NERVOUS SYSTEM (NERVOUS TISSUE)

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CONTROL AND COORDINATION

Integration of all the activities of Organs so that all of them function in a synchronized fashion

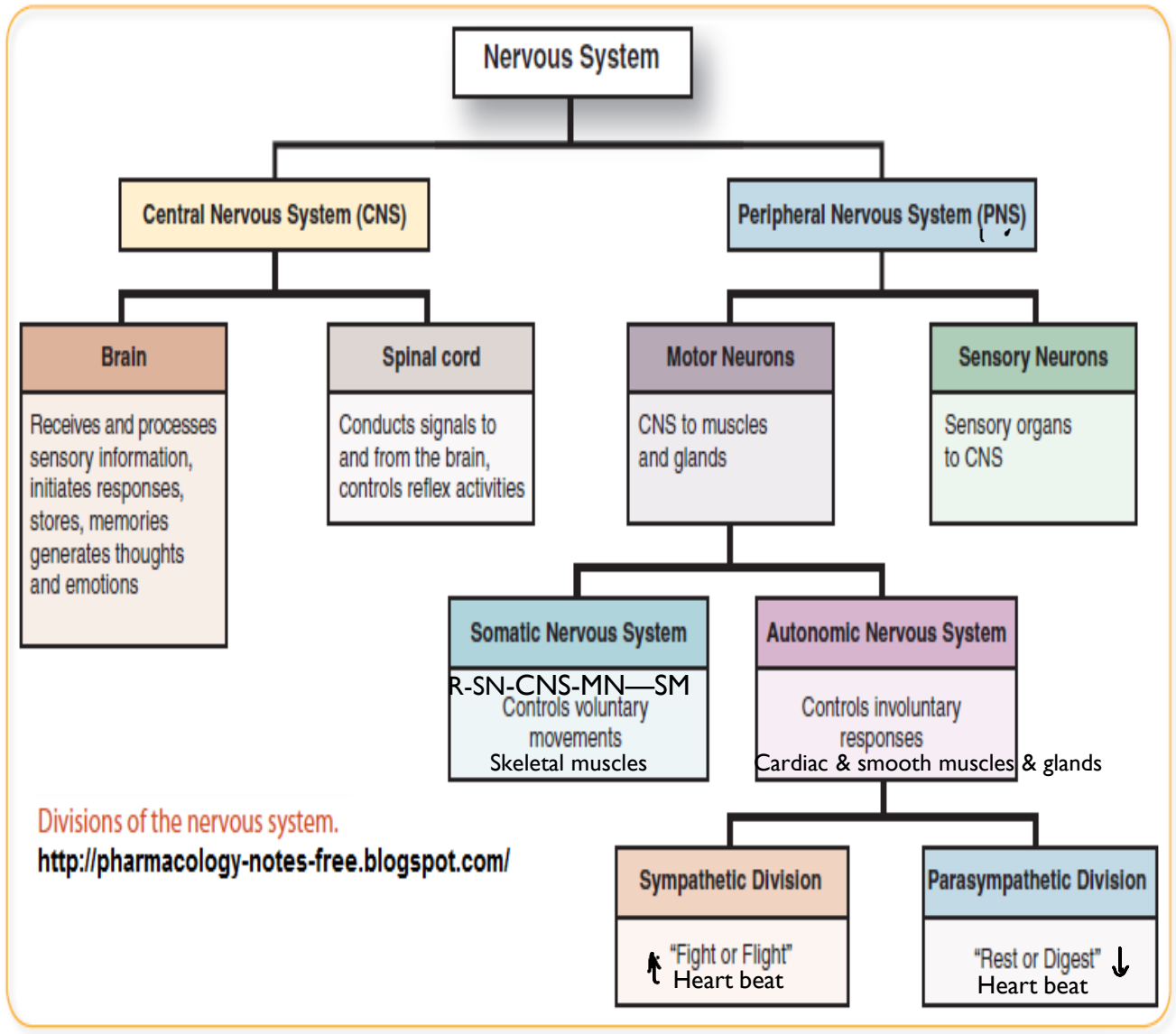
BODY (2 systems)

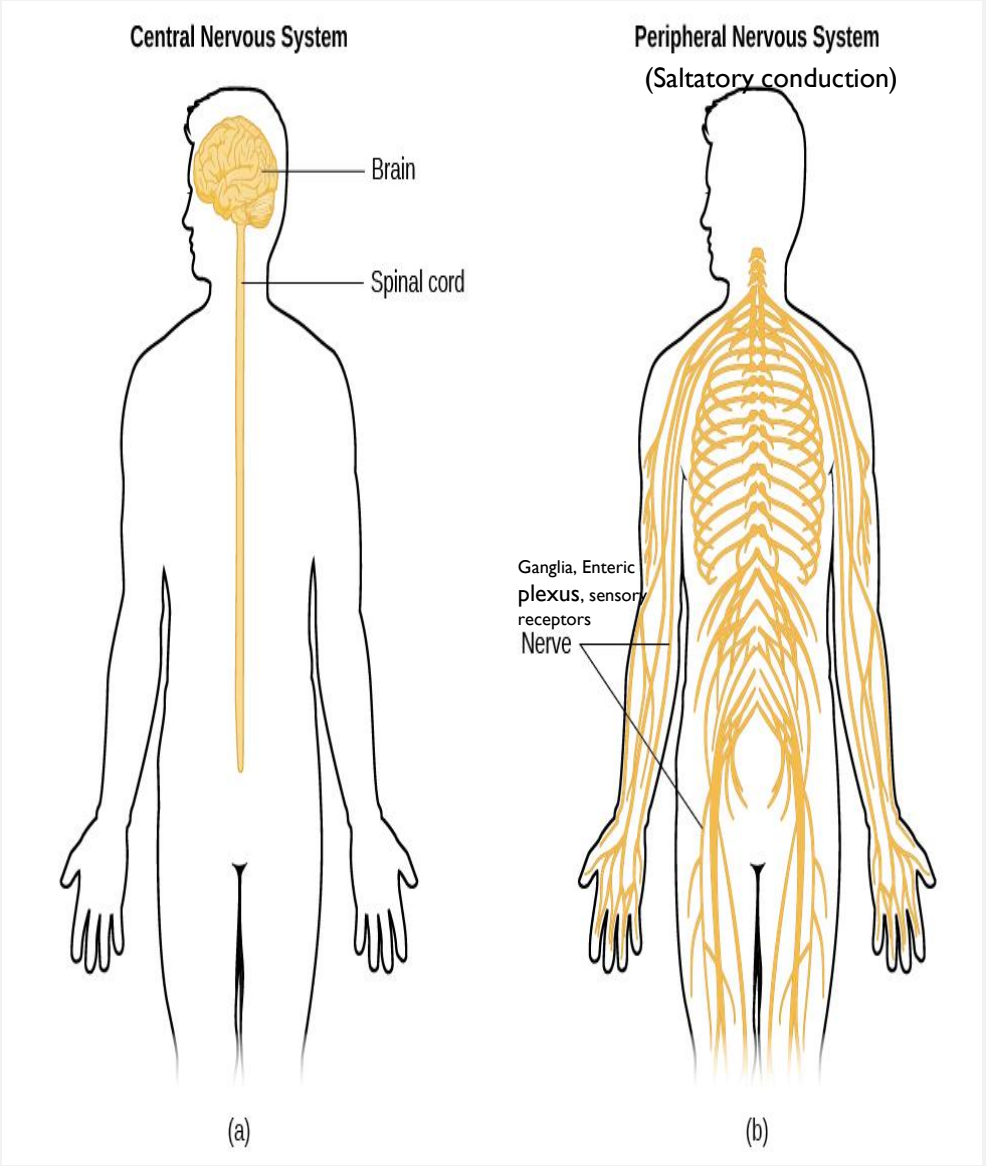
NERVOUS SYSTEM
(comprises entire mass of nervous tissues in the body)

Electric current signals (communication)
The kind of tissues which receives and Transmits stimuli in the animal body is called as **Nervous Tissue**

ENDOCRINE SYSTEM

Chemical messengers
(Hormones)





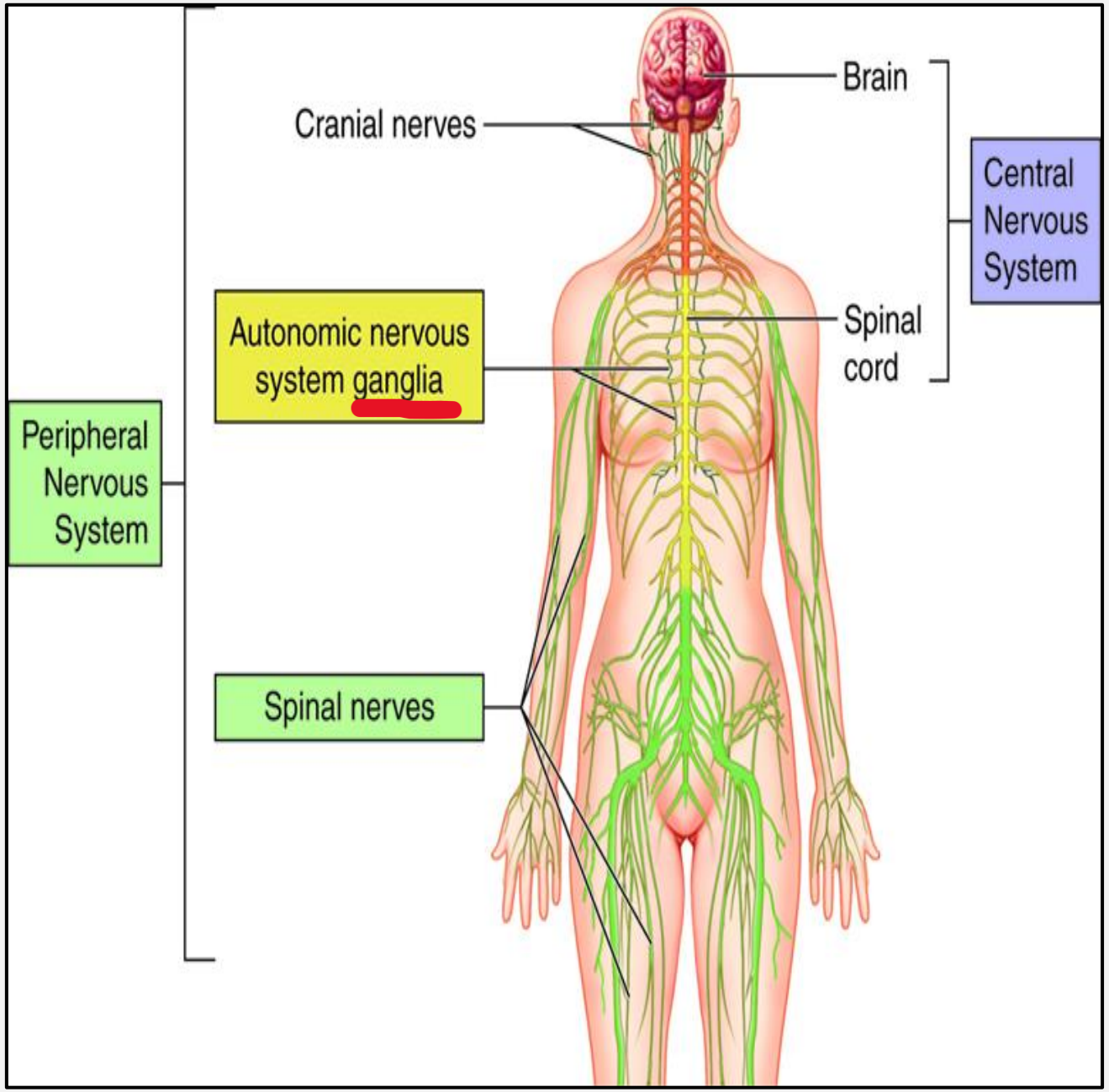
Nervous System---- main component is nervous tissue (specialized Tissue- CONDUCT IMPULSES)
Location: CNS & PNS

The **autonomic nervous system** (**ANS**), sometimes called the **visceral nervous system** and formerly the **vegetative nervous system**, is a division of the nervous system that operates internal organs, smooth muscle and glands

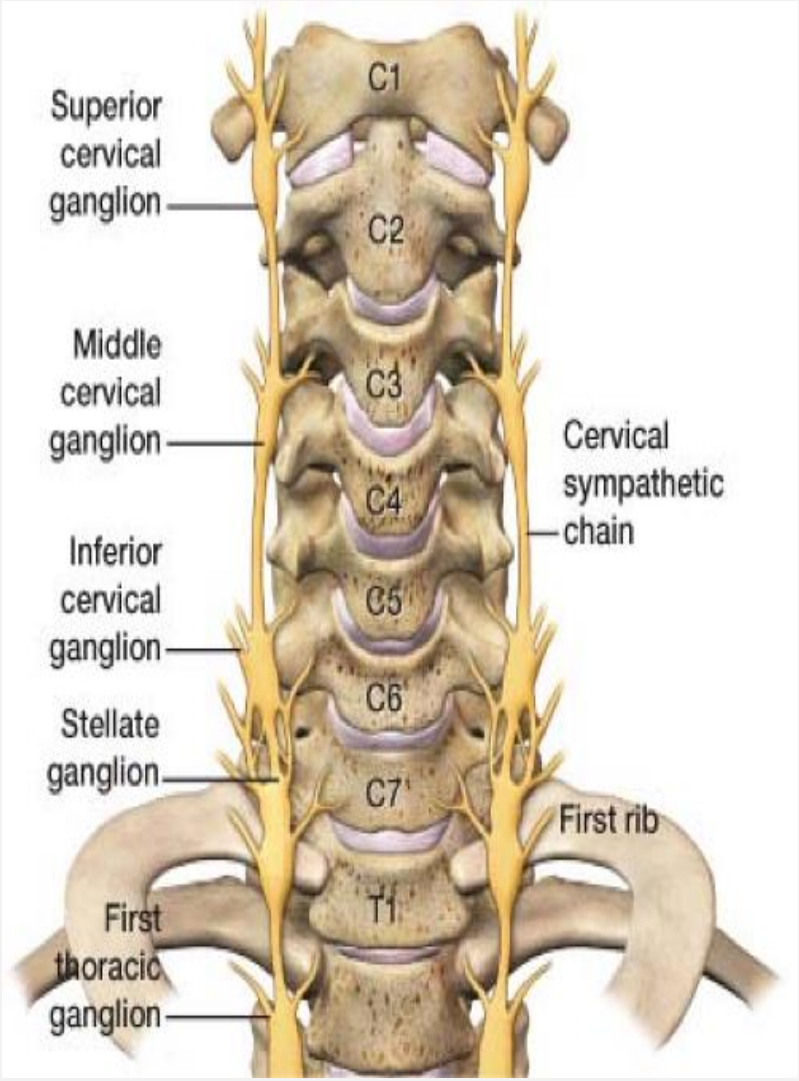
The autonomic nervous system is a component of the peripheral nervous system that regulates **involuntary physiologic processes** including heart rate, blood pressure, respiration, digestion, and sexual arousal.
It contains three anatomically distinct divisions:
sympathetic, parasympathetic, and enteric.

The sympathetic, parasympathetic, and enteric nervous systems are all parts of the autonomic nervous system, which controls involuntary bodily functions, with the key difference being that

- The sympathetic system is responsible for "fight-or-flight" responses
- The parasympathetic system manages "rest-and-digest" functions, and
- The enteric nervous system specifically controls digestion within the gastrointestinal tract

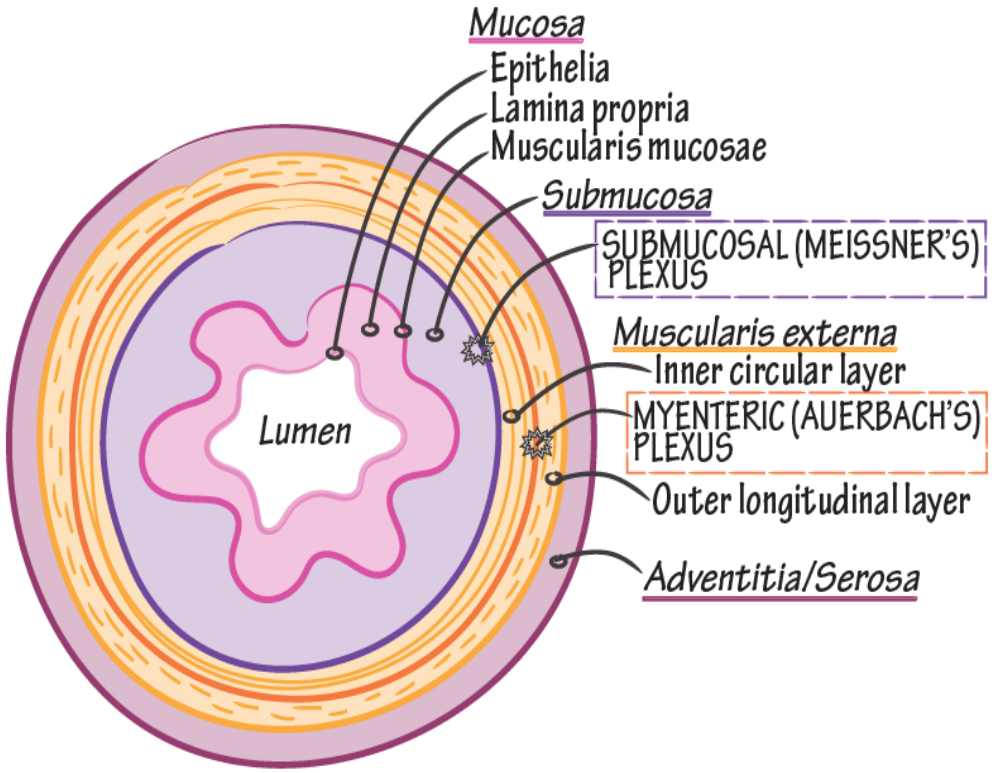

Brain
Cranial nerves
Central Nervous System
Spinal cord
Autonomic nervous system ganglia
Peripheral Nervous System
Spinal nerves

GANGLIA


C1
Superior cervical ganglion
C2
Middle cervical ganglion
C3
Cervical sympathetic chain
C4
Inferior cervical ganglion
C5
C6
Stellate ganglion
C7
First rib
T1
First thoracic ganglion

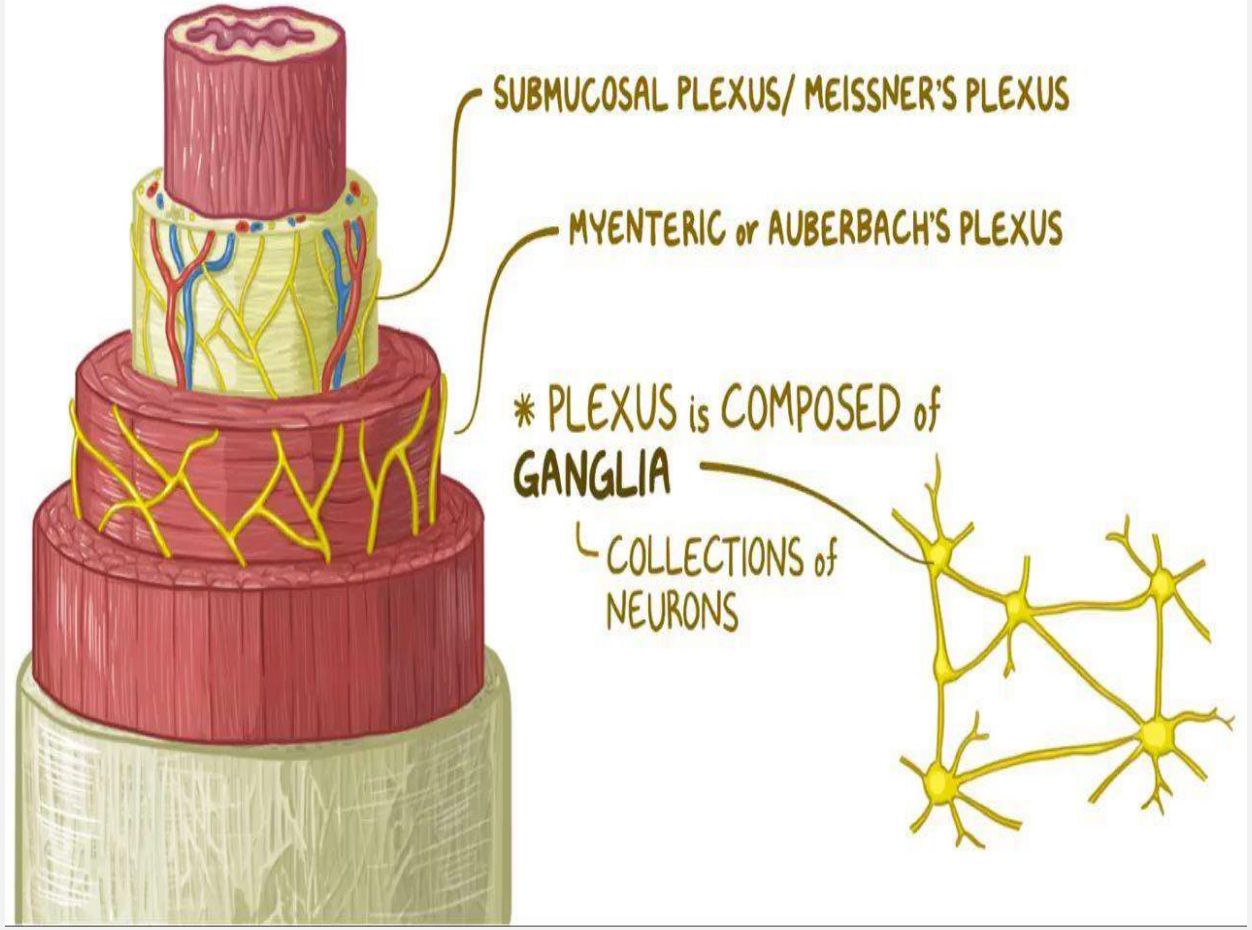
INTRINSIC

GI tract wall: Cross Section



ENTERIC NERVOUS SYSTEM

* FOUND WITHIN WALLS of ENTIRE GI TRACT



Sympathetic Nervous System

- Activated during stressful situations.
- Increases heart rate, blood pressure, and breathing rate.
- Causes pupil dilation

Parasympathetic Nervous System:

- Activated during relaxation and digestion.
- Lowers heart rate and blood pressure.
- Stimulates digestion and saliva production.
- Causes pupil constriction

Enteric Nervous System:

- Located entirely within the gastrointestinal tract.
- Controls bowel movements, absorption of nutrients, and stomach acid secretion.

