Nervous system

- Nervous system is the most complex system in our body . It is formed by a network of more than 100 million nerve cells (neurons) assisted by many more glial cells. Devoid from connective tissue

Coup and contrecoup injury

Coup-Contrecoup Injury.mp4

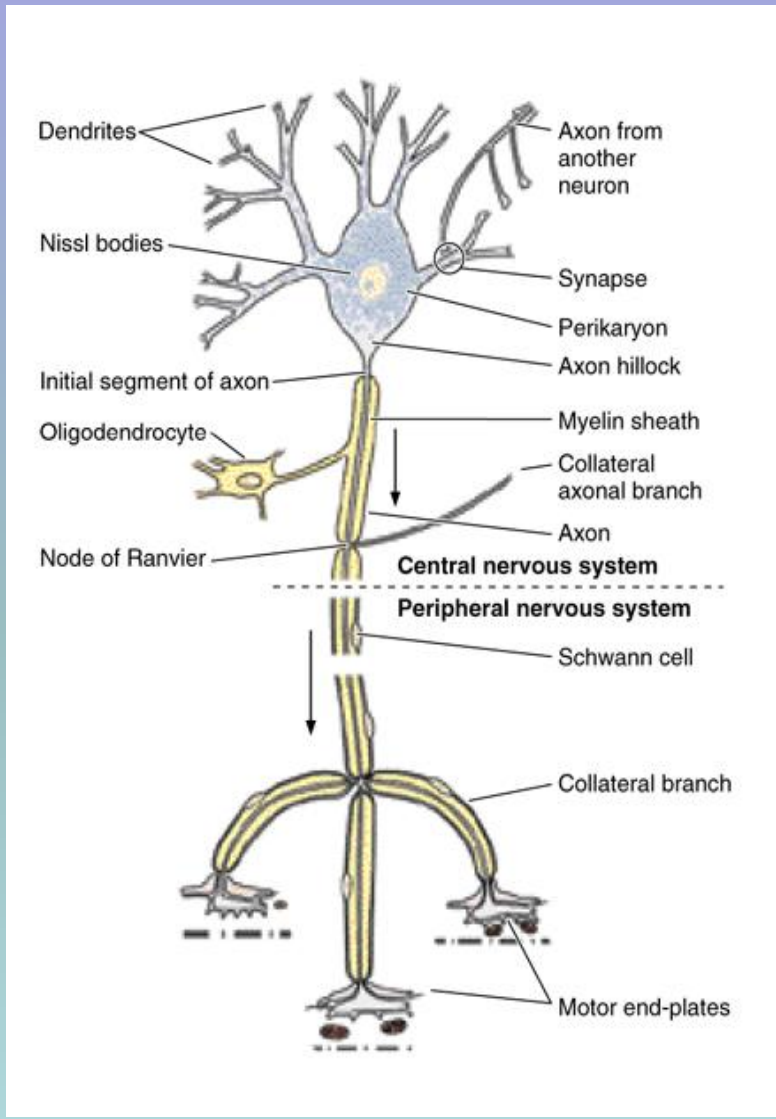
- N.S is formed from CNS and PNS
- N.S composed from two types of cells :neuron or nerve cell and glial cells

Neuron

Function : Nerve cells or neurons, are responsible for the reception, transmission and processing of stimuli; the triggering of certain cell activities; and the release of neurotransmitters.

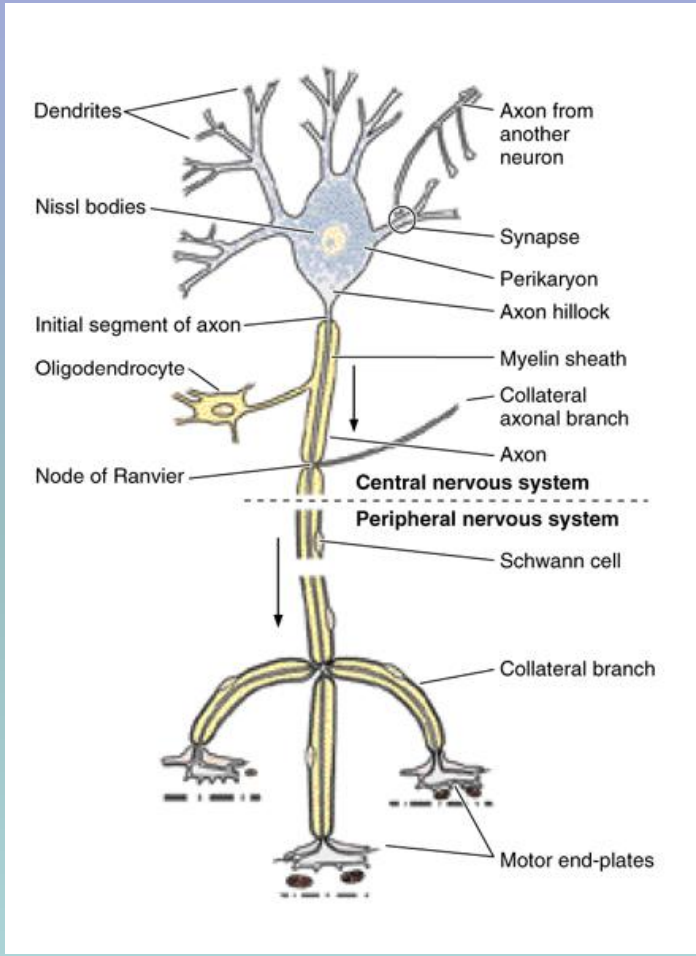
Parts of the nerve cell :

Dendrites : Most neurons consist of three parts: **the dendrites** which are multiple elongated processes specialized in receiving stimuli from the environment, sensory epithelium, or other neurons

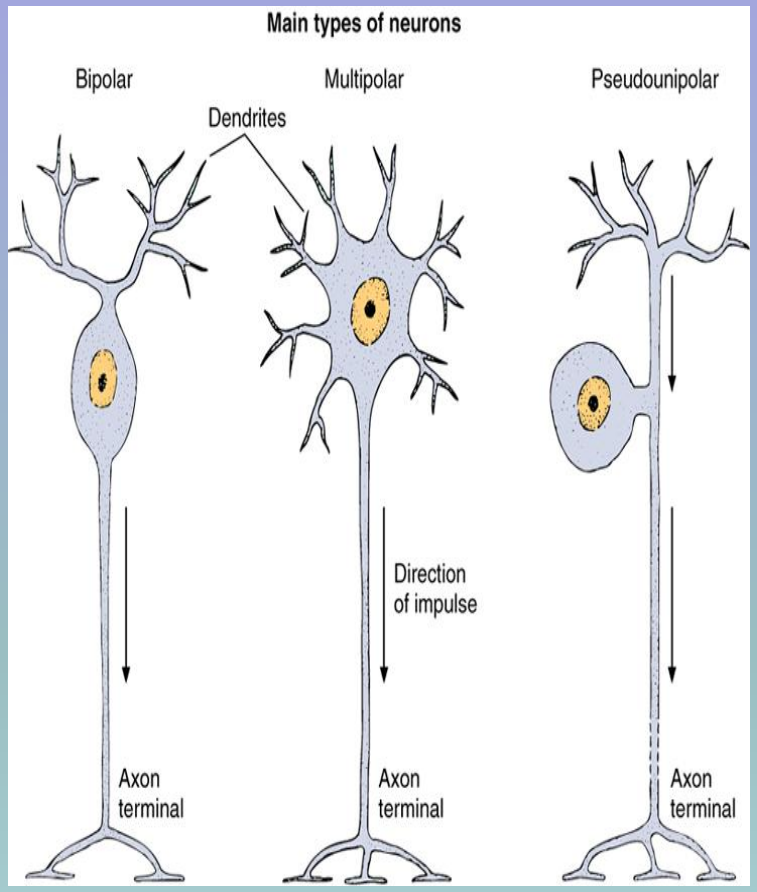


Cell body or perikaryon: which is the trophic center and is also receptive to stimulus

The axon: **the axon** which is a single process specialized in generating or conducting nerve impulse to other cells. The distal portion of the axon is usually branched and constitutes the terminal arborization, each branch is terminates on the next cell in a dilatation called end bulbs **(boutons)** which interact with other neurons or non nerve cells, forming structures called synapses, synapses transmit information to the next cell.



Neurons and their processes are variable in size and shape, cell body can be spherical. Ovoid or angular, some are very small 4-5 μm in diameter others can be seen by naked eye.



Classification:

1- According to the number of dendrites:

Multipolar neurons which have more than two processes one is the axon, the others are the dendrites, **Bipolar** neurons with one process is the axon, the other is the dendrite and **Pseudounipolar** which have a single process that divide into two processes one being the dendrite and the other is the axon. In pseudounipolar neurons, stimuli that are picked up by the dendrites travel directly to the axon terminal without passing through the perikaryon.

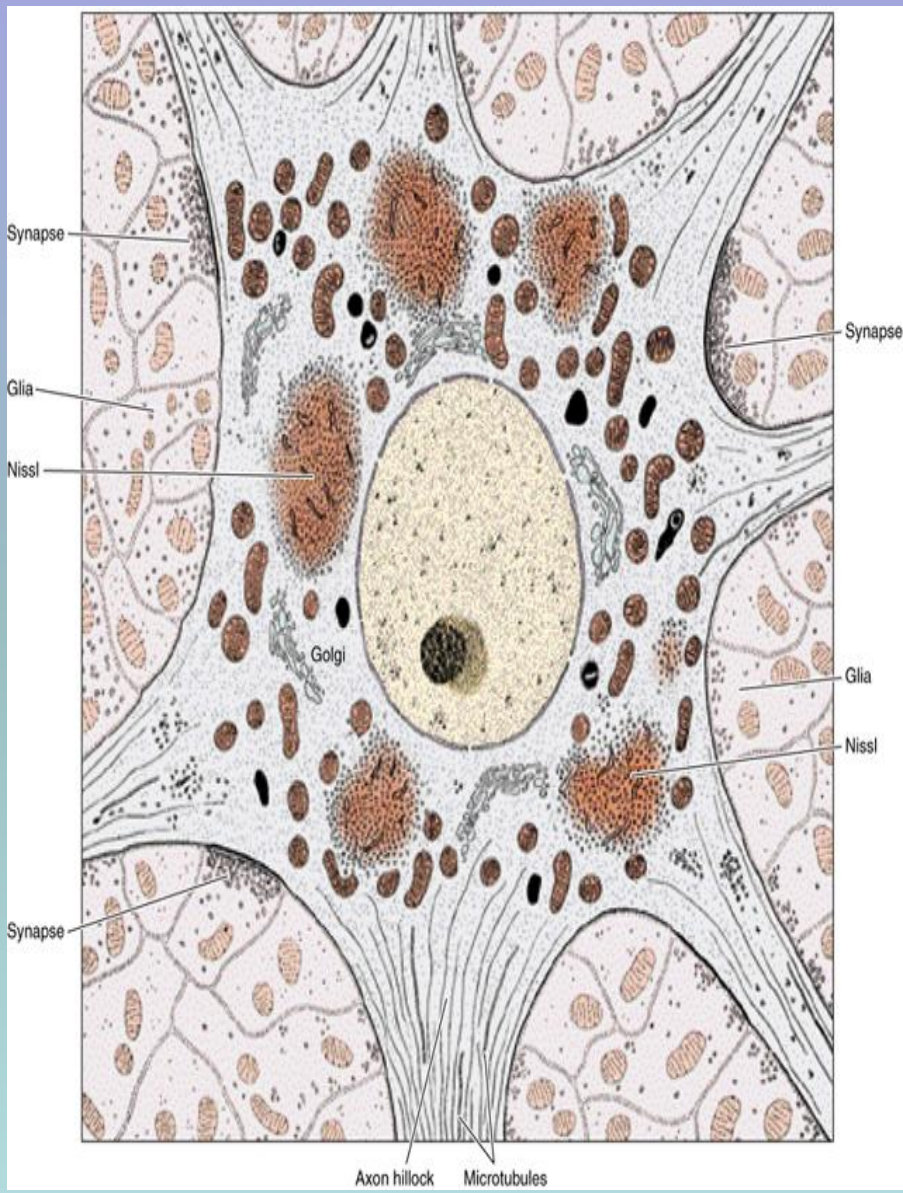
Classification:

2- According to the function

Motor neurons which control the effector organs such as muscles and glands, **Sensory** neurons are involved in the reception of sensory stimulus and **Interneurons** which establish relationship among other neurons.

