



NERVOUS TISSUE

Q:What is the CNS ?what is the feature that they have that differentiates them from the PNS ?

A:Central nervous system which is the brain and the spinal cord and they contain cell bodies .In the PNS cell bodies are only found in the ganglia.

- **Neural tissue = highly cellular (<20% is extracellular space)**
- **Cells : neurons + supporting cells (both originate from the ectoderm)**
- CNS doesn't have CT inside it's structure , But CT covers the brain and spinal cord as meninges
- CT is also found around large Bvs

Neurons : (around 100 million)

1. Conduct nerve impulses
2. Long lived cells (cannot be replaced)
3. **High metabolic rate** (require oxygen , glucose and die within minutes without o₂)
4. **Consists of 3 zones:**
 - **Input (receptive) region – dendrites**
 - **Conducting – the axon (may be from 1 mm to 1 m long)**
 - **Secretory – axon terminals**

Neuron cell body : (soma – Perikaryon)

Large spherical nucleus – prominent nucleolus

5-40 um

Range of organelles (no centrioles)- that's why no cell division takes place

Large amount of rER + Golgi known as **Nissil bodies** found distributed throughout the cytoplasm **except in the axon hillock and the axon .**

Axon hillock : the area where the body meets the axon

Q:Why are neurons rich in rER ?

A:Because they secrete neurotransmitters (which are proteins)

Q:Why don't we have rER and Golgi in the axon hillock ?

A:Because no secretion takes place in this region , only transmission

DENDRITES	CELL BODY (PERIKARYON)	AXON HILLOCK + AXON
Nissil's body	Golgi + Nissil's body	Neurotubules + neurofilaments + mitochondria

To distinguish the dendrites from axon: look for Nissil's body



The cytoplasm :

Has abundant cytoskeleton (neurofilaments and neurotubules that maintain cell shape and are involved in transport) -Some soma have inclusion bodies (**lipofuscin and aging pigment**)

Q:Why do we have prominent inclusions in neurons ?

A:Because they are residual bodies that stay for a long time in the neuron .

Q:Why is the lipofuscin called aging pigment ?

A:Because the neuron lives for a long time

Q:What is the difference between neurons in the CNS and PNS ?

A:both have cell bodies and axons but the axons in the CNS are called tracts and the axons in the PNS are called nerve bundles .

neuron process :

- 1- Axon (patterns are variables) – one and long and ends with the axon terminal
- 2- Dendrites (short + many + branched)

DENDRITES :

- Extensions of the soma into bristling , Branching (tree like structure) hat increases the surface area in the receptive input zone
- Dendritic cytoplasm is similar to soma cytoplasm but it lacks **Golgi**
- **Can contact other axons or dendrites**
- **Conduct electrical signals towards the soma**

AXONS : (conducting region)

- Cannot make proteins
- All of the material has to be transported along microtubules (kinesin + ATPase) from soma
- The plasma membrane of the axon (**axolemma**) is important for the generation of action potential
- Some are sheathed by myelin
- Some viruses (polio , herpes , bacteria EX: tetanus) use axonal transport to enter the body
- Generate and transmit impulses away from soma
- Each ends with in a swelling (buttons , synaptic knobs , axon terminals) – terminals are the secretory zone of the neuron
- Secrete neurotransmitters that are stores in vesicles in the buttons (axon terminals)

MYELIN : many concentric layers of Schwann cells in PNS – oligodendrocytes in CNS

- Covers the axolemma – a **whitish sheath that acts as an insulator**
- Dendrites don't have myelin



- The thicker the myelin sheath , the better the insulation and the quicker the conduction (conduction speed also depends on fiber diameter)
- The layers form a lipid rich sheath called the **neurilemma**.
- **Gaps in the sheath = nodes of Ranvier**

Q:Do all axons have myelin sheaths ?

A:Yes , the difference is the thickness . (unmyelinated sheaths have only one layer of myelin sheath , but myelinated axons have many layers of myelin sheaths .

Q: why can you see myelin sheath in TEM ?

A: because osmium tetroxide stain preserves the lipids

Q:Why do nodes of ranvier occur ? and what is their importance ?

A:because the schwaan cells are shorter that the length of the axon (which can be meter long) , they allow the AP to jump along the axon (saltatory or jumping conduction) – faster conduction

Saltatory conduction :

- Allowed mammalian nerves to be smaller and yet achieve the same conduction velocity
- It is very energy efficient (**since only a small part of the axon is involved in the ion exchange , so much fewer ions need to be pumped back after the AP has passed**)

white matter in CNS -> myelinated axons + glial cells

grey matter in CNS -> cell body + unmyelinated axons + glial cells

SYNAPSES : sites where **impulses are transmitted in one direction** between neurons or to another effector cells (muscle fibers or glands)

Synapses may exist between :

- Axon and dendrites
- Axon and body
- Axon and axon

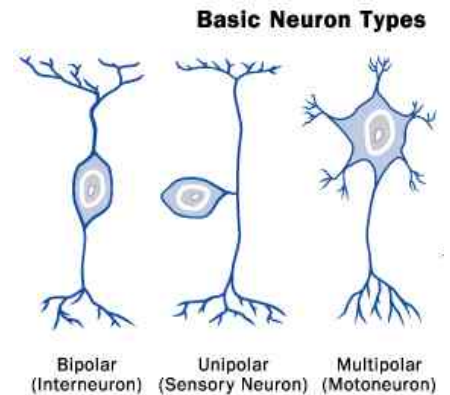
Types of synapses :

- 1- Chemical : **most synapses are chemical synapses** that transmit impulses by releasing neurotransmitters .
- 2- Electrical : conduct the impulses directly by **gap junctions** (EX : cardiac muscles)



NEURONS CLASSIFICATION (BY SHAPE) :

