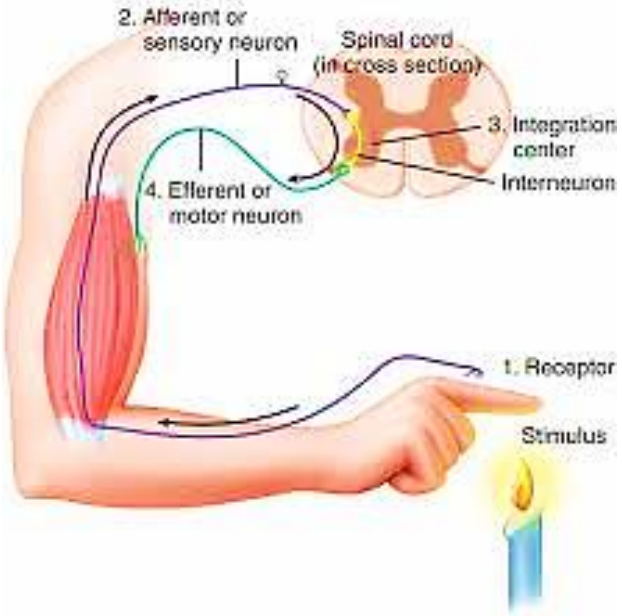
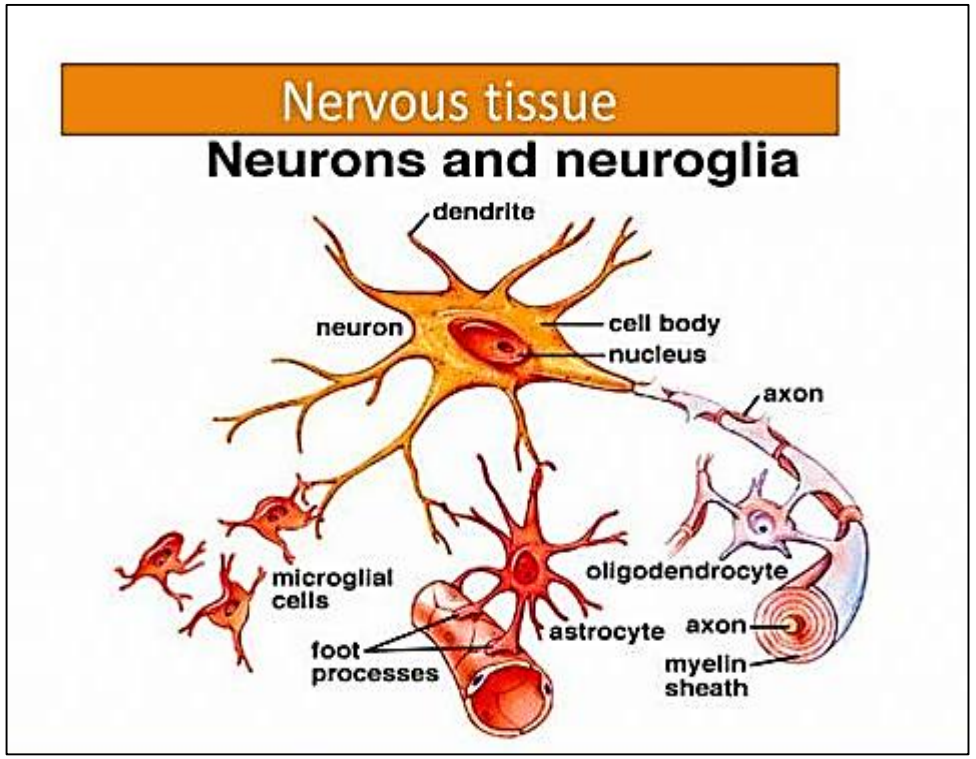
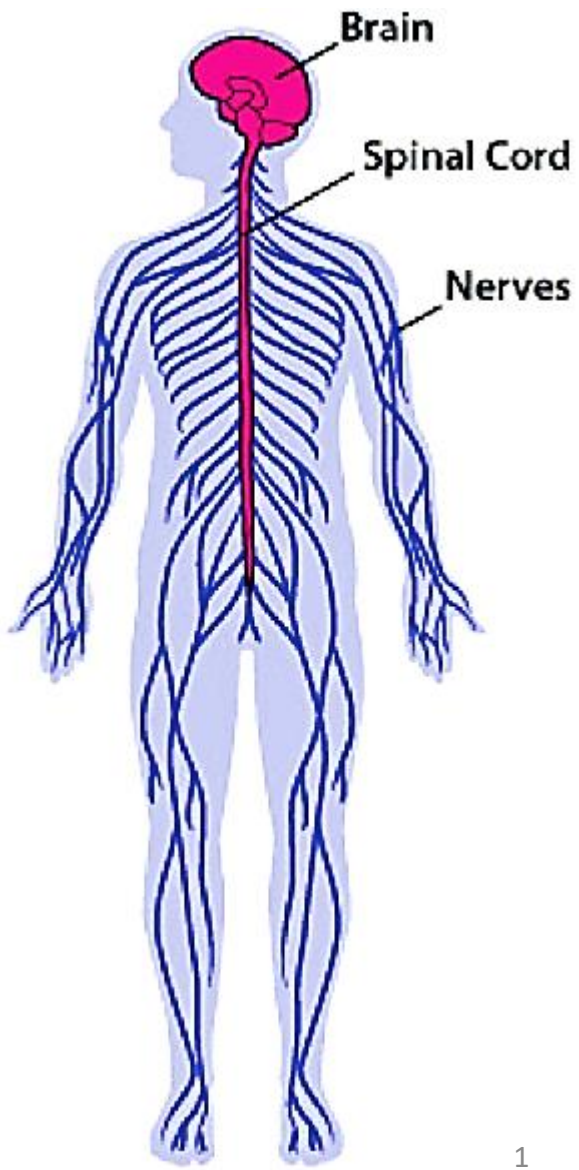
The Nervous Tissue
Nerve = Neuro….
Part I

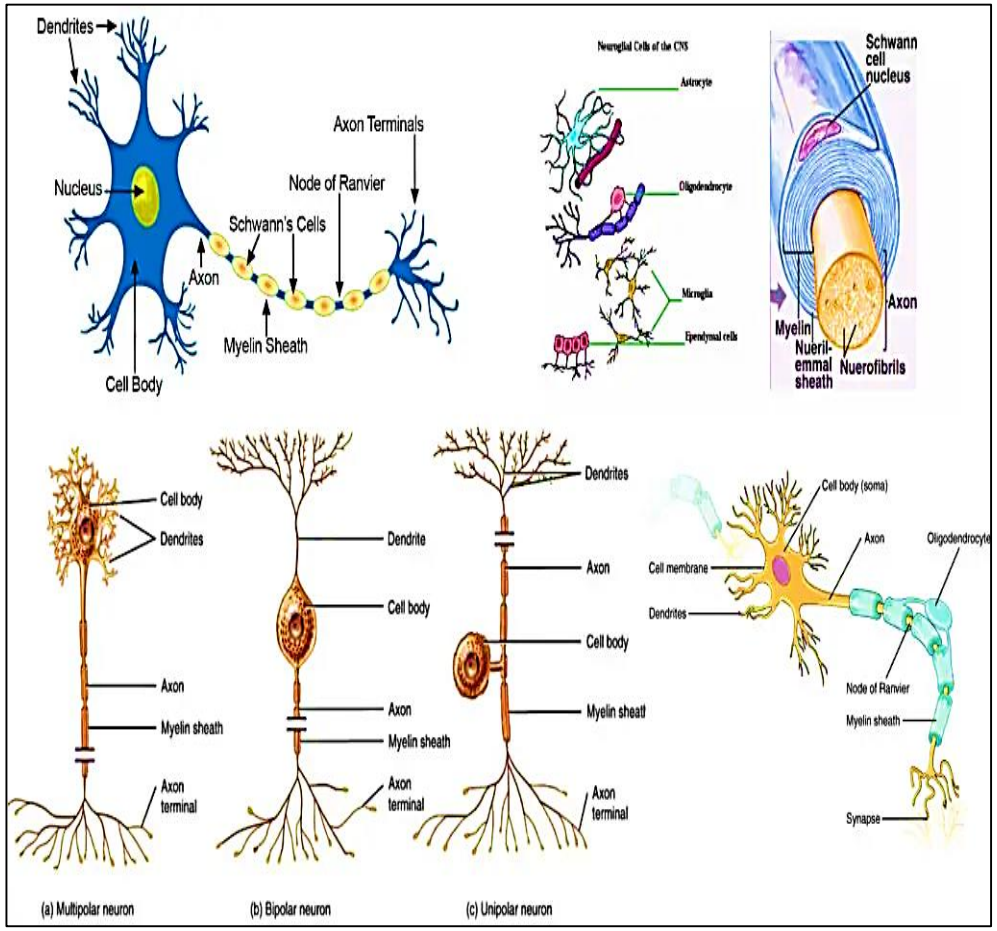






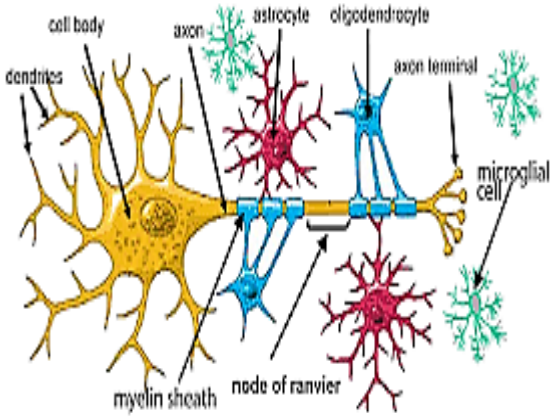
The objectives:

- 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 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

Nervous Tissue



Neurons (nerve cells)

Neuroglia (supporting cells)

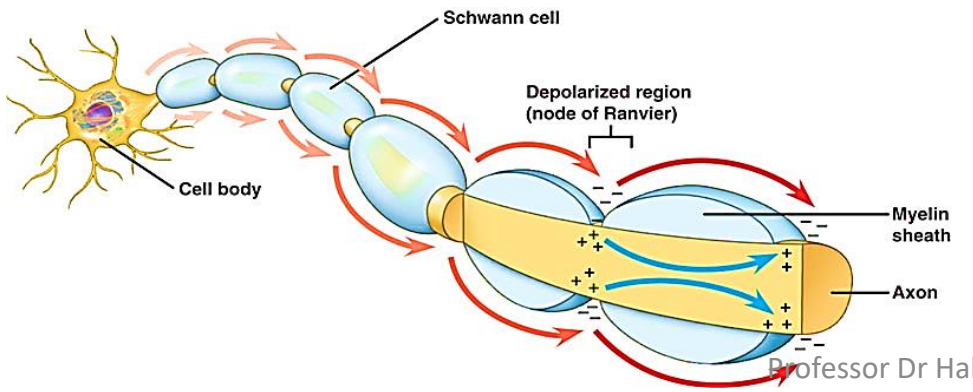
Neuron = nerve cell

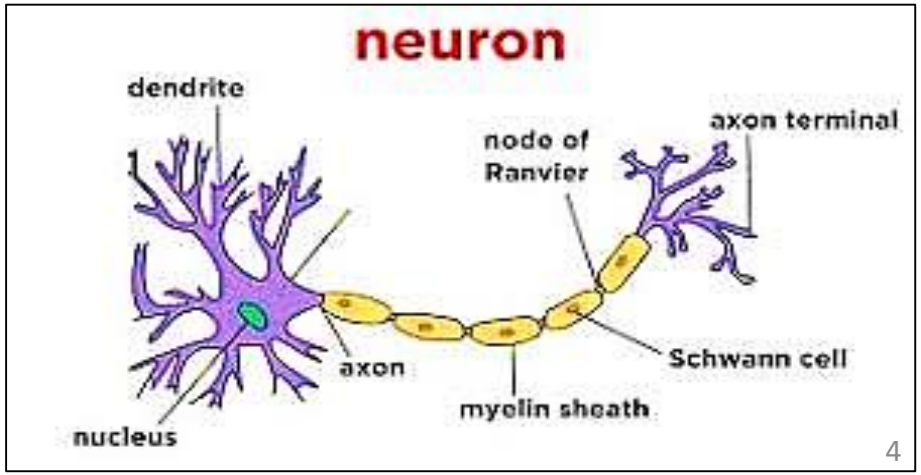
- It is the structural & functional unit of the nervous tissue

- It is characterized by:

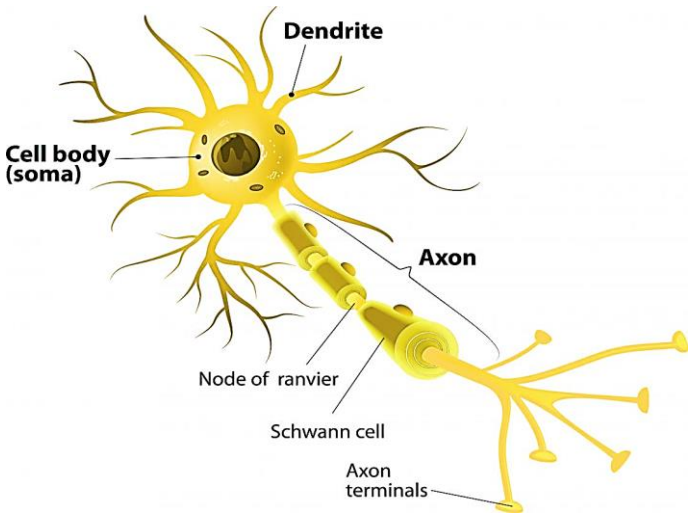
➢ Excitability: they respond to environmental changes by generating action potential or nerve impulses

➢ Conductivity : they are capable of propagating nerve impulses to other neurons , muscles & glands





Histological structure of the neuron



Neuron

Cell body

Preikaryon = soma

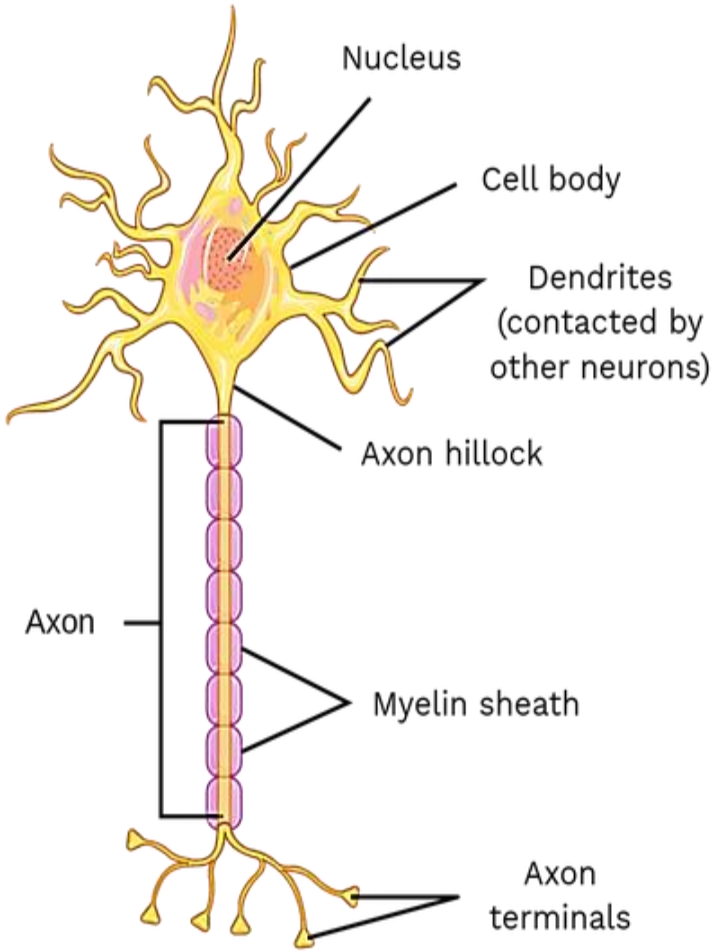
Processes

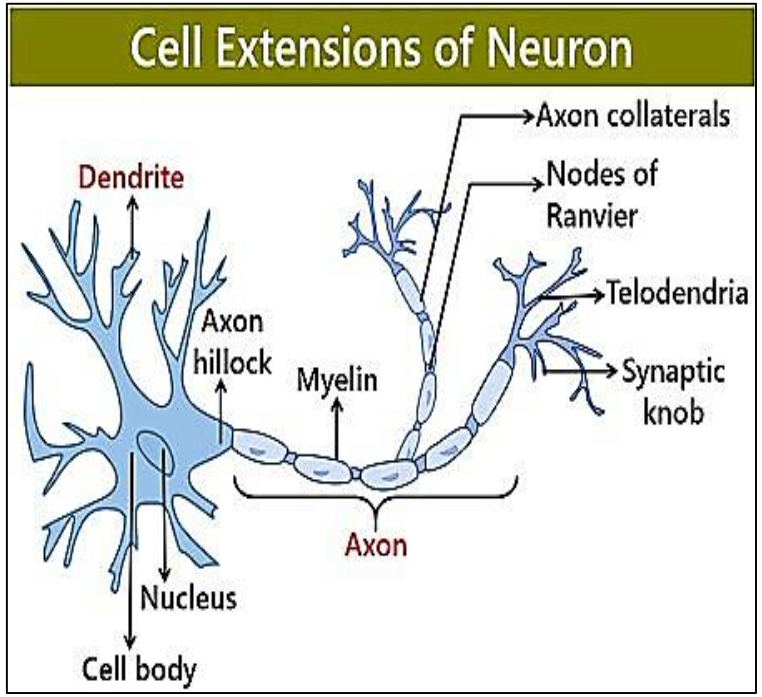
(Axon & Dendrites)

Structure of the neuron (nerve cell)