Cell body or perikaryon

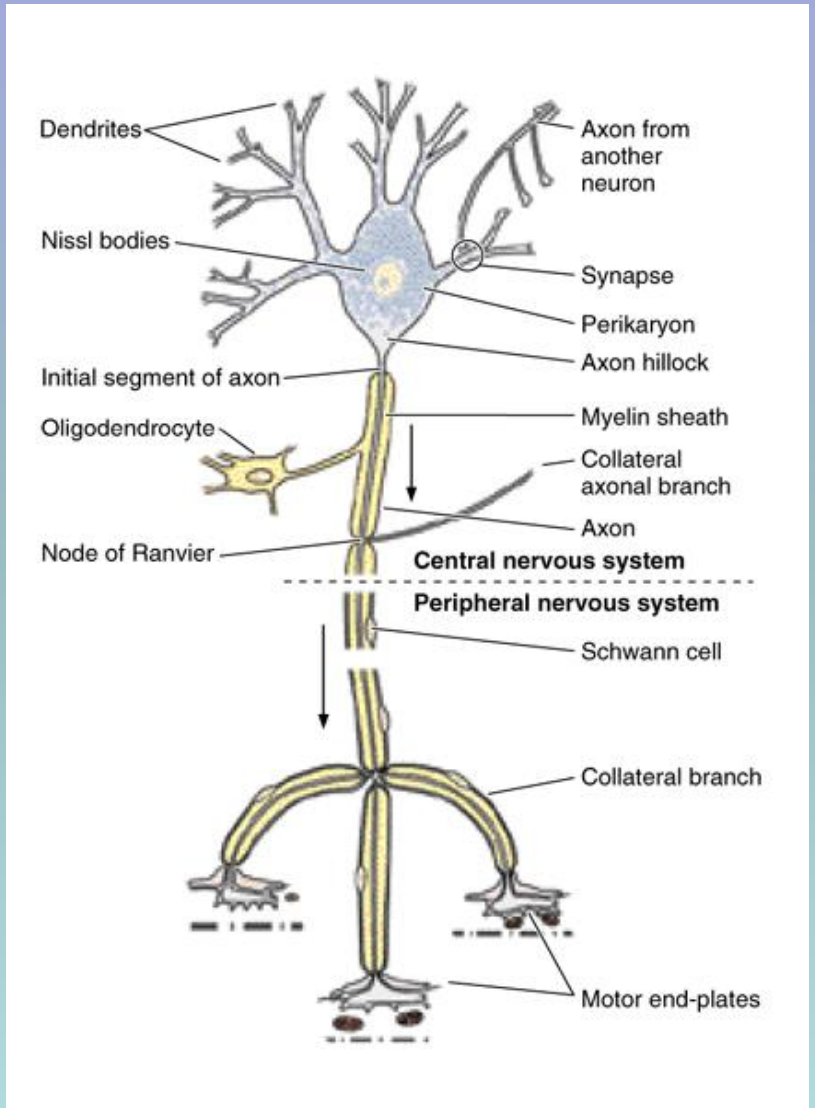
- Also called perikaryon, contains the nucleus and surrounding cytoplasm, exclussive of the cell processes. Most nerve cells have spherical unusually large, euchromatic nucleus with prominent nucleolus, it also contain highly developed rough endoplasmic reticulum organized into aggregates of parallel cisternae. Between the cisternae are numerous polyribosomes, the R.E.R and ribosomes appear under the light microscope as basophilic granular areas called (Nissl bodies), the number of which varies according to neuronal type, they are abundant in motor neurons.
- Golgi complex located only in the cell body consists of multiple arrays of smooth cisternae around the nucleus. Mitochonderia are scattered in the cytoplasm and abundant especially in the axon terminals. Neurofilaments (Intermediate filament-10nm) are abundant in the perikaryon and cell processes. Nerve cell also contains inclusions of pigments such as lipofuscin which is a residue of undigested materials by lysosome.



Thank you

Dendrites

Are usually short, divide like a tree, they receive many synapses most nerve cell have numerous dendrites which increase the surface area of the cell, these enable the nerve cell to integrate with high number of neurons. Unlike axons, which maintain a constant diameter from one end to other end, dendrites become thinner as they divide into branches, the cytoplasm of the dendritic base, close to the perikaryon is similar to that of perikaryon but devoid from Golgi complex.



The axon :

Is cylindrical process that varies in length and diameter according to the type of neuron.

All axons originate from short pyramid region called the axon hillock.

The part of the axon between the axon hillock and the point at which myelination begins is called the (initial segment).

There are several types of ion channels are localized in this segment, these channels are important in generating the change in electrical potential.

Occasionally, the axon shortly after its formation from the cell body gives rise to a branch that return to the area of the nerve cell body, all these branches are called collateral branches.

Axoplasm possesses mitochonderia, microtubules, neurofilaments, some cisternae of smooth endoplasmic reticulum, so the absence of polyribosomes and R.E.R emphasize the dependence of the axon on the perikaryon for its maintenance.

- The macromolecules and organelles that are synthesized in the cell body are transported by anterograde flow along the axon to its terminal, this flow occurs at three distinct speed:

Slow for protein and actin filaments,

Intermediate speed transport mitochonderia.

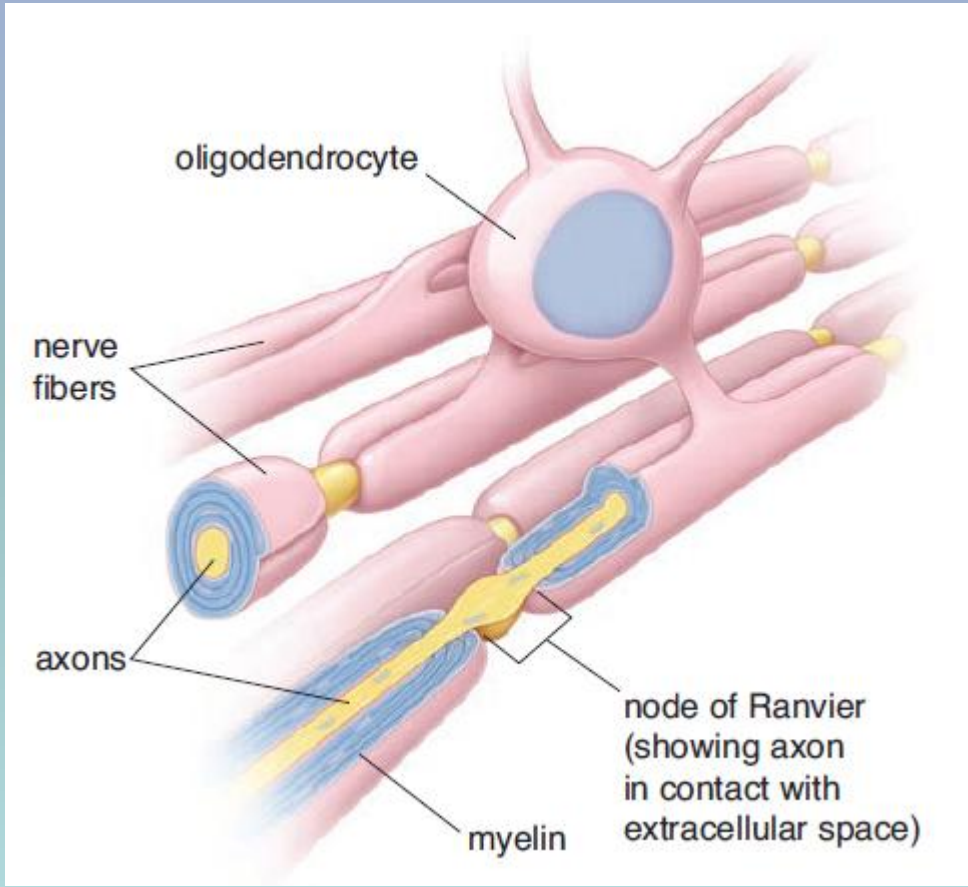
Fast stream transport substances contained in vesicles that are needed, Retrograde flow in the opposite direction transport substances taken up by endocytosis (viruses and toxins) to the cell body.

Retrograde flow in the opposite direction transport substances taken up by endocytosis (viruses and toxins) to the cell body.

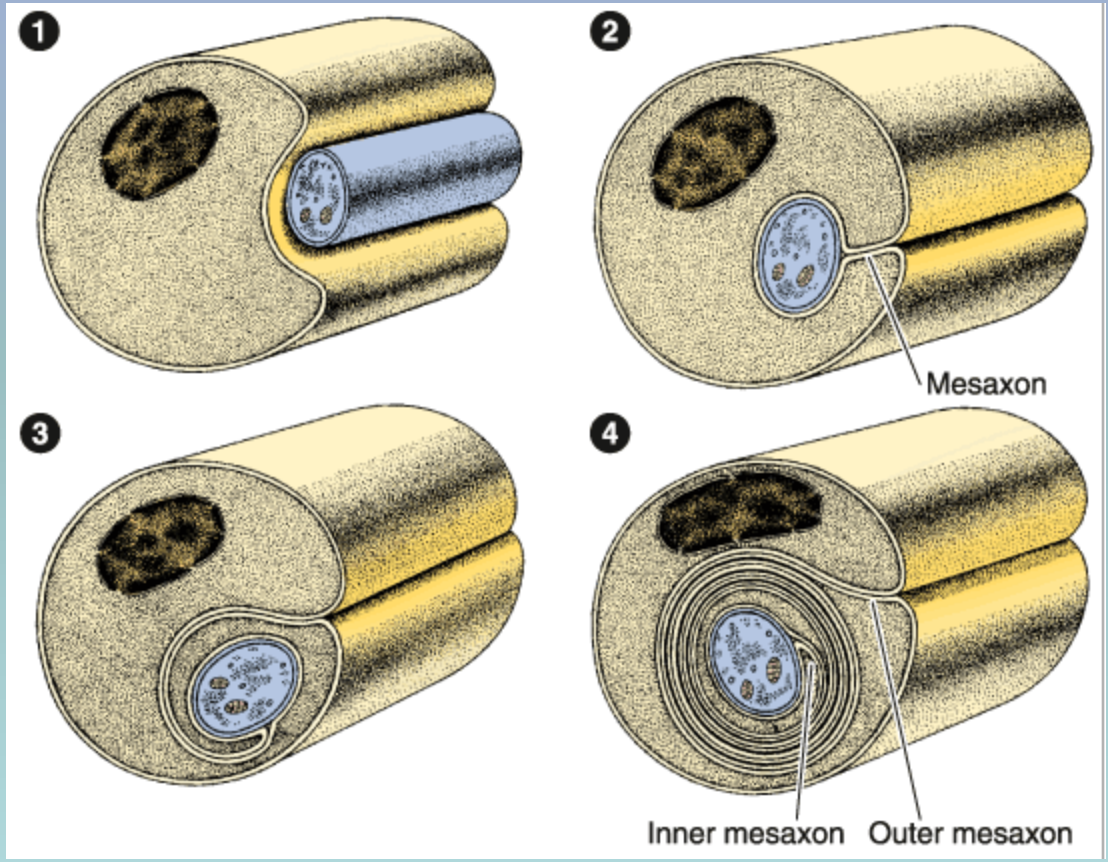
Glial cells :

They are ten times more abundant that the nerve cells

1- Oligodendrocytes



Schwann cell



Astrocytes

1-The astrocytes bind the neurons to the capillary and the pia matter

2- Control the ionic and biochemical environment of the neurons so they influence neuronal survival and activity.

3-Some astrocytes develop processes with expanded **(end feet)** that are linked to endothelial cells, it is believed that this end feet facilitate the transport of ions and molecules from the blood to the neurons.

4- In addition, astrocytes provide a covering for the “bare areas” of myelinated axons— for example, at the nodes of Ranvier and at synapses.

