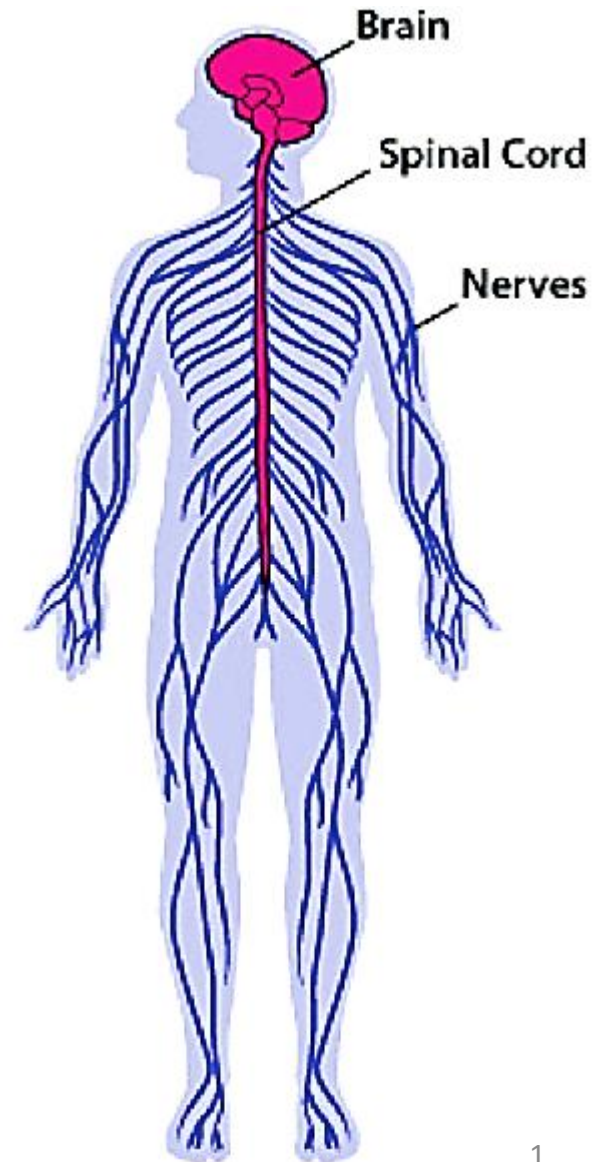
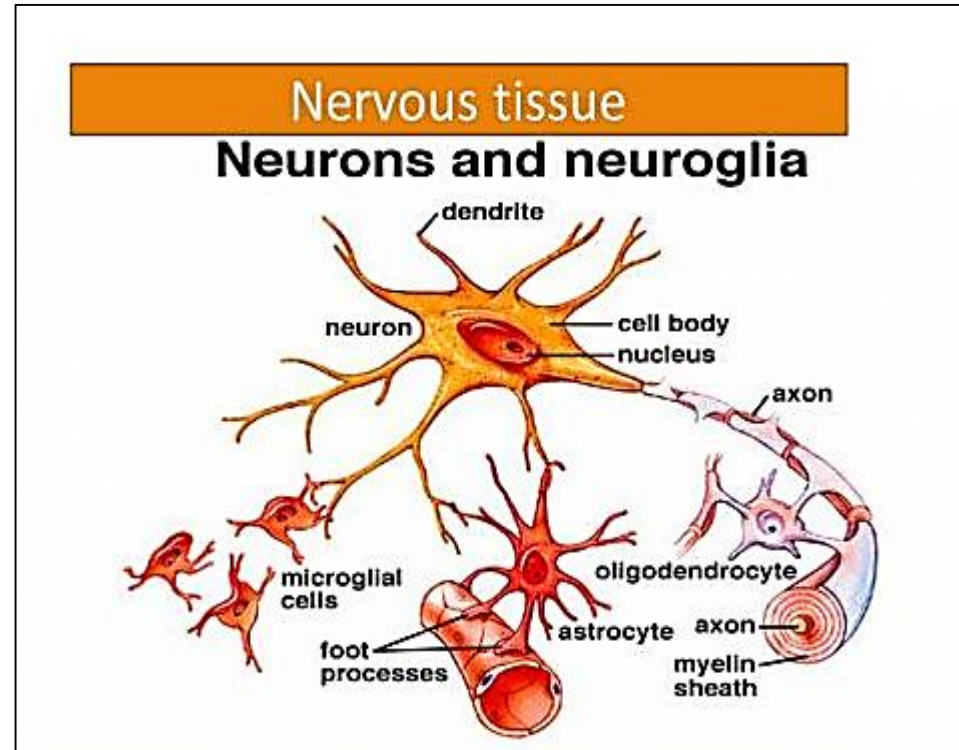
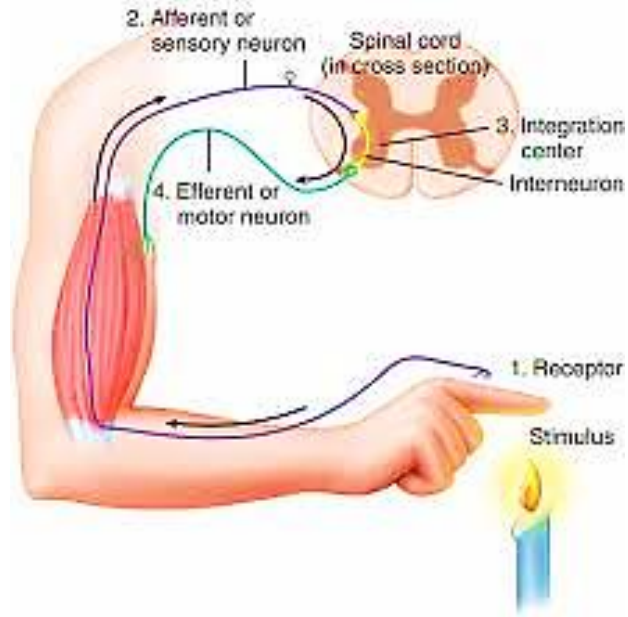


The Nervous Tissue

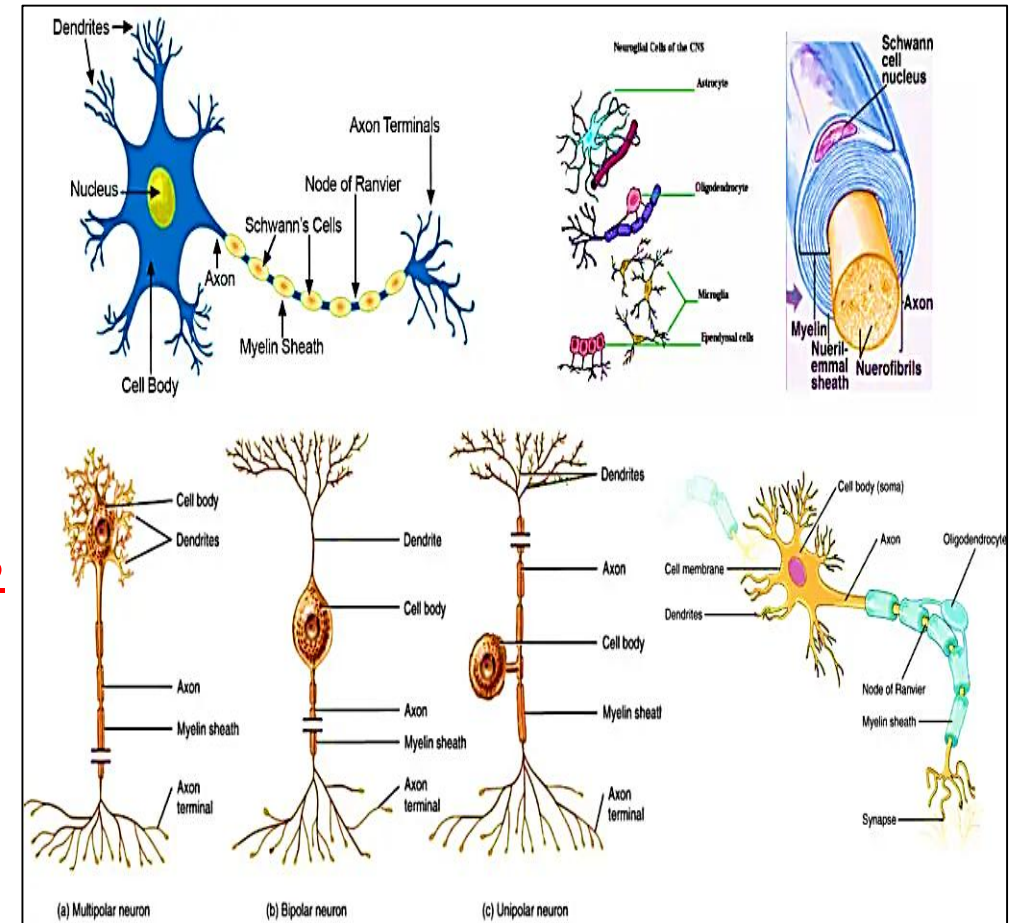
Nerve = Neuro....

Part I

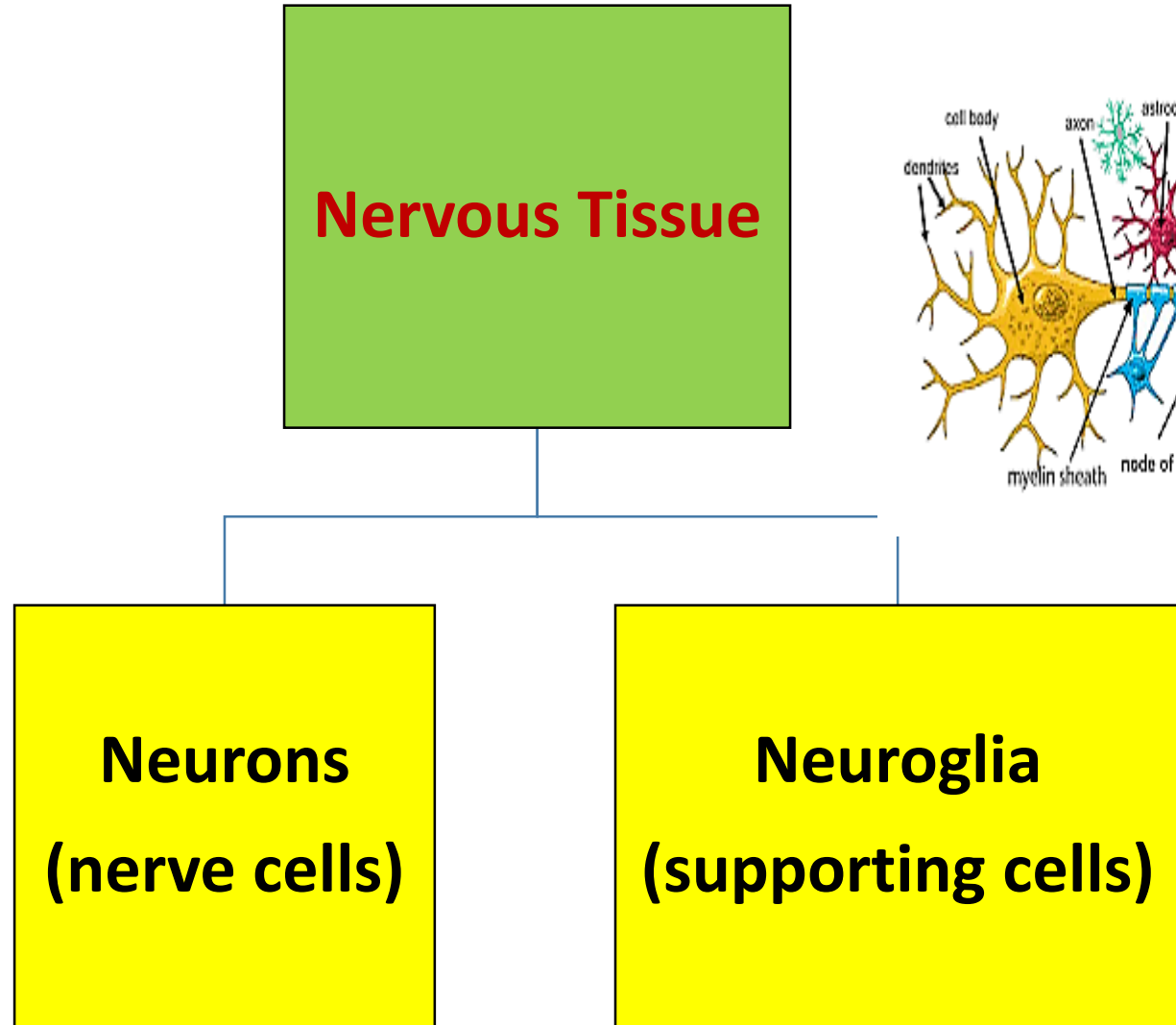


The objectives:

- Types of cells in nervous tissue
- Definition and structure of nerve fiber
- Definition and structure of peripheral nerves
- Response of the nervous tissue to injury
- Regeneration of the nervous tissue

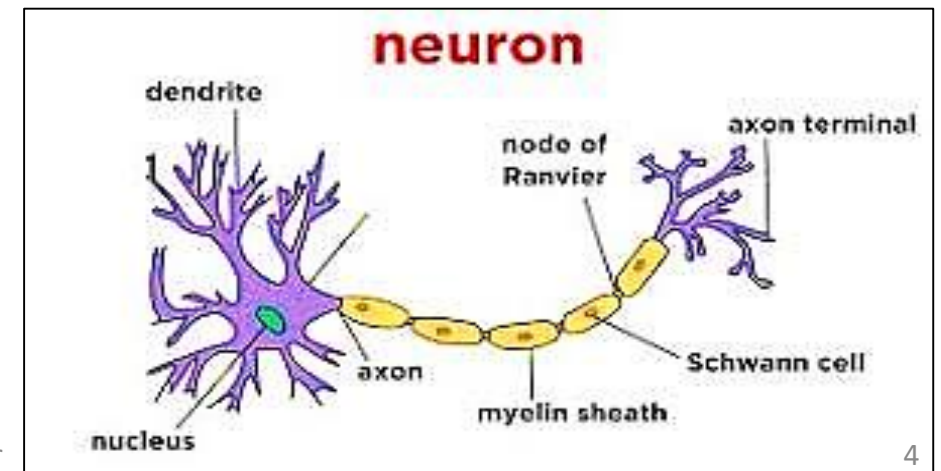
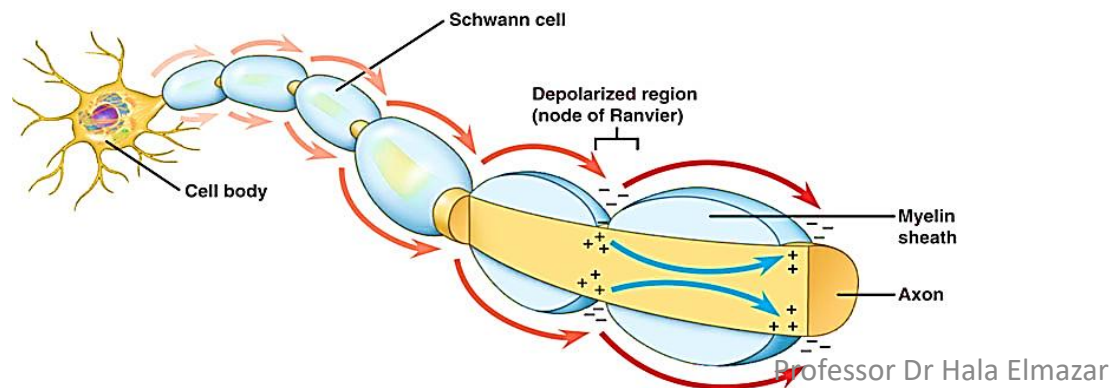


- It is one of the 4 main types of tissue in the body
- It is specialized for communication
- It is responsible for receiving stimuli , processing information and transmitting signals to different parts of the body
- It includes the brain , spinal cord and nerves , receptors , ganglia

