



## CNS BLOCK

## LECTURE 1: NORMAL CELLS OF CNS

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### Objectives:

At the end of this lecture, you should describe the microscopic structure and the function of:

#### 1- Neurons:

- Cell body (perikaryon).
- Processes: An axon and dendrites.

#### 2- Neuroglia:

- Astrocytes.
- Oligodendrocytes.
- Microglia.
- Ependymal cells.

**Black = Slides**

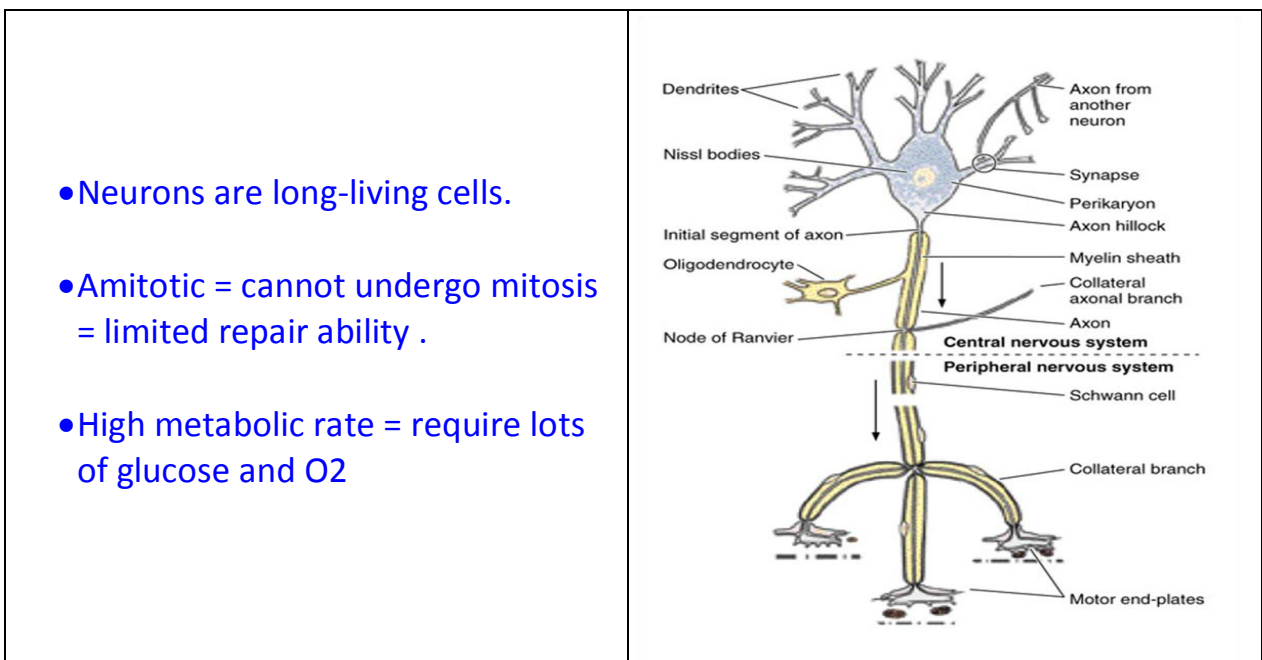
**Red = Important**

**Green = Additional information**

**Blue = Explanation**

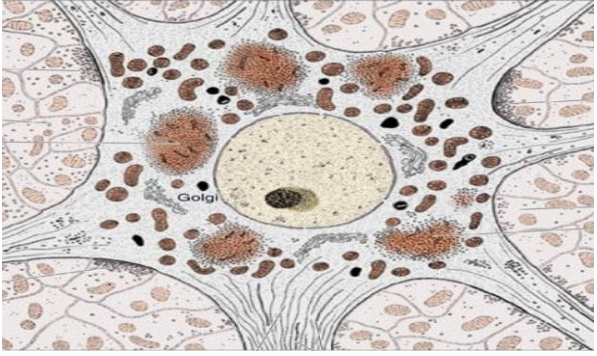
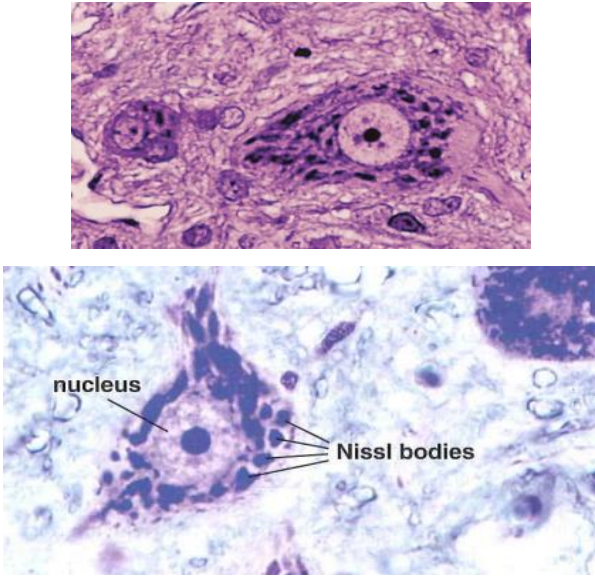
## Normal Cells of CNS