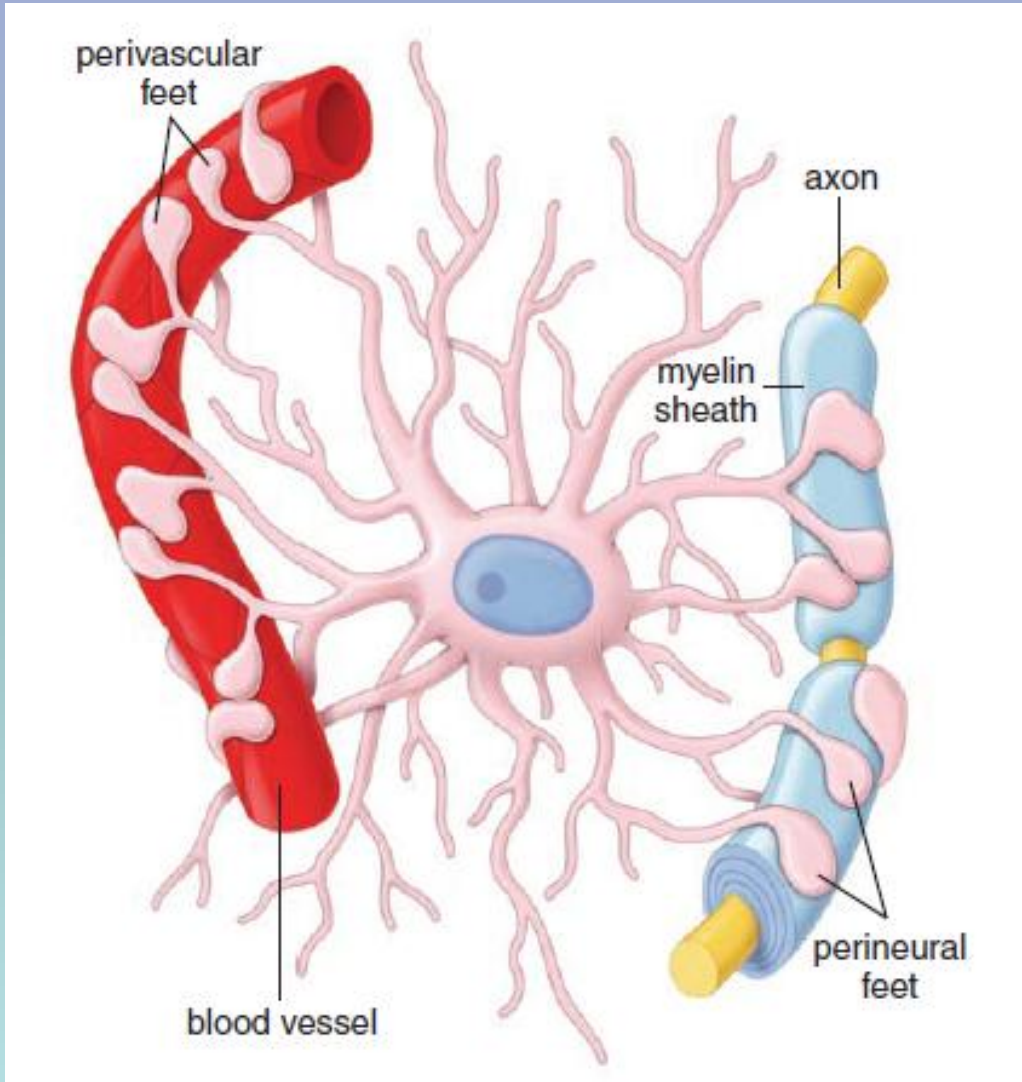
5- They may confine neurotransmitters to the synaptic cleft and remove excess neurotransmitters by pinocytosis.

6- Expanded processes are also present at the external surface of the central nervous system, where they make a continuous layer separating the nervous tissue from the pia matter called **glial limitans**.

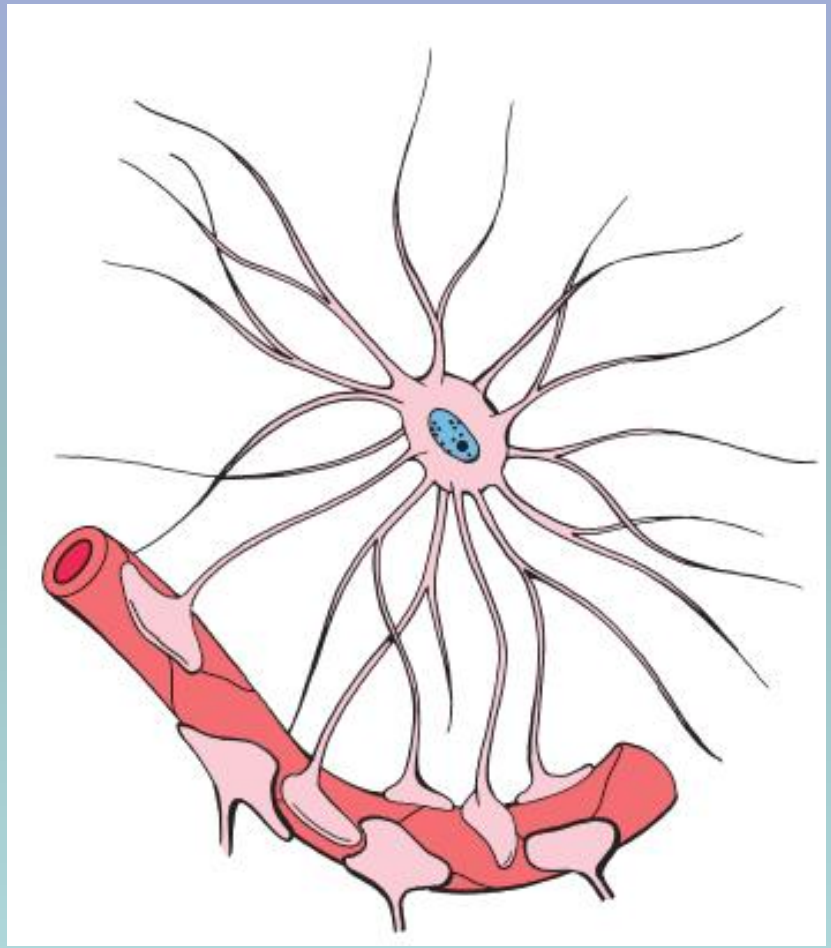
7- Furthermore, when the CNS is damaged, astrocytes proliferate to form cellular scar tissue.

8-Astrocytes can interact with the oligodendrocytes to influence myelin turnover in both normal and abnormal conditions.

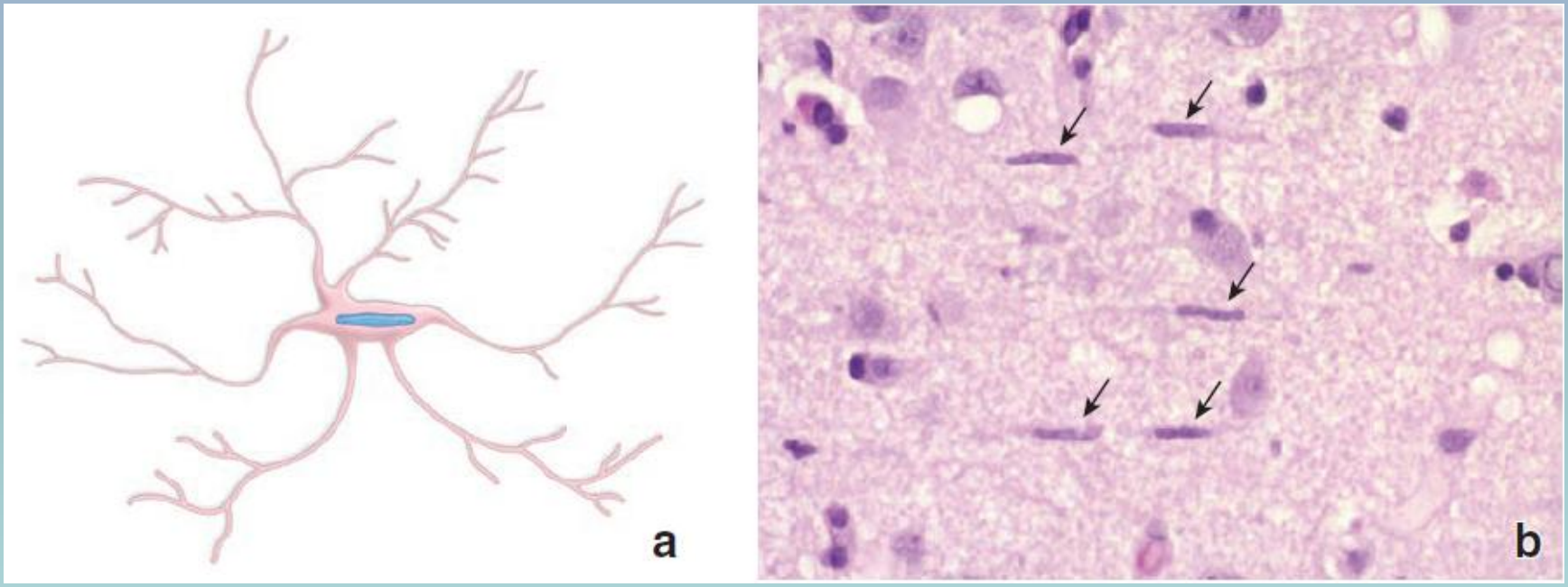
2- Astrocytes: protoplasmic and fibrous



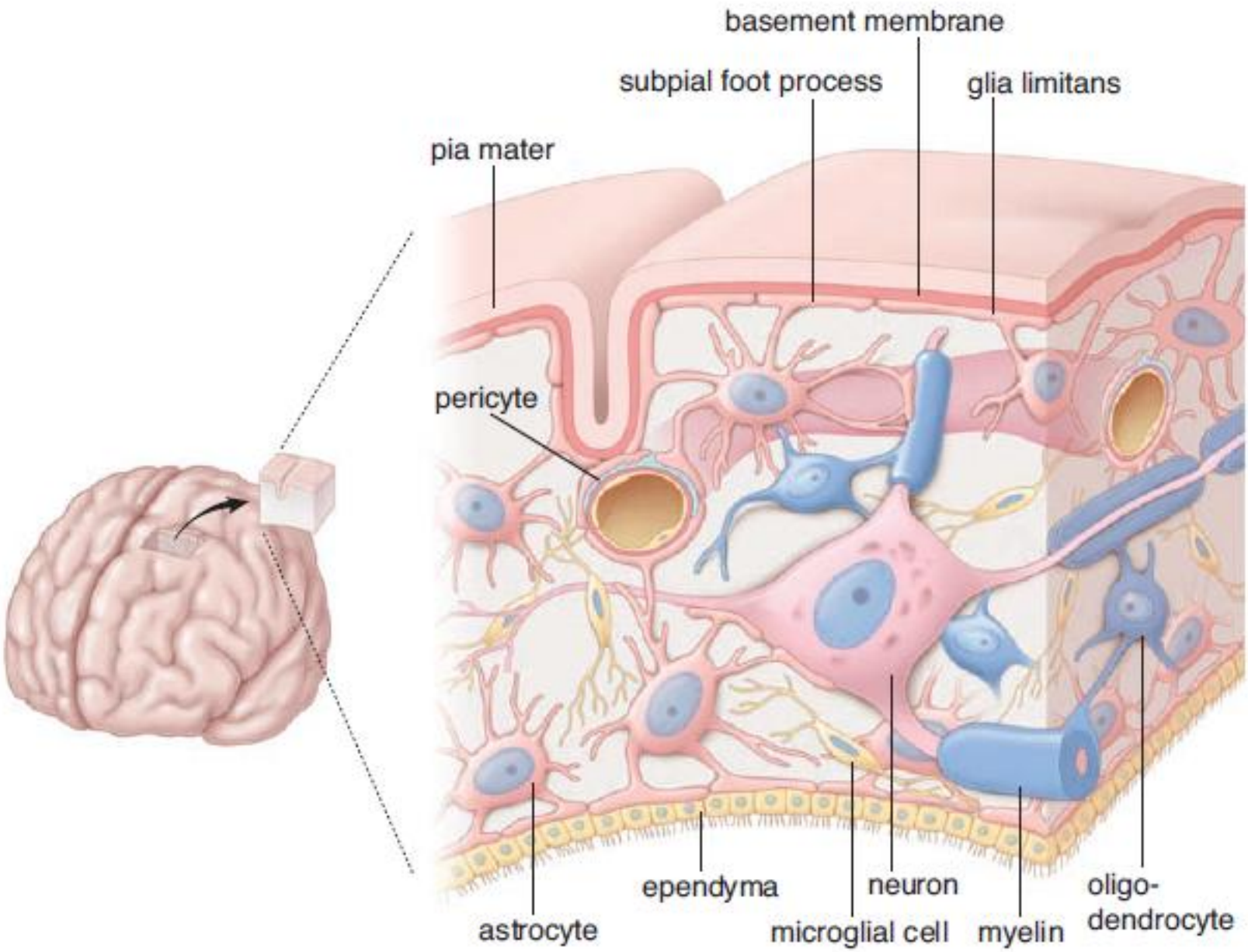
Fibrous astrocyte



Microglia



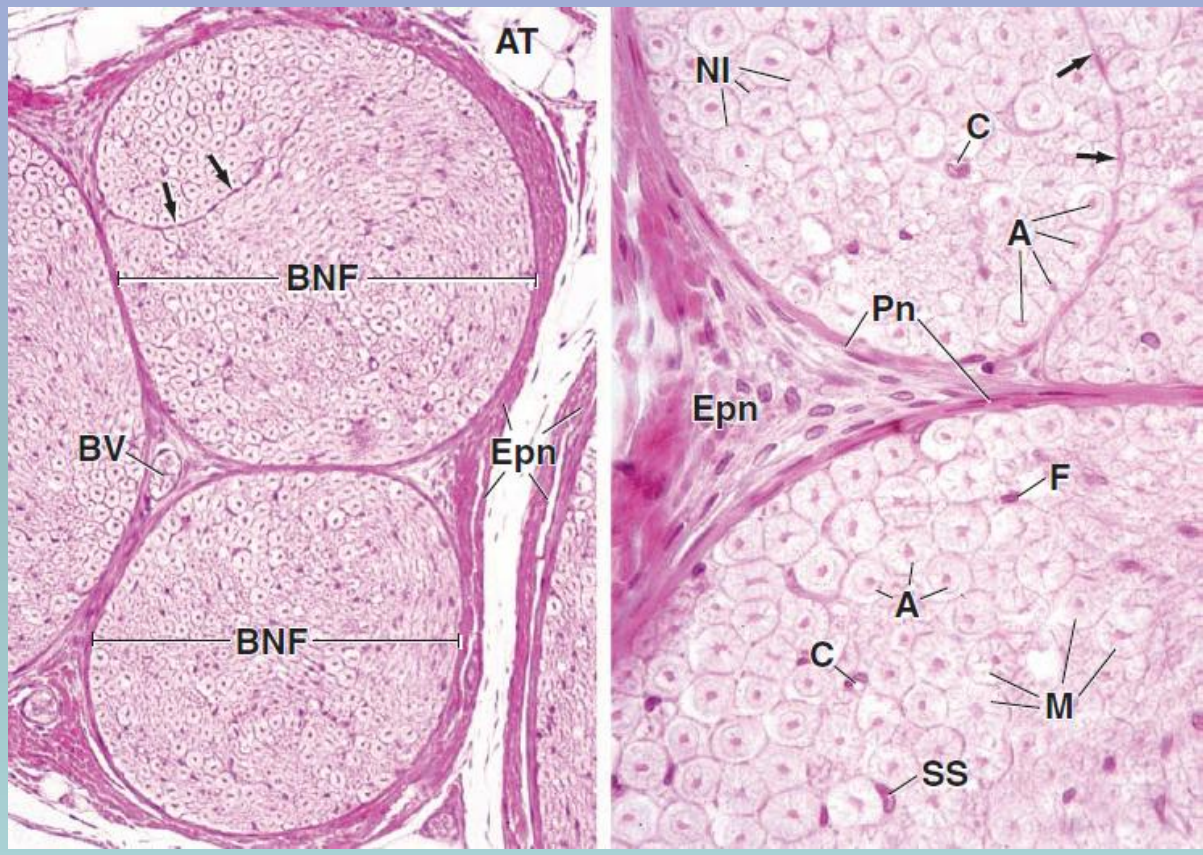
Ependymal cells


basement membrane
subpial foot process
glia limitans
pia mater
pericyte
ependyma
neuron
oligo-
dendrocyte
astrocyte
microglial cell
myelin

