Biology

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Nervous system

Neuroglia:

They outnumber neurons by about 10 to 1 in the brain, Like neurons, glia (neuroglia) have many extensions coming off their cell bodies. Unlike neurons, however, glia probably do not send out electrochemical signals. Also unlike neurons, glia are replaced constantly throughout a person's life. Most neurons are unable to survive alone for long; they require the nutritional support provided by the **neuroglial cells.** More than half the volume of the human nervous system is composed of supporting neuroglial cells.

In the brain & the spinal cord there are 4 types of supporting cells:

1. Astrocytes: stellate-shaped cells with fine processes radiating in all directions.

a. Astrocytes provide nutritional support to neurons and help keep most substances other than oxygen, carbon dioxide, glucose, and essential amino acids from entering the brain from the bloodstream.

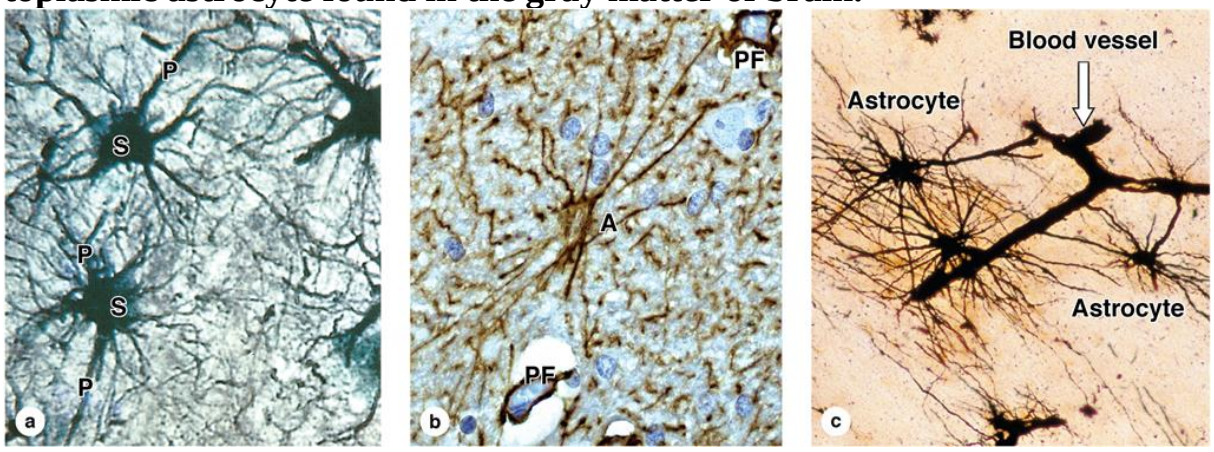
b. Astrocytes give structural support to hold neurons in place and also scavenge dead cells after an injury to the brain.

c. Processes from astrocytes called "end feet" adhere to the blood vessels of the brain and secrete chemical signals that induce (cause) the formation of tight junctions between the endothelial cells which line the blood vessels. As a result, substances from the extracellular fluid cannot move easily into these cells. Most large molecules cannot cross this blood-brain barrier. Small fat-soluble molecules and uncharged particles such as carbon dioxide and oxygen, however, diffuse easily across this barrier. So astrocytes play a role in the formation of blood-brain barrier which prevent diffusion of substances between the blood & the brain.

Astrocytes are of 2 types:

a. fibrous astrocytes found in the white matter of brain.

b. protoplasmic astrocyte found in the gray matter of brain.



2. Oligodendrocytes: round cells with few processes, these cell are located in both gray and white matter of CNS. They produce myelin within the CNS. In producing myelin, oligodendrocytes function similarly to the Schwann cells of the PNS, except that a single oligodendrocyte may wrap several axons with segments of myelin, whereas a single Schwann cell wrap only one axon with myelin.

