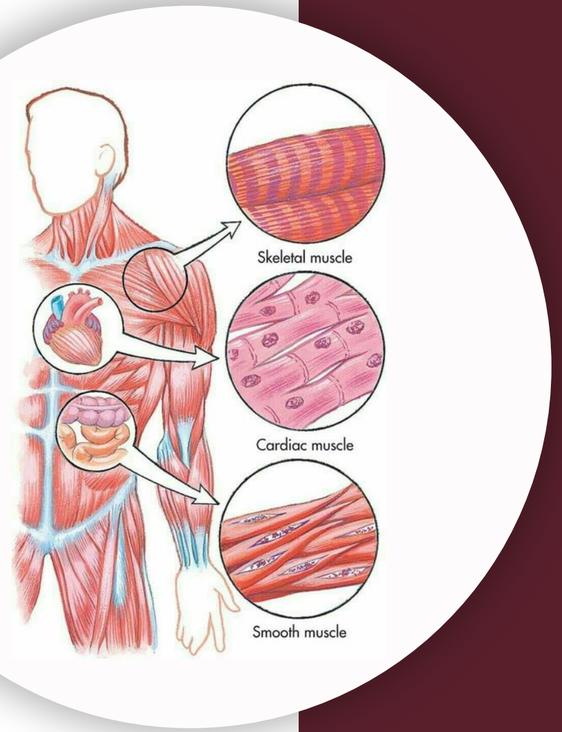
بسم الله الرحمن الرحيم

Histology | Final 7

Nervous Tissue pt.2



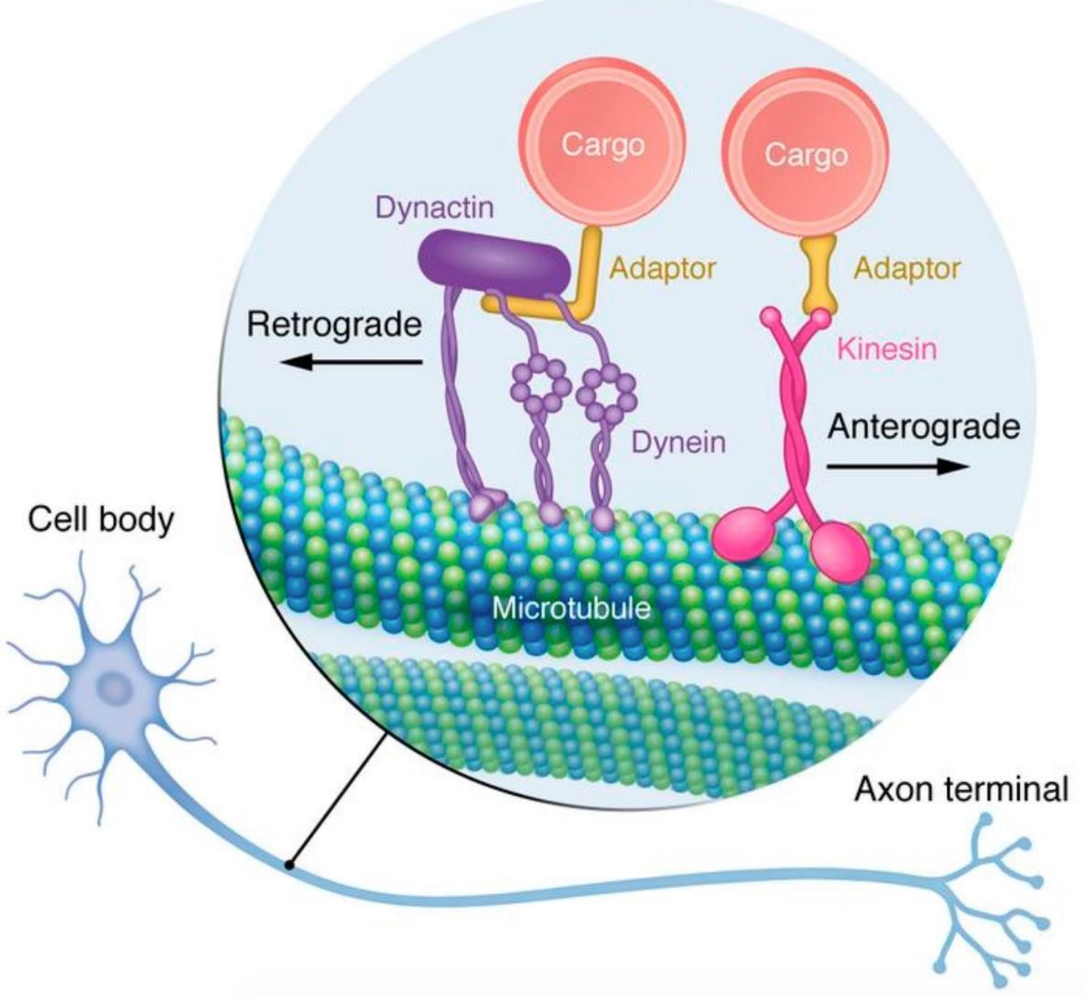
Done by : Dopamine 023

AXON/TRANSPORT

- **Anterograde** transport: away from cell body. Organelles and macromolecules synthesized in the cell body move along axonal microtubules via **kinesin** from the perikaryon to the synaptic terminals.
- **Retrograde** transport: toward cell body. in the opposite direction along microtubules via **dynein** carries certain other macromolecules–-endocytosis (including viruses and toxins).

neurons are actually very well protected , They cannot be infected with viruses, cannot be touched with toxins very easily.

- Anterograde and retrograde transports: 50-400 mm/d.



However If you have ever had chickenpox and your immune system grows weak , virus that were dormant in the nerve tissues can be re-activated ,and can use retrograde to reach the cell body and spread from the spinal cord to the peripheral NS leading to widely spread symptoms , a condition called shingles

SYNAPSES

- **Precynaptic cell**

Presynaptic axon terminal (terminal bouton)

Neurotransmotter (synaptic vesicles)

Ca^{2+} !!!