NERVOUS TISSUE CONTAINS TWO CATEGORIES OF CELL

1. Neuron

(A nerve cell with its processes that forms the structural and functional unit of the nervous system)

2. Neuroglia Or Glial Cell

(Supporting cells in nervous system)

Structure of a Typical Neuron

Processes- 2 types
1. Short one-dendrites
2. long one -axon

Dendrites
(Thickness decreases)

(Dendron)
origin point:5-10µm)
- Contains Nissl granules, neurofibrils and neuron membrane

(Cytoplasm)
neuroplasm

Axon Terminals

Axon Hillock (Conical elevation of cell body, next-small uniform diameter)

Nucleus

Node of Ranvier

Schwann's Cells

(Neurilemma)
Outermost layer of schwann cells that surrounds axons of peripheral nerve fibres, which remains even in unmyelinated neurons
Absent in CNS-Oligodendrocytes Form Myelin

Axon
Long elongated generally branchless cytoplasmic process comes out of cell body
Axon length variable
Motor neurons: axon longer than dendrites

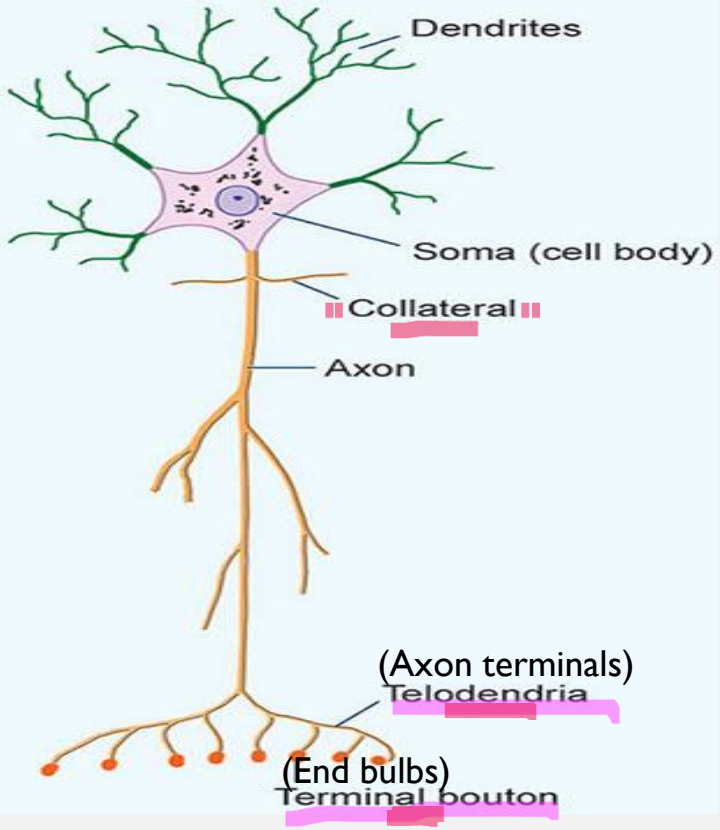
Myelin Sheath

Axoplasm
(Contain: mitochondria, neurofibrils but no Nissl granules

Cell Body(Soma/Centron/Cyton/Perikaryon)-100µm diameter

DENDRITES
Distribution: Brain Spinal cord
Function: Receives nerve impulses

AXON/ AXIS CYLINDER
Distribution: white matter of CNC & PNS
Functions: transmits impulses away from cell body



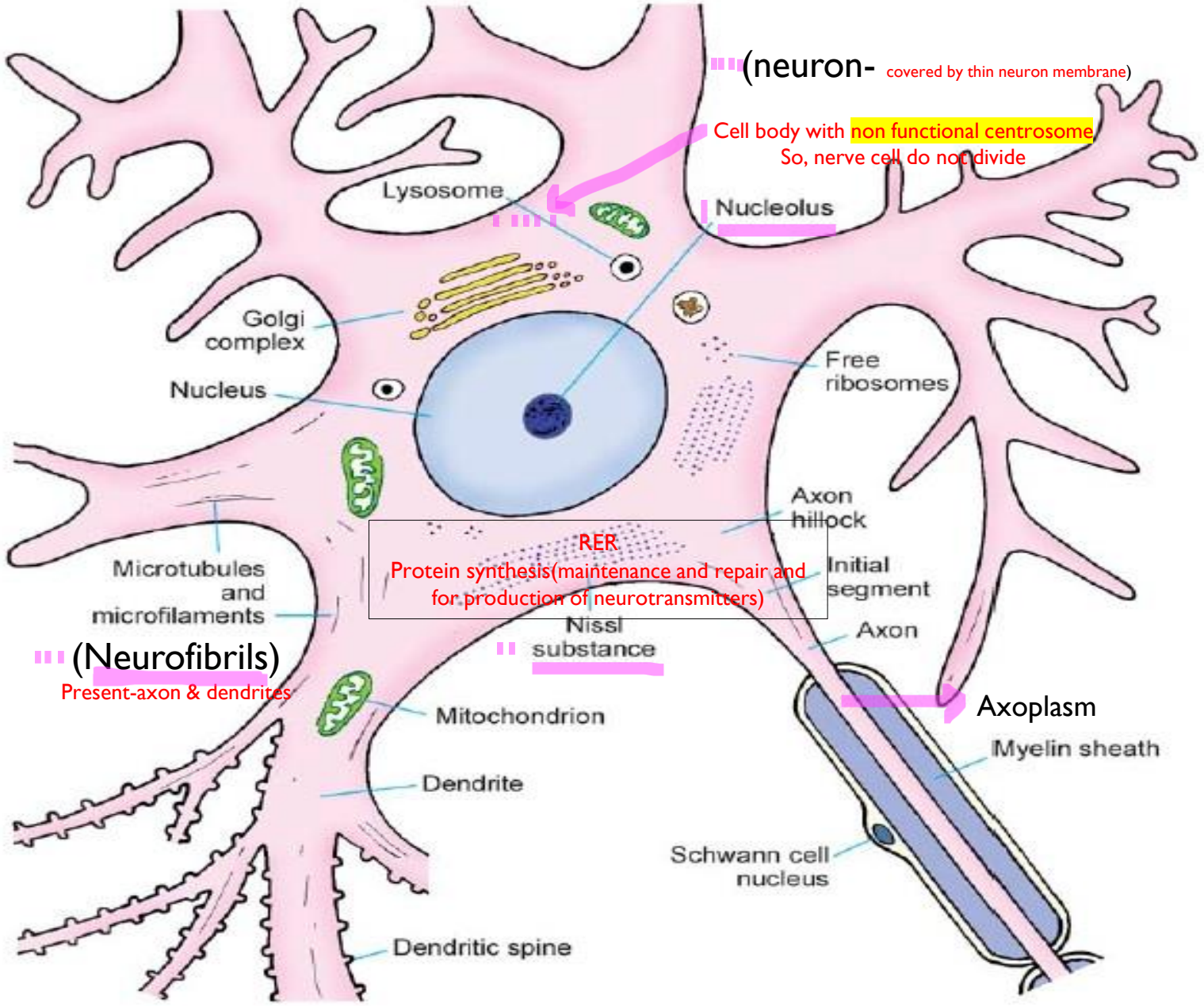


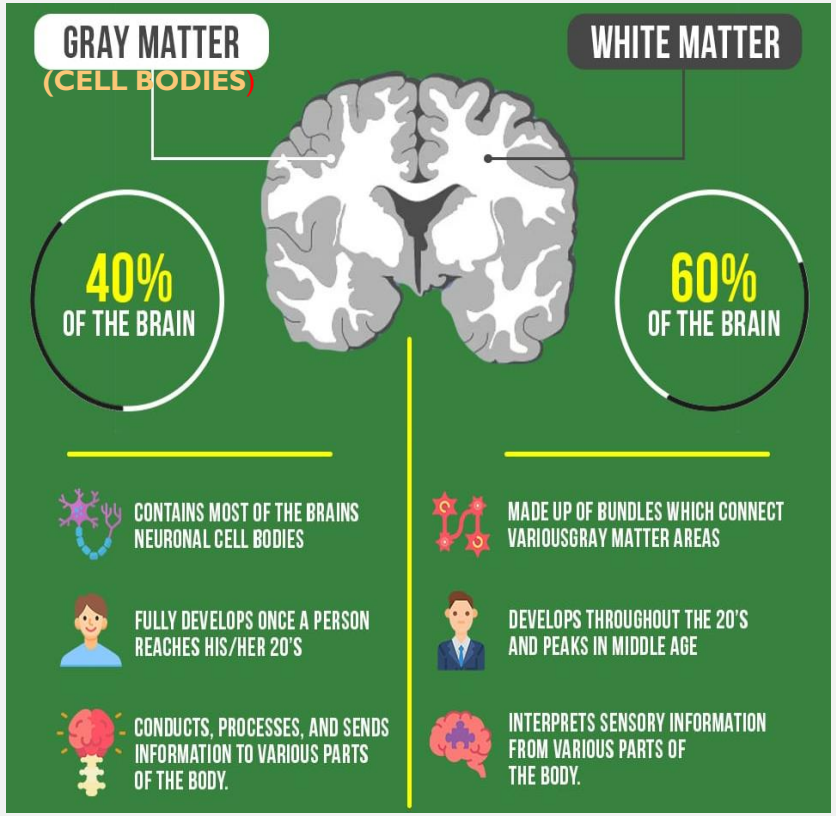
Fig. 1.2. Schematic presentation of some features of the structure of a neuron as seen by EM.

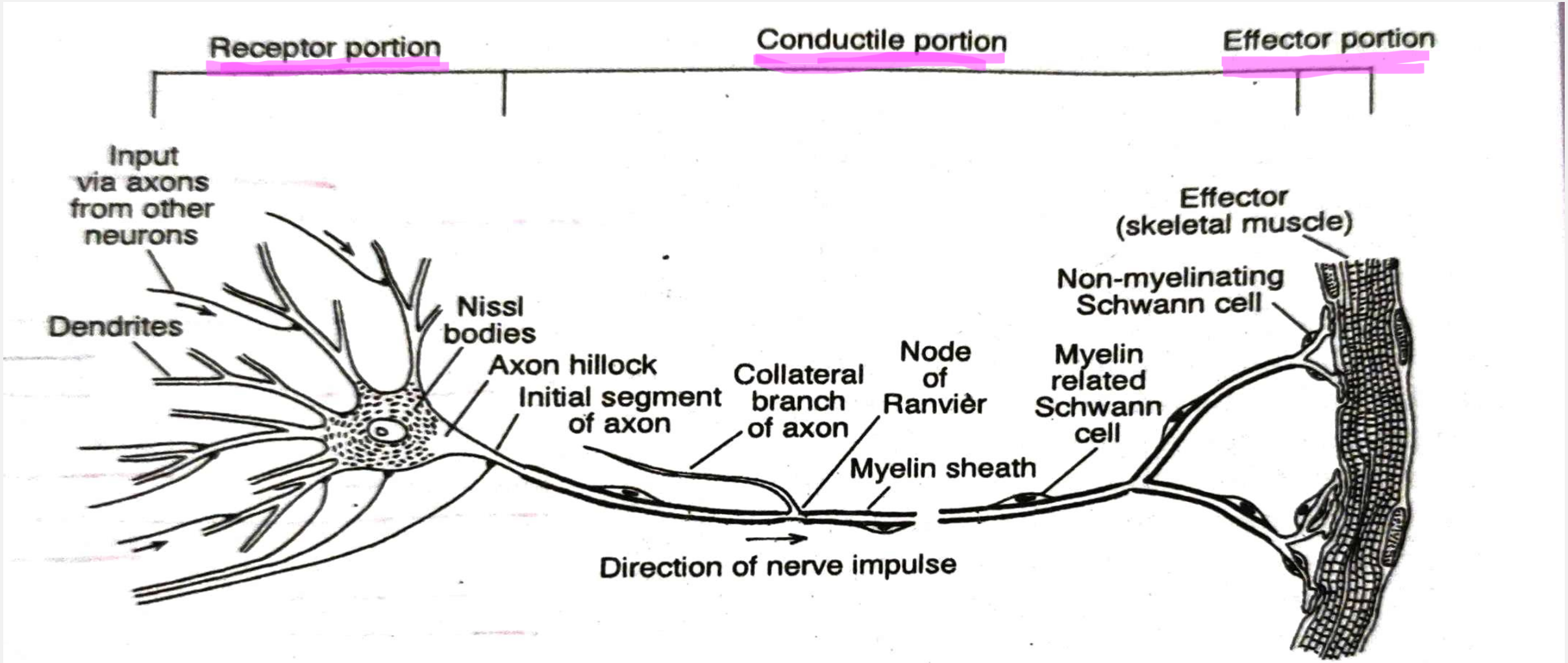
Distribution:

Brain (Grey matter)
Spinal cord

Function:

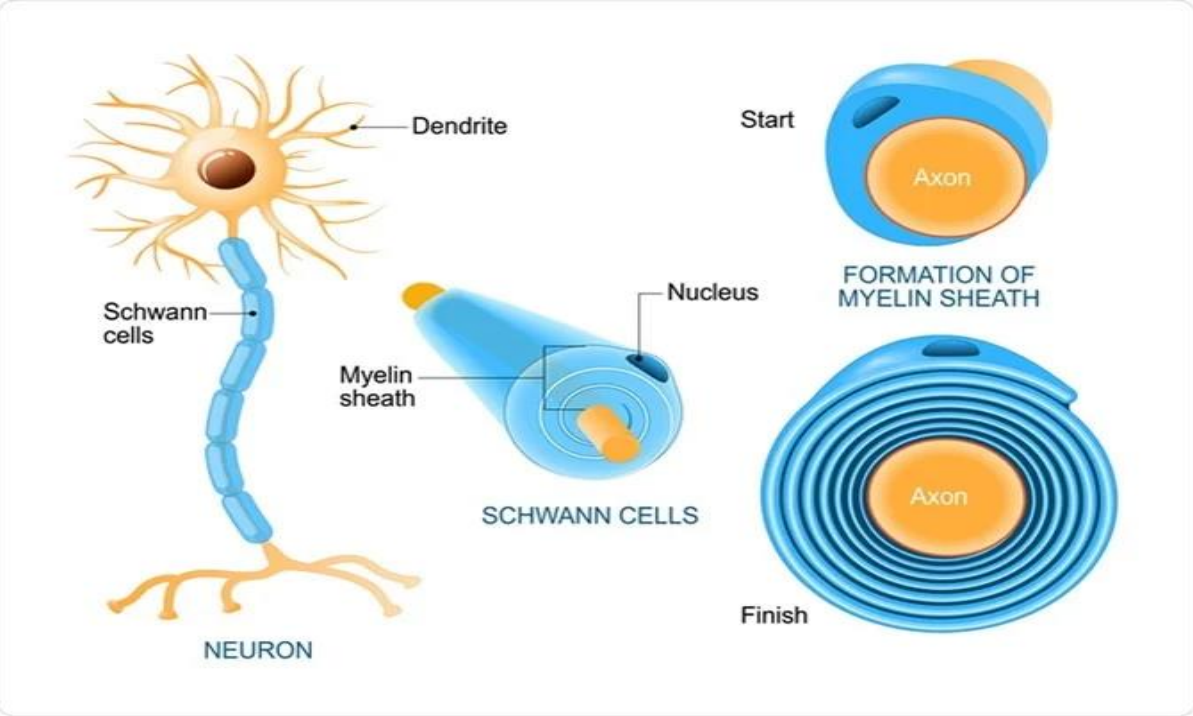
Cell body regulates and coordinates the function of a neuron

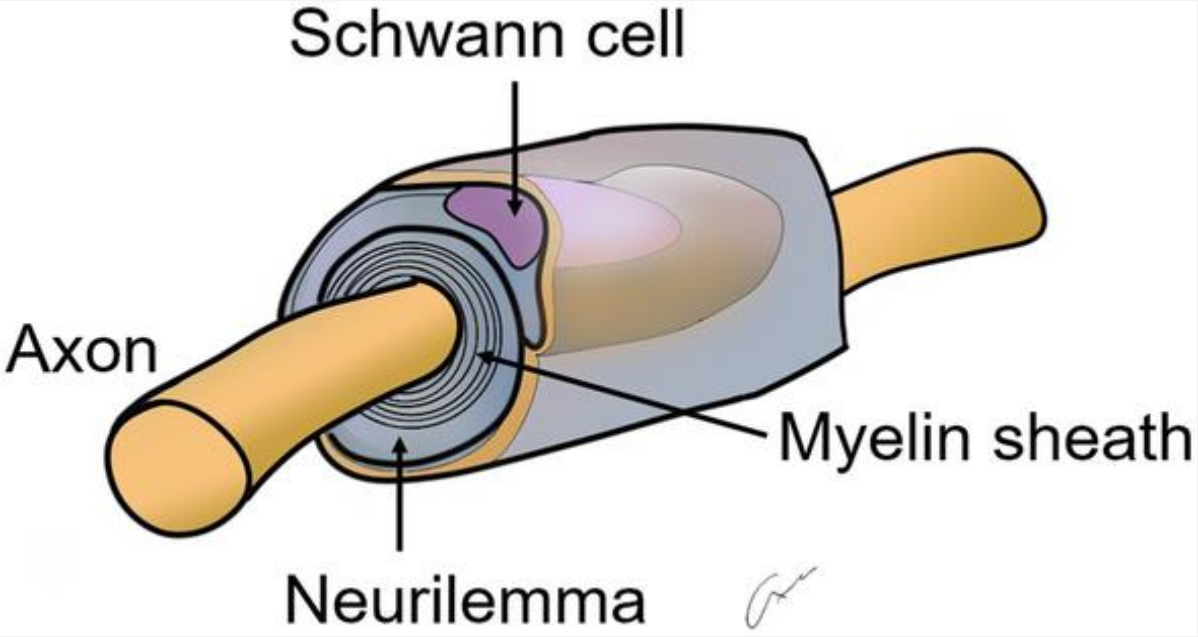




(d).1: This diagram illustrates the receptor, conductile, and effector portions of a typical large neuron. The effector endings on skeletal muscle identify this as a somatic motor neurom; in many neurons the effector endings are applied to the receptor portions of other neurons. The presence of the myelin sheath on the conductile portion of the neuron (the axon) increases conduction velocity. The axon is shown to be interrupted, for it is much longer than can be illustrated here.

SCHWANN CELLS





A well-developed Schwann cell **is shaped like a rolled-up sheet of paper, with layers of myelin between each coil.**

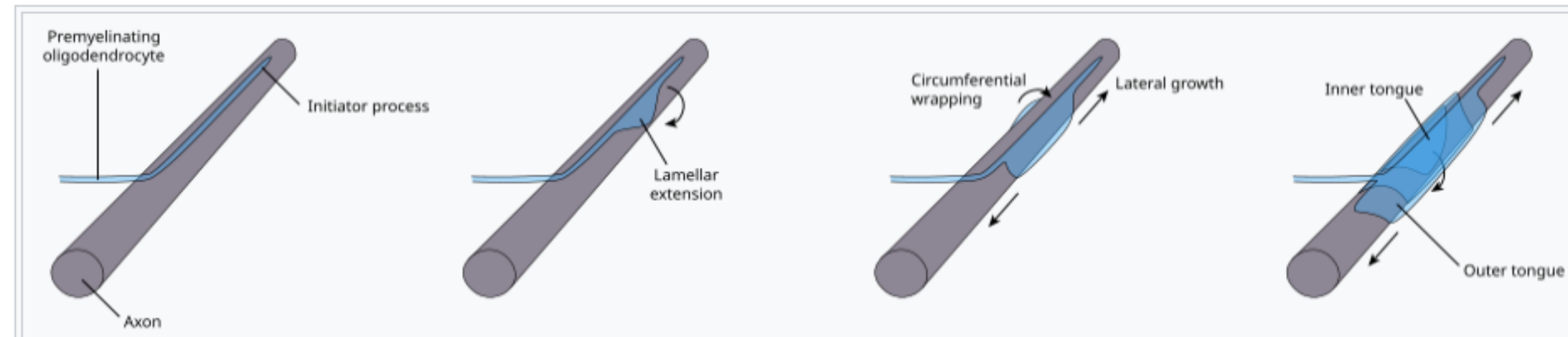
The inner layers of the wrapping **forms the myelin sheath**, while the outermost layer of nucleated cytoplasm forms the **neurilemma.**

Individual myelinating Schwann cells cover about 1 mm of an axon—equating to about 1000 Schwann cells along a 1-m length of the axon.

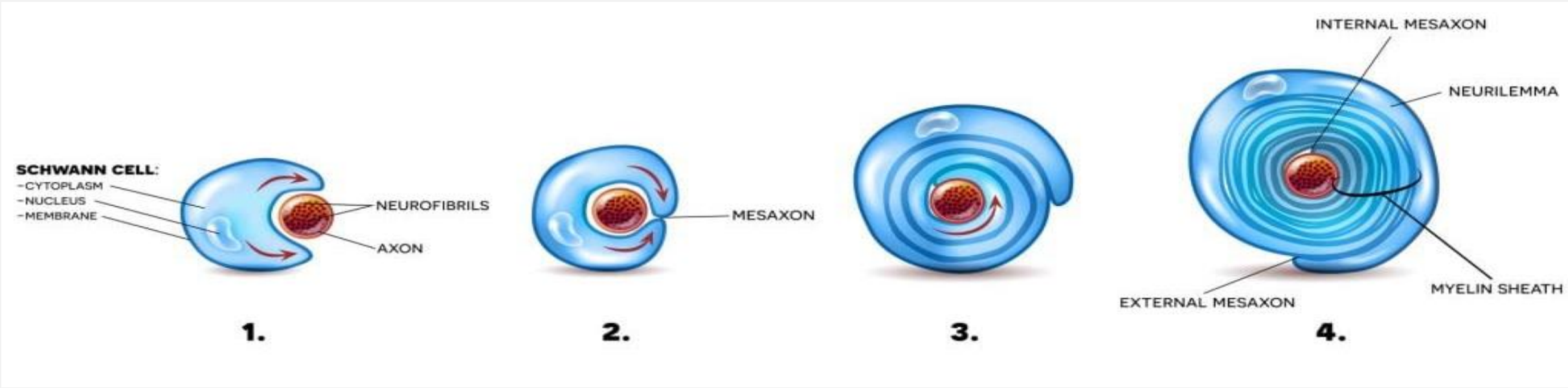
FUNCTION:

- ***Myelin sheath in PNS.***

THE FORMATION OF THE MYELIN SHEATH-MYELINOGENESIS



Myelination in the central nervous system by an oligodendrocyte



Differences between Axon and Dendrite

Character	Axon	Dendrite
1. Number	Axon is long and single which originates from the axon hillock of a cell body.	More than one short processes originate from the cell body of a neuron.
2. Branching	Generally unbranched.	More short branches are present in a dendrite.
3. Length	Longer in length.	Shorter in length.
4. Myelin sheath	Axon is myelinated.	Devoid of myelin sheath.
5. Neurilemma	In axon neurilemma is present.	Devoid of neurilemma.
6. Axoplasm	Axoplasm is seen.	Neuroplasm is noticed.
7. Schwann sheath	Sheath with schwann cell present.	Schwann sheath with cell absent.
8. Node of Ranvier	Sheath is differentiated into nodes and inter-nodes.	Absence of node of Ranvier, i.e., sheath is not differentiated into nodes and inter-nodes.
9. Nissl's granules	Absent.	Present.
10. Function	Transmits impulses received from cell body.	Receives impulses from other neuron and transmits to the cell body.

