



**AL-Mustaqbal University College**  
**Department of Pharmacy**  
**physiology lec1/ 2<sup>nd</sup> stage**



# **Nervous system**

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# The Nervous System

## Introduction

- **The nervous system** is one of the most complex systems that works through an interconnected network of **millions of neurons**. The human central nervous system (CNS) contains about  $10^{11}$  (100 billion) **neurons**.
- It also contains 10–50 times this number of **glial cells**(cells other than neurons)
- **This highly specialized network** responsible for controlling and coordinating all the functions of the body, using electrochemical signals or neurotransmitters in the transmission of **signals or impulses** from one neuron to another.
- Enabling the person to adapt, to change in internal and external environments.

# The Nervous System

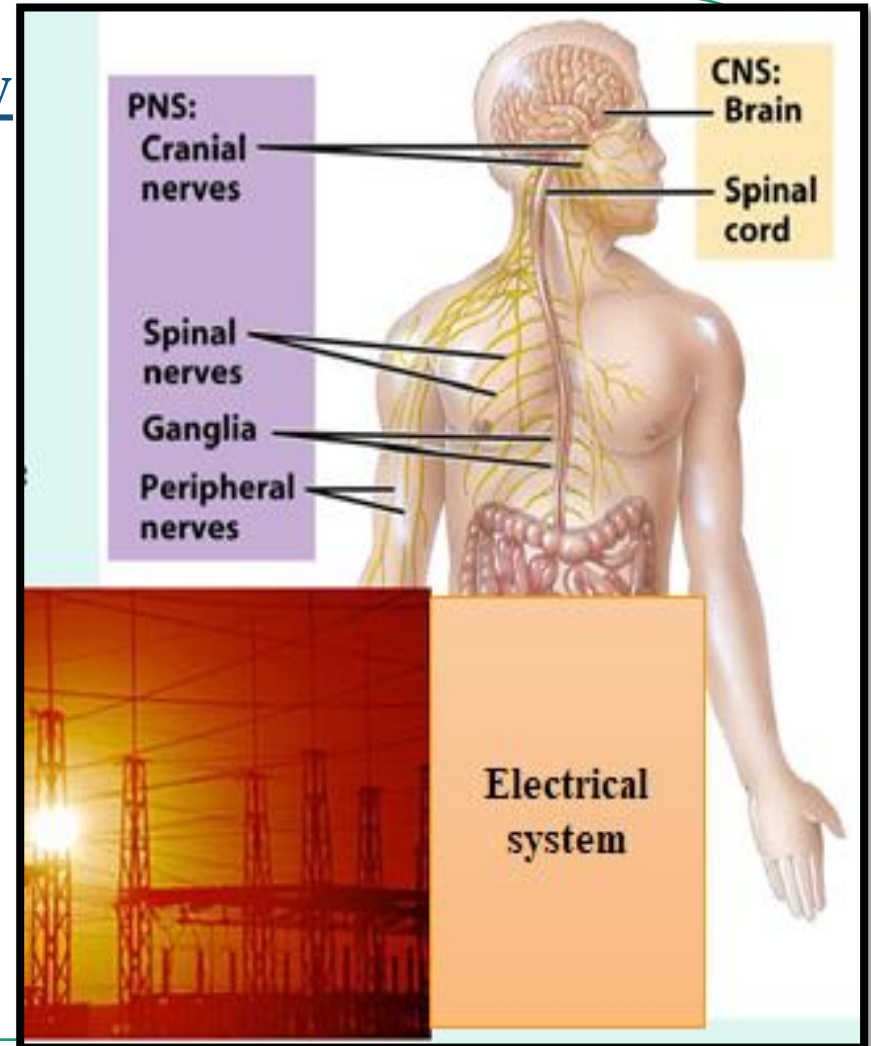
The Electrical system of body

The nervous system performs three important functions:

„« Sensory input

„« Integration

„« Motor output



**12 cranial nerves**

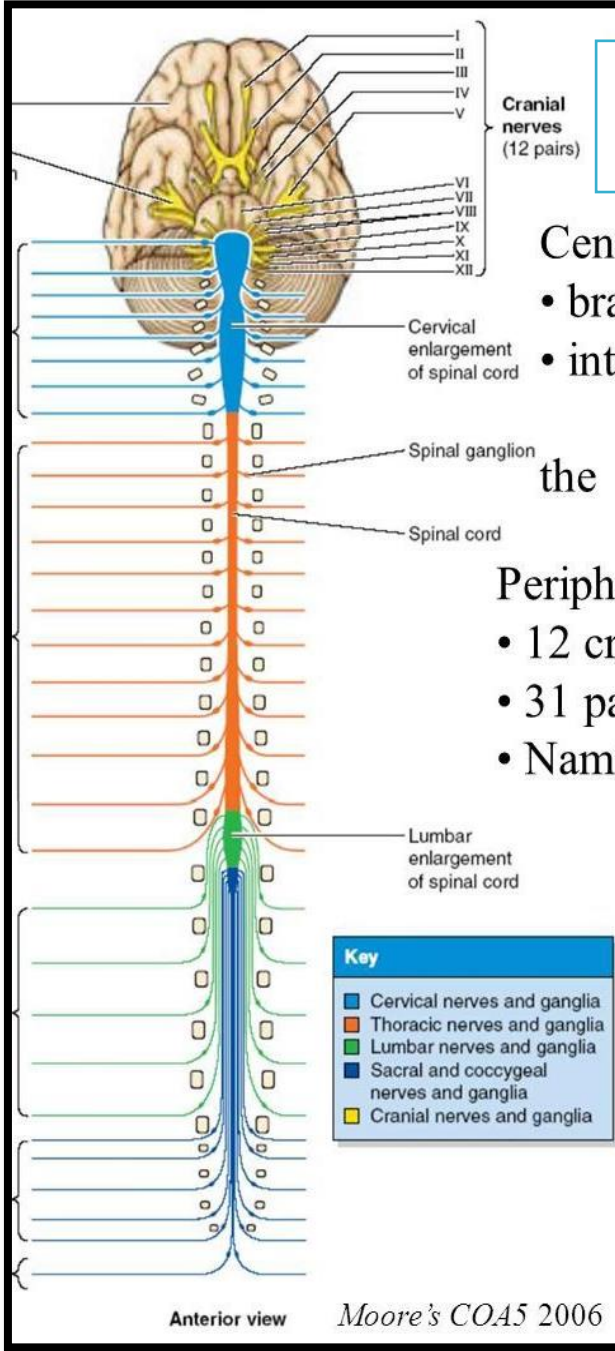
**8 Cervical**

**12 thoracic**

**5 lumbar**

**5 sacral**

**1 coccygeal**



**Nervous system  
CNS + PNS**

**Central Nervous System**

- brain & spinal cord
- integration of info passing to & from the periphery

**Peripheral Nervous System**

- 12 cranial nerves
- 31 pairs of spinal nerves
- Naming convention changes at C7/T1

**Collection of nerve cell bodies:**

- CNS: nucleus
- PNS: ganglion

# The Nervous System

**Components = Brain, spinal cord, nerves, sensory receptors**

**I / The Central Nervous System (CNS)** : consists of the **brain and the spinal cord**,

▶ **II/ The Peripheral Nervous System (PNS)** : the peripheral nervous system consists of **All the neural tissue outside CNS** , this includes:

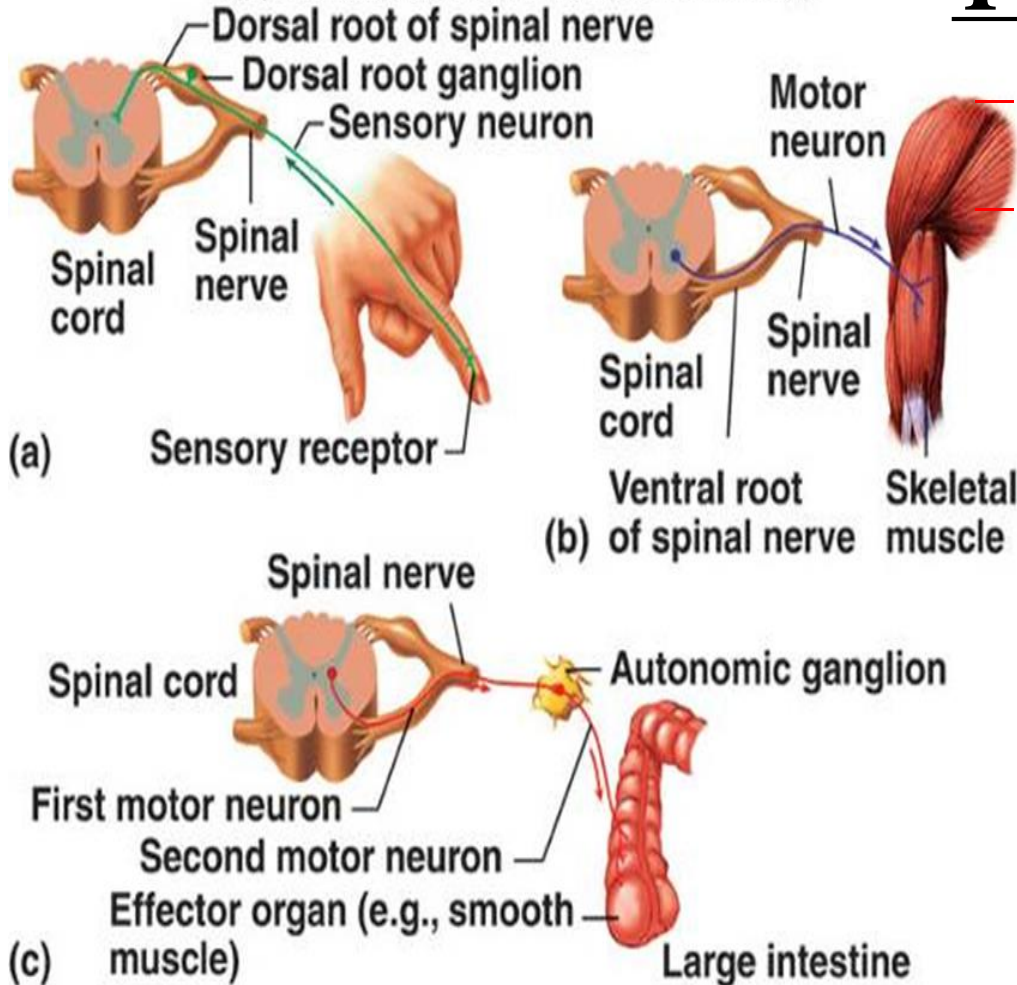
- Afferent division (sensory input)
- Efferent division (motor output)

▶ **PNS** can be divided into:

- **Somatic nervous system**,
- **Autonomic nervous system**

# The Nervous System

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- Two subcategories

- Sensory or afferent

- Motor or efferent

- Divisions

- Somatic nervous system

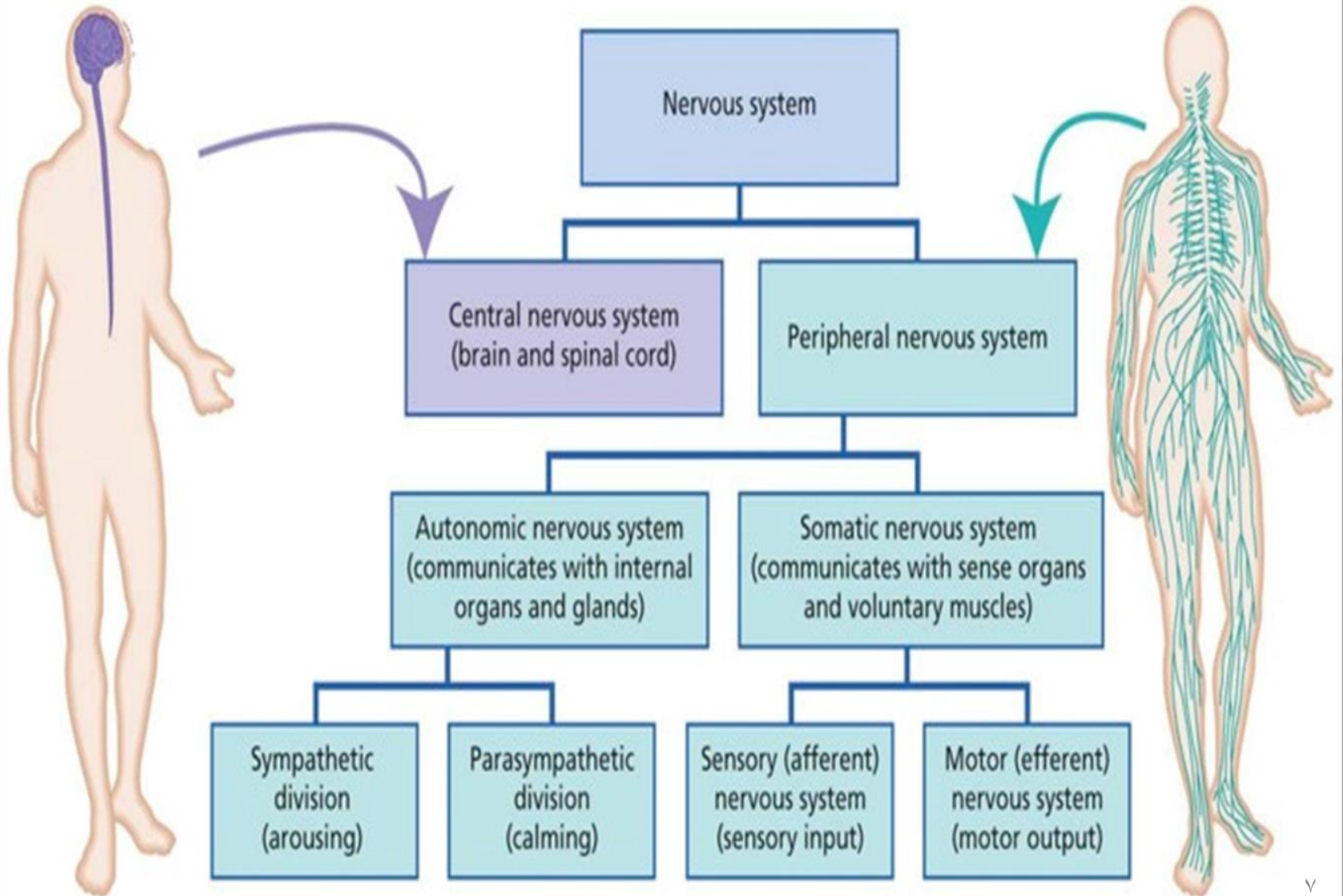
- Autonomic nervous system (ANS)

- Sympathetic

- Parasympathetic

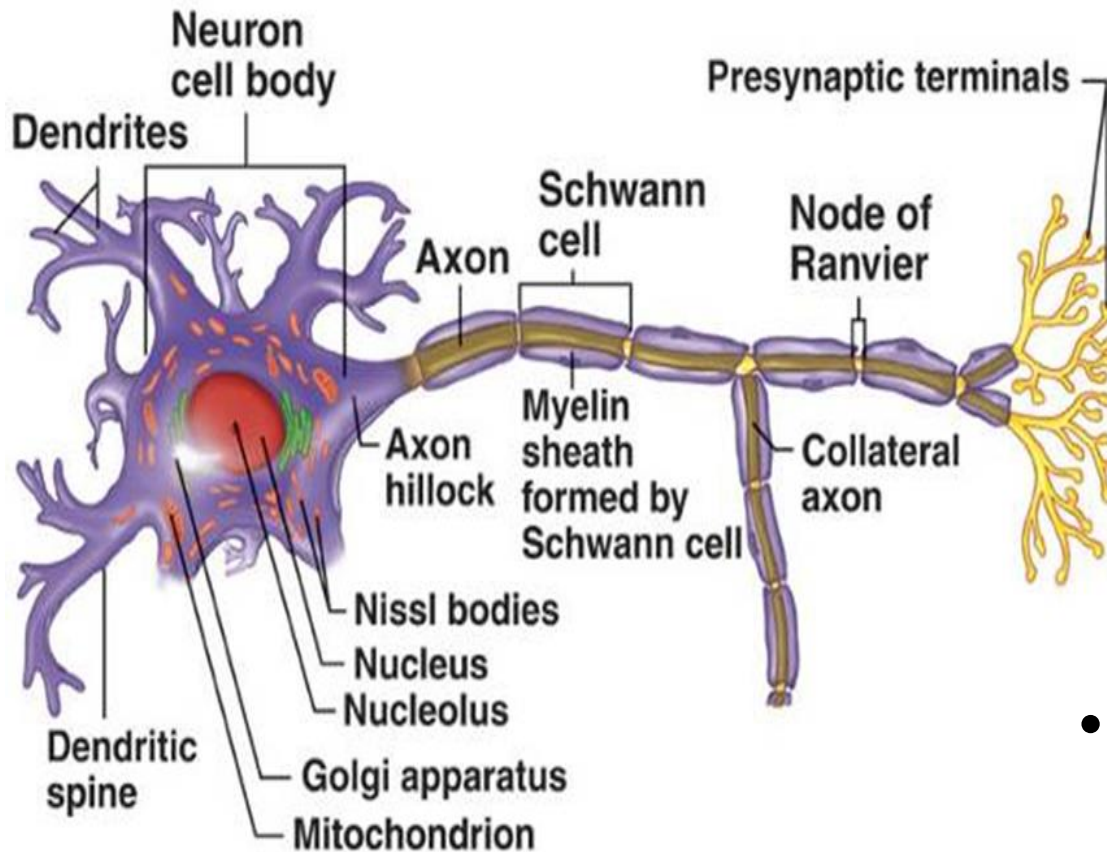
- Enteric

# The Nervous System



# Cells of Nervous System

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## • 1-Neurons or nerve cells

- cellular connection  
Receive stimuli and transmit action potentials
- Organization
  - **Cell body or soma**
  - **Dendrites: Input**
  - **Axons: Output**

## • 2-Neuroglia or glial cells

- Support and protect neurons



# Cells of Nervous System

## - The Neuron

- ▶ The functional unit of the nervous system is the nerve cell (**Neuron**).
- ▶ Nerve cells transmit signals in form of **nerve impulses**.
- ▶ Have **high metabolic rate** but **Do not divide**.
- ▶ The cell body (**soma**) contains the nucleus and is the **metabolic center** and **several processes** called **dendrites** that extend outward from the cell body and arborize extensively neuron.
- ▶ A typical neuron also has a long fibrous **axon** that originates from a somewhat thickened area of the cell body, **the axon hillock**.
- ▶ The first portion of the axon is called the **initial segment**.
- ▶ The axon divides into **presynaptic terminals**.
- ▶ Each ending in a number of **synaptic knobs** which are also called **terminal buttons or boutons**. They contain granules or vesicles in which the synaptic transmitters secreted by the nerves are stored.