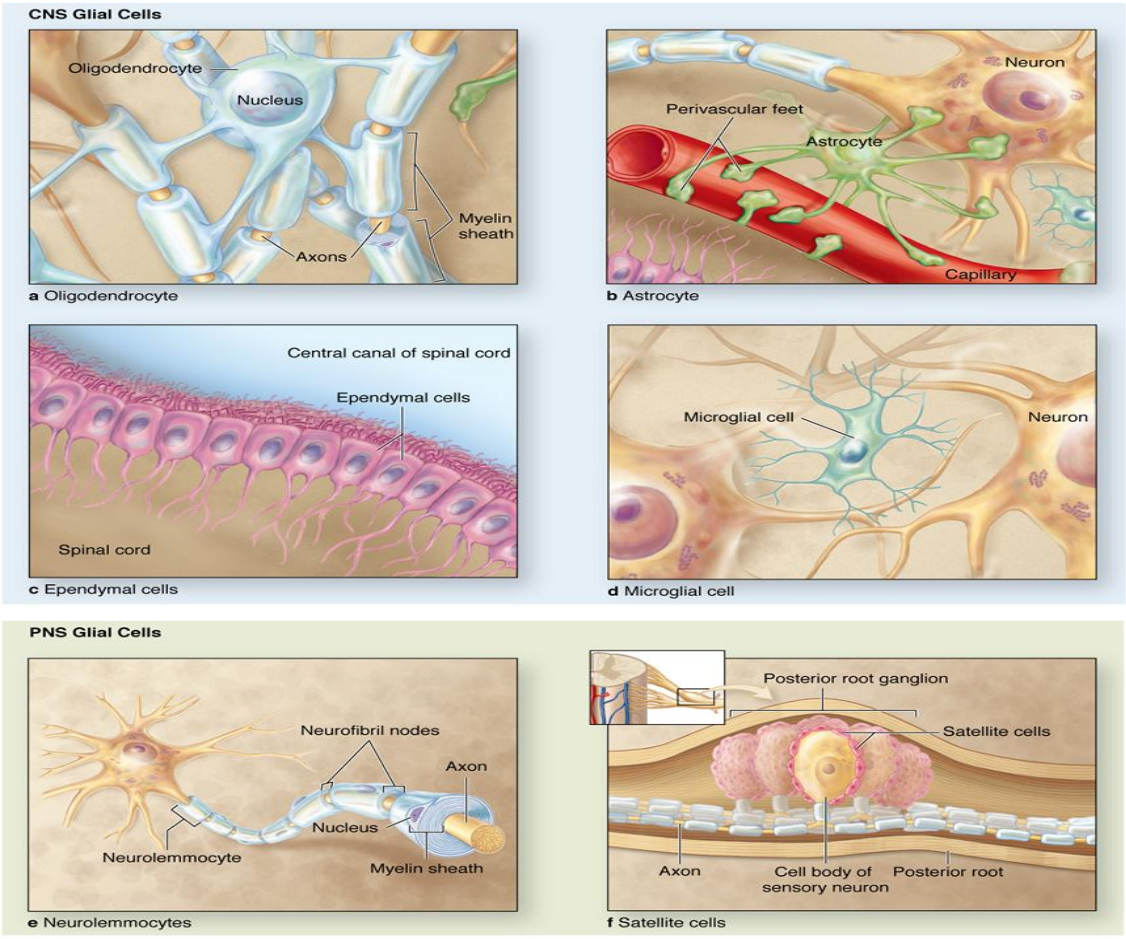
3. Ependymal cells: are epithelial cells lining the cavities (ventricles) of the brain as a sheet of cuboidal cells many of which are ciliated & they are in contact with the CSF. Cerebrospinal fluid acts as a shock-absorbing cushion to protect the brain from blows to the head. In effect, this fluid makes the brain float inside the skull. The cerebrospinal fluid also removes waste products from the brain.

4. Microglia cells: are specialized macrophages forming the immune cells in the CNS.

In PNS:

5. Schwann cell (neurolemmocytes): are found only in PNS, they function to envelop the axon of many neurons with a sheath of fatty material called myelin, which acts as an electrical insulator. Schwann cells produce myelin in the PNS, while oligodendrocytes produce myelin in the CNS. During development, these cells wrap themselves around each axon several times to form a **myelin sheath,** an insulating covering consisting of multiple layers of membrane. Schwann cells also help repair damaged nerves outside the brain and spinal cord.

6. Stellite cells of ganglia: form a covering layer over the large neuronal cell bodies in PNS ganglia and excert trophic or supportive role.



The peripheral nervous system

The main components of the peripheral nervous system are the nerves, ganglia and nerve endings.

Nerves:- are bundles of nerve fibers surrounded by a series of connective tissue sheaths.

