Histology 2nd stage
Nervous tissue
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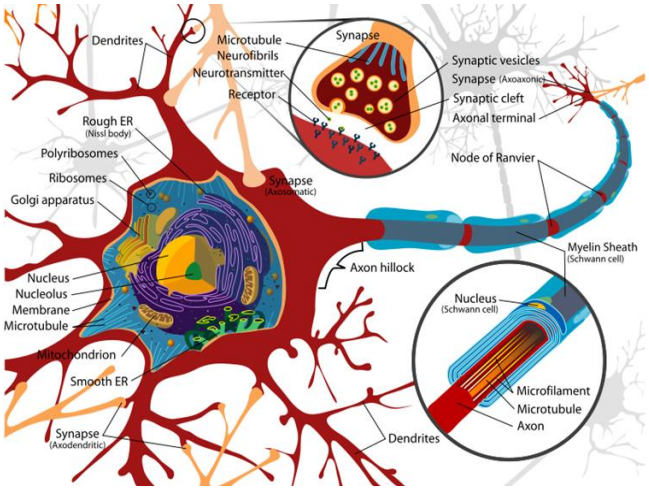
NERVOUS TISSUE

The nervous system consists of all nervous tissue in the body. It is divided anatomically into the central nervous system (CNS) and the peripheral nervous system (PNC). The CNS consists of the brain and the spinal cord. Nervous tissue of the CNS does not contain connective tissue other than that in the meninges and in the walls of large blood vessels. The two major classes of cells that make up the nervous tissue are nerve cells (neurons) and supporting cells (glia).

Neurons: are the functional and structural units of nervous tissue.

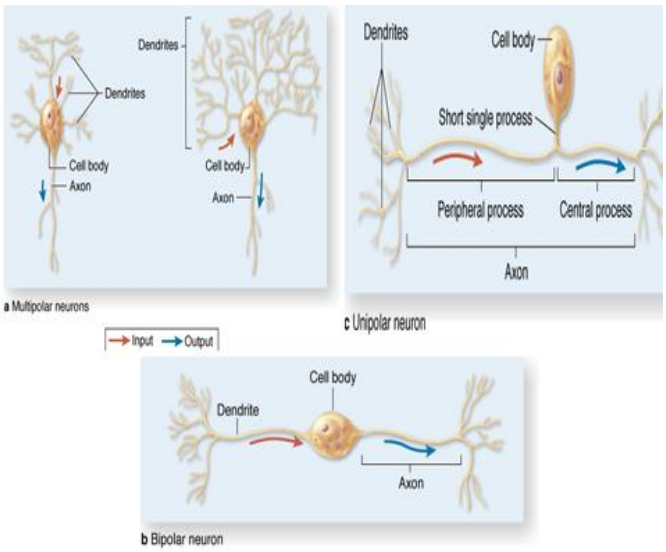


Neurons are terminally differentiated cells that are mitotically inactive, i.e. cannot divide. They have conducting pathways, and act as site of integration and analysis of nerve impulses.
Neurons have large cell body (perikaryo) and nucleus surrounded by the cytoplasm. The cell body could be spherical, ovoid, or angular with variable diameter from 5 -150µm.
Nucleus is large, with dispersed chromatin; and prominent nucleolus.
The cytoplasm contains abundant rER, basophilic granules formed of polyribosomes (Nissl bodies), intermediate neurofilaments, microtubules, diffuse Golgi and multivesicular bodies transport to organelles.

Neuronal Processes:
The processes can be divided into two functionally and morphologically different groups, dendrites and axons. The shape and orientation of the dendritic tree of the neuron determines the amount and type of information that may reach the neuron. The course of its axon determines to which neurons this information may be passed on. The location of the neuron within the CNS determines to which major system the neuron belongs.
- Dendrites: drawn out extensions of the cell body; highly branched, tapering, either ends in specialized sensory receptors (primary sensory neurons) or form synapses with neighboring neurons. They receive stimuli; information input; and generally conveys impulse toward nerve cell body (afferent). They contain most of the cell organelles except Golgi bodies. **Most nerve cells have numerous dendrites, which considerably increase the receptive area of the cell**.

