

HISTOLOGY OF NERVOUS SYSTEM

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CNS

1- the principal structures are :

- cerebrum.
- cerebellum.
- spinal cord.

2- it is gel like organ due to ??????????????

3- in freshly sectioned tissue a white region (white matter) and gray region (gray matter) recognized.

4- this difference in color is due to the distribution of the nerve cell bodies and the myelinated nerve axons.

5- the **nerve cell bodies** , dendrites , the **initial un myelinated nerve axon** and the glial cells are mainly present in the gray matter.

6- Gray matter is the region where synapses are present.

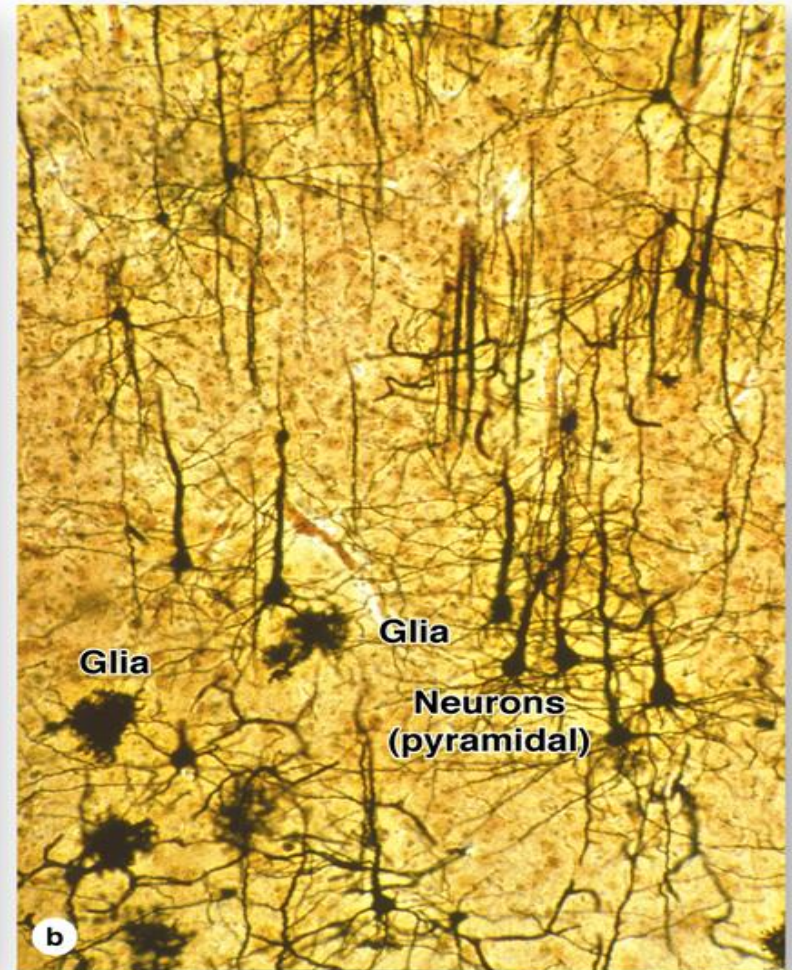
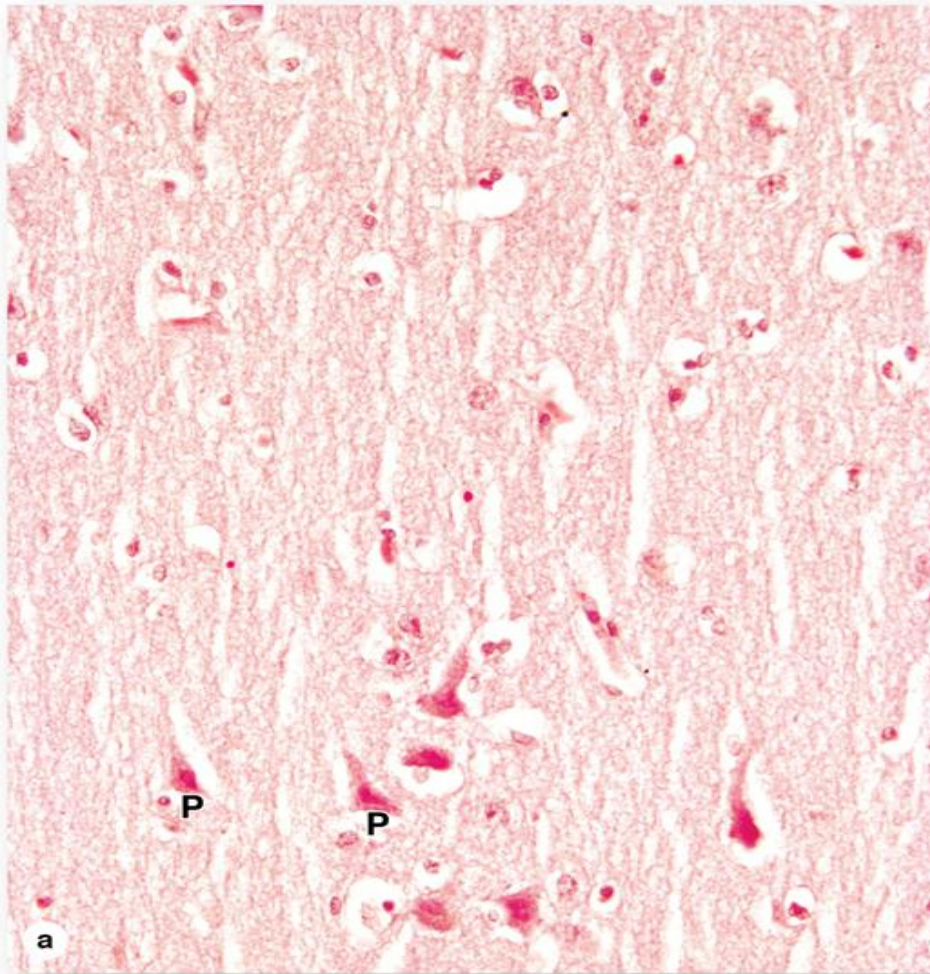
7- the white matter is composed mainly of the myelinated nerve axons together with the myelin producing oligodendrocytes , it does not contain neurons , and the nerve are grouped in to bundles or tracts .