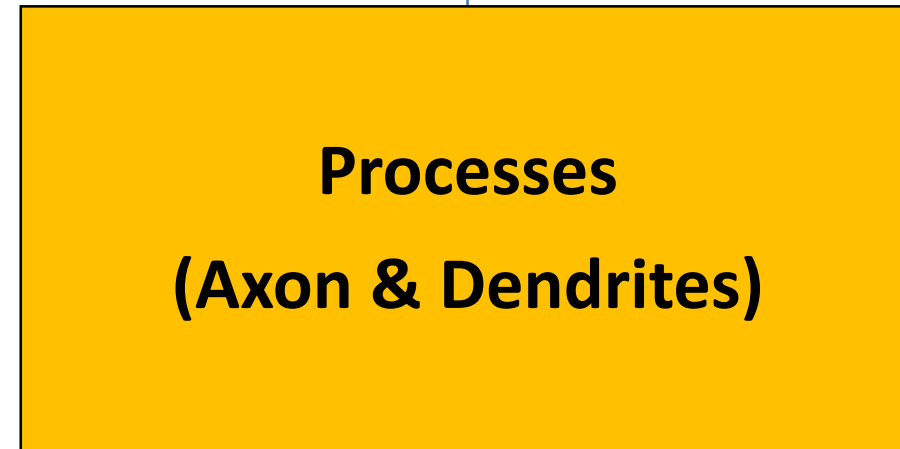
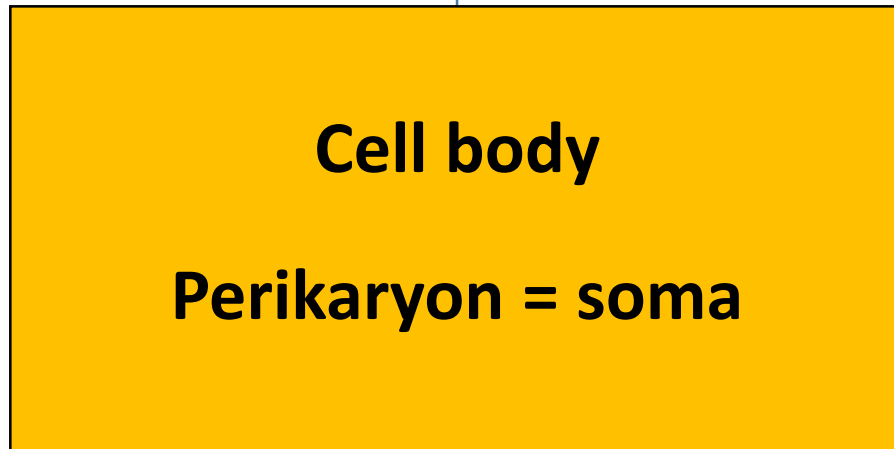
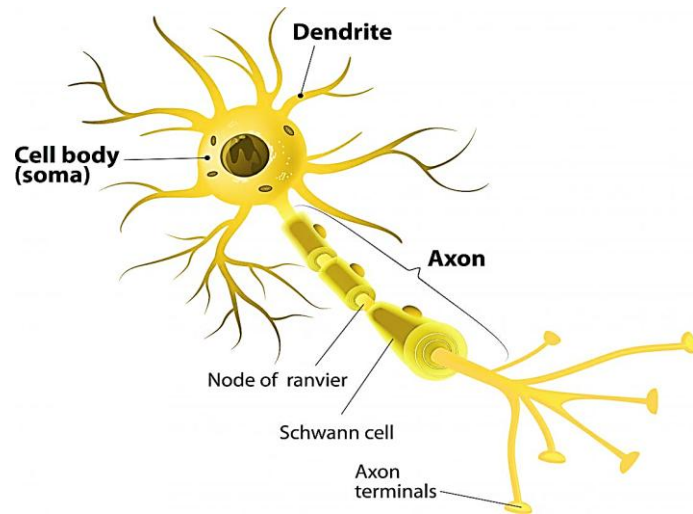


Neuron = nerve cell

- It is the structural & functional unit of the nervous tissue
- It is characterized by:
 - Excitability: they respond to environmental changes by generating action potential or nerve impulses
 - Conductivity: they are capable of propagating nerve impulses to other neurons, muscles & glands



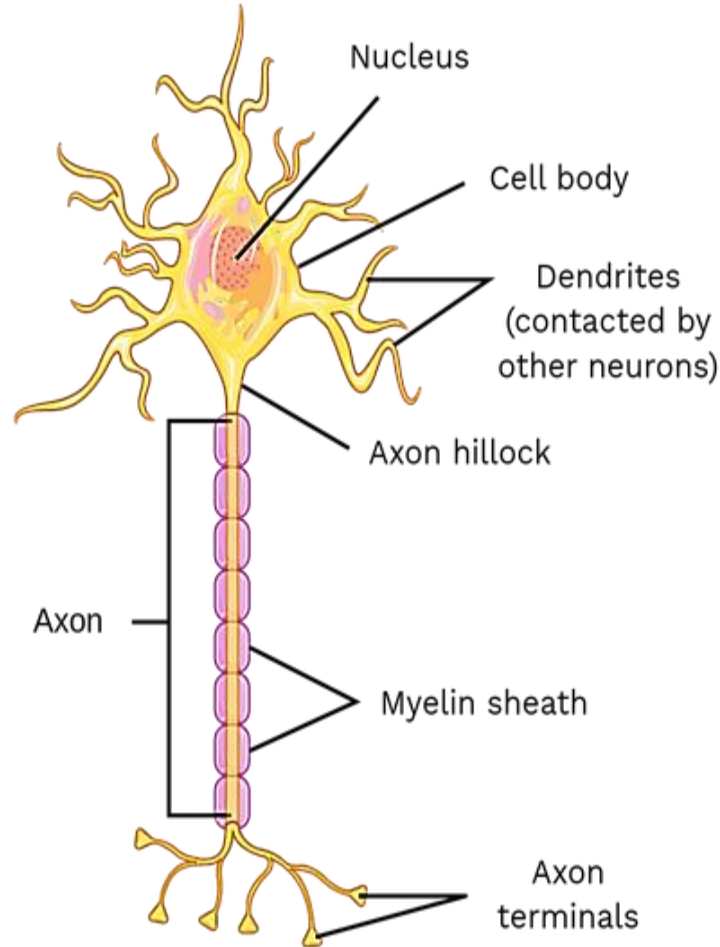
Histological structure of the neuron



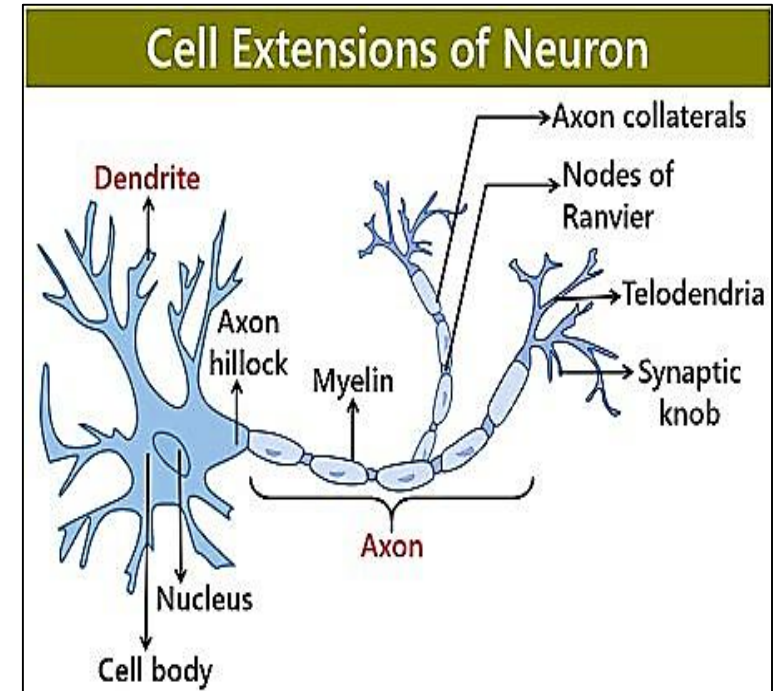
Structure of the neuron (nerve cell)

Nerve cell consists of the following main parts:

- Cell body (perikaryon)
- Dendrites
- Axon hillock
- Axon
- Axonal terminals
- Knobs
- Synapse



Professor Dr Hala Elmazar



1- cell body = soma = perikaryon

It is composed of

1- Nucleus: Euchromatic (active cell in protein synthesis
e.g. neurotransmitters)

2- Cytoplasm: contains

➤ **Nissel's bodies : basophilic granules (LM) / aggregates of ribosomes & rER (EM)** Its function is protein formation

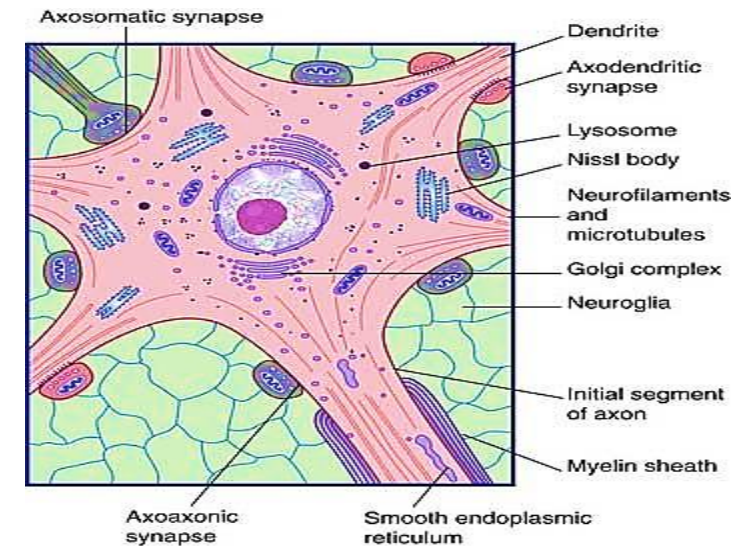
(Nissl bodies found in the cell body , **ABSCENT** in the region of **Axon hillock**)

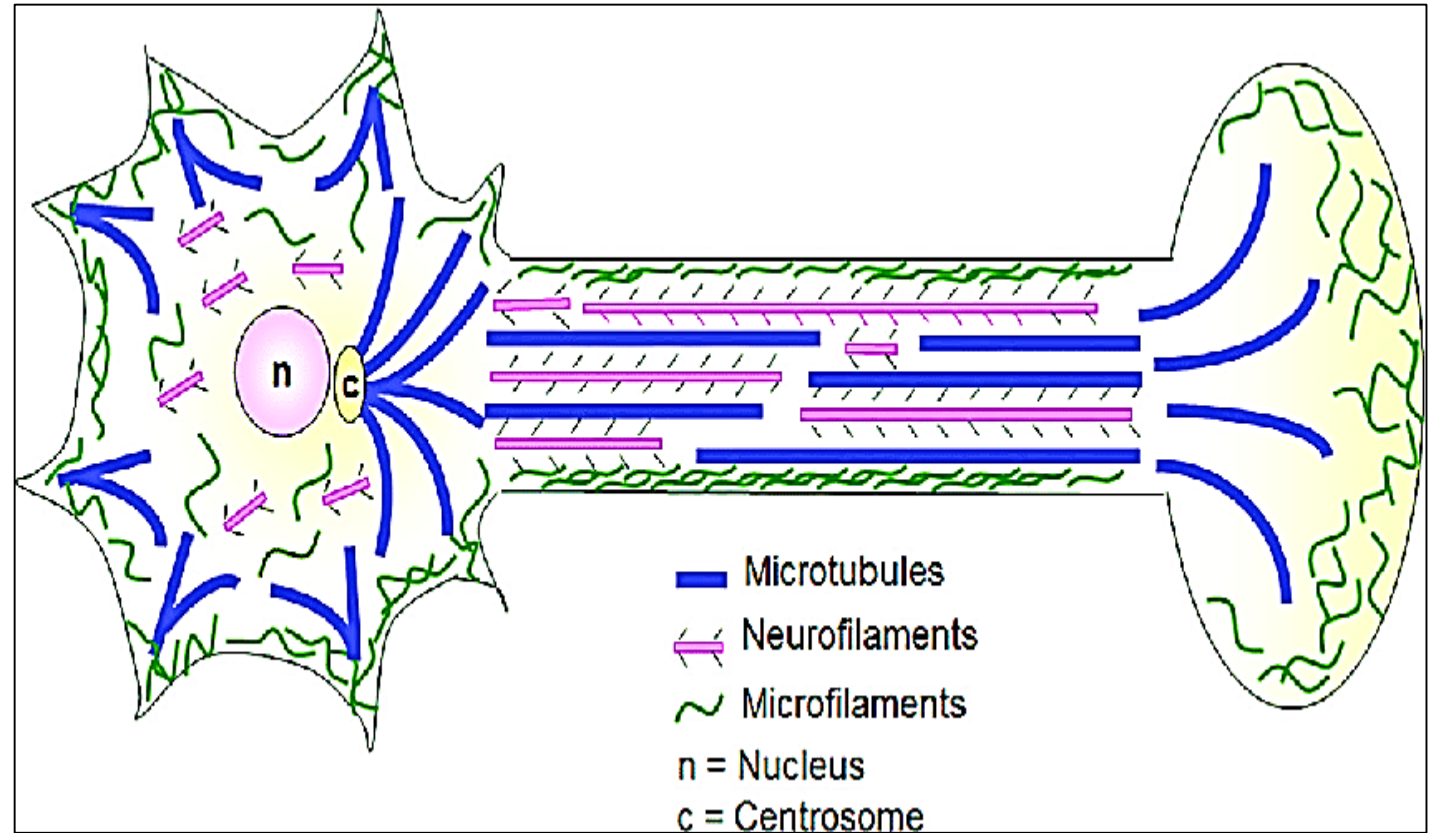
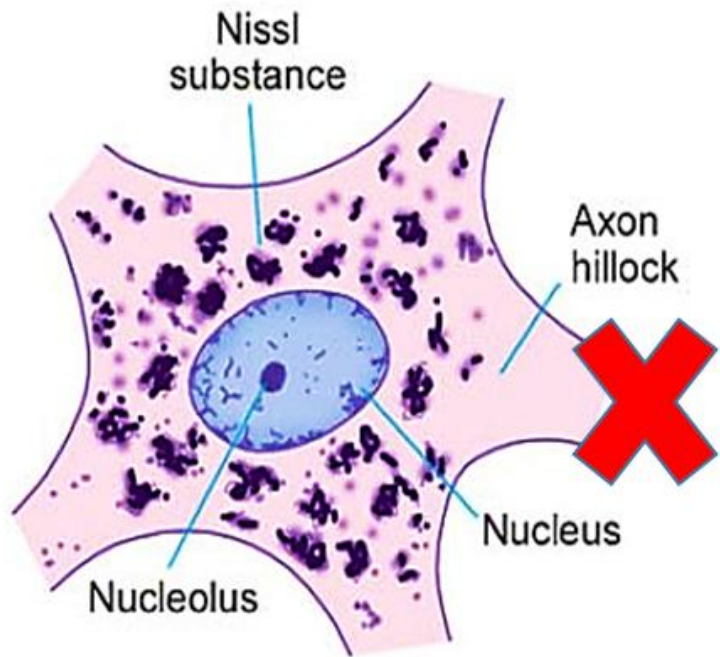
➤ **Large perinuclear Golgi apparatus** : for packing neurotransmitters into synaptic vesicles

➤ **Cytoskeleton** : formed of neurofibrils that include **neurofilaments & microtubules** which play role in support neuron & transmission of impulse

➤ **Mitochondria** : abundant for high energy requirement . **Lysosomes**

➤ **Inclusion** : lipofuscin granules & lipids





Neurofilaments & microtubules in neuron

Nissl's granules

When neuron is damaged Nissl bodies disappear =- Chromatolysis

2- the cell processes

There are 2 types of processes:

1- Axon

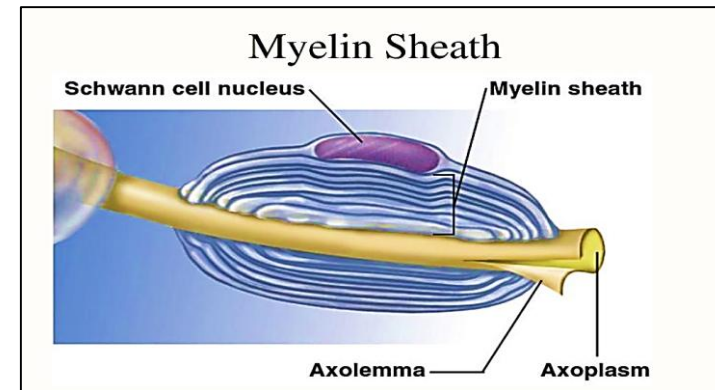
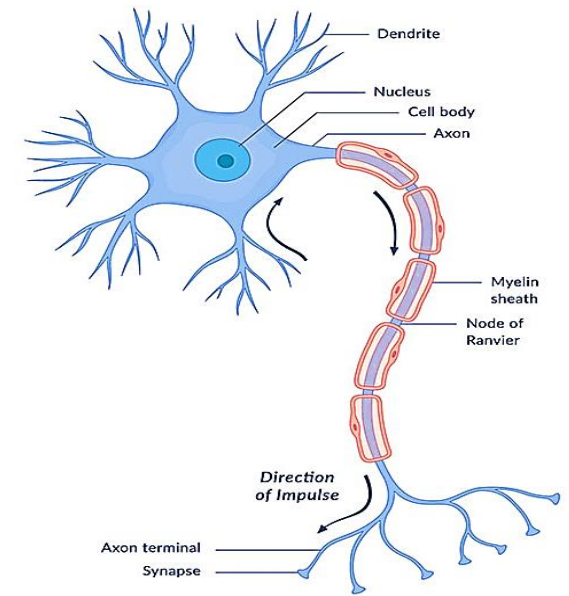
- Originate from the axon hillock
- Always single, Long cylindrical in shape
- Conducts **nerve impulses away from the cell body**
- No branching EXCEPT at axon termination.

