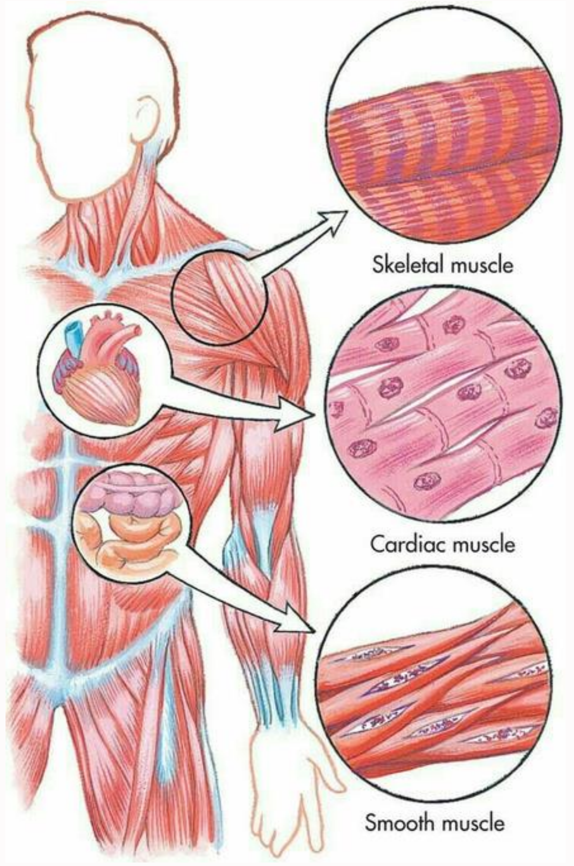
بسم الله الرحمن الرحيم

Histology - Final 8

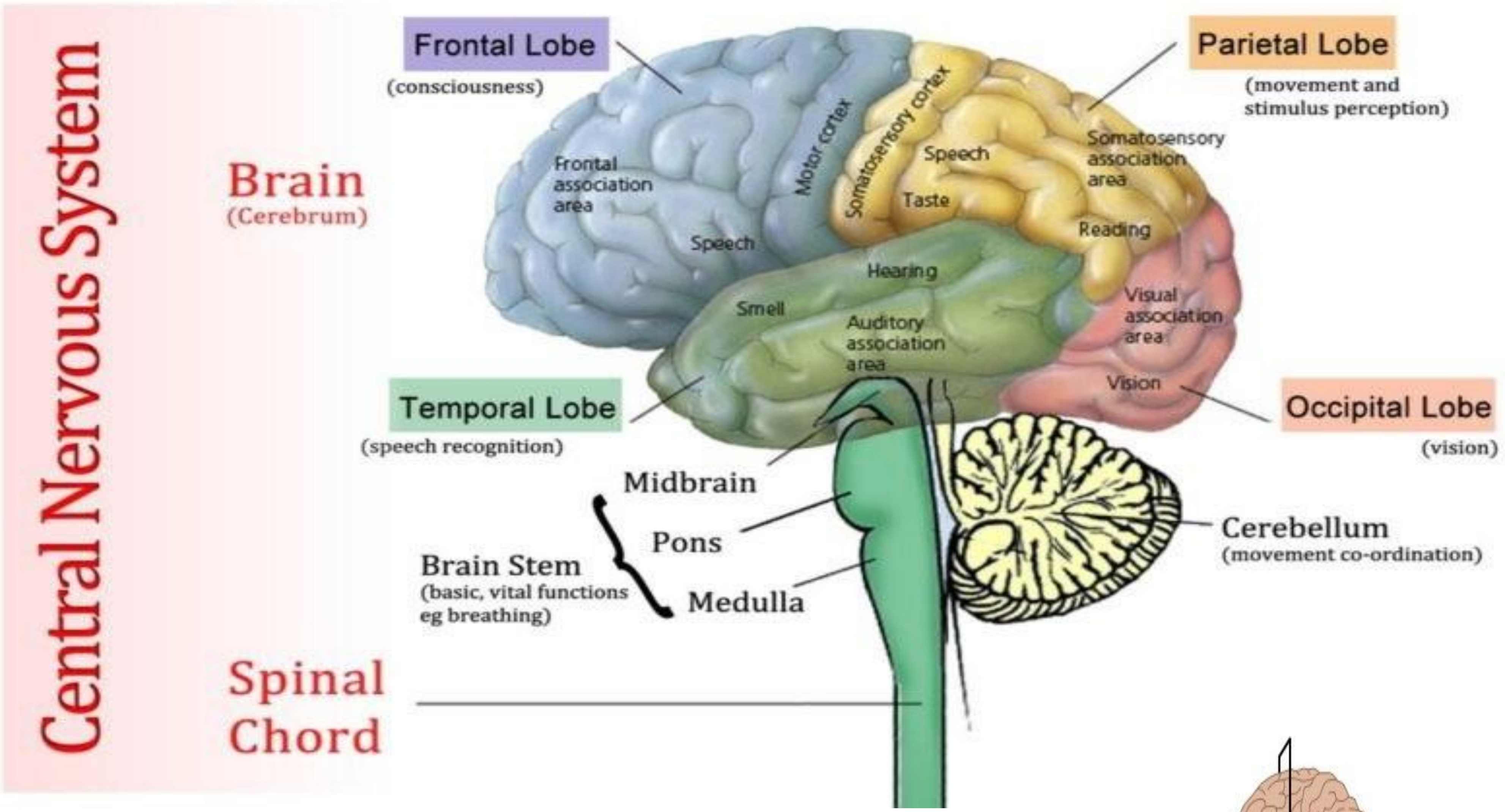
Nervous Tissue (pt.3)



Written by : Mayar Khader
Maria Baroudi

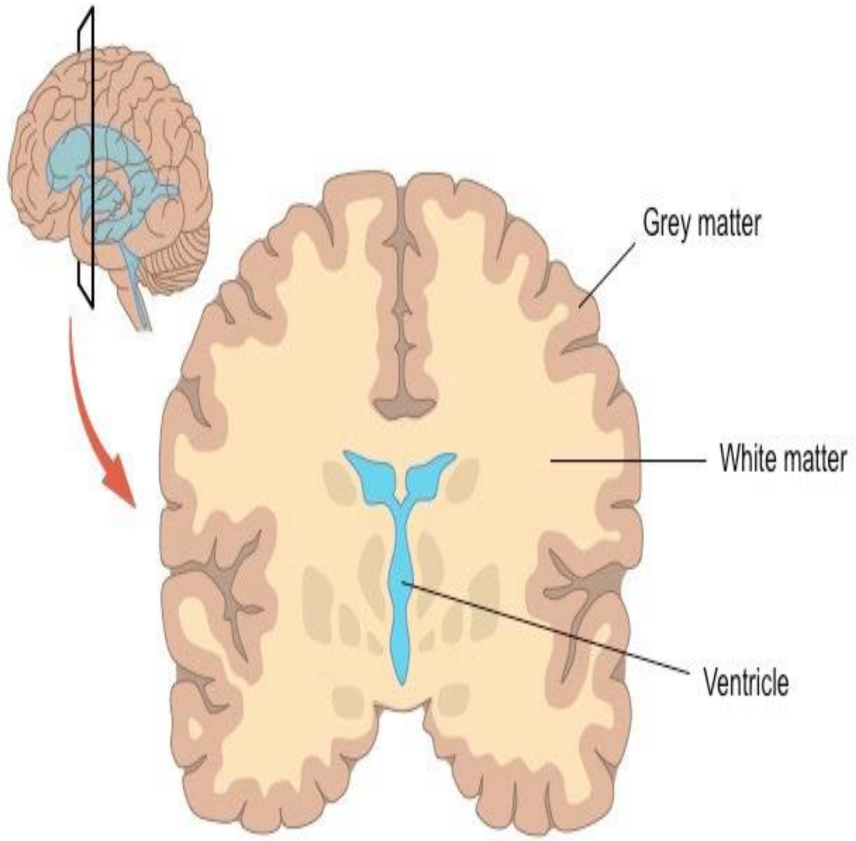
CNS

- The major structures: cerebrum, cerebellum, and spinal cord.
- Completely covered by connective tissue layers---meninges.
- Many regions show organized areas of white matter and gray matter.
- White matter: myelinated axons (often as tracts), oligodendrocytes, astrocytes, microglia, and very few neuronal cell bodies.