8- Gray matter is prevalent mainly at cortex of cerebrum and cerebellum , and the white matter present in the central region.

9- island of gray matter , nuclei , are found in the deep region of cerebrum and cerebellum.

10- the nervous tissue is devoid of C.T and very small amount of extracellular substance.

11- Cerebral cortex is composed of six layers and the neurons are arranged vertically. The most abundant neurons are efferent Pyramidal neurons , which have different sizes . The main function of the neurons is integration of sensory information and the initiation of voluntary motor responses.



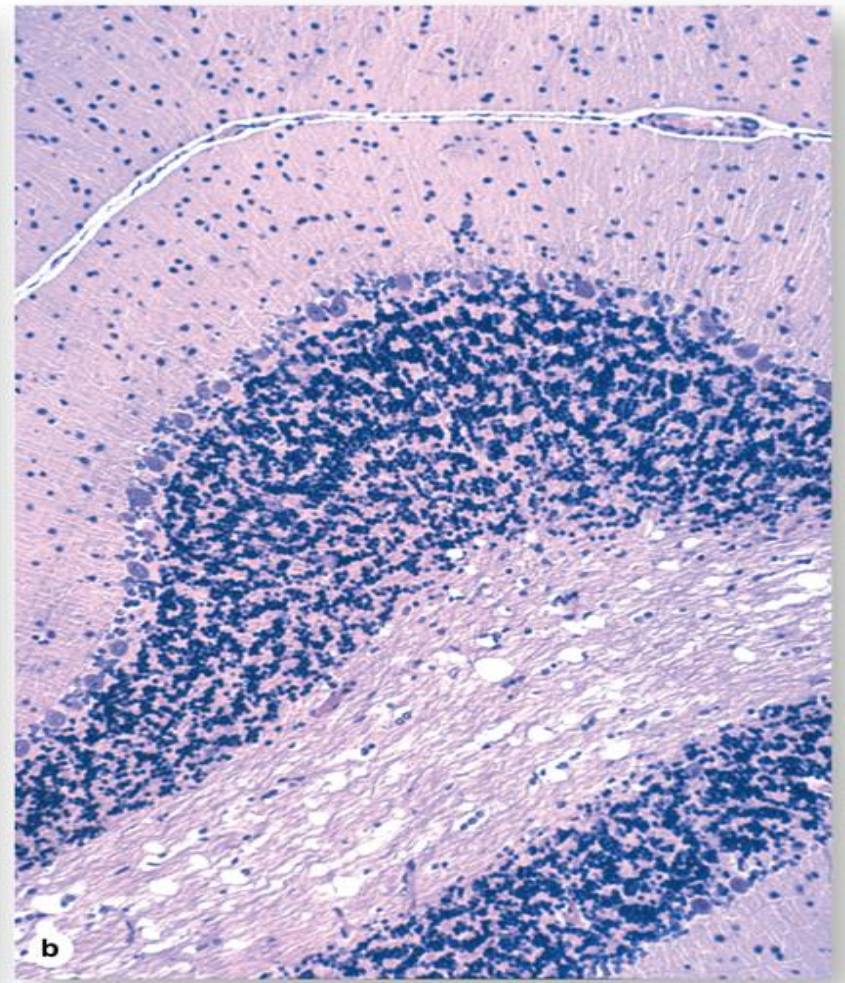
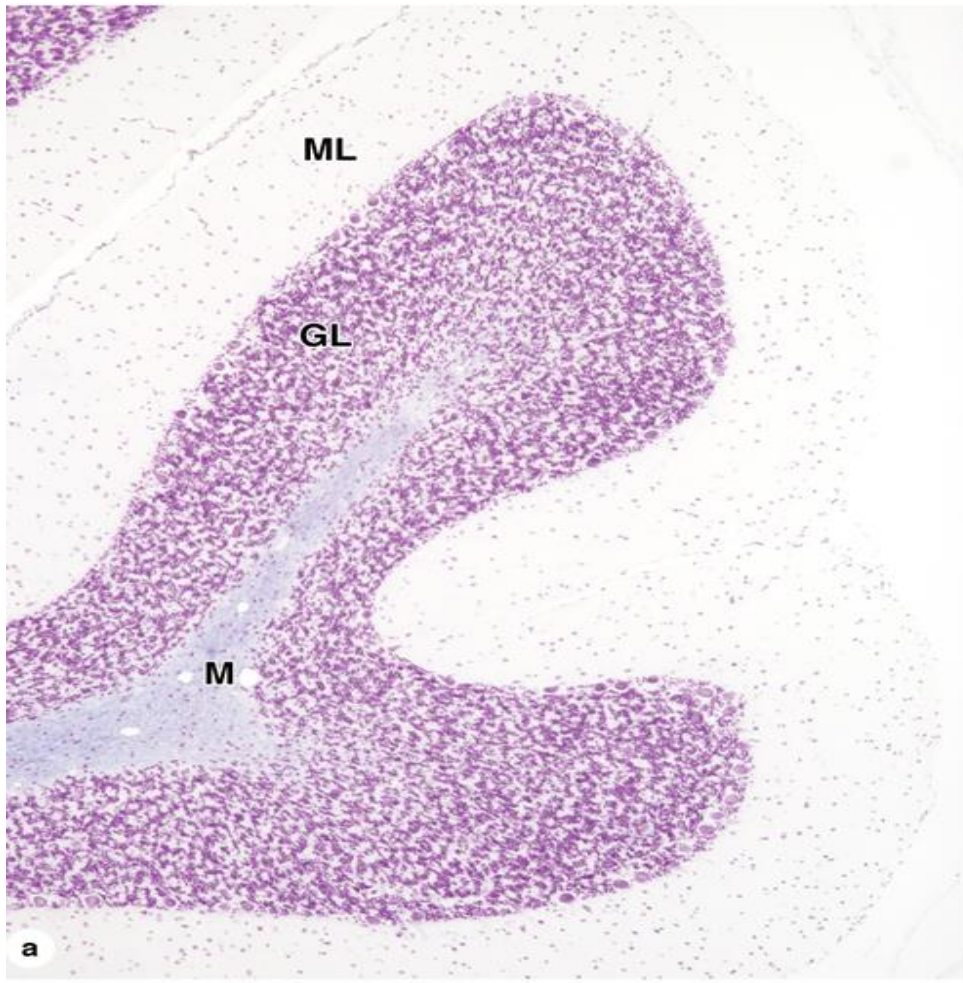
Cerebral cortex. (a): Important neurons of the cerebrum are pyramidal neurons (P), which are arranged vertically and interspersed with numerous glial cells in the eosinophilic neuropil. X200. H&E. (b): From the apical ends of pyramidal neuron, long dendrites extend in the direction of the cortical surface, which can be best seen in thick silver—stained sections in which only a few other protoplasmic glial cells are seen. X200. Silver.

12- the cerebellar cortex , which coordinates muscular activity throughout the body , has three layers :