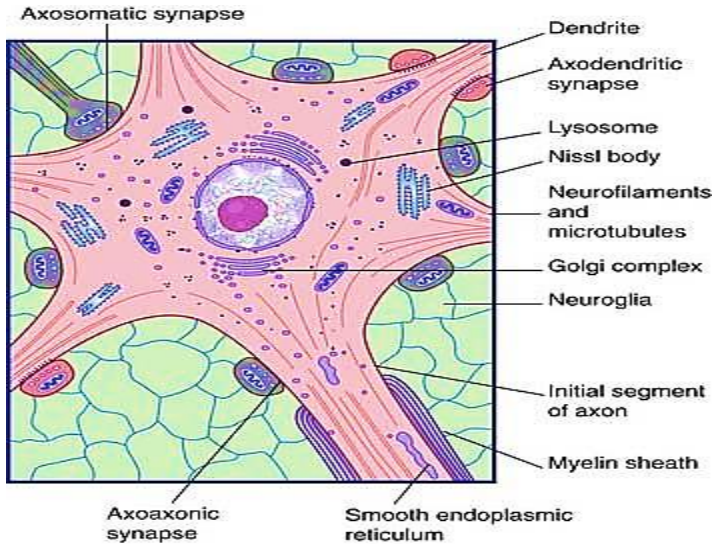
Nerve cell consists of the following main parts:

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





1- cell body = soma = perikaryon



It is composed of

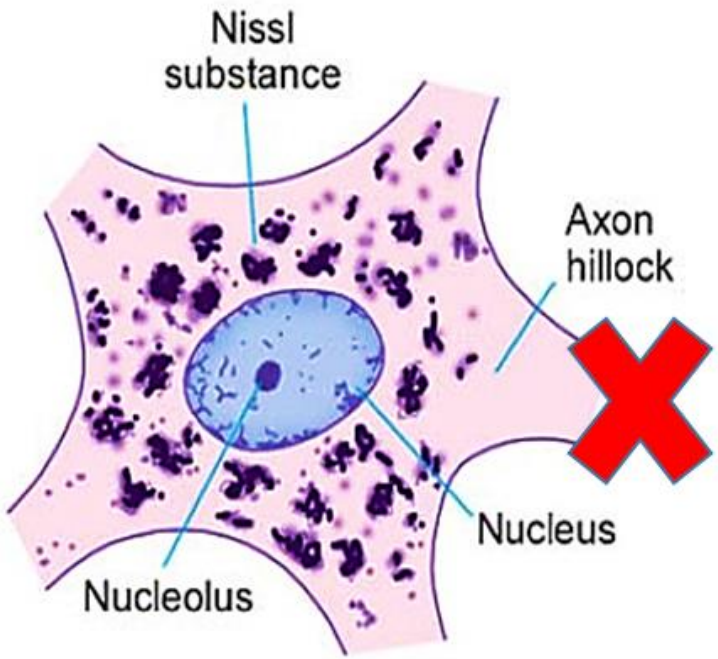
1- Nucleus: **Euchromatic** (active cell in protein synthesis e.g. neurotransmitters)

2- Cytoplasm: contains

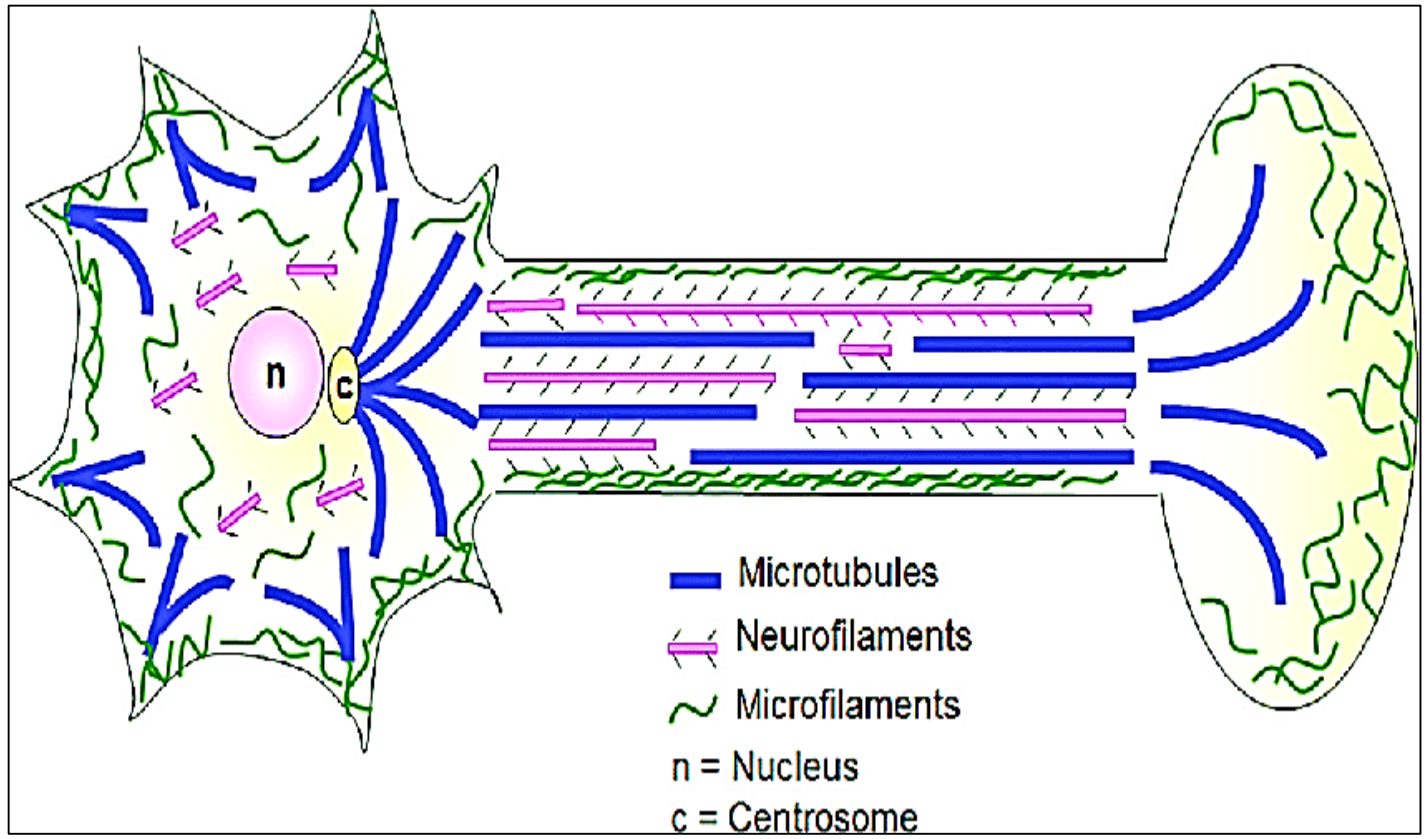
- Nissel's bodies : **basophilic granules (LM) /aggregates of ribosomes & rER (EM)** Its function is protein formation

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

- Large perinuclear Golgi apparatus : for packing neurotransmitters into synaptic vesicles
- Cytoskeleton : formed of neurofibrilis that include **neurofilaments & microtubules** which play role in support neuron & transmission of impulse
- Mitochondria : abundant for high energy requirement
- Inclusion : lipofuscin pigments & lipids

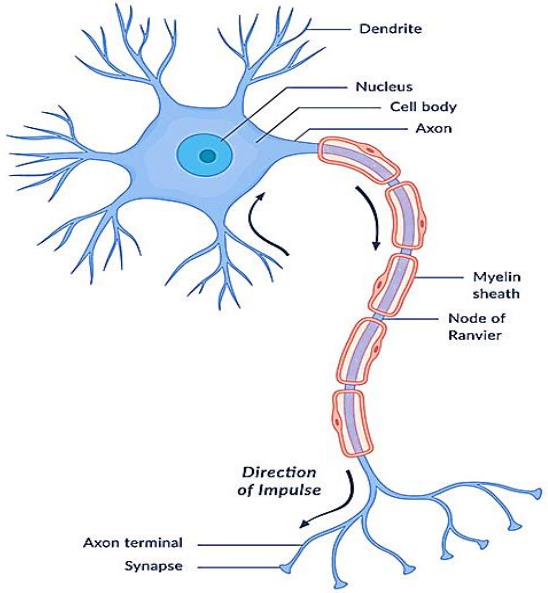


Nissl's granules



Neurofilaments & microtubules in neuron

2- the cell processes

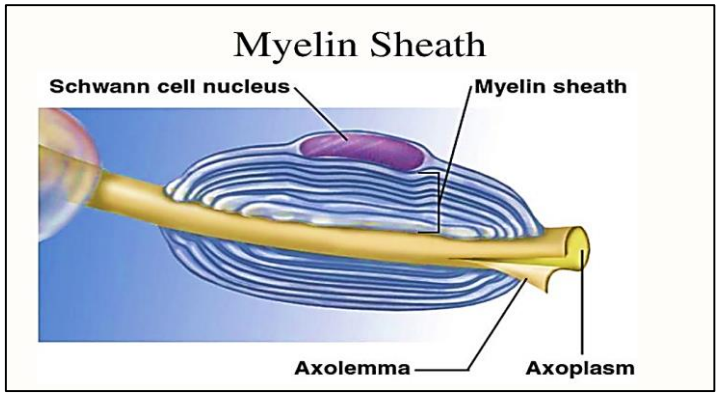


There are **2 types of processes:**

1- Axon **2- Dendrites**

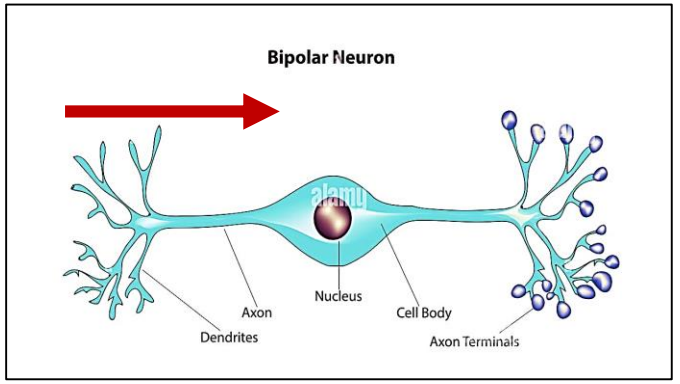
1- Axon

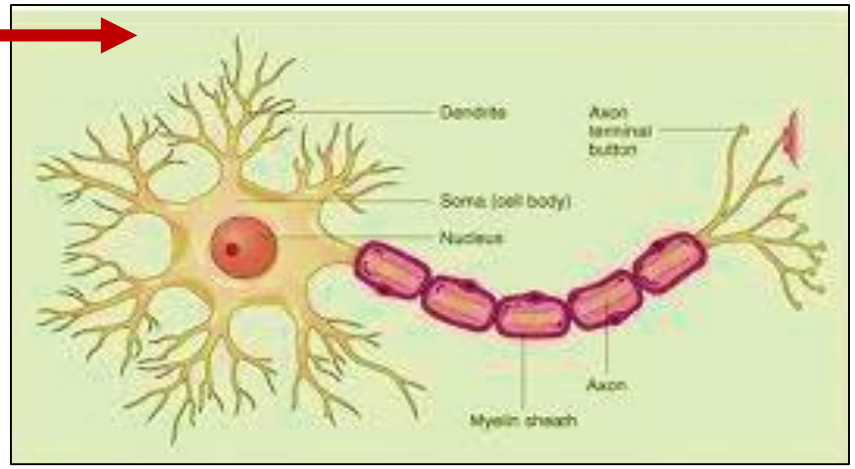
- Originate from the axon hillock
- Always single, Long cylindrical in shape
- Conducts nerve impulses away from the cell body
- No branching **EXCEPT** at axon termination.
  It may give off collaterals arising at RT angles



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

2- Dendrites

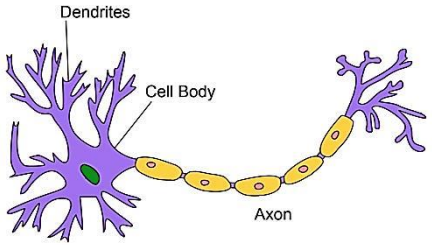




- Originate **from any part of the cell body**
- Usually multiple in(multipolar neuron).
- It may be single in (bipolar neuron)
- Conducts **nerve impulses towards the cell body**
- **Short thick** near its origin & thin towards its end
- Branching a lot to increase the surface area to receive nerve impulses
- Contains **most of the organelles** 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

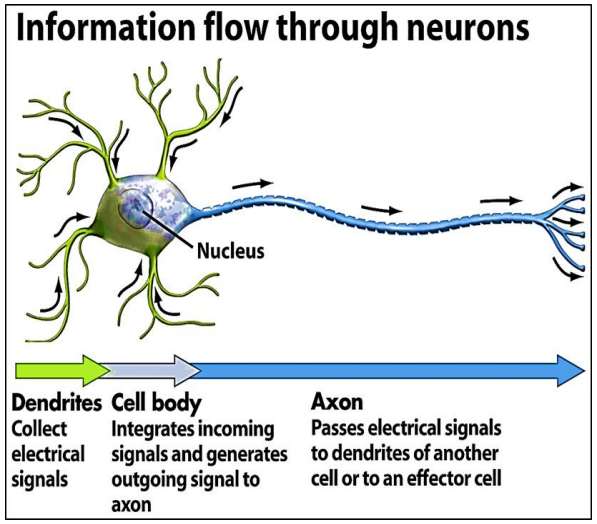
2-Short & thick

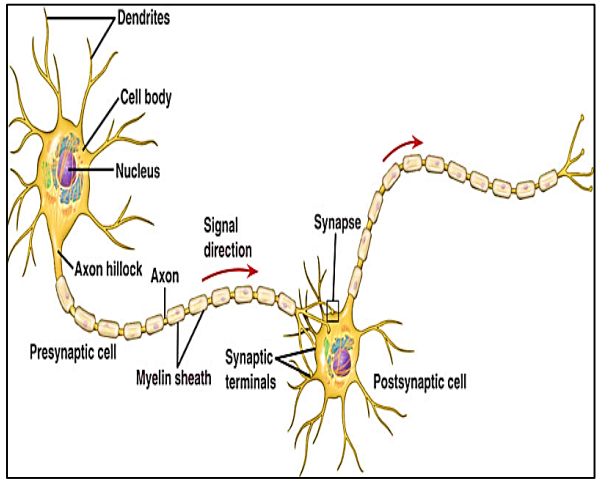
3-Their thickness decreases gradually towards ends

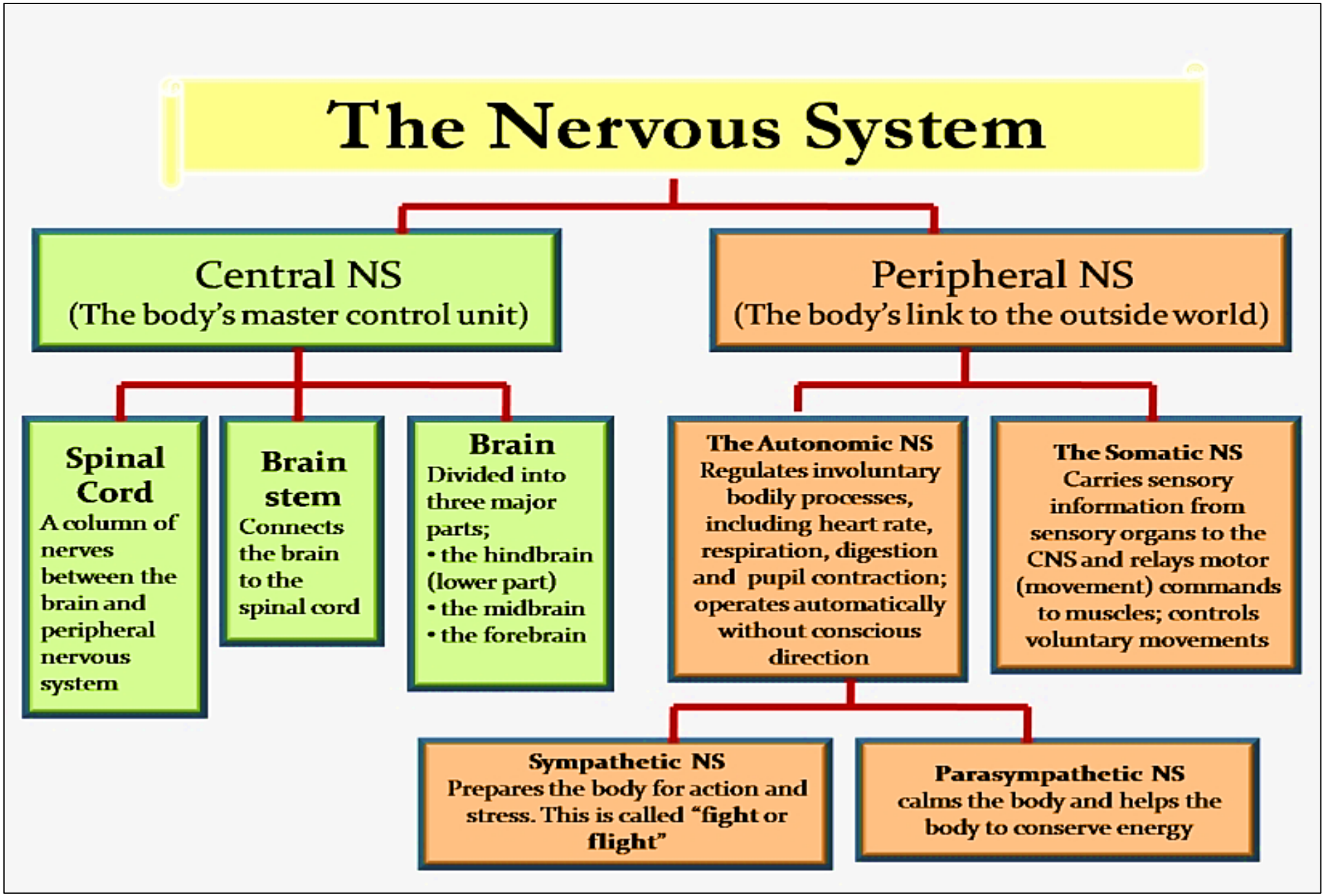
4-Give fine branches at its ends

5-Contain neurofibrils and Nissl bodies

6-Receive impulses from one neuron to another

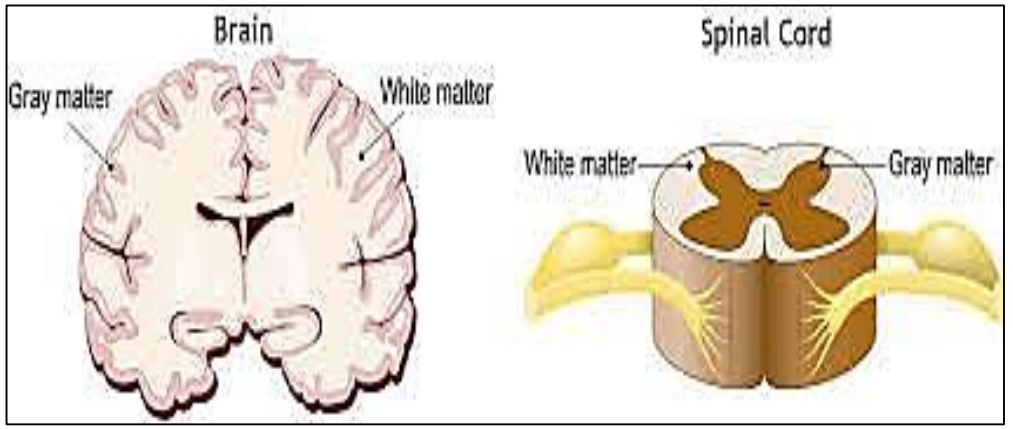





The Nervous System
Central NS
(The body's master control unit)
Peripheral NS
(The body's link to the outside world)
Spinal Cord
A column of nerves between the brain and peripheral nervous system
Brain stem
Connects the brain to the spinal cord
Brain
Divided into three major parts;
• the hindbrain (lower part)
• the midbrain
• the forebrain
The Autonomic NS
Regulates involuntary bodily processes, including heart rate, respiration, digestion and pupil contraction; operates automatically without conscious direction
The Somatic NS
Carries sensory information from sensory organs to the CNS and relays motor (movement) commands to muscles; controls voluntary movements
Sympathetic NS
Prepares the body for action and stress. This is called "fight or flight"
Parasympathetic NS
calms the body and helps the body to conserve energy