- Axon (commonly: nerve fibers): is a specialized extension of cell; usually single; arises from axon hillock. It is a cylindrical process; terminates on other neurons or effector organs through branches ending in terminal boutons. Axon generally conveys impulse away from nerve cell body (efferent); has no Nissl bodies beyond hillock except in motor end plate with striated muscle; sER prominent; and elongate mitochondria

Types of neurons:
Neurons can be classified according their function into motor, sensory or integrative. Also, they could be classified according to their axon and dendrites with respect to the cell body into:-



- **Multipolar neuron**: most common and most are motor; numerous dendrites project from cell body; which are subdivided into
*Purkinje cells of the cerebellum
*Stellate or polygonal cells of the anterior horn cells of spinal cord.
*Pyramidal cells of the cerebral cortex.
-**Bipolar neuron**: single dendrite arises opposite origin of axon; receptor neurons for sensation and present in olfactory mucosa, retina and inner ear.
-**Unipolar neuron**: spinal nucleus of trigeminal nerve.
-**Pseudo-unipolar** neuron: primary sensory neurons; single dendrite and axon arise from common stem formed by fusion; present in spinal ganglia.

Central Nervous System
The principal structures of the CNS are the cerebrum, cerebellum, and spinal cord.
the cerebrum, cerebellum, and spinal cord show regions of white (**white matter**) and gray (**gray matter**), differences caused by the differential distribution of myelin. The main components of white matter are myelinated axons. White matter does not contain neuronal cell bodies, but microglia are present.
Gray matter contains abundant neuronal cell bodies, dendrites, the initial unmyelinated portions of axons, astrocytes, and microglial cells. This is the region where synapses occur. Gray matter is prevalent at the surface or cortex of the cerebrum and cerebellum, whereas white matter is present

in more central regions. Aggregates of neuronal cell bodies forming islands of gray matter embedded in the white matter are called nuclei.

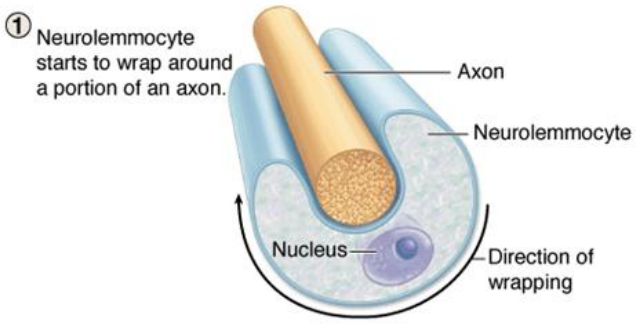
Peripheral Nerves (PN)

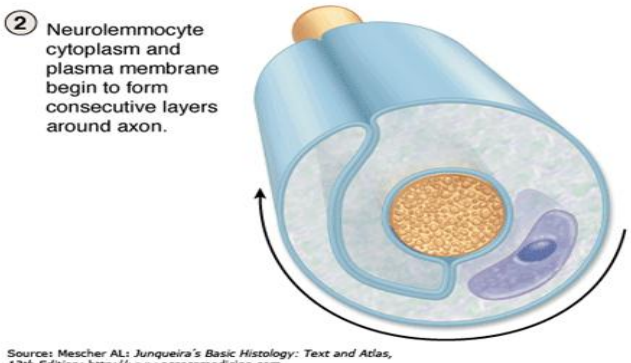
PN could be afferent, sensory fibers enter the spinal cord via the dorsal roots, or efferent، motor fibers leave the spinal cord via the ventral roots. One nerve fiber consists of an axon and its nerve sheath. Each axon in the peripheral nervous system is surrounded by a sheath of Schwann cells. An individual Schwann cell may surround the axon for several hundred micrometers, and it may, in the case of unmyelinated nerve fibers, surround up to 30 separate axons.