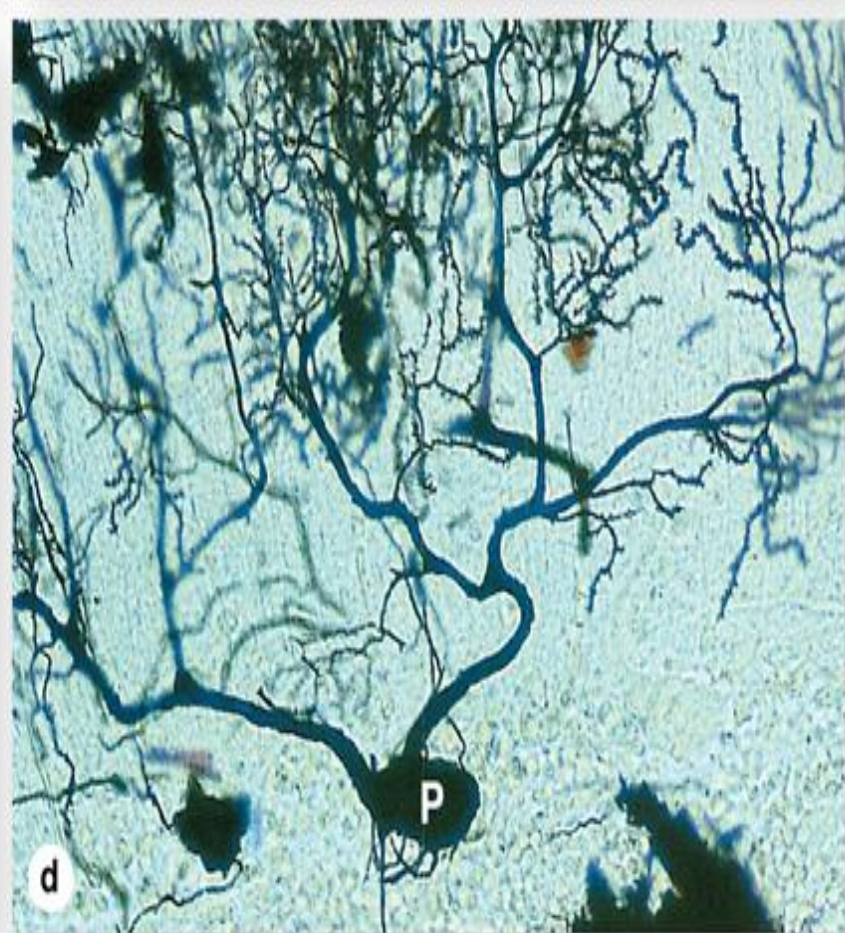
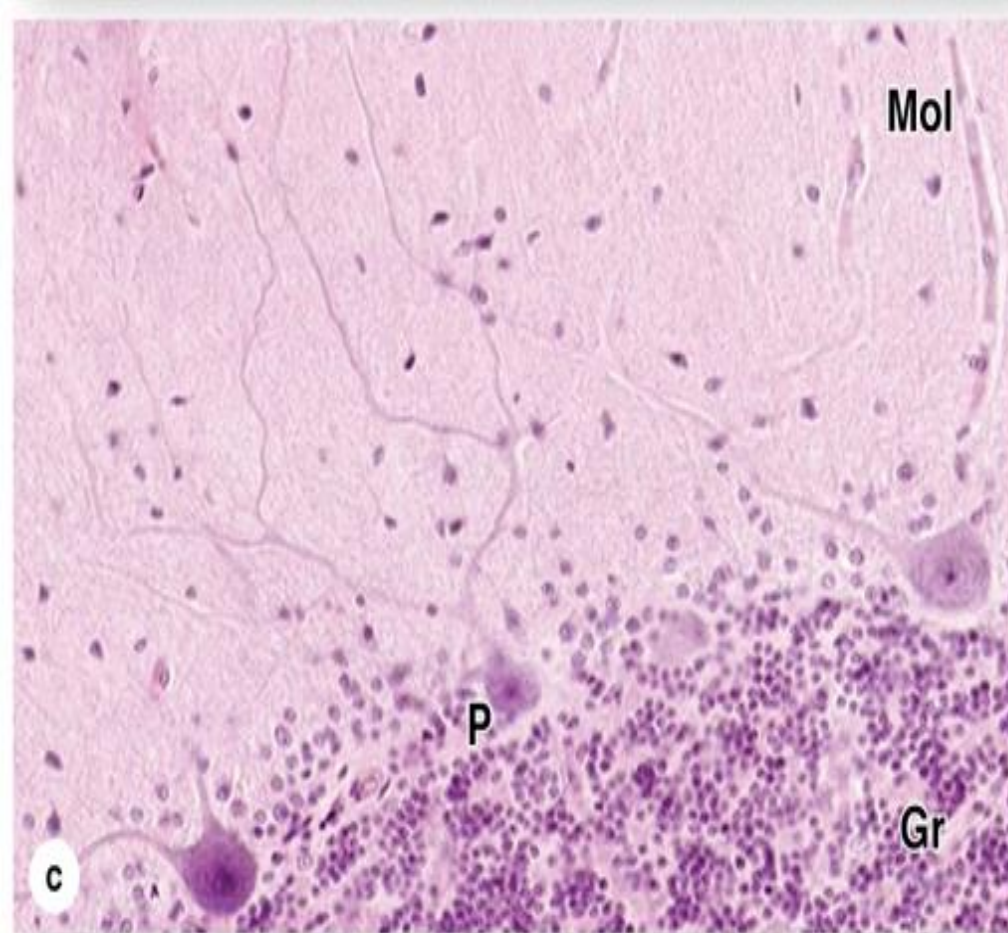
- an outer molecular layer .
- a central layer of very large neurons called purkinje cells .
- an inner granule layer.

