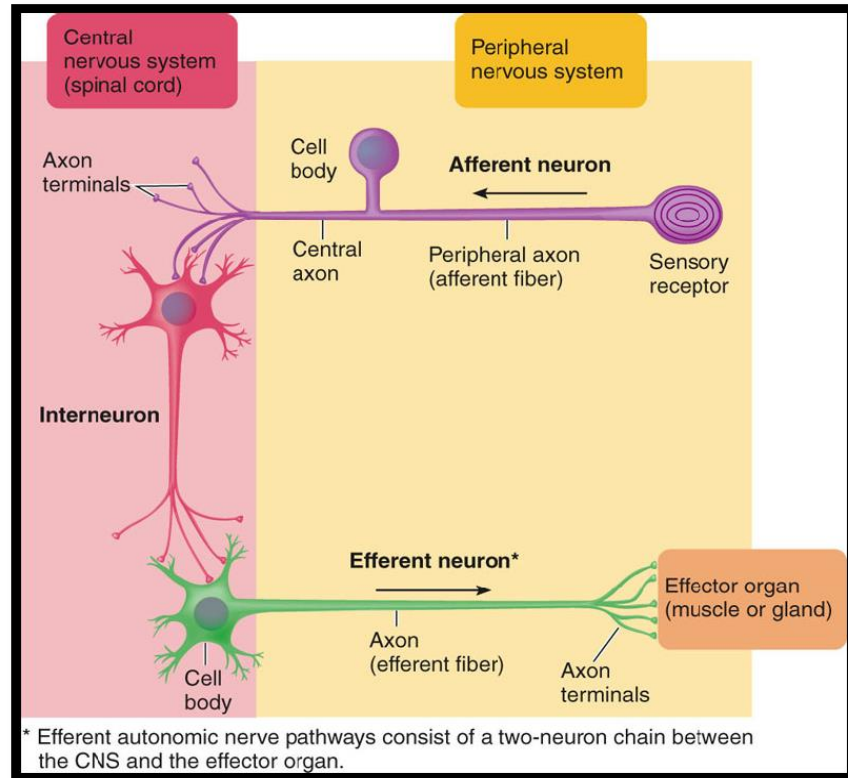


Nervous system

nervous system is composed of billions of cells, the most essential being the nerve cells or neurons. There are estimated to be as many as 100 billion neurons in our nervous system.

Two major components of nervous system

- 1- **central nervous system (CNS)** - brain, spinal cord. These neurons cannot regenerate if damaged.
- 2- **peripheral nervous system (PNS)** - nerves extending toward or away from CNS and ganglia. These neurons can regenerate if damaged.



Nervous tissue consists of two major types of cells:

1. **neurons** - responsible for conduction, propagation, and reception of nervous impulses. Processes called axons or dendrites extend from these cells.
2. **glial cells** - (neuroglia) cells associated with neurons. **No** axons or dendrites. These cells are involved in nutrition, support, insulation, protection of neurons.

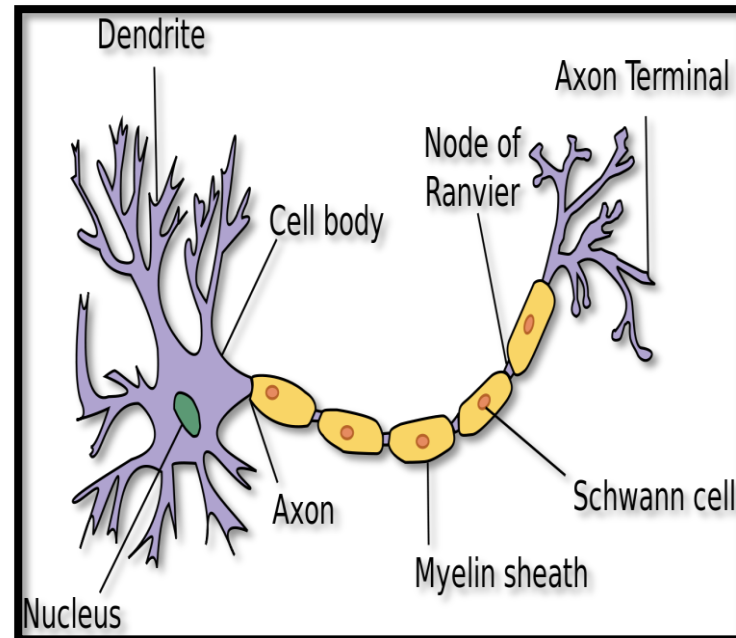
1. Neurons :