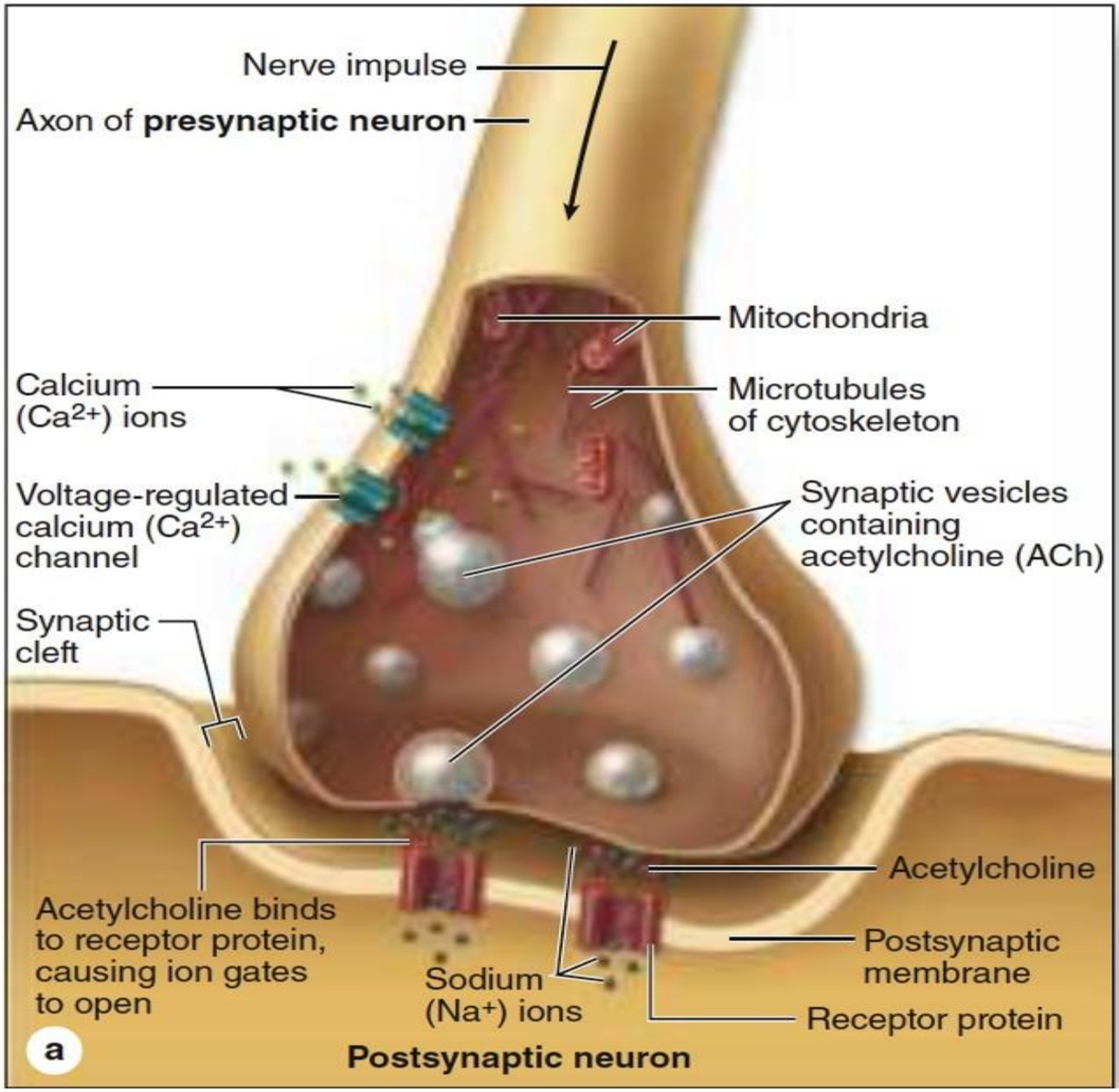
Ca+2 , contribute in facilitating the vesicles fusion with the presynaptic membrane ,which leads to the releasing of neurotransmitters to the synaptic cleft ,
then bind to its receptors on the postsynaptic membrane and that how Action potential is transmitted

- **Synaptic cleft**

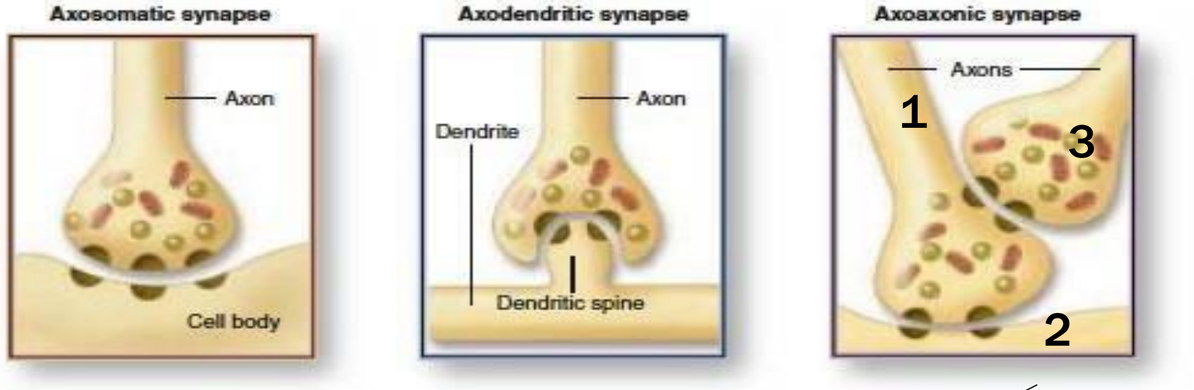
20-30 nm-wide intercellular space called the