CLASSIFICATION OF NEURONS

- STRUCTURAL CLASSIFICATION OF NEURONS (Based On No. Of Processes Extending From Cell Body)
- STRUCTURAL CLASSIFICATION OF NEURONS (Based On Variation In Axons)
- Based on Function
- Based on presence or absence of myelin sheath

STRUCTURAL CLASSIFICATION OF NEURONS

(Based On No. Of Processes Extending From Cell Body)

Neurons Based on Structure

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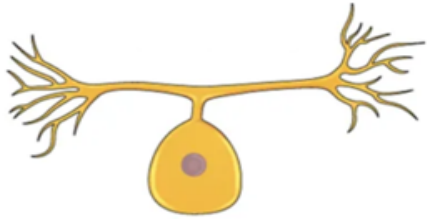
Unipolar

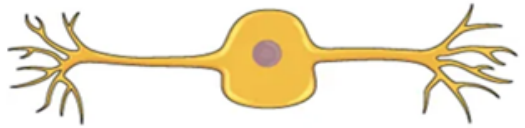
Only one process that extends from the cell body. Primary afferents of spinal and some cranial nerves in vertebrates
most common neurons in the CNS of invertebrates

Psuedopolar



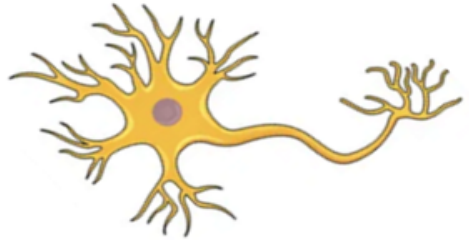
Are unipolar neurons but appears like bipolar neuron. Most sensory neurons are pseudounipolar, dorsal root ganglia of spinal nerves

Bipolar



2 distinct processes one axon and one dendrite arising directly from the cell body
Rod and cone cells of retina olfactory system

Multipolar

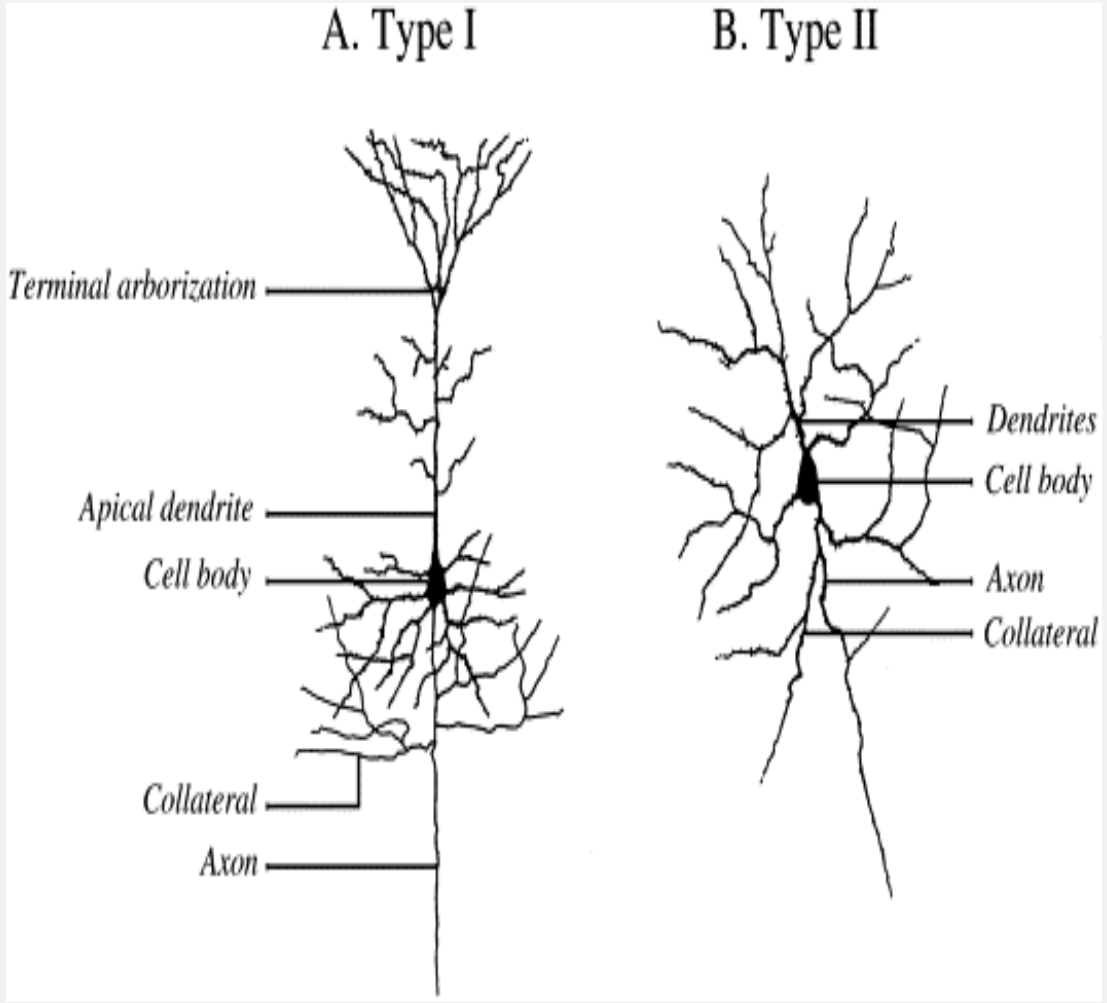


Most common with multiple extensions from soma
A motor neuron,
Majority of neurons of CNS and PNS

STRUCTURAL CLASSIFICATION OF NEURONS
(Based On Variation In Axons)

1. **Golgi type I neuron-** long axons, cell body of these neurons in CNS and axon reaches to remote peripheral organs (connect remote regions)- **motor neurons**

1. **Golgi type 2 neuron** –Axons are short and end near the cell body – **present in cerebral cortex and spinal cord (ie interneurons)**



Neurons Based on Function

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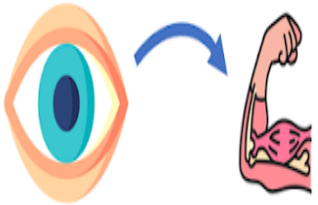
Afferent or Sensory Neuron

These neurons detect stimuli from the environment, such as light, sound, and touch. They transmit this information to the central nervous system (CNS).

Efferent or Motor Neuron

These neurons control the muscles and other organs of the body. They transmit signals from the CNS to the muscles, telling them to contract or relax.

Interneuron



These neurons connect sensory neurons and motor neurons. They help to process information and coordinate the activity of different parts of the nervous system.

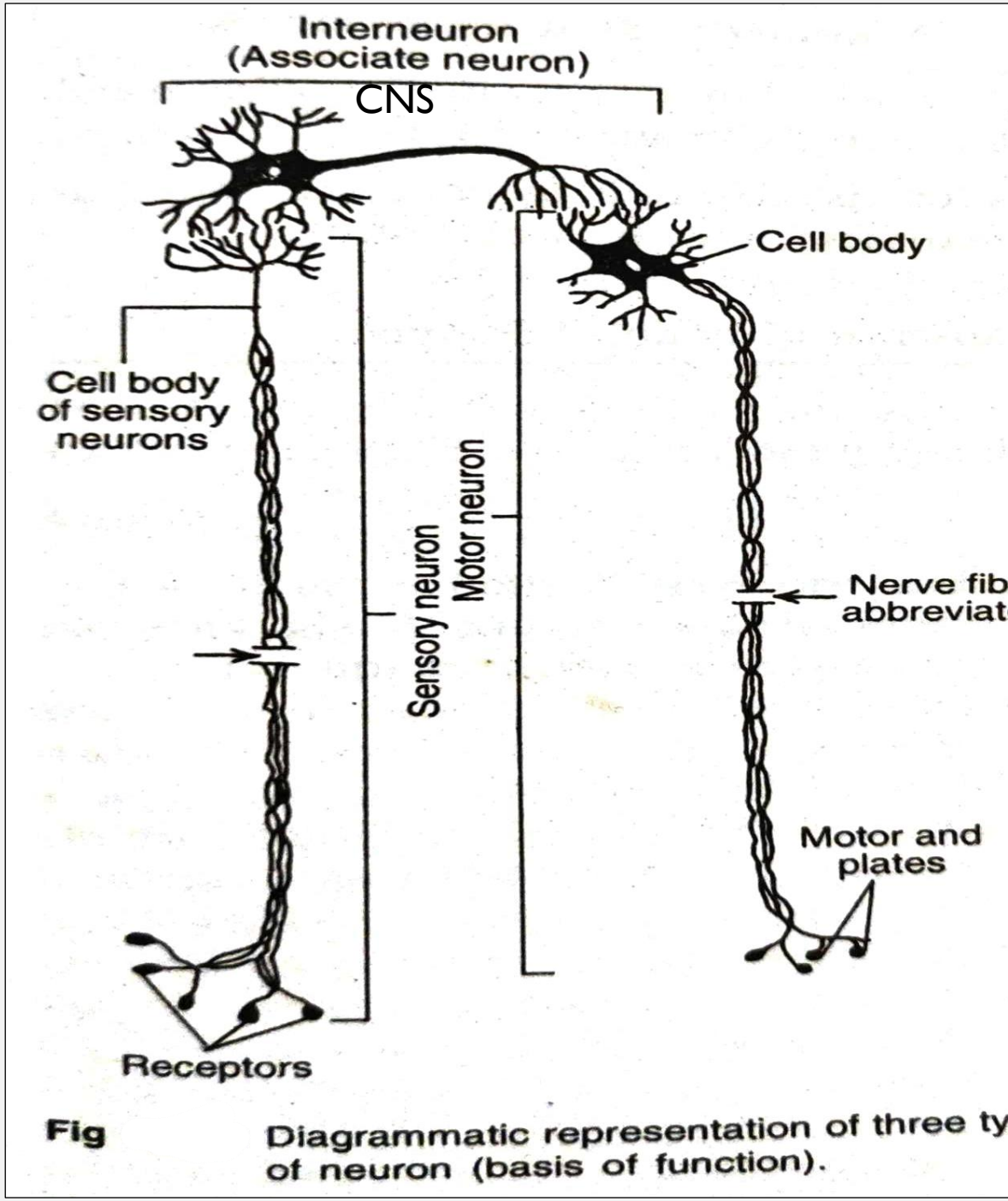
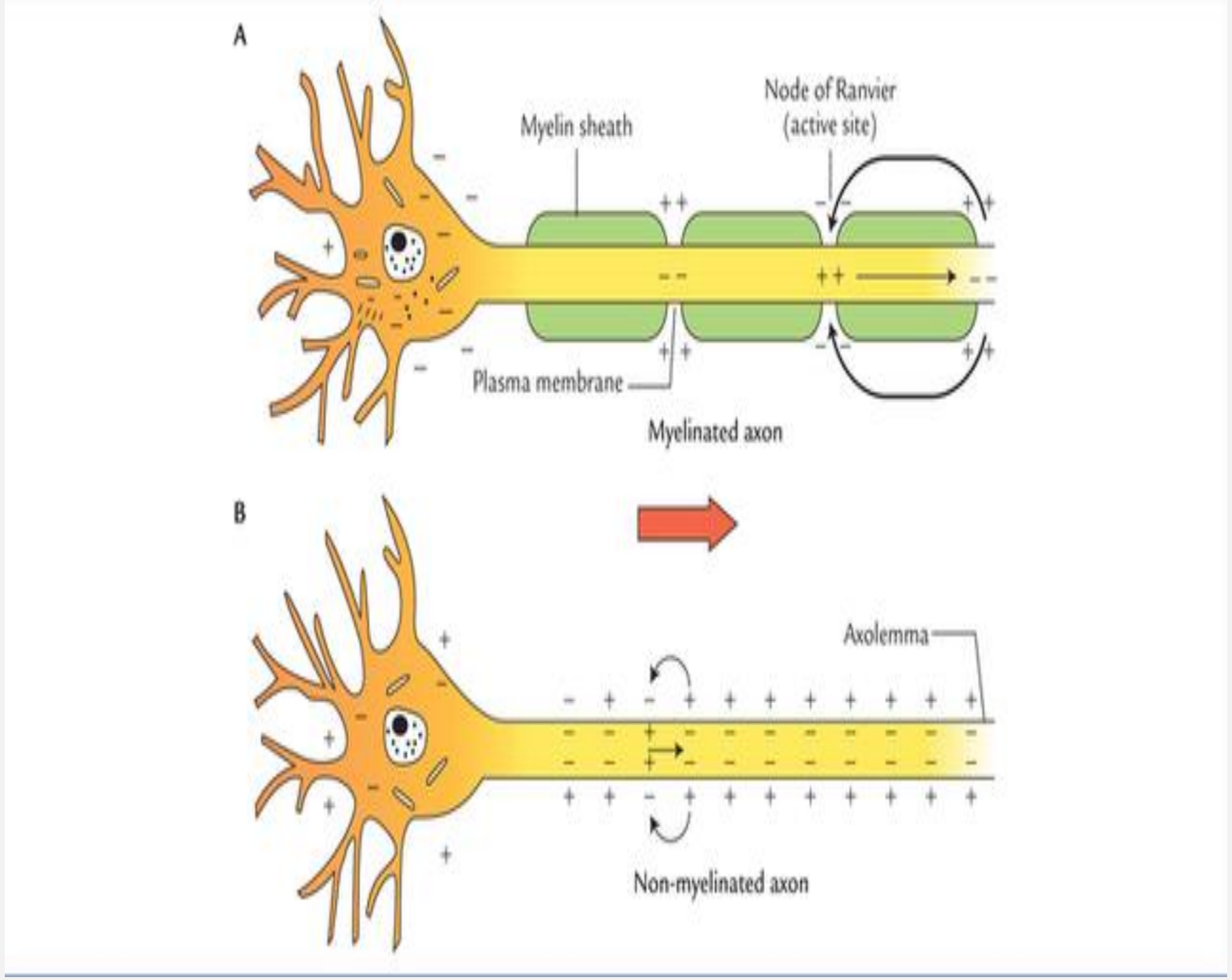
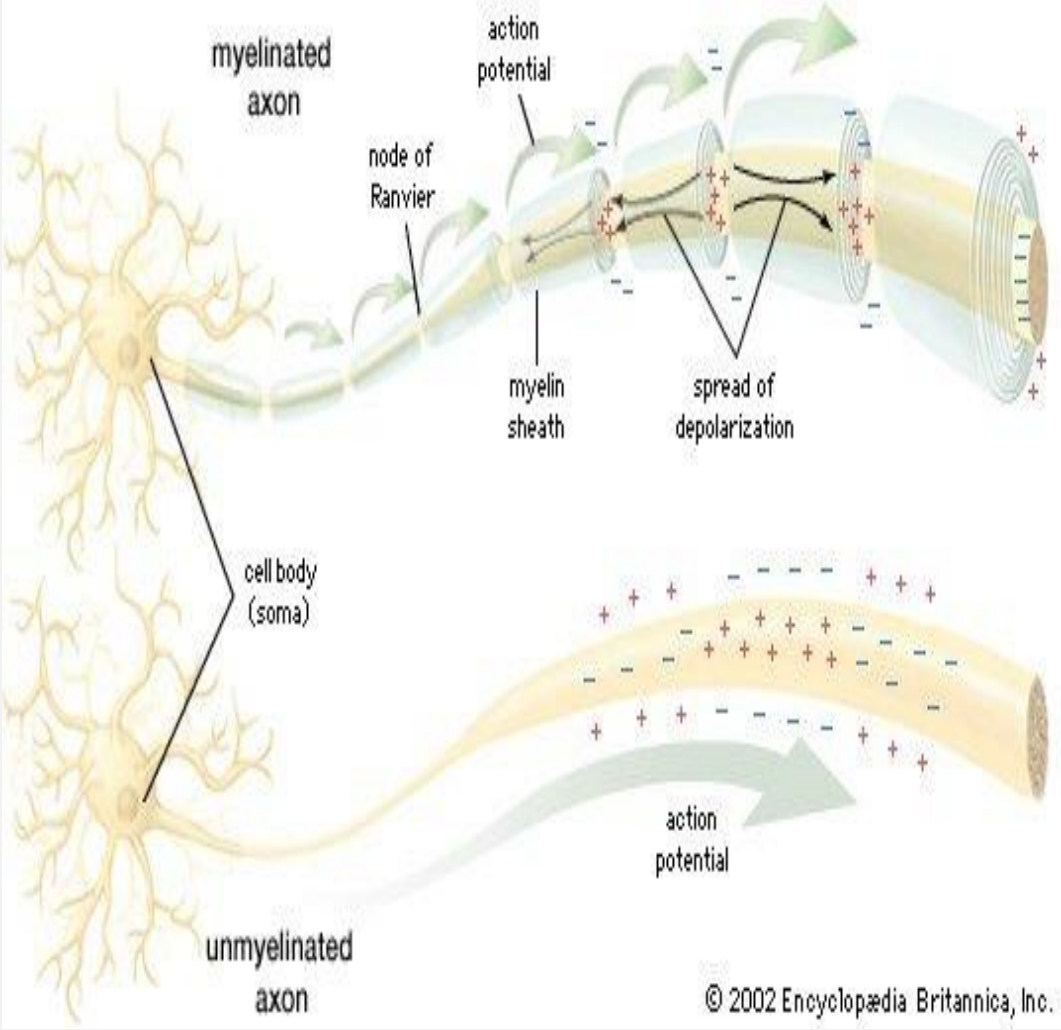


Fig Diagrammatic representation of three types of neuron (basis of function).

NEURONS BASED ON PRESENCE OR ABSENCE OF MYELIN SHEATH

(Myelinated And Non-myelinated Neurons)





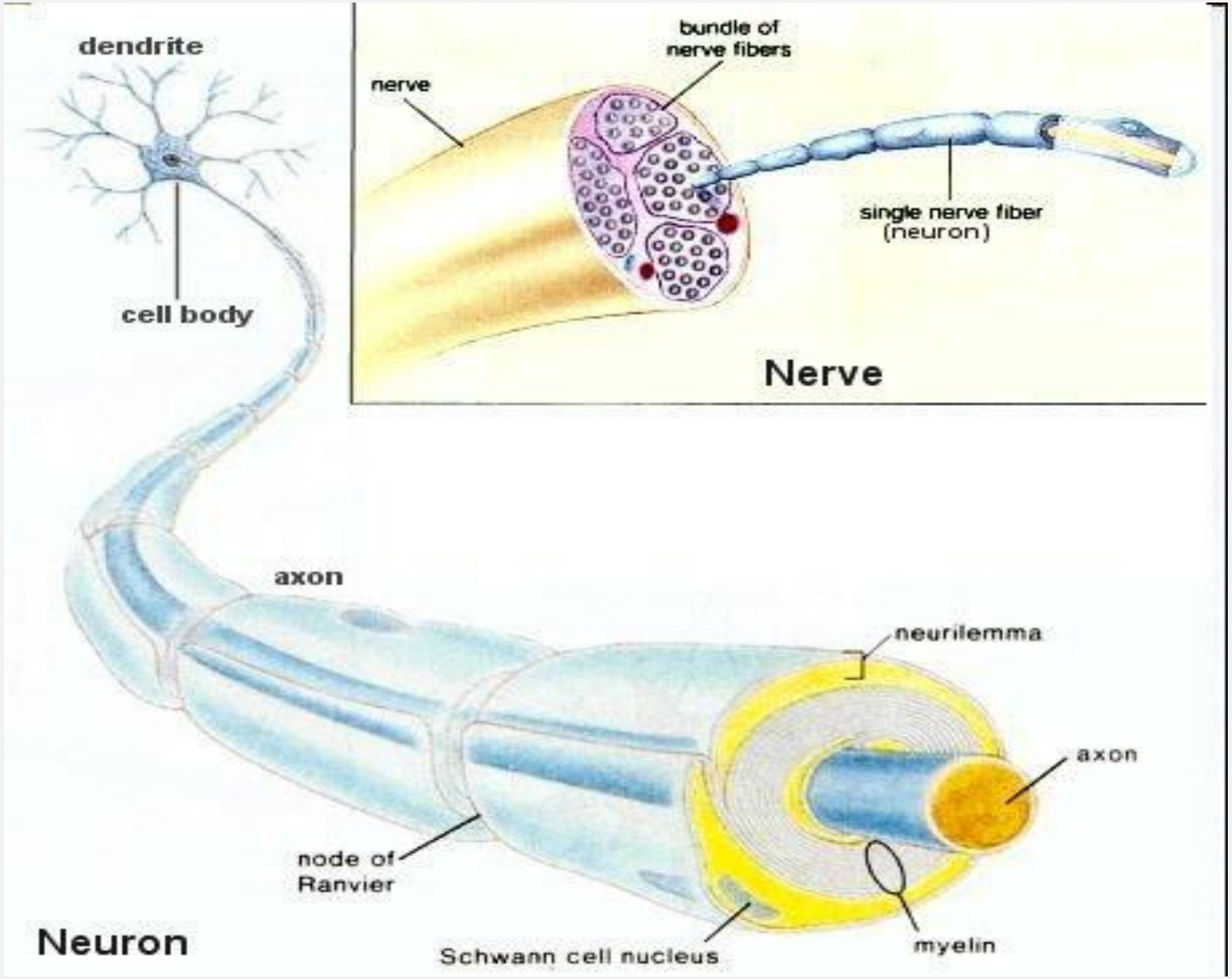
MYELINATED NERVE FIBERS VERSUS UNMYELINATED NERVE FIBERS

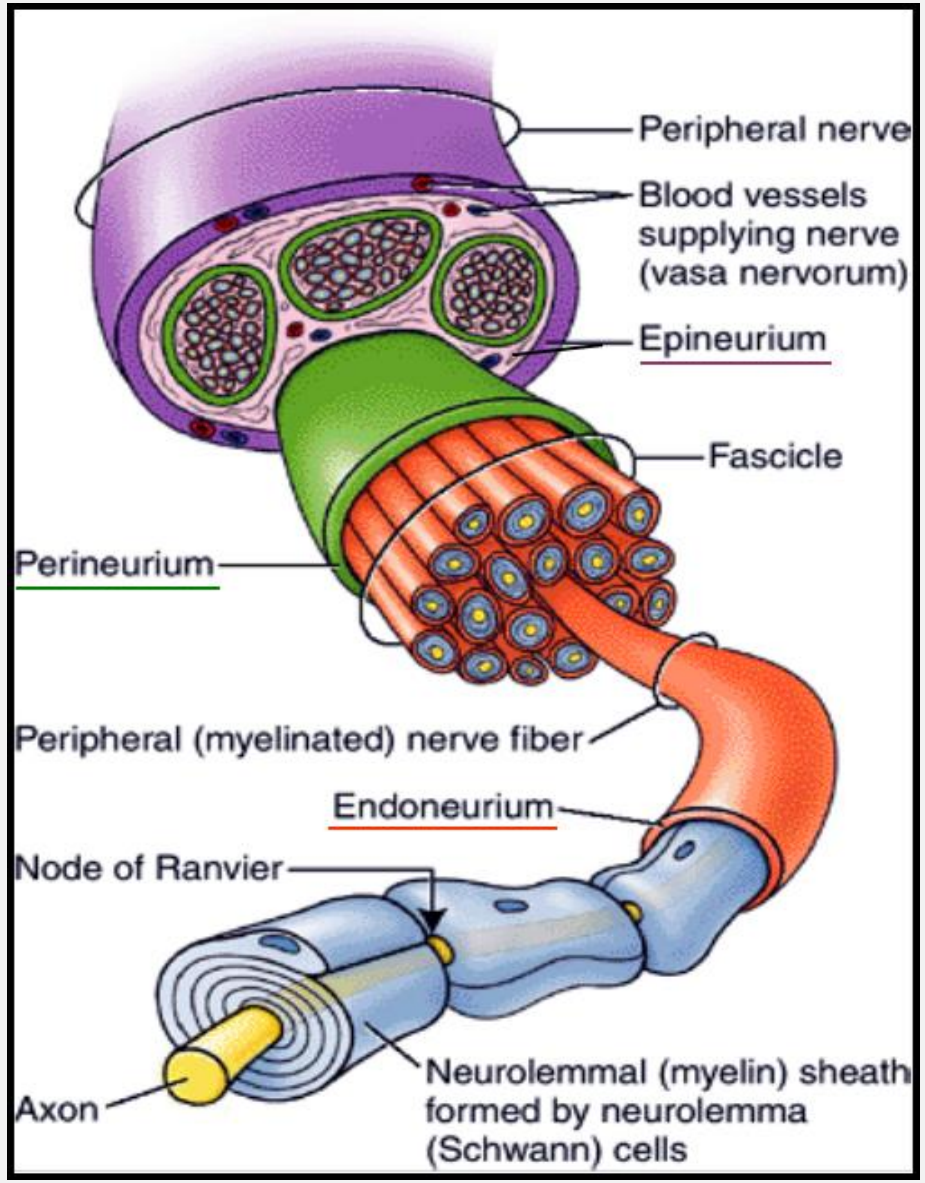
MYELINATED NERVE FIBRE

NON MYELINATED NERVE FIBRE

MYELINATED NERVE FIBRE	NON MYELINATED NERVE FIBRE
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
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
Axon of this fibre is covered internally by myelin sheath and outwardly by Neurolemma Ion channels are concentrated at Nodes of Ranvier Conduction type is Saltatory Conduction Present within the White matter of brain, Spinal cord, cranial nerve and spinal nerve	Axon is covered by neurolemma but myelin sheath is absent Ion channels are spread throughout the axon Conduction type is Continuous Conduction Present within Gray matter of brain and spinal cord and autonomic nervous system