Neurons are nerve cells (neurocytes), which, together with neuroglial cells, comprise the nervous tissue making up the nervous system. Neurons receive nerve signals (action potentials), integrate action potentials, and transmit these signals to other neurons or effector organs, such as muscles and glands.

1- Neuron

A. Cell body or soma (perikaryon) : which is the synthetic center for entire nerve cell and is receptive to stimuli, contains nucleus and typical cell organelles

- **Nucleus** - large, central in most, large amount of euchromatin , Barr body.
- **rough endoplasmic reticulum (RER)** - lots for synthesis of structural and transport proteins, Nissl bodies seen with light microscope and free ribosomes.
- **Golgi apparatus** - only found near nucleus in perikaryon. Expected, since intense synthetic activity of neurotransmitters and/or neurohormones.
- **Mitochondria** - abundant for high energy requirements
- **Neurofilaments, microtubules** - neurofilaments are intermediate filaments (10 nm) Microtubules - important in transport of materials (e.g. neurotransmitters).
- **Inclusions** - pigment vesicles - function unknown. Lipofuscin deposits - residual bodies from **autophagosome** activity. Increase with age.



B. dendrite : many elongated processes specialized to **receive** stimuli from environment , sensory epithelial cells ,or other neurons, may be branched, forms receptive area for synaptic contacts from other neurons, has tiny rough projections or spines called **gemmules** that may be points of synaptic contact, dendrites from larger neurons may be lightly myelinated by oligodendroglia. Neurons may have more than one dendrite. Cytoplasm in these processes similar to that of perikaryon, but no golgi bodies.

C. axon : which is a single process specialized in **generation** and **conducting** nerve impulses to other cells (nerve , muscle and gland cells). axons carry electrical impulses (action potentials) to synapses at end of axon.

Many axons are enclosed in sheaths formed by other cells; **axons of PNS** commonly have sheaths composed of **Schwann Cells** also called **Neurolemmocytes**, which can

tightly surround the nerve fibers (axon), while **axons lying within the CNS** are provided with a similar covering by **Oligodendrocytes**.

The nerve fibers with enclosed sheaths are known as *myelinated nerve fibers*, while those lacking the sheaths are called *unmyelinated nerve fibers*.

In junction between any two segments ,there is a gap in myelin sheath (Lack of myelin); these gaps are called **Nodes Of Ranvier**

The ends of branches form **synapses** with other neurons or muscle cells, may be myelinated by either **oligodendroglia** in **CNS** or **Schwann cells** in **PNS**. Each neuron has only one axon.

- **axon hillock** (pyramid shaped region where axon originates from the cell body or perikaryon).
- **initial segment** (unmyelinated initial portion of axon).
- **remainder of axon** (may be myelinated or unmyelinated, may be branched).

D. Synapse : it's a special site of **contact** between neurons or between neurons and other effector cells which are responsible for nerve impulse transmission from neuron to another cell and insures that transmission is unidirectional.

- **Various type of synapse are seen between neuron :**

- 1- **axosomatic** : if an axon form synapses with cell body (soma).
- 2- **axodendritic** : axon synapses with dendrite.
- 3- **axoaxonic**: axon synapses with another axon terminal branch for presynaptic inhibition) or beside the initial segment of an axon.
- 4- **dendrodendritic** : dendrite synapsing on another dendrite (very localized effect).