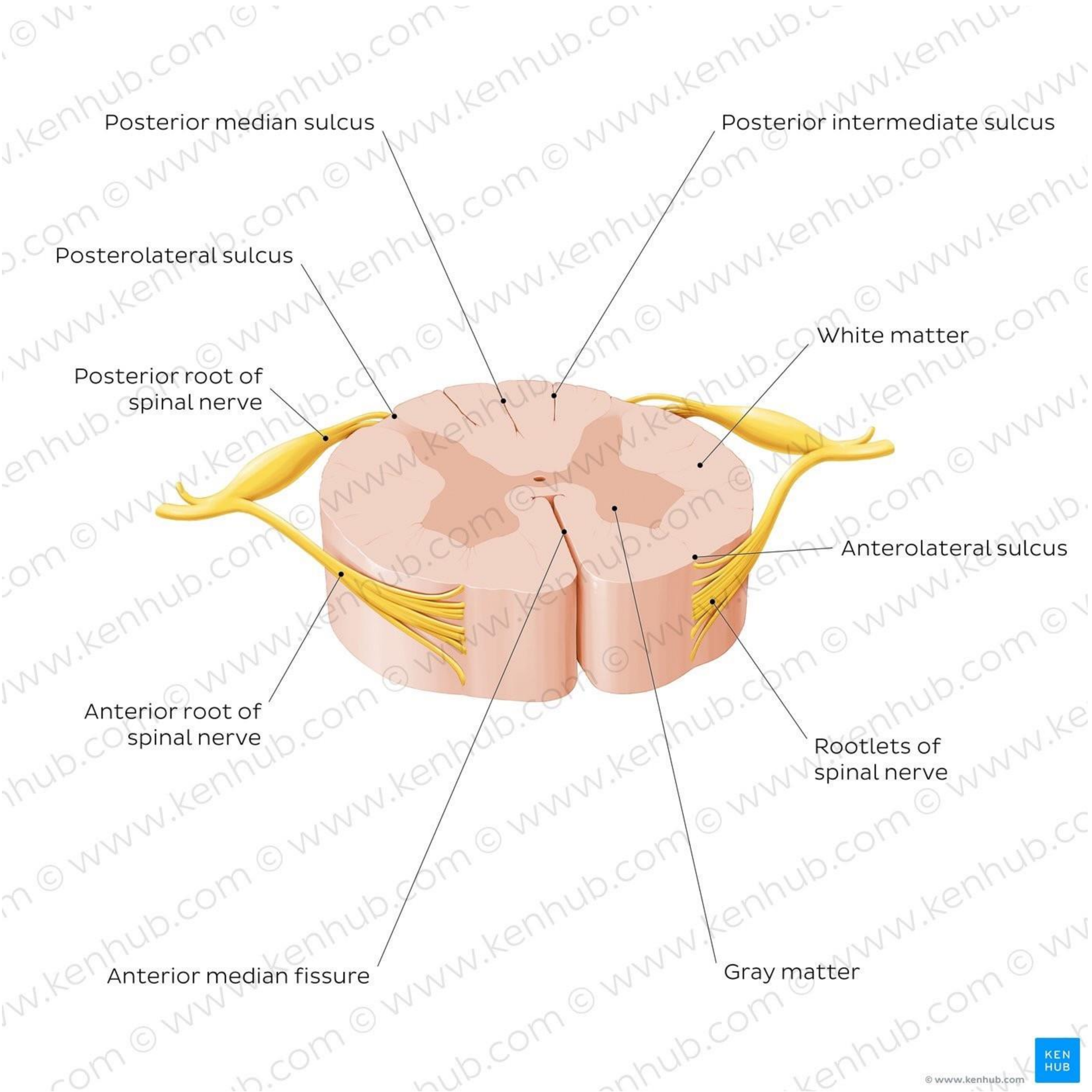
Deep regions of the CNS also have darker aggregates called nuclei consisting of large numbers of neuronal cell bodies and surrounded by white matter

- Gray Matter: abundant neuronal cell bodies, dendrites, Astrocytes, and microglial cell and is where most synapse Occur.
- Gray matter makes up the thick cortex Of both the cerebrum and the cerebellum; most white matter is in deeper regions.
- cerebral nuclei: Containing large numbers of neuronal cell bodies.



CNS

- Spinal cord: the white matter is peripheral and the gray matter forms a deeper, h-shaped mass
- Two anterior projections; the anterior horns: contain cell bodies of very large motor neurons.
- Two posterior horns contain interneurons which receive sensory fibers from neurons in the spinal (dorsal root) ganglia.
- Central canal: middle of the cord, is continuous with the ventricles of the brain, lined by ependymal cells, and contains CSF. Ependymal cells secrete CSF (cerebral spinal fluid)