DIFFERENCE---NEURON/NERVE FIBRE Vs NERVE



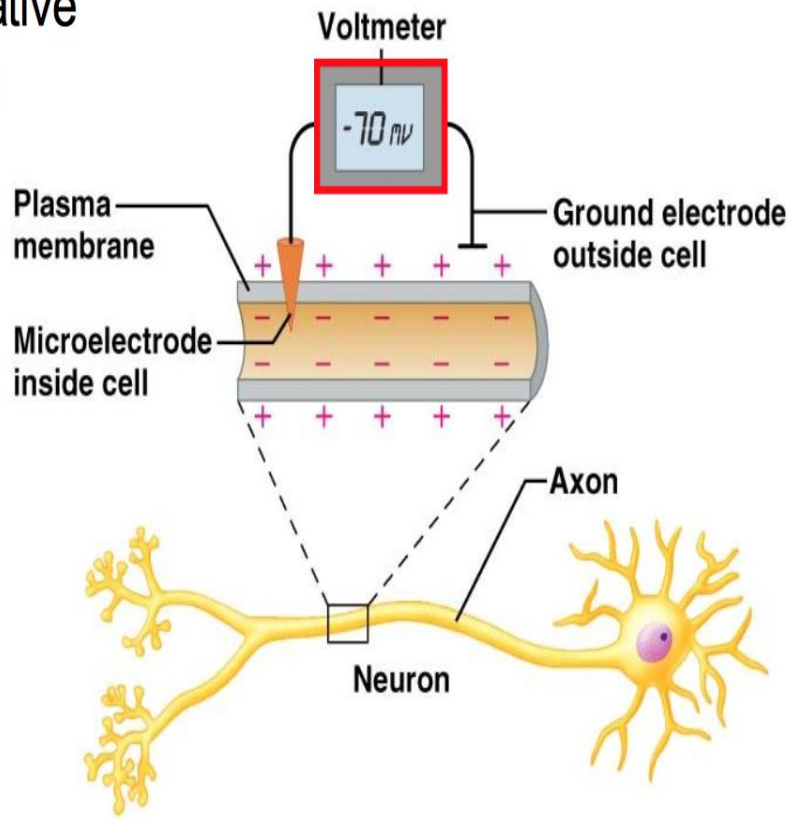


GENERATION OF NERVE IMPULSES AND PROPOGATION OF NERVE IMPULSE

NERVE CONDUCTION (2 MAIN PHASES)
RESTING POTENTIAL
ACTION POTENTIAL

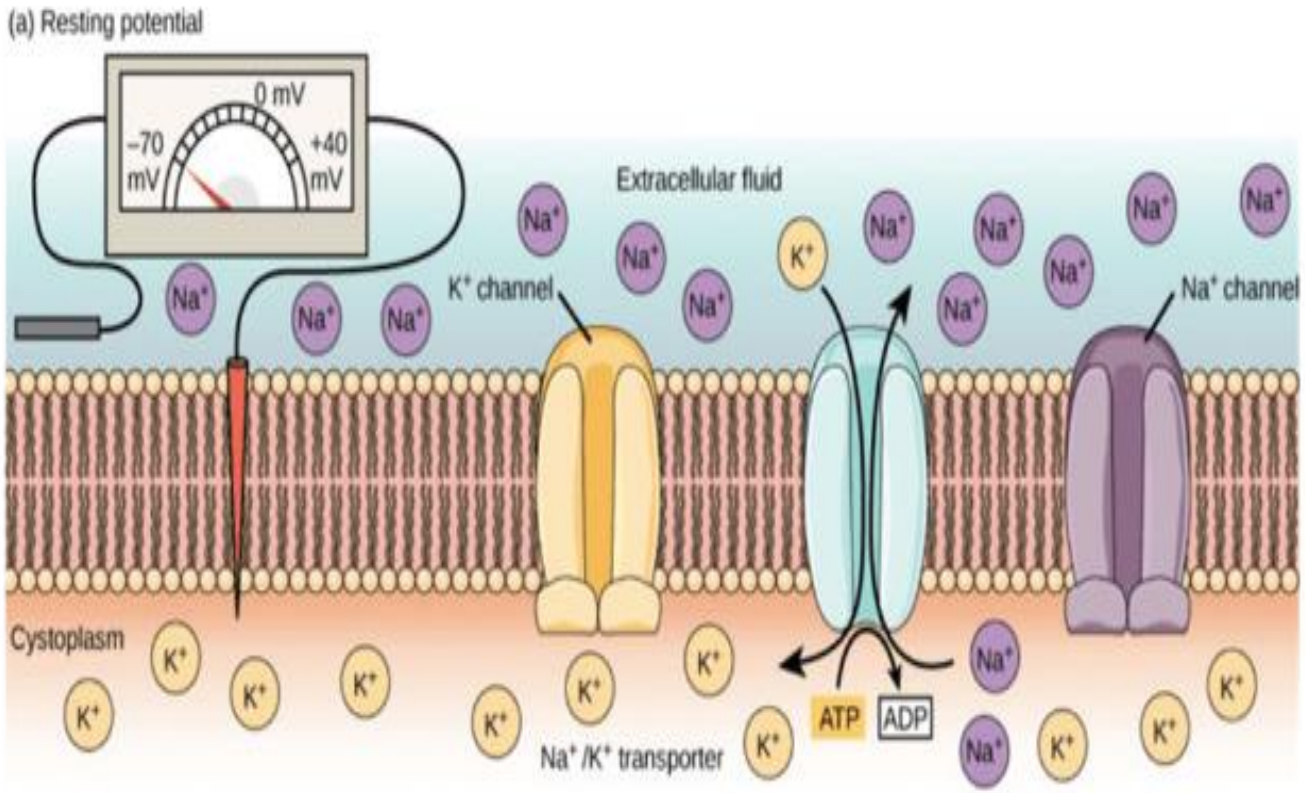
The Resting Membrane Potential

- *Usually* the cytoplasm is negative
  - (-20 to -110 mV; relative to the ECF = 0 mV)
- Depends upon ions present:
  - Permeability
  - Electrochemical gradients

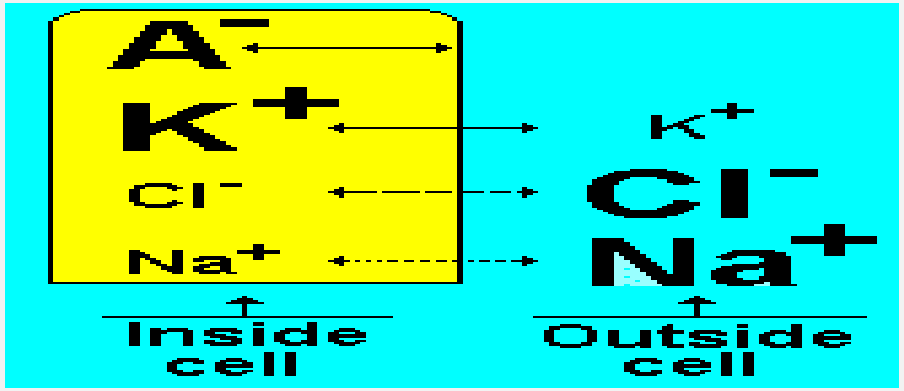


RESTING POTENTIAL

The **resting membrane potential of a cell** is defined as the difference in electrical potential across the plasma membrane when the cell is not stimulated or when the cell is in a state of relaxation.



At the resting potential, all voltage-gated Na^+ channels and most voltage-gated K^+ channels are closed. The Na^+/K^+ transporter pumps K^+ ions into the cell and Na^+ ions out.



- When a neuron is at rest, the resting potential of a neuron is typically -70 mV
- This shows **the surplus negative charged ions on the inner side of the membrane.**
- Typically, a higher level of potassium ion K+ is present inside the cell.
- At the exterior of the cell, the level of Sodium and Chloride ions (Na+ and Cl-) are in higher concentration.
- Unlike other cell types, neurons and muscle cells are capable of transitioning from a resting state to a more active one.

When at rest, the neuron is *negatively charged* relative to its environment. This is because of the following events:

i) At rest, the negatively charged ion $-Cl^-$ and the positively charged ion, Na^+, cannot easily cross the plasma membrane of the neuron (*sodium channels* close)

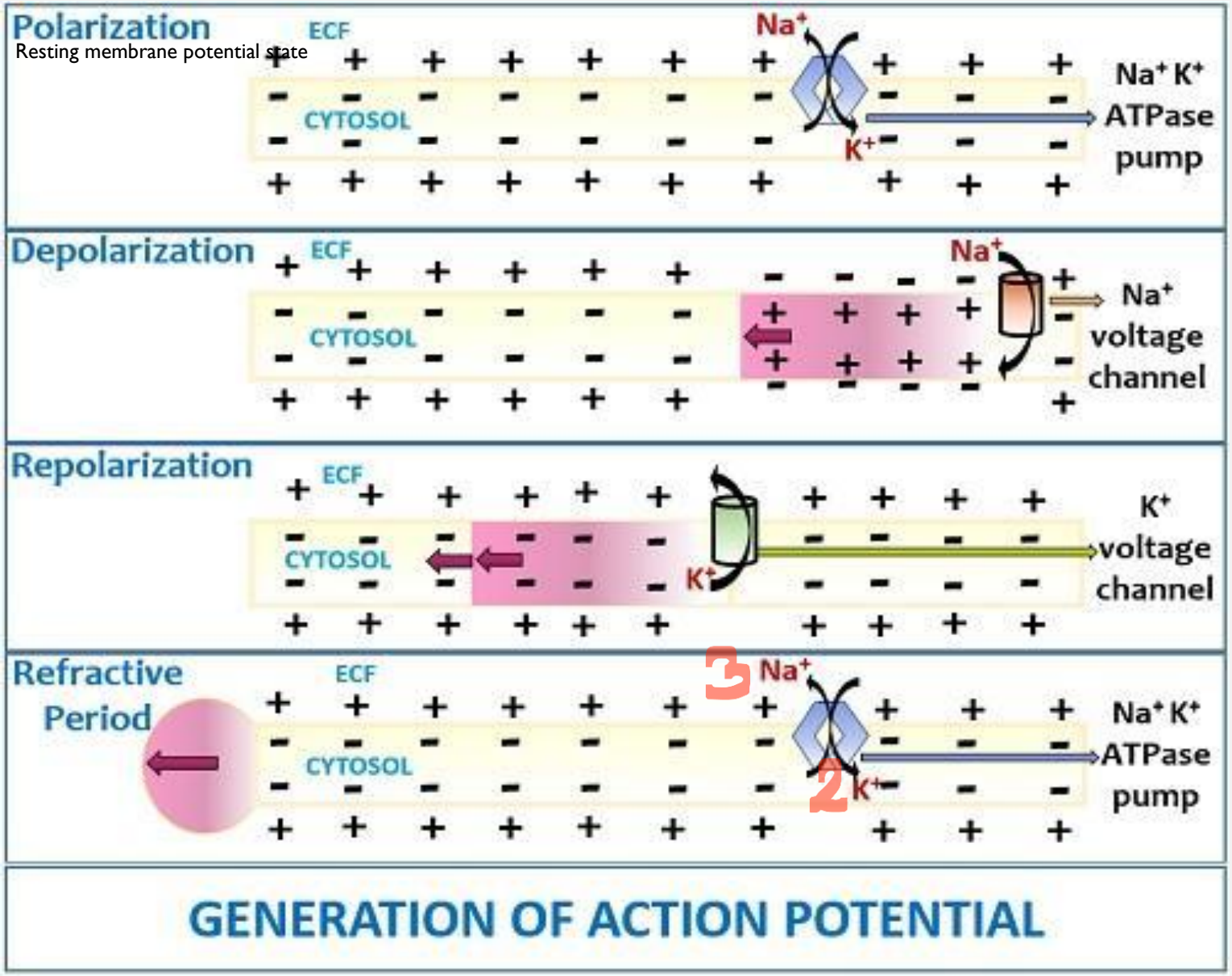
ii) Negatively charged proteins cannot readily leave the neuron as well. (Ie., UNEQUAL DISTRIBUTION OF IONS)

iii) A **membrane pump** moves *three* Na^+ out for every *two* K^+ entering the cell.

- As a result, more Na^+ ions are outside than inside and more K^+ ions inside than outside the cell.

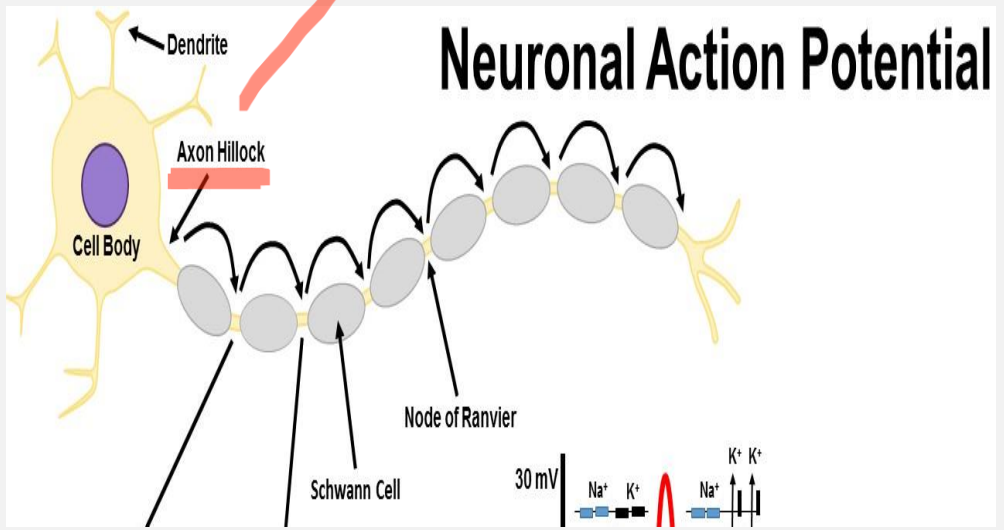
- This leads to a *resting membrane potential* of about ***-70mV***, which means the inside of the neuron is about 70 mV less than its environment

ACTION POTENTIAL



GENERATION OF ACTION POTENTIAL

ACTION POTENTIAL Begins at the Axon Hillock as a result of Depolarization

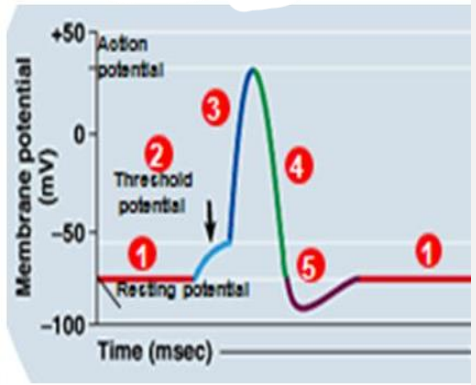


ACTION POTENTIAL: It is the change in electrical potential across the neuronal membrane.

Action potential carries the impulses from one neuron to the next neuron. Action potentials are all-or-none.

Steps in An Action Potential

1. **Resting potential** or Polarization **(-70 mV)**
   - Na+ outside, K+ inside
   - Channels closed
2. **Stimulus / Threshold**
   - Some Na+ channels open
   - Na+ comes in
   - If **threshold** is passed they all open **(-50 mV)**

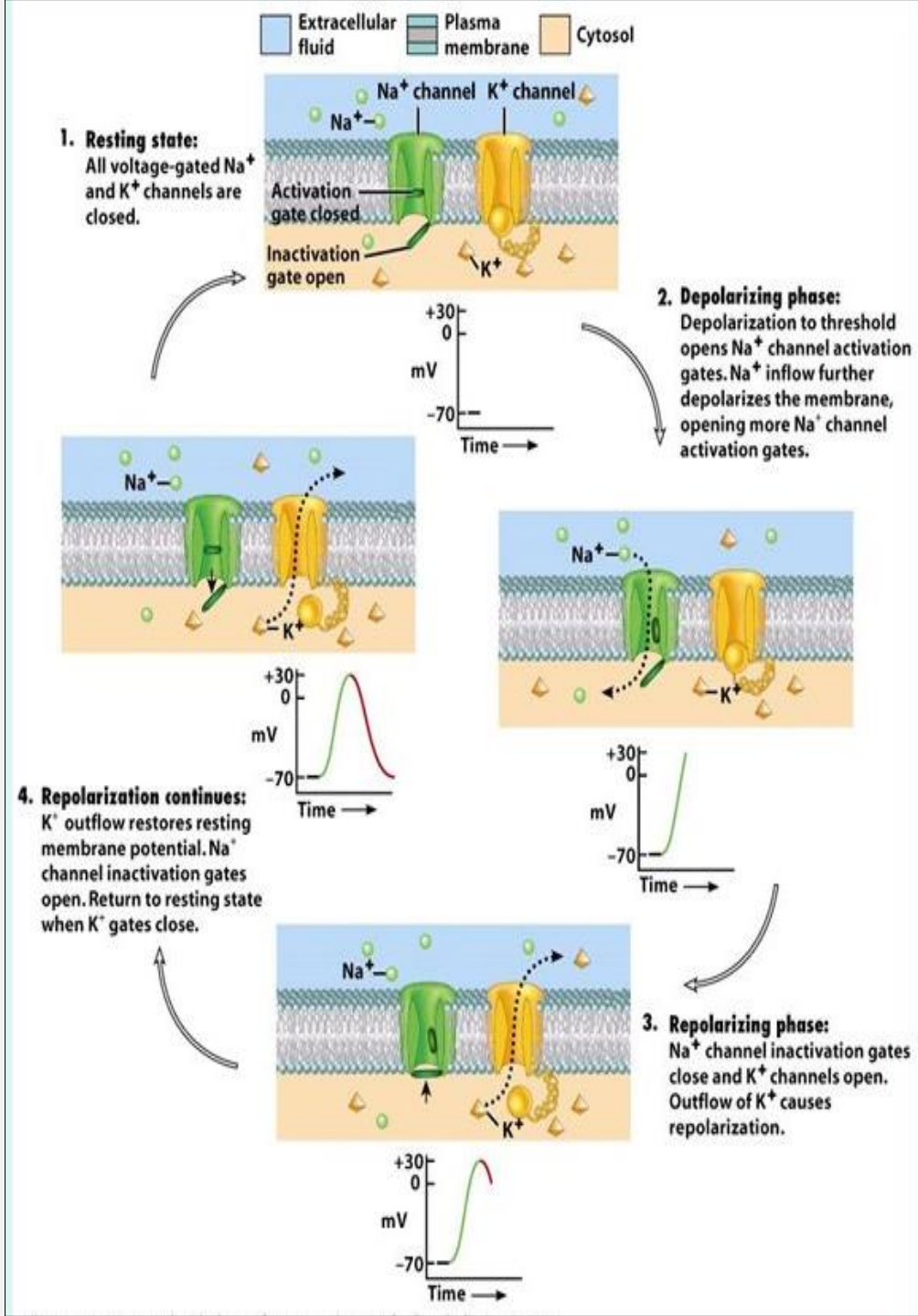


3. **Depolarization (+30 mV)**
   - Na+ channels open, Na+ comes in and the cell becomes positive
   - Chain reaction of Na+ channels opening down the axon
4. **Repolarization (-70 mV)**
   - Na+ channels close, K+ channels open
   - K+ moves out and the cell becomes negative

5. **Hyperpolarization or Undershoot & return to resting potential**

It makes the cell more negative than its typical resting membrane potential. As the action potential passes through, potassium channels stay open a little bit longer, and continue to let positive ions exit the neuron.
This means that the cell temporarily hyperpolarizes, or gets even more negative than its resting state **(-90mV)**

As the potassium channels close, the sodium-potassium pump works to reestablish the resting state by actively transporting **3 Na+ outside and 2K+ inside (ATP use)**