- **According to the way of impulse transmission:**

–**Electrical synapses** (uncommon in mammals)

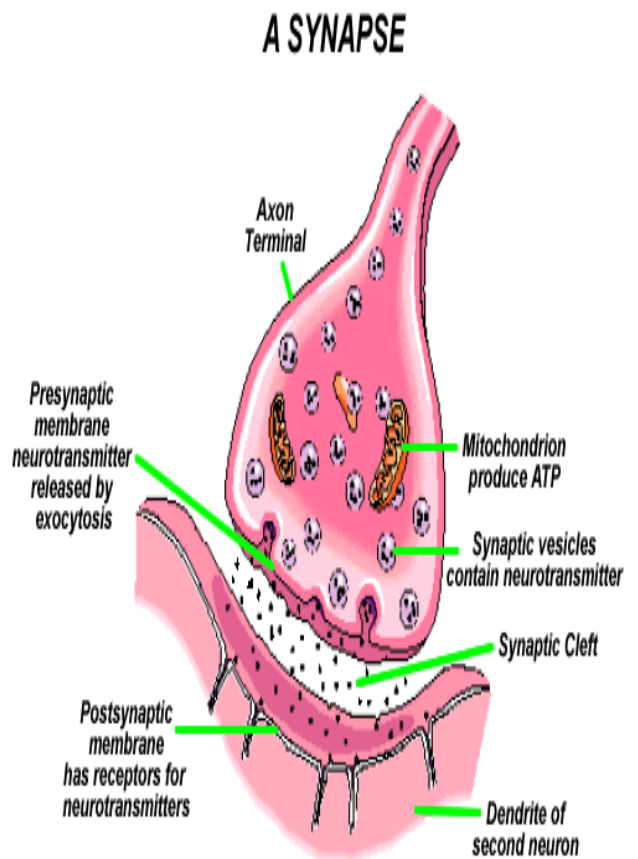
–**Chemical synapses** (by the release of neurotransmitters)

- **Synapses are comprised of three elements:**

a) **Presynaptic nerve terminal** contains synaptic vesicles which house a chemical neurotransmitter that is released after vesicle fusion with the presynaptic terminal plasma membrane.

b) **Postsynaptic element** : adendrite, a cell body, or a target cell receiving the synaptic input. Receptor protein molecules, to which neurotransmitter molecules bind, are embedded in the postsynaptic plasma membrane.

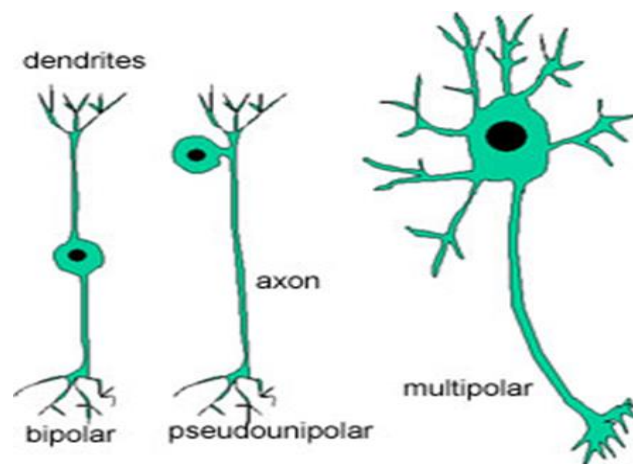
c) **Synaptic Cleft**: a gap between pre- and post-synaptic elements into which neurotransmitter molecules are released.



TYPES OF NEURONS:

◆ There are three basic shapes to the neurons:

- 1- **bipolar** (single axon and single dendrite).
- 2- **Unipolar or pseudounipolar** (single axon and dendrite arise from a common stem) - the primary general sensory neurons are usually pseudounipolar.
- 3- **multipolar** (the commonest) - most motor neurons are multipolar (single axon and numerous dendrites).