Multipolar (most common)	Bipolar	Unipolar (pseudo unipolar)
Single axon and many dendrites	Single axon and a single dendrite	Dendrite functions as axon
EX :Interneurons , motor neurons , CNS neurons	Sensory (bipolar neurons of the retina , olfactory , cells of the nose)	Dorsal root ganglia Sensory – afferent pathways to brain (ganglia neurons)

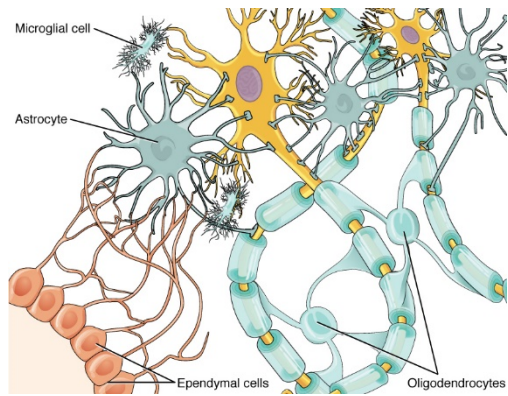


SUPPORTING CELLS IN THE CNS : (neuroglia , glial cells)

50% of mass in the brain ratio is 9:1 (glia : neuron)

TYPES OF SUPPORTING CELLS

	ASTROCYTES (most common)	MICROGLIA	EPENDYMAL CELLS	OLIGODENDROCYTES
SHAPE	Star shaped	Small thorny processes	Low columnar	Fewer processes than astrocytes
FUNCTION	branches support and bind capillaries and pia mater . if the CNS is damaged astrocytes can proliferate to form scar tissue . they communicate by GAP JUNCTIONS . (participate in BBB)	Macrophage action (phagocytosis of damaged cells), involve with inflammation & repair of CNS . Secrete immunoregulatory cytokines + dispose unwanted debris ORIGIN : BONE MARROW	Contain cilia to facilitate the movement of CSF .	Insulation for nerves Produce myelin sheath around axons of CNS .
LOCATION			line central cavities of brain and central canal of spinal cord	



Multiple Sclerosis (MS) is an autoimmune disease where the myelin sheath is worn out , since the immune system of the body attacks the myelin sheath .

Cortisone is given to lower their immune response . no cure is available .



THE CENTRAL NERVOUS SYSTEM :

The brain + spinal cord form the CNS , they show regions of white and grey matter (due to differential disruption of myelin sheath)

Gray matter	White matter
Neuronal cell bodies + dendrites + unmyelinated axons + glial cells	Myelinated axons + glial cells

- The cerebrum & cerebellum surface is made of gray matter (cortex)
- White matter is present in the central regions
- Aggregates of neuronal cell bodies form islands of grey matter embedded in white matter called nuclei .

C.S of spinal cord : central H- shaped region pf gray matter (neural cell bodies + dendrites +glial cells + unmyelinated axons) that is surrounded by white matter (myelinated axons = glial cells)

BLOOD BRAIN BARRIER : BBB

- 1- Protects the neurons and glial cells in the brain from harmful substances .
- 2- endothelial cells that form capillaries and venules ,form impermeable tight junctions + astrocytes surround endothelial cells and induce them to form those junctions
- 3- The BBB is important for maintaining the environment of neurons in the brain
 - Unlike BVs in other parts of the body , the blood – brain barrier keeps many substances (toxins) away from neurons and glial cells

BBB= protective barrier that provides a very stable microenvironment for CNS cells

Comprised of (formed by) :

- 1- The continuous endothelium in capillaries (doesn't contain fenestrations- a tiny space between epithelial cells lining the capillaries)
- 2- Thick basal lamina
- 3- The feet or astrocyte processes that cling to capillaries (joined by tight junctions)

The astrocytes are attached to capillaries by tight junctions , the endothelial cells are attached to each other by tight junctions

BBB is selective :

- nutrients move by facilitated diffusion
- wastes can't enter
- Glucose + oxygen + fats + co2 + **fat soluble substances (anesthetics + alcohol)** may move freely

There are regional variations (sites where hormones need to move EX : pituitary hormones)



PERIPHERAL NERVOUS SYSTEM :

Main components : nerves , ganglia , nerve endings

Nerve : part of the PNS that is composed of bundles of nerve fibers surrounded by layers of CT .

- External surface of the nerve is surrounded by dense layer of CT called EPINEURIM
- Strands of CT fibers divide the nerve fibers into bundles each is surrounded by PERINEURIUM
- Each nerve fiber within the bundle is surrounded by a layer of loose CT called ENDONERIUUM

-In **myelinated nerves** fibers we have only one axon surrounded by layers of myelin sheath – one schwaan cells surrounds one axon

-In **unmyelinated nerve** fibers we have many axons surrounded by one layer of myelin sheath – one schwaan cell surrounds many axons why can't you see nodes of Ranvier in unmyelinated fibers ? because we have many axons surrounded by one schwaan cell

Both myelinated and unmyelinated fibers are surrounded by basement membrane

Mesaxone : is the first areas where the schwaan cell starts to go around the nerve fiber

GANGLIA : found throughout the whole body !

Ovoid structures that contain aggregations of neuron cell bodies + glial cells + CT

Two types :

Sensory ganglia	Autonomic ganglia
Dorsal part of spinal cord	Within some organs (walls of the digestive system) – b/w 2 layers of muscle or in CT – causes involuntary actions (like bowl movements)
Large neural body (perikaryon) Nucleus circle and large – very prominent nucleolus Nissil bodies Surrounded by satellite glial cells and CT to support the cells	Few satellite cells around neurons Neurons consist of large nucleus with large nucleolus Fine Nissil bodies Lipofuscin granules Don't have a CT capsule



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