It may give off collaterals arising at RT angles

- The axoplasm contains few organelles (neurofibrils, synaptic vesicles & mitochondria)
- **NO Nissl bodies**
- The axolemma may be surrounded myelin or not according to the type of nerve fiber

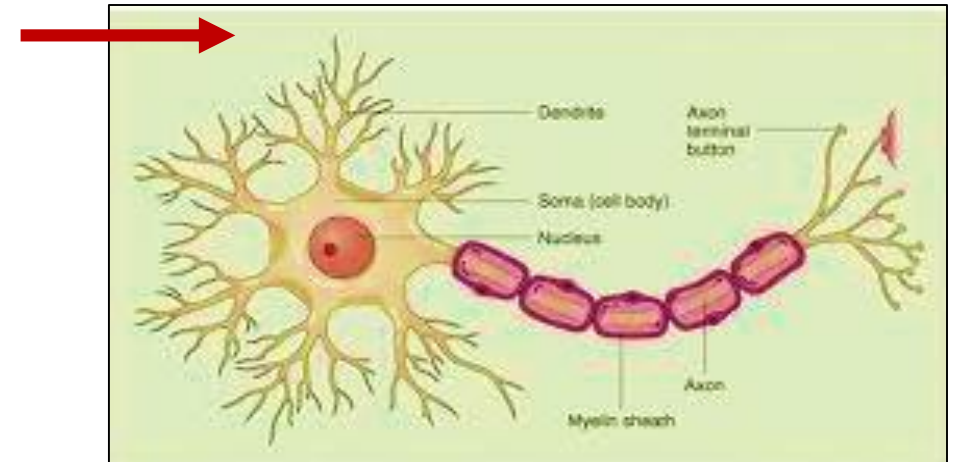
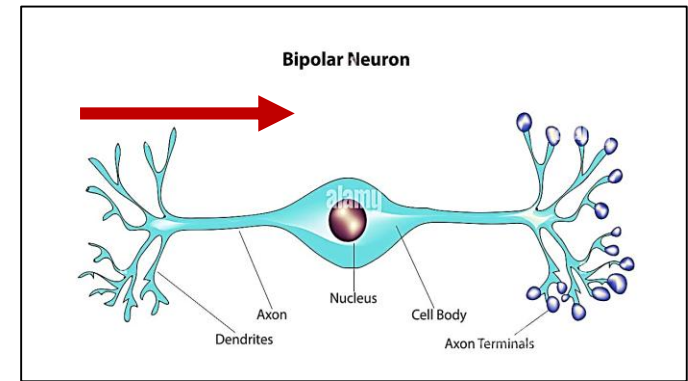
2- Dendrites

1- Axon



2- Dendrites

- Originate **from any part of the cell body**
- Usually multiple in (multipolar neuron).
- It may be single in (bipolar neuron)
- Conducts **nerve impulses towards the cell body**
- **Short thick** near its origin & thin towards its end
- Branching a lot to increase the surface area to receive nerve impulses
- Contains **most of the organelles (Nissl bodies found)** as in perikaryon **EXCEPT** Golgi apparatus
- **Not surrounded by any sheaths**



Axon

1-Single

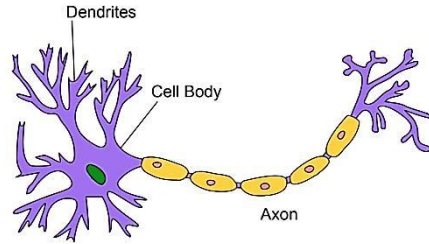
2-Thin & long

3-Uniform diameter along its length

4-Non-branched except at its ends

5-Contains neurofibrils but no Nissl bodies

6-Carries impulses from one neuron to another neuron or muscle



Dendrites

1-Multiple (single in bipolar)

2- Thick & short

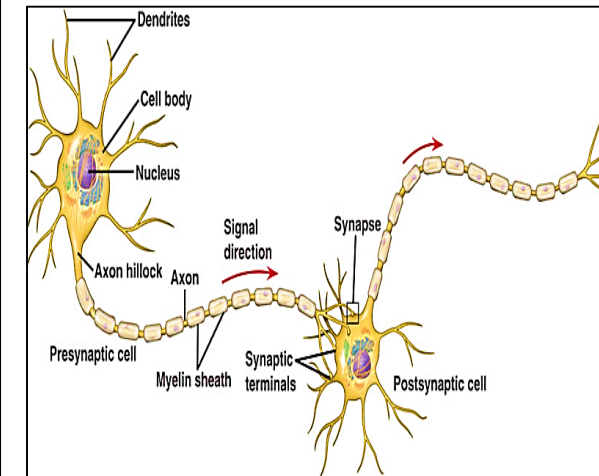
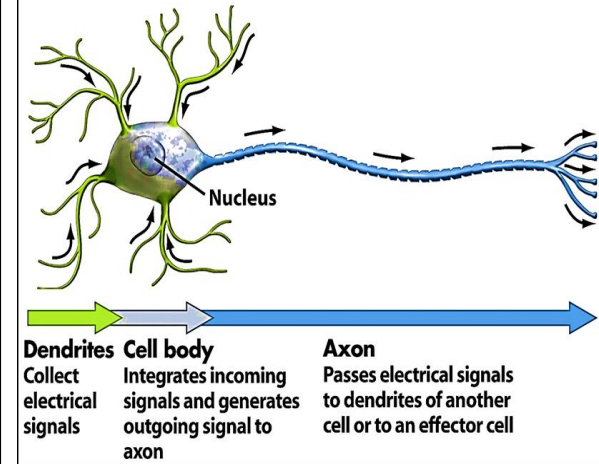
3-Their thickness decreases gradually towards ends

4-Give fine branches at its ends

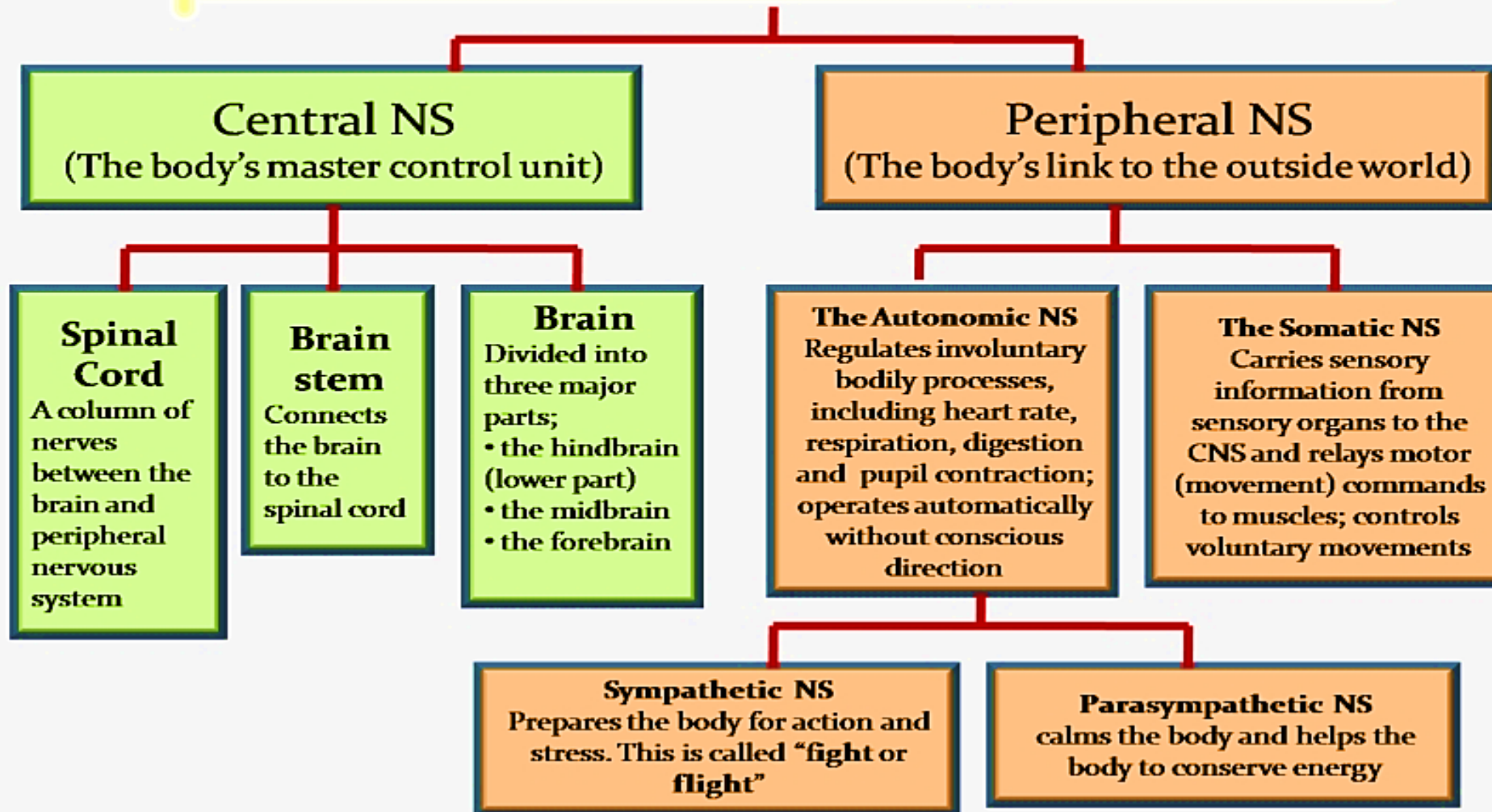
5-Contain neurofibrils and Nissl bodies

6-Receive impulses from another neuron

Information flow through neurons

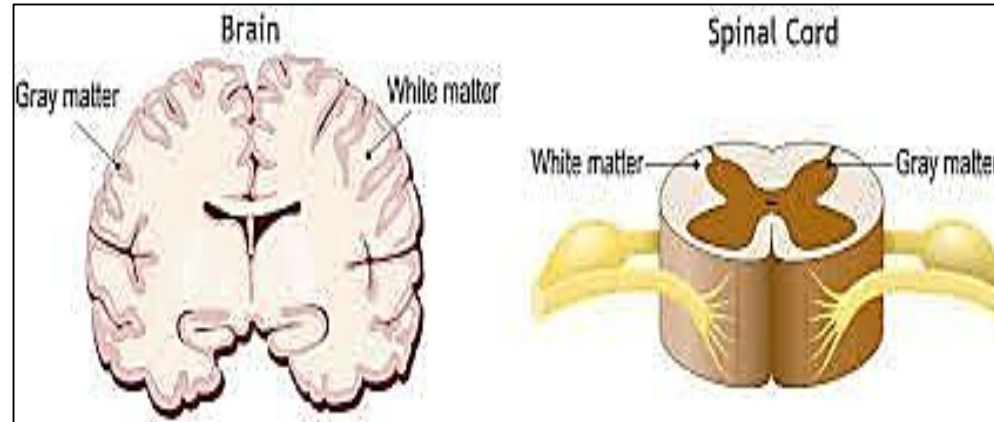


The Nervous System



The central nervous system (CNS):

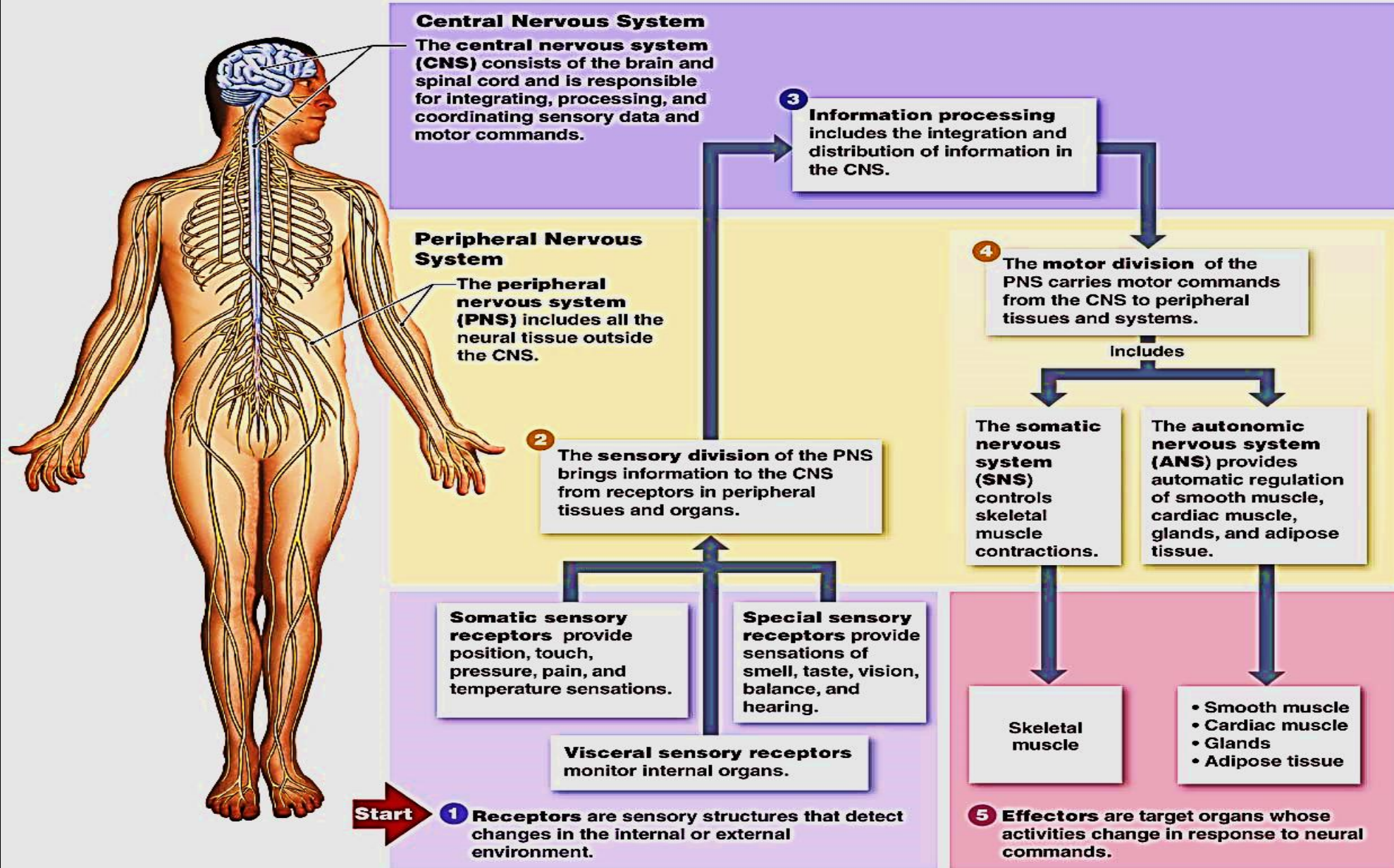
- Includes the [brain & spinal cord](#)
- The nerve cell bodies are present mainly in the [grey matter](#) while their axons are present in the [white matter](#)



The peripheral nervous system (PNS)

- Includes [nerve endings , peripheral nerves, ganglia](#)
- The nerve cell bodies are present mainly in the [ganglia](#) while the axons form the [peripheral nerves](#)

The major components and functions of the nervous system



The peripheral nervous system

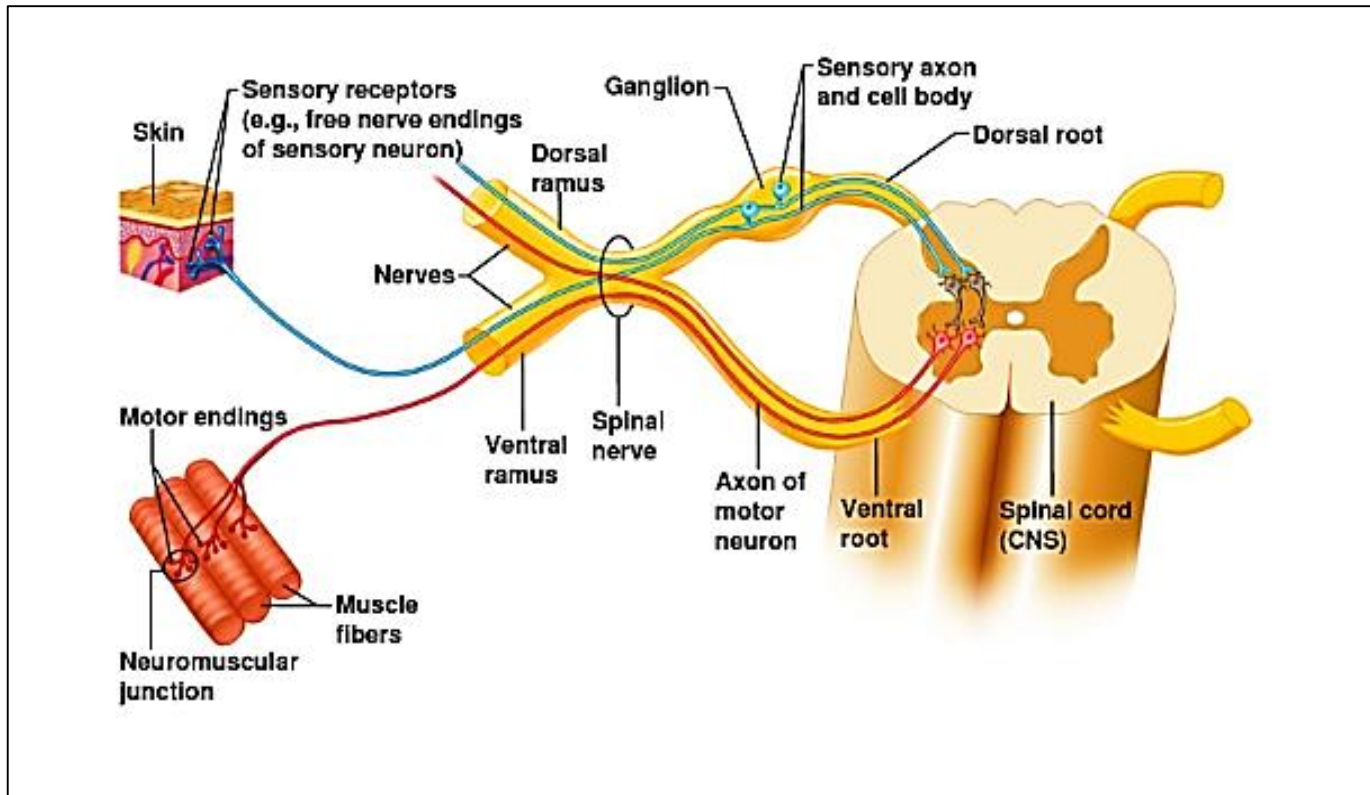
- Carries information **To & FROM** CNS
- It includes the following