◆ Neuron classification based on function:

- 1- **Motor neurons** - efferent, action potential moves from CNS to effector organ (e.g. muscle).
- 2- **Sensory neurons** - afferent, action potential moves from sensory organ to CNS, associated with pacinian corpuscles, touch, pressure).
- 3- **Interneurons** - form connections between neurons

2. glial cells

There are many more glial cells in the nervous system than there are neurons. These cells are situated among the neurons and are generally smaller. Glial cells have been shown to have nutritive and support functions, but in general, the functions of these cells within the CNS are not well understood.

Supporting cells (neuroglia) in the central nervous system : In the central nervous system, there are four types of supporting cells. And in PNS there are two type.

Supporting cell in CNS:

1. Astrocytes - two types

a. **protoplasmic astrocytes** : granular cytoplasm, many branches on short processes , some of processes are closely applied to neurons, while others form intimate contacts with blood vessels. Thought to form a duct for nutrients from blood vessels to neurons. found in **gray matter**.

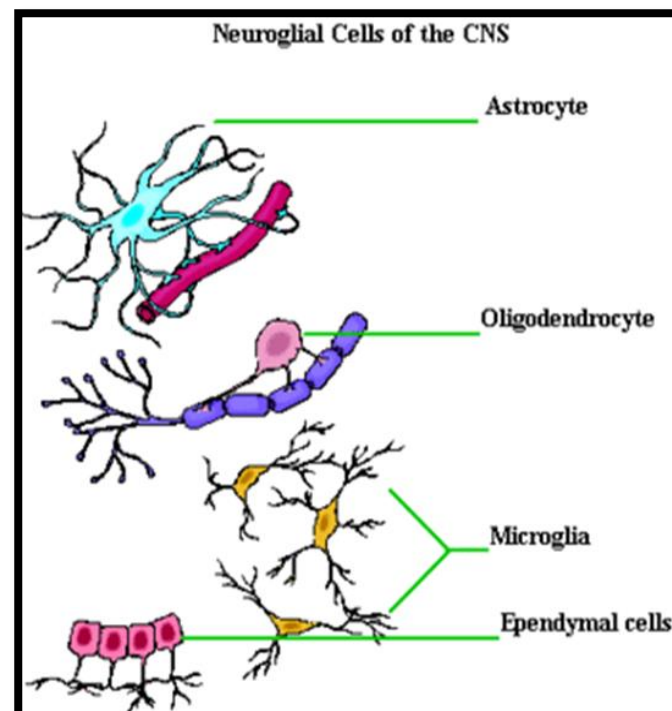
b. **fibrous astrocytes**: long slender processes ,function not well understood ,found chiefly in **white matter**.

2. oligodendroglia (also

called **oligodendrocytes**): Smaller than astrocytes, fewer processes, found in both **gray and white matter** . In white matter, these cells form the myelin sheaths that are around many axons, in gray mater they may lightly myelinate some dendrites.

3. **Microglia** :small cell body that is elongated. Elongate nucleus with mostly heterochromatin .Can be differentiated from other glia by elongate nucleus. Other have a spherical nucleus. Many of what were thought to be microglia under the light microscope, have turned out to be oligodendroglia when cells were examined with EM.

4. **ependymal cells** : ciliated cells forming single layer of cuboidal epithelium that lines the entire neurocoel , ciliary action acts to circulate cerebral spinal fluid.



Supporting cell in PNS:

1-Schwann cells :A type of support cell that surrounds all axons in the PNS.

Support myelinated and unmyelinated nerve fibers in the PNS

- Produce the myelin sheath in the PNS
- cleaning up the PNS debris
- regrowth of PNS axons.
- Single Schwann cell myelinate only one axon
- Schwann cell can envelope several unmyelinated axons
- Schwann cell is covered by a basal lamina

2-Satellite cells : Small cuboidal, flattened cells found in the ganglia of the PNS that help regulate and stabilize the environment around ganglion cell bodies.

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3- Jonquiere's basic histology text and atlas 13th edition (2013) by Anthony L. Mescher ; Di Fiore's Atlas of Histology 12th ed. (2013) Victor P. Eroschenko