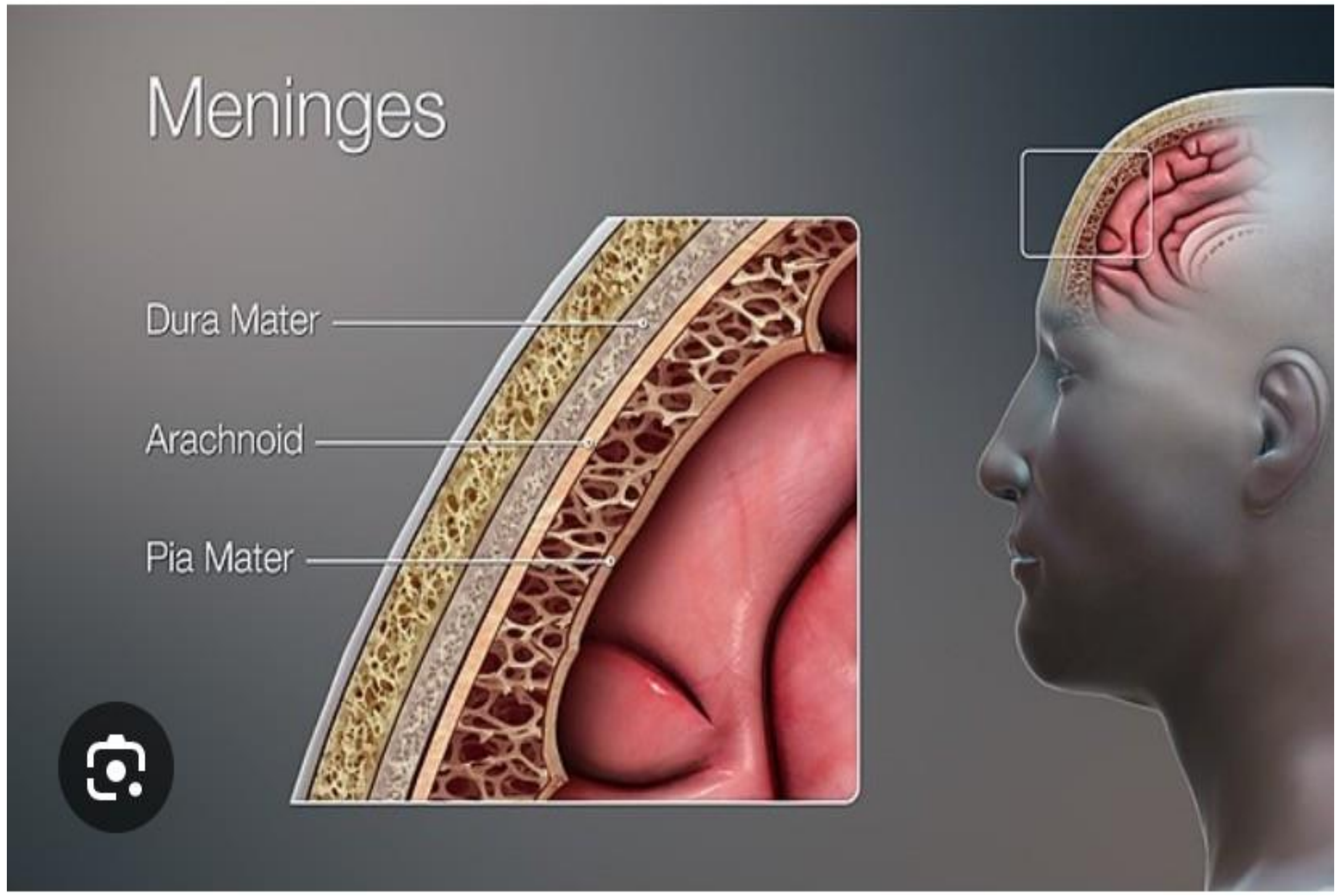


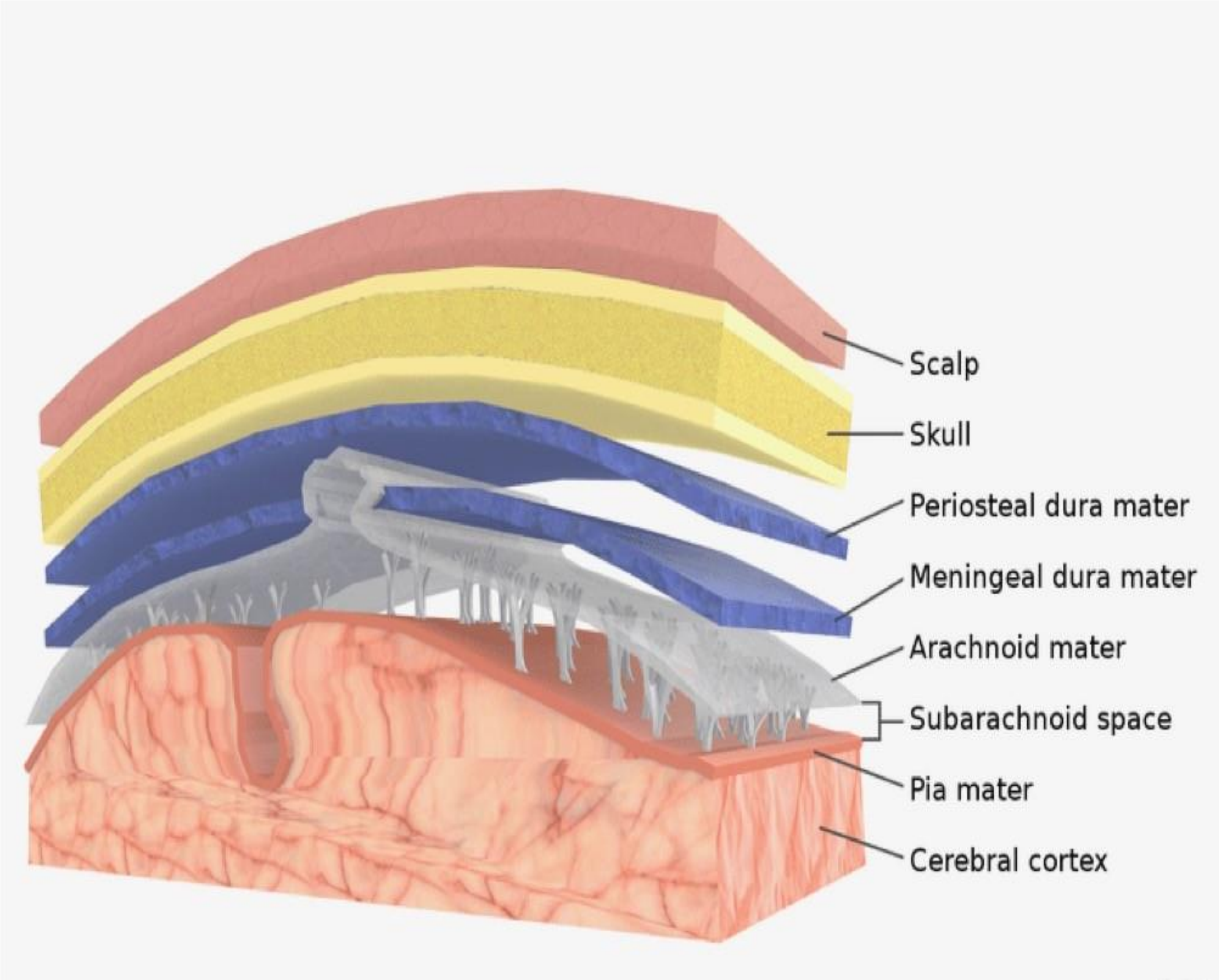
MENINGES

- Membranes of connective tissue between the bone and nervous tissue.
- 3 layesr

1. Dura mater (Tough mother)

- The thick external.
- Consists of dense irregular connective tissue organized as an Outer periosteal layer continuous with the periosteum of the skull, and an inner meningeal layer (in contact with the arachnoid)
- Spinal cord: the dura mater is separated from the periosteum by the epidural space.





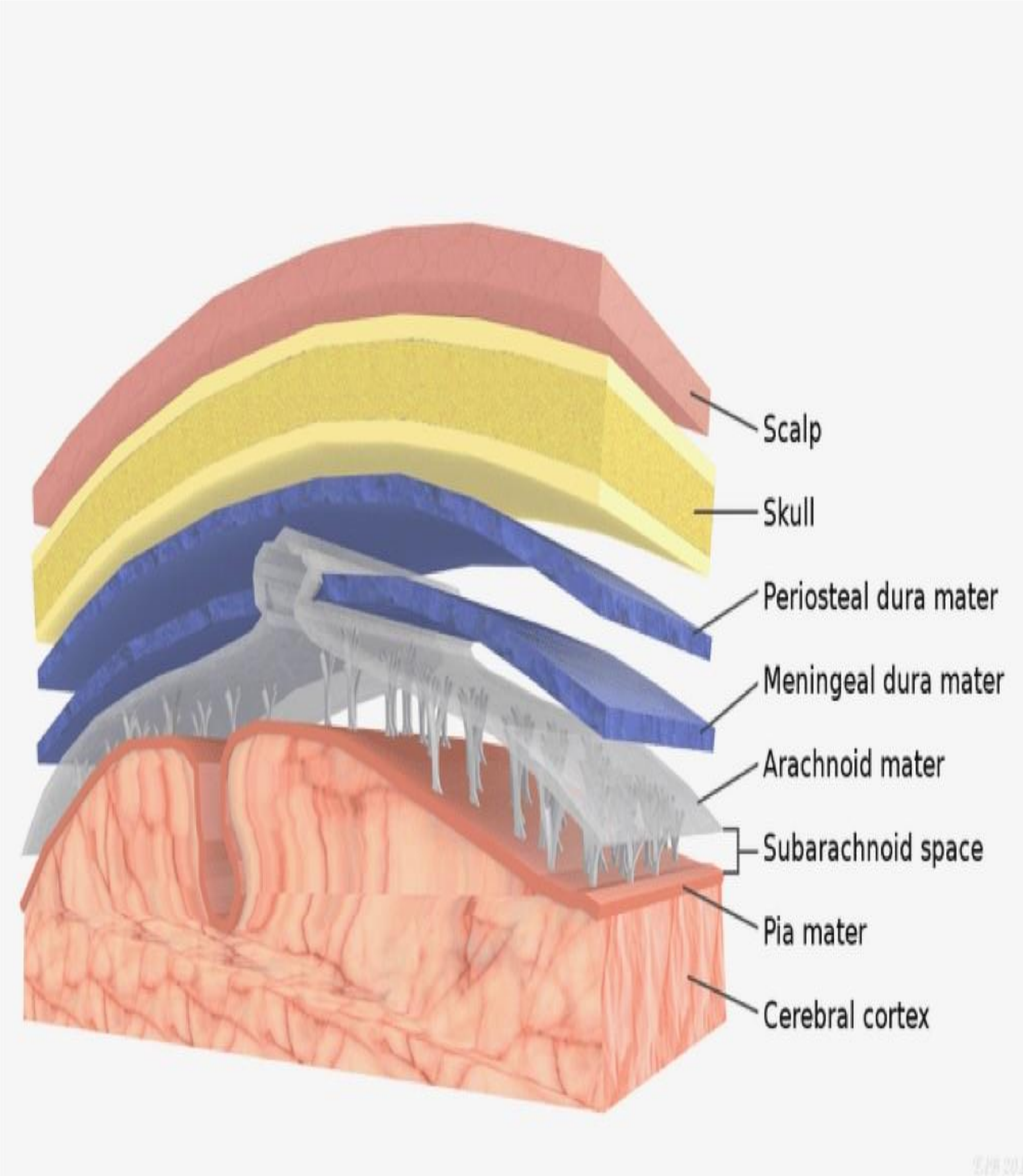
MENINGES

2. Arachnoid

- Has two components: (1) a sheet of connective tissue in contact with the dura mater and (2) a system of loosely arranged trabeculae (collagen and fibroblasts) continuous with the pia mater layer.
- Avascular–-lacks nutritive capillaries.
- The arachnoid and the pia mater are intimately associated.