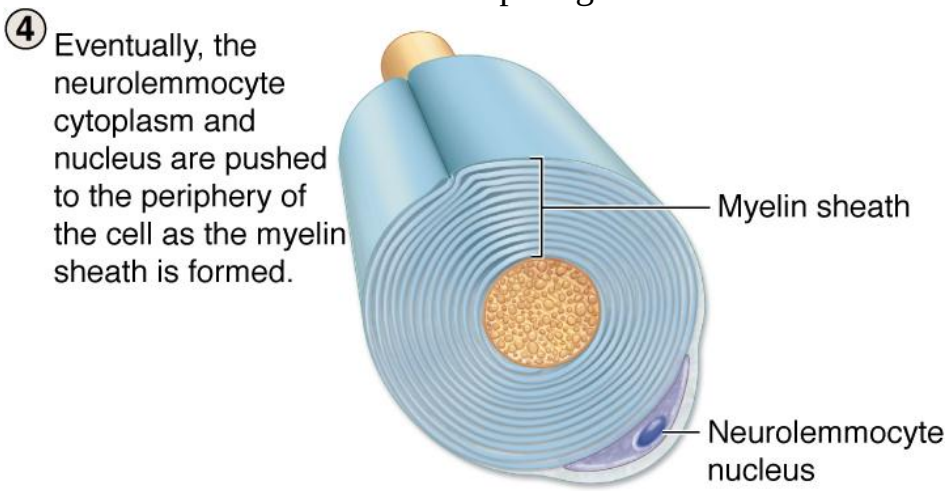
Nerve fibers:- consist of axons enveloped by a special sheath derived from cells of ectodermal origin. Nerve fibers exhibit differences in their enveloping sheaths, related to

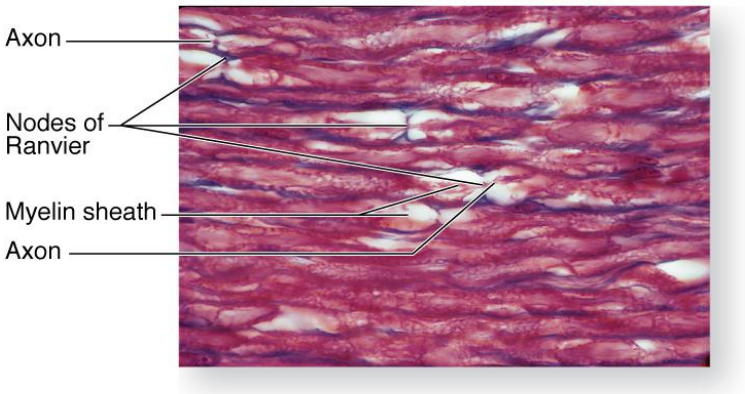
whether the fibers are part of the central or the peripheral nervous system. In peripheral nerve fibers, the sheath cell is the schwann cell, and in central nerve fibers it is the oligodendrocyte.

There are 2 types of nerve fibers:

1. **Myelinated nerve fibers:**

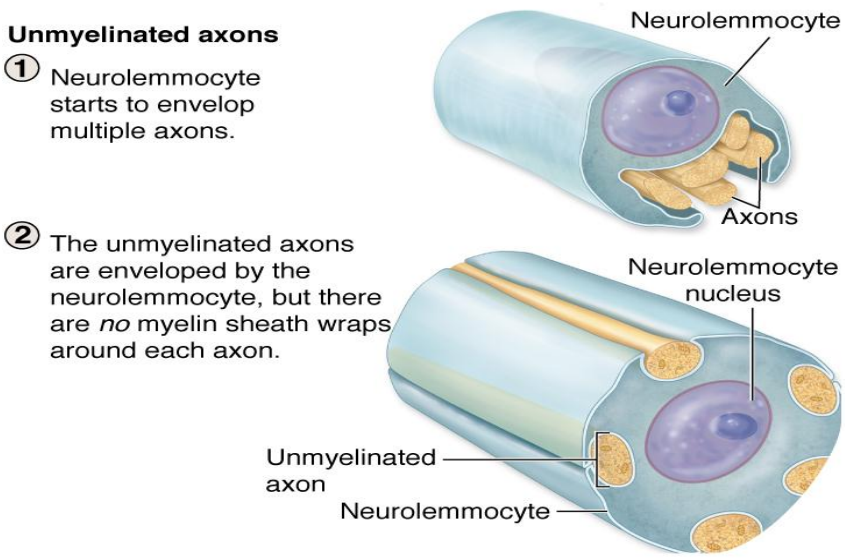
   In myelinated nerve fibers of the PNS, the plasmalemma of the covering Schwann cell winds and wraps around the axon. The layers of membranes of the sheath cell unite and form myelin. In PNS, each axon is surrounded by myelin formed by a series of Schwann cells. The myelin sheath shows gaps along its path called the Nodes of Ranvier represent the spaces between adjacent Schwann cells along the length of the axon. The distance between 2 nodes is called an internode and consists of one Schwann cell. There are no Schwann cells in the CNS, there the myelin sheath is formed by the processes of the oligodendrocytes, which differ from Schwann cells in that different branches of one cell can envelope segments of several axons.