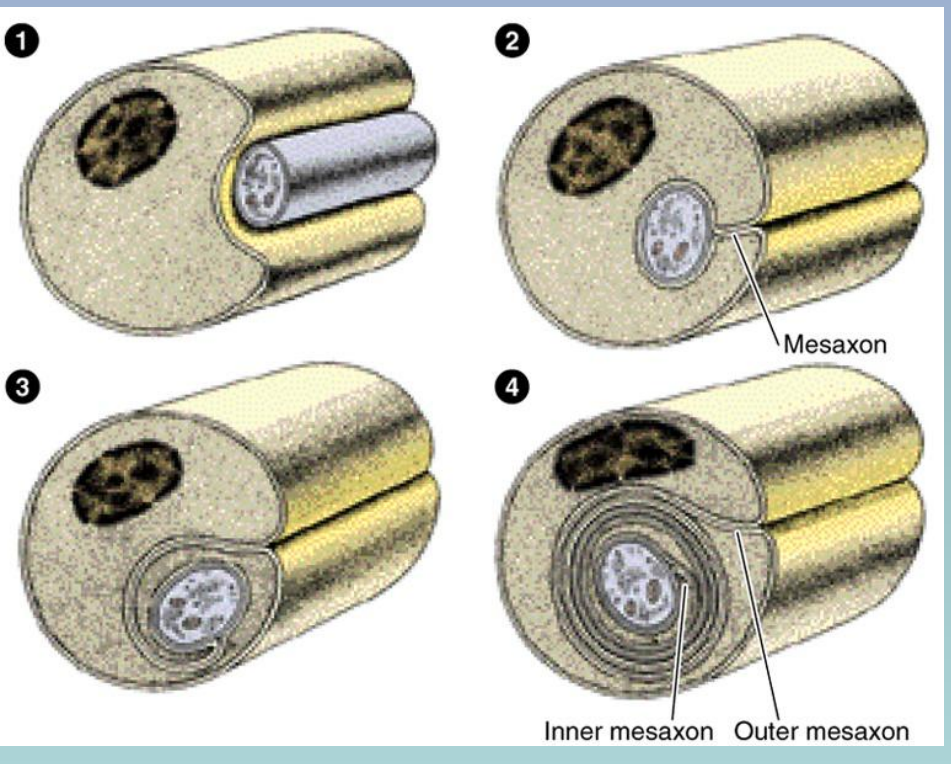
Thank you

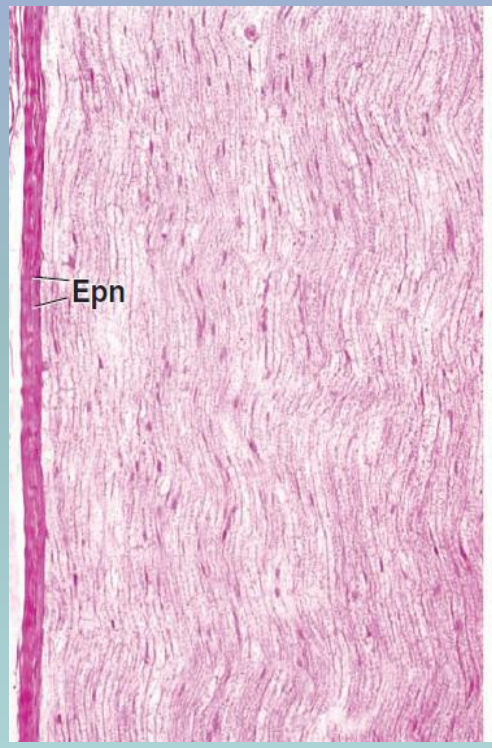
Nerves

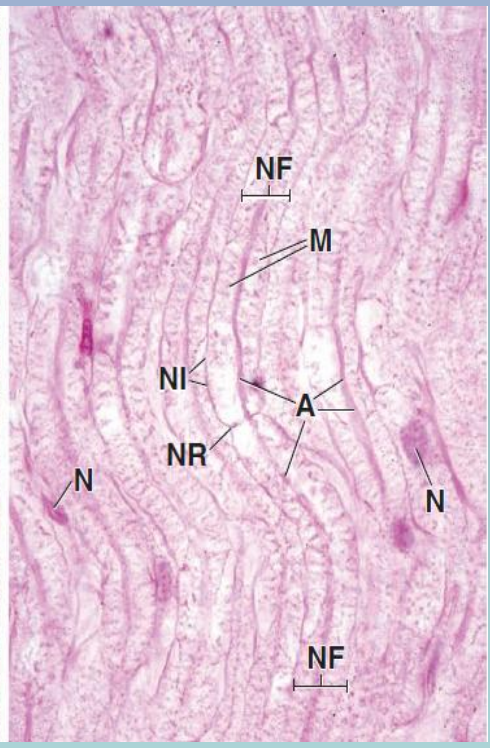
- Endoneurium
- Perineurium
- Epineurium



Myelinated nerve fibers





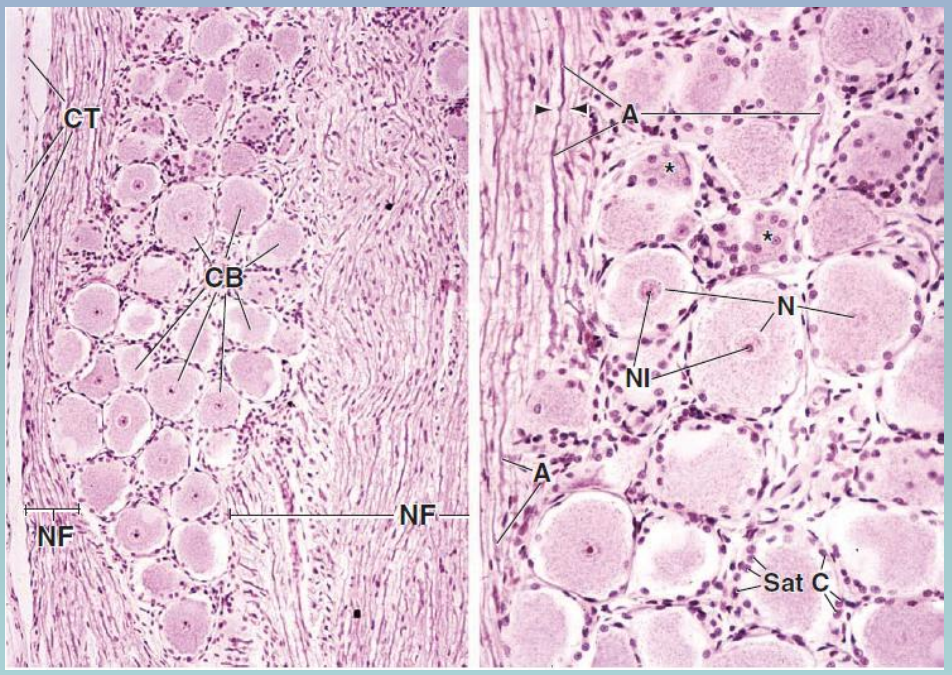


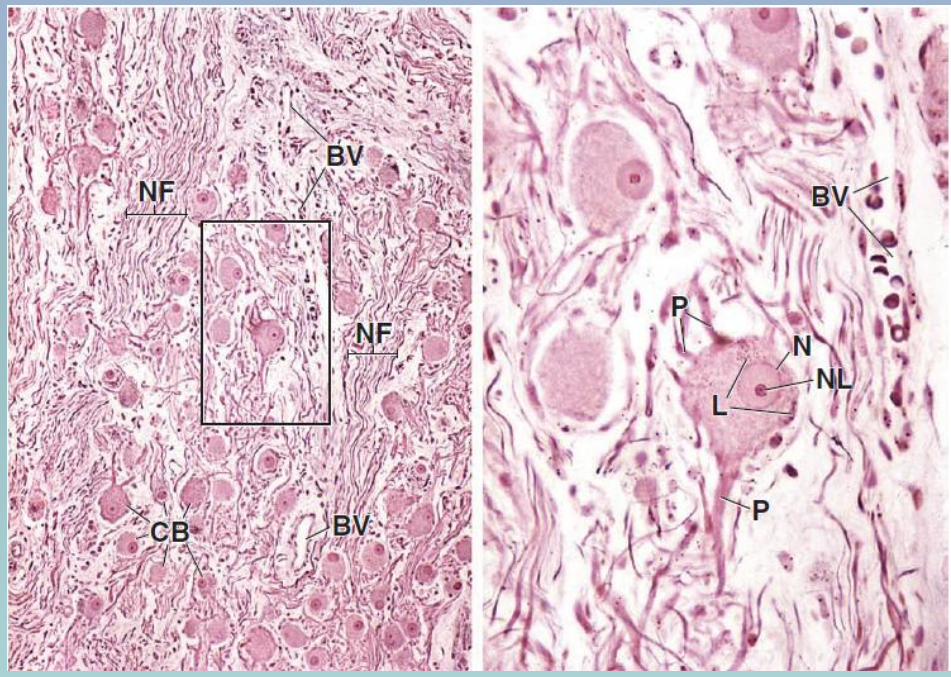
Unmyelinated nerve fibers: In both the PNS and CNS, not all the axons are sheathed in myelin. In PNS, all unmyelinated axons are enveloped within simple clefts of the Schwann cells. Each Schwann cell can sheathe many unmyelinated nerve fibers, these nerves do not have Ranvier node. The CNS is rich in Unmyelinated nerve fibers.