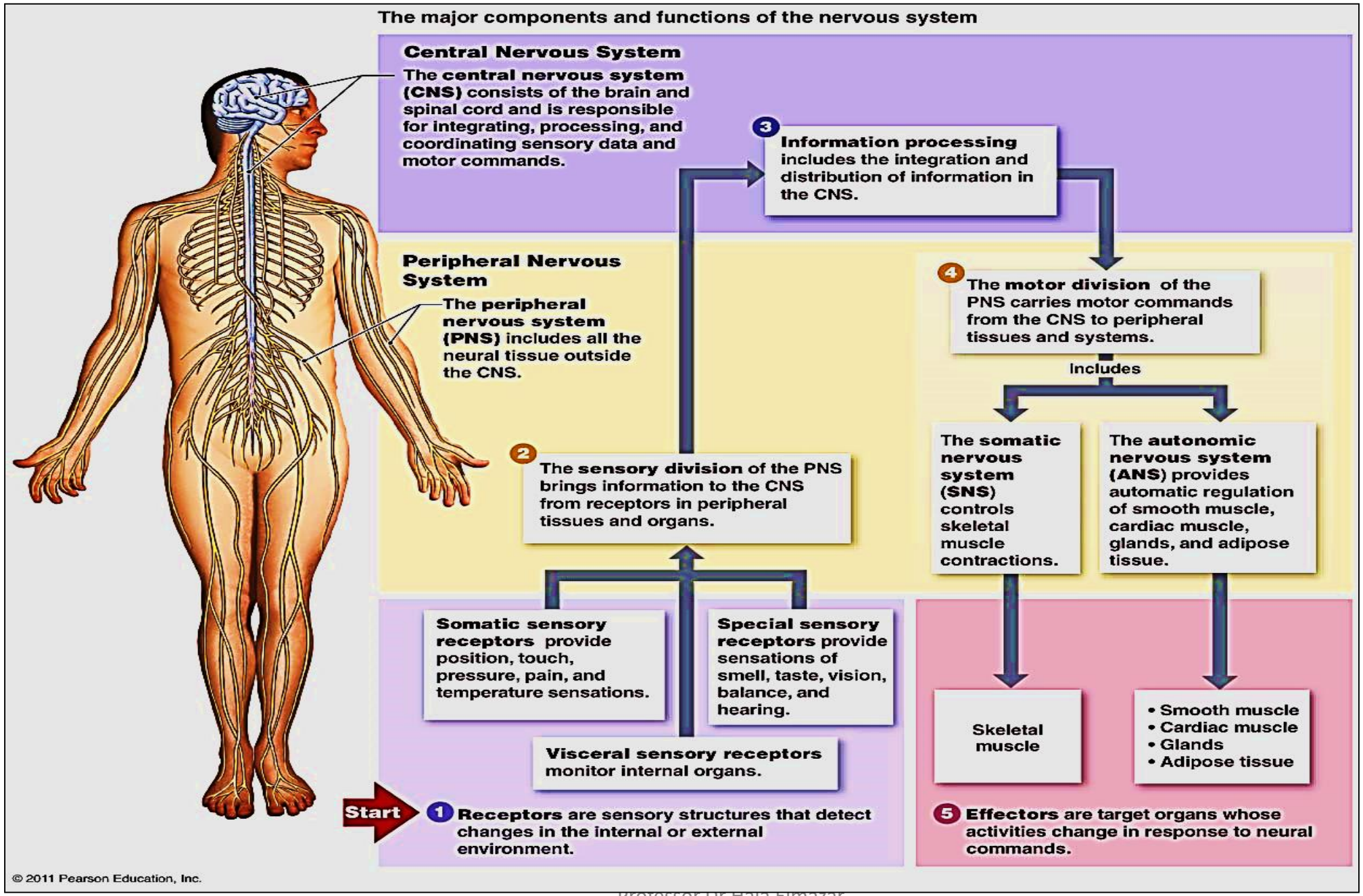
The central nervous system (CNS):

- 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
Central Nervous System
The central nervous system (CNS) consists of the brain and spinal cord and is responsible for integrating, processing, and coordinating sensory data and motor commands.
3 Information processing includes the integration and distribution of information in the CNS.
Peripheral Nervous System
The peripheral nervous system (PNS) includes all the neural tissue outside the CNS.
4 The motor division of the PNS carries motor commands from the CNS to peripheral tissues and systems.
Includes
The somatic nervous system (SNS) controls skeletal muscle contractions.
The autonomic nervous system (ANS) provides automatic regulation of smooth muscle, cardiac muscle, glands, and adipose tissue.
2 The sensory division of the PNS brings information to the CNS from receptors in peripheral tissues and organs.
Somatic sensory receptors provide position, touch, pressure, pain, and temperature sensations.
Special sensory receptors provide sensations of smell, taste, vision, balance, and hearing.
Visceral sensory receptors monitor internal organs.
Skeletal muscle
• Smooth muscle
• Cardiac muscle
• Glands
• Adipose tissue
Start
1 Receptors are sensory structures that detect changes in the internal or external environment.
5 Effectors are target organs whose activities change in response to neural commands.
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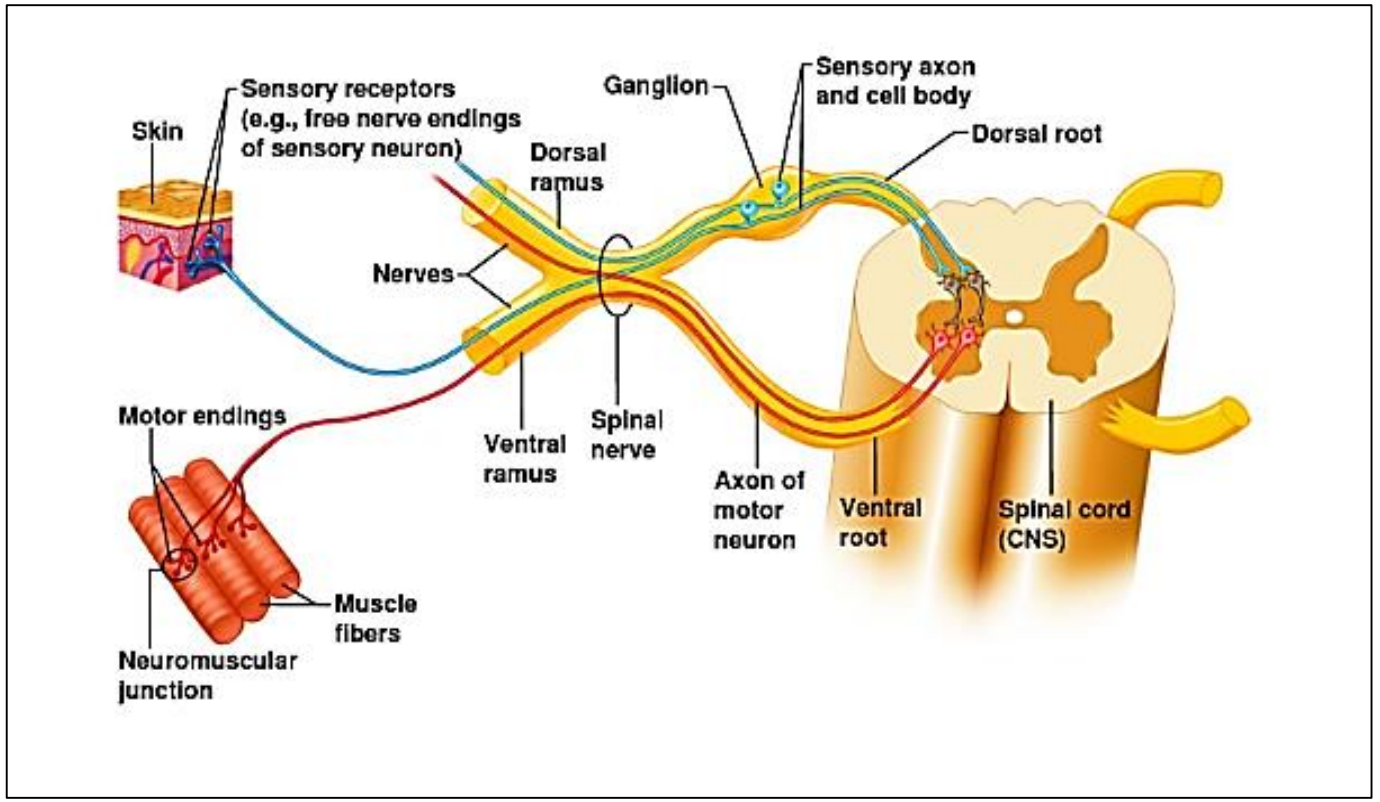
The peripheral nervous system

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

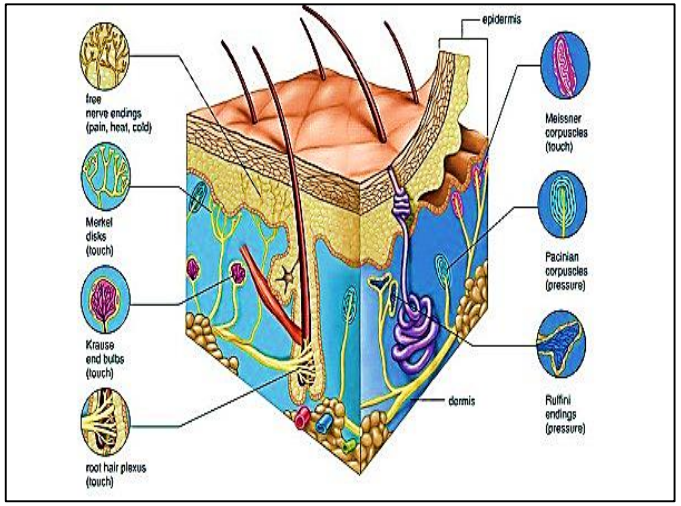
- Sensory receptors
- Motor endings
- Peripheral nerves
- Ganglia



Sensory receptors

Somatic receptors

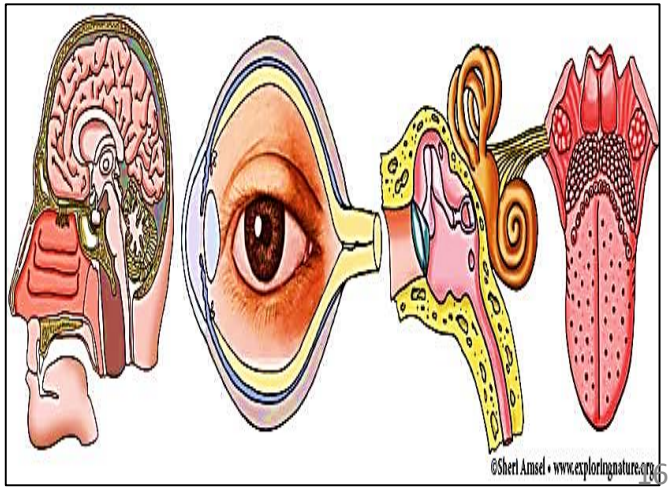
Pain , touch , temperature, position of body



Visceral receptors of internal organs

Special sensory receptors

Vision, hearing , smell , taste



Peripheral nerves

Afferent nerves (Sensory)

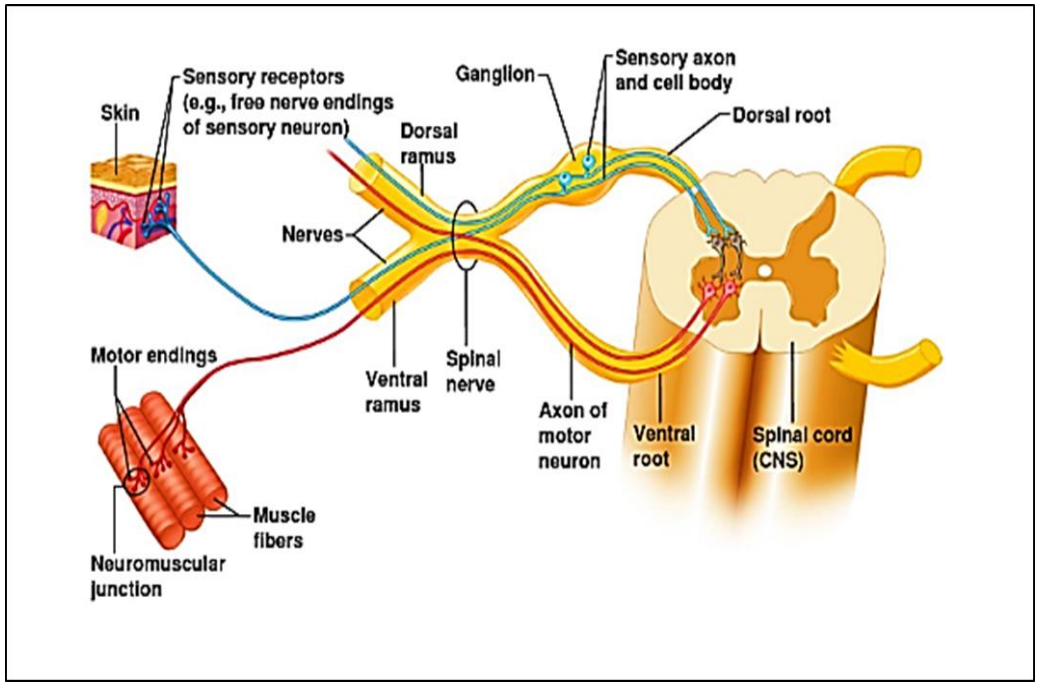
Efferent nerves (Motor)

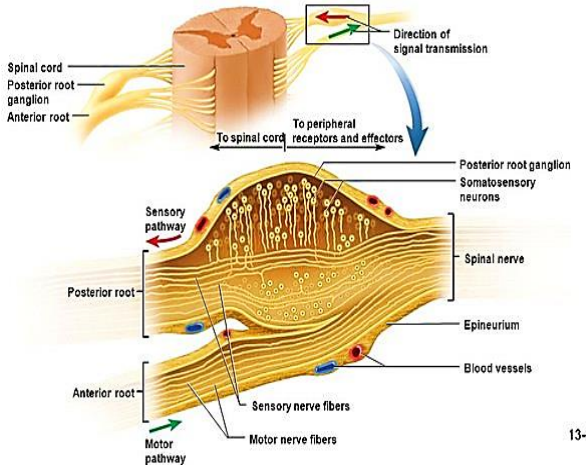
Motor Somatic to skeletal muscles

Motor Autonomic

Sympathetic

Parasympathetic





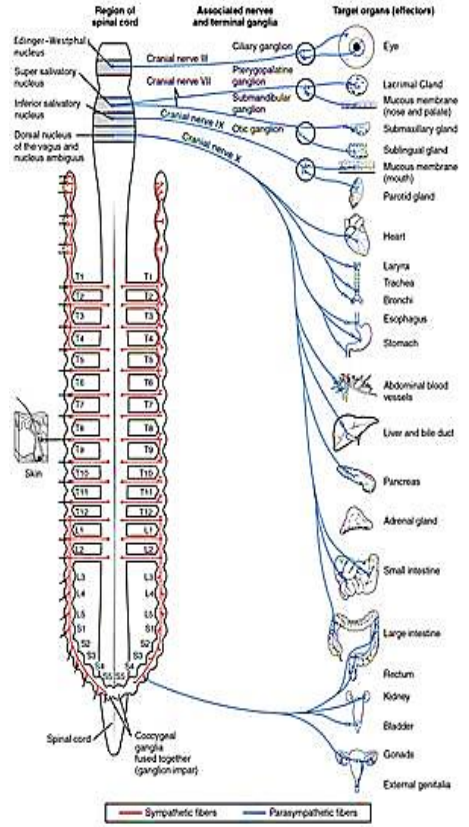
Ganglia

Sensory ganglia always with sensory nerves

- Cranial ganglia (cranial nerves)
- Spinal Ganglia (spinal Nerves)

