Cells of the Nervous System Physiology

Cells of the nervous system are grouped into two functional categories: **Neurons and the Neuroglia**

The **neurons** are cells specialized in the transmission and integration of nerve impulses.
There are about 100 billion neurons in the central nervous system.

These neurons are divided into:

1. *Afferent neurons,*
2. *Interneurons and*
3. *Efferent neurons*

Neuroglia play a supporting role in the neurons.
They are approximately 1-5 trillion glial cells in the nervous system.

They are also divided into central nervous system neuroglia and peripheral nervous system Neuroglia.

In the central nervous system we have:

1. Astrocytes,
2. Oligodendrocytes,
3. Microglia and,
4. Ependymal cells.

On the other hand, in the peripheral nervous system we have:

1. Schwann cells/Neurolemmocytes and,
2. Satellite cells.

What Is The Structure Of the Neuron

The neuron is the functional unit or the basic building blocks of the nervous system.
Its size and Structure varies from site to site.

The neuron has 3 basic parts, and there are:

1. **Cell body:**
   It contains nuclei and other organelles.
2. **Dendrites:**
   Dendrites are branched protoplasmic extensions of a nerve cell that propagate the electrochemical stimulation received from other neural cells to the cell body, or soma, of the neuron from which the dendrites project. Therefore dendrites are the receiving end of the neuron.

3. **Axon:**
   This is a single process from the cell body of a neuron.
   It divides into terminal branches ending into synaptic knobs.

Dendrites

As we have mentioned above, the dendrites are highly branched processes from the cell body that take impulses to the soma. The presence of numerous dendrites enables many neurons to have an effect on one cell.

The Cell Body

The cell body is also known as soma or perikaryon,
It has a nucleus and cytoplasm, along with the organelles normally found in any cell.

Special features present in a cell body are:

- *The prominent rough endoplasmic reticulum is known as Nissl bodies.*
- *Most neurons do not have a centriole and lose the ability to multiply.*

All necessary proteins are synthesized in the endoplasmic reticulum and packaged Golgi apparatus of the cell body and then transported along the axon to the synaptic knobs.

Clusters of cell bodies of neurons in the central nervous system are called **nuclei** (exception, basal ganglia).
These clusters when present in the peripheral nervous system are known as **ganglia.**

Axon

The axon is a long process that leads off the cell body. It helps conduct impulses away from the cell body.
It may have many branches, known as collaterals. These collaterals help the cell communicate with more than one neuron.

Antegrade and retrograde transport may take place along microtubules in the axon. If the axon is cut, the part distal to the cut degenerates by the process known as Wallerian degeneration.

Synaptic knob

A synaptic knob or synaptic vesicle is one of many terminal endpoints on a neuron's axon. The synaptic vesicles recycle in the membrane, but some used vesicles are carried back to the cell body and deposited in lysosomes.

Some of the material taken up at the ending by endocytosis, including nerve growth factor and various viruses, is also transported back to the cell body.

Anatomic Classification Of Neurons

Anatomically the neurons are divided into three: ***Unipolar, bipolar and multipolar neurons***

Unipolar Neurons

A unipolar neuron is a type of neuron in which only one protoplasmic process (neurite) extends from the side of a cell body. The process then divides into two processes: *the axon and the dendrite*.

Sensory neurons are of this type.

Bipolar Neurons

These are types of neurons that have two processes extending from either end of the cell body, i.e dendrite, and axon. This type of neuron is rare and is found in the retina of the eye.

Multipolar Neurons

This is the most common neuron,
The cell body has several dendrites and one axon.
All the neurons Motor to the skeletal muscles are of this type.

Functional Classification of Neurons.

Neurons can be classified according to the functions they perform.

Sensory/afferent neurons

These type of neurons take impulses to the central nervous system.
They are further named according to the type of information they sense such as *Mechanoreceptors, chemoreceptors, nociceptors, thermoreceptors,*

They can also be named according to site/position, for example, *Exteroceptors, Interoceptors, and proprioceptors*

Motor/efferent neurons.

Motor neurons take impulses away from the processing center which is the central nervous system.

Interneurons, or association neurons.

Interneurons or association neurons are situated between a sensory and motor neuron or between any two neurons.

Other Classification of Neurons

Neurons are also classified on the basis of myelination. According to the presence or absence of myelin sheaths as myelinated *or Non-myelinated neurons)*.

Let us now move into another type of the cells of the nervous system.

Neuroglia

In our introduction to the cells of the nervous system, we mentioned that the neuroglia are the supporting cells. They are 10 – 50 times more abundant than neurons.

We mentioned that there are four types of glial cells in the central nervous system:

- Ependymal cells,
- Astrocytes,
- Microglia, and
- Oligodendrocytes

and two types in the PNS:

- Schwann cells, or Neurolemmocytes, and
- Satellite cells, or ganglionic gliocytes.

The ependymal cells

These groups of cells of the nervous system are located in the central nervous system (CNS) lining the cavities in the brain and spinal cord.

They are responsible for producing, circulating, and monitoring the cerebrospinal fluid (CSF). CSF is the fluid inside and around the CNS that cushions and protects the brain.

The astrocytes,

As their name suggests, astrocytes are star-shaped cells of the nervous system.
Astrocytes are the most abundant of the neuroglial cells.
They are present between the blood capillaries and the brain & spinal cord, They send processes to blood vessels, where they induce capillaries to form the tight junctions that form the blood-brain barrier.

> The blood-brain barrier is a dynamic conduit for transport between blood and brain of those nutrients, peptides, proteins, or immune cells that have access to certain transport systems localized within the blood-brain barrier membranes. Designed to protect the brain from harmful agents, it is also a barrier to CNS therapeutics.

They are of 2 types astrocytes:

Fibrous astrocytes, which contain many intermediate filaments and are found primarily in white matter.
Protoplasmic astrocytes are found in gray matter and have granular cytoplasm.

Functions of astrocytes

1. They produce substances that are trophic to neurons.
2. Help maintain the appropriate concentration of ions and neurotransmitters by taking up potassium ions and the neurotransmitters glutamate and ?-aminobutyrate (GABA).
3. Preventing sudden changes in the environment around the CNS.
4. Monitoring the substances that enter and leave the brain.

Microglia

Microglia are small cells similar to the monocytes and macrophages in the blood.
They probably come from the bone marrow and enter the nervous system from the circulating blood vessels. The function of these microglia is to engulf dead cells and cellular remnants in the CNS.

Oligodendrocytes

Oligodendrocytes are neuroglia with long, slender processes that come in contact with cell bodies and axons in the CNS.
The processes form thin sheaths in the region where they contact an axon.