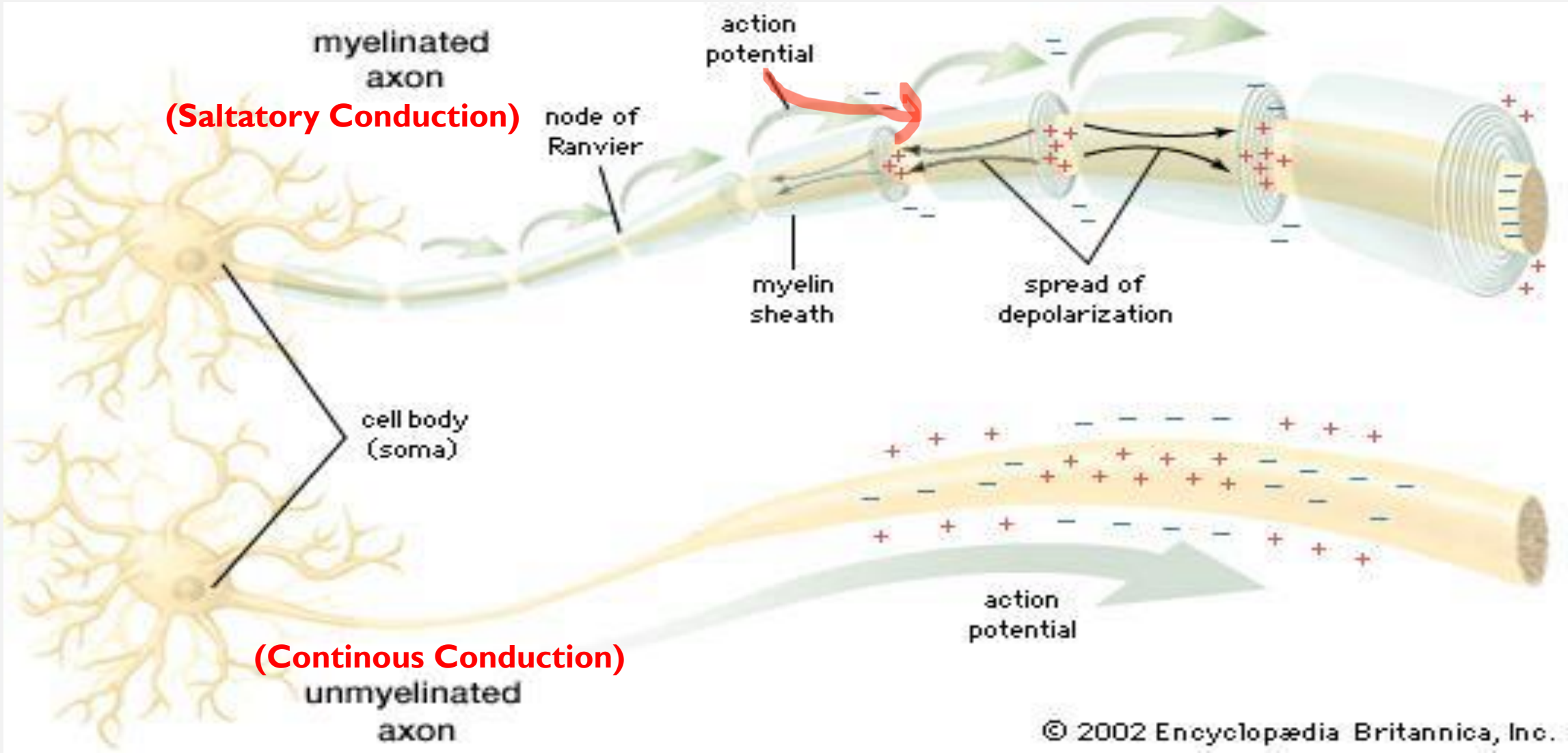


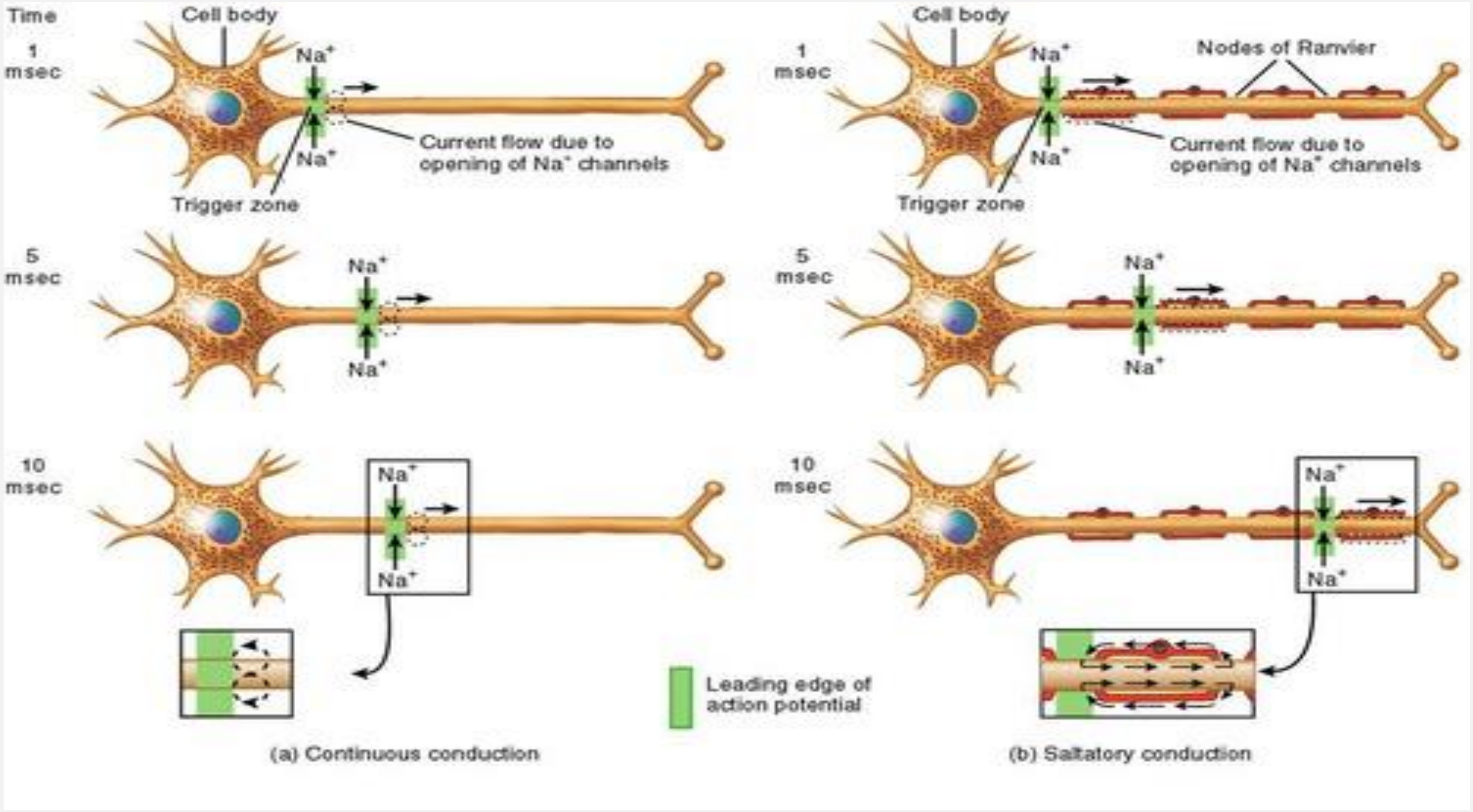
The Action Potential: Summarized

- Resting membrane potential is -70mV
- Depolarization is the change from -70mV to +30 mV
- Repolarization is the reversal from +30 mV back to -70 mV

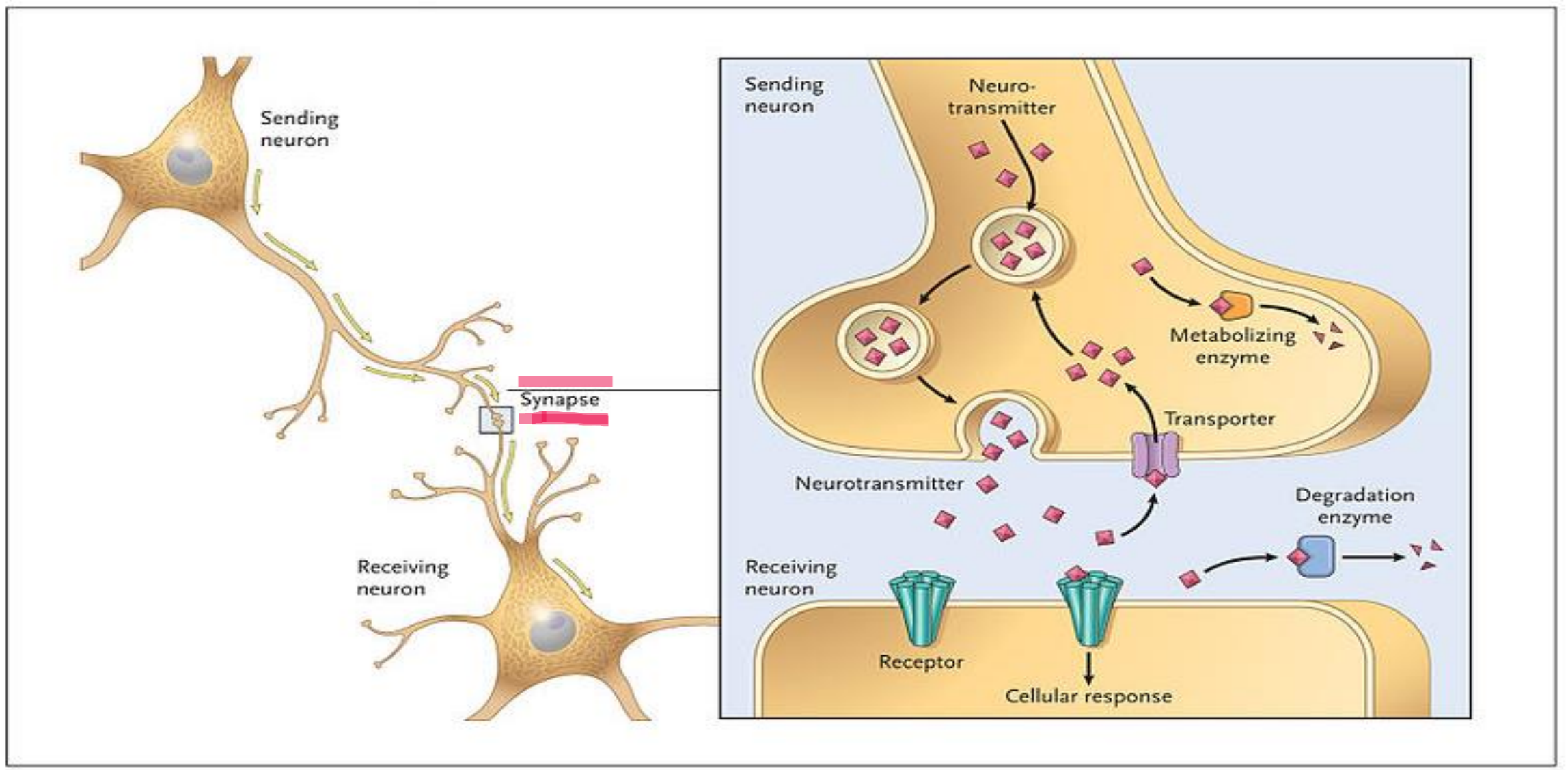
PROPOGATION OF NERVE IMPULSE OR SIGNAL

1. MYELINATED NERVE FIBRE 2. NON-MYELINATED NERVE FIBRE




Time
Cell body
1 msec
Na+
Na+
Current flow due to opening of Na+ channels
Trigger zone
5 msec
Na+
Na+
10 msec
Na+
Na+
Leading edge of action potential
(a) Continuous conduction
Cell body
1 msec
Na+
Nodes of Ranvier
Na+
Current flow due to opening of Na+ channels
Trigger zone
5 msec
Na+
Na+
10 msec
Na+
Na+
(b) Saltatory conduction

SYNAPSE


Sending neuron
Synapse
Receiving neuron
Sending neuron
Neuro-transmitter
Metabolizing enzyme
Transporter
Neurotransmitter
Degradation enzyme
Receiving neuron
Receptor
Cellular response

SYNAPSE

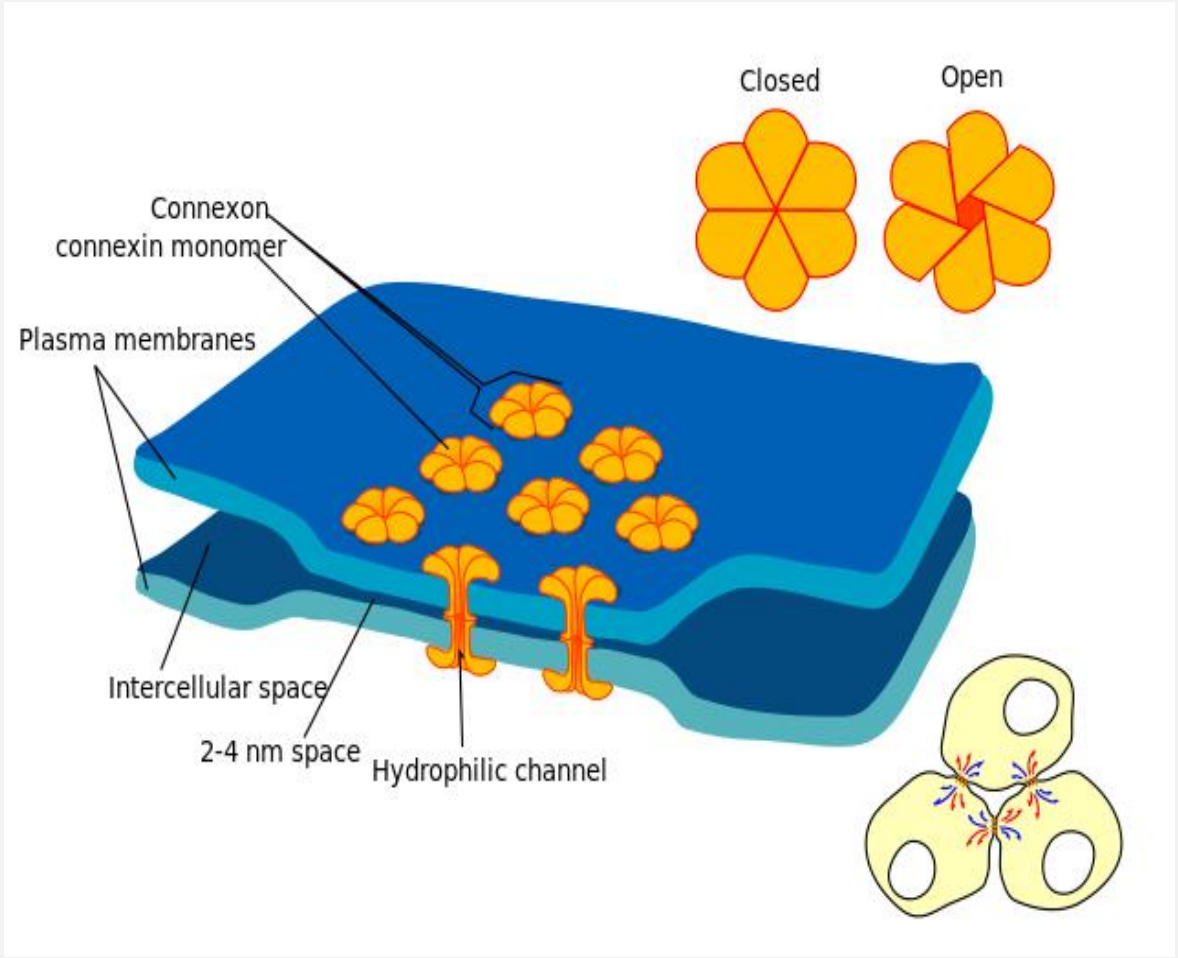
Synapse can be broadly classified into 2 Types

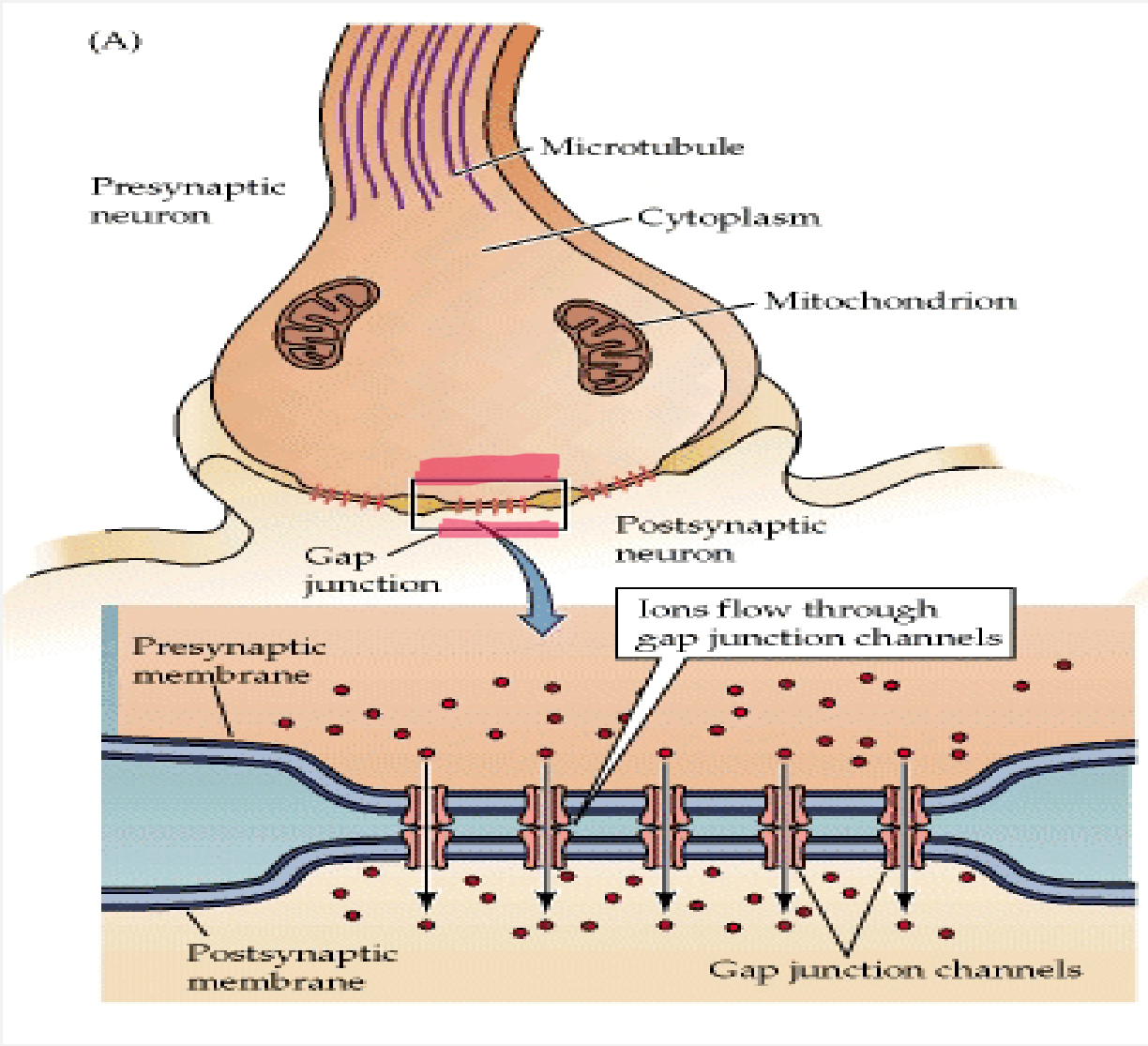
A. Electrical Synapse

B. Chemical Synapse(Human CNS synapses)

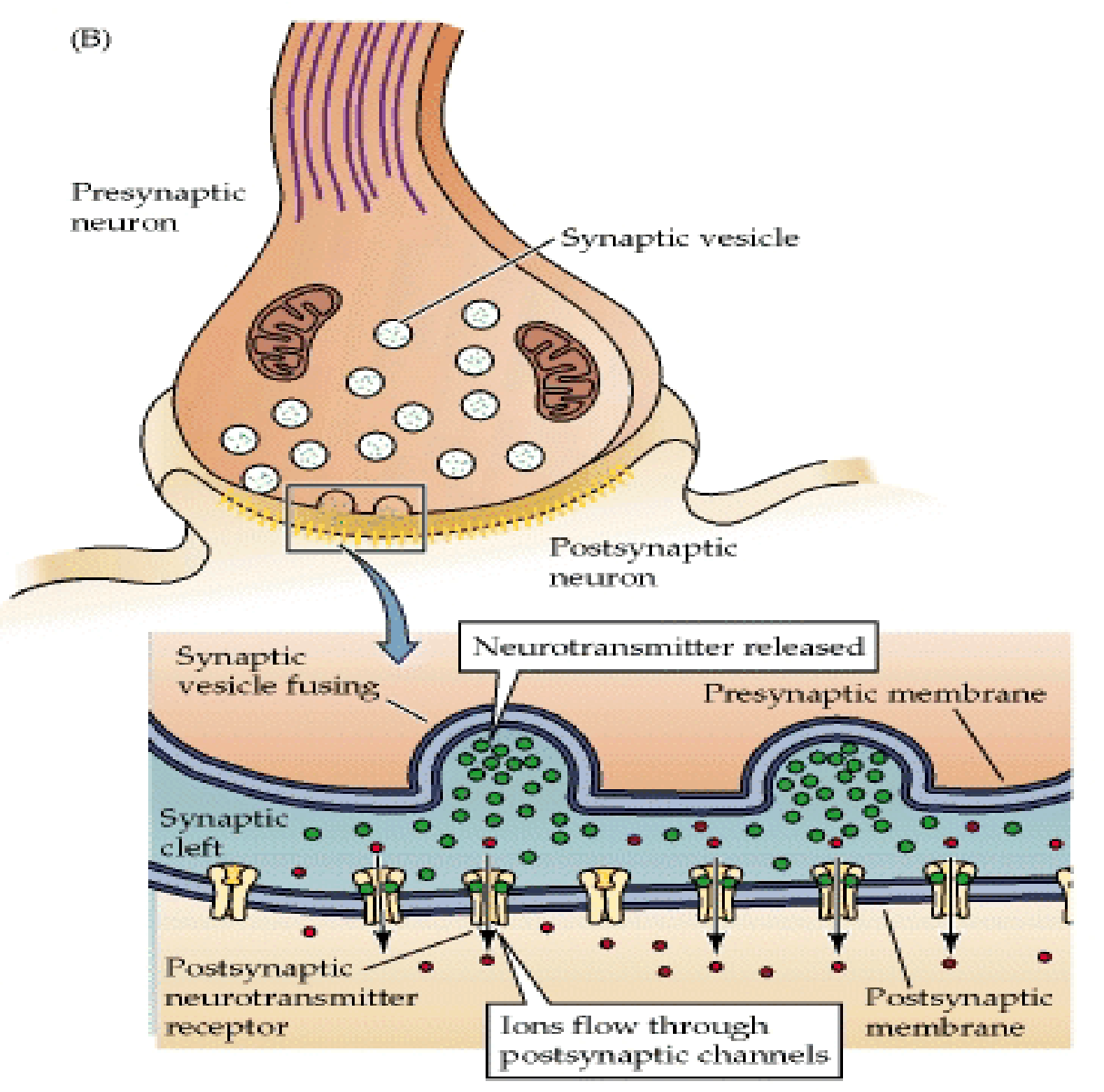
A. Electrical Synapse with connexon

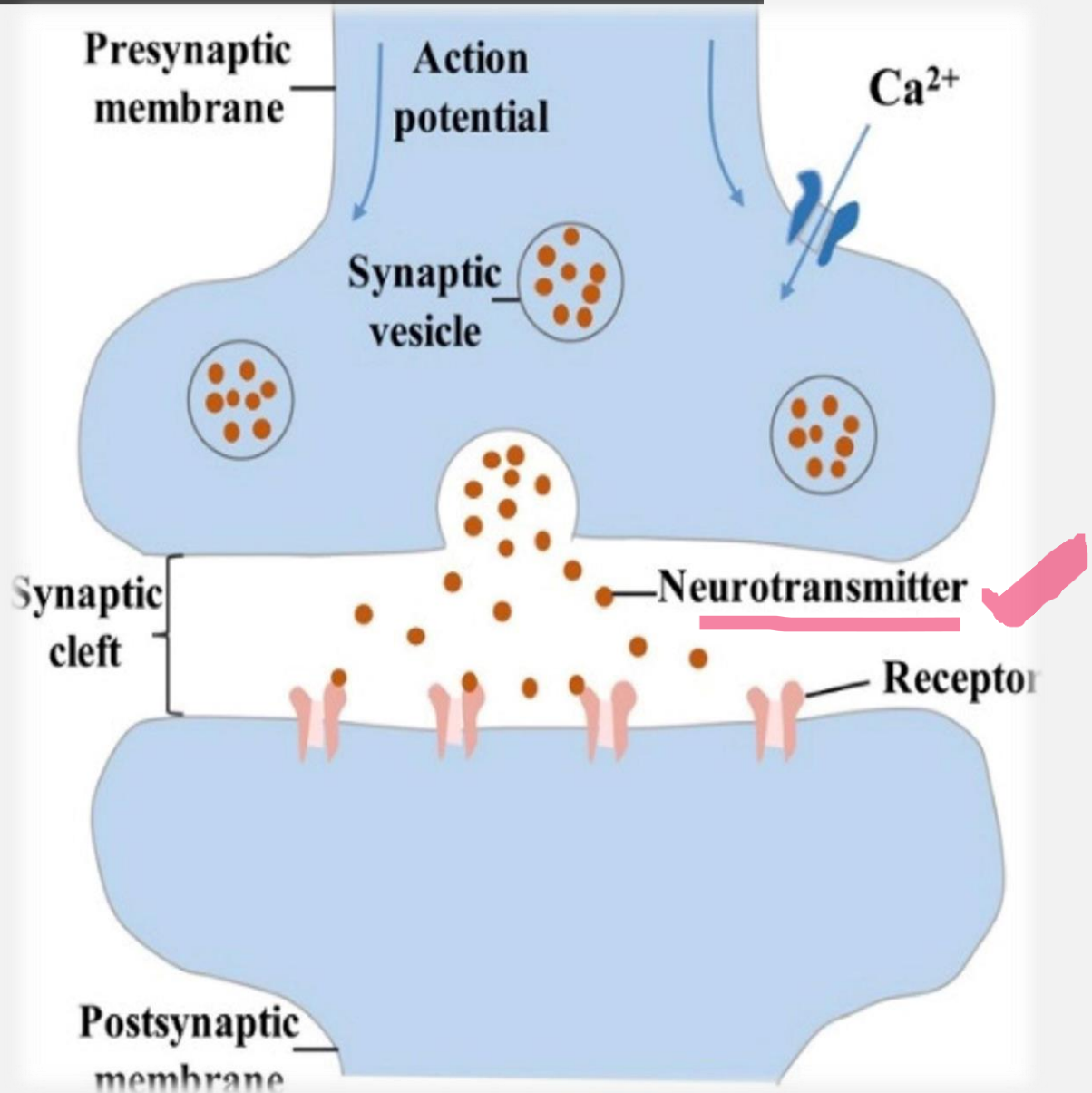
(common in lower vertebrates and invertebrates, found in brains of mammals also)