Motor ganglia always with motor autonomic

- Sympathetic ganglia Thorao- lumbar
- Parasympathetic ganglia Cranio –sacral



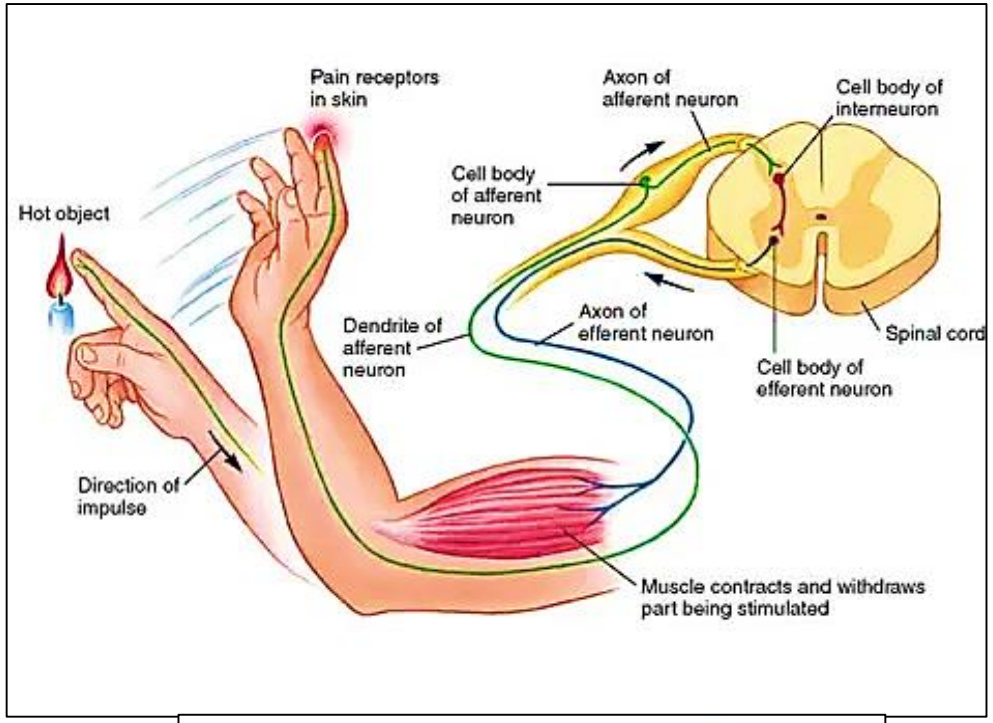
Classification of neurons/ Functional

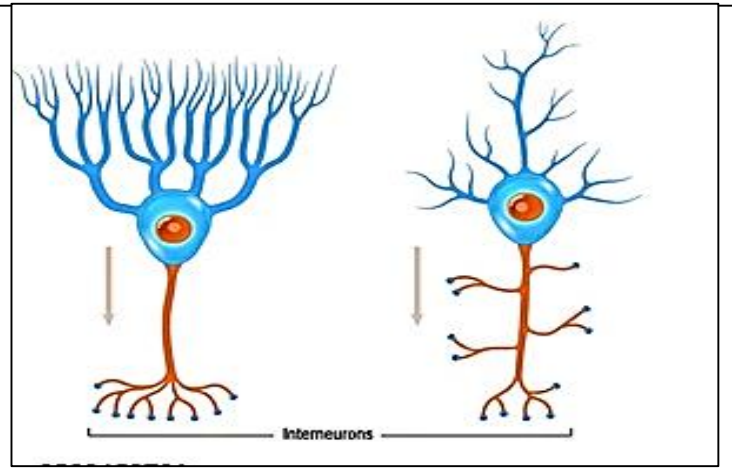
Based on the direction of **conduction of impulses**

- **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

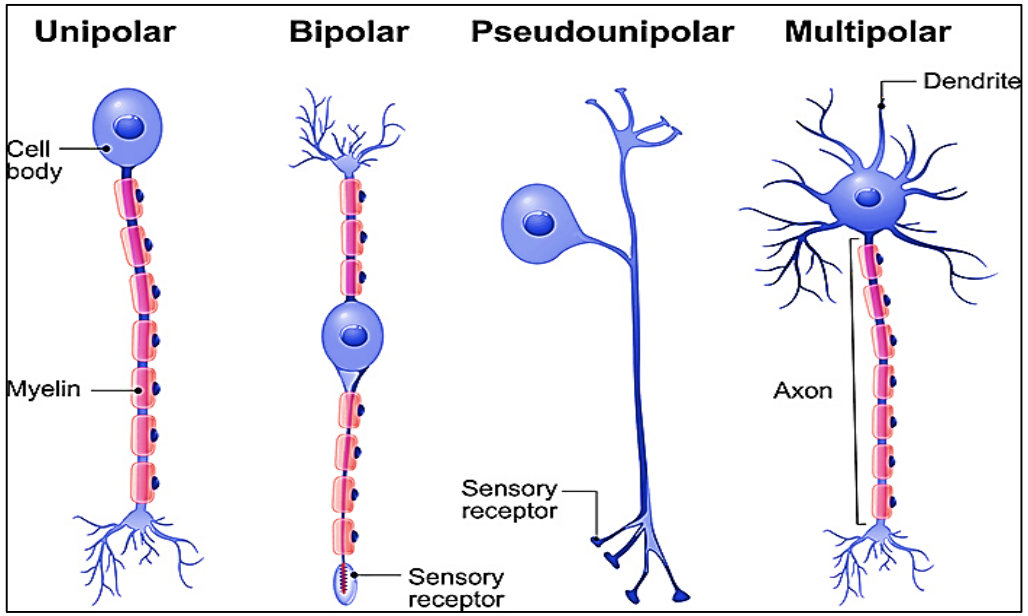
Classification of PNS neurons/ morphology

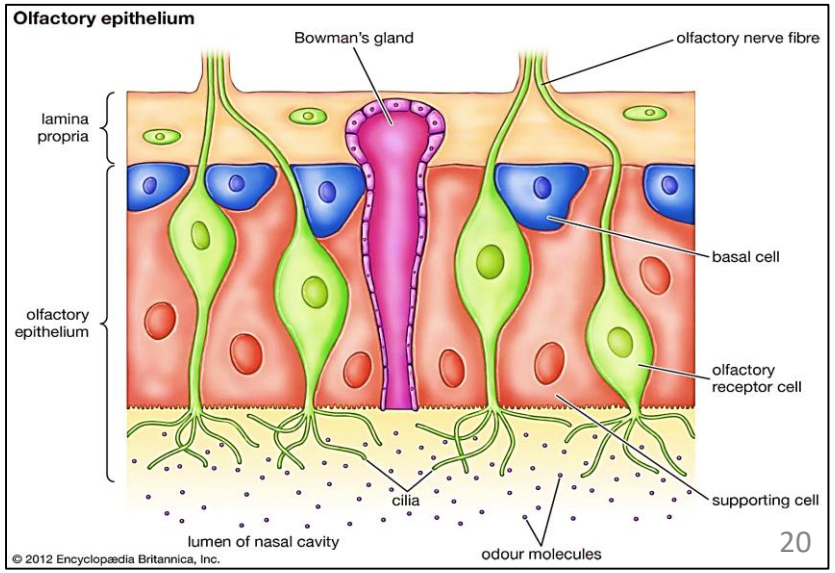
Neurons are classified according to number of their process into:

1- Unipolar: have only on 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)

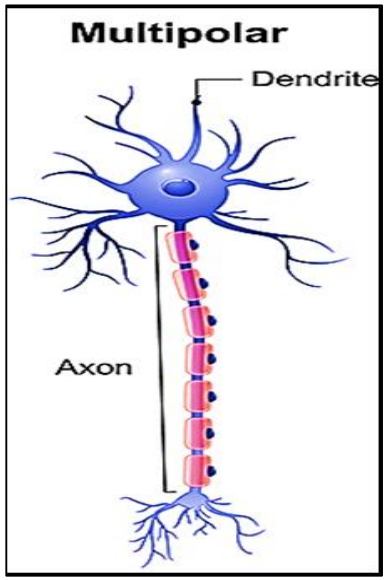
B- Pyramidal neuron : cerebral cortex

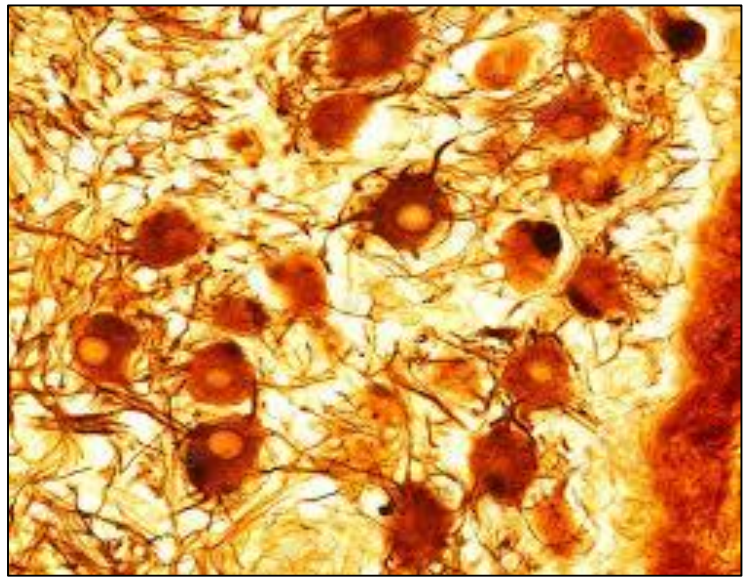
D- Pyriform neuron: cerebellum

(Purkinje cells) & the retina (ganglion cells

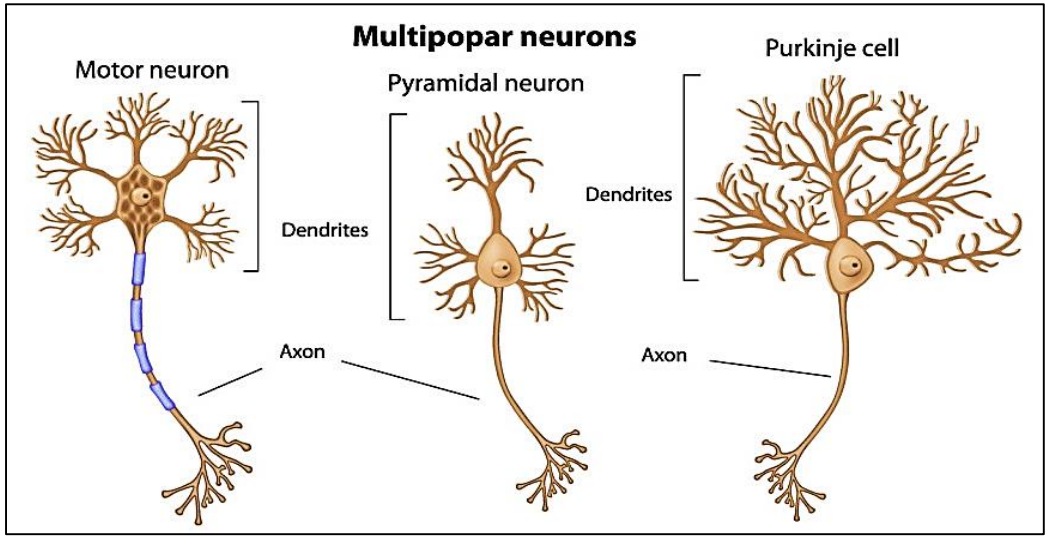
C- Granule neuron : found in the cerebellum

the granular layer of the





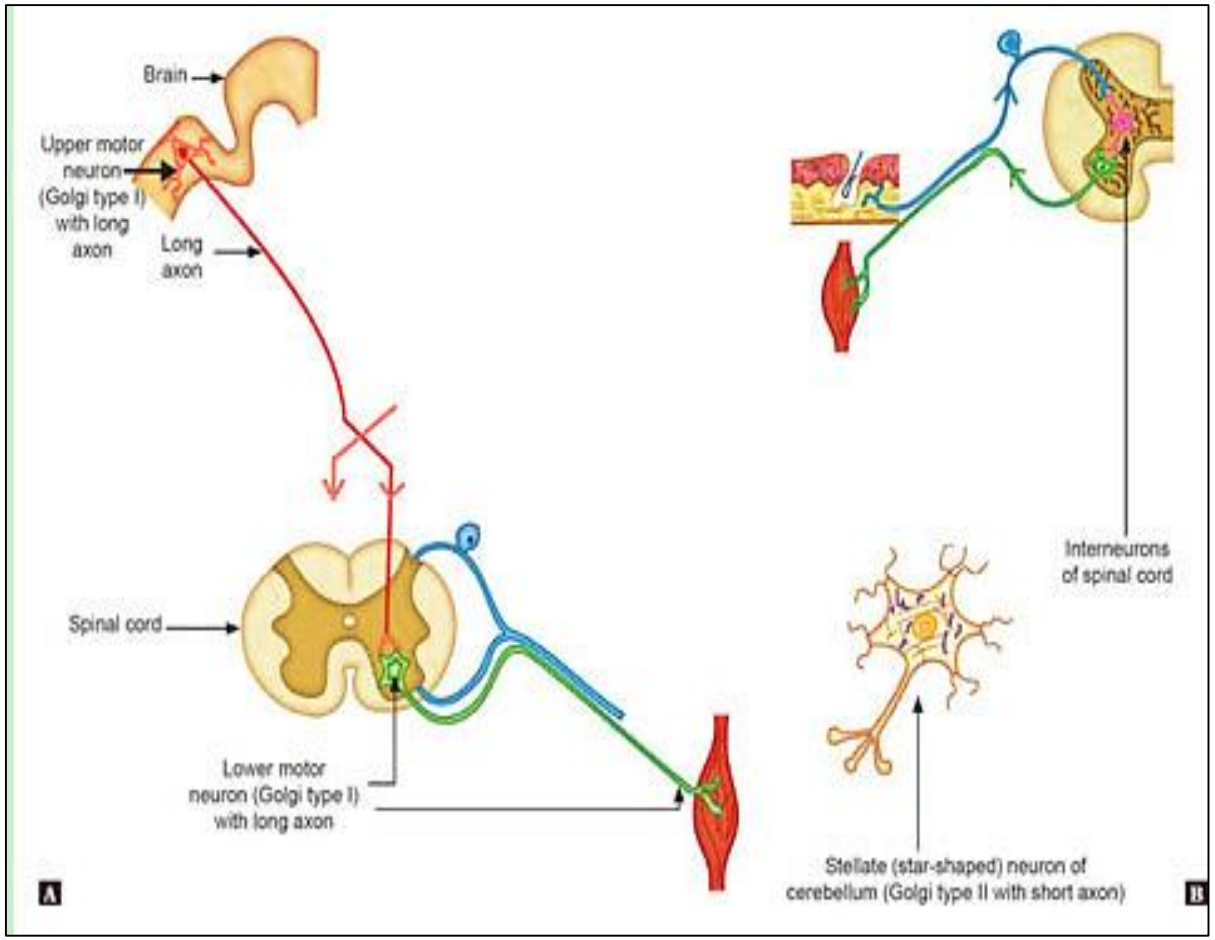
Autonomic ganglia

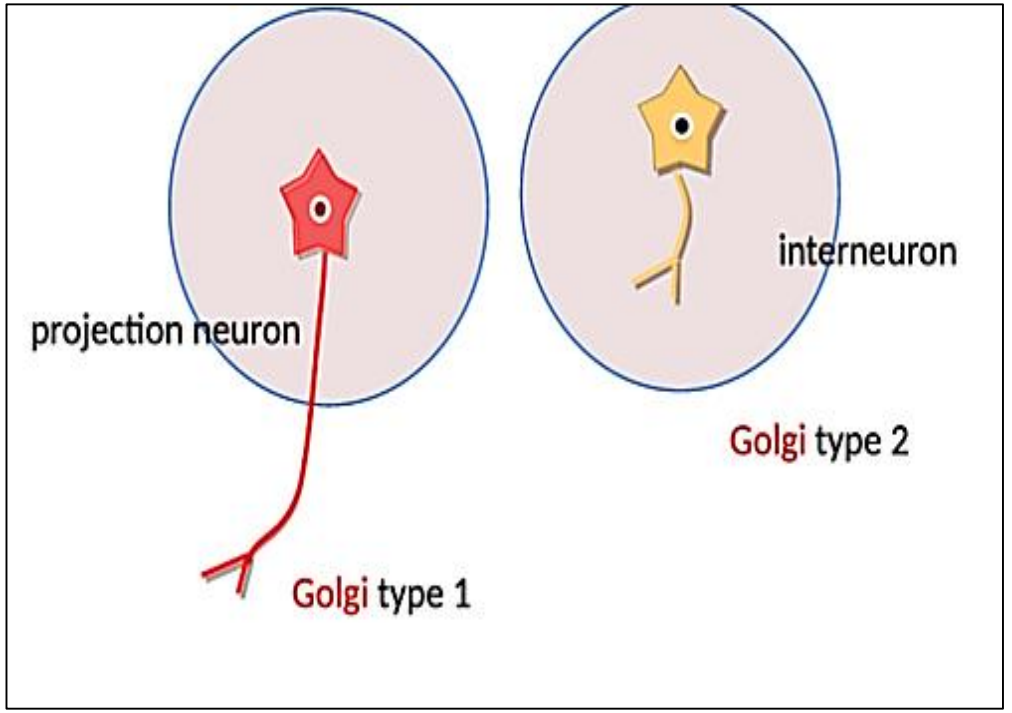


Neurons are classified according to **length of their axons** into:

1- Golgi I (long axon)