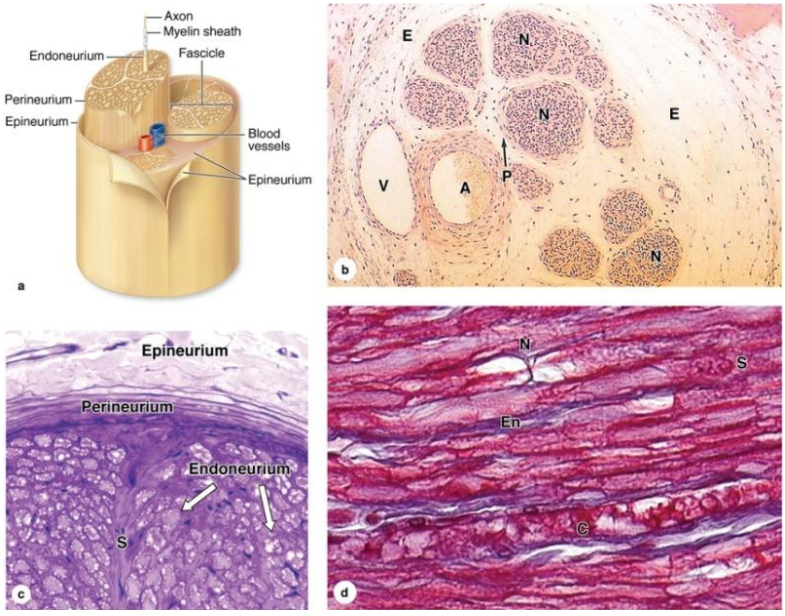
2. **unmyelinated nerve fibers:**

   In both CNS, PNS, not all axons are sheathed in myelin. In the PNS, all unmyelinated axons are enveloped within simple clefts of the Schwann cells. Each Schwann cell can sheath many unmyelinated axons. Unmyelinated nerve fibers do not have nods of Ranvier, because abutting Schwann cells are united to form a continuous sheath.



Peripheral nerves:

Peripheral nerves are bundles of nerve fibers (axons) surrounded by several investments of connective tissue sheaths. Surrounding the whole nerve called epineurium, composed of collagen fibers, fibroblast, blood vessels, the bundles of nerve fibers each one surrounded by a sheath of C.T. called perineurium, within this perineurium are strands of fine C.T. extending between individual nerve fibers. These strands compose the endoneurium. These myelinated bundles (fascicles) appear white because of the presence of myelin. Each bundle of nerve fibers has both sensory and motor components.



Clinical notes:

1. Demyelinating Diseases can affect either PNS or CNS, which are characterized by damage to myelin sheath, resulting in decreased or lost ability to transmit impulses along nerve fibers.
2. Guillian-Barre syndrome (GBS) is a PNS demyelinating disease, affected patient suffers from ascending muscle paralysis & loss of cutaneous sensation

3. Multiple sclerosis (MS) is a disease that attacks myelin in the CNS, in which oligodendrocytes are targeted by immune response. It is characterized by neurological deficits such as vision loss, lack of muscle coordination.
4. Injured fibers in peripheral nerves have a good capacity for regeneration and return to function depending on the type of the nerve injury.

Homework
Q1: A wound to the upper arm produce an injury to the biceps muscle, what do you think about the regeneration and healing process of this muscle?
Q2: mention the source of myelin formation in both central and peripheral nerves.