Sensory receptors

Motor endings

Peripheral nerves

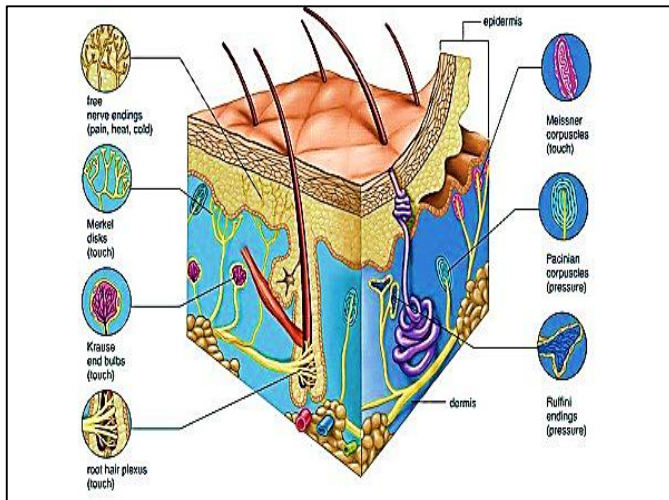
Ganglia



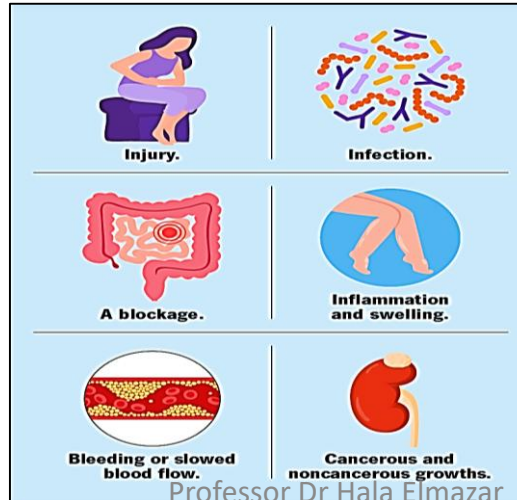
Sensory receptors

Somatic receptors

Pain , touch , temperature,
position of body

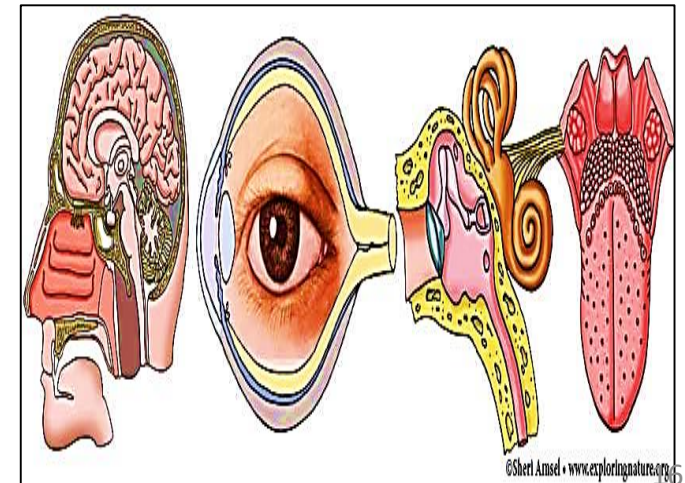


Visceral receptors of internal organs



Special sensory receptors

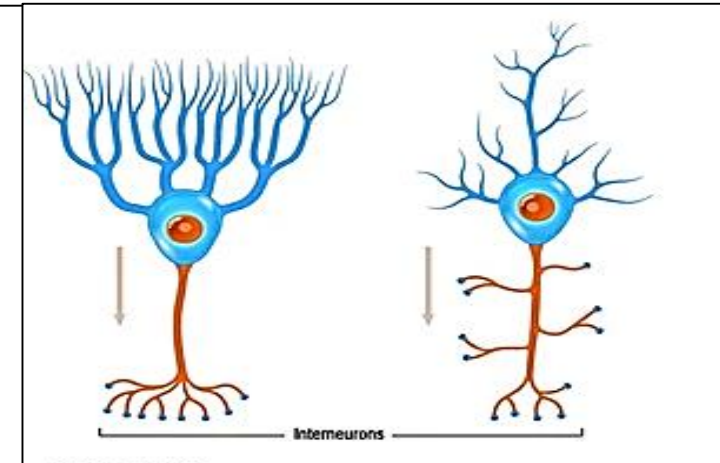
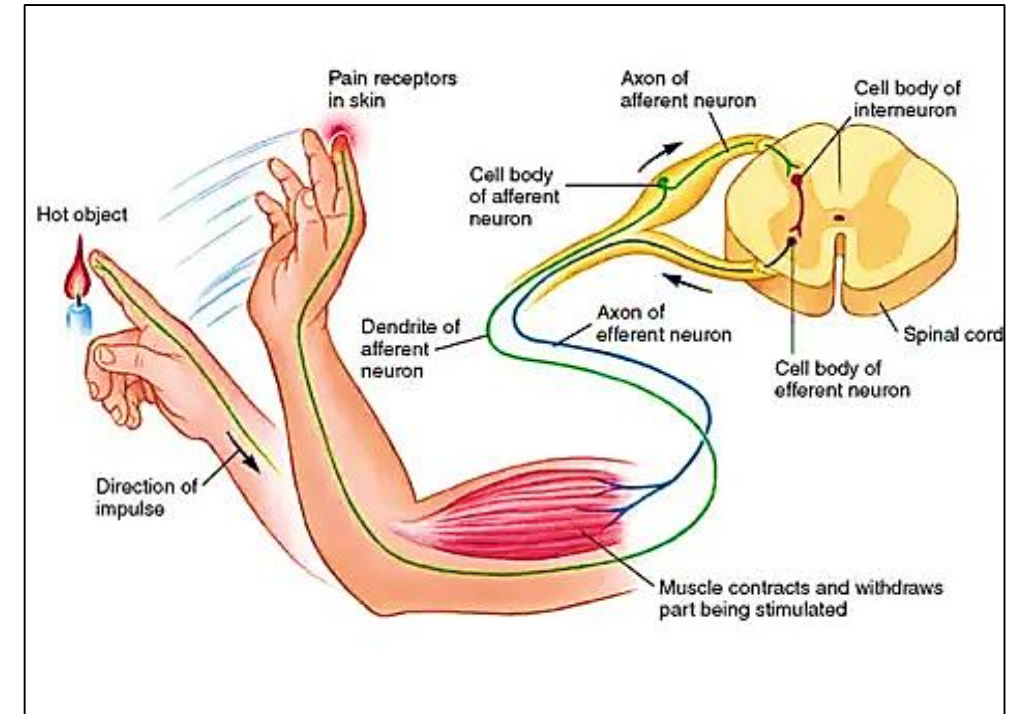
Vision, hearing , smell , taste



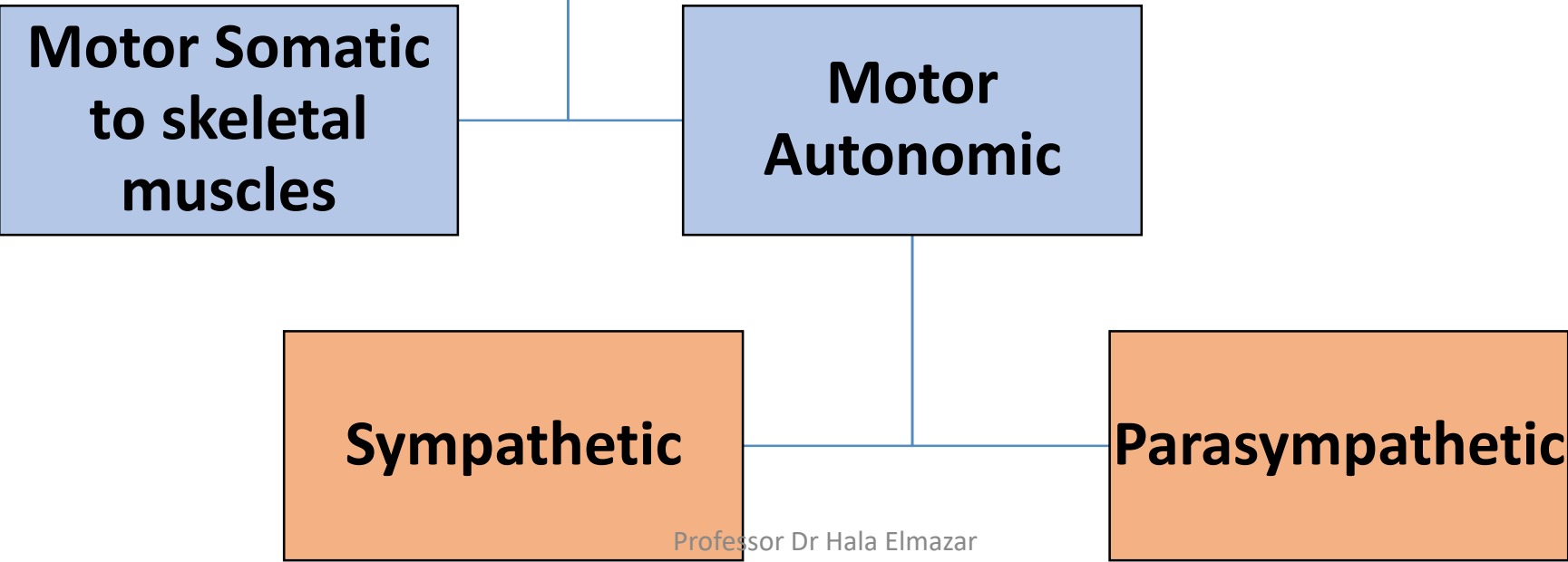
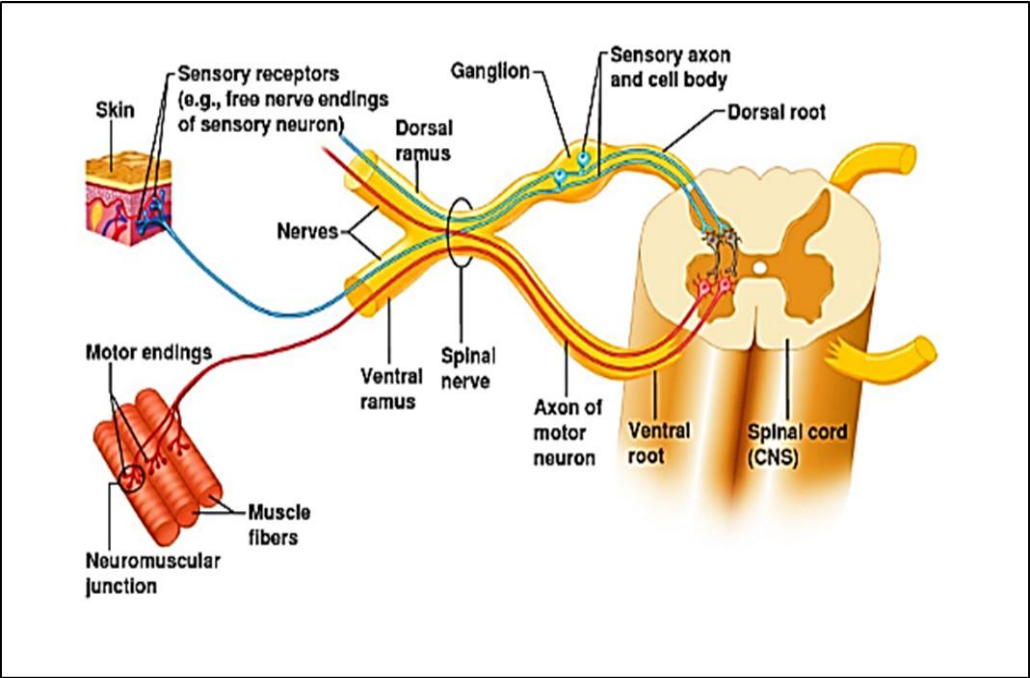
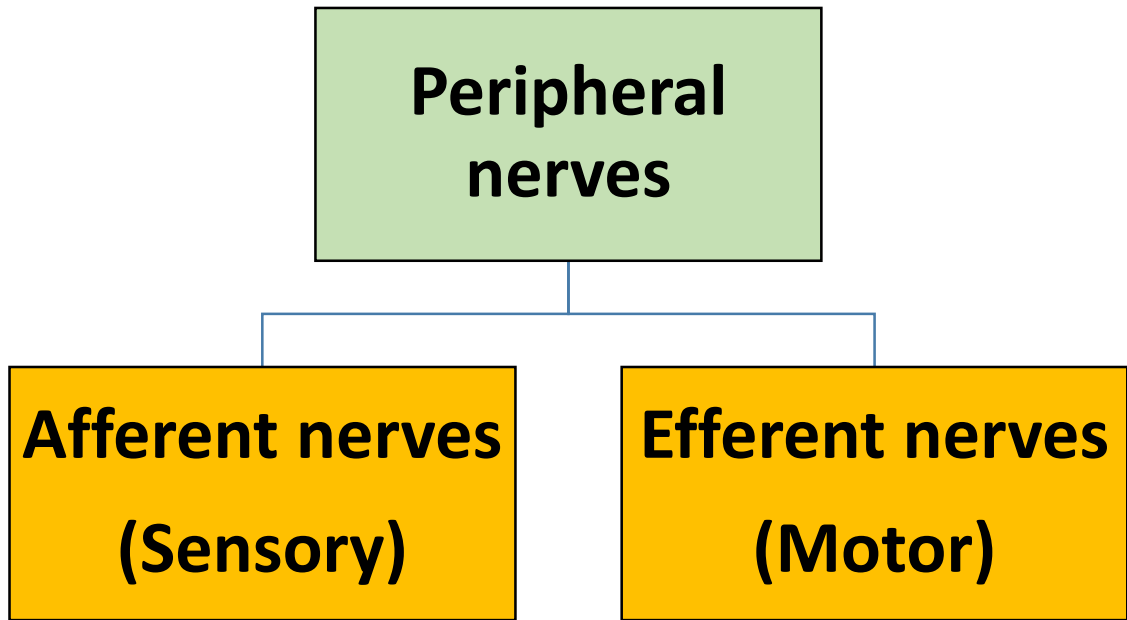
Classification of neurons/ Functional

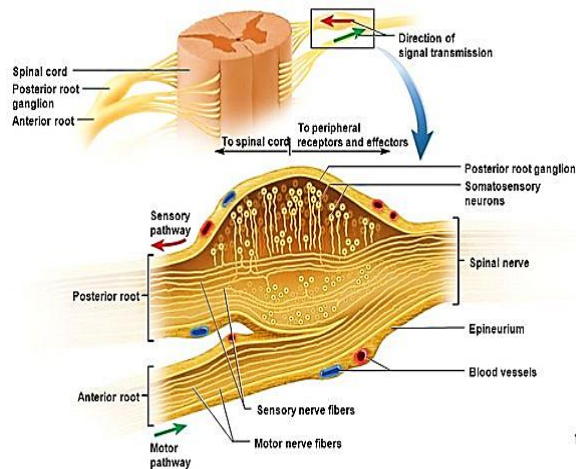
Based on the direction of **conduction of impulses**

- **Afferent (Sensory) neuron**: conduct impulses (stimuli) toward **CNS**
- **Interneuron (association neurons)**: lie entirely in the CNS. Interposed between sensory and motor neurons, perform integrative function
- **Efferent (Motor) neuron**: they transmit the appropriate response from the CNS to an **end organ (muscle & glands)** to carry out the body's response to stimuli



Interneuron





Ganglia

**Sensory ganglia
always with
sensory nerves**

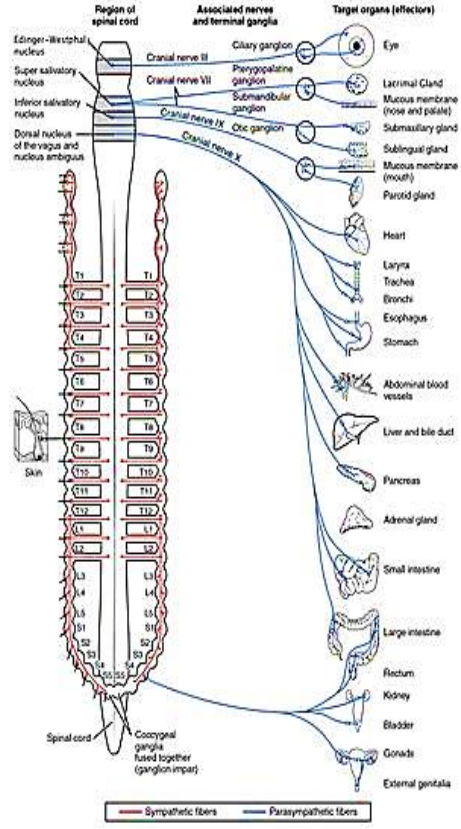
**Motor ganglia
always with motor
autonomic**