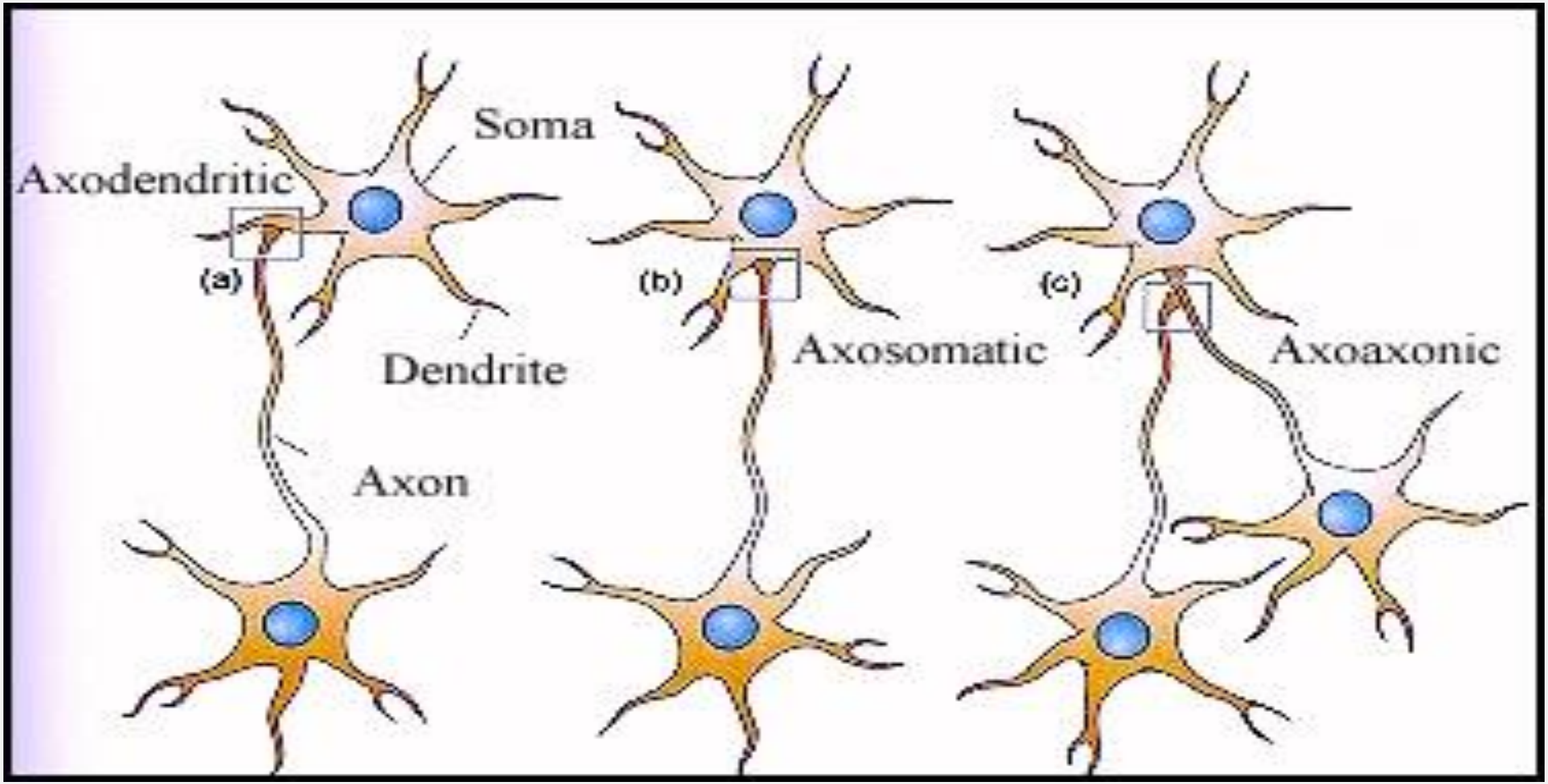
B) CHEMICAL SYNAPSE (Neurotransmitters Involve)





CLASSIFICATION OF CHEMICAL SYNAPSE

(Based On Neuronal Elements Associated)



NEUROTRANSMITTER

- Neurotransmitters are chemical substances that transmit signals between neurons (nerve cells) or from neurons to muscles, glands, or other target cells.
- They are crucial for communication within the nervous system and influence various physical and psychological functions of the body.
- When a neuron is activated by an electrical signal (action potential), neurotransmitters are released from small sacs called synaptic vesicles in the neuron.
- These chemicals cross the synapse (the gap between neurons) and bind to receptors on the target neuron or cell. Once bound, neurotransmitters either stimulate (excitatory) or inhibit (inhibitory) the next neuron, influencing its electrical activity.

Types of Neurotransmitters:

Neurotransmitters can be broadly classified into two types **based on their effects on the target cells**. Each type plays a specific role in maintaining balance in the nervous system.

Functional Classification

Function	Examples
Excitatory (leads to depolarization)	Glutamate
	Aspartate
	Serotonin
	Histamine
	ATP, CO
Inhibitory (leads to hyperpolarization)	Glycine
	Gamma amino butyric acid (GABA)
	Taurine
Excitatory & Inhibitory (leads to depolarization and hyperpolarization depending on type of receptor)	Acetylcholine
	Epinephrine (Adrenaline)
	Dopamine
	Norepinephrine (Noradrenaline)
	NO
	Endorphins, enkephalins, substance P, cholecystokinin

NEUROTRANSMITTERS

ADRENALINE
fight or flight
produced in stressful situations. Increases heart rate and blood flow, leading to physical boost and heightened awareness.

GABA
calming
Calms firing nerves in the central nervous system. High levels improve focus, low levels cause anxiety. Also contributes to motor control and vision.

NORADRENALINE
concentration
affects attention and responding actions in the brain. Contracts blood vessels, increasing blood flow.

ACETYLCHOLINE
learning
Involved in thought, learning and memory. Activates muscle action in the body. Also associated with attention and awakening.

DOPAMINE
pleasure
feelings of pleasure, also addiction, movement and motivation. People repeat behaviors that lead to dopamine release.

GLUTAMATE
memory
Most common neurotransmitter. Involved in learning and memory, regulates development and creation of nerve contacts.

SEROTONIN
mood
contributes to well-being and happiness. Helps sleep cycle and digestive system regulation. Affected by exercise and light exposure.

ENDORPHINS
euphoria
Released during exercise, excitement and sex, producing well-being and euphoria, reducing pain

1. Excitatory neurotransmitters: when released excitatory neurotransmitters have excitatory effects on the neuron. It stimulates a neuron that will fire an action potential (electrical signal), causing the target cell to become more active.

Mechanism of Action

When these excitatory neurotransmitters bind to their receptors on the postsynaptic neuron, **they often lead to the influx of positive ions (sodium)** into the neuron. **This depolarizes the neuron** and brings it **closer to the threshold for firing an action potential.**

Common Examples

Excitatory Neurotransmitters:

- **Glutamate: The most common excitatory neurotransmitter in the brain. It plays a key role in learning and memory.**
- **Aspartate: Another excitatory neurotransmitter, less abundant than glutamate but still important in brain regions. Binds with NMDA (N-Methyl D-Aspartate) Receptors which are crucial for synaptic plasticity learning and memory.**

2. Inhibitory neurotransmitters: Inhibitory neurotransmitters **have inhibitory effects on the neuron.** It **decreases the likelihood that a neuron will fire an action potential**, calming the nervous system and **preventing overstimulation.**

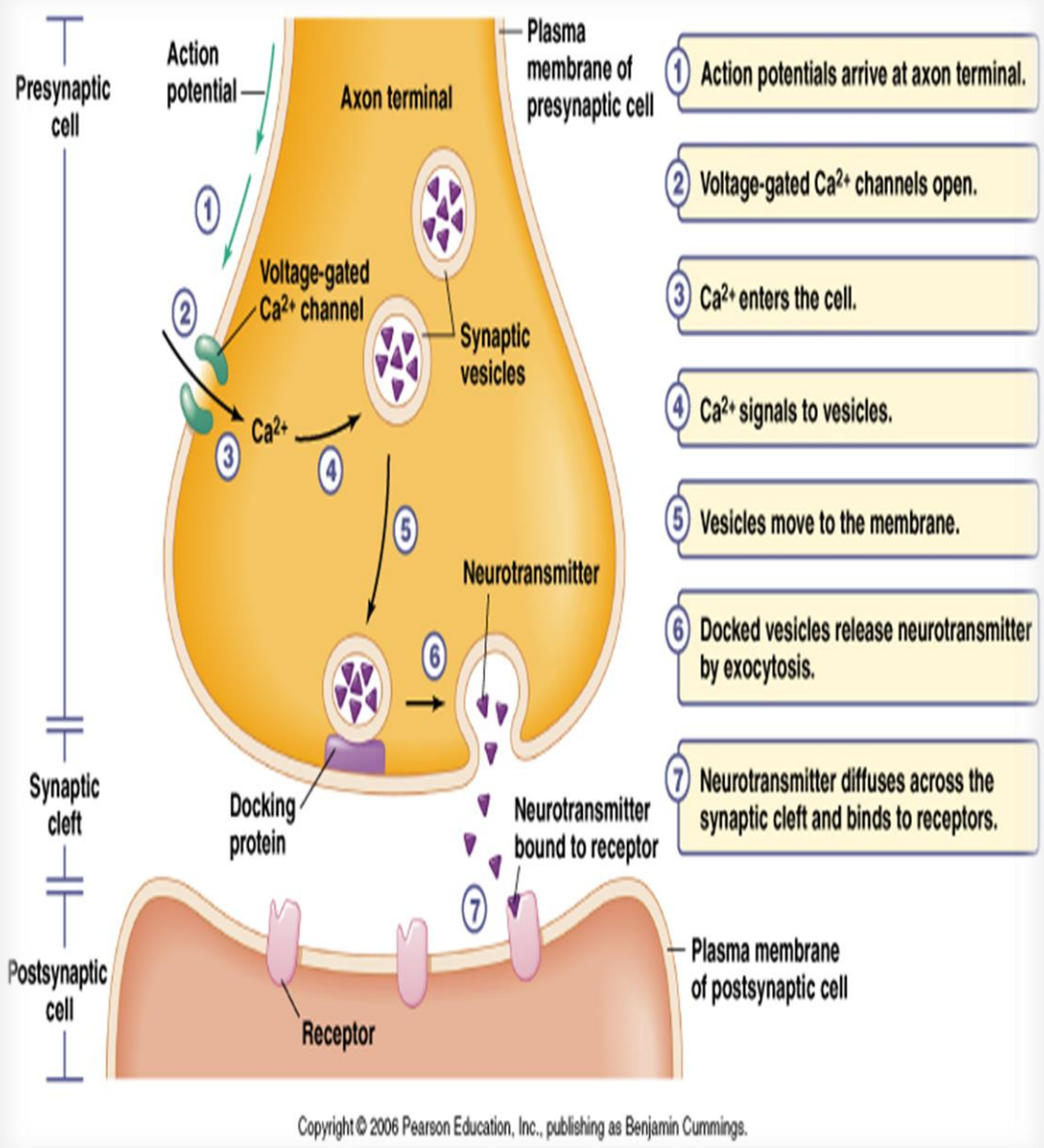
Mechanism of Action

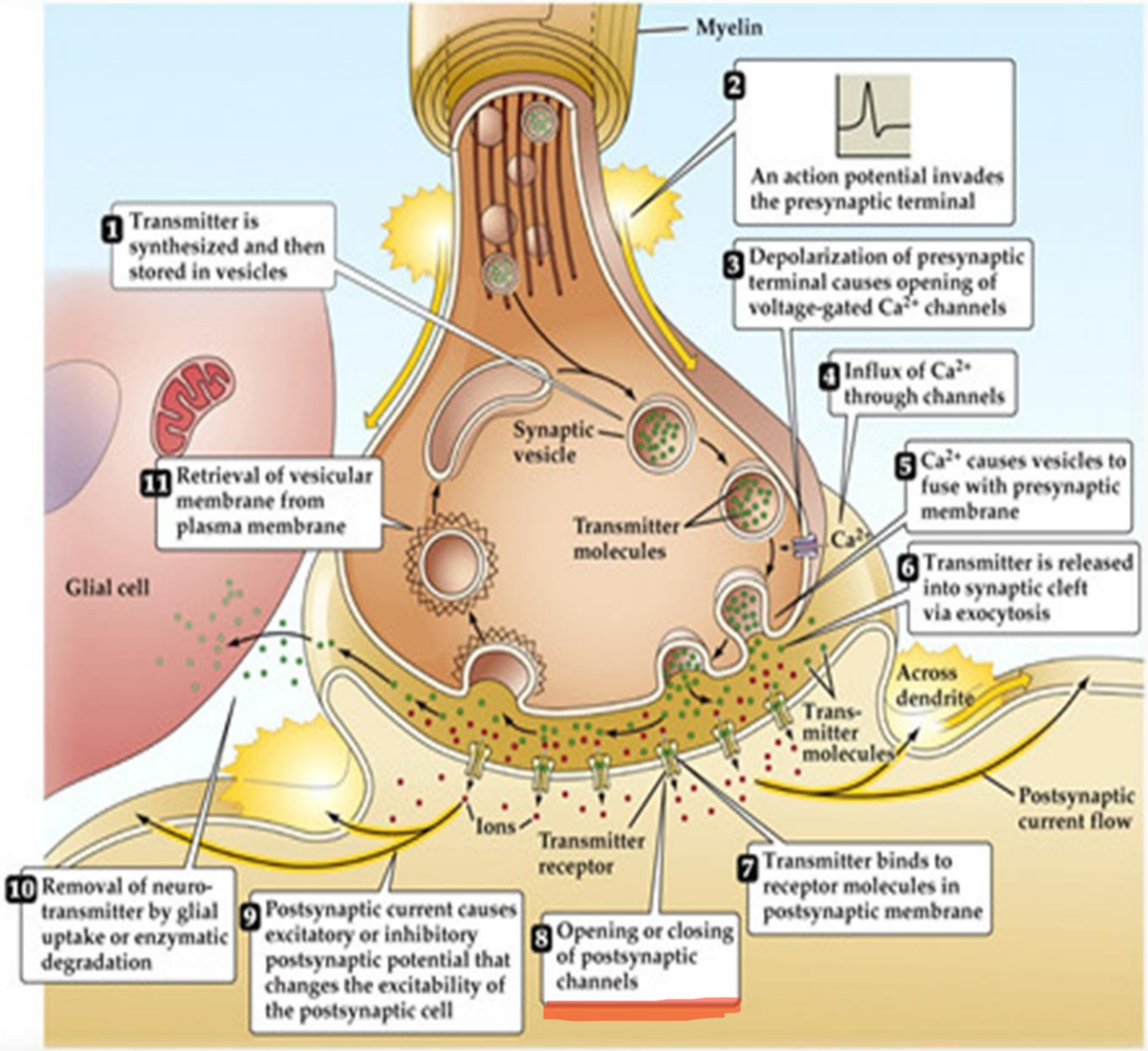
Inhibitory Neurotransmitters: when they bind to their receptors, these neurotransmitters often lead to the **influx of negative ions (like chloride) or the efflux of positive ions (like potassium)**. They make the **inside of the neuron more negative,** which makes it less likely to reach the threshold needed to trigger an action potential.

Eg: Inhibitory Neurotransmitters:

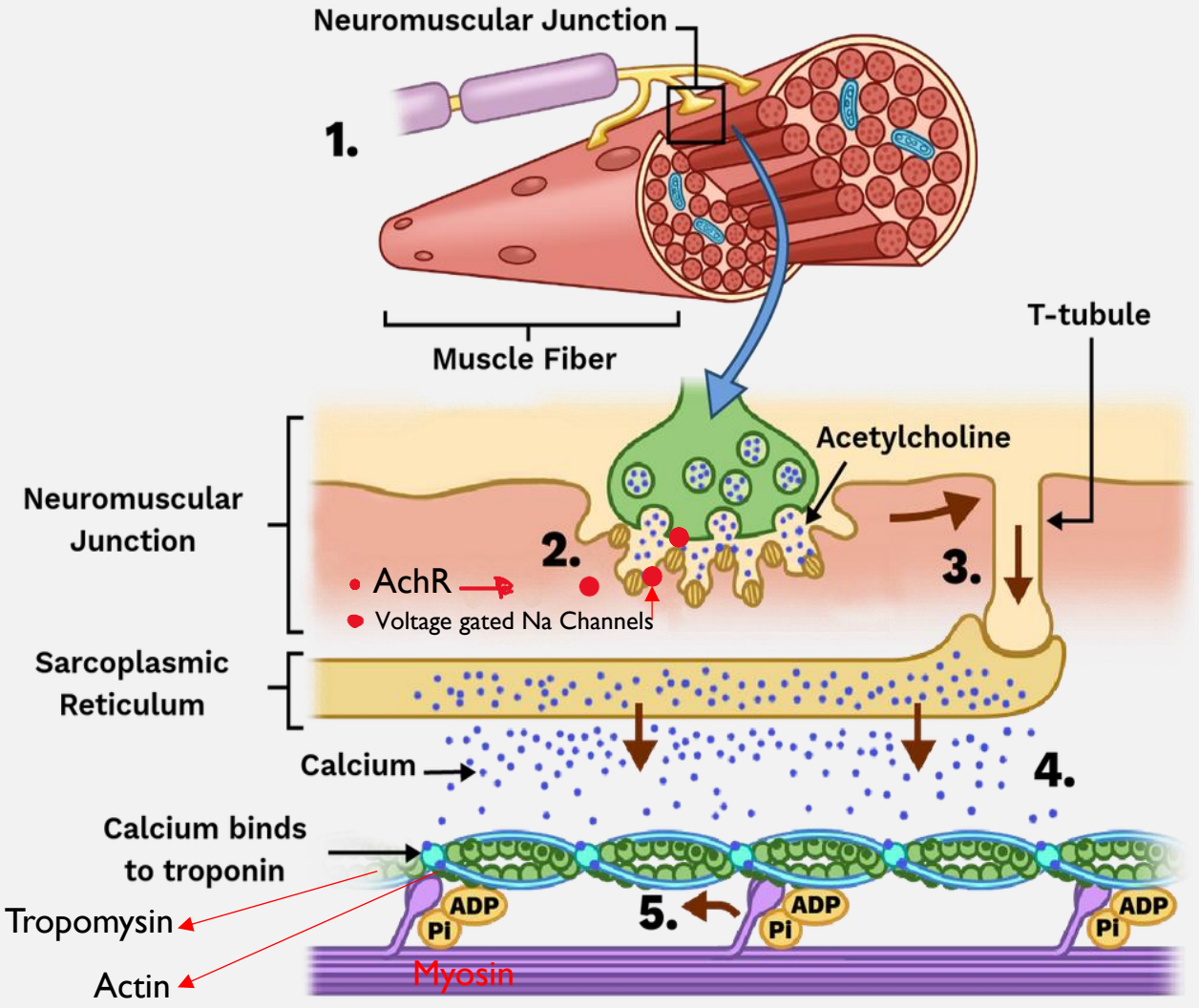
- **GABA** (Gamma-Aminobutyric Acid): **The primary inhibitory neurotransmitter** in the **brain**. It helps regulate anxiety and muscle tone.
- **Glycine:** Commonly **found in the spinal cord and brainstem**, it plays a crucial role in inhibiting motor neurons.

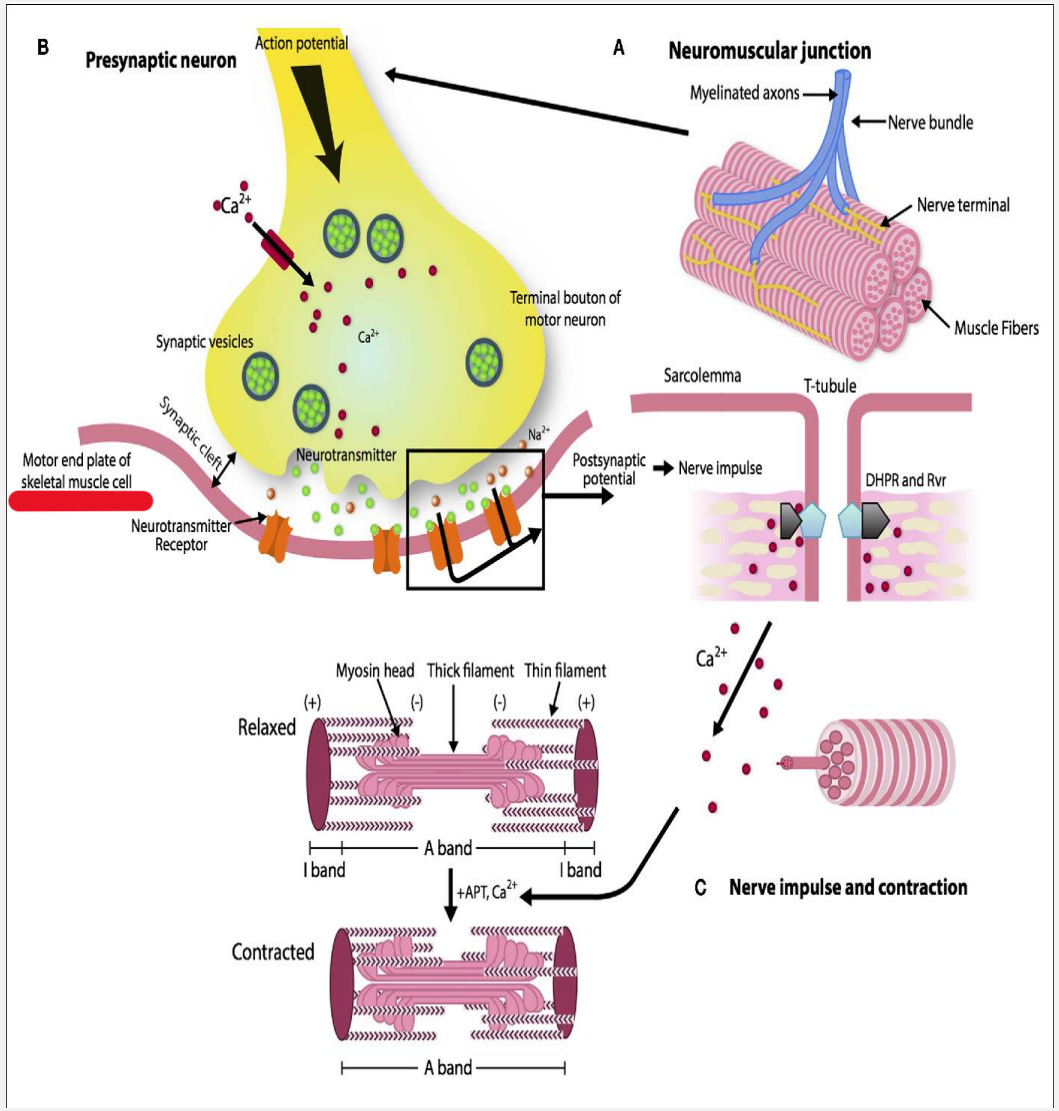
SYNAPTIC TRANSMISSION





NEUROMUSCULAR JUNCTION





Neuromuscular Junction (NMJ)

The neuromuscular junction (NMJ) is a specialized synapse between a **motor neuron** and a **skeletal muscle fiber**. It is the site where **nerve impulses are transmitted from neurons to muscles**, leading to **muscle contraction**.