Ganglia

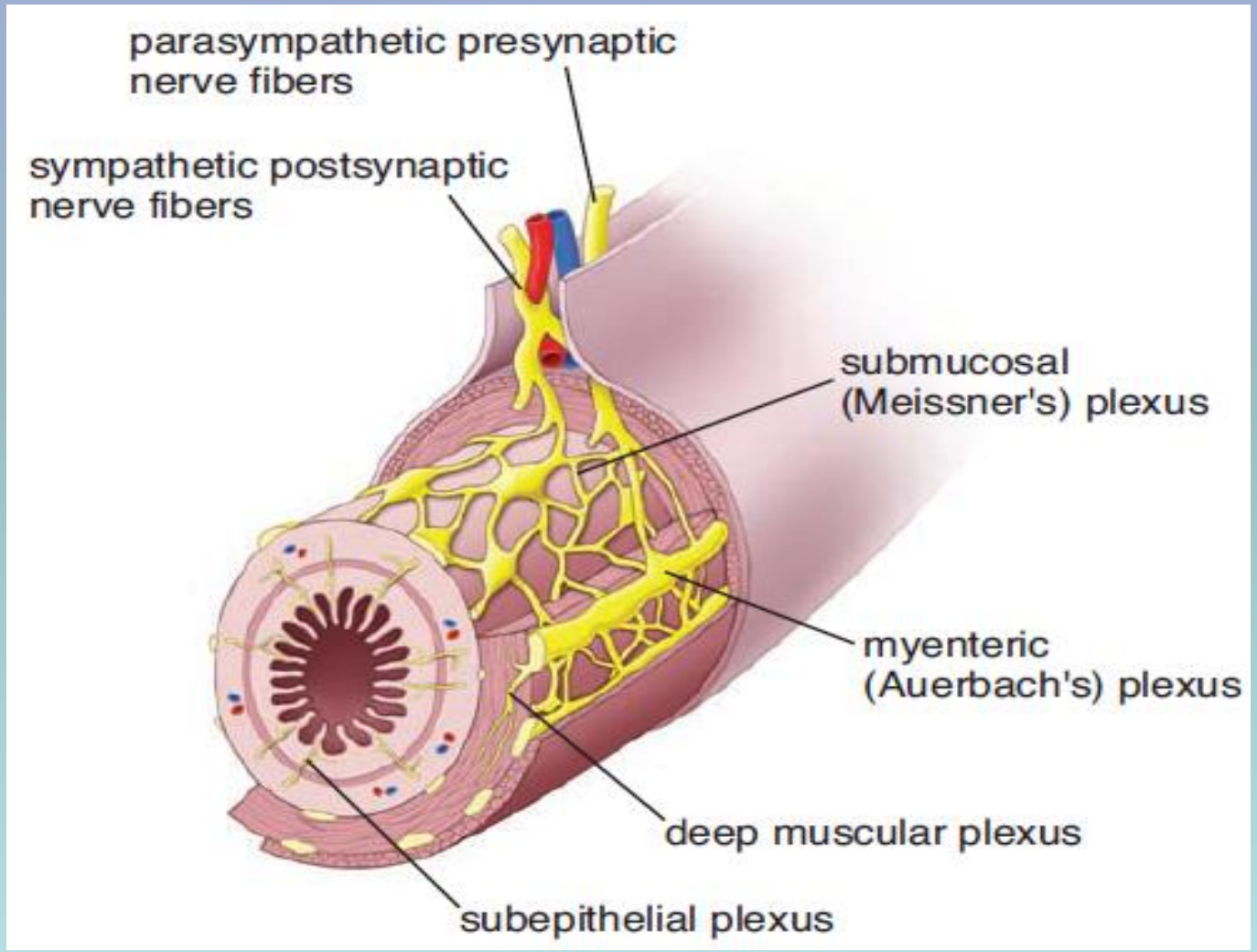
Sensory ganglia	*Autonomic ganglia*
1-Ganglionic cells are found at the periphery	**1-Scaterred uniformly**
2-Each ganglionic cell is surrounded by satellite cells to form a capsule.	**2-Less number of satellite cells**
3-Connective tissue framework and capsule which support the ganglia	**3-Devoid from connective tissue or capsule**
4-The neurons are pseudounipolar .	**4-Multipolar.**

Ganglia



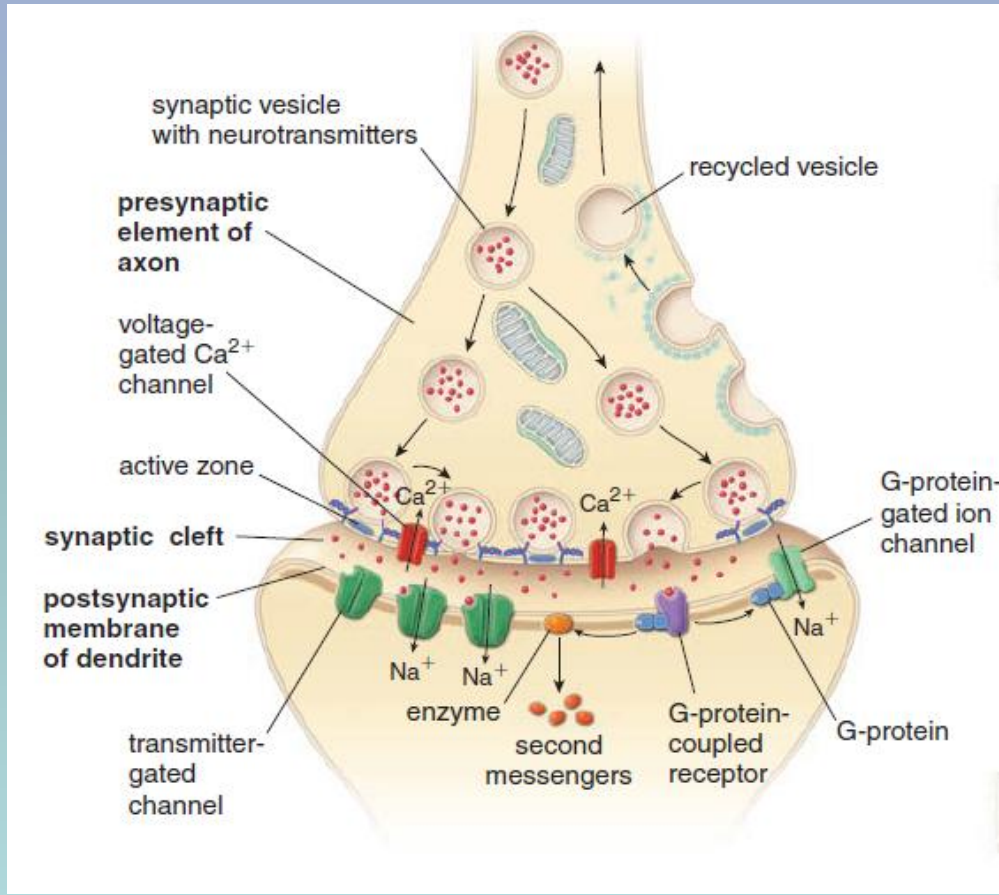


Intramural ganglion



Synapses

The synapse is formed by: an axon terminal (presynaptic terminal) that deliver the signal, a region on the surface of another cell at which a new signal is generated (post synaptic terminal) and a thin intercellular space called the synaptic cleft.



Types of synapses :

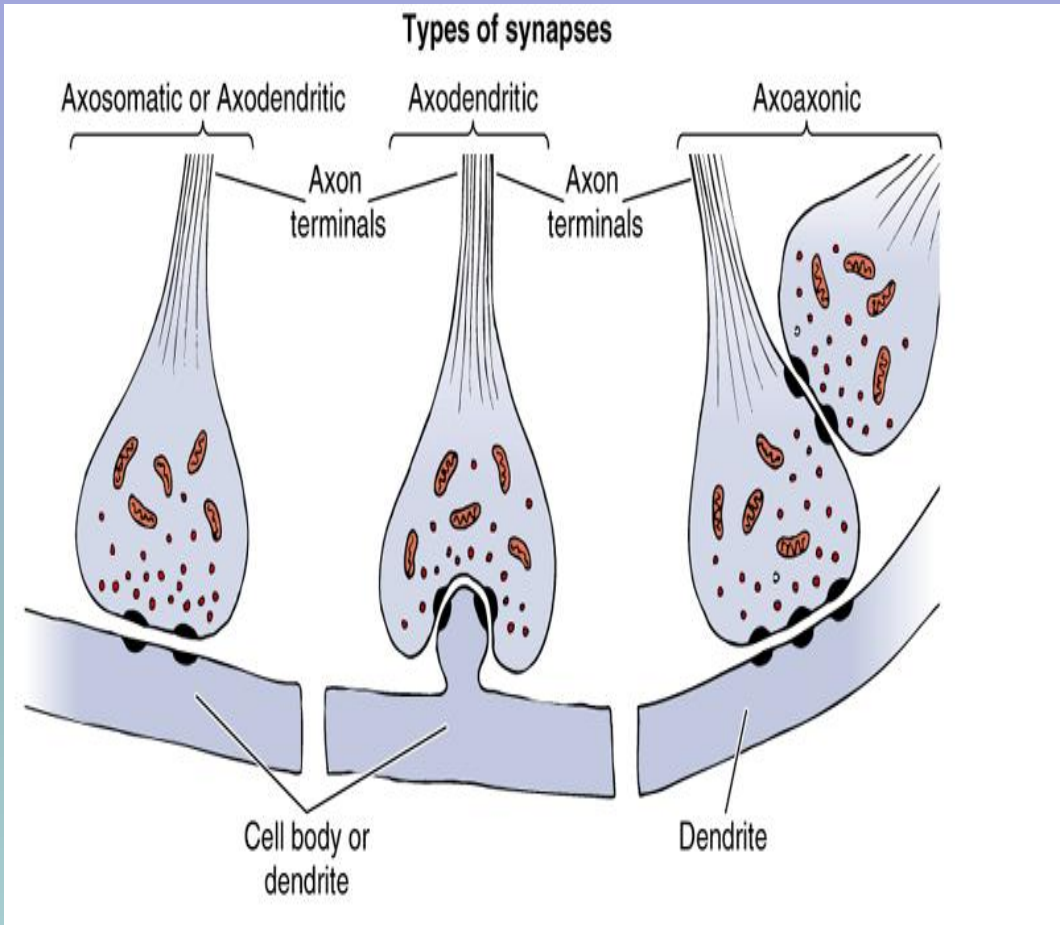
1- Chemical:

A: axosomatic

B: Axodendritic

C: axoaxonal

2- Electrical



Central Nervous System

This system consists from **cerebrum**, **cerebellum** and **spinal cord**, it is gel like organ.

When sectioned these organs show white region **(white matter)** and gray region **(gray matter)**.

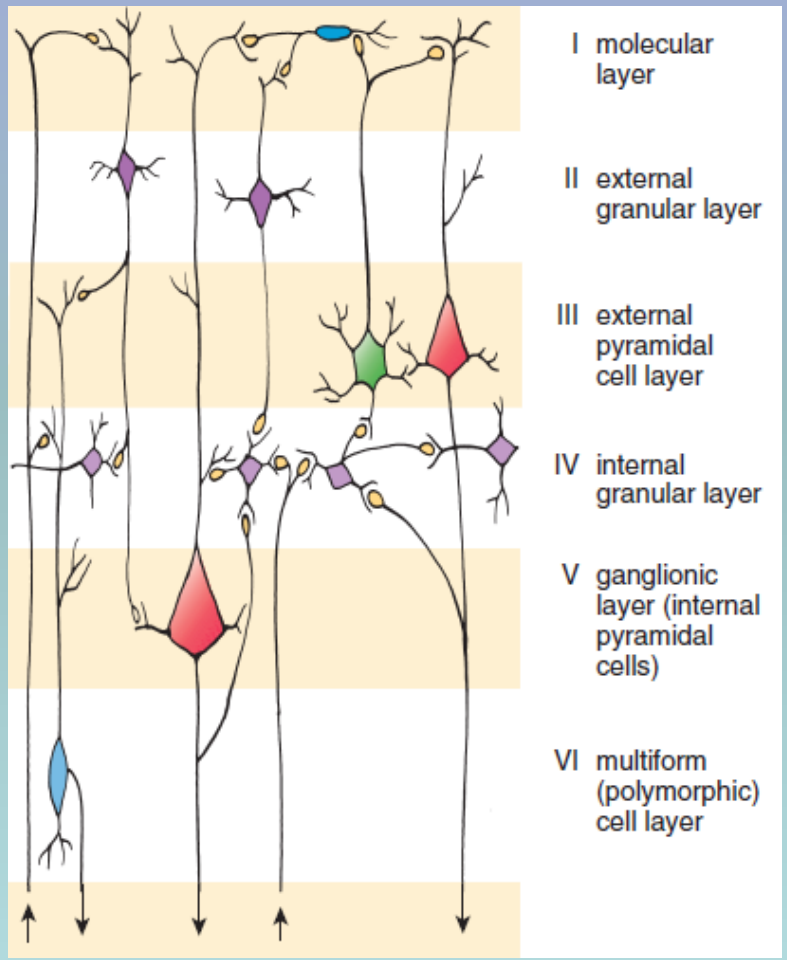
The main component of the white matter is myelinated axons and the oligodendrocytes.