13- the purkinje cell bodies are conspicuous in H&E stain and their dendrites extend throughout the molecular layer as branching basket of nerve fibers .

14- the granule layer is formed by very small neurons (the smallest in the body) , which are packed together densely , in contrast to the neuronal cell bodies in the molecular layer which are sparse.



Cerebellum. (a): The cerebellar cortex is convoluted with many distinctive small folds, each supported at its center by cerebellar medulla (M), which is white matter consisting of large tracts of axons. X6. Cresyl violet. (b): Immediately surrounding the white matter of the medulla is the granular layer (GL) of the cortex, which is densely packed with very small, rounded neuronal cell bodies. The outer, "molecular layer" (ML) consists of neuropil with fewer, more scattered small neurons. X20. H&E

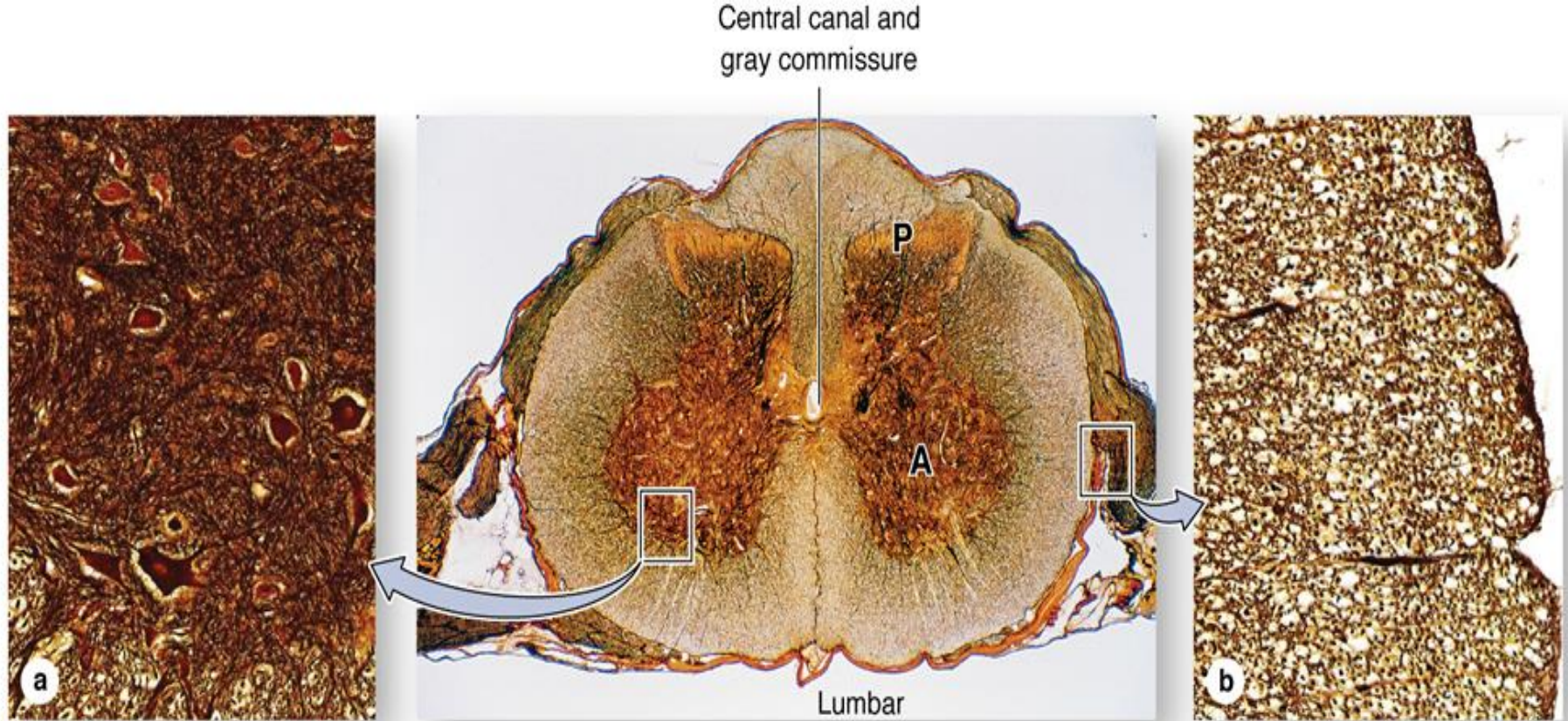


(c): At the interface between the granular and molecular layers is a single layer with very large neuronal cell bodies of unique Purkinje cells (P), whose axons pass through the granular layer (Gr) to join tracts in the medulla and whose multiple branching dendrites ramify throughout the molecular layer (Mol). X40. H&E. (d): Although not seen until well after H&E staining, dendrites of Purkinje cells have hundreds of small branches, each covered with dendritic spines, which can be demonstrated with silver stains. Axons from the small neurons of the granular layer are unmyelinated and run together into the molecular layer where they form synapses with the dendrites spines of Purkinje cells. The molecular layer of the cerebellar cortex contains relatively few neurons or other cells. X40. Silver.