- **Postsynaptic cell**

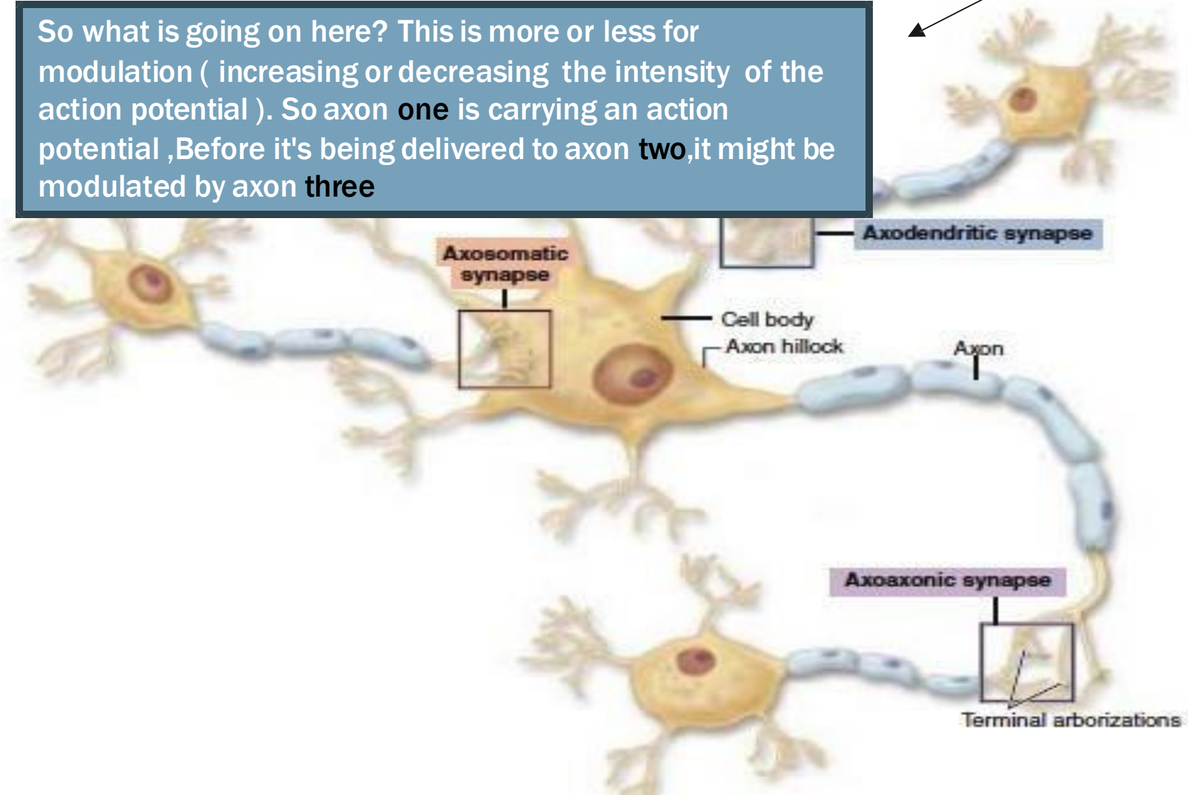
Postsynaptic cell membrane



How do the neurons interact In order for the action potential to be transferred from one neuron one to the other? the two neurons have to physically contact to each other.



So what is going on here? This is more or less for modulation (increasing or decreasing the intensity of the action potential). So axon one is carrying an action potential ,Before it's being delivered to axon two,it might be modulated by axon three



The diagrams show three common morphologic types of synapses. Branched axon terminals usually associate with and transmit a nerve impulse to another neuron's cell body (or soma) or a dendritic spine. These types of connections are termed an **axosomatic synapse** and an **axodendritic synapse**, respectively. Less frequently, an axon terminal forms a synapse with an axon terminal of another neuron; such an **axoaxonic synapse** functions to modulate synaptic activity in the other two types.

All three morphologic types of synapses have the features of all true synapses: a presynaptic axon terminal that releases a transmitter; a postsynaptic cell membrane with receptors for the transmitter; and an intervening synaptic cleft.

Synaptic structure usually cannot be resolved by light microscopy, although components such as dendritic spines may be shown with special techniques (Figure 9–5).

TYPES OF SYNAPSES

1 Axo-somatic:
Axo : from the terminals of the axon of the presynaptic neuron
somatic : to the soma (body) of the post synaptic cell (it could be neuron or effector cell)
2 Axo-dendritic :
dendritic: to the dendritic spine on the post synaptic neuron
3 Axo –axonic:
axonic: to the axon of another neuron .

SYNAPSES

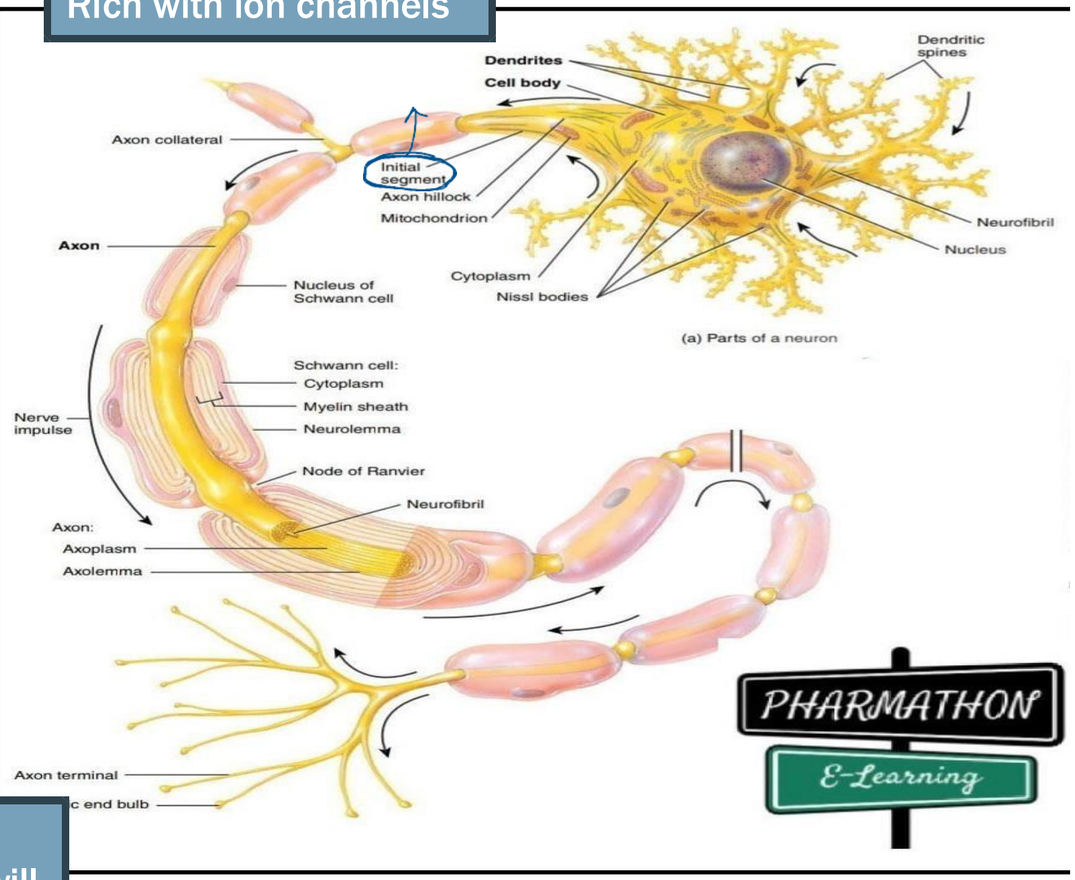
- **Excitatory** synapses cause postsynaptic Na^+ channels to open--- depolarization wave in the postsynaptic neuron (or effector).
- **Inhibitory** synapses neurotransmitters open Cl^- (or other anion), causing ---influx of anions -----hyperpolarization--- membrane potential more negative--- resistant to depolarization.
- The response in postsynaptic neurons is determined by the **summation** of activity at hundreds of synapses on that cell.