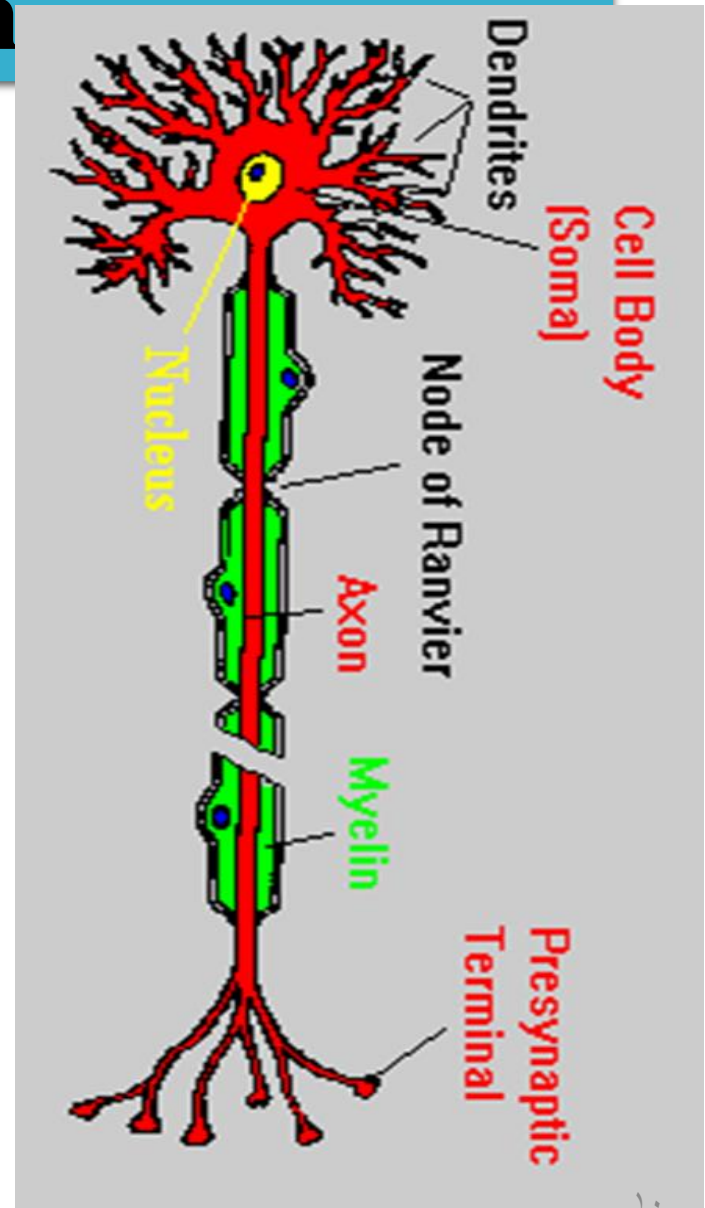
# Structure and function

## Typical Neuron has 4 region

- Cell Body
- Dendrites
- Axon
- Presynaptic Terminals

Each region is specialized  
for its particular function

Information flows in a single  
direction



# Neuron Cell Body Location

- Most are found in the central nervous system

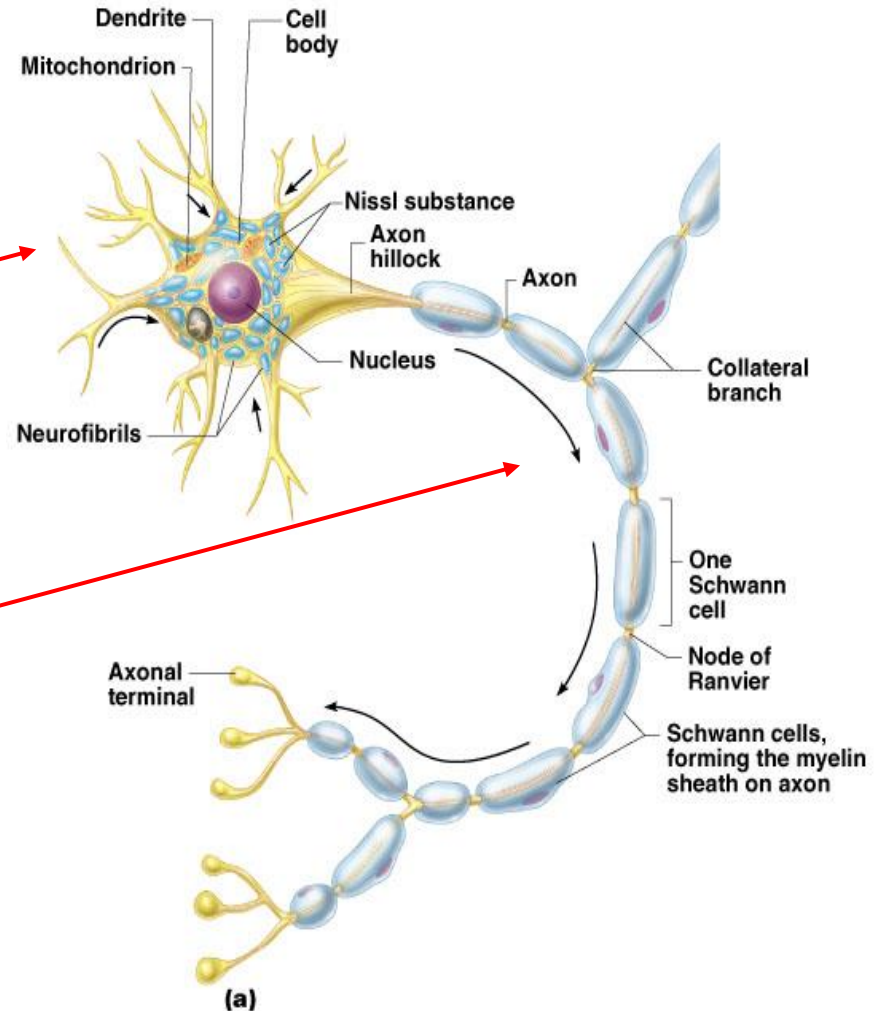
**Gray matter** : cell bodies and unmyelinated fibers

**Nuclei** :- clusters of cell bodies within the white matter of the central nervous system

**Ganglia** :- collections of cell bodies outside the central nervous system

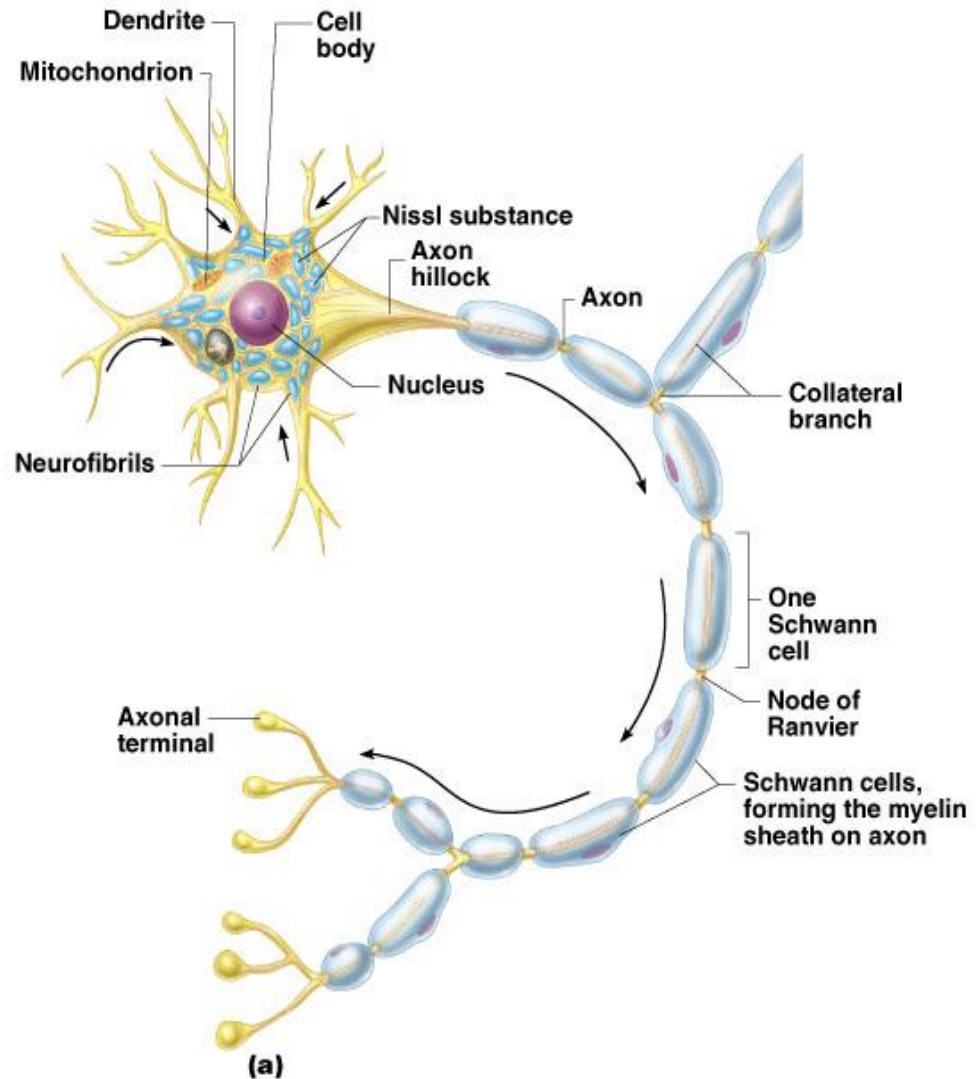
# Structure function (dendrites)

- Extensions outside the cell body
  - Dendrites – conduct impulses toward the cell body
  - Axons – conduct impulses away from the cell body (only 1!)



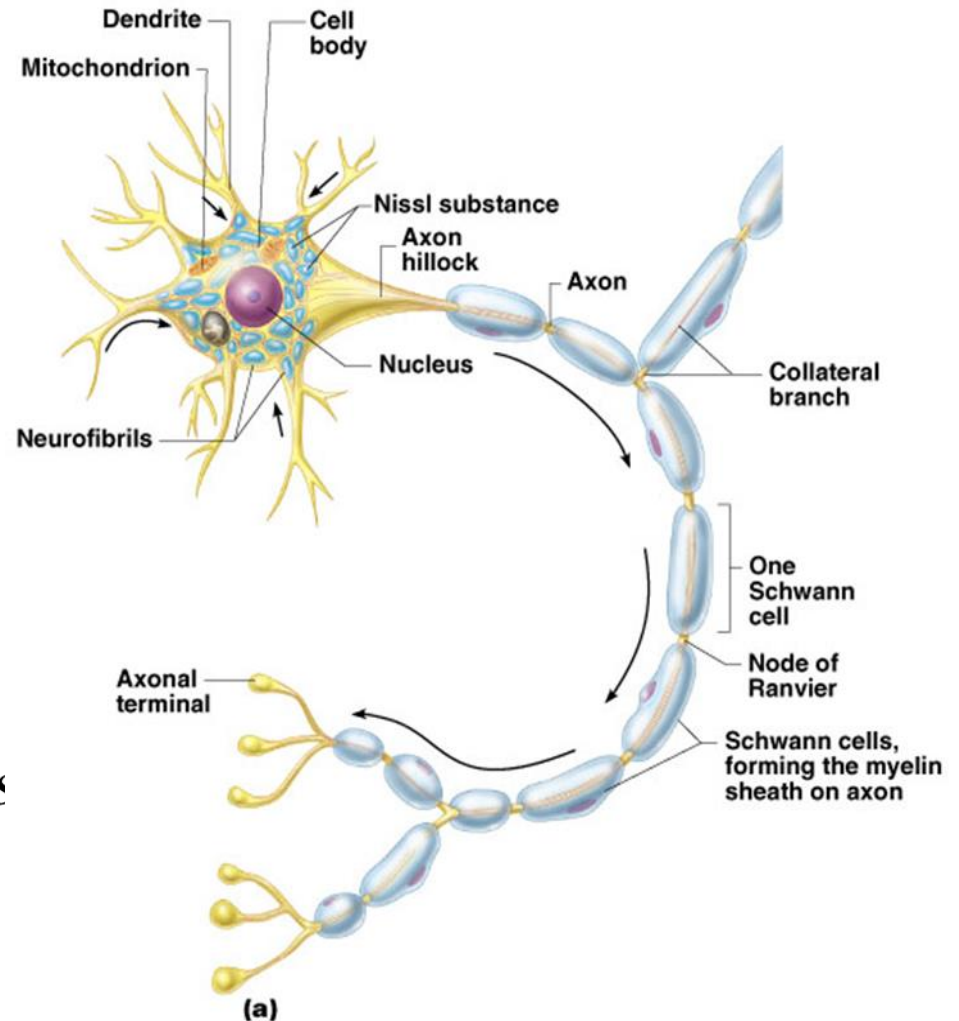
# Dendrites of Motor Neurons

- Short, tapering, and diffusely branched processes
- They are the receptive, or input, regions of the neuron
- Electrical signals are conveyed as graded potentials (not action potentials)