Structure of the Neuromuscular Junction

1. Motor Neuron Terminal (Presynaptic Terminal):

1. The end of the motor neuron axon.
2. Contains **synaptic vesicles** filled with the neurotransmitter **acetylcholine (ACh)**.
3. Has voltage-gated **calcium (Ca^{2+}) channels**.

2. Synaptic Cleft:

1. A narrow space (~20-30 nm) between the nerve terminal and the muscle fiber membrane.
2. Contains **acetylcholinesterase (AChE)**, the enzyme that breaks down ACh.

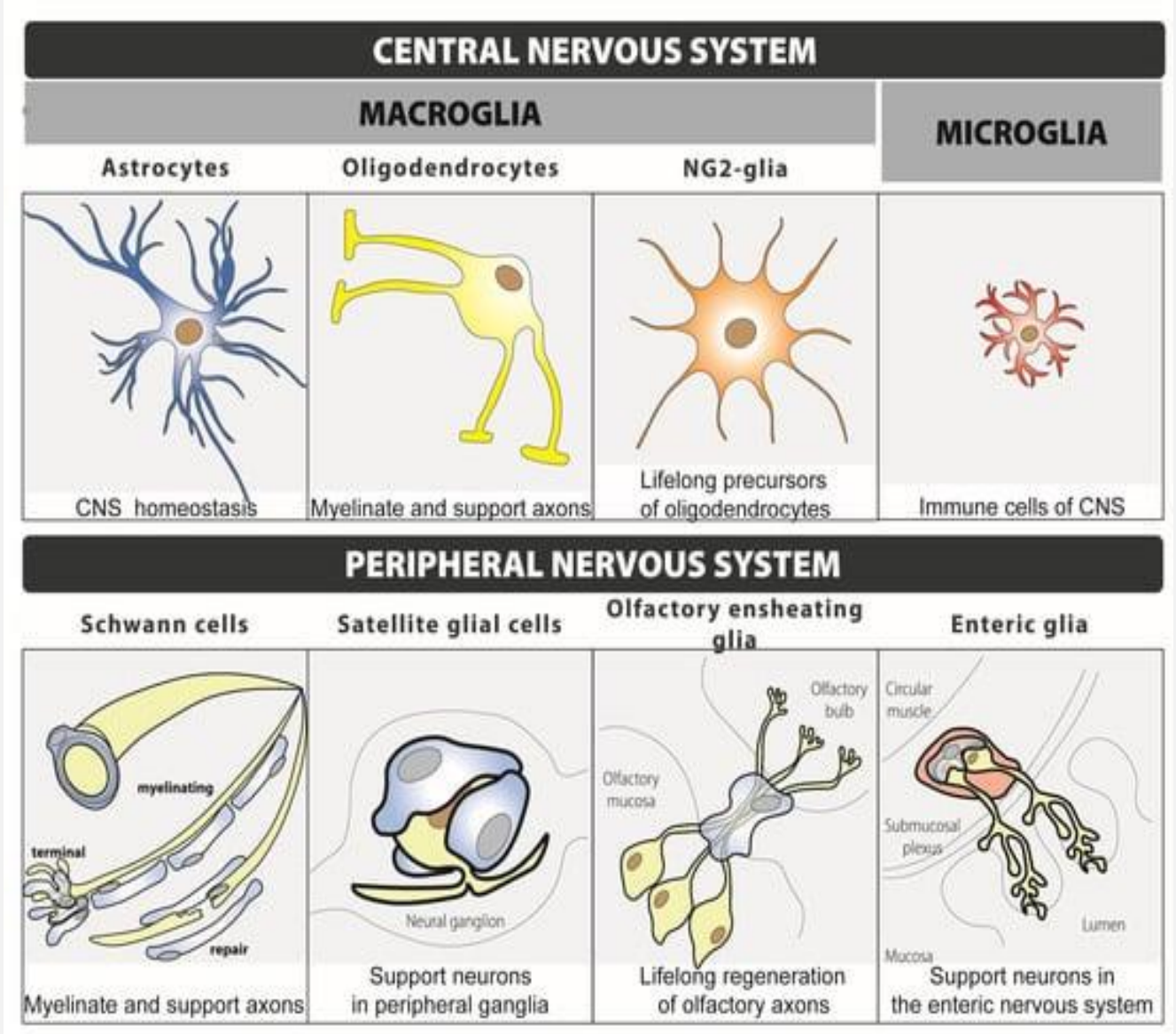
3. Motor End Plate (Postsynaptic Membrane):

1. The specialized area of the **sarcolemma** (muscle cell membrane) that lies opposite the neuron terminal.
2. Contains **nicotinic acetylcholine receptors (nAChRs)**.
3. Highly folded to increase surface area for receptors.

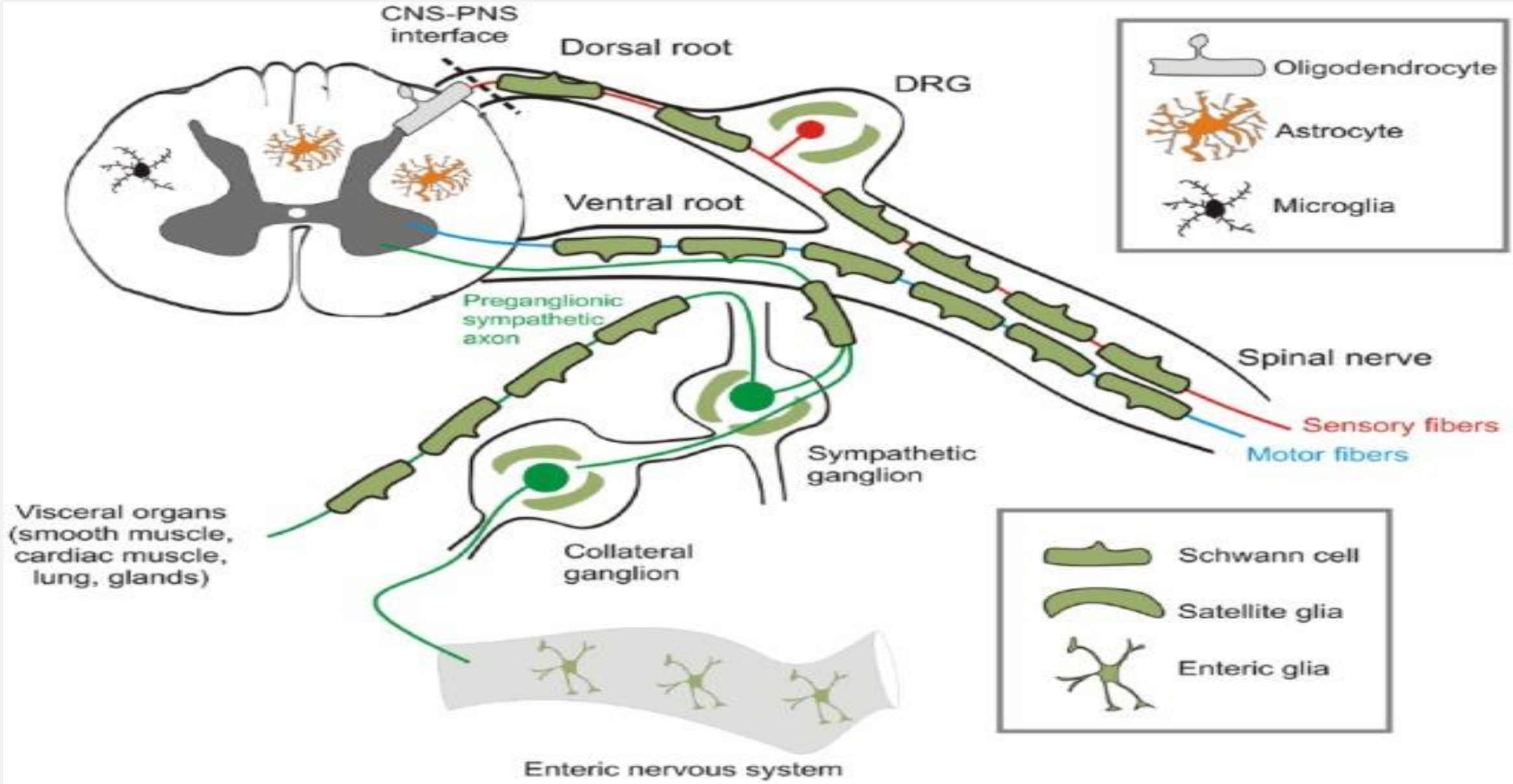
NEUROGLIA
OR
GLIAL CELLS
(Supporting Cell)

NEUROGLIA OR GLIAL CELLS- Supporting Cell

Neuroglia - Cells that provide metabolic support and immune protection for neurons. Neuroglia outnumber neurons by about 10:1 in the Central Nervous System. Neuroglia do not generate or conduct nerve impulses. However, unlike neurons, glial cells can regenerate if injured



NEUROGLIA OR GLIAL CELLS- Supporting Cell



Neuroglial Cell Types & Function

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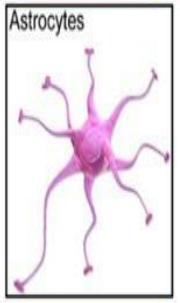
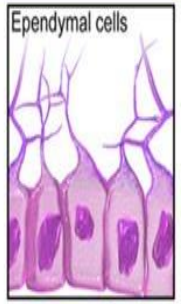
Central Nervous system

Astrocytes



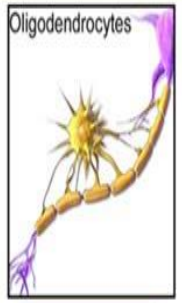
Maintain blood brain barrier -controlling the levels of neurotransmitter around synapses, -regulate ion, and providing metabolic support.

Ependymal cells



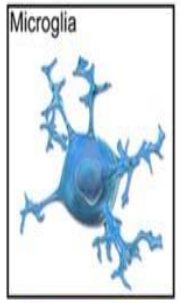
Line spinal cord & ventricles of the brain. -involved in producing cerebrospinal fluid (CSF).

Oligodendrocytes



Myelinate CNS axons, provide structural framework

Microglia



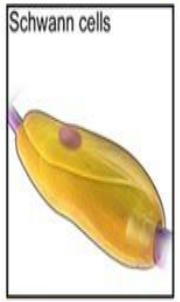
Brain's immune cells -Remove dead cells and pathogens by phagocytosis

Peripheral Nervous system

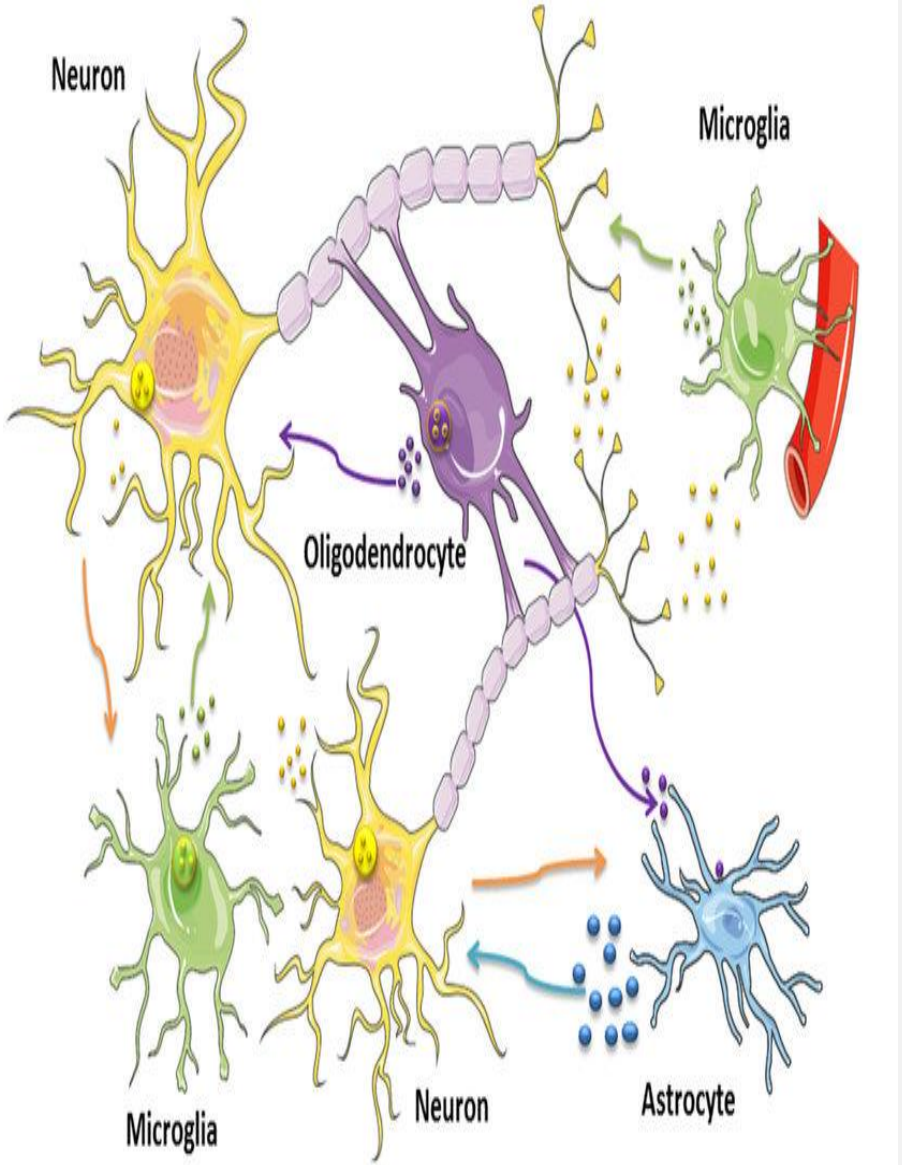
Satellite cells

Surround neuron cell bodies in ganglia. Regulate neurotransmitter levels

Schwann cells



Myelinate neurons in PNS. maintenance and regeneration of neurons after injury



NEUROGLIA CELLS IN CENTRAL NERVOUS SYSTEM

ASTROCYTES

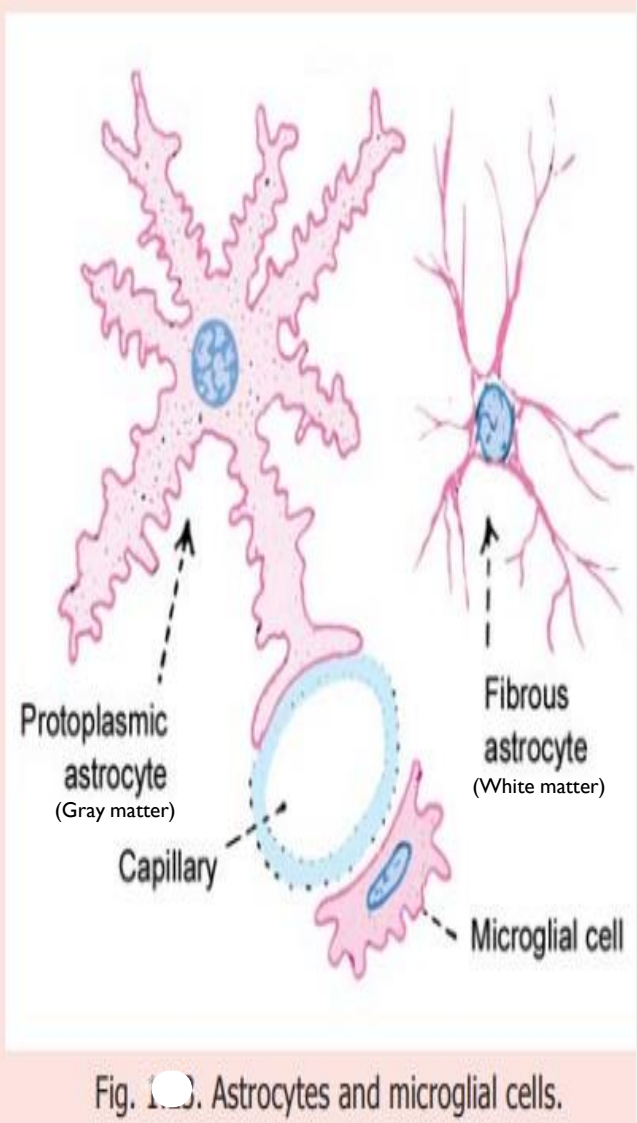
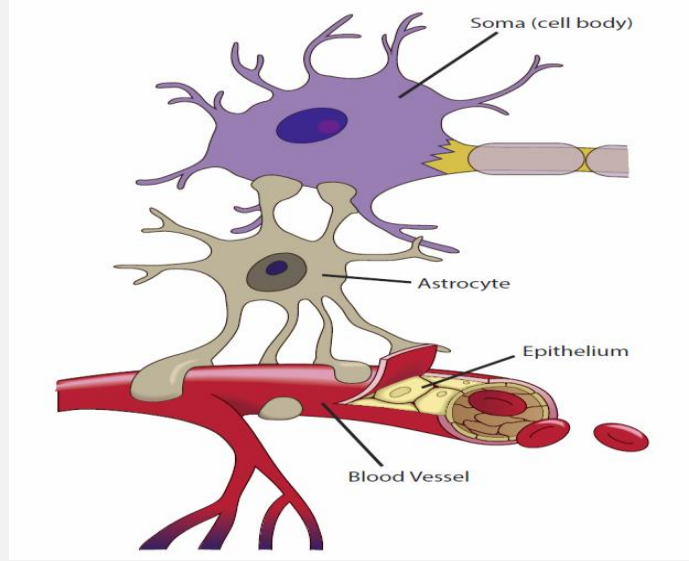


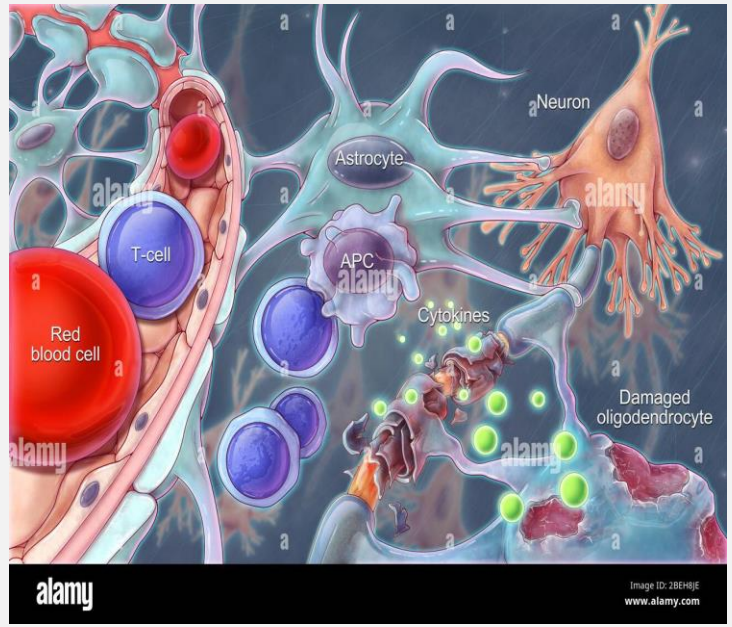
Fig. [illegible]. Astrocytes and microglial cells.