whether we will have an initiation or an action potential in the initial segment that will propagate through this exon depends on the summation of the synapses

So let's assume that this neuron has 100 synapses from 100 different neurons. we have about 70 excitatory ones and we have 30 inhibitory ones. So it seems like the excitatory will outnumber the inhibitory and we will have an initiation of an action potential

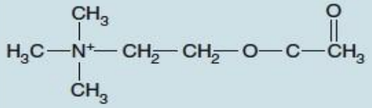
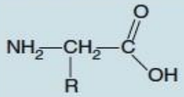
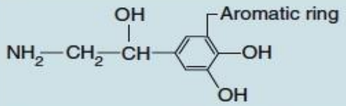
how will that actually take place?Think about it has to deal with ion channel which we are opening. So the excitatory will work on the sodium, which means we We will have depolarization, depolarization that propagation of an action potential. Whereas the inhibitory, they are more associated with the chloride. Chloride should be hyperpolarization .

Rich with ion channels



NEUROTRANSMITTERS (READ ONLY)

TABLE 9–1 Common neurotransmitters and their actions.

Neurotransmitter	Description/Action
ACETYLCHOLINE (ACh)	
	Chemical structure significantly different from that of other neurotransmitters; active in CNS and in both somatic and autonomic parts of PNS; binds to ACh receptors (cholinergic receptors) in PNS to open ion channels in postsynaptic membrane and stimulate muscle contraction
AMINO ACIDS	
	Molecules with both carboxyl (—COOH) and amine (—NH_2) groups and various R groups; act as important transmitters in the CNS
Glutamate	Excites activity in neurons to promote cognitive function in the brain (learning and memory); most common neurotransmitter in the brain; opens Na^+ channels
Gamma-aminobutyric acid (GABA)	Synthesized from glutamate; primary inhibitory neurotransmitter in the brain; also influences muscle tone; opens or closes various ion channels
Glycine	Inhibits activity between neurons in the CNS, including retina; opens Cl^- channels
MONOAMINES	
	Molecules synthesized from an amino acid by removing the carboxyl group and retaining the single amine group; also called biogenic amines
Serotonin or 5-hydroxytryptamine (5-HT)	Has various functions in the brain related to sleep, appetite, cognition (learning, memory), and mood; modulates actions of other neurotransmitters
Catecholamines	A distinct group of monoamines
Dopamine	Produces inhibitory activity in the brain; important roles in cognition (learning, memory), motivation, behavior, and mood; opens K^+ channels, closes Ca^{2+} channels
Norepinephrine (noradrenaline)	Neurotransmitter of PNS (sympathetic division of autonomic nervous system) and specific CNS regions
Epinephrine (adrenaline)	Has various effects in the CNS, especially the spinal cord, thalamus, and hypothalamus
NEUROPEPTIDES	
	Small polypeptides act as signals to assist in and modulate communication among neurons in the CNS
Enkephalin	Helps regulate response to noxious and potentially harmful stimuli
Neuropeptide Y	Involved in memory regulation and energy balance (increased food intake and decreased physical activity)
Somatostatin	Inhibits activities of neurons in specific brain areas
Substance P	Assists with pain information transmission into the brain
Cholecystokinin (CCK)	Stimulates neurons in the brain to help mediate satiation (fullness) and repress hunger
Beta-endorphin	Prevents release of pain signals from neurons and fosters a feeling of well-being
Neurotensin	Helps control and moderate the effects of dopamine
OTHERS	
Adenosine	Also part of a nucleotide, inhibits activities in certain CNS neurons
Nitric oxide	Involved in learning and memory; relaxes muscle in the digestive tract; important for relaxation of smooth muscle in blood vessels (vasodilation)

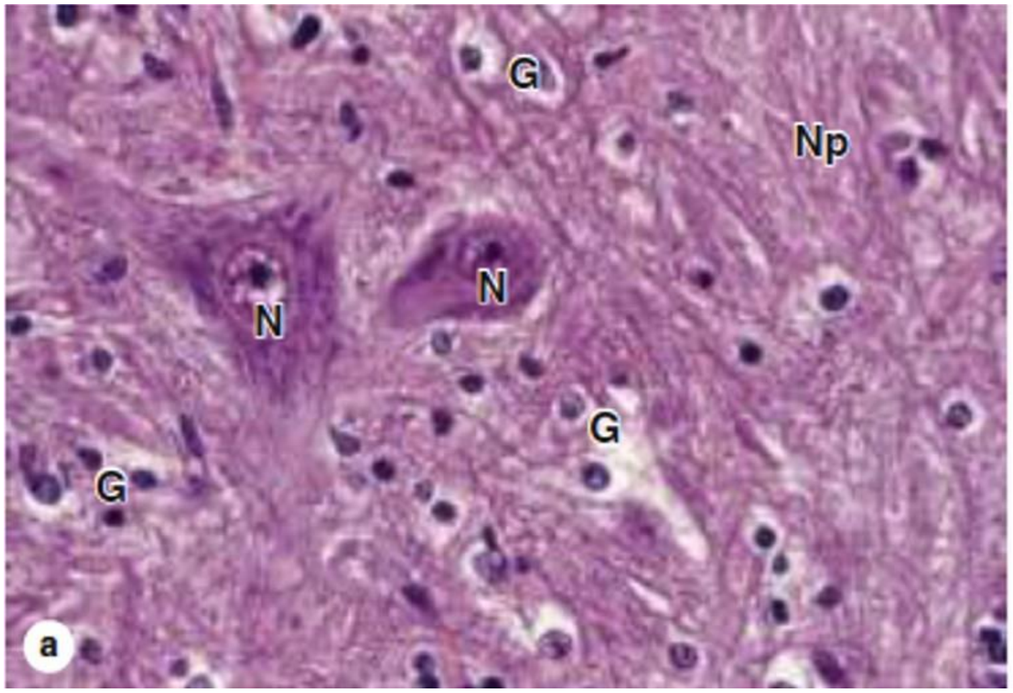
GLIAL CELLS

Nervous tissue is composed of two main types of cells

- **Neurons** – These are the primary functional units of the nervous system.
- **Neuroglial (glial) cells** – These are the supporting cells that outnumber neurons and provide structural, metabolic, and immunological support.