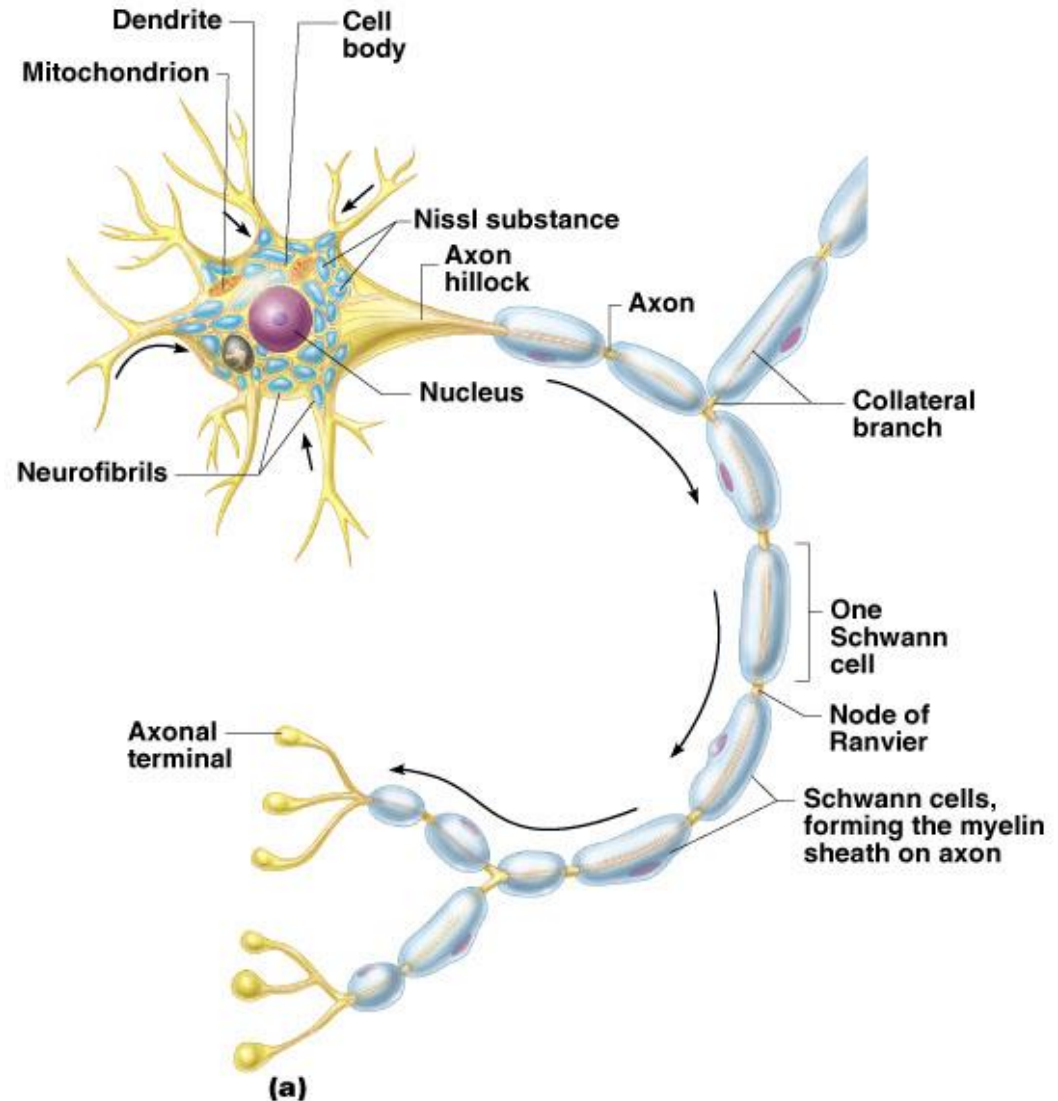
# Axons: Structure

- Slender processes of uniform diameter arising from the hillock
- Long axons are called nerve fibers
- Usually there is only one unbranched axon per neuron
- Rare branches, if present, are called *axon collaterals*
- Axonal terminal – branched terminus of an axon



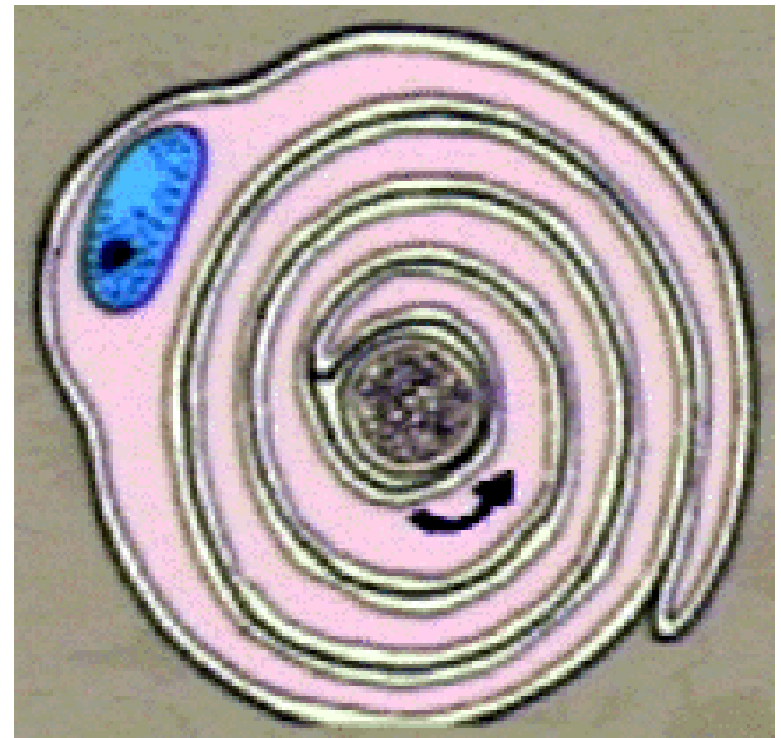
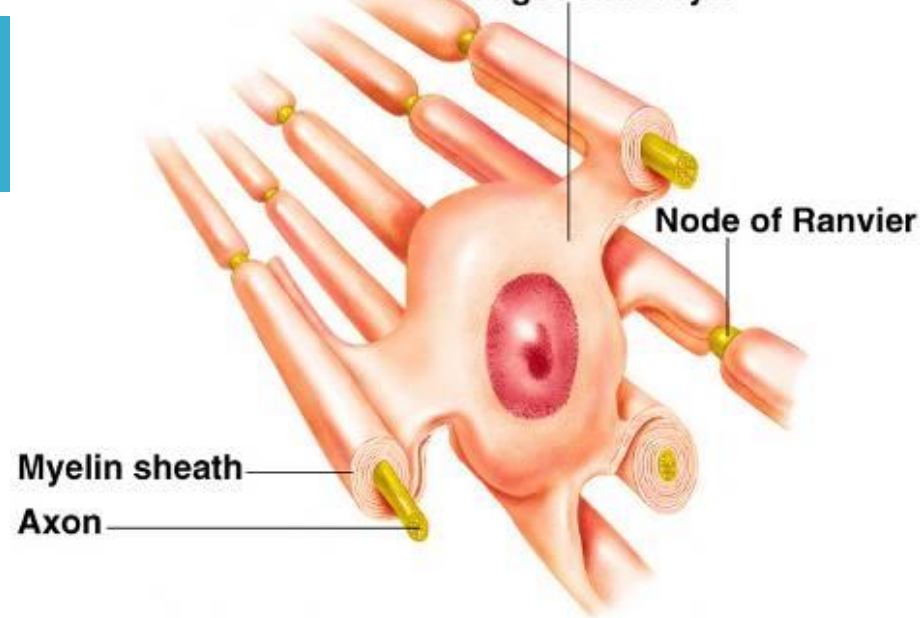
# Axons: Function

- **Generate and transmit** action potentials
- **Secrete** neurotransmitters from the axonal terminals



# Myelin

- Myelin: whitish, fatty (protein-lipid), segmented sheath around most long axons.
- **CNS: from oligodendrocytes**
- **PNS: from Schwann cells**





# Myelin Sheath

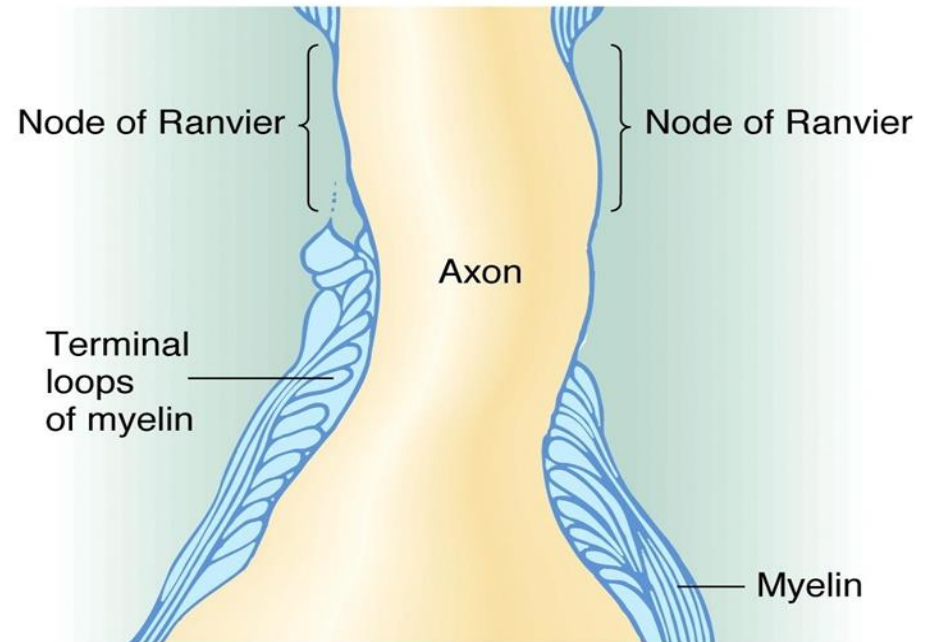
## Myelin functions in :

- Protection of the axon
- Electrically insulating fibers from one another
- It increases the excitability of the nerve fiber**
- Increasing the speed of nerve impulse transmission