Gray matter contains neuronal cell bodies, dendrites and the initial unmyelinated portions of axons and glial cells

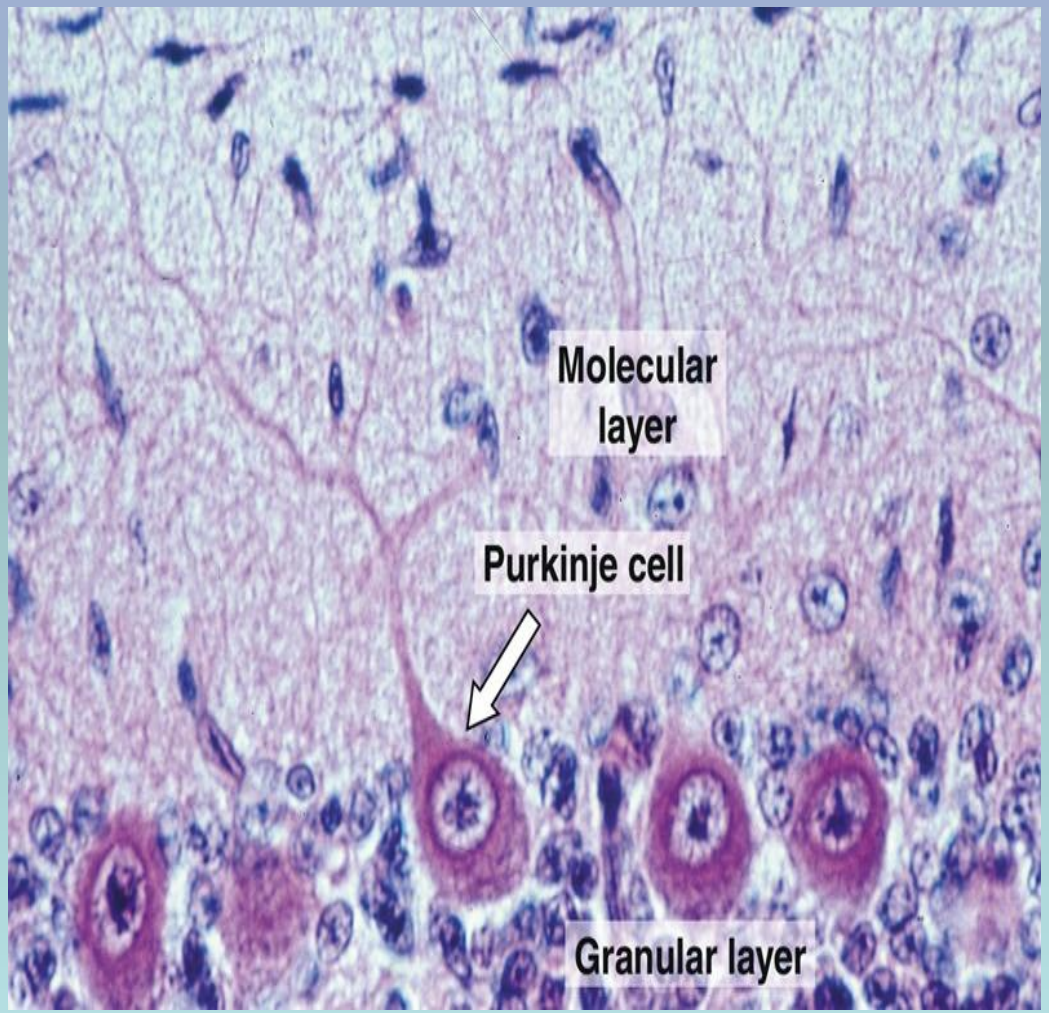
Gray matter is at the surface of the cerebrum and cerebellum. Aggregate of neuronal cell bodies forming islands of gray matter embedded in white matter are called nuclei

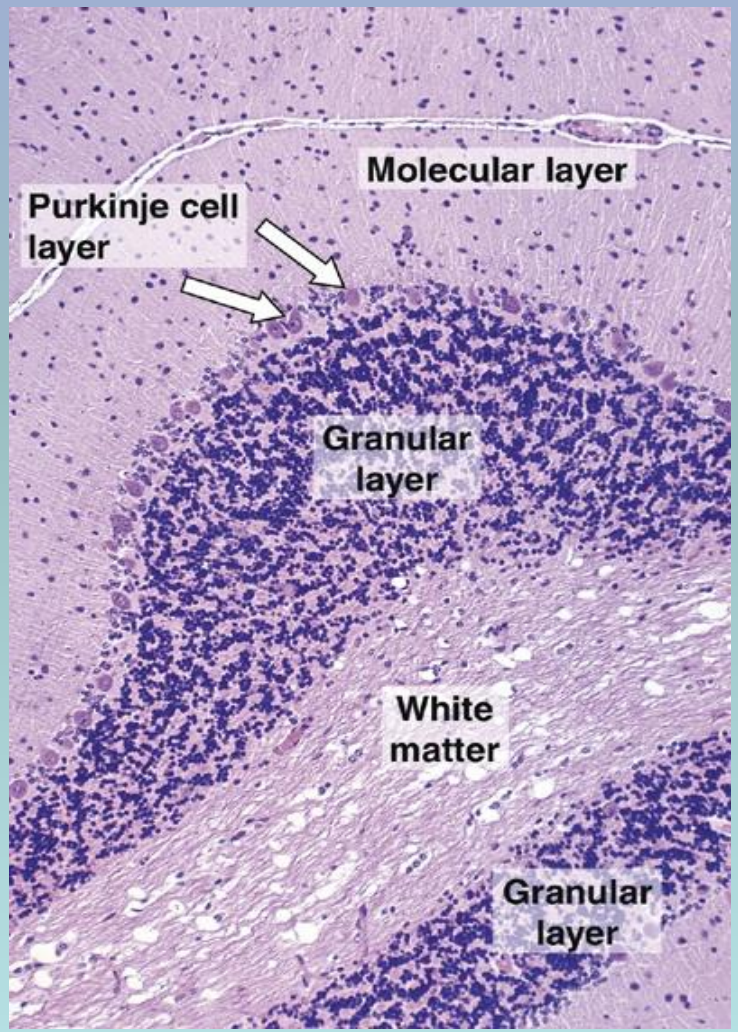
Cerebral cortex

- In the cerebral cortex, the gray matter has six layers of cells with different forms and sizes