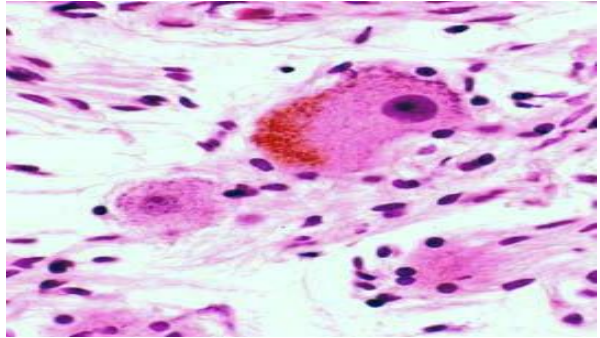
- ❖ As we know, there are 4 types of tissues in our body:
  1. Epithelial Tissue
  2. Connective Tissue
  3. Muscular Tissue
  4. Nervous Tissue
  
- ❖ The nervous tissue is made up of nerve cells called Neurons.
- ❖ Neuron is the structural & functional unit of the nervous tissue.
  
- ❖ Characteristics of neuron (Nerve cell):



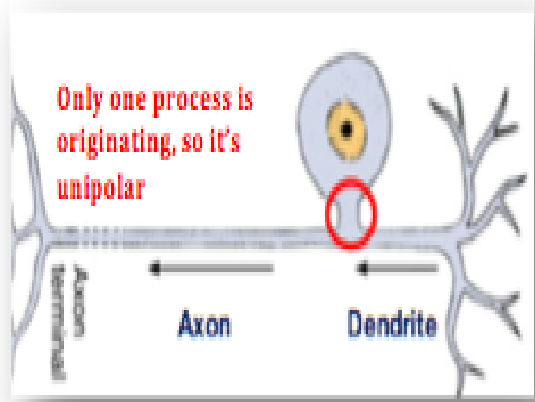
- The nervous system has specific function in our body, so the cells in nervous tissue are modified and they differ in structure from other body cells.
- I.e. processes of neurons are characteristic to nerve cells; there are no processes in other body cells.

❖ Components of neurons:

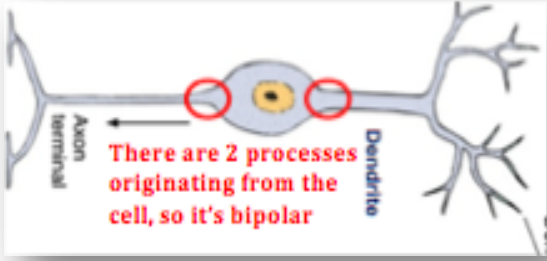
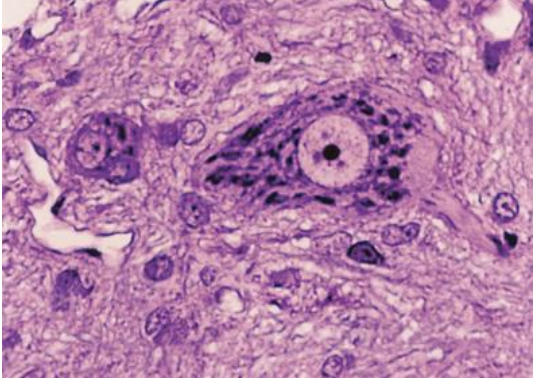
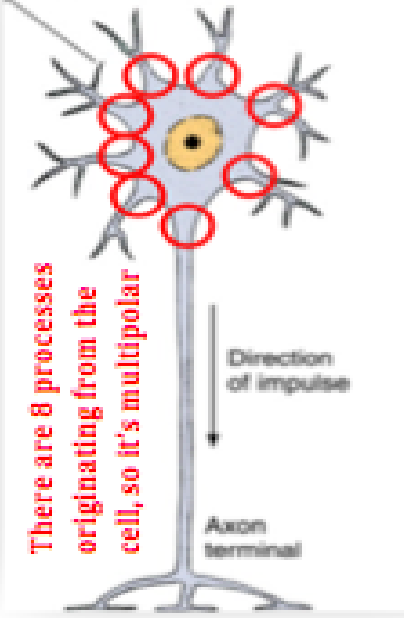
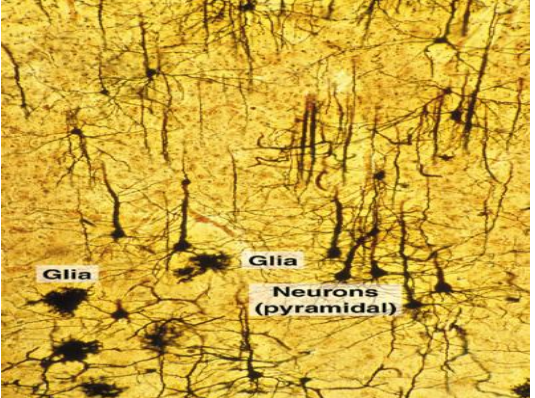
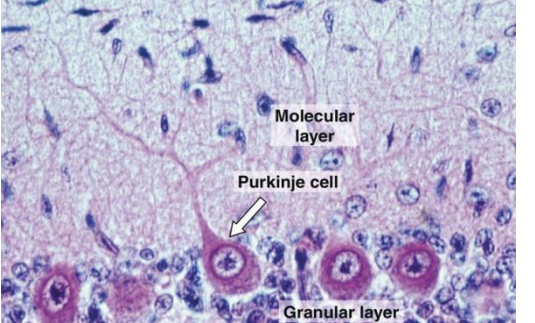
Components		Description	
<p>A) Cell Body, also called Perikaryon or soma (any cell containing a nucleus)</p>	Nucleus	<p>Single, usually central, rounded and vesicular (composed of small sac-like bodies) with prominent nucleolus since the neurons are very active all the chromatin is the pale euchromatin (active form) there is no dark heterochromatin (inactive) to hide the nucleolus</p>	
	Cytoplasm	<p><b>1- Nissl bodies:</b> are basophilic patches (appears blue with H&amp;E stain) of rER and free ribosomes in the cell body and bases of wide dendrites but not in axons, axon hillock or dendrite terminals.            – Ribosomes &amp; rER synthesize most of the cell's peptides and proteins (neurotransmitters).</p>	
	<p><b>2- Neurofilaments:</b> are intermediate filaments which are bundled together to form neurofibrils. They're found in the cell body, axon and dendrites.            – They're narrow strands of protein for support and transport.</p>		
	<p><b>3- Microtubules:</b> are found in the cell body, axon and dendrites.            – Function: moving the secretory vesicles down the axon to the synaptic knob.</p>		
	<p><b>4- Golgi apparatus:</b> surrounds the nucleus all around (they modify neurotransmitters).</p>		
	<p><b>5- Mitochondria:</b> numerous. They make ATP which supplies energy for cellular activity.</p>		
	<p><b>6- Centriole:</b> most adult neurons have only one rudimentary centriole.            – They cannot divide.</p>		
<p><b>7- Some fat and glycogen granules.</b></p>			