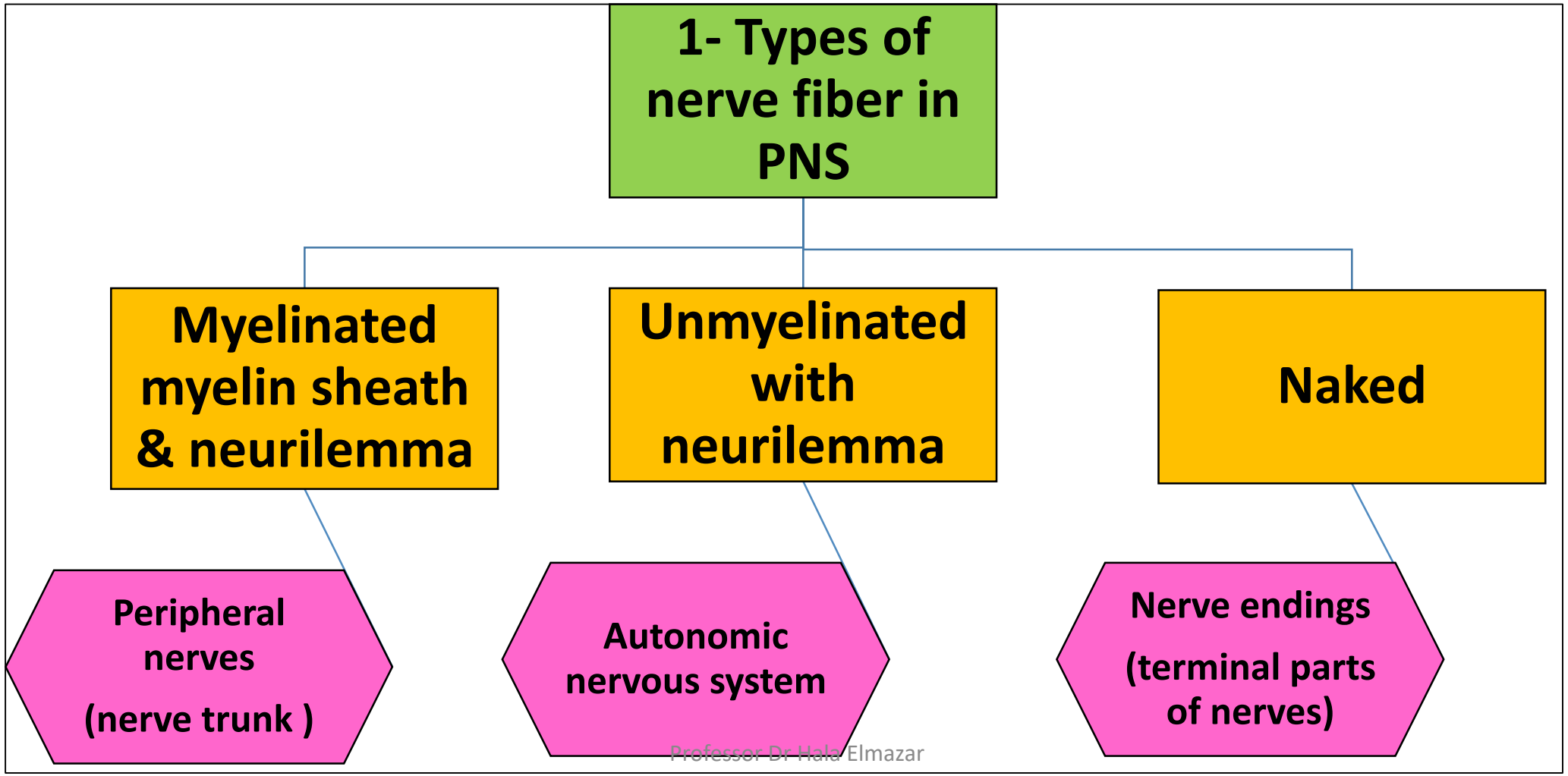
2- Golgi II (short axon)

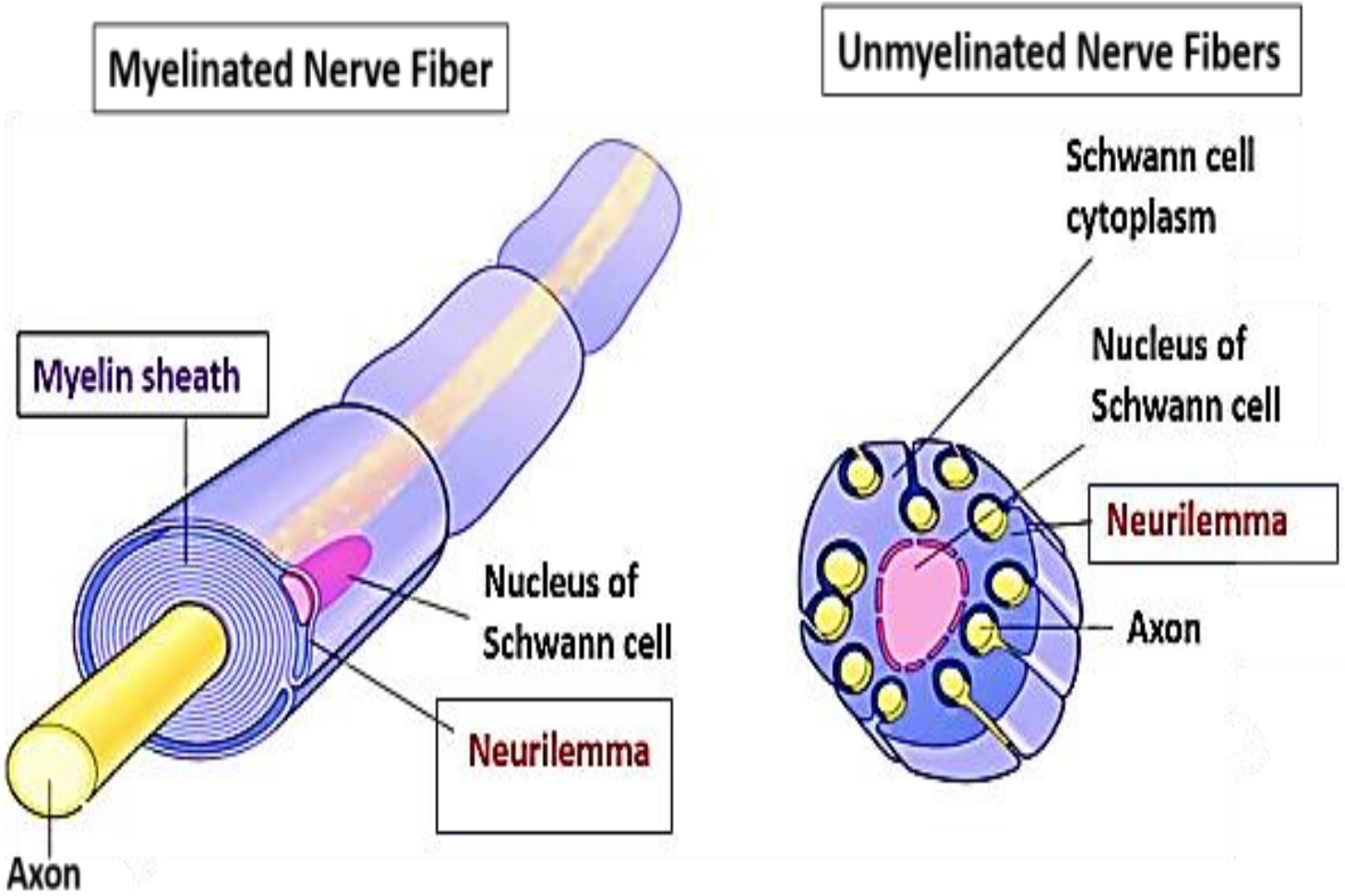




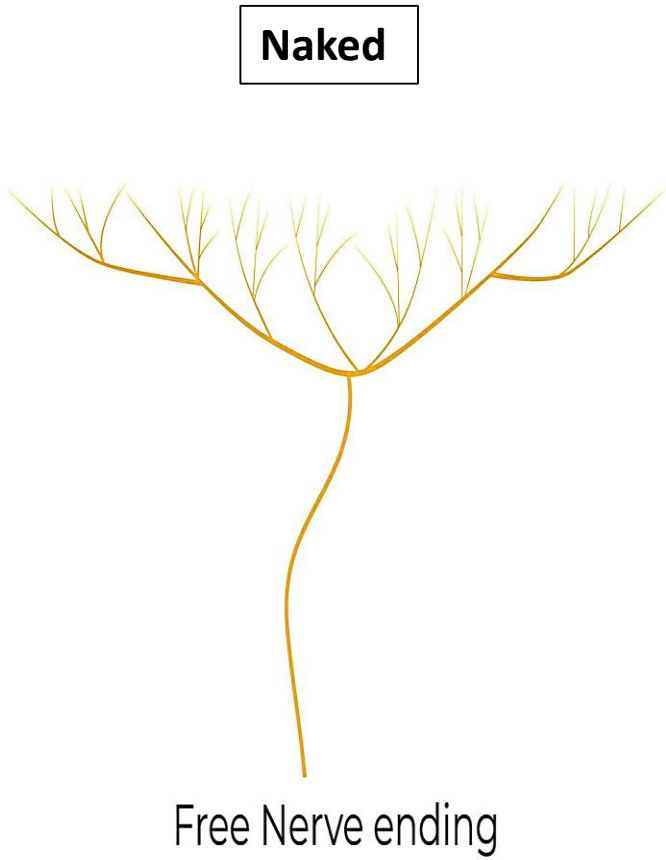
Nerve Fiber

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



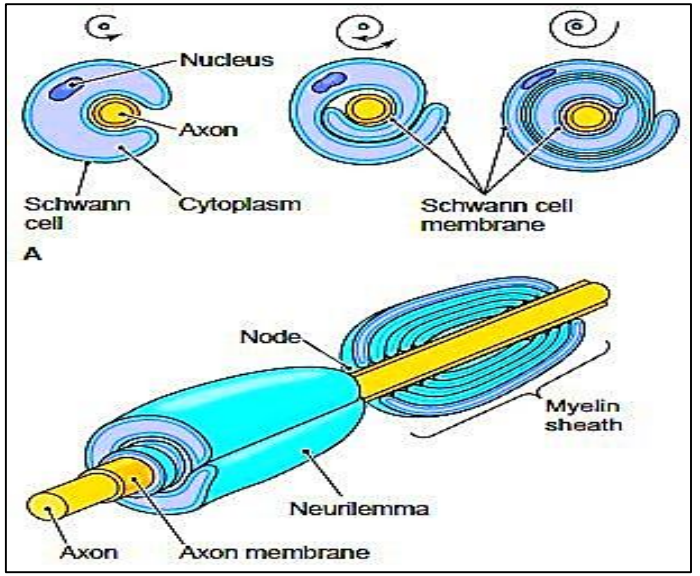

Myelinated Nerve Fiber
Myelin sheath
Nucleus of
Schwann cell
Neurilemma
Axon

Unmyelinated Nerve Fibers
Schwann cell
cytoplasm
Nucleus of
Schwann cell
Neurilemma
Axon


Naked
Free Nerve ending

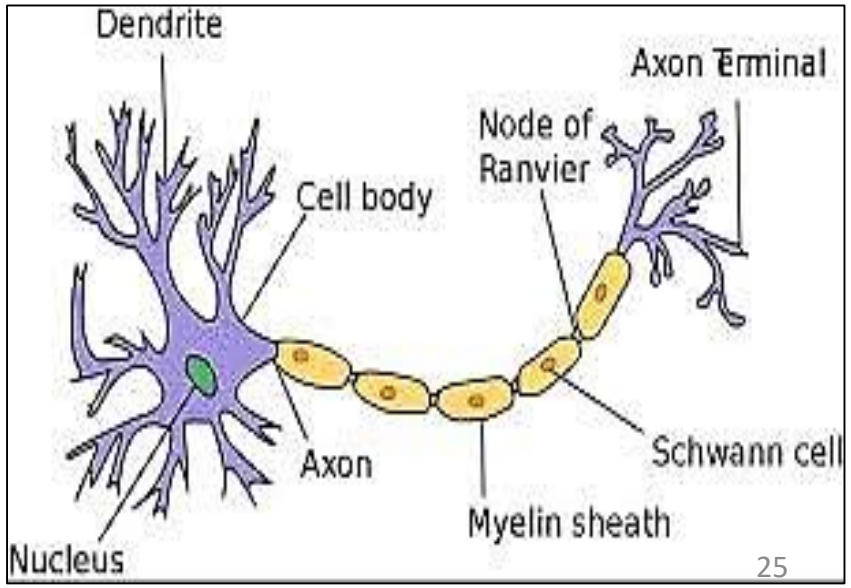
Myelinated nerve fibers in PNS

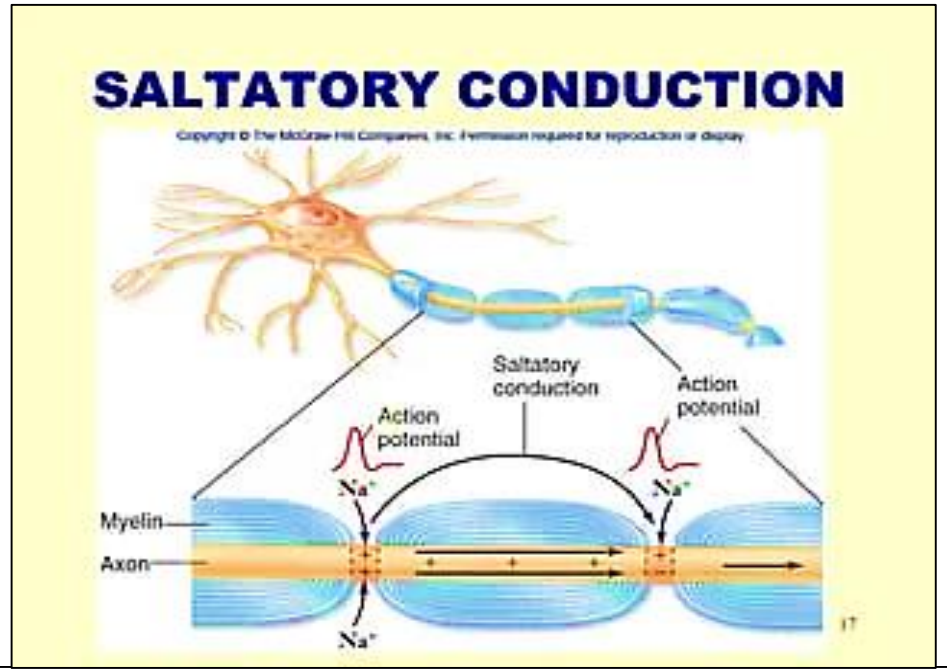
They are large axons enveloped by myelin sheath & neurilemmal sheath



A- Myelin sheath

- **Lipid** rich coat covers the axon
- Is formed by Schwan 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 Schwan cell
- **Function:** insulation, protection and fast conduction of nerve impulse
- Dendrites **are not** myelinated





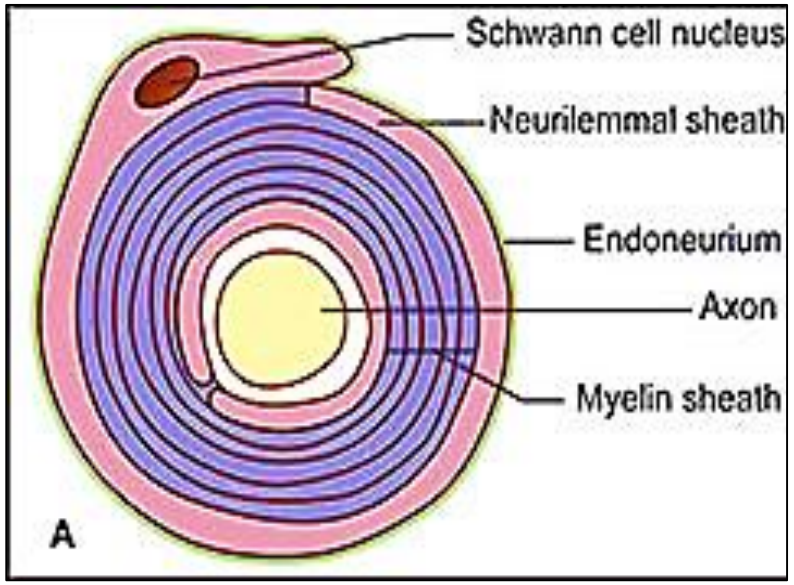
Node of Ranvier (NOR) increases conduction velocity of the action potential (= rate of transmission of impulse).