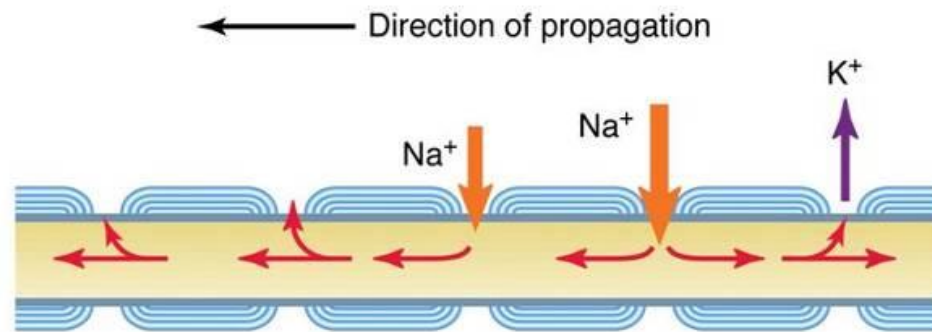
- **Clinical significance**
- Multiple sclerosis (MS)
- Guillain Barre syndrom (GBS)
- Vitamin B.12

# Nodes of Ranvier

- Gaps in the myelin sheath between adjacent Schwann cells
- They are the sites where collaterals can emerge
- Salutatory (welcome) conduction

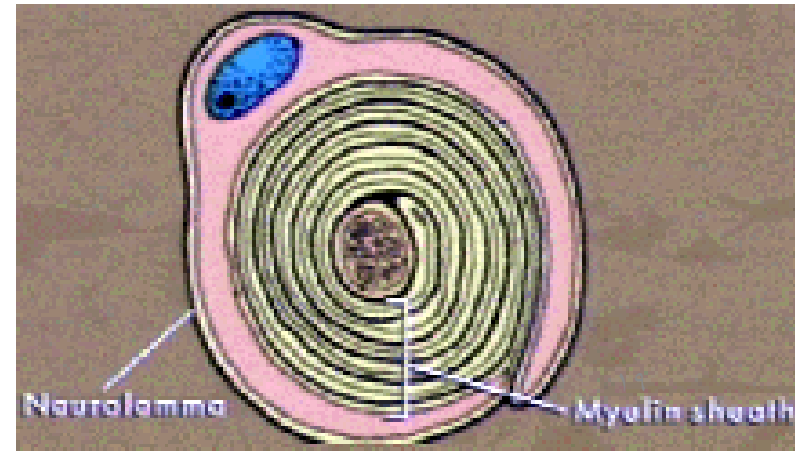


(a)

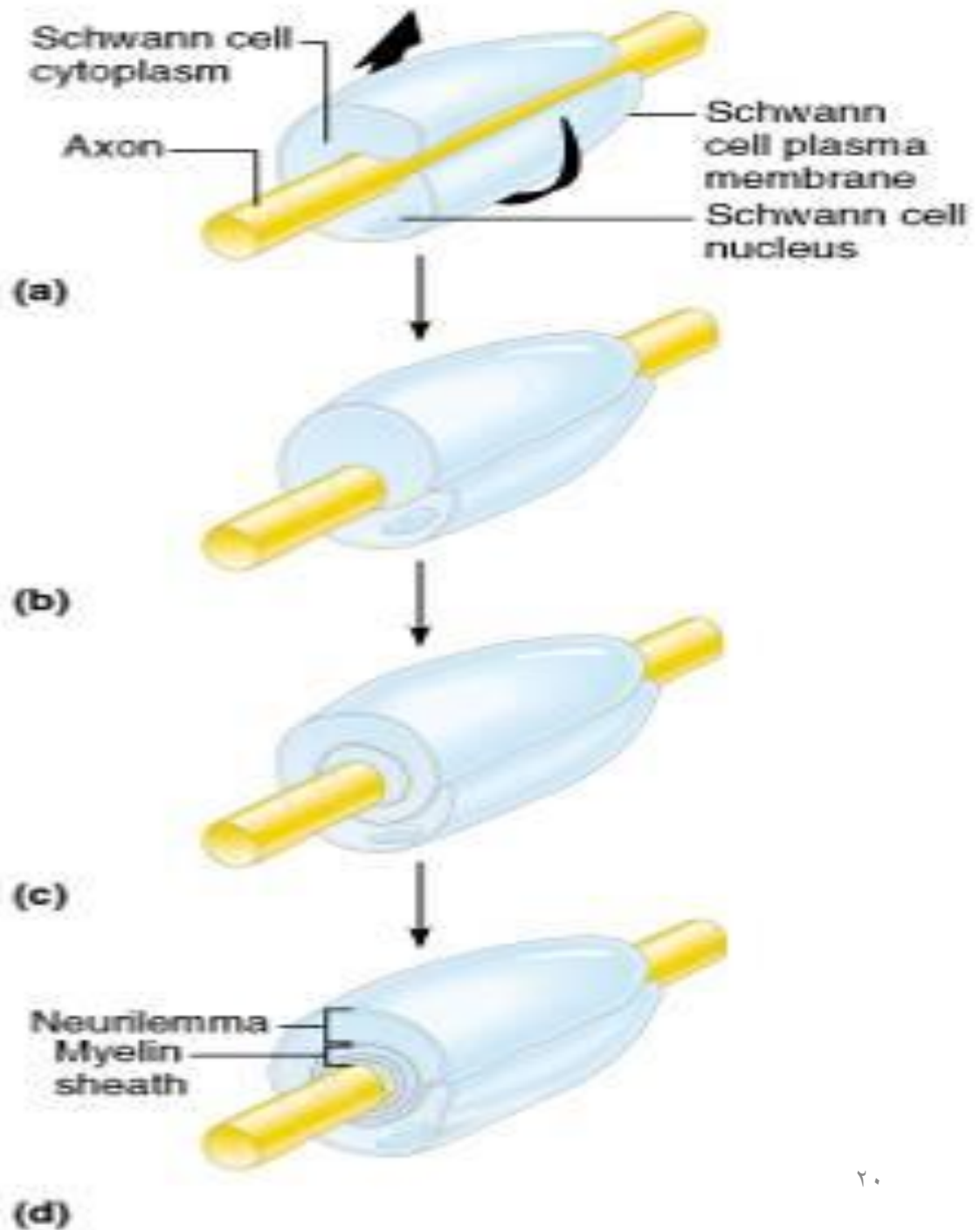


# Myelin Sheath and Neurilemma: Formation

- Formed by Schwann cells in the PNS
- A Schwann cell:
  - Envelopes an axon in a trough
  - Encloses the axon with its plasma membrane
  - Concentric layers of membrane make up the myelin sheath
- Neurilemma – remaining nucleus and cytoplasm of a Schwann cell

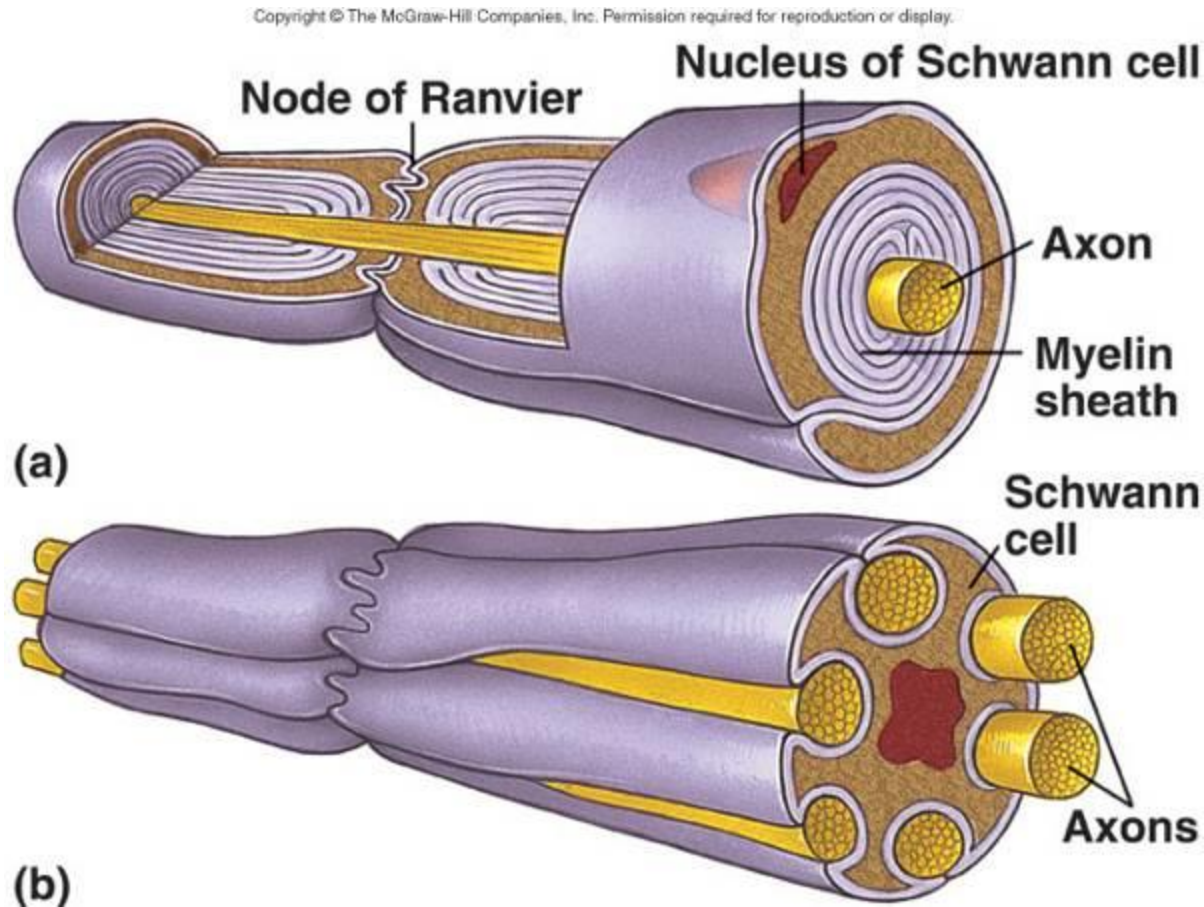


# Myelin Sheath and Neurilemma: Formation



# Non -myelinated Axons

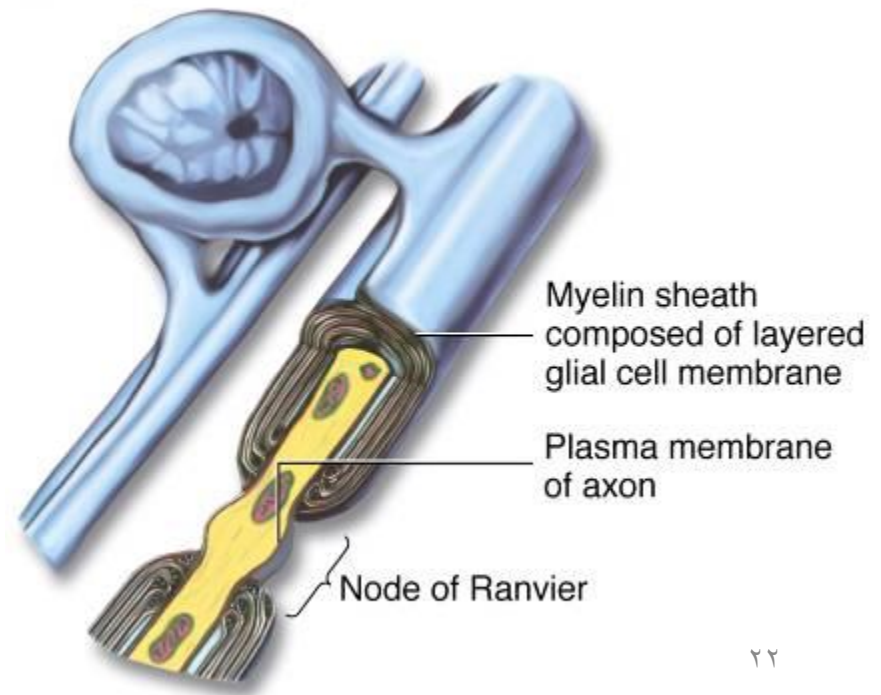
- A Schwann cell surrounds nerve fibers but coiling does not take place
- Schwann cells partially enclose 15 or more axons