**Cranial ganglia
(cranial nerves)**

**Spinal Ganglia
(spinal Nerves)**

**Sympathetic
ganglia
Thoraco- lumbar**

**Parasympathetic
ganglia
Cranio –sacral**



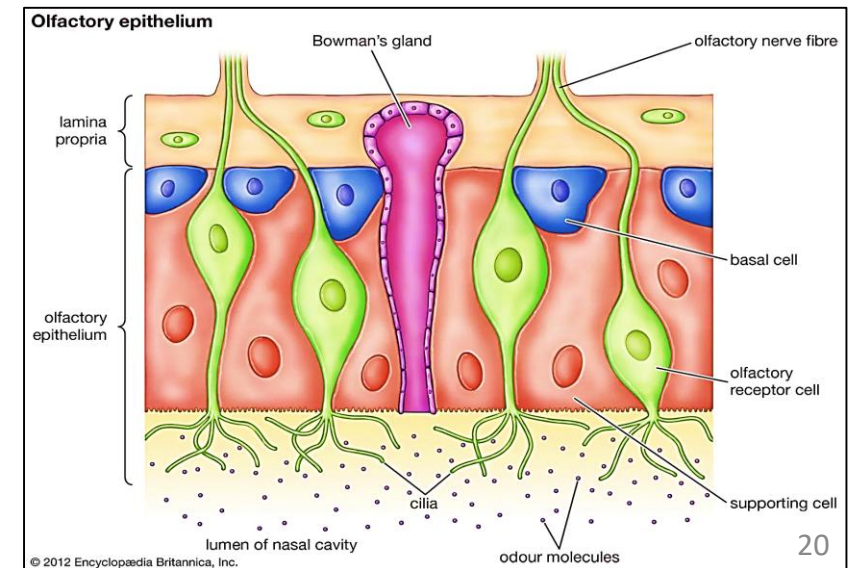
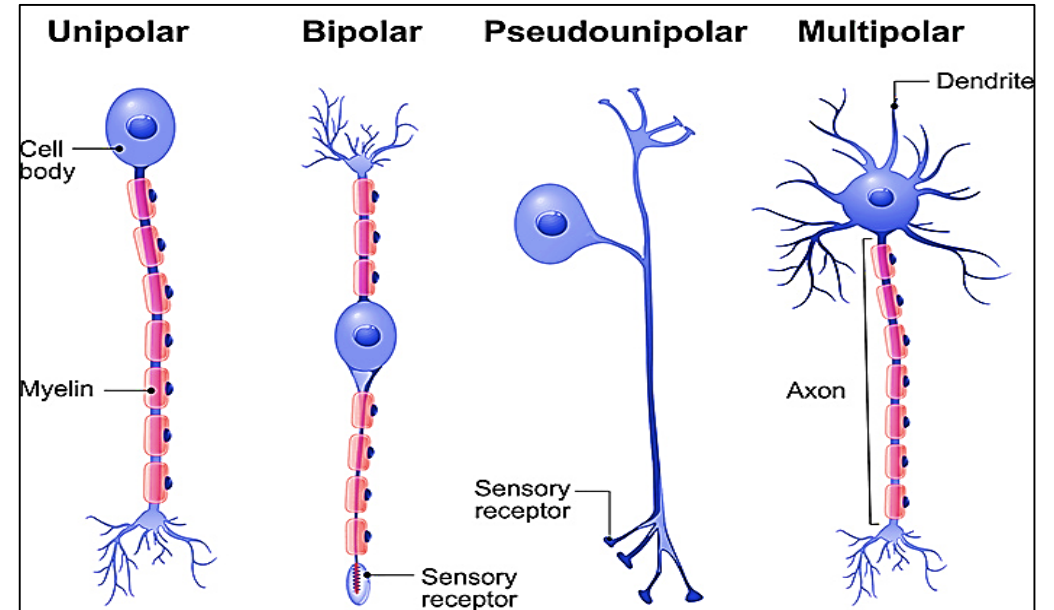
Classification of PNS neurons/ morphology

Neurons are classified according to number of their process into:

1- Unipolar: have only one cell process, found only in embryonic stage

2- Pseudounipolar: have single process that divides like T- letter into 2 branches (one acts like axon the other acts like dendrites) e.g. cranio- spinal ganglia

3- Bipolar: have 2 processes one is an axon the other is dendrites e.g. olfactory epithelium (smell sensation)



4- Multipolar : cell body have multiple dendrites,

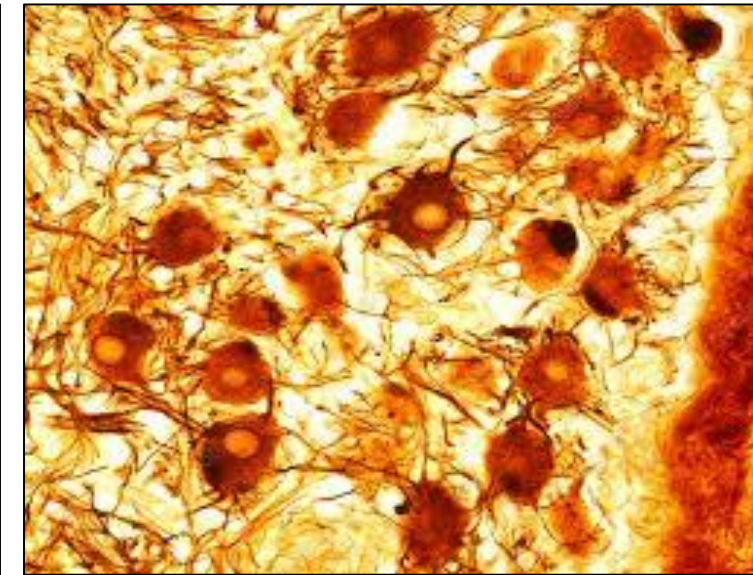
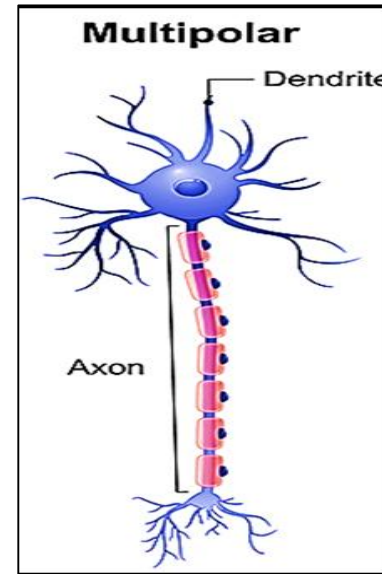
Multipolar is further subdivided up to the shape the perikaryon into:

A- Stellate neuron : autonomic ganglia
(Star shape)

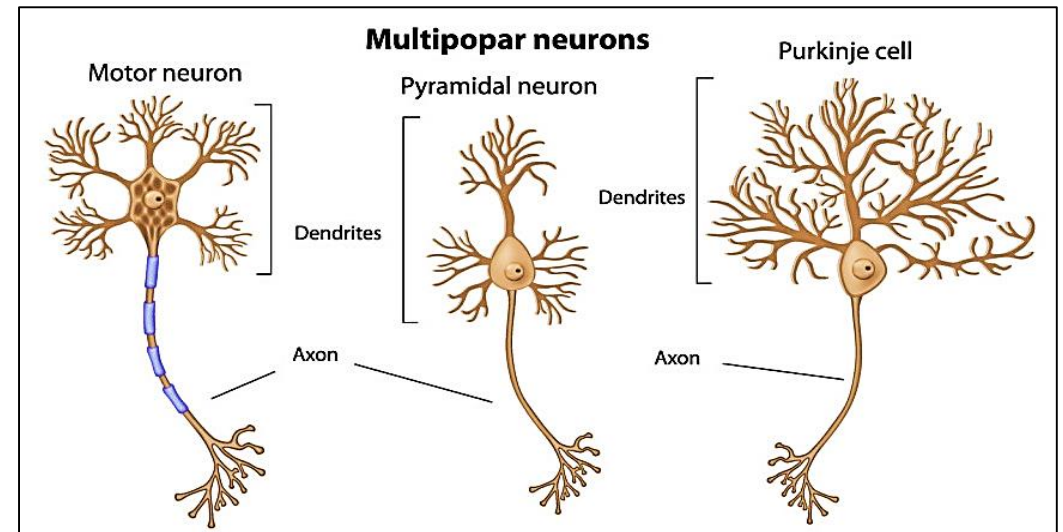
B- Pyramidal neuron : cerebral cortex

C- Pyriform neuron: cerebellum (Purkinje cells) & the retina (ganglion cells)

D- Granular neuron : found in the cerebellum the granular layer of the



Autonomic ganglia

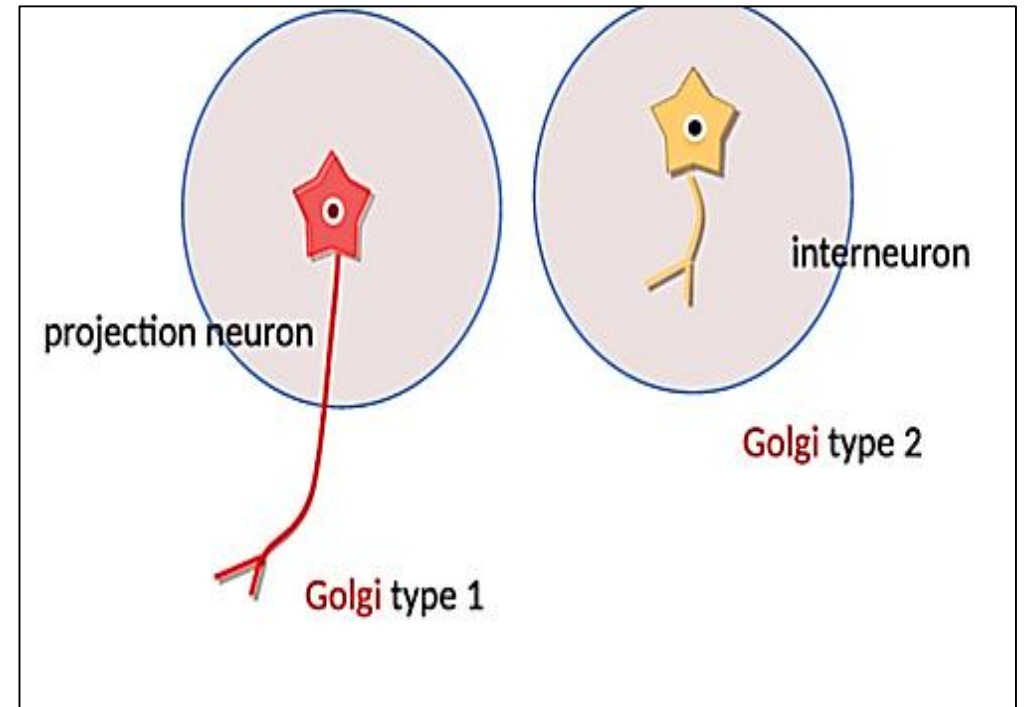


Neurons are classified according to length of their axons into:

- 1- Golgi I (long axon)
- 2- Golgi II (short axon)

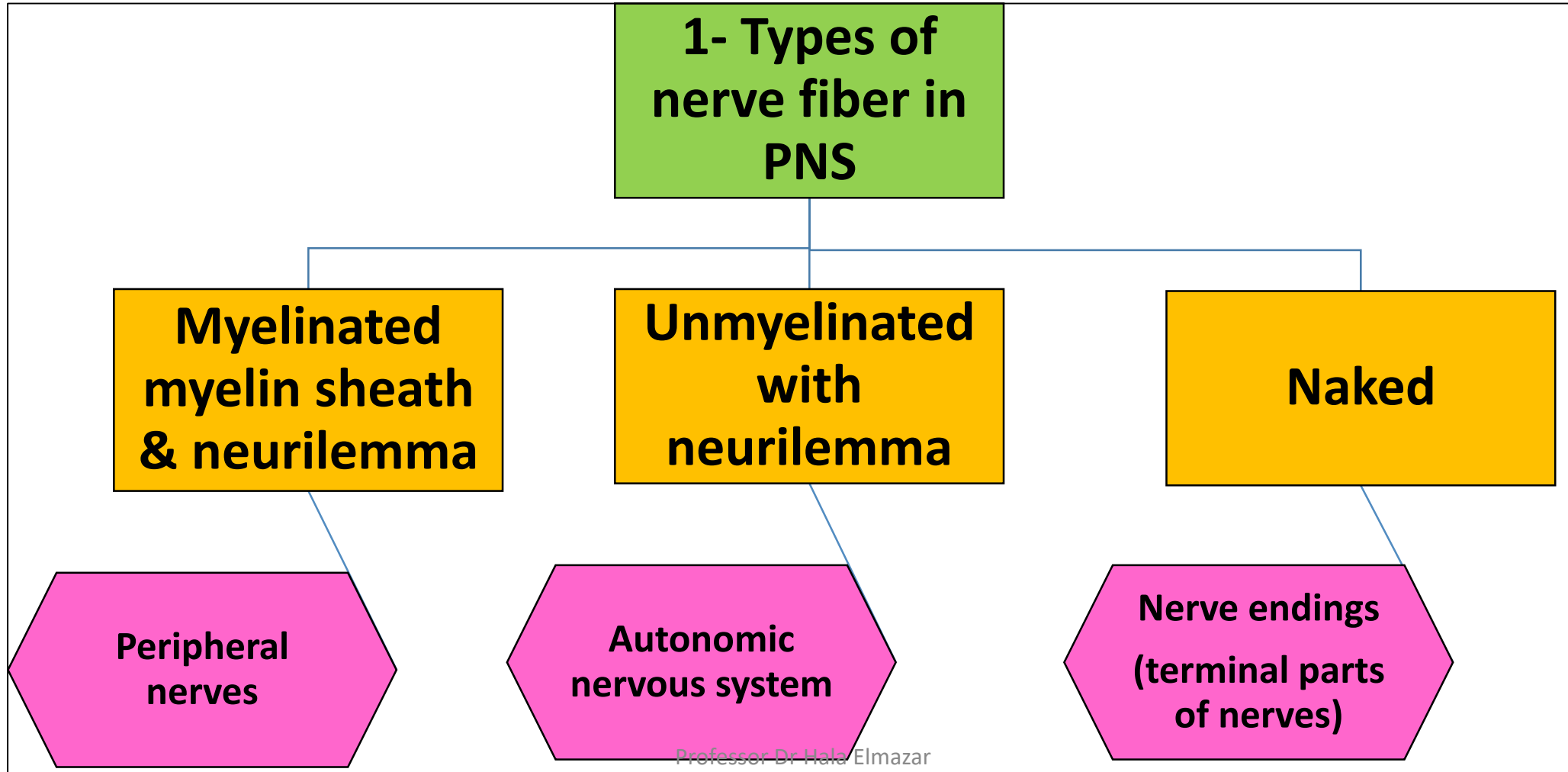
Golgi type I neurons have long axons transmit impulses over long distance .e.g. motor neuron & pyramidal neurons

Golgi type II neuron have short axons confined to local area e.g. interneuron & granular neuron

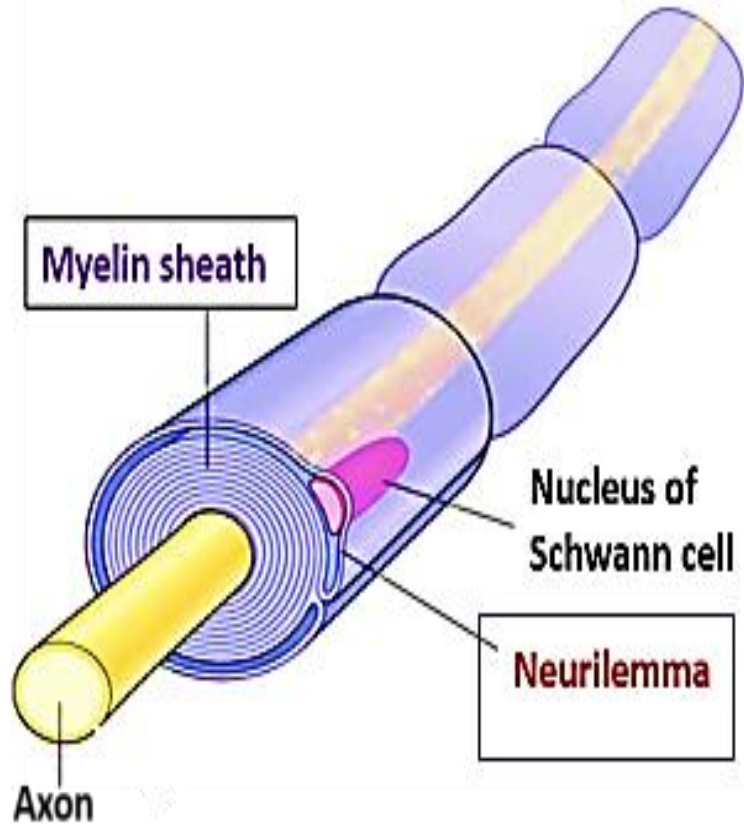


Nerve Fiber

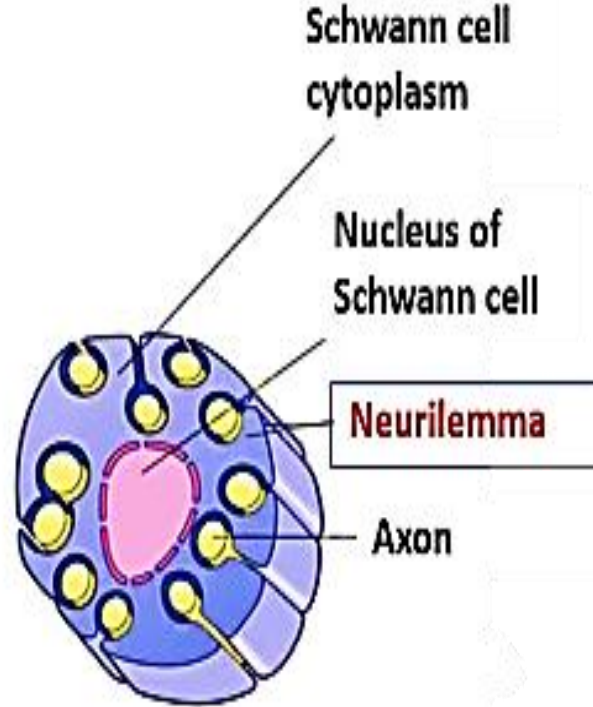
- It is the **axon** enveloped by a special sheath
- Depends on whether the nerve fiber is located in the CNS or PNS