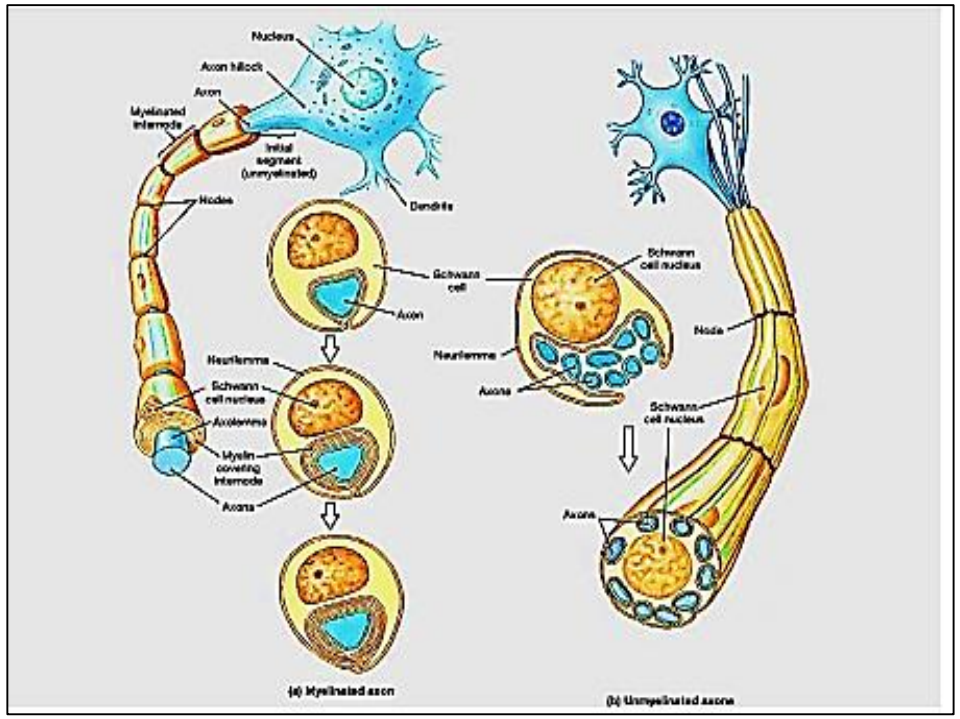
action potentials "jump" between Nodes of Ranvier→ Saltatory conduction

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- Schwan cell sheath (neurilemmal sheath)

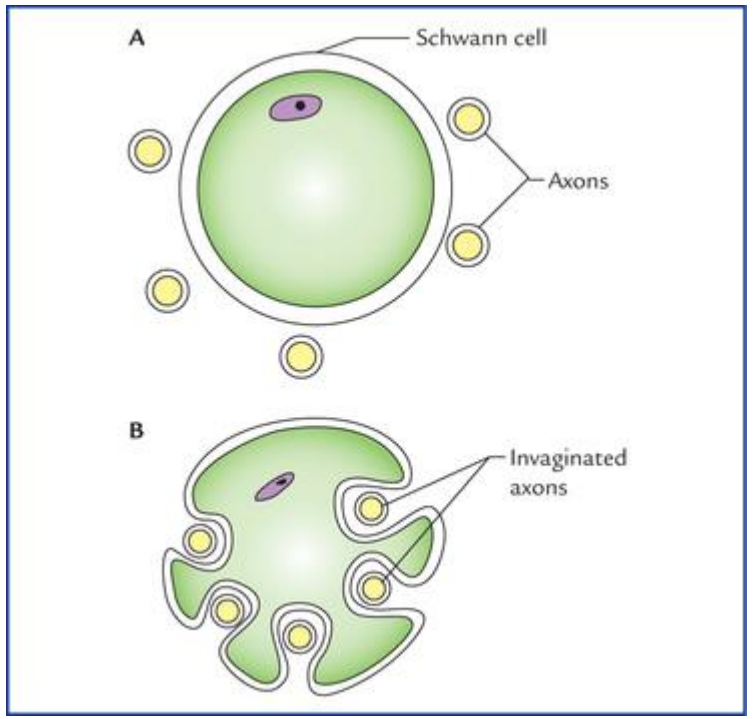
- Formed by cell membrane of Schwan cells and after forming the myelin sheath
- **Neurilemma** has supportive function for peripheral nerve fibers & imp for nerve regeneration (damaged nerve fiber may regenerate if the cell body of Schwan cell is not damaged)

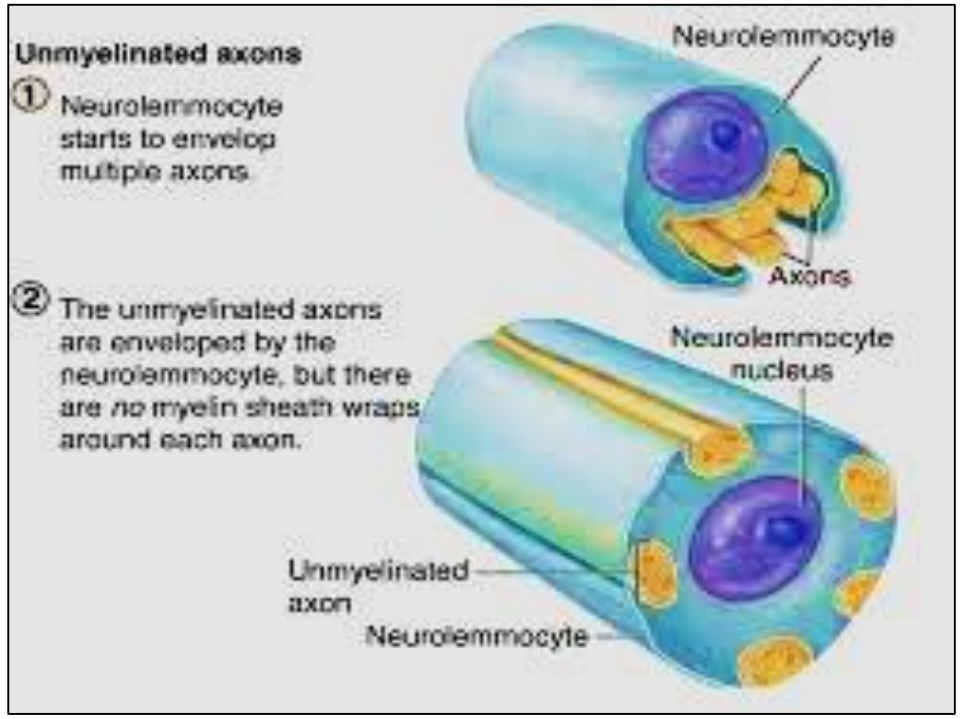


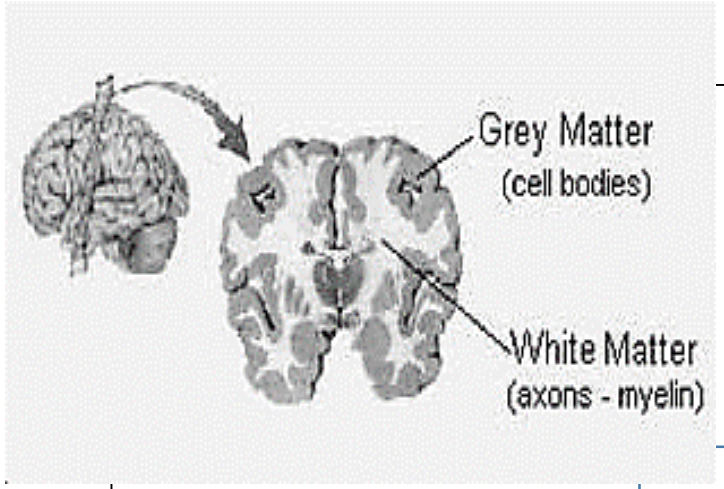


Unmyelinated nerve fibers in PNS

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







2- Types of nerve fiber in CNS

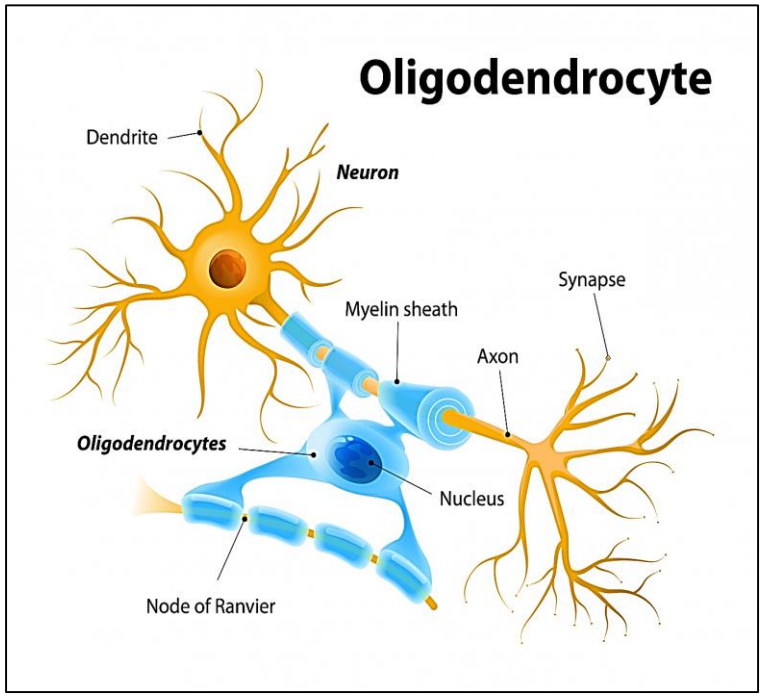
- **Myelinated without neurilemma**
  - **White matter**
- **Naked**
  - **Grey matter**

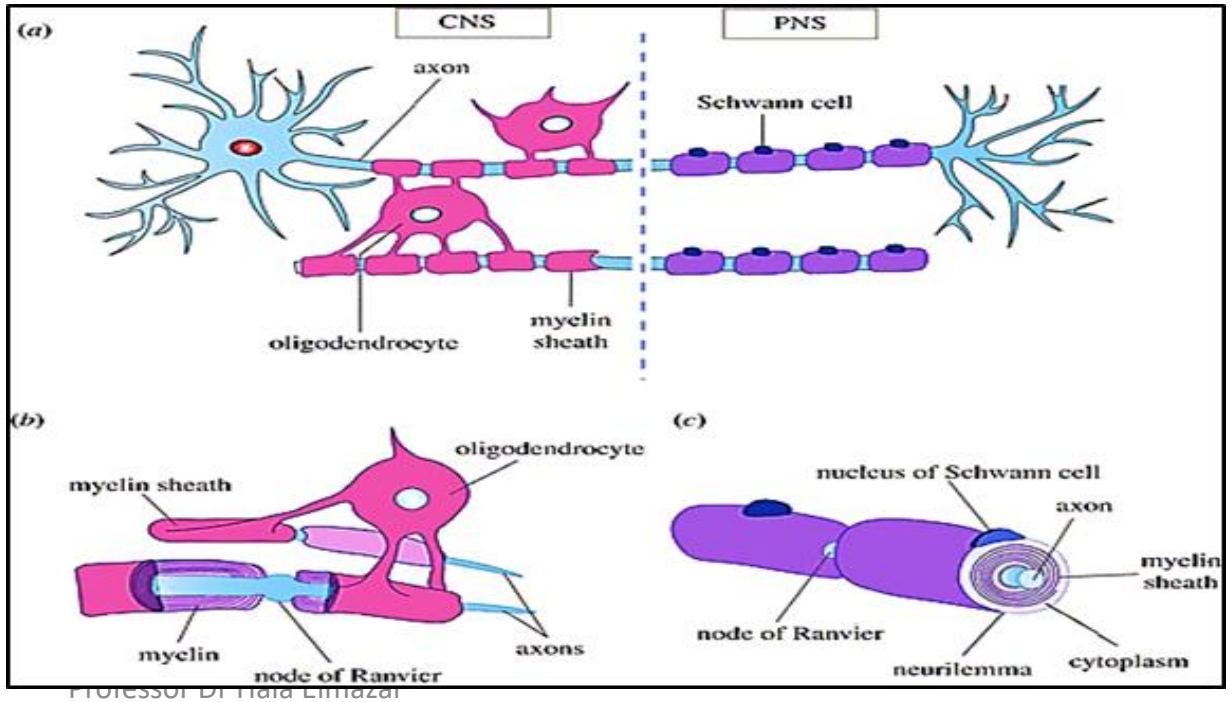
Q: Myelin of CNS is formed by _____?

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

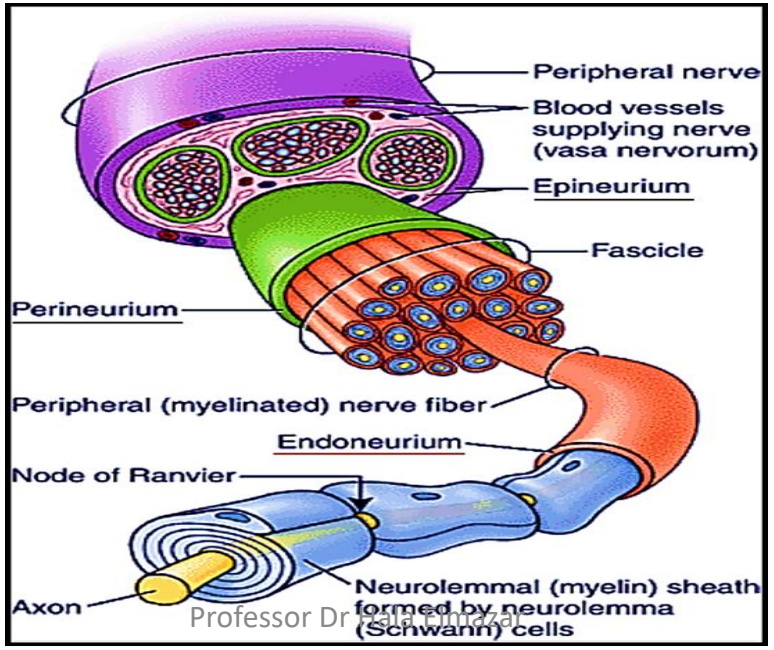
(Nuerilemma is a Key difference between PNS & CNS in regeneration ability)

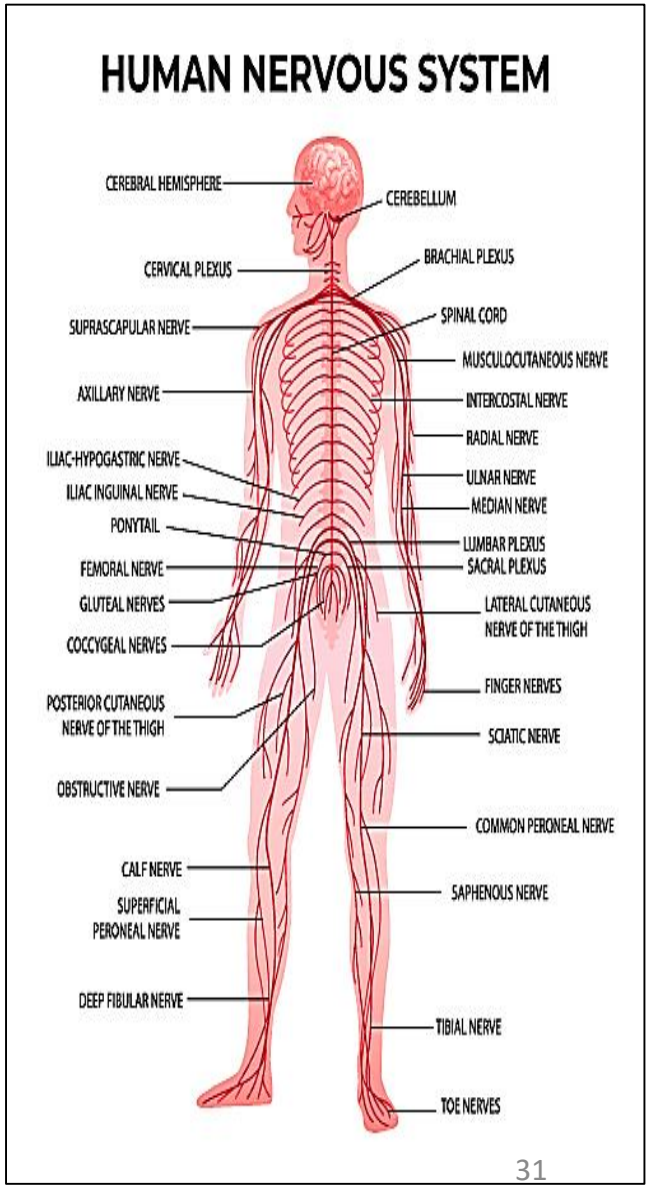




Peripheral nerve = nerve trunk

- 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:

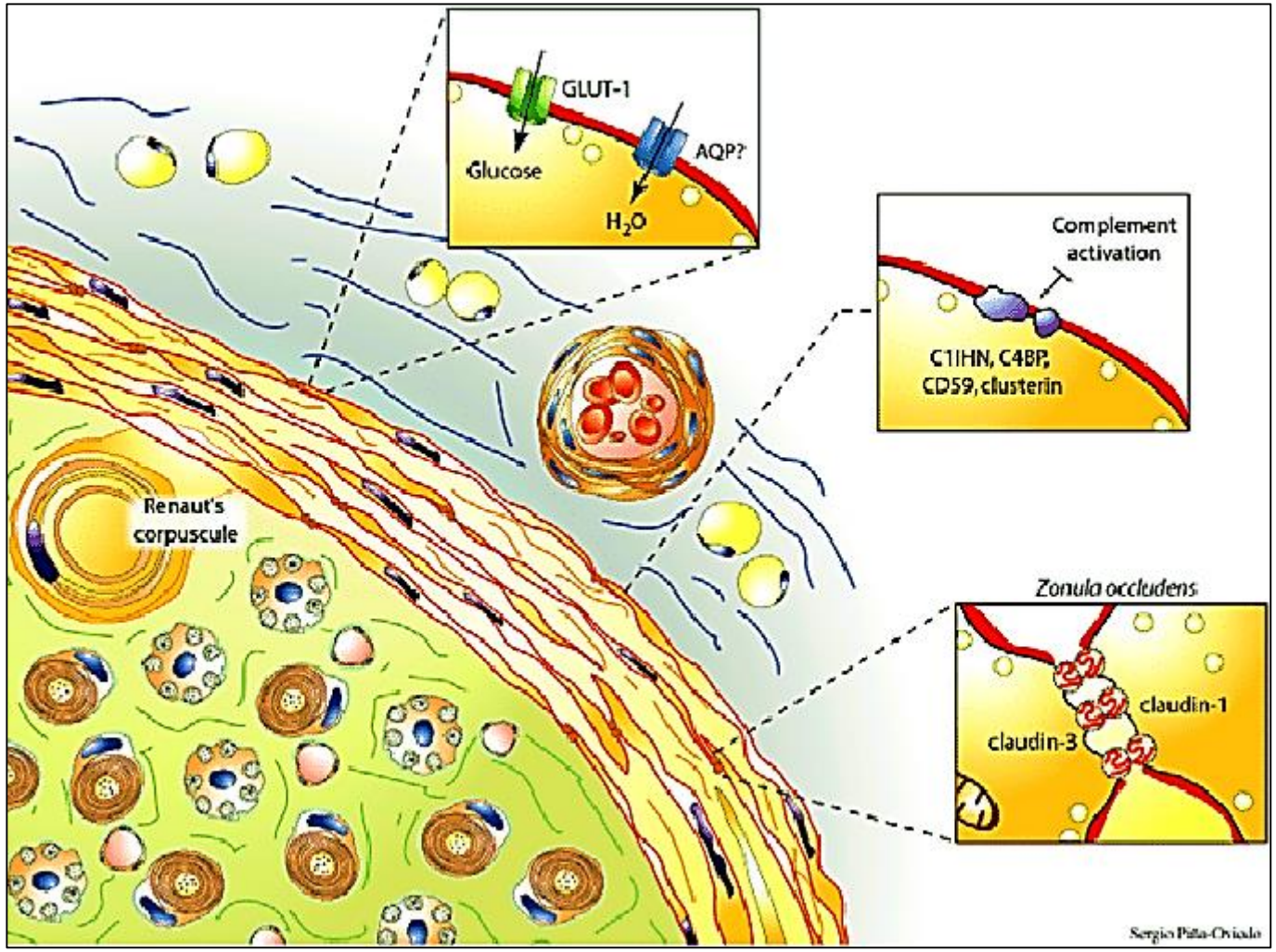
- Dense CT the outermost covers of the nerve trunk
- Consists of longitudinally arranged collagen fibers
- Fat cells are seen enclosed to act as shock absorber