		<p><b>8- Pigments:</b></p> <p><b>A) Lipofuscin</b> (in old age),          – It's wear-and-tear pigment, yellowish-brown in color.</p>	
		<p><b>B) Melanin</b> (in neurons of <u>substantia nigra</u> of the midbrain).</p>	
B) Neuron Processes	Dendrites	<ul style="list-style-type: none"> <li>– It can be one or more.</li> <li>- Branched elaborations of the cell body – carry electrical signals <i>towards cell body</i>.</li> <li>- They have similar organelles to those in the cell body.</li> </ul>	
	Axon	<ul style="list-style-type: none"> <li>– Only one.</li> <li>- Carry nerve impulses <i>away from the cell body</i>.</li> <li>▪ Axon hillock – cone-shaped region of cell body that axon arises from.</li> <li>▪ Axolemma – plasma membrane of axon.</li> <li>▪ Axoplasm – cytoplasm of axon – does not contain Nissl bodies.</li> <li>▪ Telodendria – end branches of an axon</li> <li>▪ Synaptic knobs – bulbous distal ending of the telodendria.</li> </ul>	

❖ Classification of neurons: **A) Structural**

Based on number of processes	Shape \ Description	Example	L\M
Pseudounipolar \ unipolar	<ul style="list-style-type: none"> <li>- Rounded neuron.</li> <li>- Has one process only, that divides into two branches; one acts as a dendrite and the other as an axon.</li> </ul>	<p><b>1-</b> Mesencephalic nucleus of trigeminal nerve.</p> <p>* <b>Mesencephalon = midbrain</b></p> <p><b>2-</b> Dorsal root (spinal) ganglion.</p>	

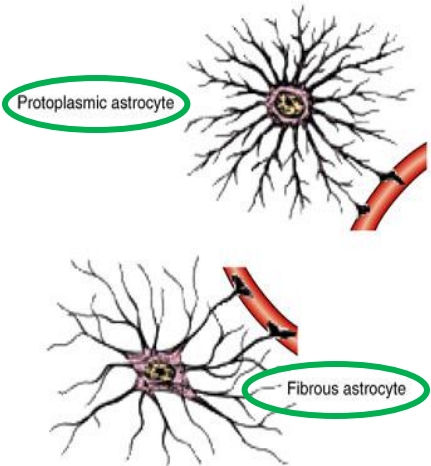
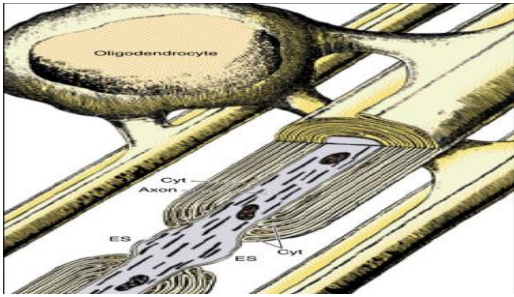


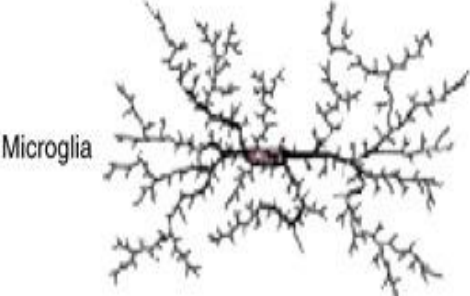
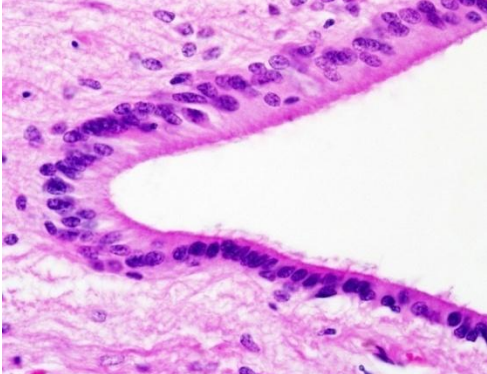
<p>Bipolar</p>	<ul style="list-style-type: none"> <li>- Spindle-shaped neuron.</li> <li>- Has two processes (one arising from each pole of the cell body), one of them is the dendrite and the other is the axon.</li> </ul>	<p>1- Retina. 2- Olfactory epithelium.</p>	
<p>Multipolar</p>	<ul style="list-style-type: none"> <li>- Has one axon and multiple dendrites.</li> <li>- It divides into 3 types.</li> </ul>	<p><b>1- Stellate neuron:</b> (star shaped) neuron – Most common type. – Distributed in most areas of CNS. – E.g. anterior horn cells of the spinal cord.</p>	
		<p><b>2- Pyramidal neurons:</b> – Distributed in motor area 4 of the <b>cerebral</b> cortex.</p>	
		<p><b>3- Pyriform neurons:</b> – Pear shaped – E.g. Purkinje cells of <b>cerebellar</b> cortex.</p>	

### B) Functional:

- Sensory neurons – afferent, usually unipolar or maybe bipolar
- Motor neurons – efferent, usually are multipolar
- Association – interneurons, connect sensory and motor neurons in CNS, usually multipolar.