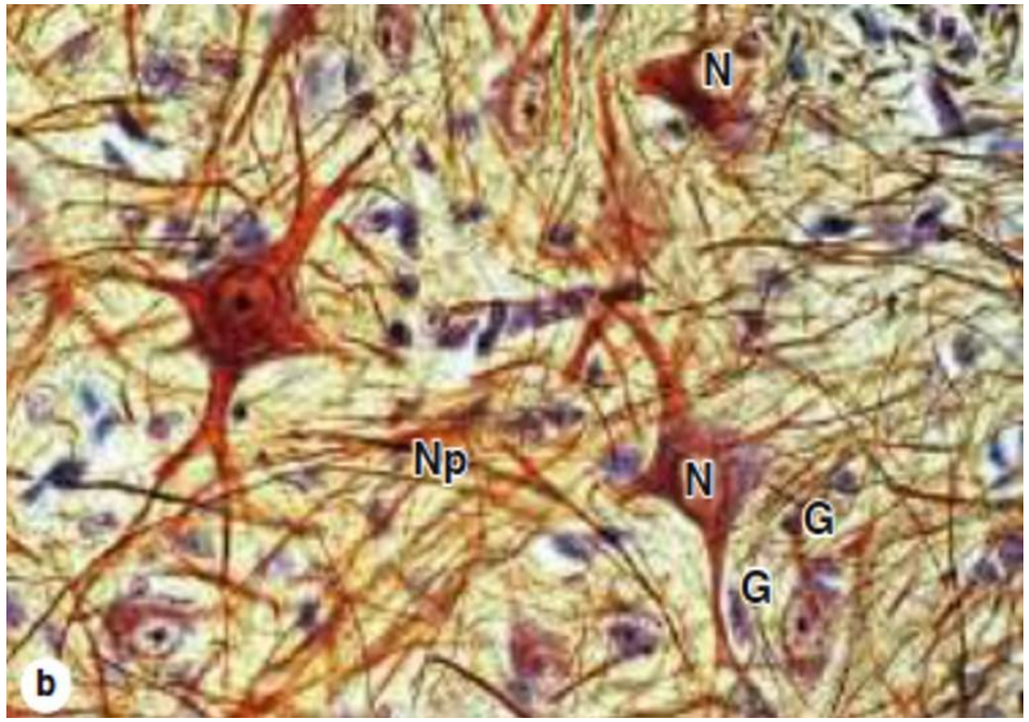
GLIAL CELLS

- Support neuronal survival and activities.
- Ten times more abundant.
- Most glial cells develop from neural plate cells
- In the CNS surrounds both the cell bodies and the processes of axons and dendrites (occupying the spaces between neurons).
- Substitute for cells of connective tissue creating immediately around those cells microenvironments that are optimal for neuronal activity.



This is a Hematoxylin and Eosin (H&E) stained sections, **neurons** are easily recognized as the largest cells in the field. Their prominent size and large nuclei make them stand out. Surrounding each neuron are numerous smaller nuclei, which belong to the **glial cells.**

Np = neuropil; network of fine cellular processes emerging from neurons and glial cells. Such processes are collectively called the neuropil



This is a gold-stained preparations, neurons again appear as the largest elements.
The surrounding fine fibrillary background, known as the **neuropil**, is made up of the interwoven processes of neurons and glial cells. These structures may resemble collagen, but they are actually composed of axons, dendrites, and glial processes, not connective tissue.

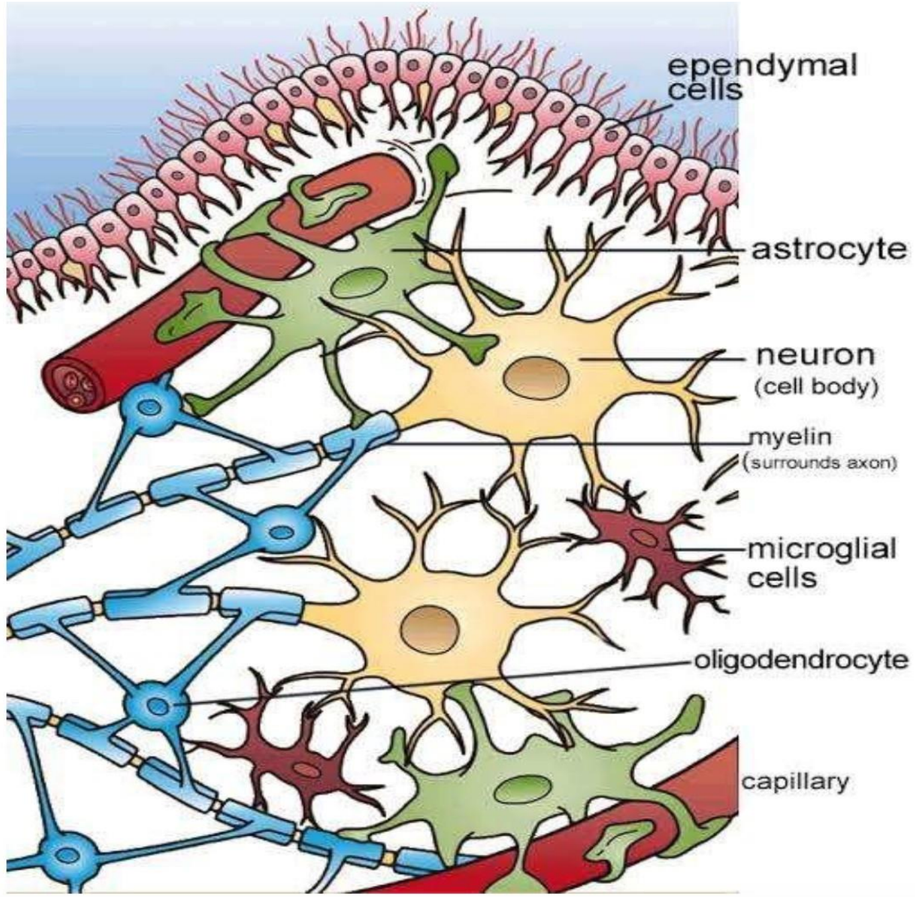
Development of Nervous Tissue

Nervous tissue primarily develops from the neural plate, which folds to form the neural tube. The neural crest, arising at the borders of the neural plate, gives rise to many components of the nervous system. However, one important exception is the microglial cells, which do not originate from the neural tube or neural crest, but rather from **mesoderm-derived** monocytes.

Types of Neuroglia

Neuroglia are classified into:

- Central Neuroglia – Located within the brain and spinal cord.
- Peripheral Neuroglia – Located outside the CNS, primarily in peripheral nerves.