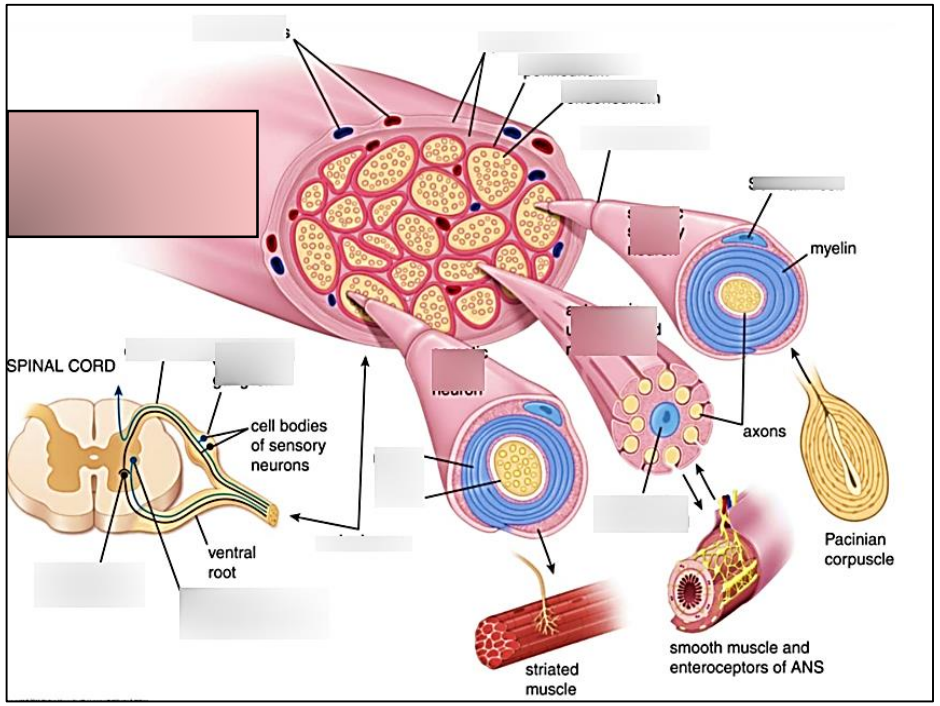
Perineurium:

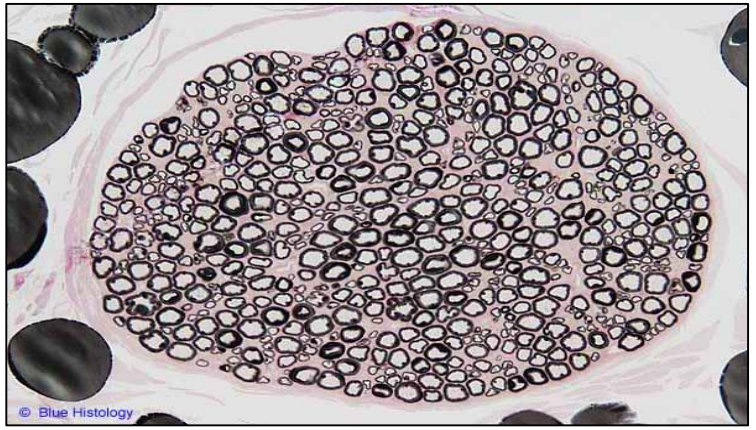
- Surround each bundle (fascicle) of nerve fibers
- Formed of fibroblasts joined together by tight junctions and surrounded by external lamina
- This layer forms the **BLOOD NERVE BARRIER** that prevent the passage of harmful molecules to the nerve fibers

Endoneurium:

- Thin reticular fibers surround each nerve fiber



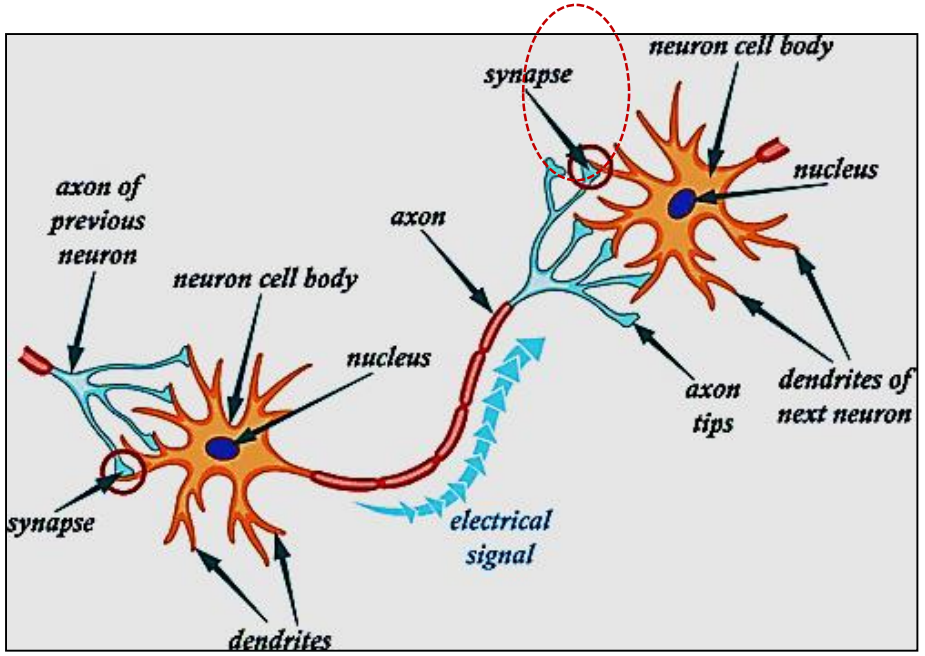


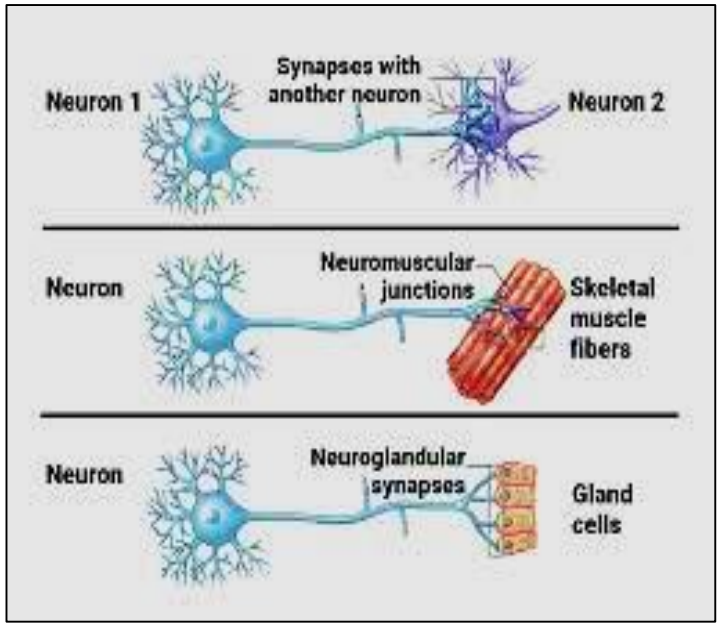


- **The perineurum forms the Blood – Nerve Barrier**
- **The majority of nerve trunks are mixed i.e contain myelinated and unmyelinated nerve fibers**
- **Osmium tetroxide stains myelinated fibers (lipids) with black**

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.

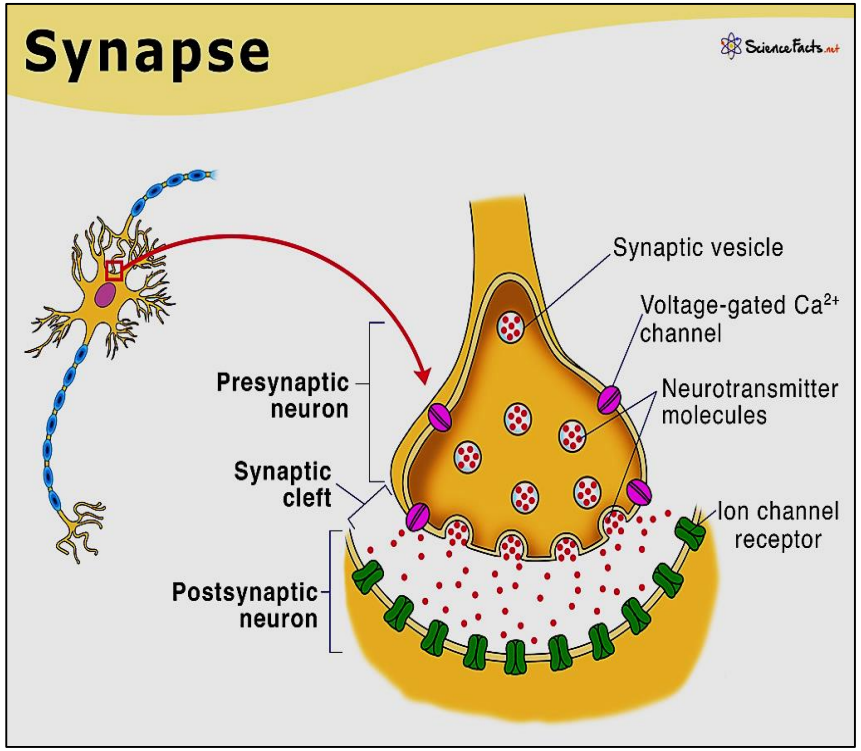




Structure of synapse

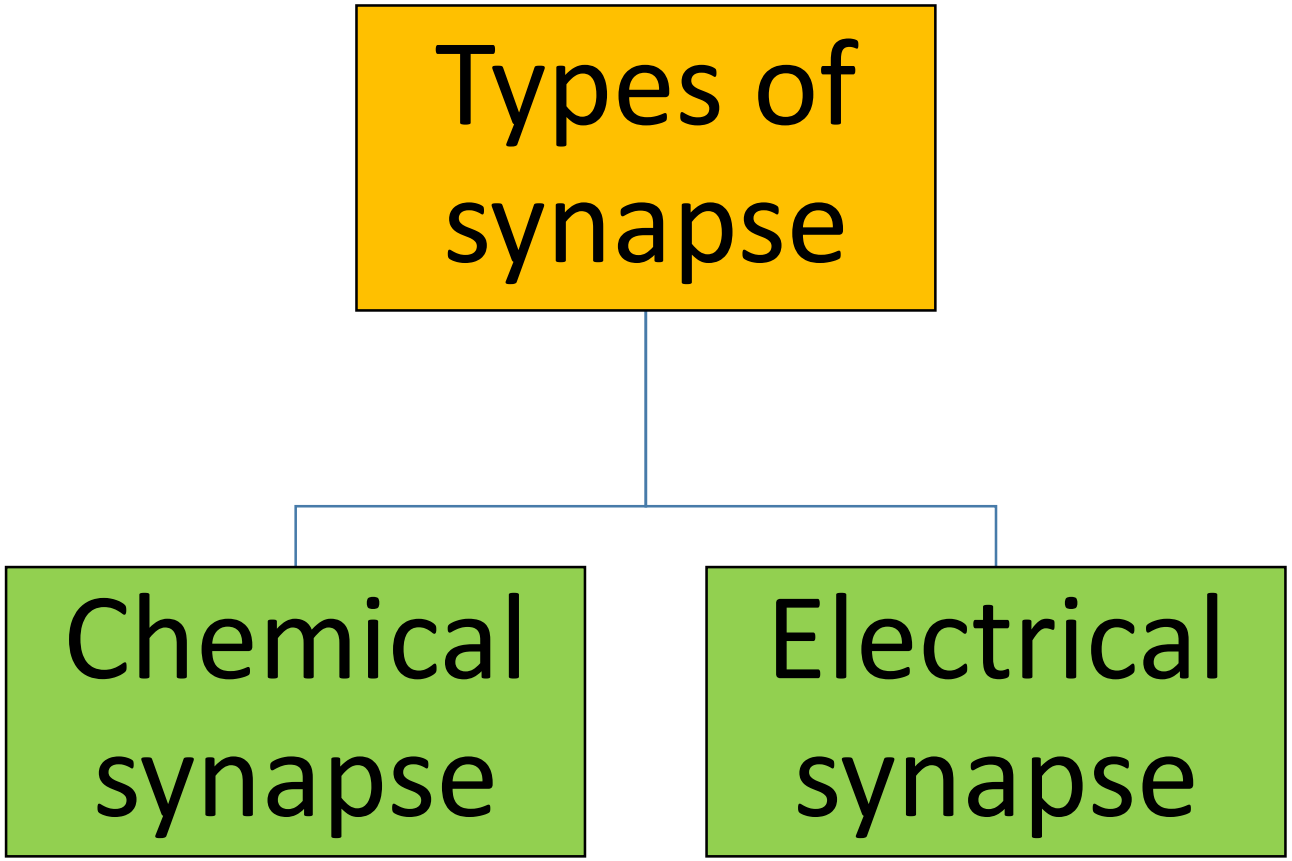
1- Presynaptic axon terminal (terminal knob):

which has vesicles that contain Neurotransmitters, ↑ mitochondria



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

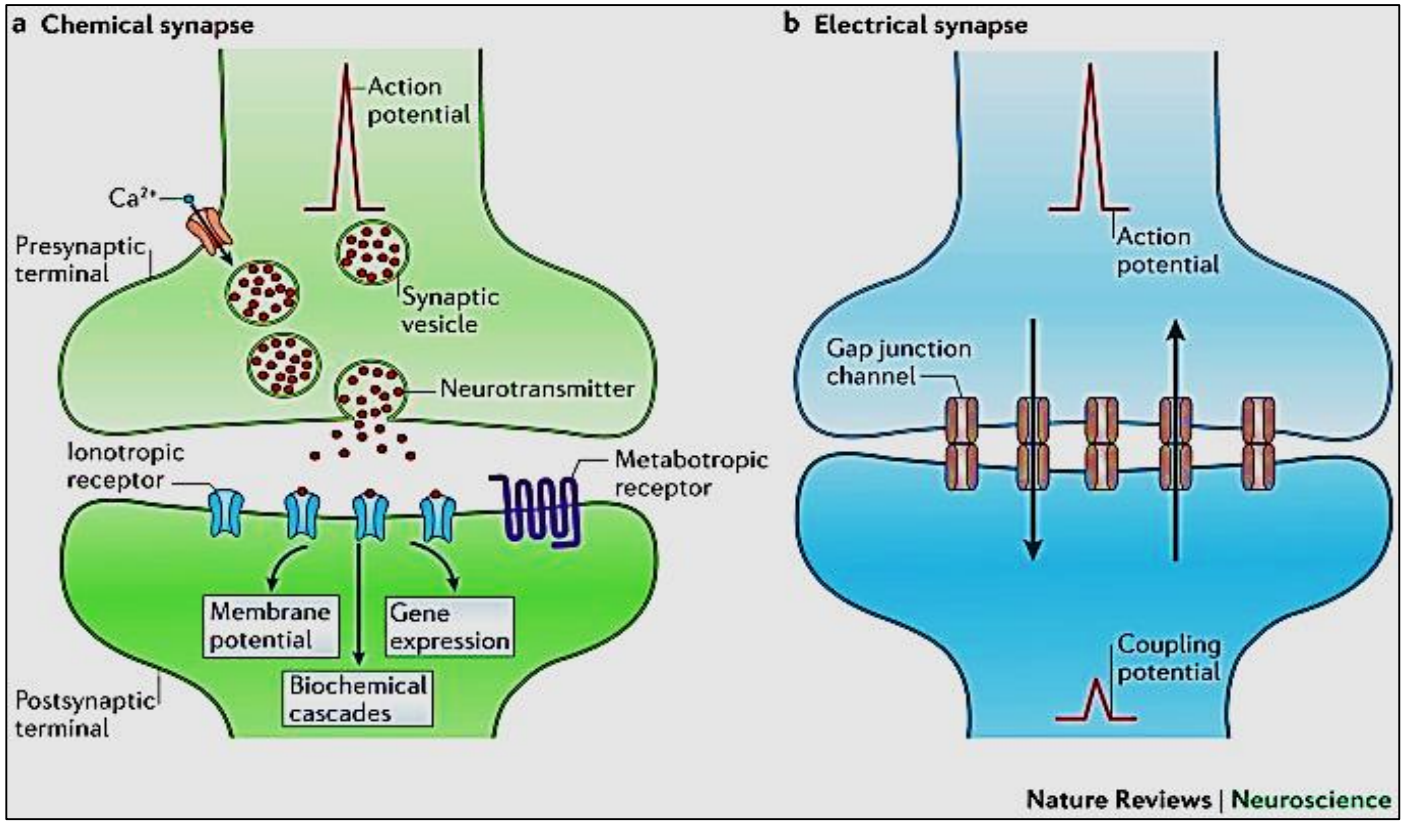
3- Postsynaptic cell membrane: which has receptors for the chemical transmitters


Types of synapse
Chemical synapse
Electrical synapse

Methods of signal transmission

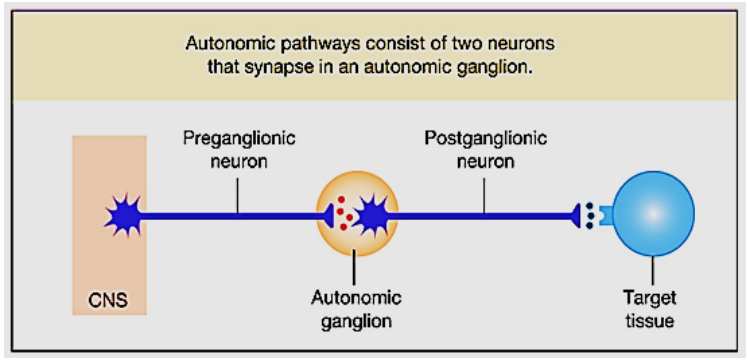
1- Chemical synapses: neurotransmitters e.g motor end plate

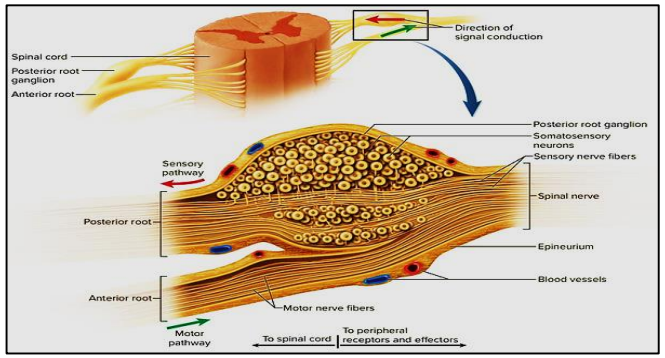
2- Electrical synapses: gap junction (ionic signals) e.g. cardiac muscles