❖ **Neuroglia:** Are group of cells that act as the supportive tissue of CNS.

The Cell \ Shape	Characteristic Features	Site	Function
<p><b>1- Astrocytes</b></p> <p>- They are <u>star-shaped</u> cells with numerous long processes.</p>  <p>The diagram shows two types of astrocytes. The top one is a protoplasmic astrocyte, characterized by a central cell body with numerous fine, radiating processes. The bottom one is a fibrous astrocyte, which has a more elongated cell body and fewer, but longer, processes. Labels 'Protoplasmic astrocyte' and 'Fibrous astrocyte' are circled in green.</p>	<ul style="list-style-type: none"> <li>- They are the commonest type of neuroglia cells.</li> <li>- They are found in both the grey and white matter.</li> <li>- Has 2 types.</li> </ul>	<p><b>a) Protoplasmic astrocytes:</b></p> <ul style="list-style-type: none"> <li>- Are found in the <b>grey matter</b> of CNS.</li> <li>- Their processes branch extensively.</li> </ul> <p><b>b) Fibrous astrocytes:</b></p> <ul style="list-style-type: none"> <li>- Are found in <b>white matter</b> of CNS.</li> <li>- Their processes have fewer branches but longer.</li> </ul>	<ol style="list-style-type: none"> <li>1. <u>Repair of injury of CNS tissue (gliosis).</u> * Gliosis is like fibrosis but gliosis occurs in CNS.</li> <li>2. <u>Supportive and nutritive functions to the neurons (to prevent toxic materials from entering neurons).</u></li> <li>3. <u>Participate in the formation of blood-brain barrier.</u></li> </ol> <p>- Also, the basal lamina of blood vessel wall is thick to protect neurons from toxic materials.</p>
<p><b>2- Oligodendrocytes</b></p>  <p>The diagram shows an oligodendrocyte cell body with several short, thick processes extending outwards. These processes are shown myelinating multiple axons. Labels include 'Oligodendrocyte', 'Cyt', 'Axon', and 'ES'.</p>	<ul style="list-style-type: none"> <li>- Are branching cells with few, short processes.</li> </ul>	<p>They are distributed in <b>the grey and white matter</b> of CNS.</p>	<ol style="list-style-type: none"> <li>1. <u>Formation of myelin sheath in the CNS.</u></li> <li>2. <u>Insulation of nerve fibers.</u></li> </ol>

<p><b>3- Microglia:</b> - Are spindle-shaped cells.</p>  <p>Microglia</p>	<ul style="list-style-type: none"> <li>- Are rich in lysosomes.</li> <li>- They have branching processes raise from each pole of the cell.</li> </ul>	<ul style="list-style-type: none"> <li>- Are distributed in <b>the grey and white matter</b> of CNS.</li> </ul>	<p>Phagocytosis (it resembles the function of macrophages in connective tissue because both of them have the same cellular origin; monocytes).</p>
<p><b>4- Ependymal cells</b></p> 	<ul style="list-style-type: none"> <li>- Are simple columnar epithelial cells (partially ciliated).</li> <li>- They are the only cells that do not contain processes.</li> </ul>	<ul style="list-style-type: none"> <li>- Lining the brain ventricles.</li> <li>- The central canal of spinal cord.</li> </ul>	

❖ **Nerve Fibers (nerves) in CNS:**

There are 2 types in CNS:

- 1- **Unmyelinated without** neurilemmal sheath (in grey matter).
- 2- **Myelinated without** neurilemmal sheath (in white matter).

**Need to know:**

- Neurolemma: Schwann cells covering the nerve fibers in peripheral nervous system (PNS).
- **In CNS:** nerve fibers are myelinated by **processes of oligodendrocytes**.
- **In PNS:** nerve fibers are myelinated by **many Schwann cells**.