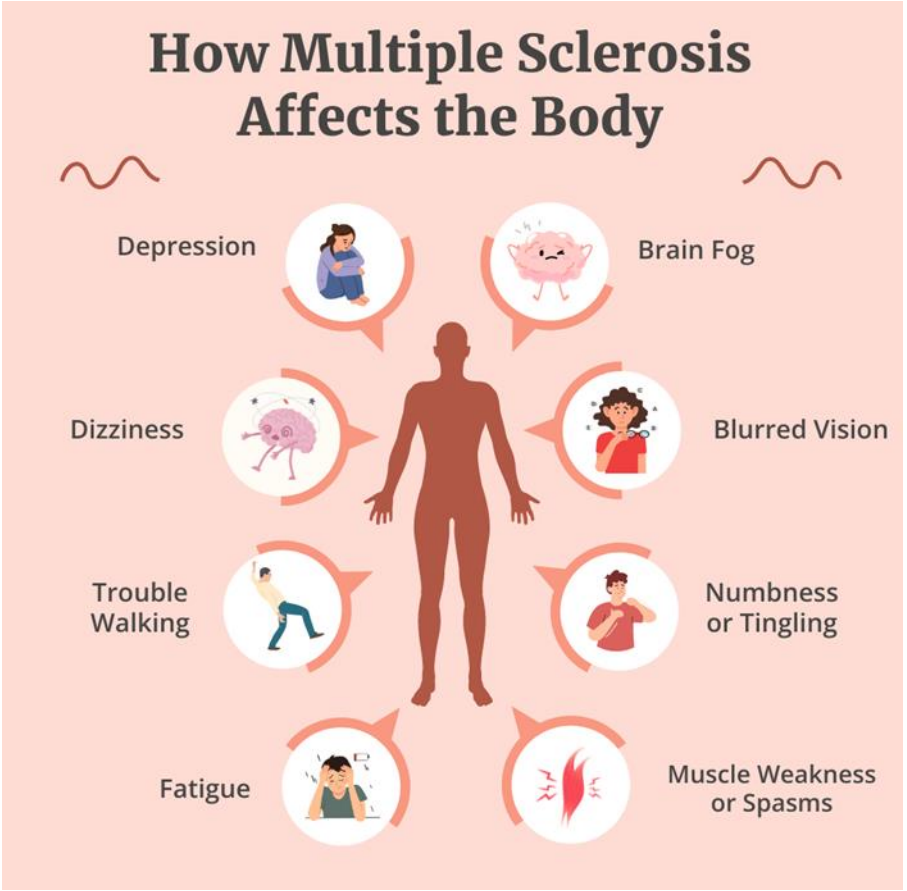