* In cross section of the spinal cord , white matter is peripheral and gray matter is internal and has general butterfly shape . In the center is an opening , the central canal , which develops from the lumen of the embryonic neural tube and is lined by ependymal cells .

* The gray matter form the anterior horns , which contain the motor neurons whose axon make up the ventral roots of spinal nerves , and the posterior horns , which receive sensory fibers from neurons in the spinal ganglia (dorsal root).

*spinal cord neurons are large and multipolar , especially the motor neurons in the anterior horns.



Spinal cord. The spinal cord varies slightly in diameter along its length, but in cross—section always shows bilateral symmetry around the small, CSF—filled central canal. Unlike the cerebrum and cerebellum, in the spinal cord the gray matter is internal, forming a roughly H—shaped structure that consists of two posterior (P) horns (sensory) and two anterior (A) (motor) horns all joined by the gray commissure around the central canal. (a): The gray matter contains abundant astrocytes and large neuronal cell bodies, especially those of motor neurons in the ventral horns. (b): The white matter surrounds the gray matter and contains primarily oligodendrocytes and tracts of myelinated axons running along the length of the cord.

(c): Micrograph of the large motor neurons of the ventral horns show large nuclei, prominent nucleoli, and cytoplasm rich in chromatophilic substance (Nissl substance), all of which indicate extensive protein synthesis to maintain the axons of these cells which extend great distances. (d): In the white commissure ventral to the central canal, tracts run lengthwise along the cord, seen here in cross—section with empty myelin sheaths surrounding axons, as well as tracts running from one side of the cord to the other, seen here as several longitudinally sectioned tracts of eosinophilic axons. Center: X5; a–d: X200.; Center, a, b: silver; c, d: H&E.

Meninges

1- the meninges are membranes of connective tissue that invest and protect the brain and the spinal cord.

2- they are dura mater , the arachnoid mater , and the delicate pia mater.

- the Dura mater is the outer most layer , is composed of dense fibroelastic layer that is strongly adhered to the periosteum of skull.

- the Arachnoid is fibrous C.T layer in contact with the dura , and connected by trabeculae to the pia mater.

- the pia mater is loose C.T contain many blood vessels , although it is located close to the nerve tissue , it is attached to the surface of the brain and continues into sulci and around the blood vessels.

Blood Brain Barrier

1- it is a functional barrier that prevents the passage of some substances , such as antibiotics and chemicals and bacterial toxic matter , from blood to the nerve tissue.

2- the CNS capillaries are impermeable to certain plasma constituents , especially large molecules .

this characteristic feature for the capillaries of the CNS is due to:

- A- occluding junctions between endothelial cells of the capillaries
- B- the endothelial cells are not fenestrated with very few pinocytotic vesicles.
- C- Astrocyte foot processes.

Choroid Plexus

- 1- is avascular structure consists of invaginated folds of pia mater , rich in dilated fenestrated capillaries that arise from the walls of the brain ventricles .
- 2- it is covered with simple cuboidal to low columnar epithelium , with K.K of ion transporting cells.
- 3- it is in the roofs of the third and fourth ventricles , and in walls of lateral ventricles .
- 4- it is responsible for the production of cerebrospinal fluid CSF.
- 5- CSF is produced at a constant rate , it completely

Fills the ventricles , central canal of the spinal cord , subarachnoid space , and perivascular space.

6- it is reabsorbed from the subarachnoid space into superior sagittal venous sinus via finger like projections called the arachnoid villi.

CSF ??????????

Autonomic Nervous System

1- the autonomic nervous system is related to the control of smooth muscle , secretion of some glands , and the modulation of cardiac rhythm.

2- it's function to maintain constant internal environment (homeostasis) .

3- the term “autonomic” covers all neural elements concerned with visceral functions.

4- it is classified into :

- Sympathetic division.
- Parasympathetic division.