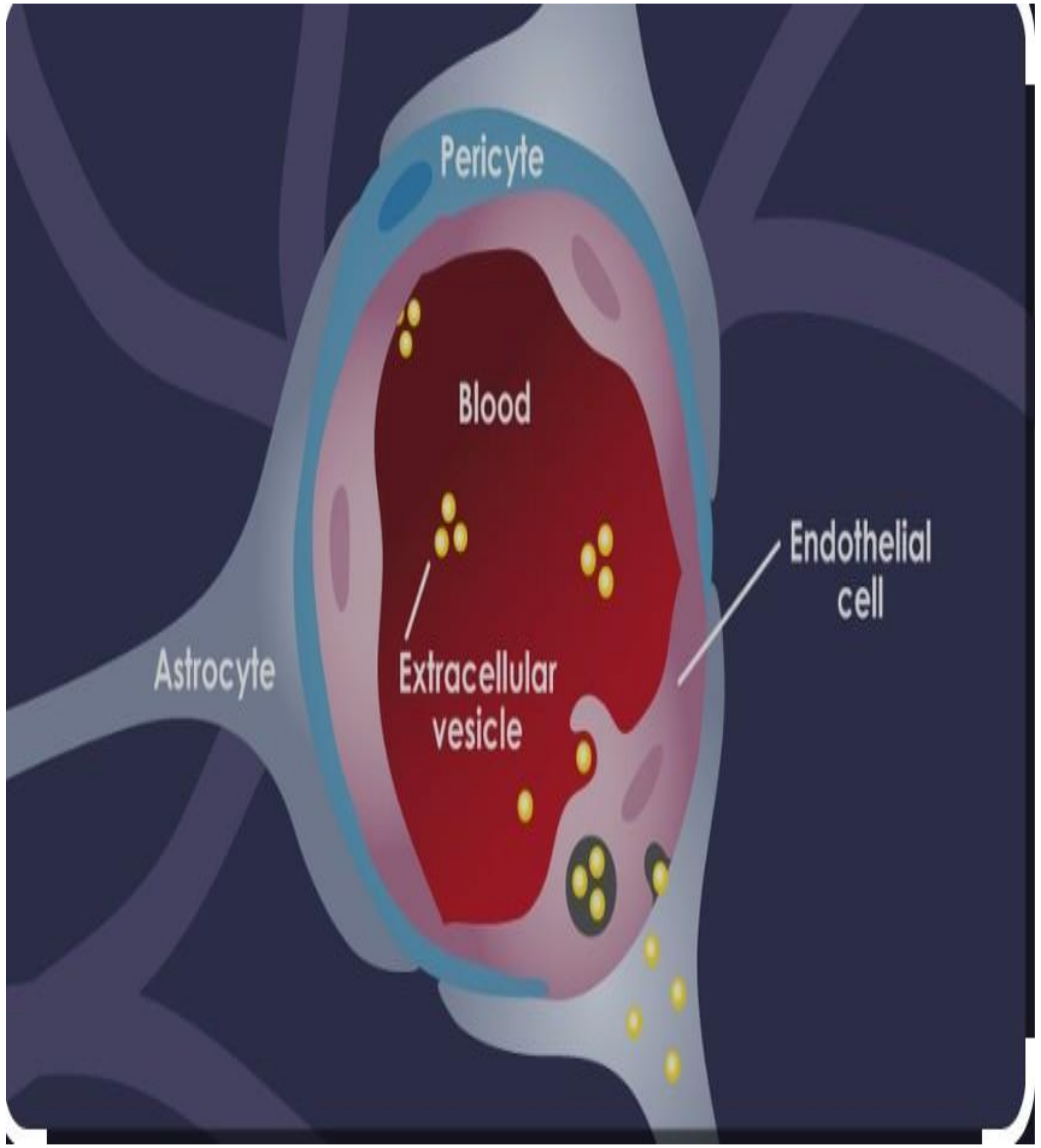
3. Pia mater

- Consists of flattened, mesenchymal-derived cells closely applied to the entire surface of the CNS tissue.
- The pia does <u>not directly contact </u>nerve cells or fibers---thin superficial layer of astrocytic processes (the glial limiting membrane)

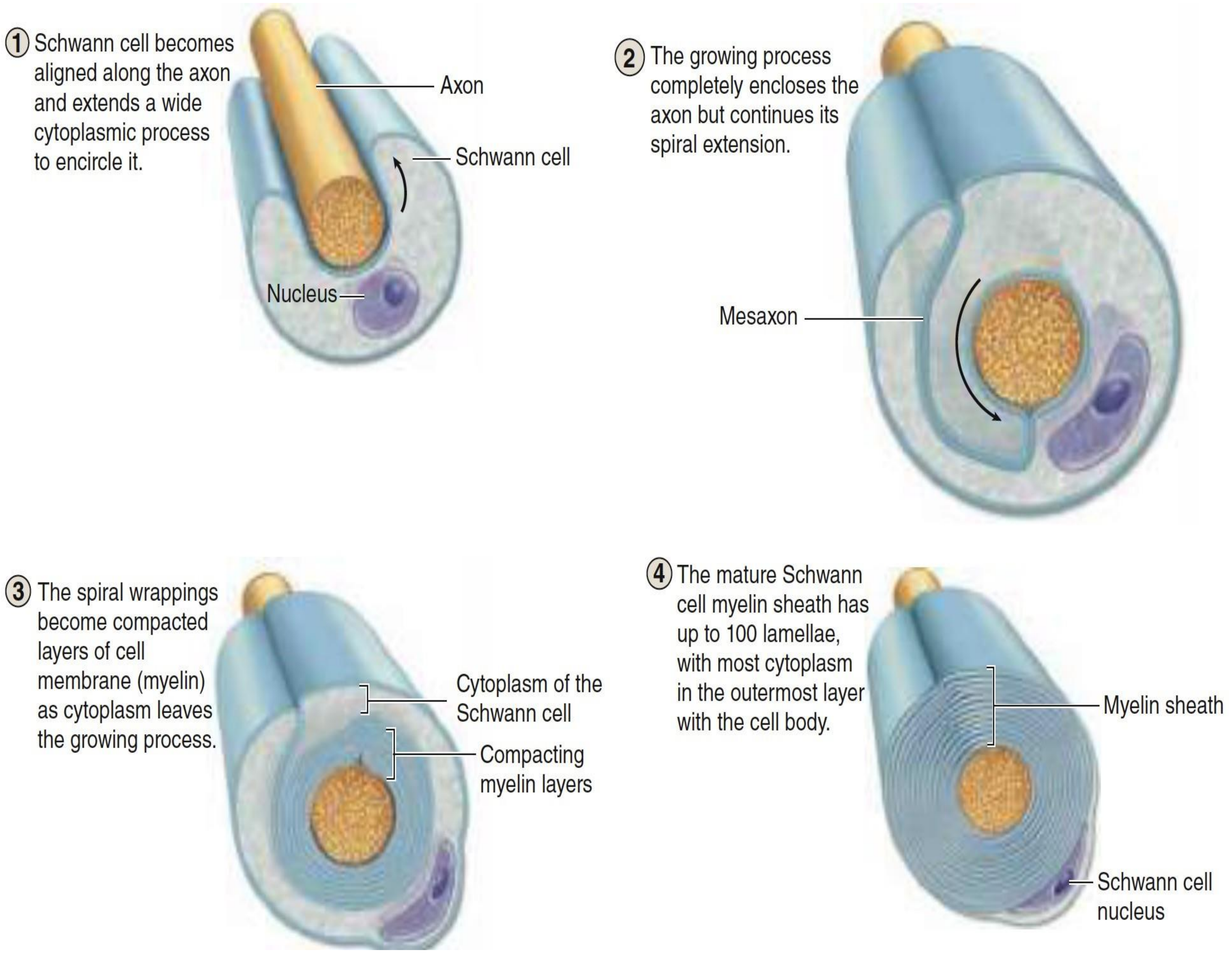


BLOOD-BRAIN BARRIER

- A functional barrier that allows tight control over the passage of substances from blood into the CNS tissue.
- The main component is the capillary **endothelium**: cells are tightly sealed together with well-developed occluding junctions, with little or no transcytosis activity, and surrounded by the basement membrane . they have advanced adhesion to each other
- The **astrocytic** feet that envelops the basement membrane of capillaries.
- Protects CNS from bacterial toxins, infectious agents, and other substances, and helps maintain the stable composition and constant balance of ions in the interstitial fluid.
- BBB is not present in regions of the hypothalamus where plasma components are monitored.



PERIPHERAL NERVOUS SYSTEM



- **The main components:**

➢ Nerves, ganglia, and nerve endings.

➢ Nerves are bundles of nerve fibers (axons surrounded by Schwann cells (neurolemmocytes)and layers of connective tissue.

➢ Mesaxon: plasma membrane of each covering Schwann cell fuses with itself

➢ Use Shawn cells have an extra amount of lipid in their plasma membrane

The Schwann cell membrane fuses around the axon and elongates as it becomes wrapped around the axon (Schwann cells keep
wrapping that's why we see many layers of the double layer of plasma membrane).