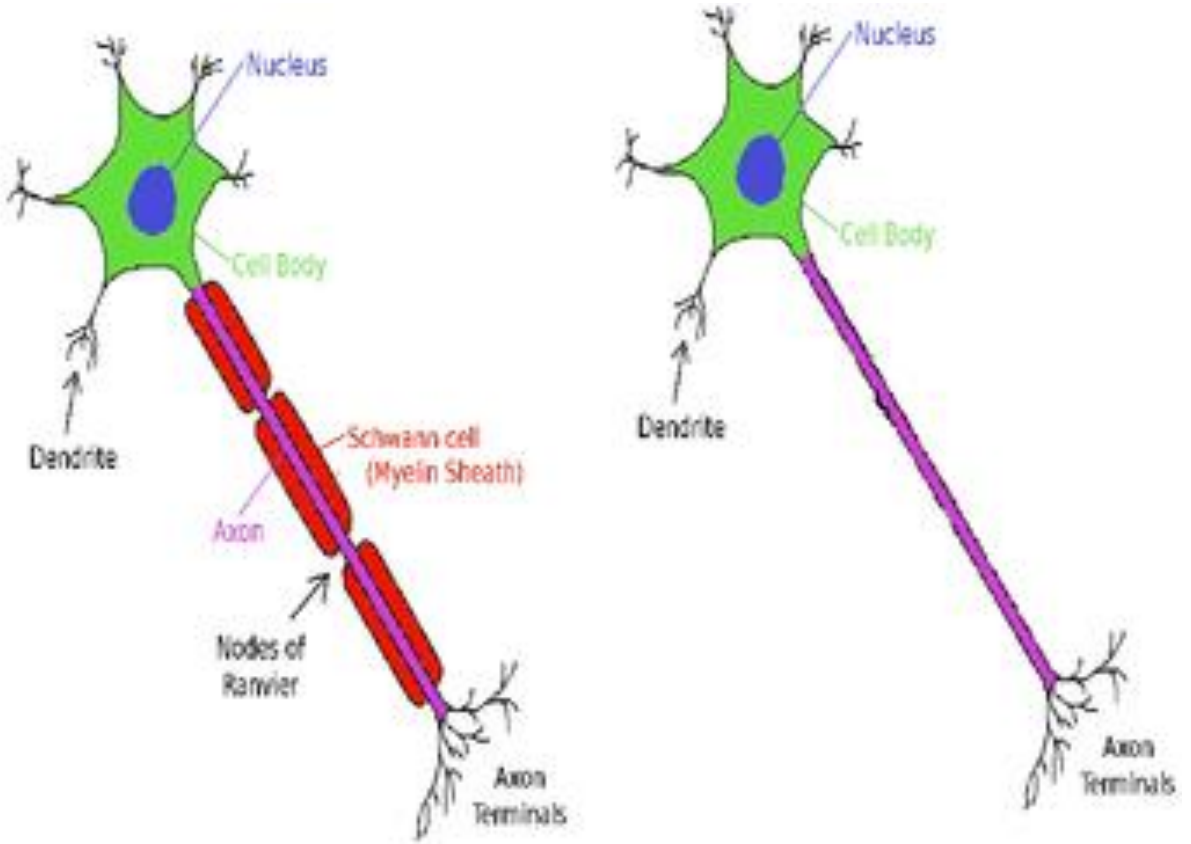