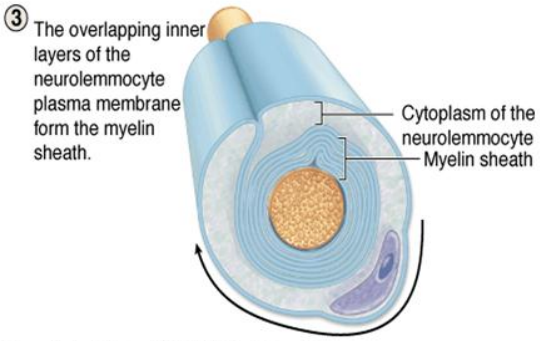
In the case of myelinated nerve fibers, Schwann cells form a sheath around one axon and surround this axon with several double layers (up to hundreds) of cell membrane. The myelin sheath formed by the Schwann cell insulates the axon, improves its ability to conduct and, thus, provides the basis for the fast saltatory transmission of impulses. Each Schwann cell forms a myelin segment, in which the cell nucleus is located approximately in the middle of the segment. The node of Ranvier is the place along the course of the axon where two myelin segments abut.

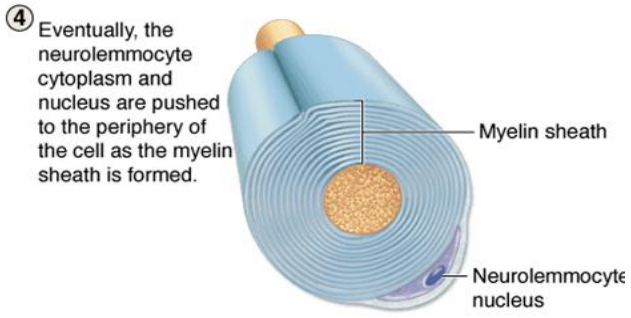
Schwann Cells (Neurolemmocytes)

are found only in the PNS and have trophic interactions with axons and allow for their myelination like the oligodendrocytes of the CNS. One neurolemmocyte forms myelin around a segment of one axon, in contrast to the ability of oligodendrocytes to branch and sheath parts of more than one axon.









Types of peripheral nerve fibers:

·Type A fibers (myelinated) are 4 - 20 µm in diameter and conduct impulses at high velocities (15 - 120 m/ second). Examples: motor fibers, which innervate skeletal muscles، and sensory fibers.

·Type B fibers (myelinated) are 1 - 4 µm in diameter and conduct impulses with a velocity of 3 - 14 m/ second. Example: preganglionic autonomic fibers.

·Type C fibers (unmyelinated) are 0.2 - 1 µm thick and conduct impulses at velocities ranging from 0.2 to 2 m/ second. Examples: autonomic and sensory fibers

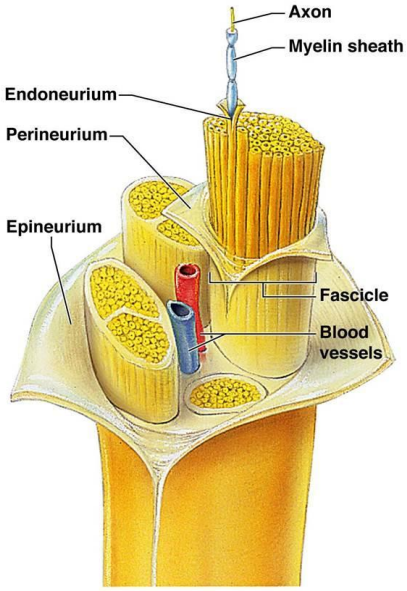
Types of nerve fibers in CNS:

-Naked fibers: They are unmyelinated nerve fibers and also without neurolemmal sheath. Present in gray matter of CNS as well as at the beginning and termination of nerve fibers.

-Myelinated nerve fibers with neurolemmal sheath as in peripheral somatic nerves.

-Myelinated nerve fibers but without neurolemmal sheath as in fibers of the white matter and in optic nerve fibers.

- Unmyelinated nerve fibers with neurolemmal sheath as in sympathetic nerve fibers.