TEM

MYLEIN SHEATH

- Membranes of Schwann cells have a higher proportion of lipids than do other cell membranes

Cross section of PNS fibers in the TEM reveals differences between myelinated and unmyelinated axons. Large axons (**A**) are wrapped in a thick myelin sheath (**M**) of multiple layers of Schwann cell membrane.

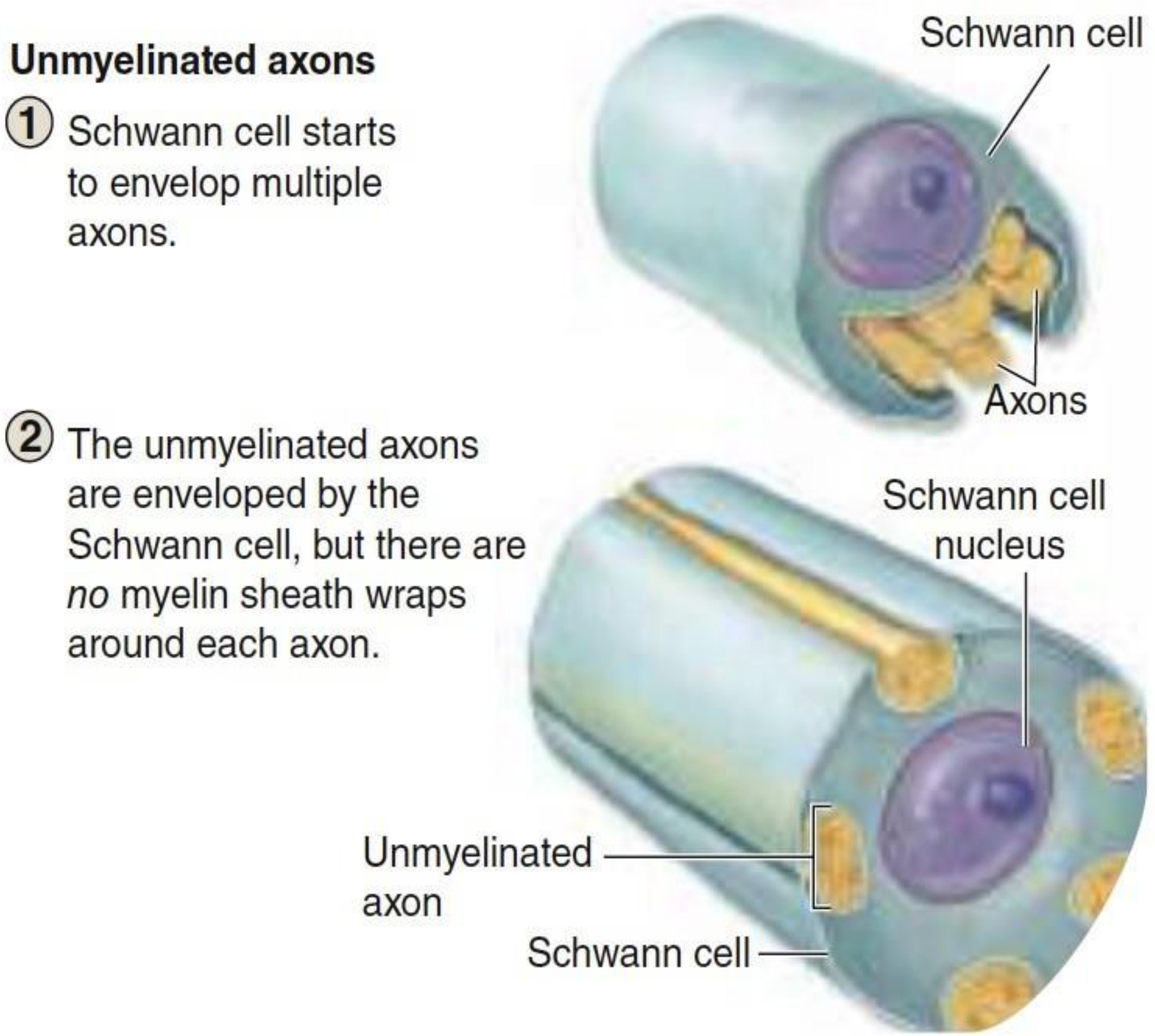
The inset shows a portion of myelin at higher magnification in which the major dense lines of individual membrane layers can be distinguished, as well as the neurofilaments (**NF**) and microtubules (**MT**) in the axoplasm (**A**). At the center of the photo is a Schwann cell showing its active nucleus (**SN**) and Golgi-rich cytoplasm (**SC**). At the right is an axon around which myelin is still forming (**FM**).

Unmyelinated axons (**UM**) are much smaller in diameter, and many such fibers may be engulfed by a single Schwann cell (**SC**). The glial cell does not form myelin wrappings around such small axons but simply encloses them. Whether it forms myelin or not, each Schwann cell is surrounded, as shown, by an external lamina containing type IV collagen and laminin like the basal laminae of epithelial cells. (X28,000, inset X70,000)

(Used with permission from Dr Mary Bartlett Bunge, The Miami Project to Cure Paralysis, University of Miami Miller School of Medicine, Miami, FL.)

UNMYLINATED AXONS

- In CNS, many short axons are not myelinated.
- Each Schwann cell can enclose portion of many axons with small diameters--- no multiple wrapping of a myelin sheath.
- No nodes of Ranvier.
- Evenly distributed voltage-gated ion channels.
- Impulse conduction is much slower than that of myelinated axons.
- The unmyelinated axons have schwann cells but there are no myelin warps around each axon.



NERVE ORGANIZATION

- Nerves have a whitish, glistening appearance ---myelin and collagen.
- Endoneurium (the inner one): immediately around the external lamina of the Schwann cells, consisting of reticular fibers, scattered fibroblasts, and capillaries. It is an irregular dense connective tissue.
- Perineurium (the middle one): surrounds groups of axons with Schwann cells and endoneurium–- fascicles– containing flat fibrocytes with their edges sealed together by tight junctions.
- Epineurium (the most external): irregular fibrous coat extends deeply to fill the space between fascicles. It surrounds every nerve ,it contains reticular fibers fibroblast and capillaries

NERVES

NOTE: There are tiny blood vessels (capillaries) between the axons in the fascicle and blood vessels between the fascicles .