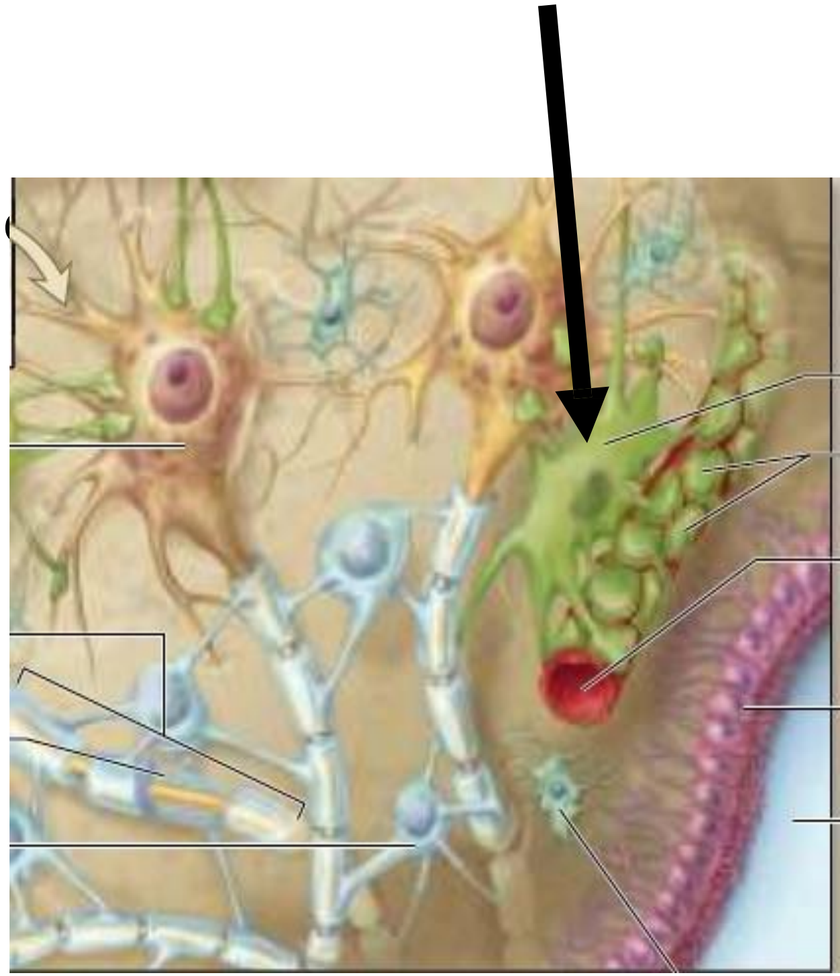
NEUROGLIA

CENTRAL NEUROGLIA

Astrocytes
The most abundant glial cells, especially in **gray matter.**
Extend processes that contact blood vessels and neurons, contributing to the blood-brain barrier (BBB).
Involved in repair processes—they do not regenerate neurons but proliferate to fill spaces left by dead neurons

ASTROCYTES

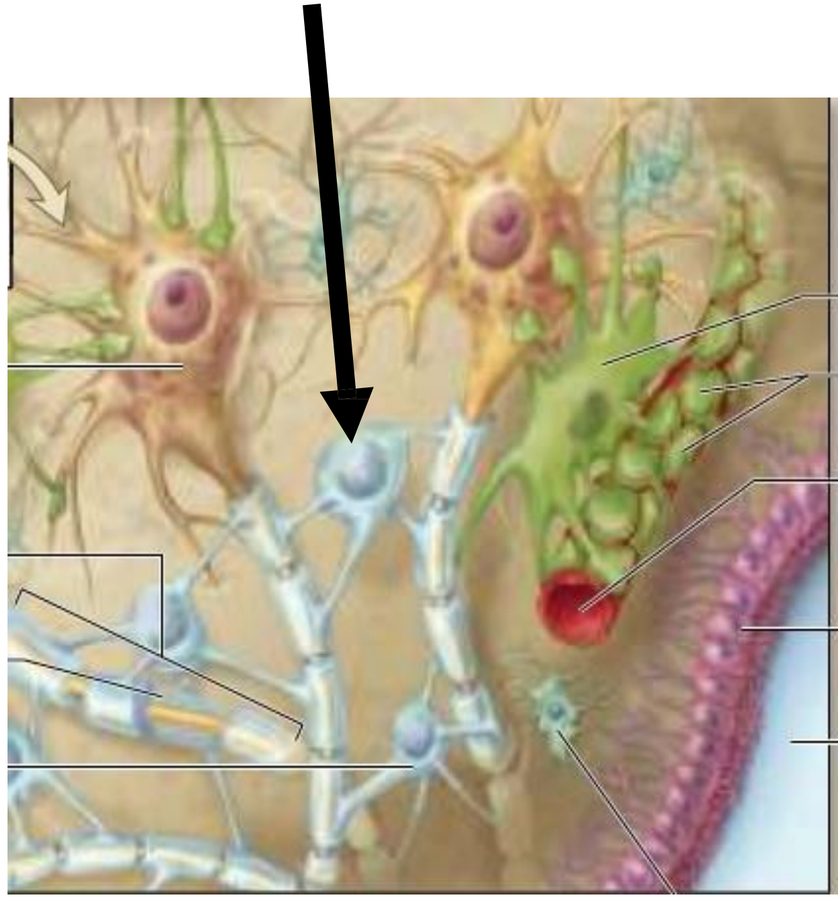
- Have a large number of long radiating, branching processes
- Terminal processes of a single astrocyte associate with over a many synapti sites.
- Astrocytes originate from neural tube cells.
- Most numerous glial cells of the brain.
- Most diverse structurally and functionally.
- Participate in blood-brain barrier. (This statement was deleted in the slides of the new recorded lecture)
- **Fibrous** astrocytes–- white matter ---- long delicate processes
- **Protoplasmic** astrocytes–- gray matter----- shorter processes.
- Communicate directly with one another via gap junctions.



CENTRAL NEUROGLIA

Oligodendrocytes

- Extend many processes—-sheet-like and wraps repeatedly around a portion of a nearby CNS axon (myelin: electrical insulation—rabid transmission of impulses).
- Many oligodendrocytes for axon's full length
- Are the predominant glial cells in white matter.
- Appear as small cells with rounded, condensed nuclei and unstained cytoplasm.



Oligodendrocytes
Form the myelin sheath in the central nervous system.
Each cell can myelinate multiple axons or multiple segments of different axons.
Functionally similar to Schwann cells in the peripheral nervous system, but unlike Schwann cells, they do not wrap their entire body around axons—only their processes do.
Derived from the neural tube.