Myelinated Nerve Fiber



Unmyelinated Nerve Fibers



Naked

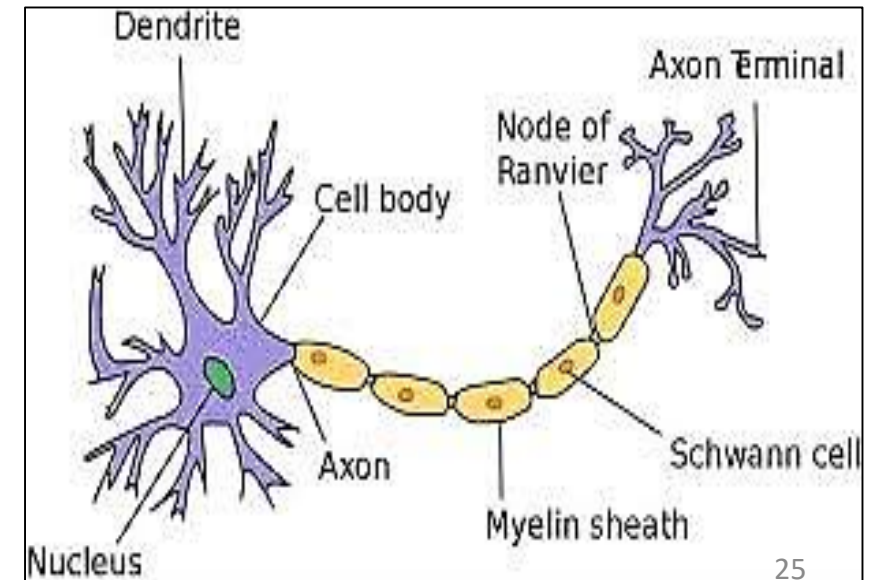
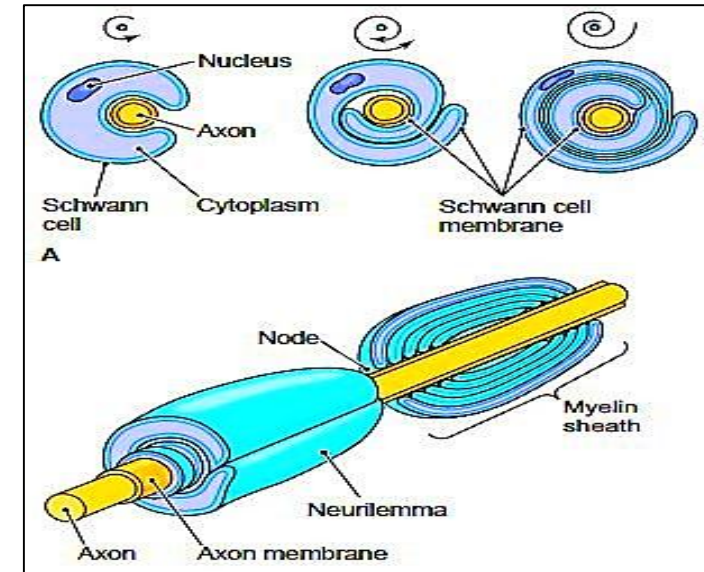


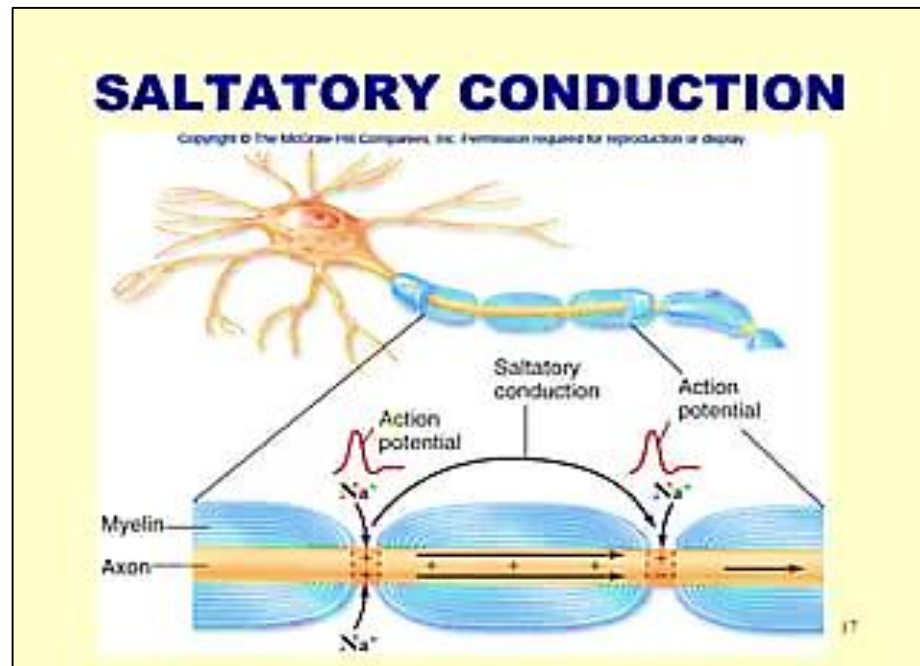
Myelinated nerve fibers in PNS

They are large axons enveloped by myelin sheath & neurilemmal sheath

A- Myelin sheath

- **Lipid** rich coat covers the axon
- Is formed by **Schwann cell** which wraps itself around the axon
- Is interrupted at equal intervals by areas called **nodes of Ranvier**
- The segment between two nodes is called **the intermodal segment** & is occupied by single Schwann cell
- **Function:** insulation, protection and fast conduction of nerve impulse
- Dendrites **are not** myelinated





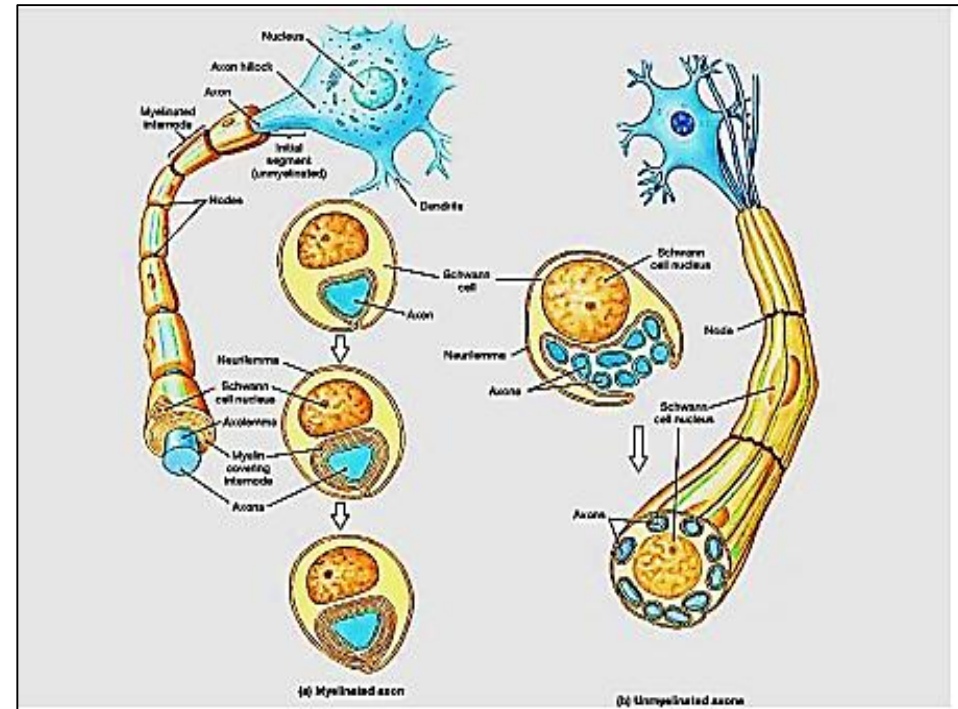
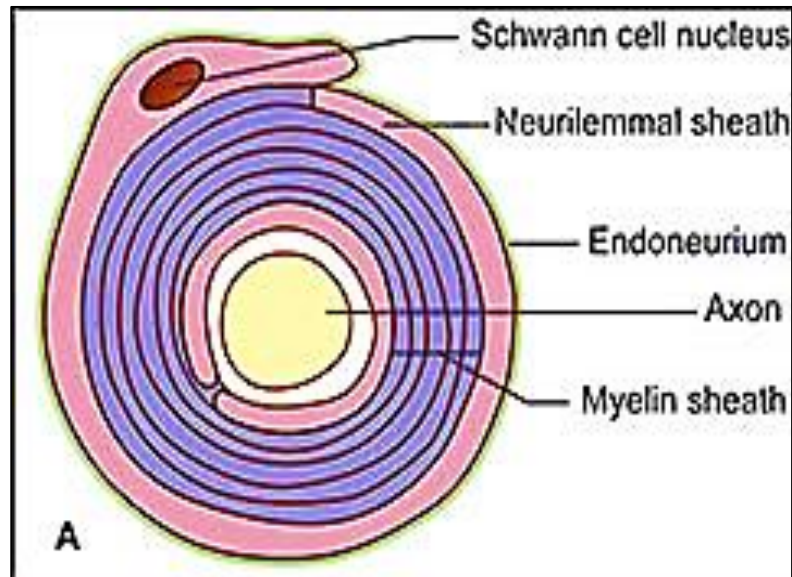
Node of Ranvier (NOR) increases **conduction velocity of the action potential** (= rate of transmission of impulse).

action potentials "jump" between Nodes of Ranvier → Saltatory conduction

The depolarization cannot occur at the cells making up the myelin sheath, the wave of depolarization can only occur at the Nodes of Ranvier. Thus, action potentials appear to jump from node to node when travelling down an axon

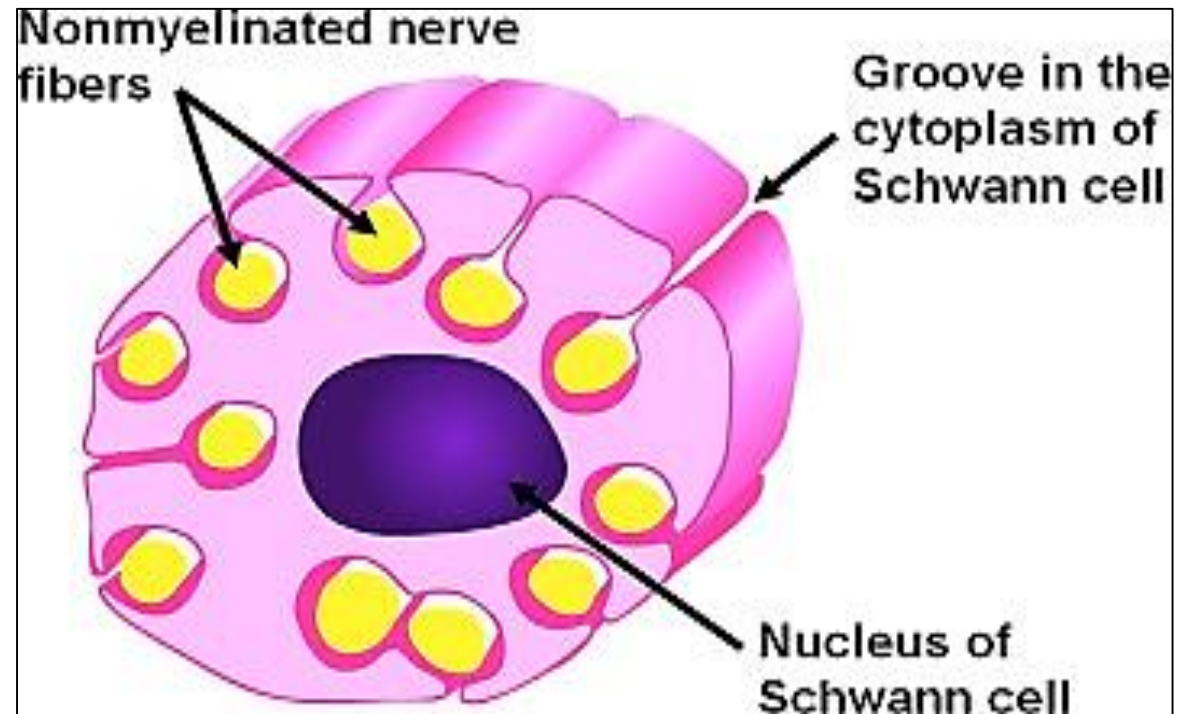
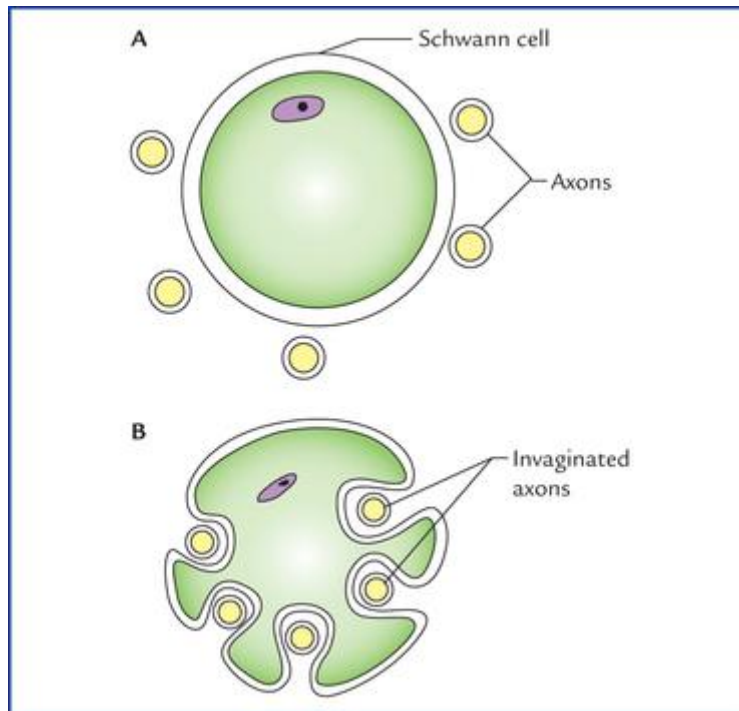
B- Schwann cell sheath (neurilemmal sheath)

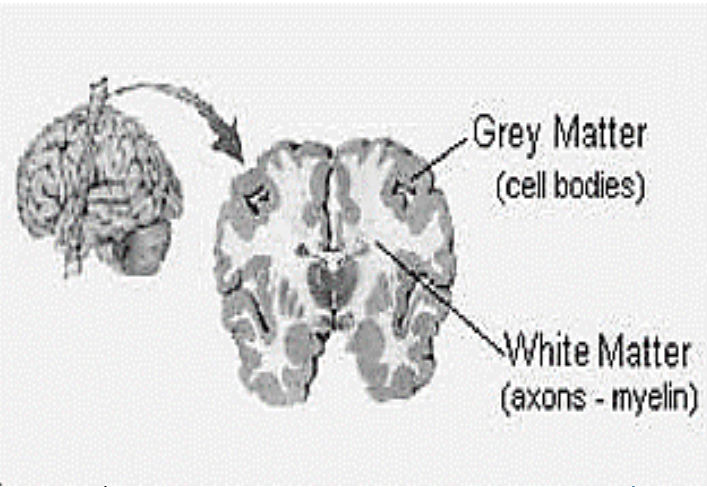
- Formed by cell membrane of Schwann cells and after forming the myelin sheath
- **Neurilemma** has supportive function for peripheral nerve fibers & imp. for nerve regeneration (damaged nerve fiber may regenerate if the cell body of Schwann cell is not damaged)



Unmyelinated nerve fibers in PNS

- Axons are usually small in diameter & enveloped by Schwann cell sheath only (neurilemma)
- Single Schwann cell envelops multiple segments of different axons





2- Types of nerve fiber in CNS

**Myelinated
without
neurilemma**

White matter

Naked

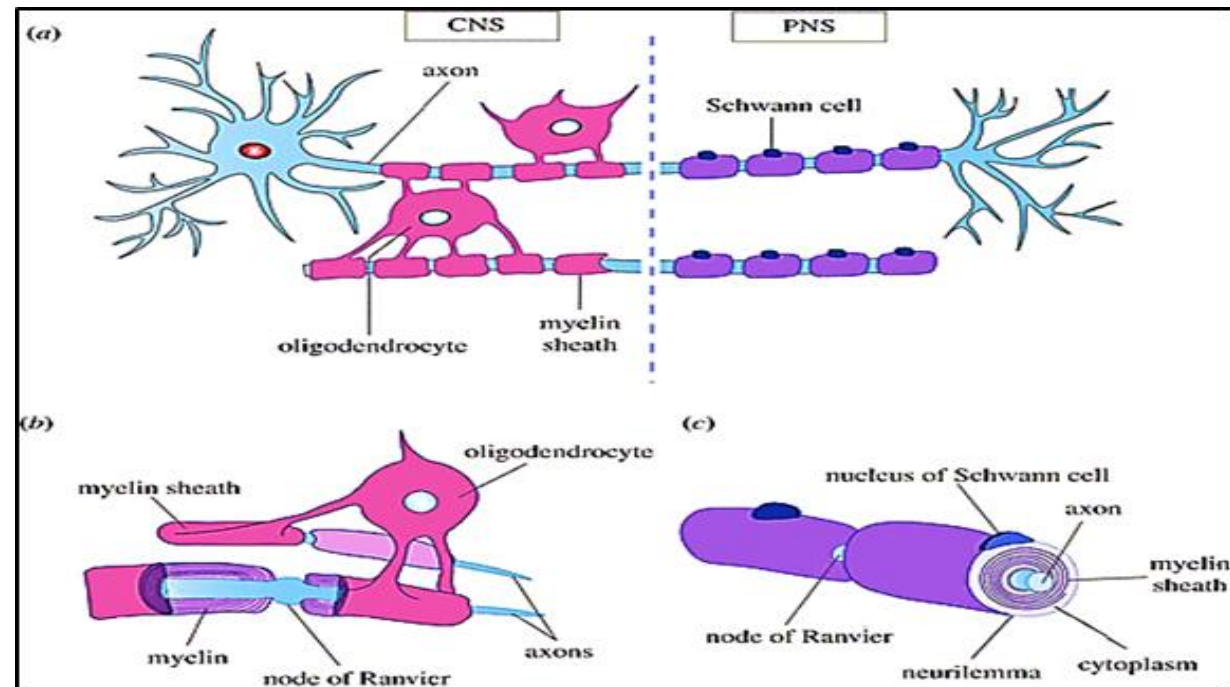
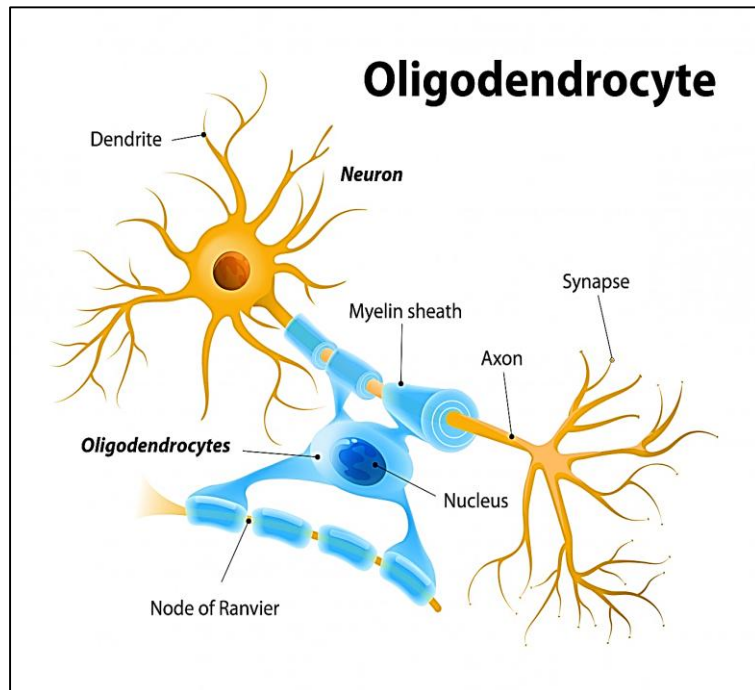
Grey matter

Q: Myelin of CNS is formed by _____?