# Axons of the CNS

- Both myelinated and unmyelinated fibers are present
- Myelin sheaths are formed by oligodendrocytes
- Nodes of Ranvier are widely spaced
- There is no neurilemma

(a) Oligodendrocyte



# Glial cells

- **Glial cells** (neuroglia) are the “glue” of the NS
- They also perform many functions
- There are six basic types:
  - **Astrocytes** (CNS)
  - **Microglia** (CNS)
  - **Oligodendrocytes** (CNS)
  - **Ependymal cells** (CNS)
  - **Schwann cells** (PNS)
  - **Satellite cells** (PNS)
- **Glial cells** outnumber neurons about 10 to 1

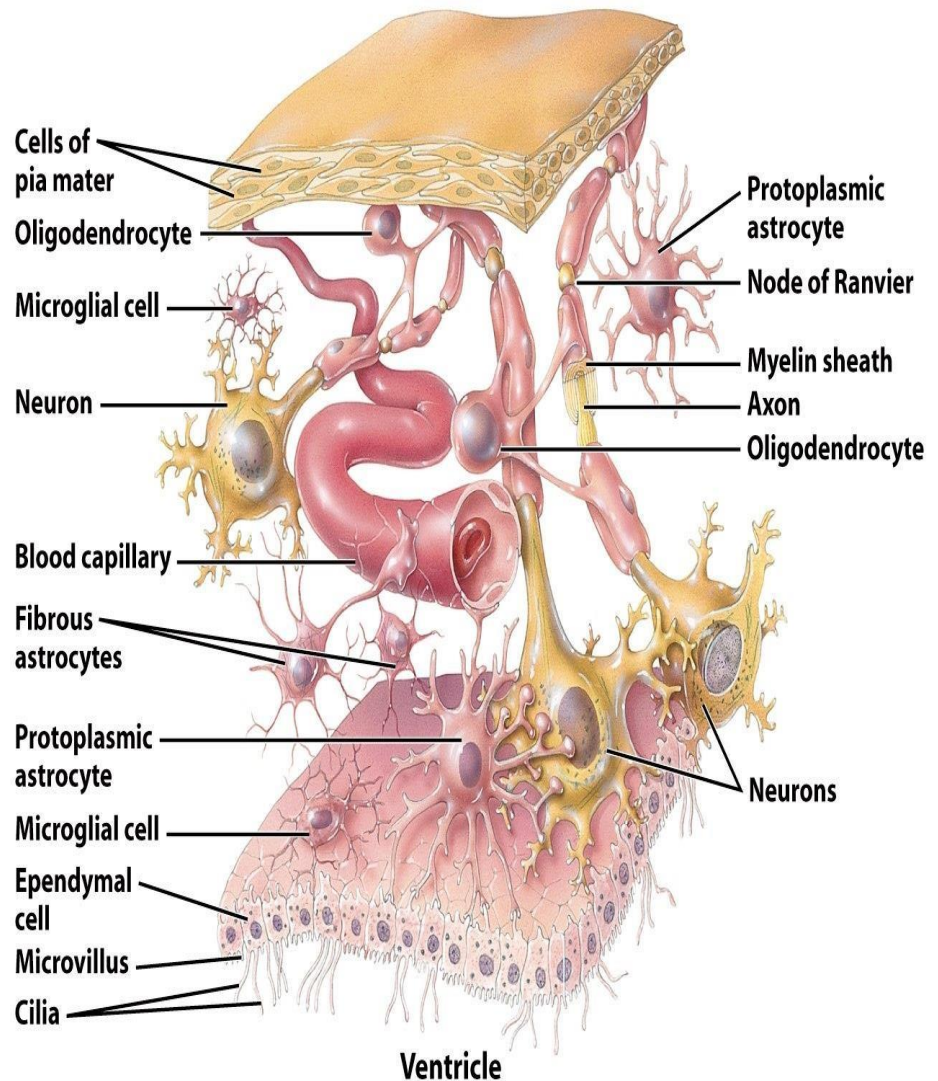


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# Glia

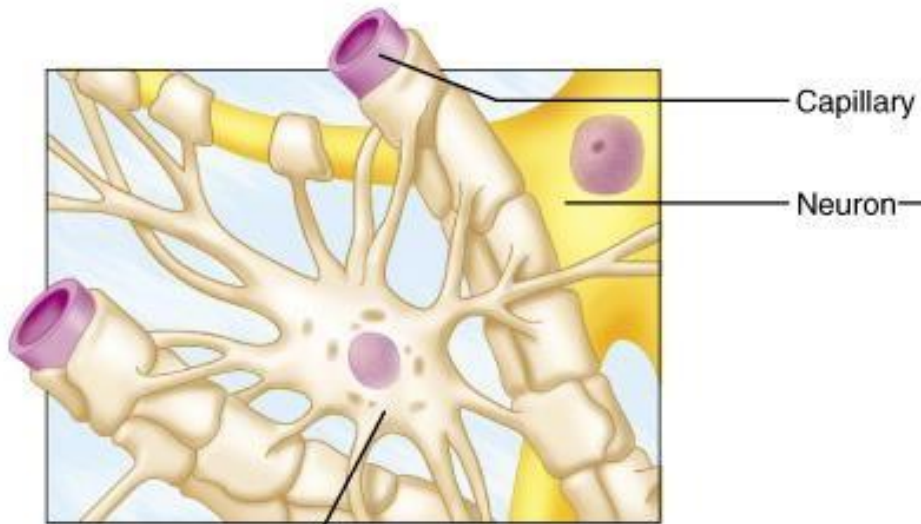
**Glia: other than Neuron cell in Nervous system**

**Microglia:** Are scavenger cells that resemble tissue macrophages and remove debris resulting from injury, infection.

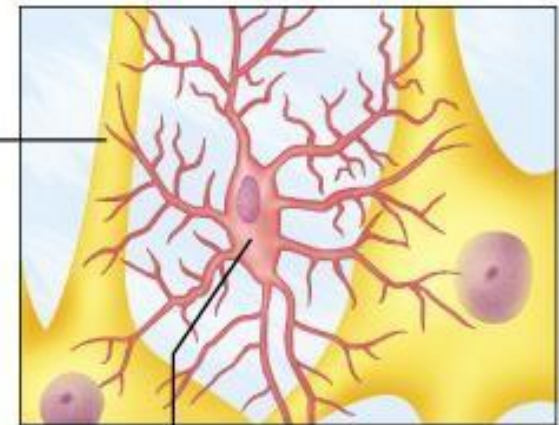
In the **peripheral nervous system** there are two types of glial cells:

- a. **Schwann cells.**
- b. **Satellite cells.**

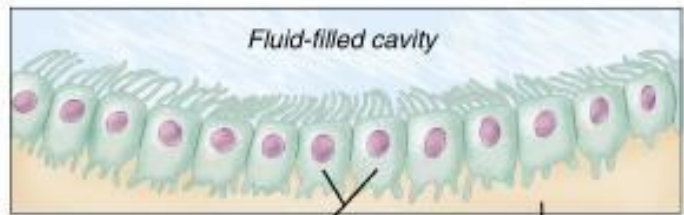




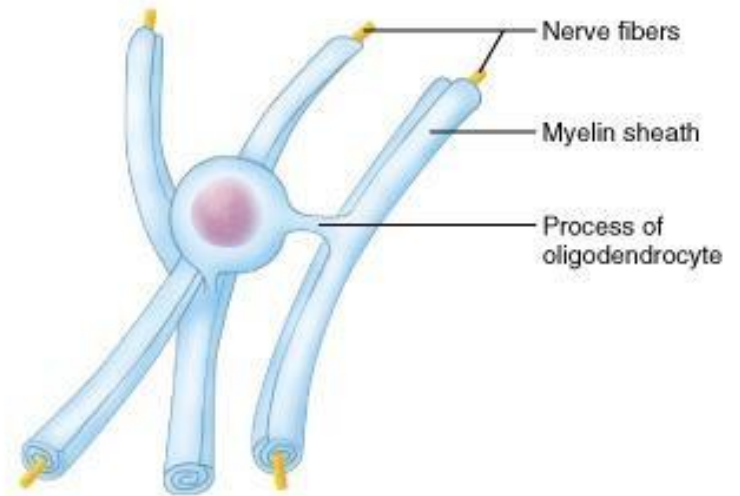
(a) Astrocyte



(b) Microglial cell

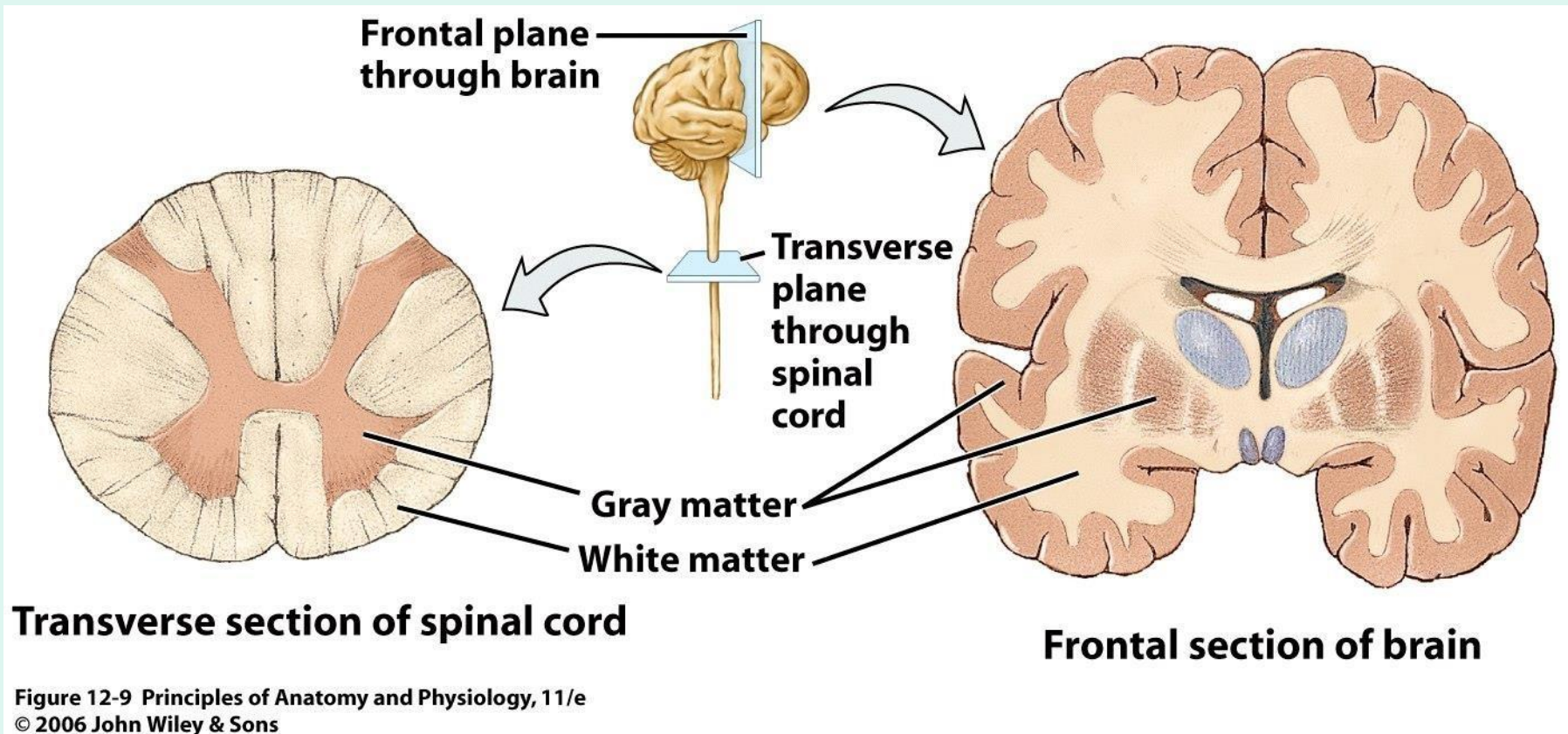


(c) Ependymal cells



(d) Oligodendrocyte

# Nervous System Tissue: Gray & White Matter

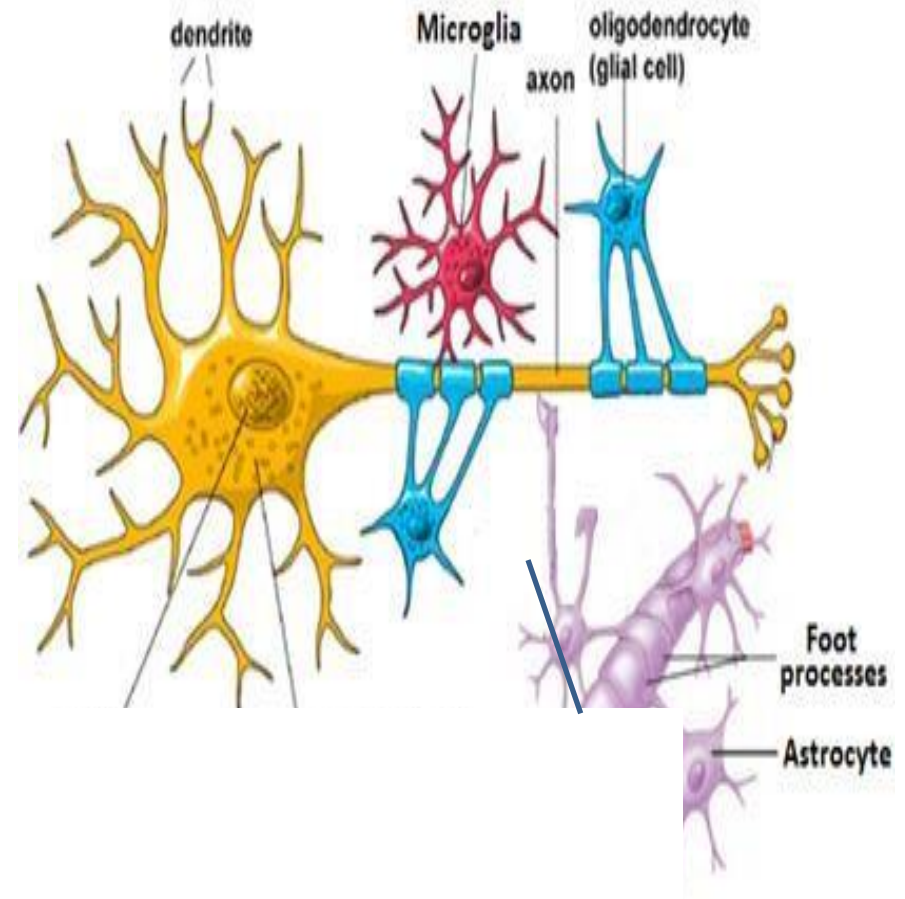


- **Gray matter** consists of cell bodies, unmyelinated axons, dendrites, and glial cells
- **White matter** consists of myelinated axons

# Glia:

In the **central nervous system** there are four types of glial cells:

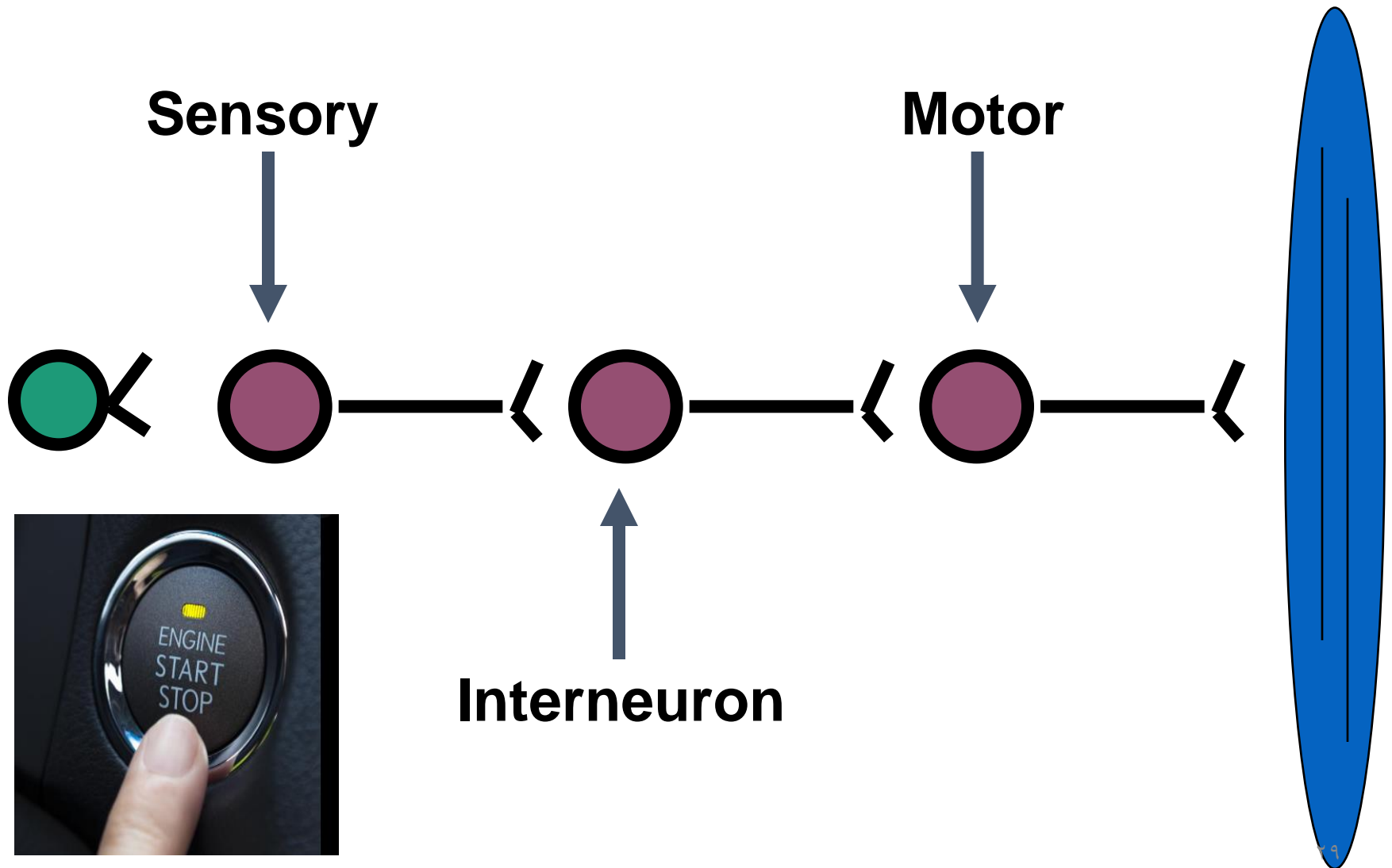
- a. Building the **Blood-brain barrier (BBB)**
- b. **Envelop** synapses and the surface of nerve cells.
- c. They **produce substances** that are trophic to neurons.
- d. **Maintain** the appropriate concentration of substances in the brain interstitial fluid.
- e. **Provide neurons** with lactate as an energy source.
- f. **Synthesize neurotransmitter (NT) precursors** for neurons.