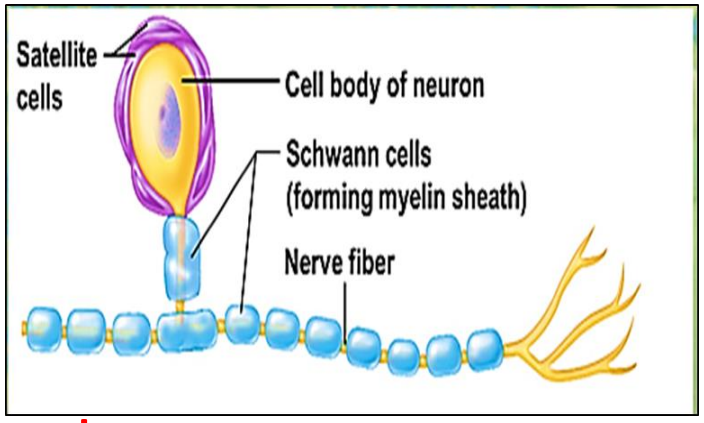


Ganglia

- 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



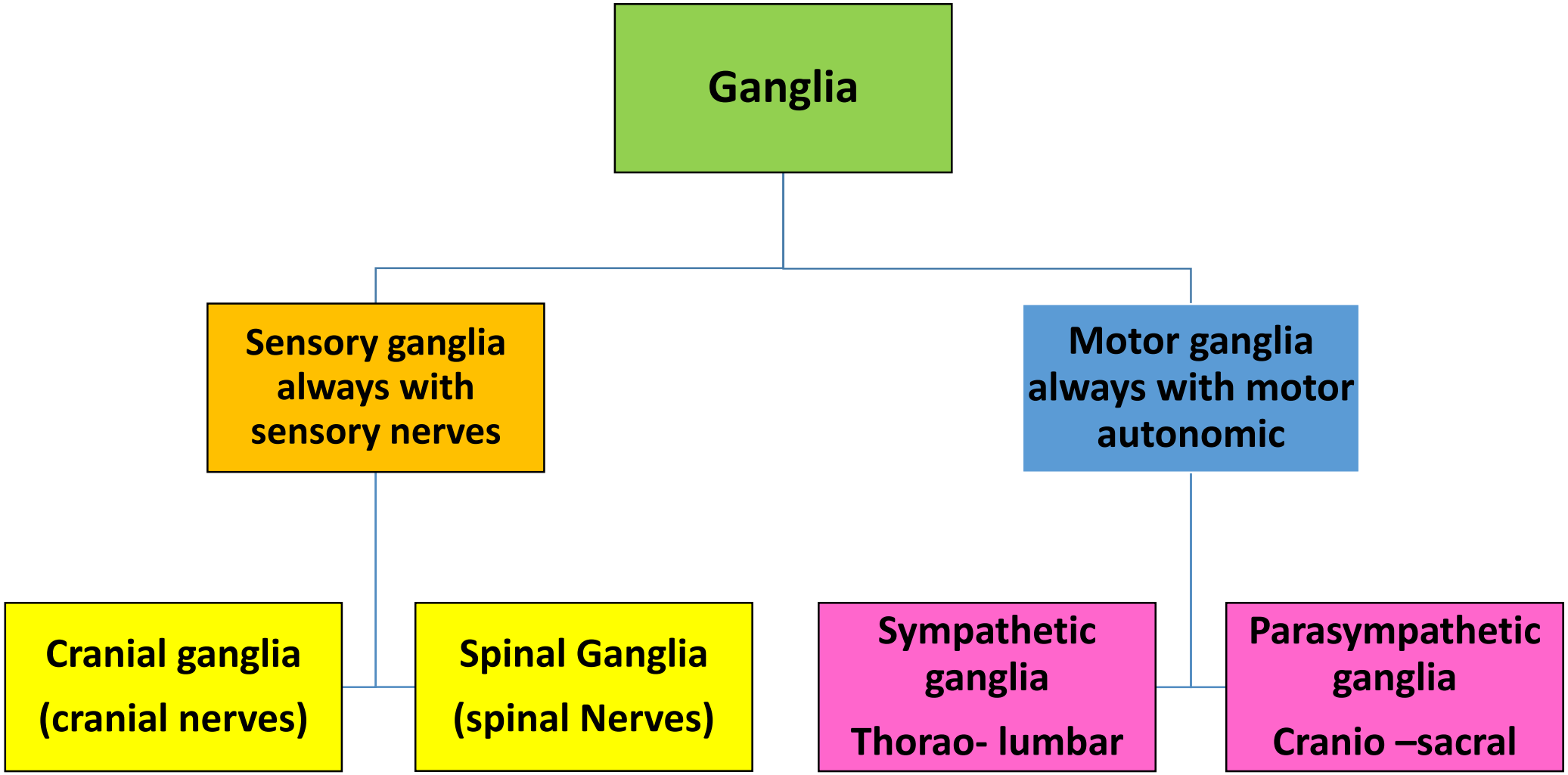


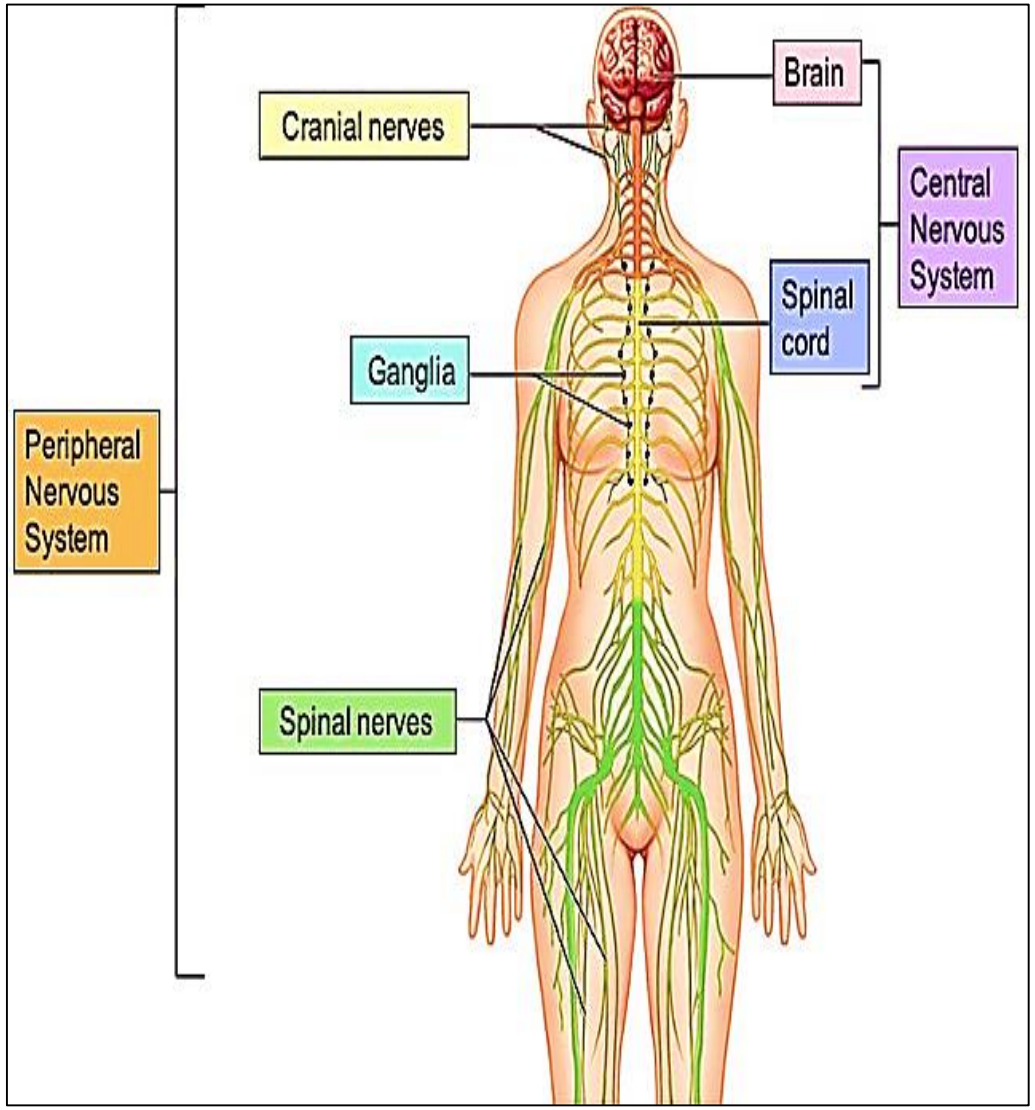


- They are two main types: up to the direction of n. impulses

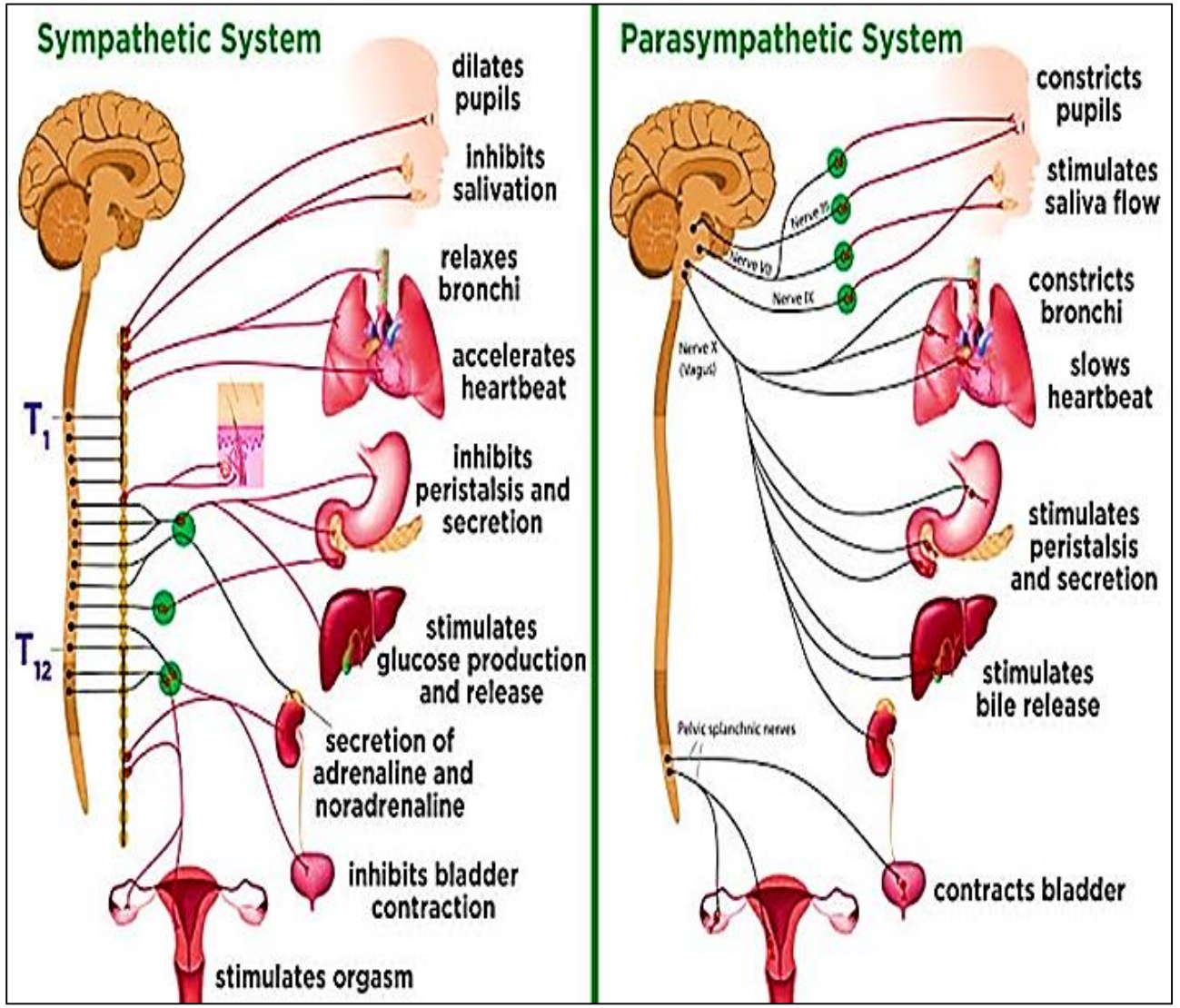
➢Sensory ganglia (sensory) : spinal & cranial ganglia

➢Autonomic ganglia (motor) : sympathetic or parasym. gan.


Ganglia
Sensory ganglia always with sensory nerves
Motor ganglia always with motor autonomic
Cranial ganglia (cranial nerves)
Spinal Ganglia (spinal Nerves)
Sympathetic ganglia Thorao- lumbar
Parasympathetic ganglia Cranio –sacral



Sensory ganglia



Autonomic ganglia

Sensory ganglia

Sensory ganglia (31 pairs)

carry **afferent** impulses to CNS

Example:

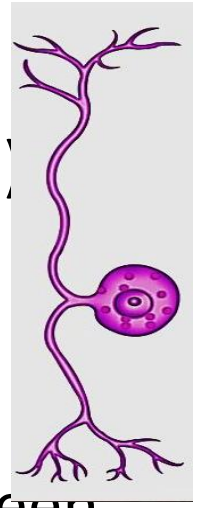
- **Cranial ganglia** e cranial nerves
- **Dorsal root g**. e spinal nerves

Nerve cell bodies are:

Unipolar (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

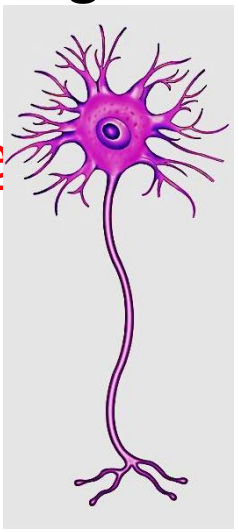
- **Sympathetic** ganglia
- **Parasympathetic** ganglia

Nerve cell bodies are

Multipolar

Small , numerous

Eccentric nuclei

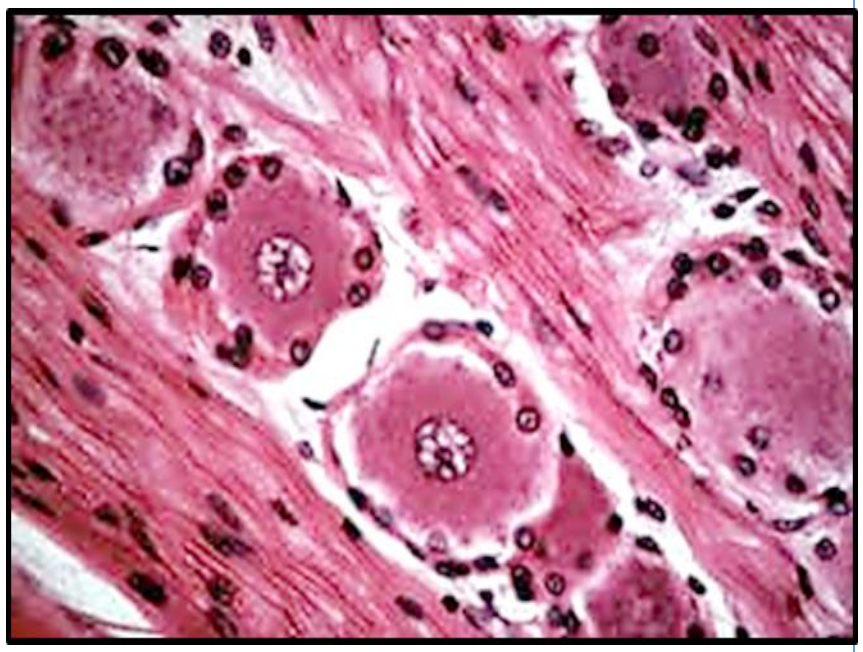


Scattered , no groups

Spinal ganglia

The groups of cells are separated with myelinated nerve fibers

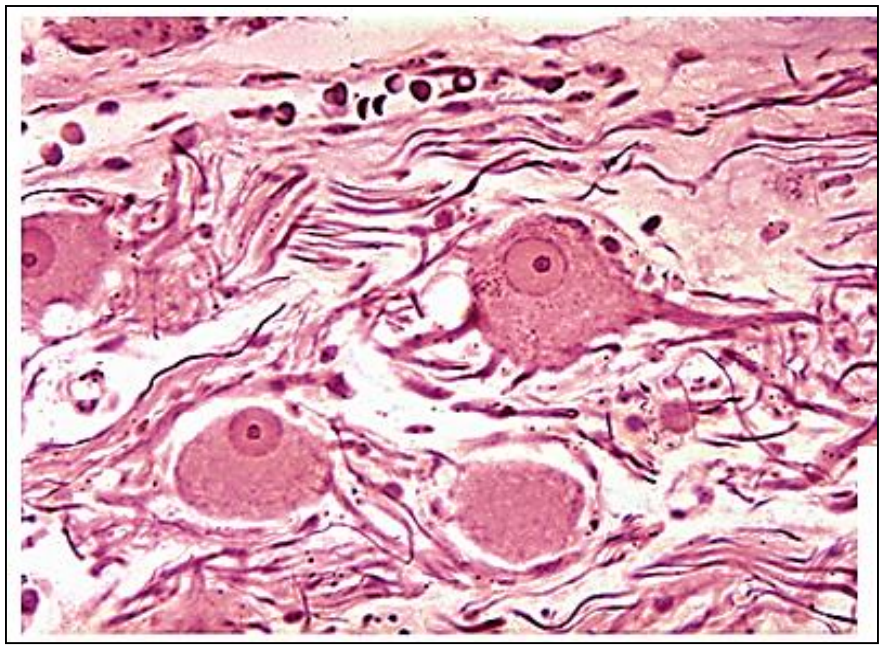
satellite cells are more around each nerve cell body



Sympathetic ganglia

The cells are separated with un/ little mylinated nerve fibers

satellite cells are less



Thank you