A: Oligodendrocytes

The myelin sheath of axons in CNS **don't have neurilemma** because oligodendrocytes extend processes to multiple axons & myelinated them and any excess cytoplasm is directed centrally toward the oligodendrocyte cell body. **The cell body locate at distance from axon it myelinates**

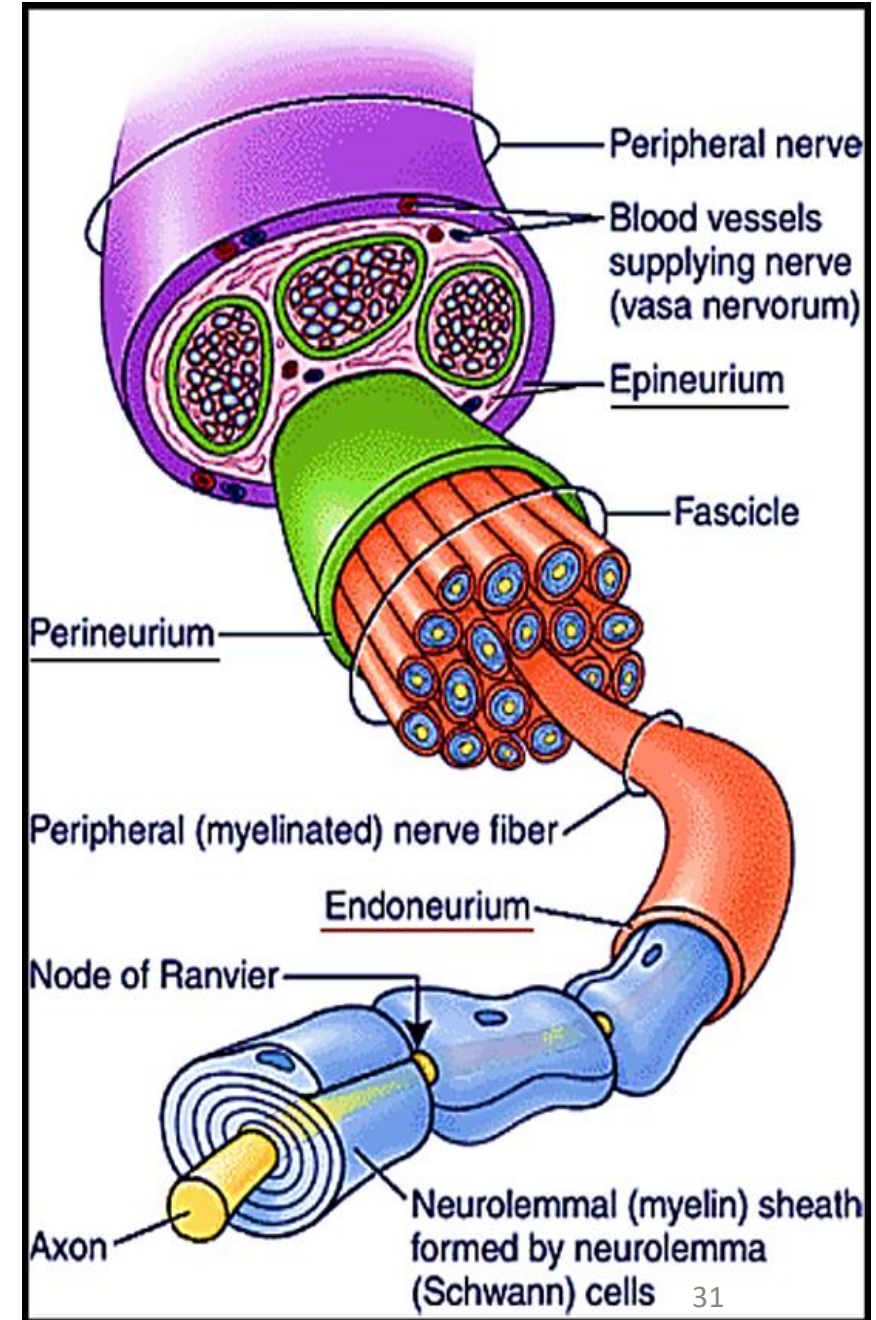
(Nuerilemma is a Key difference between PNS & CNS in regeneration ability)



Nerve trunk

- Example : median, sciatic, ulnar ...etc.
- Nerve trunk consists of group of nerve fibers (Axons) surrounded by connective tissue sheath
- Peripheral nerves are protected e **3 layers** of CT which support, protect & carry blood BV and nerves

- Epineurium
- Perineurium
- Endoneurium



Epineurium:

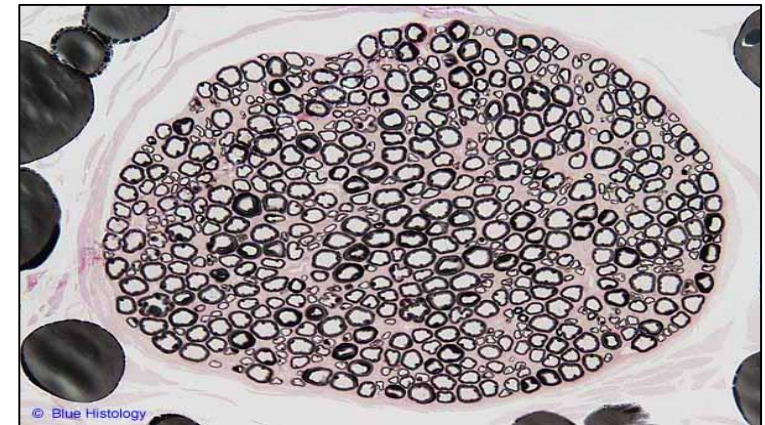
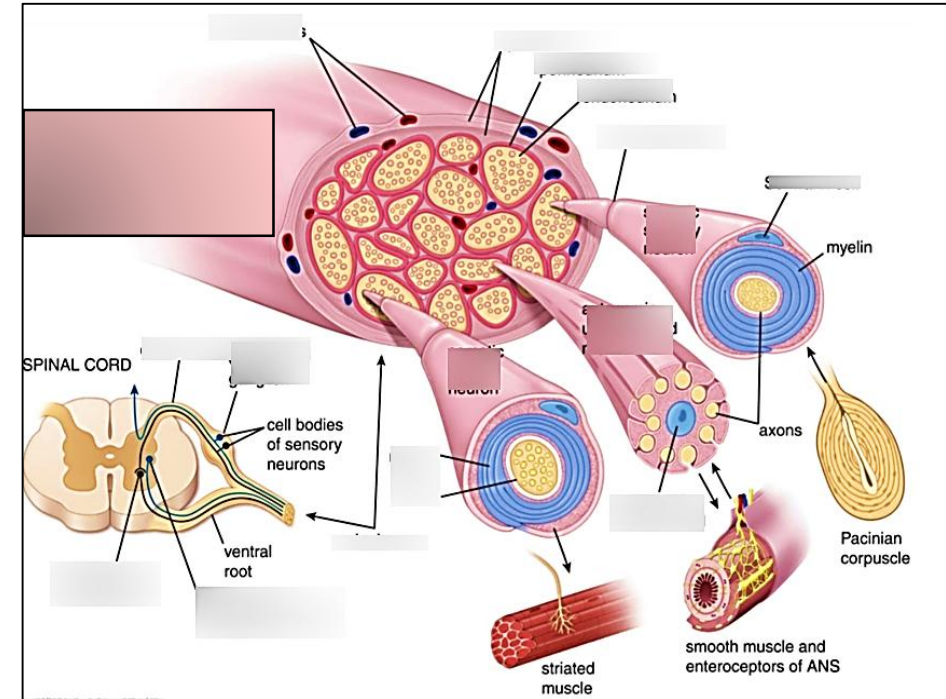
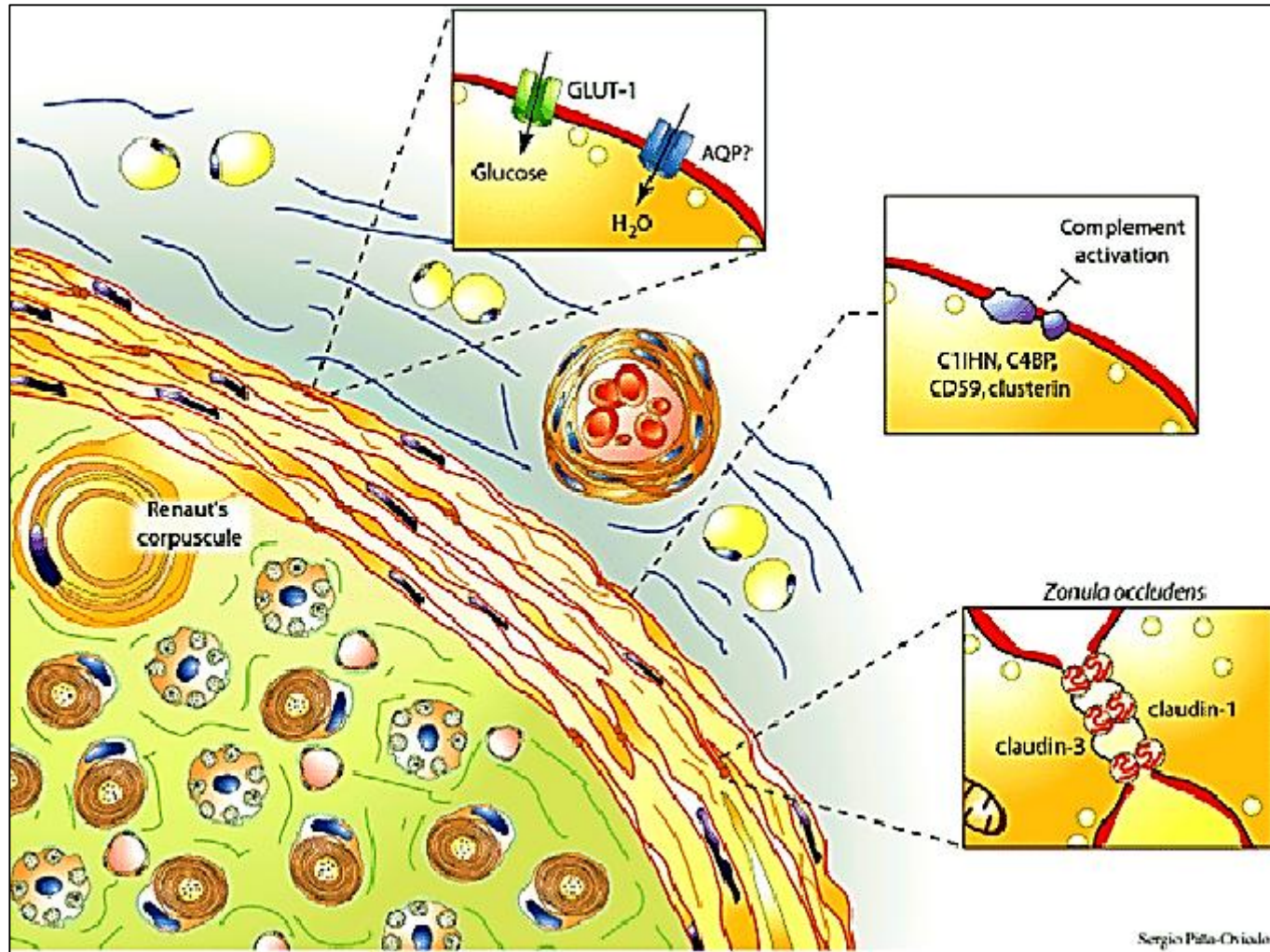
- Dense CT the outermost covers of the nerve trunk
- Consists of longitudinally arranged collagen fibers
- Fat cells are seen enclosed to act as shock absorber

Perineurium:

- Surround each bundle (fascicle) of nerve fibers
- Formed of fibroblasts joined together by tight junctions and surrounded by external lamina
- This layer forms the BLOOD NERVE BARRIER that prevent the passage of harmful molecules to the nerve fibers

Endoneurium:

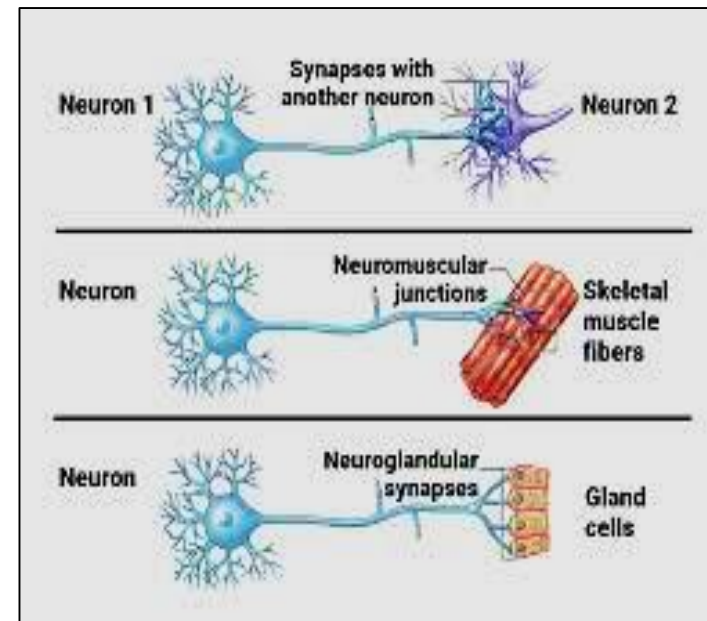
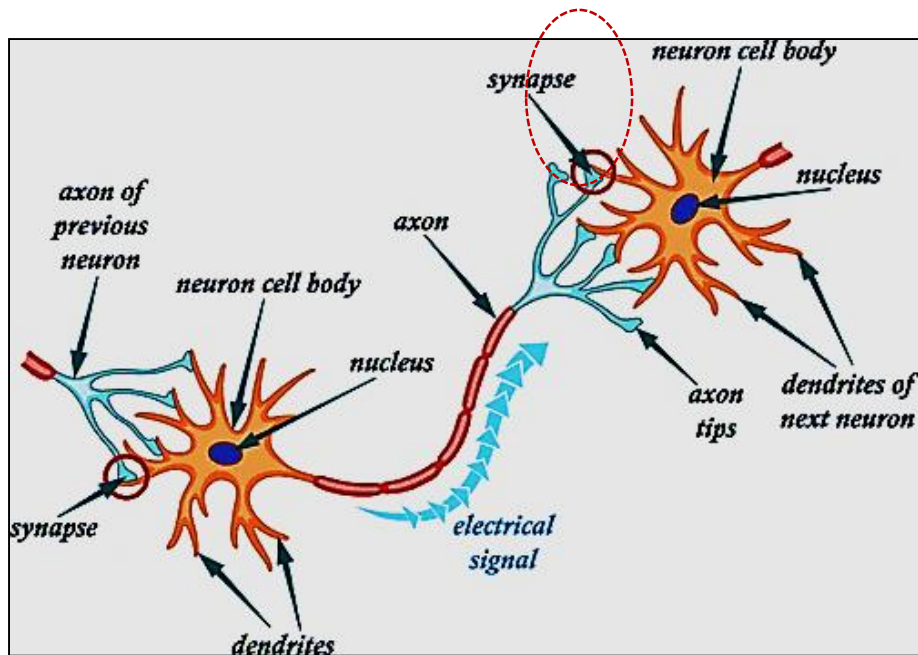
- Thin reticular fibers surround each nerve fiber



- **The perineurium forms the Blood – Nerve Barrier**
- **The majority of nerve trunks are mixed i.e contain myelinated and unmyelinated nerve fibers**
- **Osmium tetroxide stains myelinated fibers (lipids) with black**

Synapse

- Sites of **connection** between neurons or between neurons & target effector cell e.g. muscle cell or gland cell. Allow the transmission of electrical or chemical signals
- At Synapse **unidirectional transmission of nerve impulses** occurs.