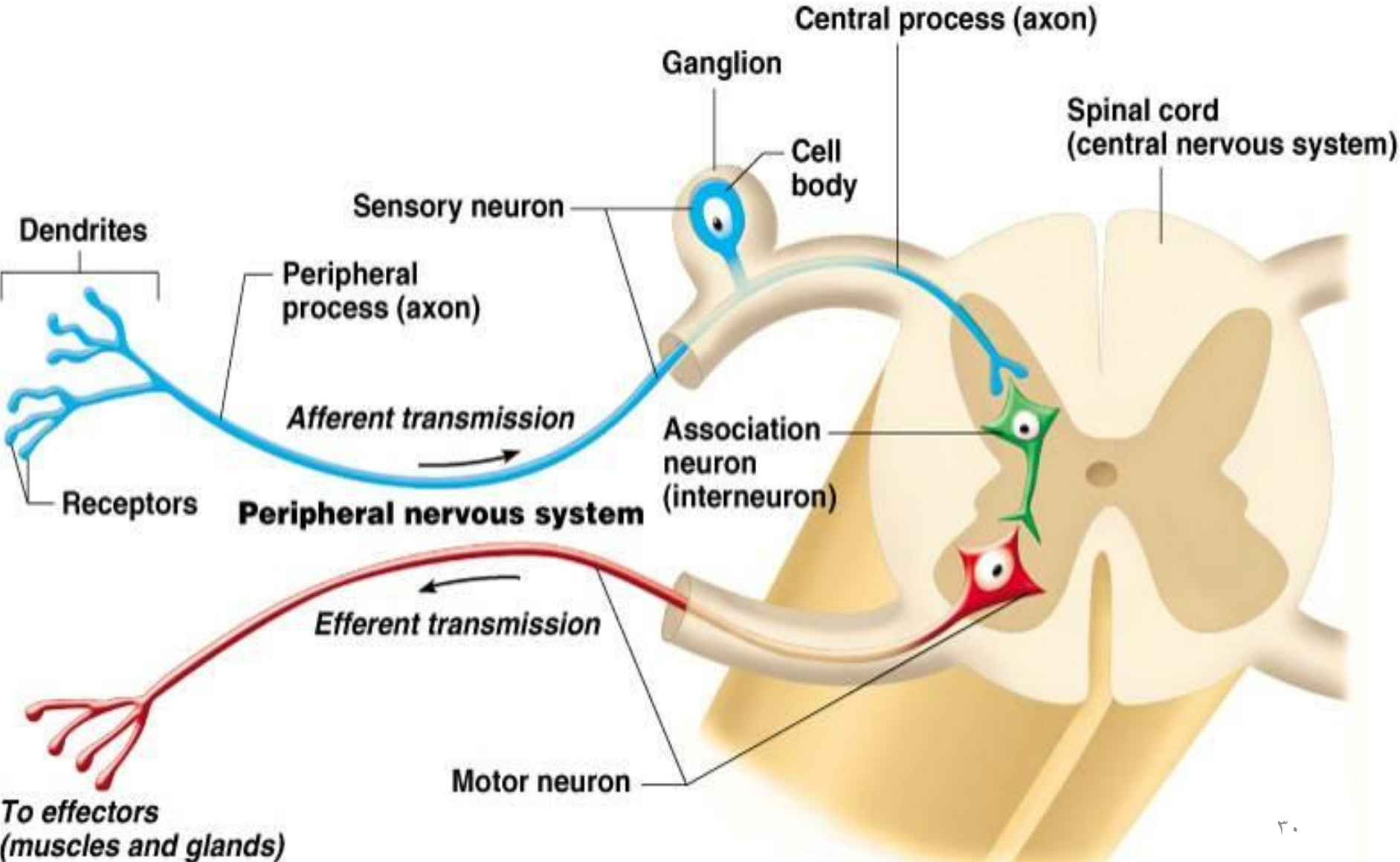
# Classification of neuron according to function

- **Sensory (afferent) neurons**
  - Carry impulses from the sensory receptors
    - Cutaneous sense organs
    - Proprioceptors – detect stretch or tension
- **Motor (efferent) neurons**
  - Carry impulses from the central nervous system
- **Interneurons (association neurons)**
  - Found in neural pathways in the central nervous system
    - Connect sensory and motor neurons

# By function (connections)



# Neuron Classification



# Neuron Types by structure

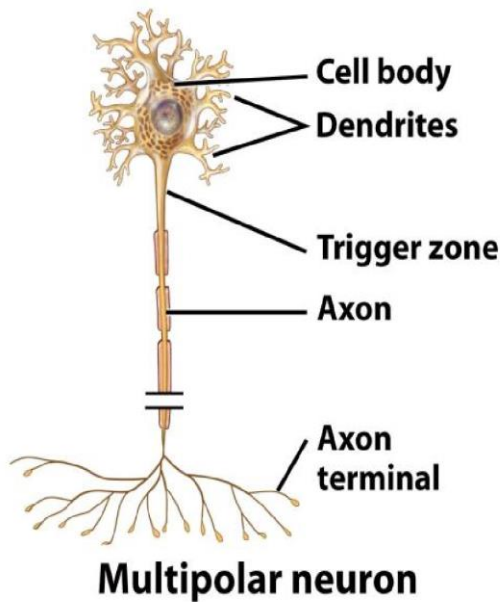


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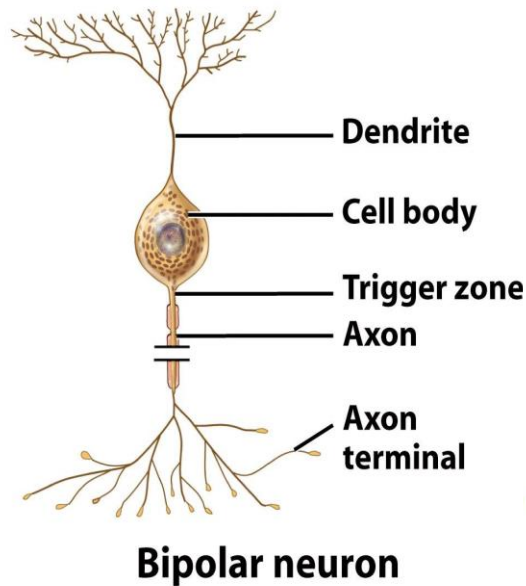


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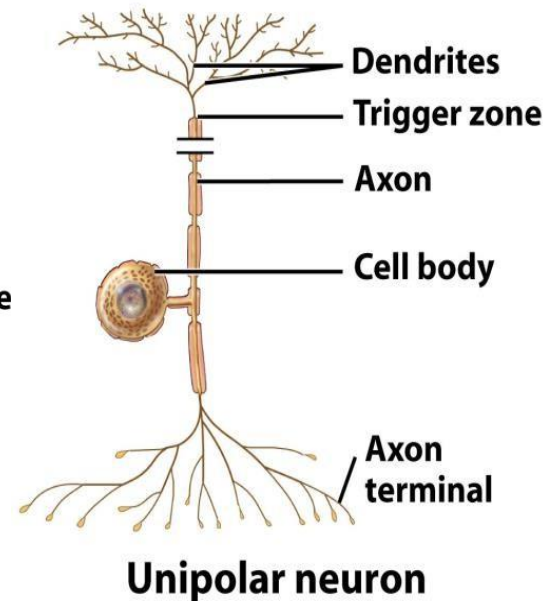


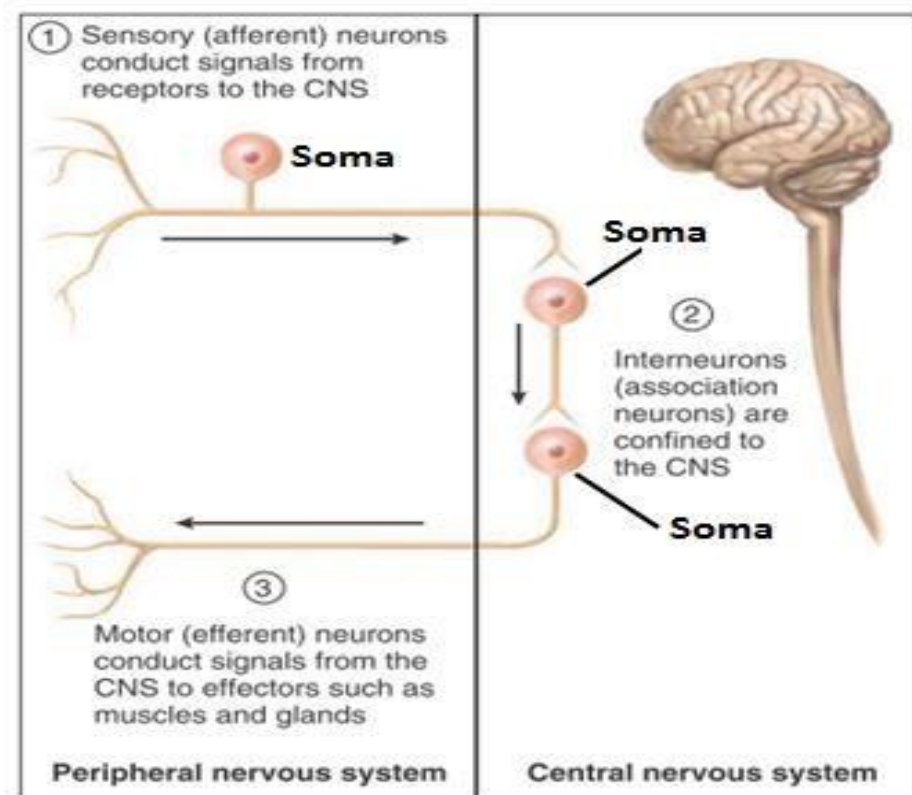
Figure 12-4c Principles of Anatomy and Physiology, 11/e  
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- **Multipolar neurons** have many dendrites and one axon. Most CNS neurons are multipolar.
- **Bipolar neurons** have one dendrite and one axon. They are found in many special sense organs.
- **Unipolar neurons** have one process that diverges from the cell body and forms dendrites on one end and axon terminals on the other. They are found in many ganglia of the cranial and spinal nerves.

# Nerve fibers and Classification

A- The fibers can be classified according to the direction in which they conduct impulses.

- ❖ **Sensory, or Afferent**
- ❖ **Motor, or Efferent (somatic and autonomic),**
- ❖ **Interneurons.**





# Nerve fibers and Classification

B- The fibers can be classified **according to their conduction velocity** into the following general types:

**1. Type A fibers: Myelinated**

Alpha ( $\alpha$ ) fibers

Beta ( $\beta$ ) fibers

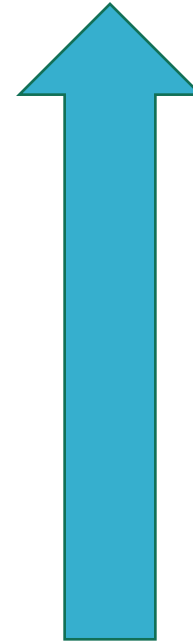
Gamma ( $\gamma$ ) fibers

Delta ( $\delta$ ) fibers

**2. Type B fiber: Myelinated**

**3. Type C fibers: Unmyelinated**

speed





**Thank You  
For Your  
Attention**