Peripheral Nervous System

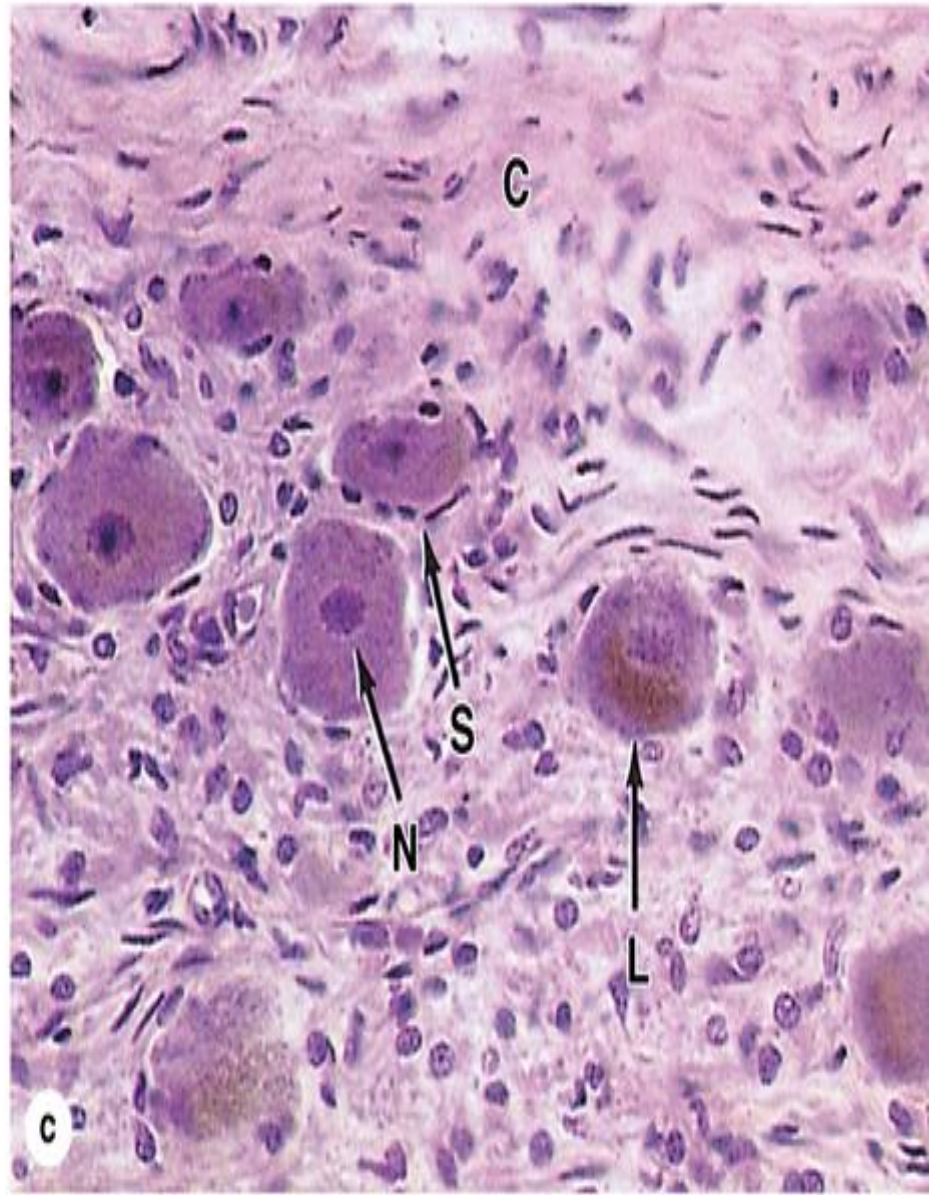
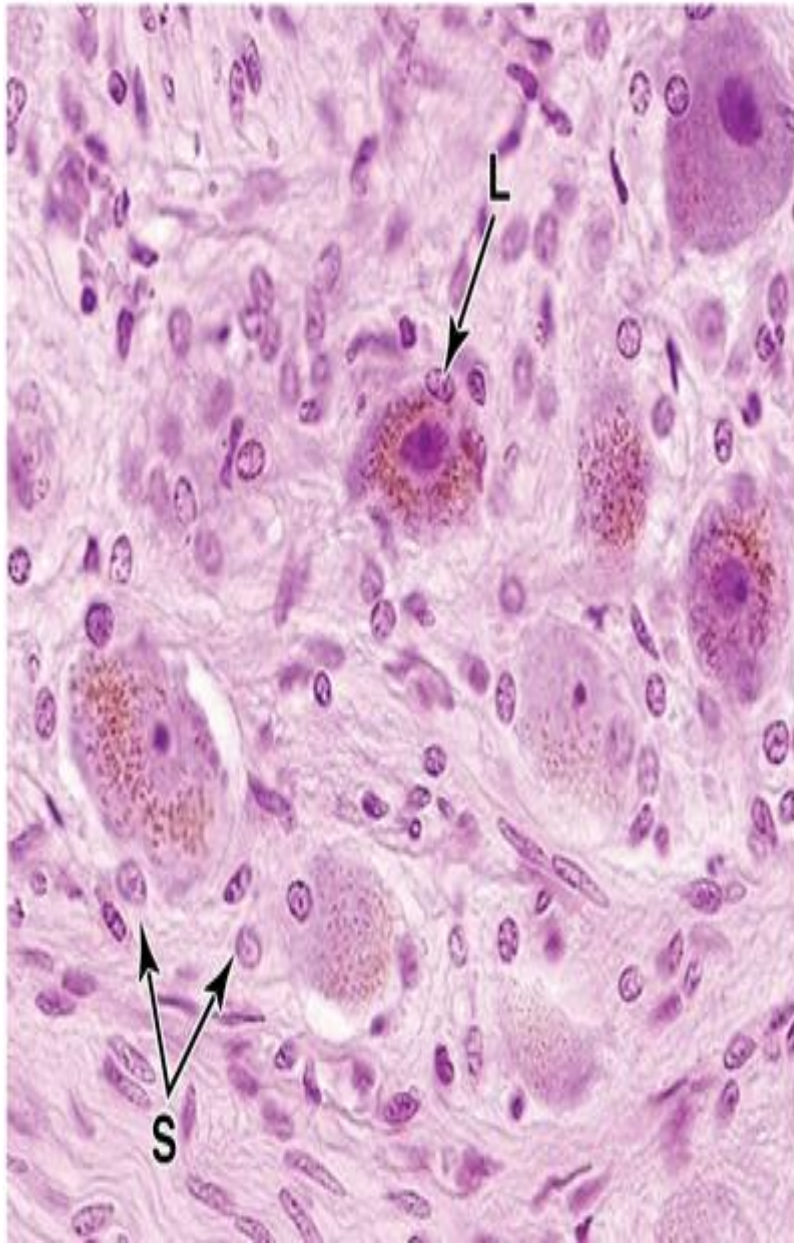
- * It consists of Nerves , Ganglia , and Nerve endings.
- * The ganglia are nodular masses of neuronal cell bodies (ganglion cells) , together with their supporting peripheral neuroglia , capsule cells or satellite cells.
- * There are two kinds of ganglia in the PNS :
 - Sensory ganglia , which contain cell bodies of sensory (afferent) .
 - Autonomic ganglia , which contain cell bodies of certain efferent neurons of the autonomic nervous system.