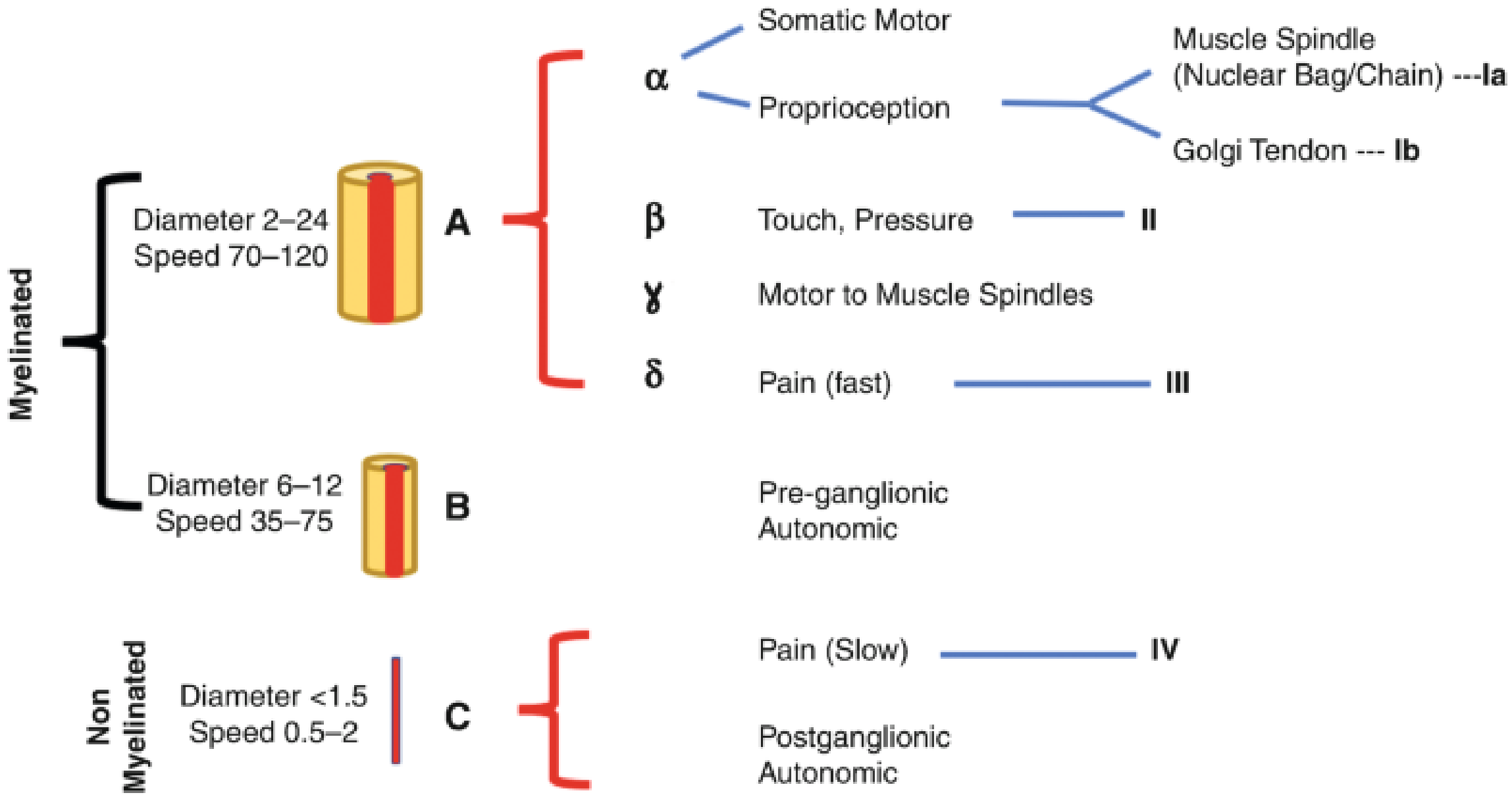


Classification of Nerve Fibers

- Based on the structure, the nerve fibers are classified into two types:
  1. Myelinated nerve fibers that are covered by myelin sheath.
  2. Nonmyelinated nerve fibers which are not covered by myelin sheath.

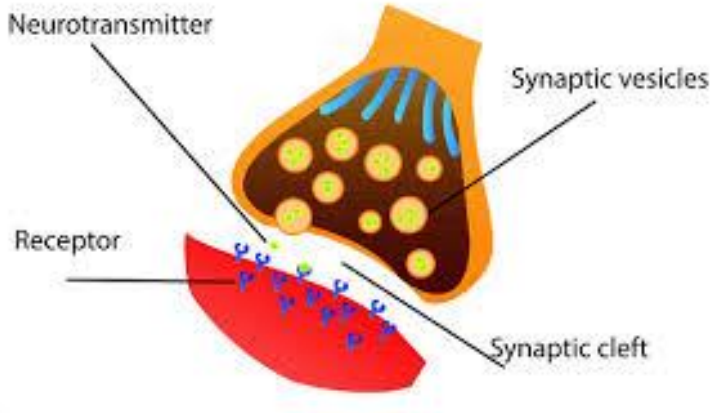


Classification of Nerve Fibers



Synapse

- **Synapse** is the point at which a nervous impulse passes from one neuron to another. **Synaptic function** is to transmit nerve impulses **between two nerve cells (neurons)** or **between a neuron and muscle cell**. Synapses connect one neuron to another and are thus responsible for the transmission of messages from the nerves to the brain and vice versa.In the CNS, this other cell is also a neuron. In the PNS, the other cell may be either a neuron or an effector cell within a muscle or gland.
- Synapses at muscle fibers are also called **neuromuscular junctions** or **myoneural junctions**.