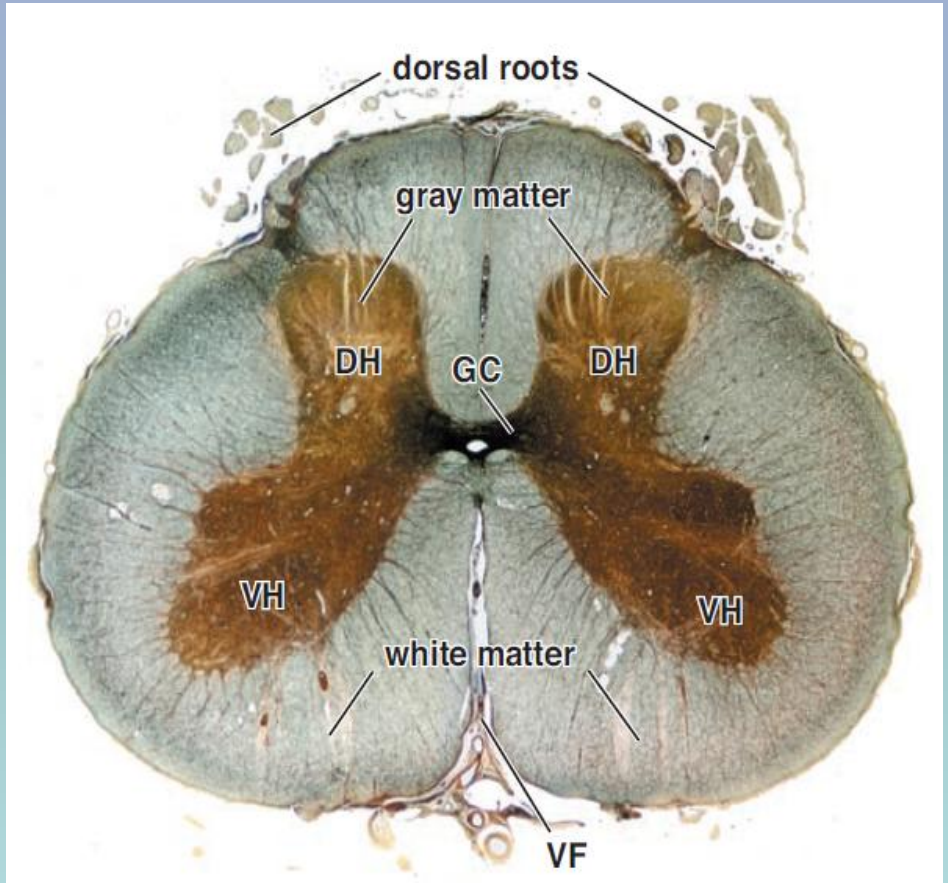


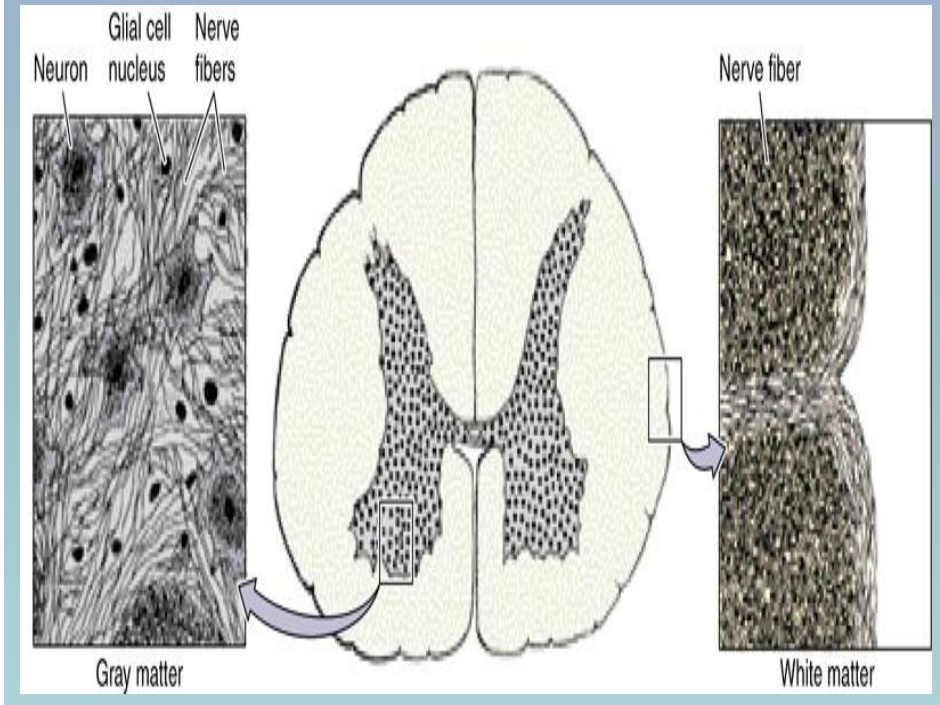
Cerebellar cortex





Spinal cord


dorsal roots
gray matter
DH
GC
DH
VH
VH
white matter
VF


Neuron
Glial cell nucleus
Nerve fibers
Nerve fiber
Gray matter
White matter

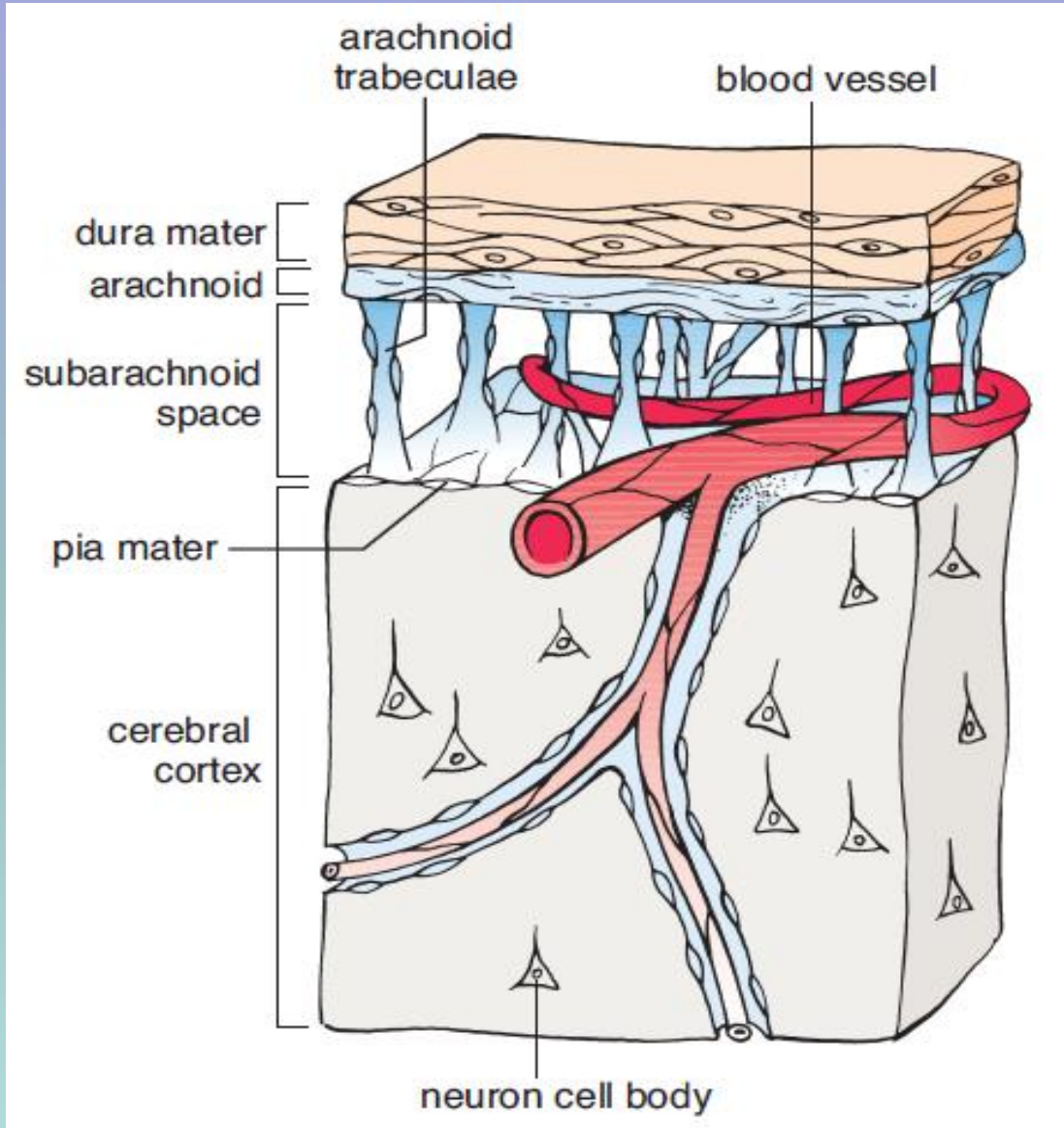
Thank you

Meninges

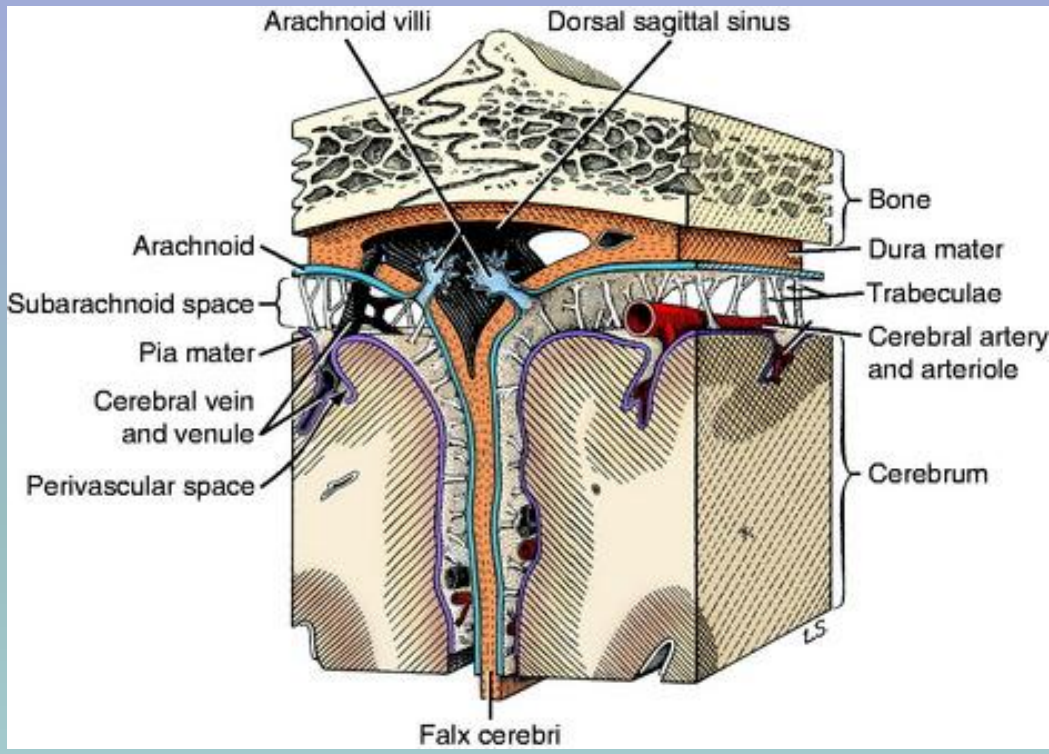
Membranes of connective tissue that encased the CNS are:

Dura matter, Arachnoid

and the Pia matter .



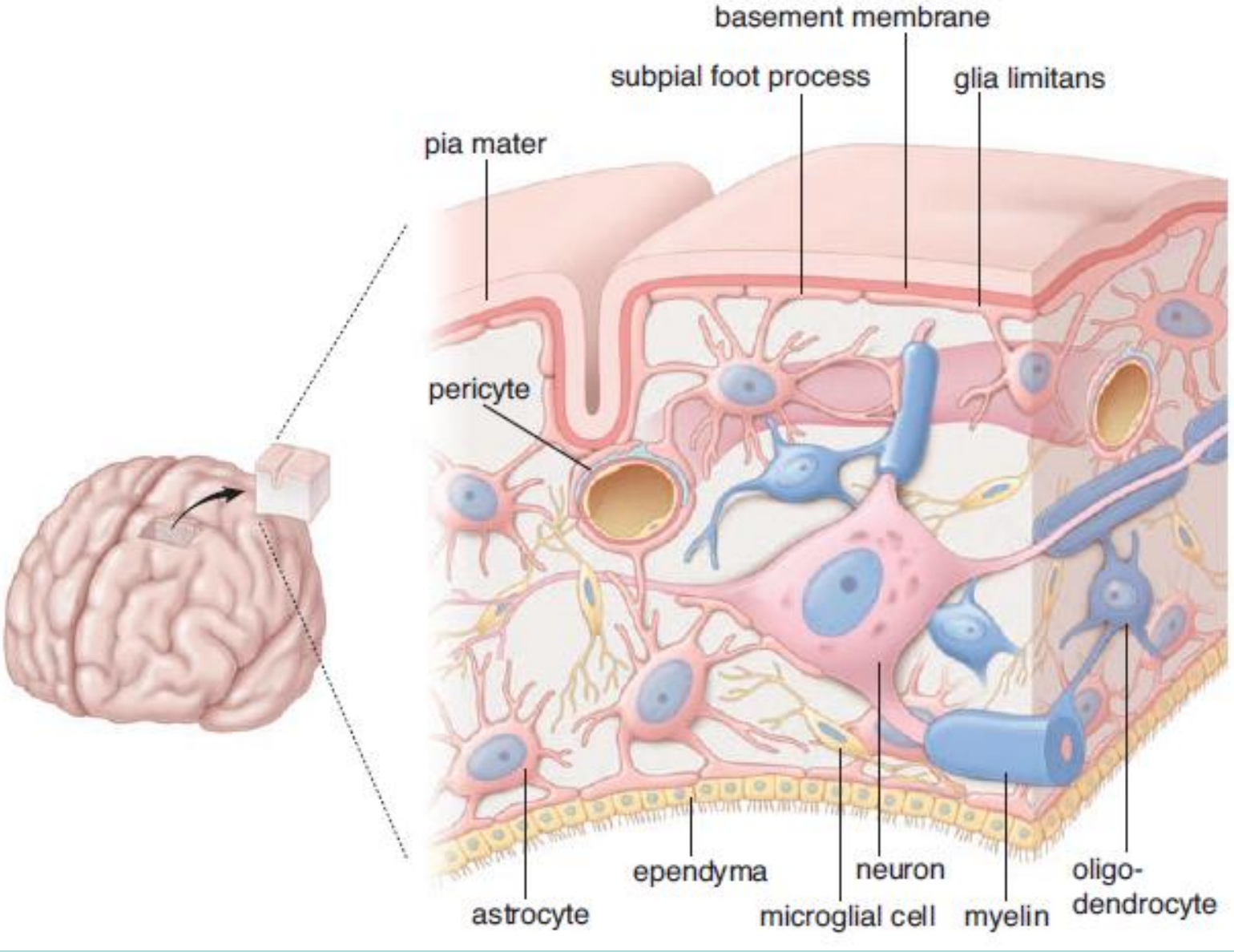
Arachnoid villi



Pia matter:

The pia matter is a loose connective tissue containing many blood vessels, it is located quite close to the nerve tissue but it is not in contact with nerve cells. Between the pia matter and neuronal elements is a thin layer of neurological processes adhering firmly to the pia matter and forming a physical barrier, this barrier separate the CNS from CSF. The pia matter follows all the irregularities of the surface of CNS.

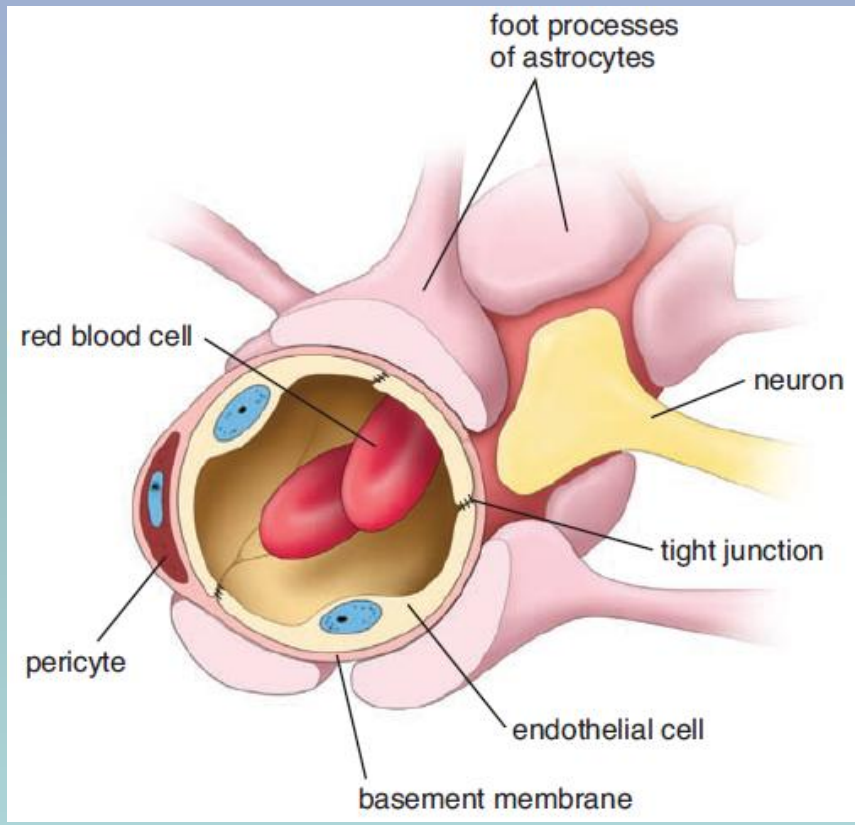
Blood vessels penetrate the CNS through a tunnel covered by pia matter-perivascular spaces. The pia matter disappears before the blood vessels are transformed into capillaries. In the CNS the blood capillaries are covered by expansion of the neurological cell processes.

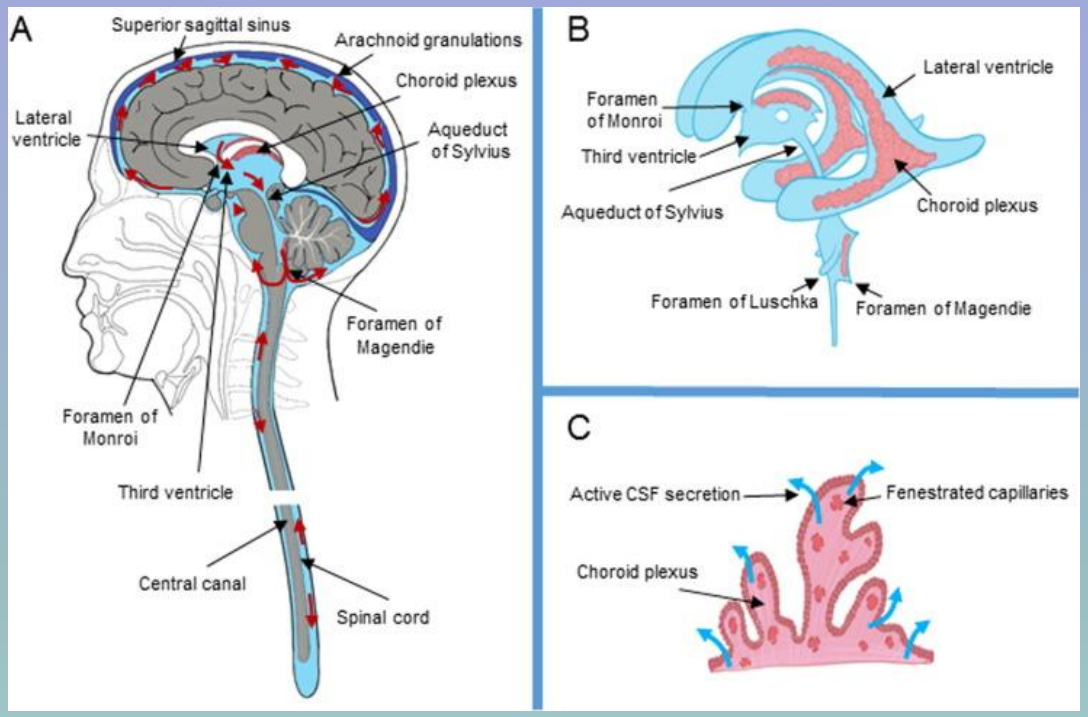

basement membrane
subpial foot process
glia limitans
pia mater
pericyte
ependyma
neuron
oligo-
dendrocyte
astrocyte
microglial cell
myelin

Blood Brain Barrier

Is functional barrier that prevent the passage of injurious substances to reach the brain due to the presence of occluding junction between the endothelial cells .