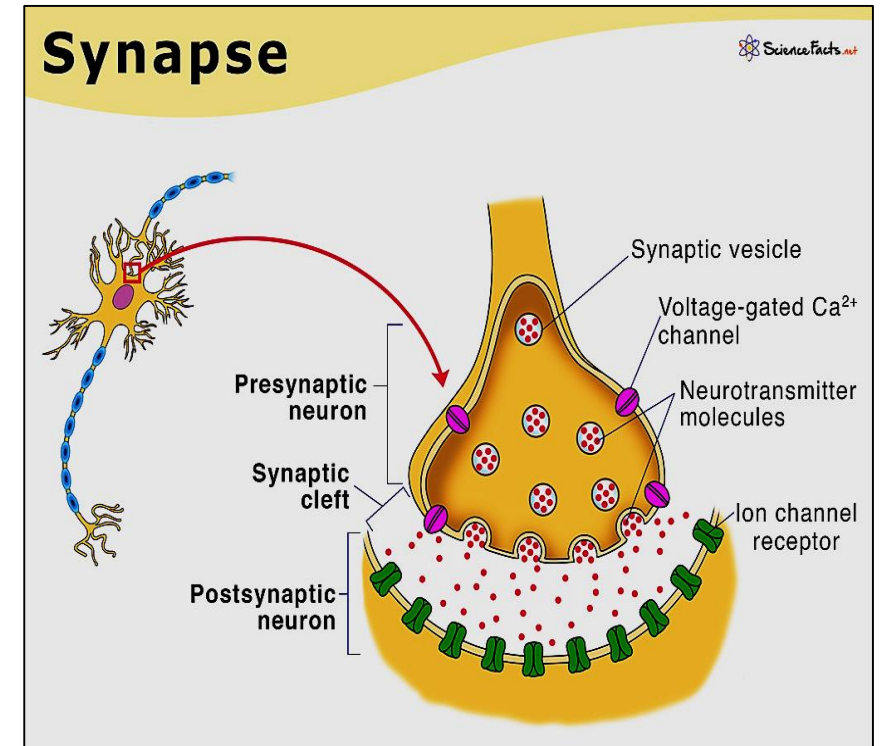
Structure of synapse

1- Presynaptic axon terminal (terminal knob):

which has vesicles that contain Neurotransmitters, ↑ mitochondria

2- Synaptic cleft: narrow space between presynaptic & postsynaptic membranes

3- Postsynaptic cell membrane: which has receptors for the chemical transmitters



Types of synapse

```
graph TD; A[Types of synapse] --> B[Chemical synapse]; A --> C[Electrical synapse];
```

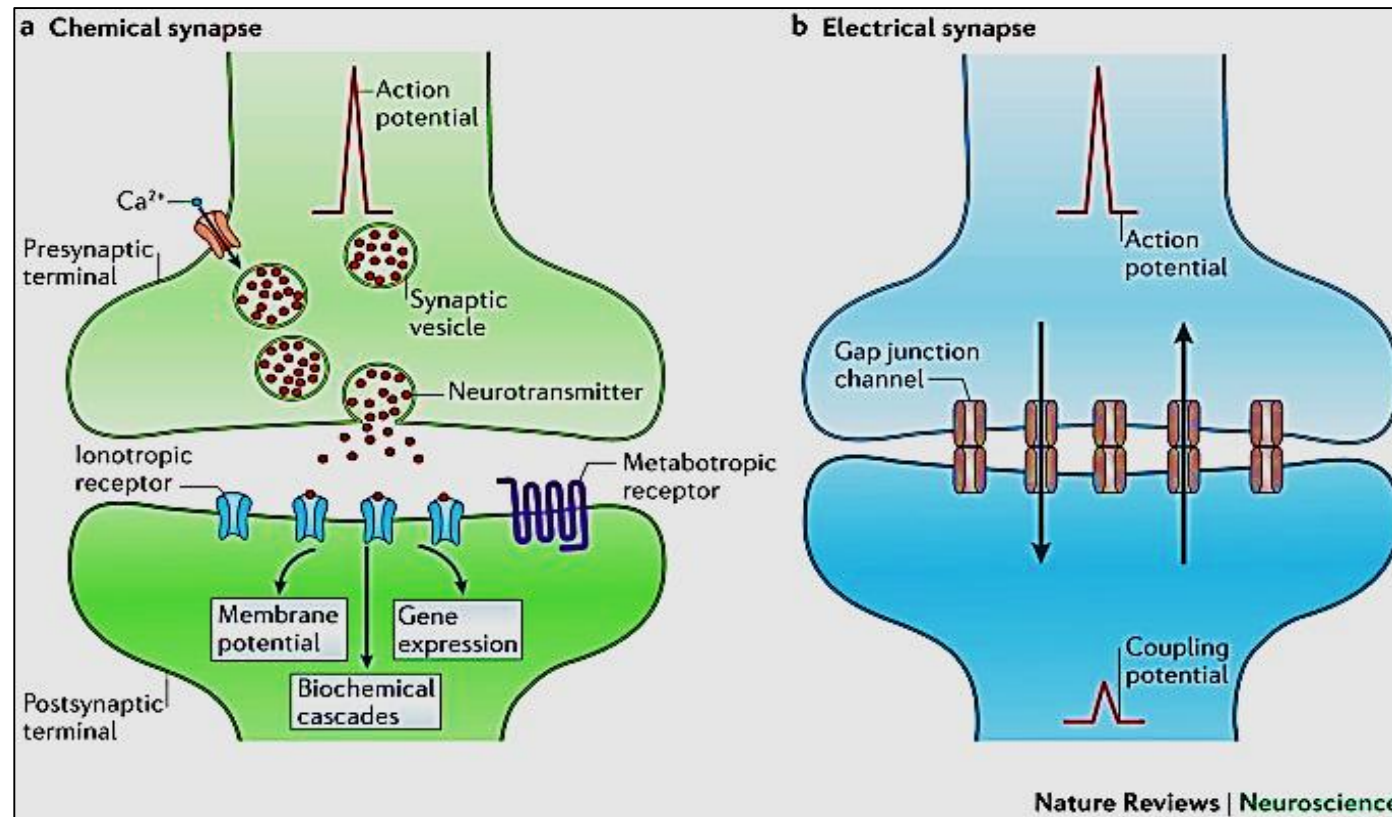
Chemical
synapse

Electrical
synapse

Methods of signal transmission

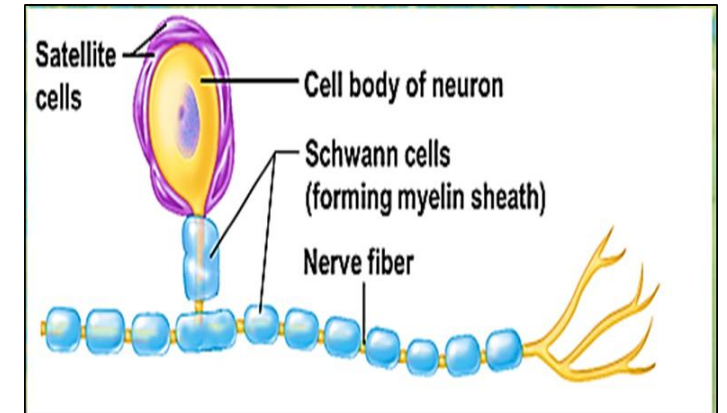
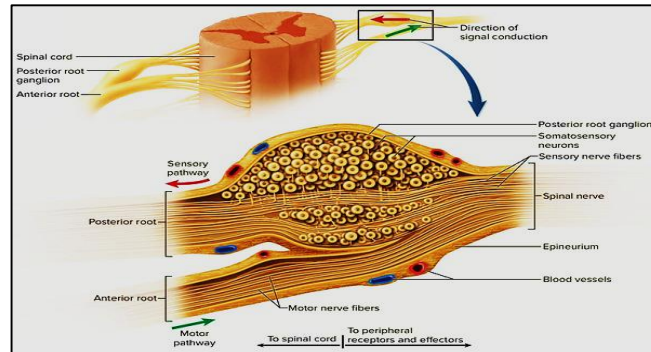
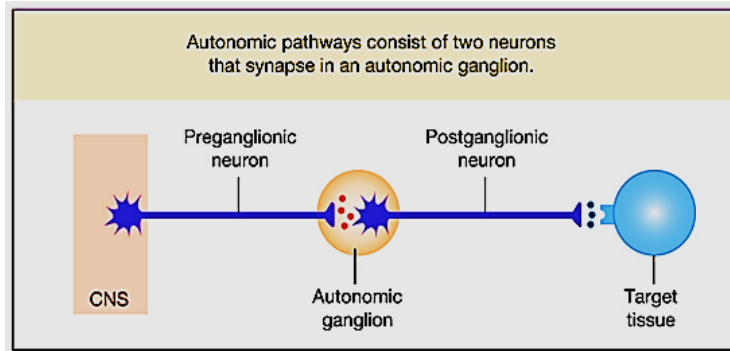
1- Chemical synapses: neurotransmitters e.g motor end plate

2- Electrical synapses: gap junction (ionic signals) e.g. cardiac muscles

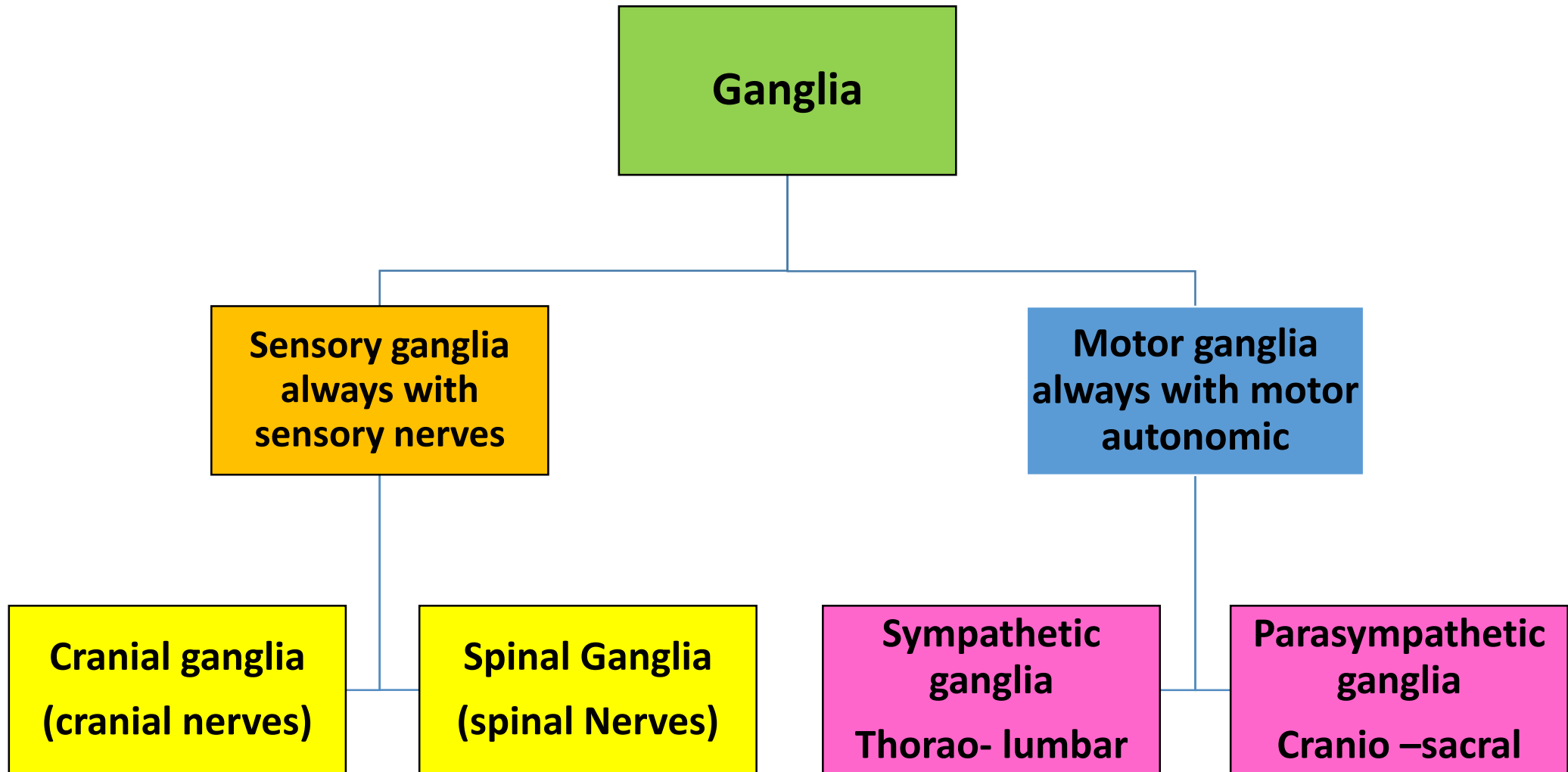


Ganglia

- Ovoid structures contain aggregations of **nerve cell bodies & satellite cells** supported by **CT**.
- **Ganglia located outside the CNS** (i.e. clusters of nerve cell bodies outside CNS (in PNS))
- They serve as **relay station for nerve signals** from CNS to peripheral organs or vice versa



- They are two main types: up to the **direction of n. impulses**
 - **Sensory ganglia** (sensory) : **spinal & cranial ganglia**
 - **Autonomic ganglia** (motor) : **sympathetic or parasym. gan.**



Sensory ganglia

Sensory ganglia (31 pairs)
carry **afferent** impulses to CNS

Example:

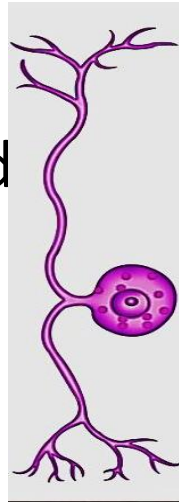
- **Cranial ganglia** e cranial nerves
- **Dorsal root g.** e spinal nerves

Nerve cell bodies are:

Pseudounipolar (rounded shape)

Large , **few** in numbers

Central nuclei



Arranged in groups between the fibers

Autonomic ganglia

Motor ganglia (21-23 pairs)
Carry **efferent** impulses from CNS

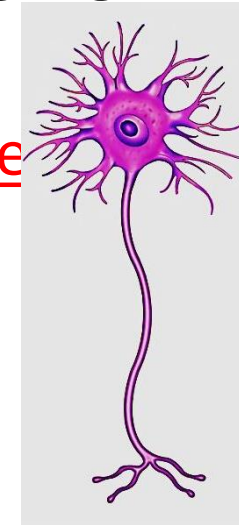
- **Sympathetic** ganglia
- **Parasympathetic** ganglia

Nerve cell bodies are

Multipolar

Small , numerous

Eccentric nuclei

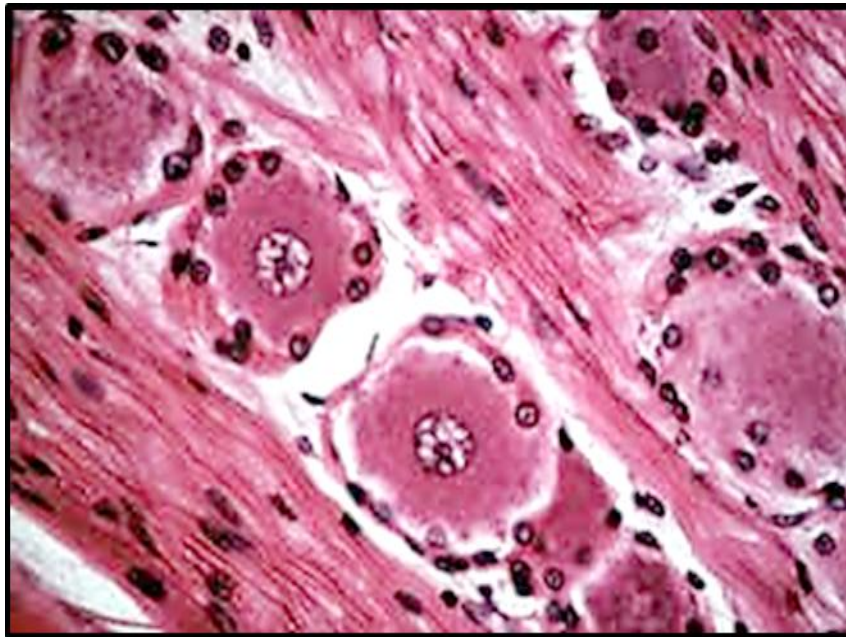


Scattered , no groups

Spinal ganglia

The groups of cells are separated with **myelinated** nerve fibers

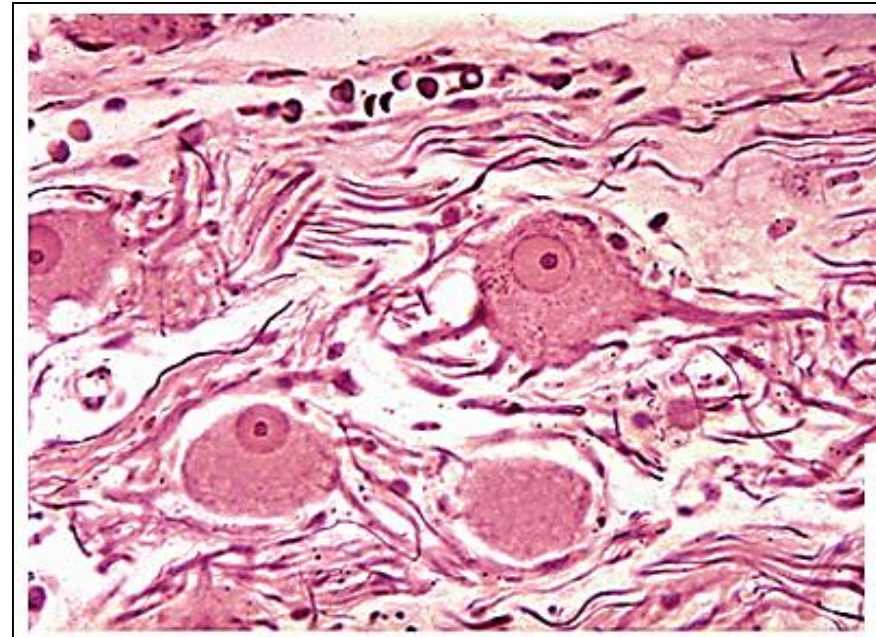
satellite cells are more around each nerve cell body



Sympathetic ganglia

The cells are separated with **un/little myelinated** nerve fibers

satellite cells are less



Thank you