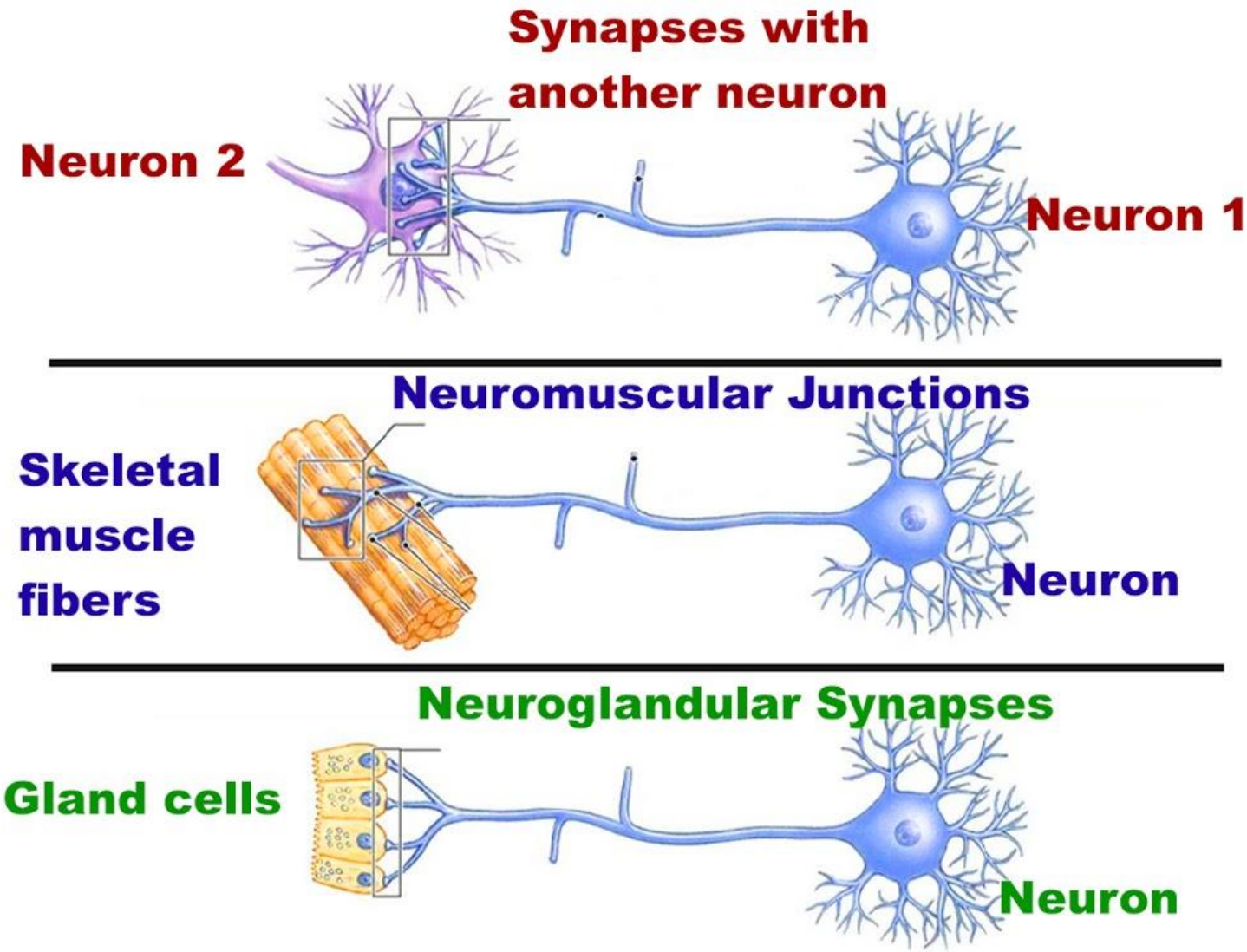


Types of Synapses

Synapses with another neuron

Neuromuscular Junctions

Neuroglandular Synapses



Role of Synapse

- Neurons communicate with one another at junctions called synapses.

  At a synapse, one neuron sends a message to a target neuron—another cell. Most synapses are **chemical**; these synapses communicate using chemical messengers. Other synapses are **electrical**; in these synapses, ions flow directly between cells.

- **Synapse connects sensory organs**, like those that detect **pain or touch**, in the peripheral nervous system to the brain.
- **Synapses connect neurons in the brain to neurons in the rest of the body and from those neurons to the muscles.**


THANK YOU ☺