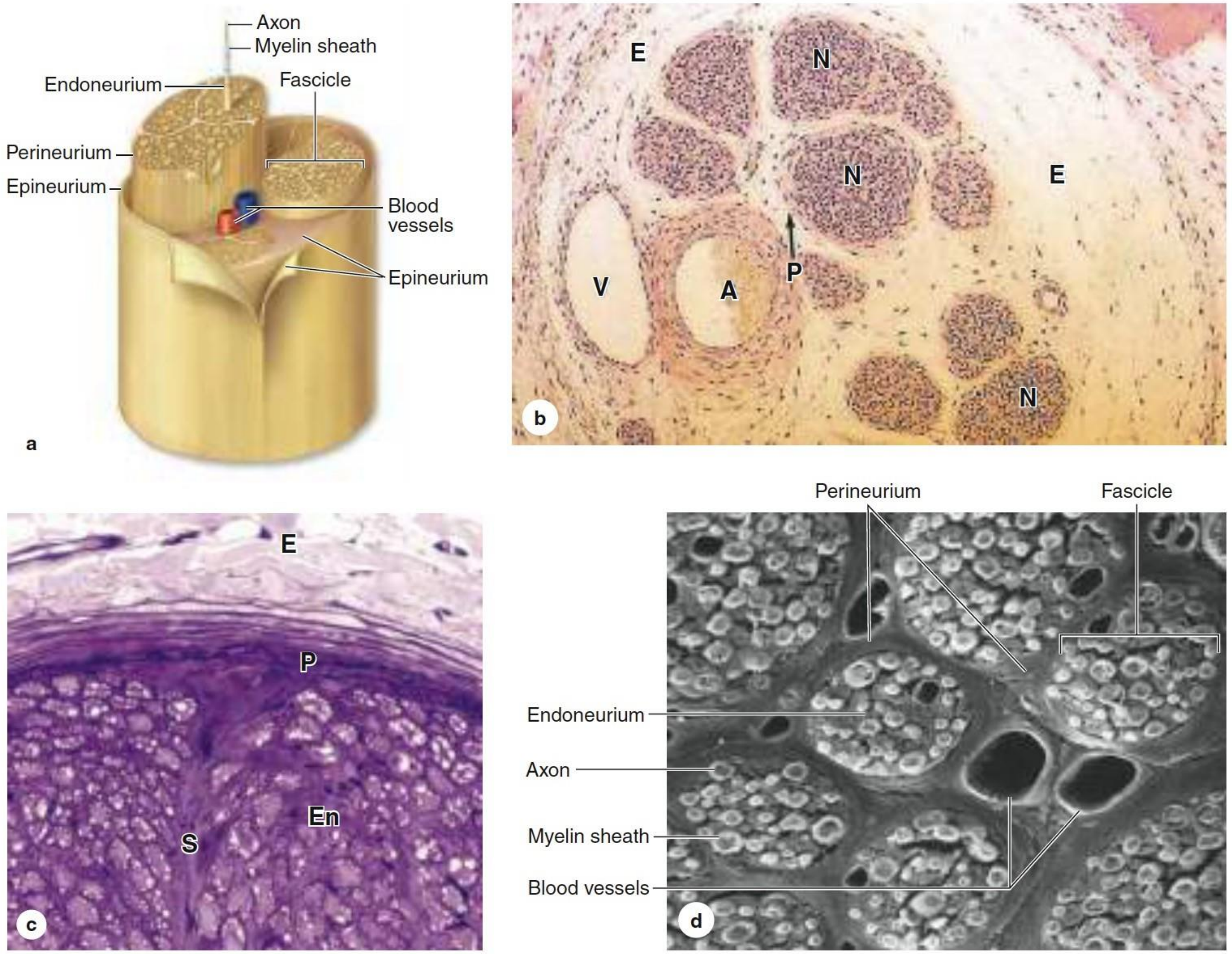
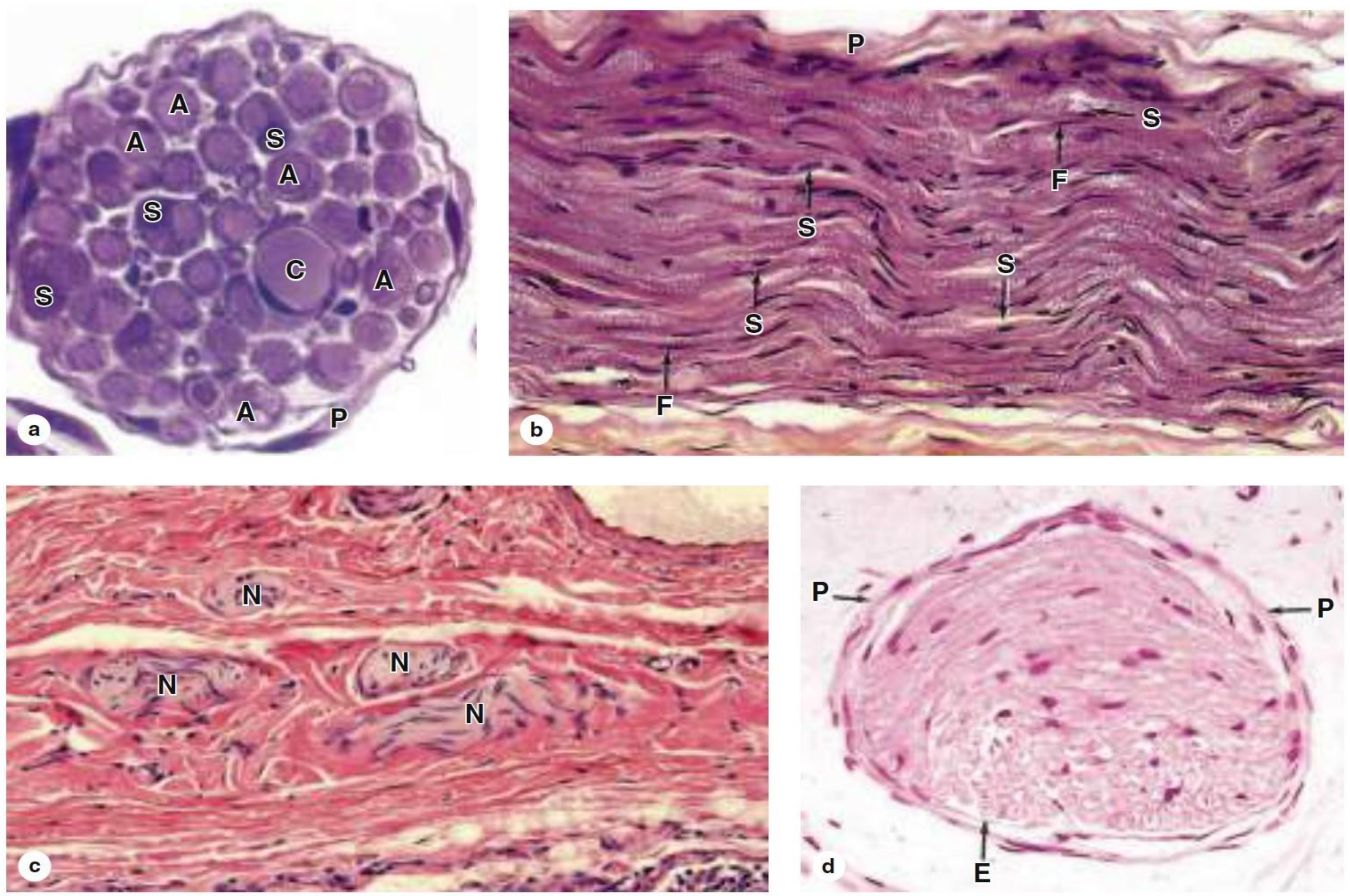


FIGURE 9–28 Small nerves.



GANGLIA

Are collection of neurons outside the CNS

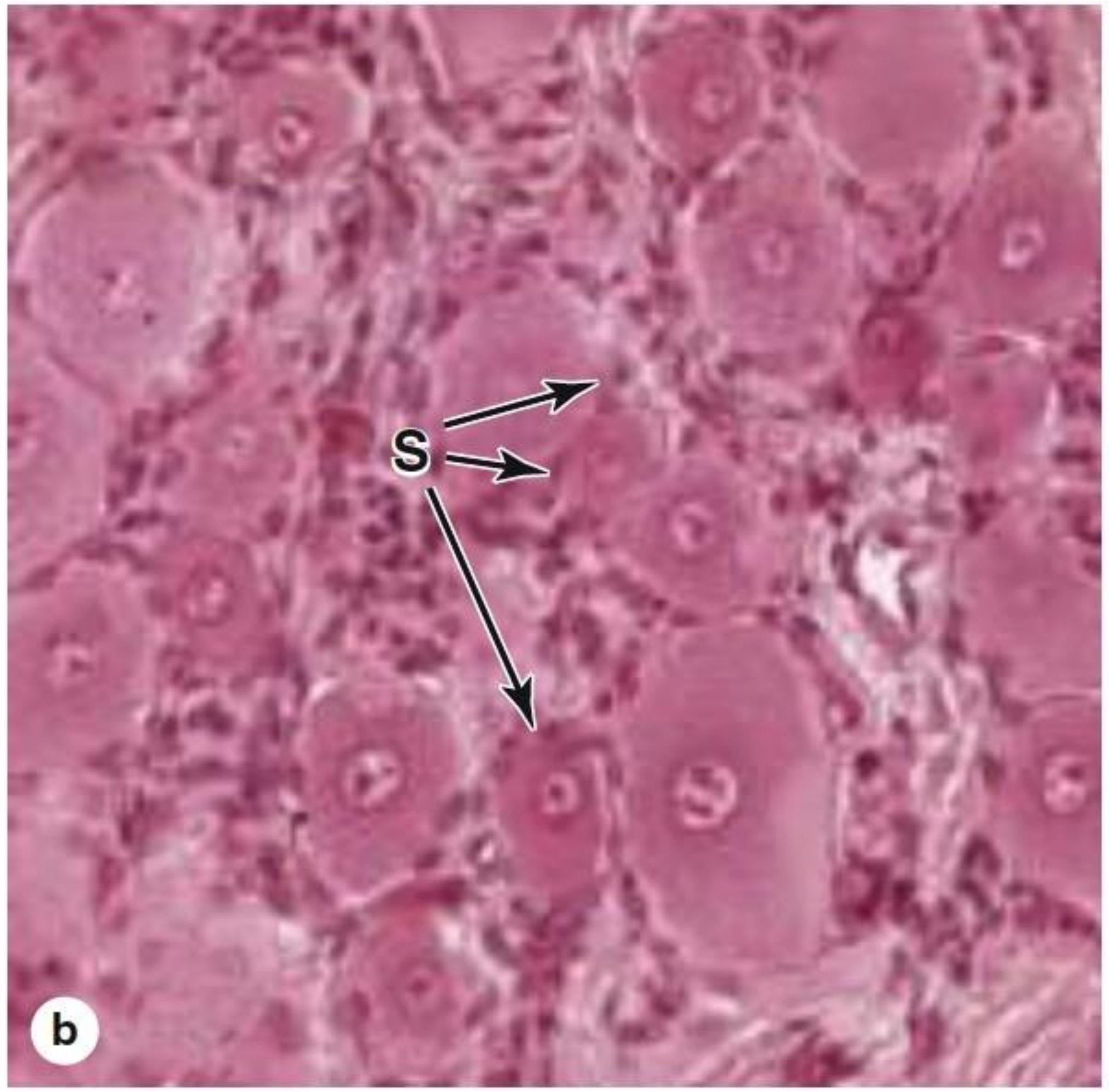
- Ganglia contain the cell body of neurons and supporting cells which are glial cells (satellite cells), also it contains a supporting connective tissue with an outermost capsule to protect the cells .
- Ovoid structures containing neuronal cell bodies and their surrounding glial satellite cells supported by delicate connective tissue and surrounded by a denser capsule.