CENTRAL NEUROGLIA

Ependymal Cells
Line the ventricles (spaces within the brain that are filled with cerebrospinal fluid (CSF)) , of the brain and the central canal of the spinal cord.
Possess long microvilli on their surfaces.
Aid in the production and circulation of cerebrospinal fluid (CSF).

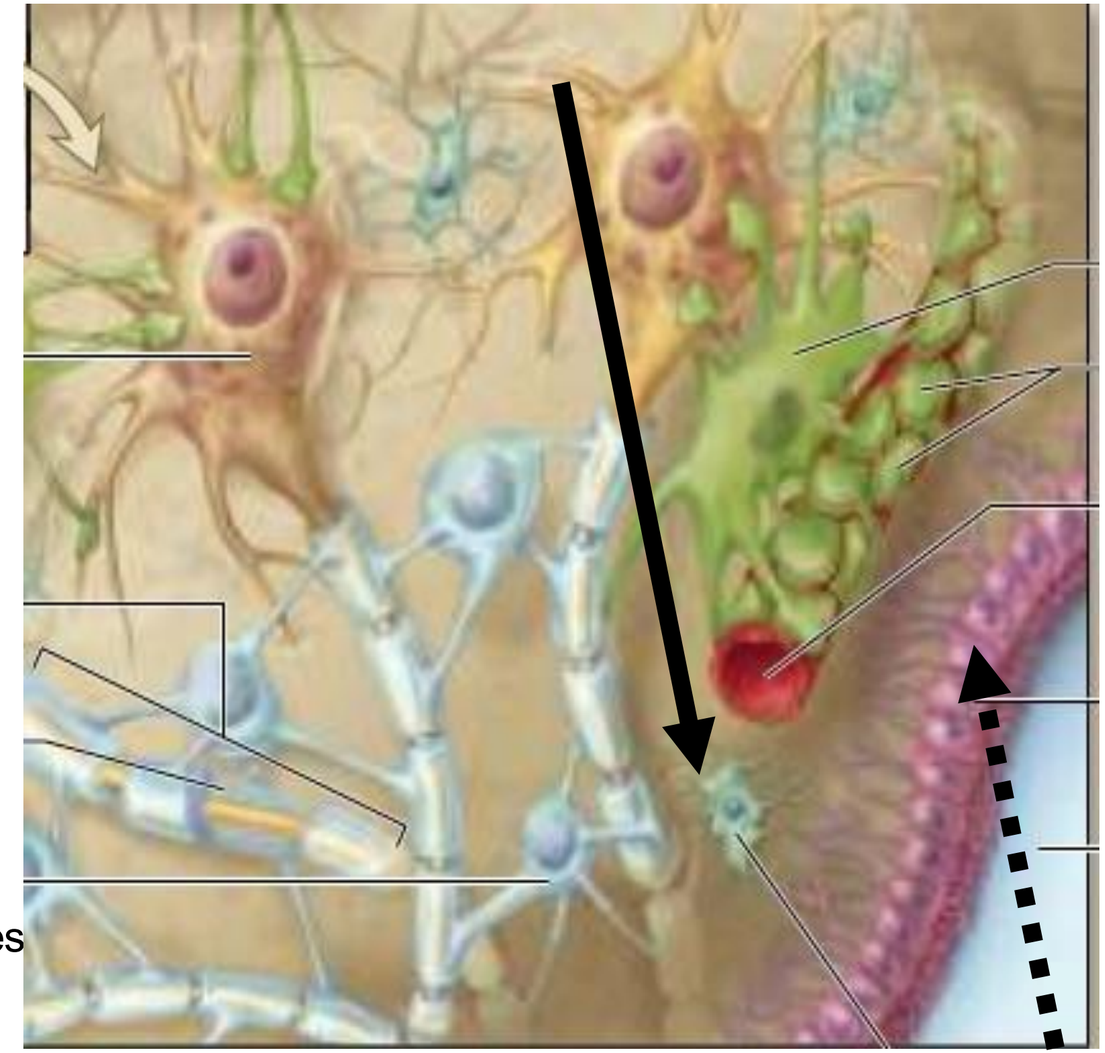
Ependymal cells

- Columnar or cuboidal cells that line the ventricles of the brain and the central canal of the spinal cord.
- Aid in CSF production and circulation

Microglia

Microglial Cells
The immune cells of the CNS, functioning as macrophages.
Involved in phagocytosis, clearing debris, and pruning unnecessary synapses and processes
Derived from monocytes of **mesodermal origin,** making them the only CNS glial cells not derived from the neural tube.

- Less numerous.
- Throughout gray and white matter
- Microglia migrate to remove damaged or effete synapses.
- Constitute the major mechanism of immune defense in the CNS. Remove any microbial invaders and secreting a number of immunoregulatory cytokines
- Originate from circulating blood monocytes.