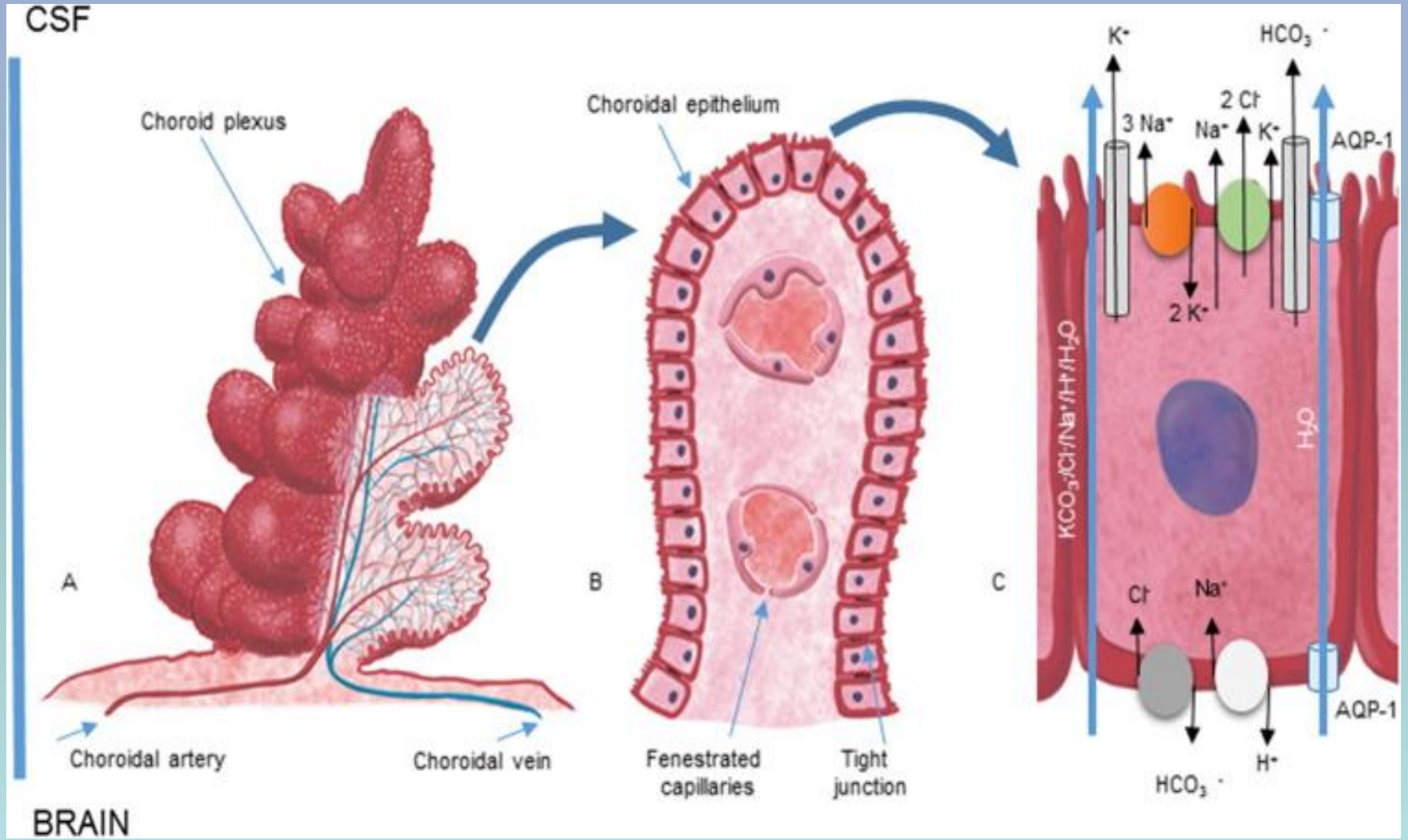
The expansions of neurological cells processes that envelop the capillaries are partly responsible for their low permeability.



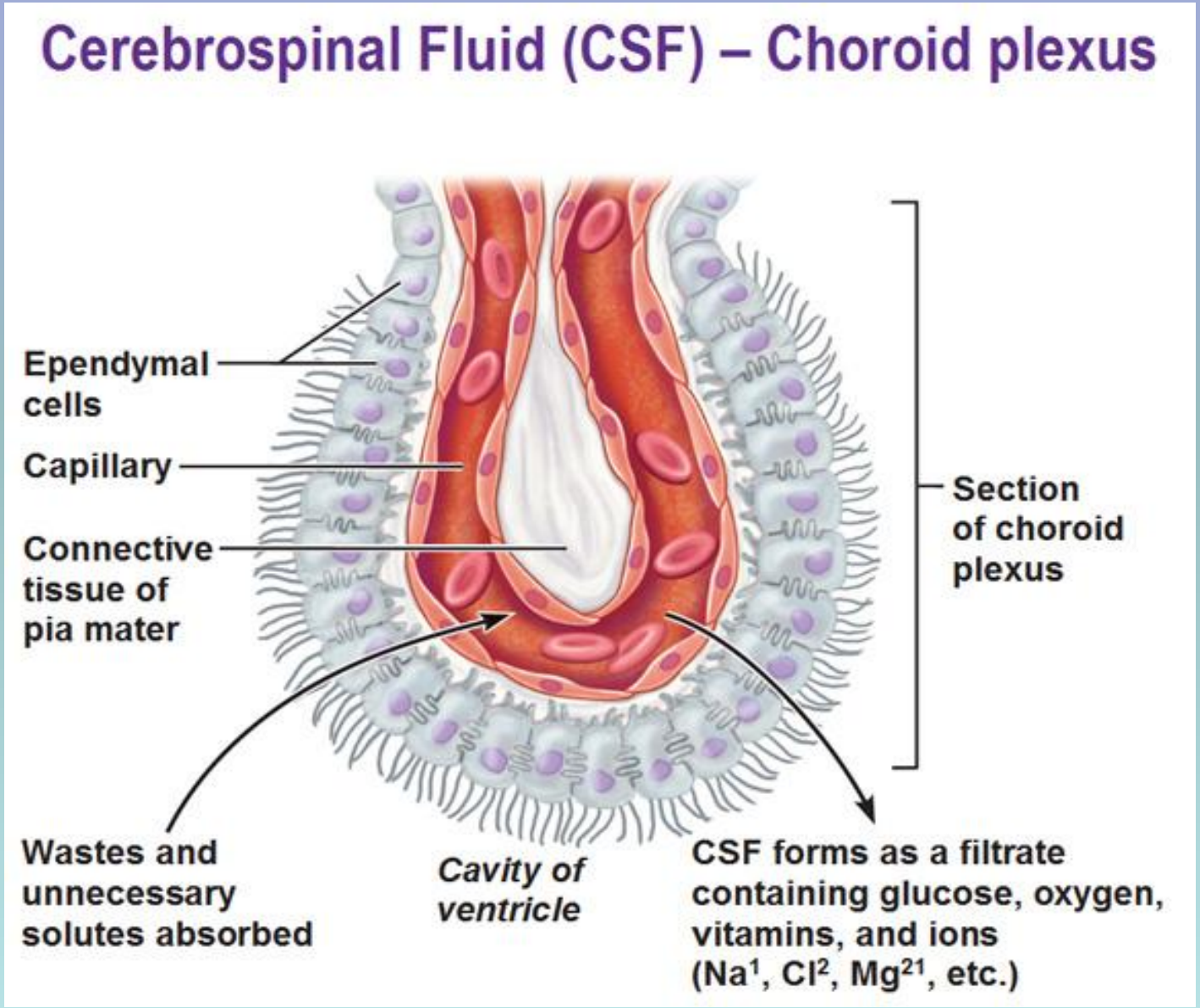


- **The choroids plexus consists of envaginated folds of pia matter, rich in dilated fenestrated capillaries that penetrate the interior of brain ventricles. It is found in the roof of the third and fourth ventricles and in part in the walls of the lateral ventricles. The main function of the choroids plexus is to elaborate CSF which completely fills the ventricles, central canal of the spinal cord, subarachnoid space and perivascular space.**

Choroid plexus



Choroid plexus

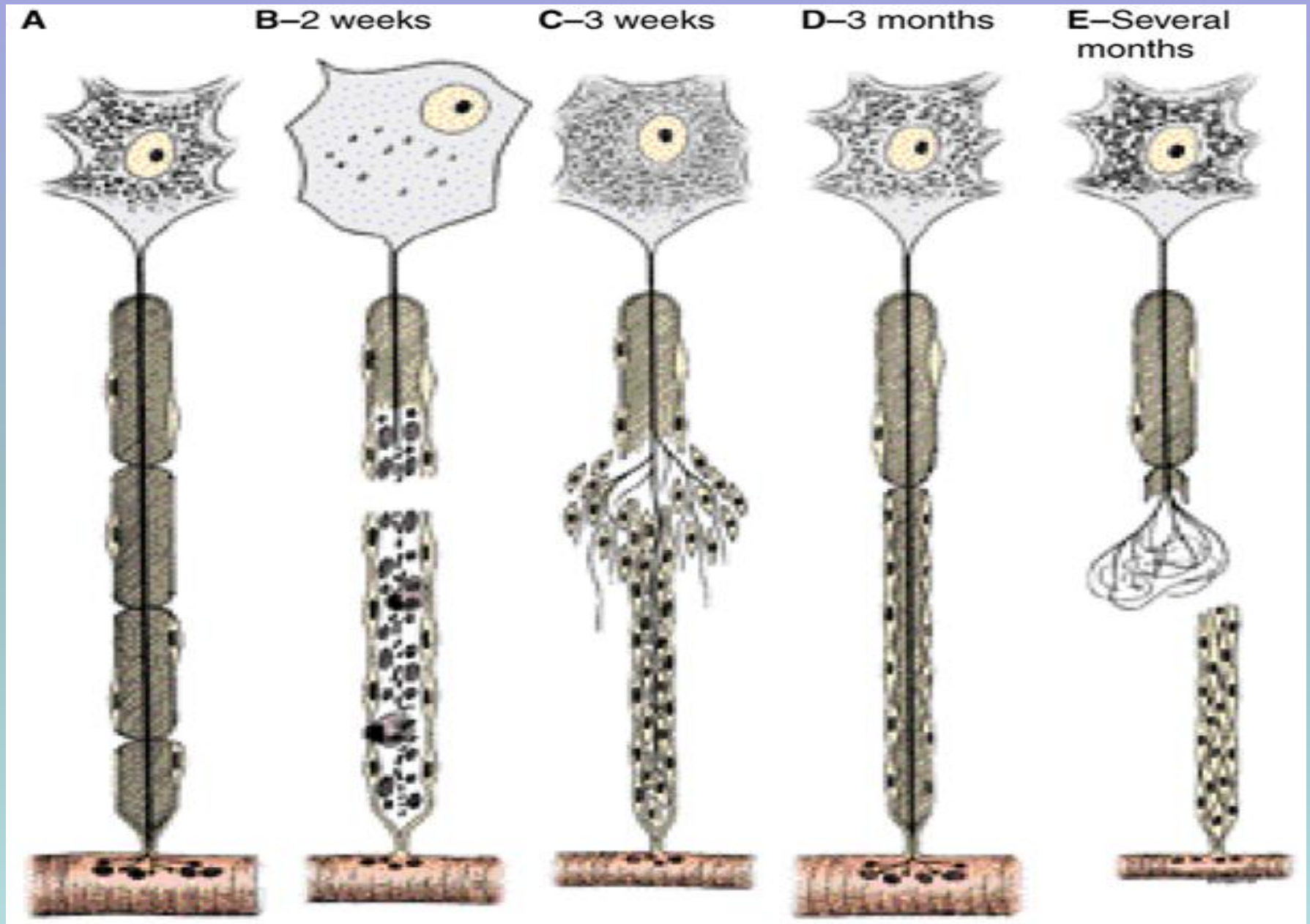


CSF

It is clear ,very low in protein ,few desequamated cells and 2-5 lymphocytes/ml

CSF is continuously produced and circulate through ventricles from which it pass into the subarachnoid space

The arachnoid villi provide the main pathway for absorption of CSF into the venous circulation


A
B–2 weeks
C–3 weeks
D–3 months
E–Several months

Neuronal plasticity

Plasticity is very prominent during embryonic development, when an excess of nerve cells is formed, and the cells that do not establish correct synapses with other neurons are eliminated. After nerve injury the neuronal circuits may be reorganized by the growth of neuronal processes, forming new synapses to replace the ones lost by injury and to recover the functions of neurons, this property of nerve tissue is called ***neuronal plasticity.***

The regenerative processes in the nervous system are controlled by several growth factors produced by neurons, glial cells, and Schwann cells. These factors form a family of molecules called neurotrophins.

Neural stem cells

- In several tissues of adult organs, there is a stem cell population that may generate new cells continuously or in response to injury. Because neurons do not divide to replace the ones lost by accident or disease, the subject of neural stem cells is now under intense investigation. Some regions of the brain and the spinal cord of adult mammals retain stem cells that can generate astrocytes, neurons and oligodendrocytes.


Thankyou