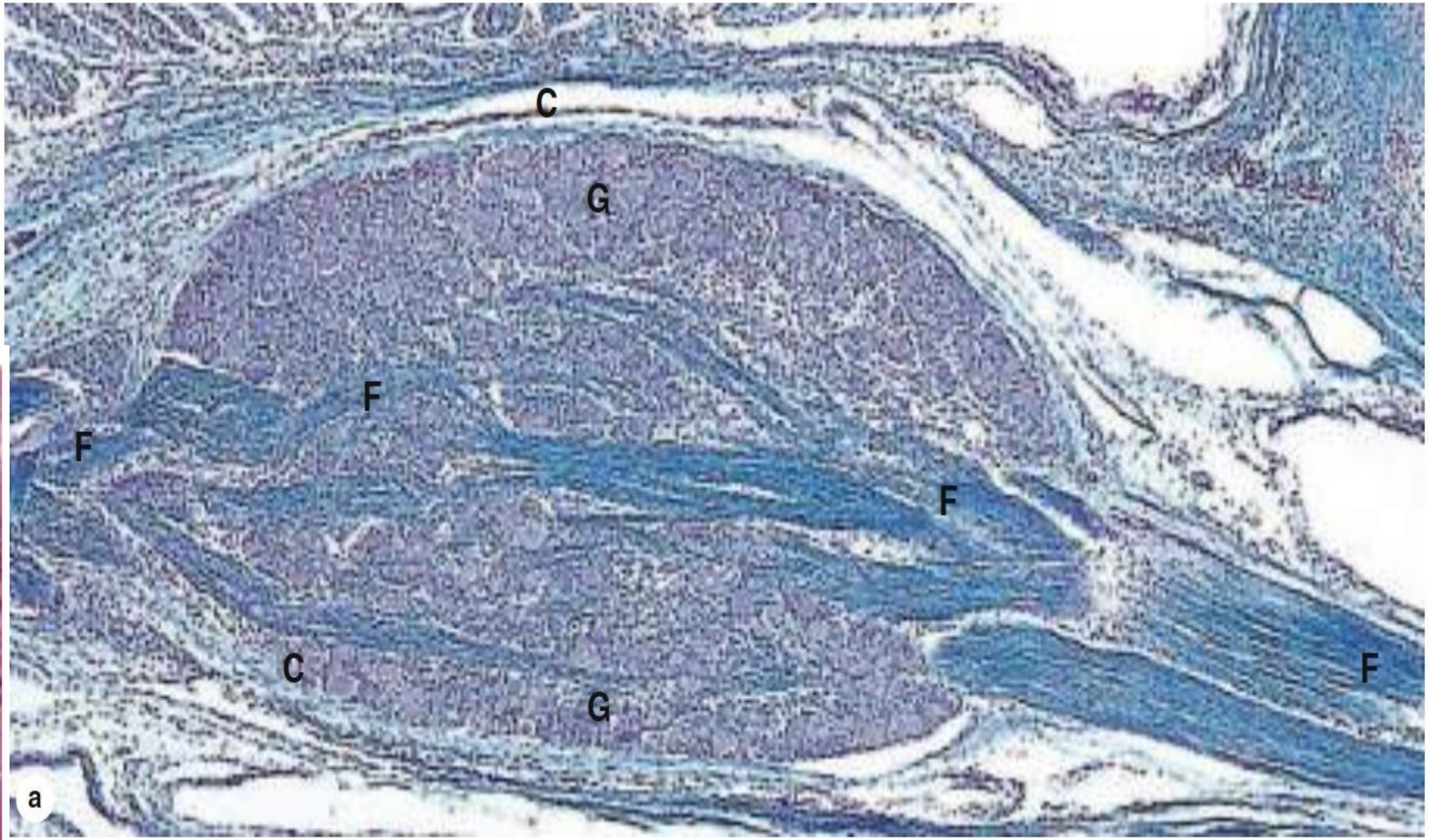
There are two types of ganglia :

Sensory ganglia

- Sensory ganglia receive afferent impulses that go to the CNS.
- Sensory ganglia are associated with both cranial nerves (cranial ganglia) and the dorsal roots of the spinal nerves (spinal ganglia).
- Are pseudounipolar and relay information from the ganglion’s nerve endings to the gray matter of the spinal cord via synapses with local neurons.

SENSORY G.





A) The stain used is trichrome stain.
B) The stain used is H&E.

ANS

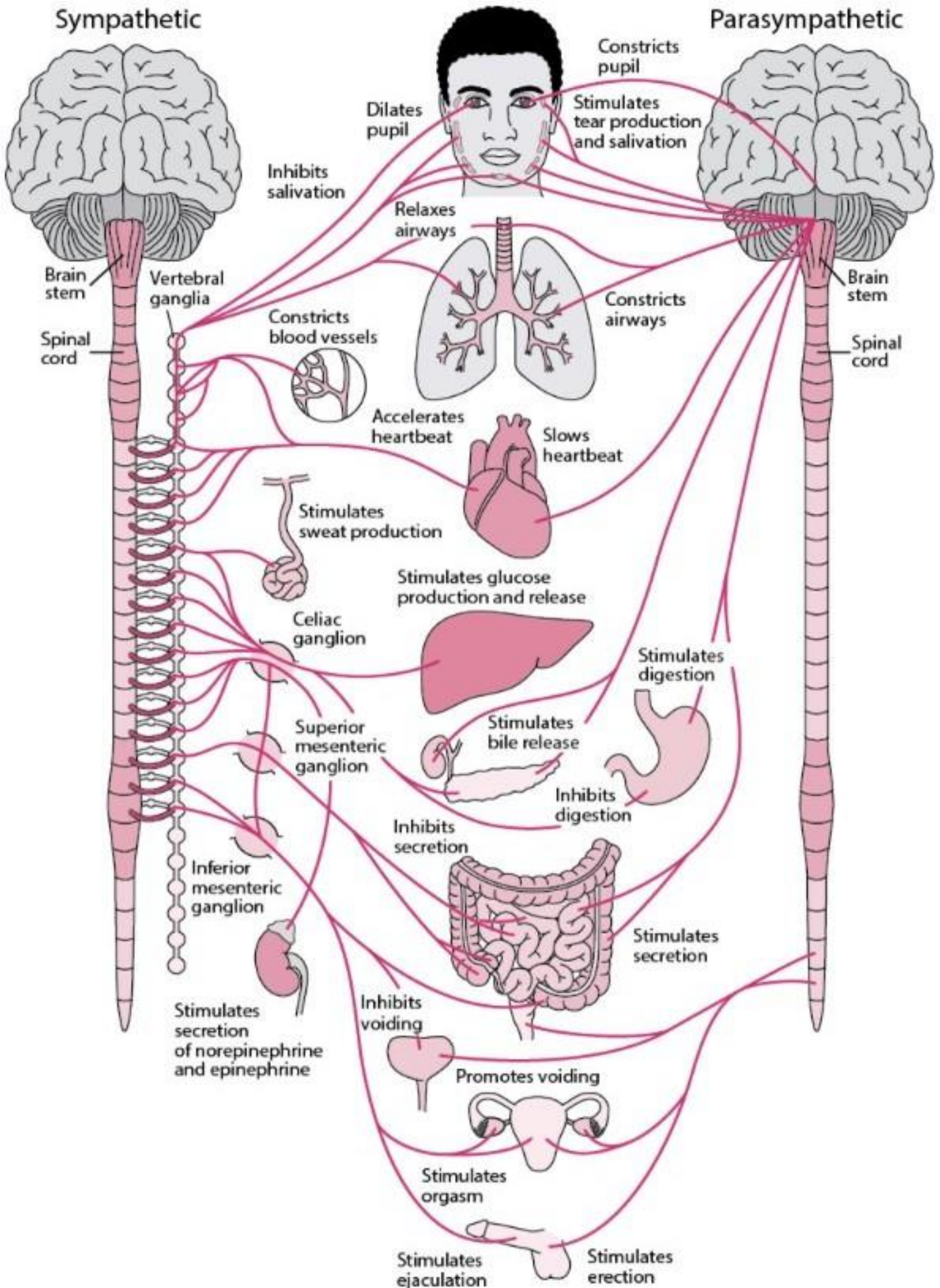
- Two divions: sympathetic and parasympathetic.
- Two-neurons circuits:

1. P**reganglionic** neuron are located in CNS:

➢ Sympathetic: thoracic and lumbar segments.