* The sensory ganglia include the :

- Cranial ganglia , which are associated with some of the cranial nerves .
- Spinal ganglia , known as posterior (dorsal) root ganglia , which are associated with posterior root of the spinal nerve.

Spinal ganglia

- 1- Ganglion cells have the typical features of neurons , i.e. large rounded cell bodies , intense cytoplasmic basophilia with fine nissl bodies , the nucleus is large spherical pale staining with prominent nucleolus (owl's eye appearance) , and is centrally located .
- 2- lipofuscin pigment may be present in cytoplasm.
- 3- a layer of flat satellite cells invest the cell body , the satellite cells are neuroglia cells in the peripheral nervous system.
- 4- the ganglion cells are pseudounipolar neurons , therefore in tissue sections they appear



Autonomic ganglia ????

Peripheral nerves

1- are tough and resilient .

2- they have a whitish , homogenous , glistening appearance because of their myelin and collagen content.

3- nerves have an external fibrous coat of dense C.T called epineurium , which also fills the space between the bundles of nerve fibers.

4- each bundle is surrounded by the perineurium , a sleeve formed by layers of flattened epithelium like cells.

5- within the perineurial sheath run the Schwann cell – sheathed axons and their enveloping C.T , the endoneurium.

6- the endoneurium consists of thin layer of reticular fibers , produced by Schwann cells.

Nerve Endings(Receptors)

1- nerve receptors are distributed throughout the body , mainly in the skin .

2- two types of nerve ending have been identified:

A- Free nerve endings.

B- Encapsulated nerve ending.

A-Free nerve endings

- * They are situated in the deeper layer of the epidermis and in the papillary layer of the dermis.
- * they are supplied with afferent nerve endings that are free of investing Schwann cells.
- * They are thermoreceptor , nociceptors , and the mechanoreceptors.

B- Encapsulated nerve endings

* These are :

- Pacinian corpuscles
- Meissners corpuscles.
- Ruffini corpuscle.
- Krause end bulb.

Pacinan corpuscles

- * They are the largest encapsulated receptors; they are pressure – sensitive mechanoreceptors , present in joint and the pancreas.
- * They are easy recognized in sections as they are similar to onion bulbs.
- * The afferent nerve ending is surrounded by multiple concentric layers of flat cells (regarded as modified Schwann cells) and the corpuscle is invested by strong C.T capsule.

Meissner's corpuscles

- * They are for touch sensitivity and are highly sensitive.
- * They are best observed in the dermal papillae , composed of flat cells (modified Schwann cells) lie transversely in the corpuscle , parallel to the skin surface.
- * Helical terminal branches of several afferent nerve fibers lie with the cells and a C.T capsule invest the whole corpuscle.

END