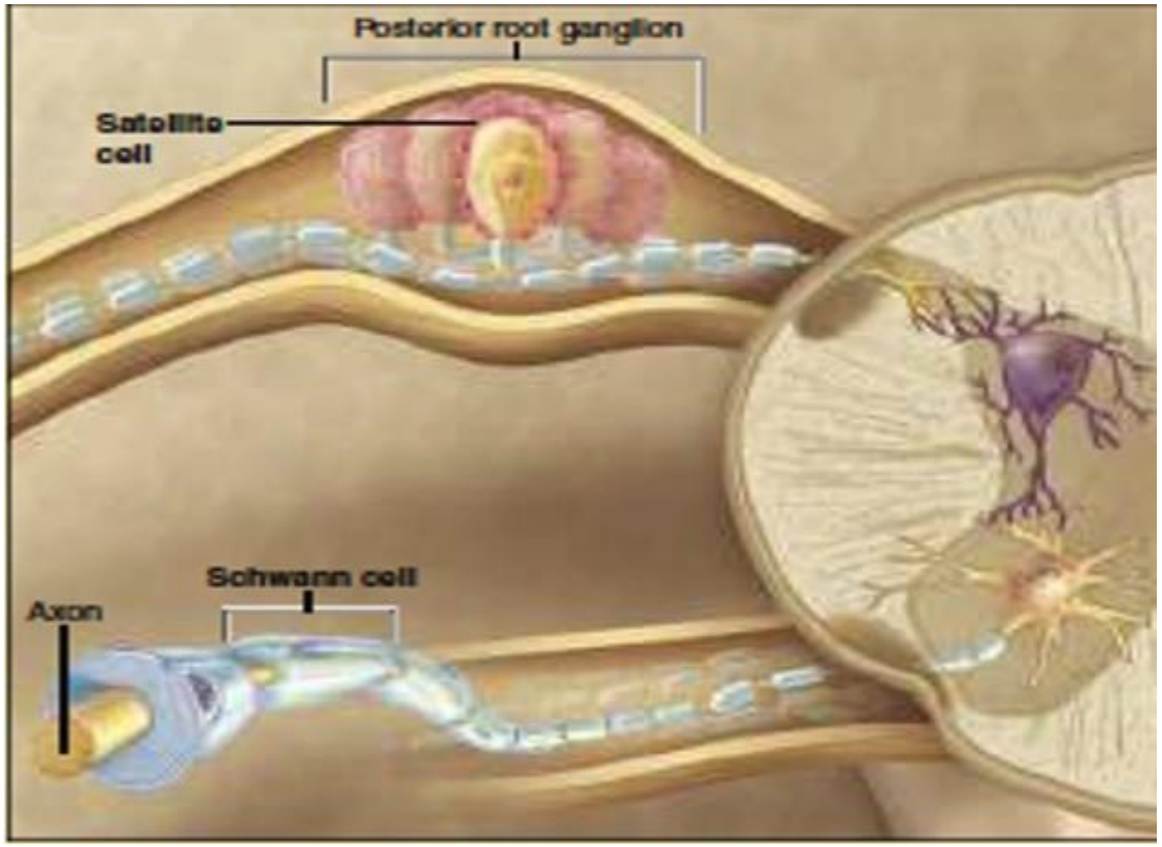
PERIPHERAL NEUROGLIA

Schwann cells

- Are found only in the PNS
- Differentiate from precursors in the neural crest.
- Are the counterparts to oligodendrocytes of the CNS,
- Having trophic interactions with axons and most importantly forming their myelin sheathes.
- Forms myelin around a portion of only one axon.

Satellite cells of ganglia

- Derived from the embryonic neural crest.
- Form a thin glial layer around neuronal cell body in the ganglia.



the whole cell wraps with its cytoplasm & nucleus (one axon & one segment)

PERIPHERAL NEUROGLIA

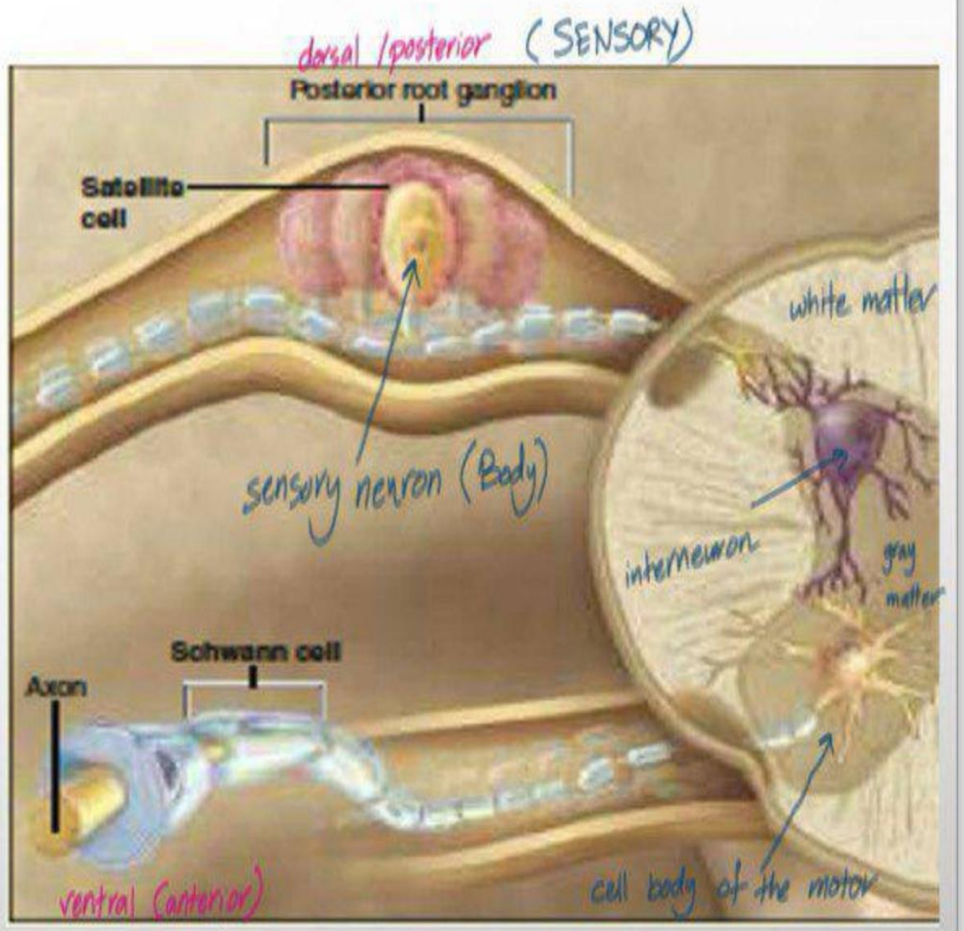
* cranial nerves attached to the brain (pure Motor OR pure Sensory)
* spinal nerves attached to the spinal cord (MIXED) +autonomic

Schwann cells

- Are found only in the PNS
- Differentiate from precursors in the neural crest.
- Are the counterparts to oligodendrocytes of the CNS,
- Having trophic interactions with axons and most importantly forming their myelin sheathes.
- Forms myelin around a portion of only one axon.

Satellite cells of ganglia (Inside the ganglia)

- Derived from the embryonic neural crest.
- Form a thin glial layer around neuronal cell body in the ganglia.



VERY IMPORTANT

NEUROGLIA (REQUIRED)

Glial Cell Type	Origin	Location	Main Functions
Oligodendrocyte	Neural tube	CNS	Myelin production, electrical insulation
Astrocyte	Neural tube	CNS	Structural and metabolic support of neurons, especially at synapses; repair processes
Ependymal cell	Neural tube	Line ventricles and central canal of CNS	Aid production and movement of CSF
Microglia	Bone marrow (monocytes)	CNS	Defense and immune-related activities
Schwann cell	Neural crest	Peripheral nerves	Myelin production, electrical insulation
Satellite cells (of ganglia)	Neural crest	Peripheral ganglia	Structural and metabolic support for neuronal cell bodies

For any feedback, scan the code or click on it.

Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1		-	The whole file has been changed according to the new record
V1 → V2			

Additional Resources:

رسالة من الفريق العلمي:

Reference Used:
(numbered in order as cited in the text)

1. First reference
2. Second reference
3. …

Extra References for the Reader to Use:

1. Video
2. Webpage
3. …

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