➢ Parasympathetic: medulla/midbrain and sacral segment of spinal cord.

2. P**ostganglionoic**neuron (outside CNS; in a ganglion).



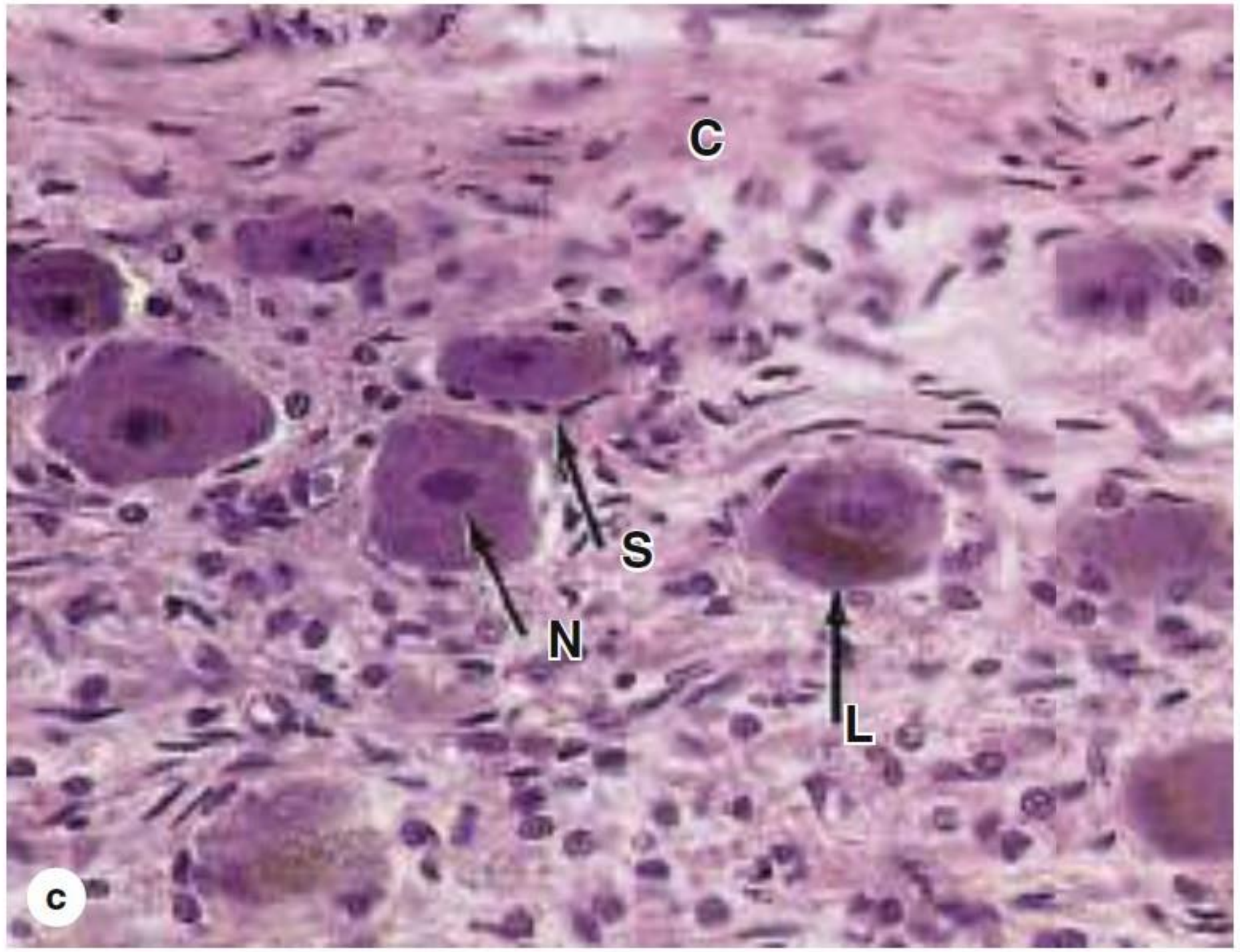
AUTONOMIC NS

Autonomic ganglia

In the sympathetic nervous system, the ganglia are located closer to the spinal cord, whereas in the parasympathetic nervous system, they tend to be farther away closer to the target organs. Some parasympathetic ganglia are even embedded within the walls of the organs themselves; these are known as intramural ganglia

- Small bulbous dilations in autonomic nerves, usually with multipolar neurons.
- Some are located within certain organs, especially in the walls of the digestive tract --- intramural ganglia.
- Autonomic nerves use two-neuron circuits.
- The first neuron of the chain, with the **preganglionic** fiber, is located in the CNS–- synapse with **postganglionic** fibers of the second multipolar neuron in the chain located in a peripheral ganglion system.

H&E stain



NERVE PLASTICITY AND REGENRATION

- Major players in nerve regeneration:
- Neurotrophins: growth factors produced by both neurons and glial cells.
- Stem cells.
- Astrocytes.
- Existing neurons.

➢ Neurons regeneration is limited to formation of new synapse by the existing ones.

➢ Present neurons can not divide to replace lost ones.

➢ Division of astrocytes at the site of injury could interfere with axonal regeneration.

➢ Stem cells in CNS are under heavy investigation in regeneration.

The damage to the neuron is more serious than the damage to just the axon.

Children's brains have a remarkable ability to compensate for damage, even significant damage like tumor removal .If a part of the brain is removed (e.g., the area controlling the right hand), other areas of the brain can rewire themselves to take over that function. In extreme cases, like a hemispherectomy (removal of half the brain), the remaining brain can still adapt and regain a significant degree of functionality. This plasticity is much more pronounced in young children than in older individuals .The brain's ability to reorganize and compensate for damage is particularly strong in young children. This neuroplasticity allows them to recover function even after significant brain surgery, although this ability diminishes with age.

NERVE REGNRATION

- Injured axons have a much greater potential for regeneration and return of function if the cell bodies are intact, damaged, or severed ONS axons can regenerate.
- Distal portions of axons, isolated from their source of new proteins and organelles, degenerate; the surrounding Schwann cells dedifferentiate, shed the myelin sheaths, and proliferate within the surrounding layers of CT
- Cellular debris including shed myelin is removed
- By blood-derived macrophages, which also secrete neurotrophins to promote anabolic events of axon regeneration.

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	7	The Schwann cell membrane fuses around the axon and elongates as it becomes wrapped around the axon while the cell body moves around the axon many times.	The Schwann cell membrane fuses around the axon and elongates as it becomes wrapped around the axon (Schwann cells keep wrapping that's why we see many layers of the double layer of plasma membrane).
	10	It surrounds every single **axon**,it contains reticular fibers fibroblast and capillaries	It surrounds every **nerve**, it contains reticular fibers fibroblast and capillaries
V1 → V2			

رسالة من الفريق العلمي

ٱللَّهُ لَآ إِلَٰهَ إِلَّا هُوَ
ٱلْحَىُّ ٱلْقَيُّومُ ۚ لَا تَأْخُذُهُۥ سِنَةٌ وَلَا نَوْمٌ ۚ لَّهُۥ مَا فِى ٱلسَّمَٰوَٰتِ
وَمَا فِى ٱلْأَرْضِ ۗ مَن ذَا ٱلَّذِى يَشْفَعُ عِندَهُۥٓ إِلَّا بِإِذْنِهِۦ ۚ يَعْلَمُ
مَا بَيْنَ أَيْدِيهِمْ وَمَا خَلْفَهُمْ ۖ وَلَا يُحِيطُونَ بِشَىْءٍ مِّنْ عِلْمِهِۦٓ إِلَّا
بِمَا شَآءَ ۚ وَسِعَ كُرْسِيُّهُ ٱلسَّمَٰوَٰتِ وَٱلْأَرْضَ ۖ وَلَا يَـُٔودُهُۥ حِفْظُهُمَا ۚ
وَهُوَ ٱلْعَلِىُّ ٱلْعَظِيمُ ٢٥٥