<u>Connective tissue covering nerve fibers</u>: Peripheral nerves contain a considerable amount of connective tissue. The entire nerve is surrounded by a thick layer of dense connective tissue, the epineurium. Nerve fibers are frequently grouped into distinct bundles; the layer of connective tissue surrounding the individual bundles is called perineurium. The perineurium is formed by several layers of flattened cells, which maintain the appropriate microenvironment for the nerve fibers surrounded by them. The space between individual nerve fibers is filled by loose connective tissue, the endoneurium, which contain fibrocytes, macrophages and mast cells. Nerves are richly supplied by intraneural blood vessels, which form numerous anastomoses. Arteries pass into the epineurium, form arteriolar networks in the perineurium and give off capillaries to the endoneurium.

Neuroglia or Gliacells: CNS tissue contains several types of non-neuronal, supporting cells, neuroglia. It is estimated that for every neuron there are at least 10 neuroglia, however, as the neuroglia are much smaller than the neurons they only occupy about 50% of the total volume

of nerve tissue. Neurons cannot exist or develop without neuroglia.
Neuroglia differ from neurons:
 Neuroglia have **no action potentials** and cannot transmit nerve impulses
 Neuroglia **are able to divide** (they are the source of tumors of nervous system)
 Neuroglia **do not form synapses**
 Neuroglia **form the myelin sheathes** of axons.
There are 4 basic types of neuroglia, based on morphological and functional features.
 Astrocytes (or Astroglia(
 Oligodendrocytes (or Oligodendroglia(
 Microglia
 Ependymal cells
The astrocytes and oligodendroglia are large cells and are collectively known as Macroglia.
-Oligodendrocytes (or oligoglia) have fewer and shorter processes. Oligodendrocytes form myelin sheath around axons in the CNS and are the functional homologue of peripheral Schwann cells. Oligodendrocytes may, in contrast to Schwann cells in the periphery, form parts of the myelin sheath around several axons.
-Astrocytes (Astroglia): They are star-shaped cells present only in the CNS. They are the largest of the neuroglia and have many long processes, which often terminate in " perivascular foot processes or pedicels" on blood capillaries, so they contribute to the blood-brain-barrier. Astrocytes provide physical and metabolic support to the neurons of the CNS. They participate in the maintenance of the composition of the extracellular fluid. There are two categories of astrocytes:
* Protoplasmic astrocytes. These are present in the gray matter of the brain and spinal cord. Their processes are relatively thick.
* Fibrous astrocytes. These are present in the white matter of the CNS. Their processes are much thinner than those of the protoplasmic astrocyte.
#Microglia is small cells with complex shapes. Microglia is of mesodermal origin. They are derived from the cell line which also gives rise to monocytes, i.e. macrophage precursors which circulate in the blood stream. In the case of tissue damage, microglia differentiates into phagocytotic cells.
- Ependymal cells: The ependyma is composed of neuroglia that line the internal cavities (ventricles) of the brain and spinal cord (central canal). They are similar in appearance to a stratified columnar epithelium. The ependymal cells are bathed in cerebrospinal fluid (CSF). Modified

ependymal cells of the choroid plexuses of the brain ventricles are the main source of the CSF.

Neuronal Synapses

Neural activity and its control require the expression of many genes. The keys to the understanding of the function of a neuron lies in (1) the shape of the neuron and, in particular، its processes, (2) the chemicals the neuron uses to communicate with other neurons (neurotransmitters) and (3) the ways in which the neuron may react to the neurotransmitters released by other neurons.

- Synapses

The synapse (Gr. *synapsis*, union) is responsible for the transmission of nerve impulses from neuron to another cell and insures that transmission is unidirectional. Synapses are sites of functional contact between neurons or between neurons and other effector cells. The function of the synapse is to convert an electrical signal (impulse) from the **presynaptic** cell into a chemical signal that acts on the **postsynaptic** cell. Most synapses transmit information by releasing **neurotransmitters** during this signaling process. Neurotransmitters are chemicals that bind specific receptor proteins to either open or closed ion channels or initiate second-messenger cascades. A synapse, has the following structure:

- Presynaptic axon terminal (**terminal bouton**) from which neurotransmitter is released,
- Postsynaptic cell membrane with receptors for the transmitter and ion channels or other mechanisms to initiate a new impulse,
- 20–30 nm wide intercellular space called the **synaptic cleft** separating the presynaptic and postsynaptic membranes.

Types of synapses