- They are star-shaped cells
- In expansion to blood vessels or in relation to surface of the brain.
- *Gliosomes* are present on the processes of astrocytes rich in mitochondria.
- In general, there are two types of astrocytes The processes of astrocytes are connected to those of other astrocytes through gap junction and communicate (calcium channels)

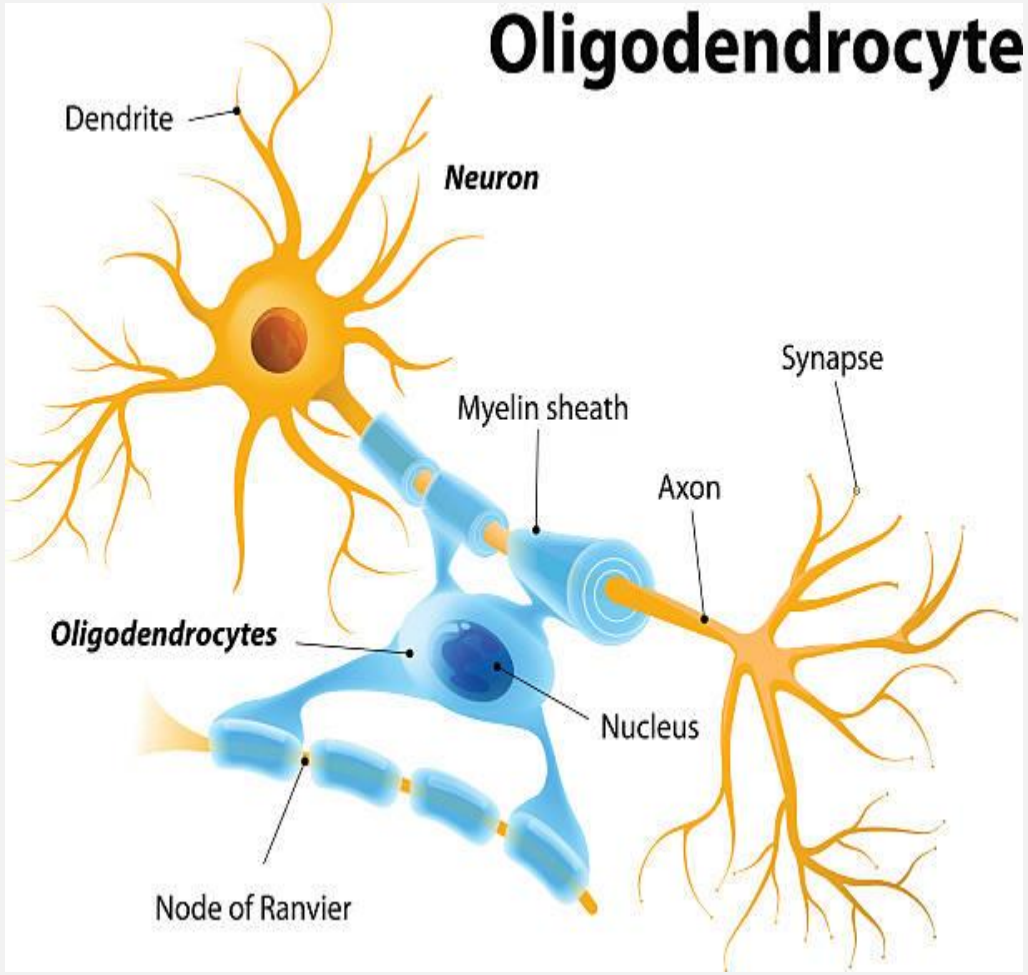
FUNCTION:

- ***Blood brain barrier***
- ***Structural integrity***
- ***metabolite exchange(glucose)***
- ***Removes excess glutamate from synapse***





OLIGODENDROCYTES

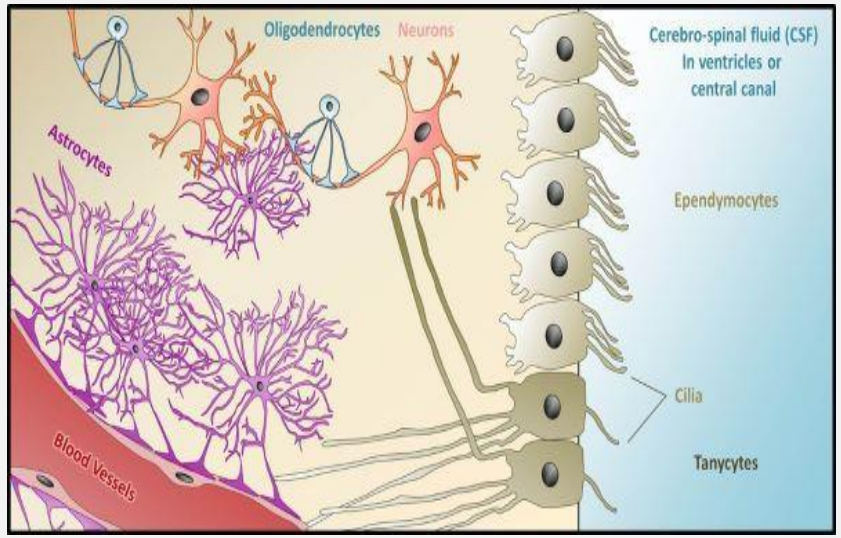


- **Oligodendrocytes have rounded or pear-shaped bodies with relatively few processes.**
- **The soma is small and the nucleus distinctive**
- **The dense cytoplasm stains darkly**
- **The processes extend to different axons and forms myelin sheath around them**

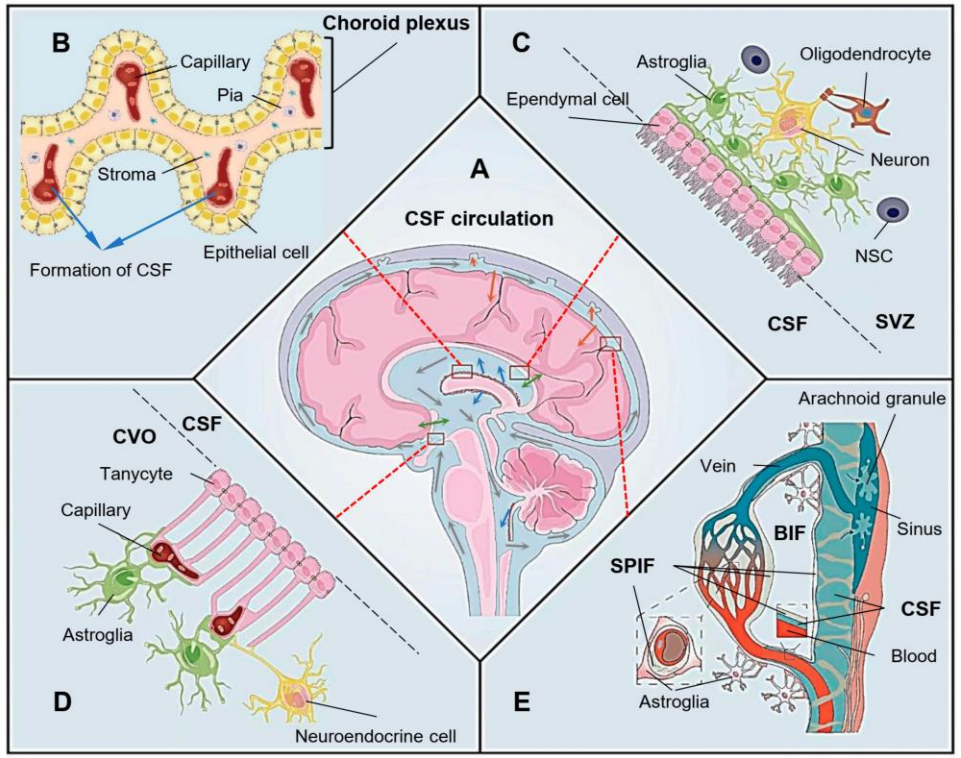
FUNCTION

- **Forms Myelin sheath**

EPENDYMAL CELLS

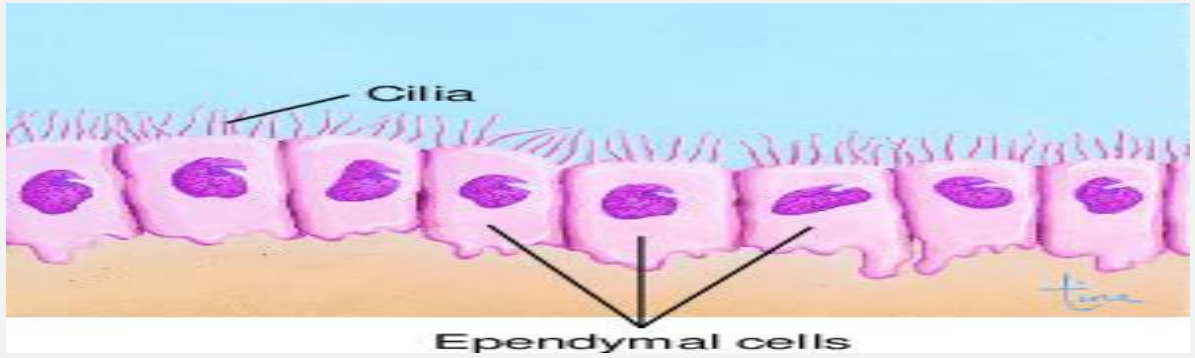


- Ependymal cells **similar in appearance to epithelial cells,** line the spinal cord and ventricular system of the brain.
- These cells contain cilia and has prominent nucleus.
- The ependymal cells are of three variants.
- The ependymocytes promote the free movement of molecules. It does so between the neurons and the cerebrospinal fluid.
- Tanycytes respond to alterations in the hormonal levels. It does within the blood-derived hormones.
- choroidal epithelial cells control the chemical composition of the **cerebrospinal fluid.**



FUNCTION:

- ***Production of CSF and its movement***
- ***Acts as barrier between CSF in the ventricular system and the brain***



NG-2 GLIAL CELLS

NG-2 cells represent a resident **glial progenitor cell population** that exists throughout the Gray and white matter of the developing and mature mammalian CNS.

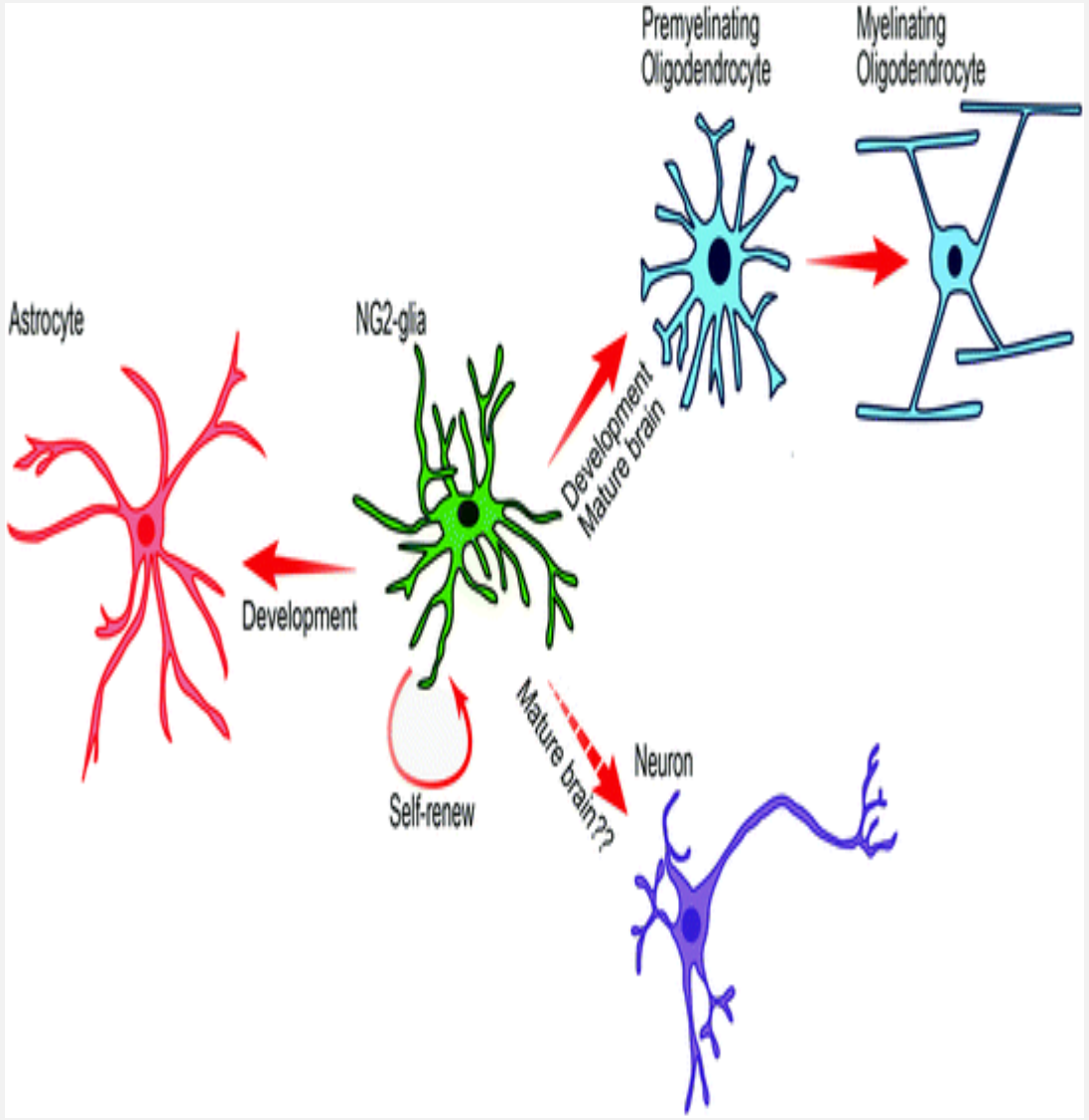
NG2-glia are defined by their expression of the chondroitin sulphate proteoglycan NG2 (**cspg4**)

2-8% of all the cells in the adult CNS.

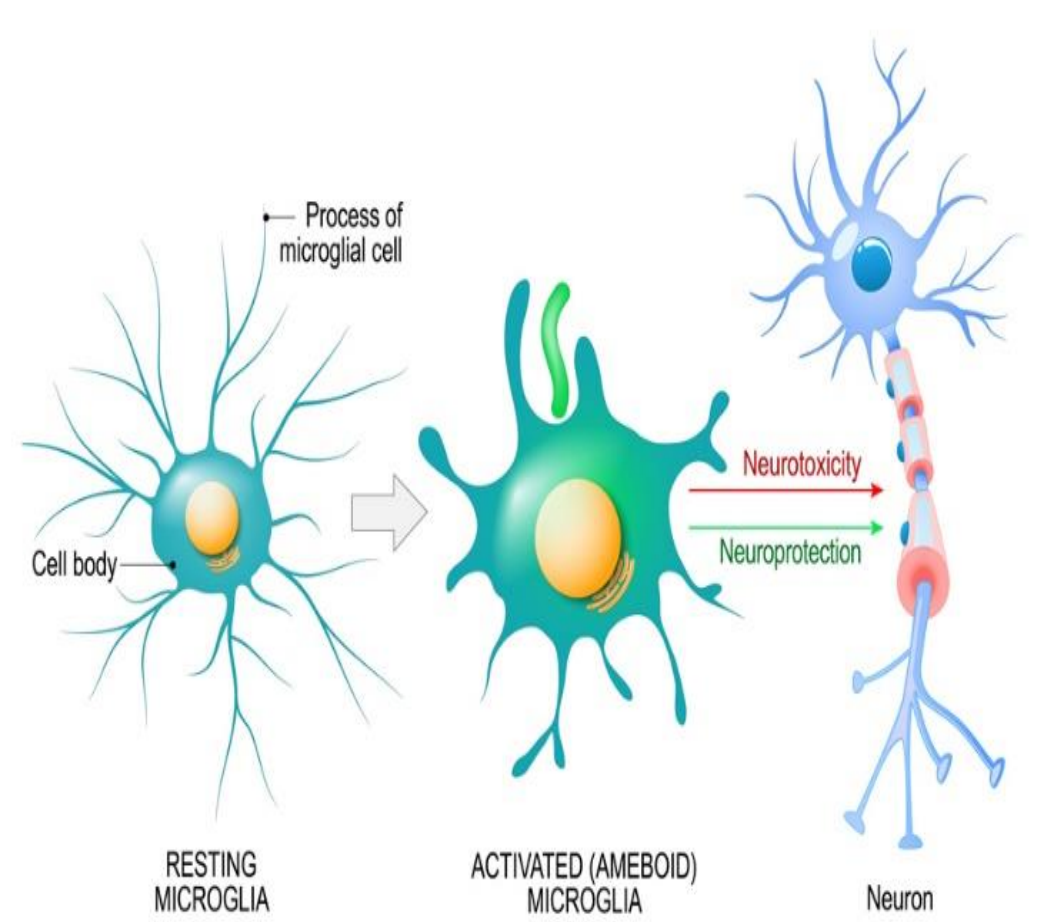
NG2 glia had large euchromatic nuclei with prominent nucleoli and thick and branched processes

Function

*These cells are often equated with **oligodendrocyte precursor cells (OPCs)** because of their ability to generate myelinating and non-myelinating oligodendrocytes.*



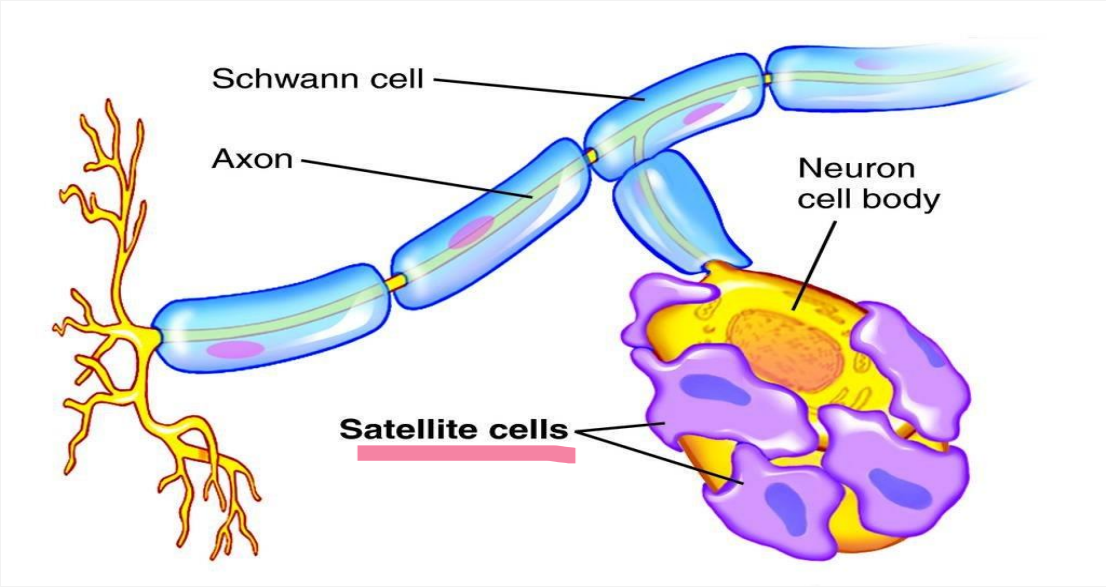
MICROGLIA OR SMALL GLIAL CELLS



- These are the **smallest neuroglial cells**.
- The cell body is flattened. The processes are short. These cells are frequently seen in relation to capillaries.
- They became active after damage to nervous system tissue by trauma or diseases
- Its forms-- tends to keep changing mainly after it has engulfed a foreign body. They are mobile within the brain and multiply when the brain is damaged.

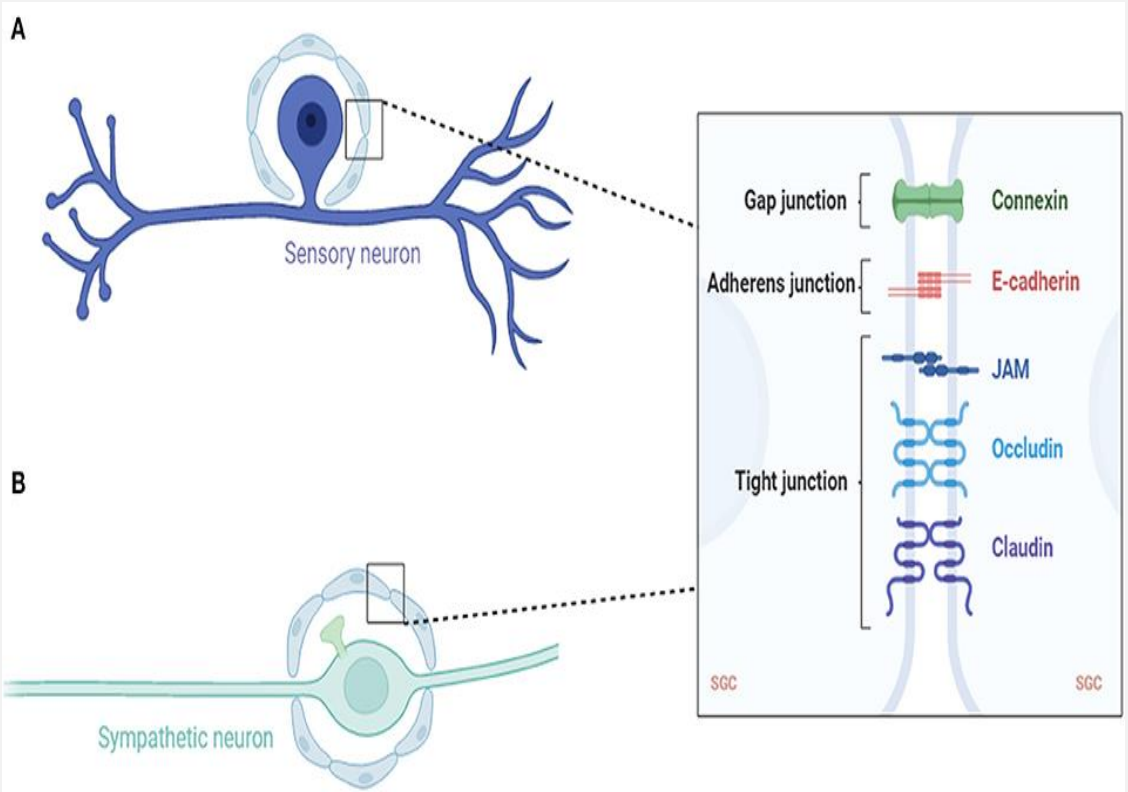
Function: immune cells of the CNS *The microglia are phagocytic cells. They engulf pathogens cells and protect the brain from invading microorganisms and degrade dead cells or damaged portion of the nerve. Thus, serve a defensive role within the nervous system and acts as* ***immune system of the CNS.***

NEUROGLIA CELLS IN PERIPHERAL NERVOUS SYSTEM



1. SATELLITE CELLS

Satellite glial cells are small cells that surround **neurons cell body** in sensory, sympathetic, and parasympathetic ganglia, which are a cluster of nerve cell bodies outside CNS. **Like astrocytes**, they are interconnected by junctions.



Function:

Satellite cells surround and physically support neurons within ganglia. They form a protective layer around the neuronal cell bodies, shielding them from damage and providing structural support.

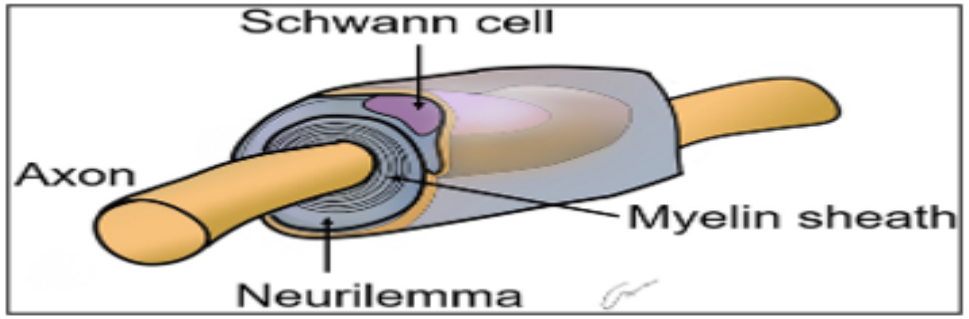
These cells help regulate the chemical environment around neurons by controlling the levels of ions, neurotransmitters, and other essential substances. For example, they can regulate the concentration of potassium ions, which is crucial for neuronal function.

2. ***Schwann Cells***

A well-developed Schwann cell is shaped like a rolled-up sheet of paper, with layers of myelin between each coil. The inner layers of the wrapping, which are predominantly membrane material, form the myelin sheath, while the outermost layer of nucleated cytoplasm forms the neurilemma.

One Schwann cell myelinate a single axon.

Individual myelinating Schwann cells cover about 1 mm of an axon—equating to about 1000 Schwann cells along a 1-m length of the axon. During peripheral nerve regeneration, 9-O-acetyl GD3 is expressed by Schwann cells. They are Neural crest cell derived.



Function: produce myelin sheath

Similar in function to oligodendrocytes, Schwann cells provide myelination to axons in the peripheral nervous system (PNS). They also have phagocytotic activity and clear cellular debris that allows for regrowth of PNS neurons

FUNCTION OF NEUROGLIA

The following are the functions of neuroglia.

(1) They provide mechanical support to neurons.

(2) In view of their non-conducting nature they serve as insulators and prevent neuronal impulses from spreading in unwanted directions.

(3) They are believed to help neuronal function by playing an important role in maintaining a suitable metabolic environment for the neurons. They can absorb neurotransmitters from synapses thus terminating their action. It has been held that they play a role in maintaining the blood-brain barrier, but this view is open to question.

(4) They are responsible for repair of damaged areas of nervous tissue. Neuroglial cells proliferate in such regions (gliosis). These cells (specially microglia) may act as macrophages.

(Macrophages are cells that can engulf and destroy unwanted material).

(5) As mentioned above, oligodendrocytes provide myelin sheaths to nerve fibres within the central nervous system.

(6) Ependymal cells are concerned in exchanges of material between the brain and the cerebrospinal fluid.