

THE NERVOUS TISSUE

Definition: The nervous tissue is an assemblage of cells and supportive elements (materials) in which there is a predominance of cells which are highly specialized in the property of **excitability** and **conductivity**, whereby they are capable of generating and conducting electrochemical wave along their plasma membrane. The specialized cells of the nervous tissue are called **NEURONS** while the supportive cells are called **NEUROGLIAL CELLS**.

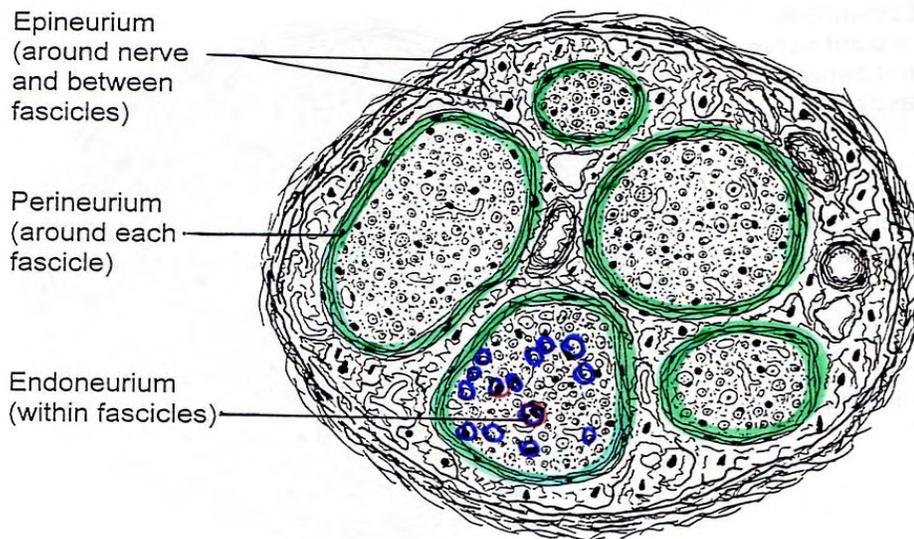
The electrochemical wave conducted along the plasma membrane is referred to as **NERVE IMPULSE**. The nervous tissue is developed from the ectodermal germ layer of the embryo.

COMPONENT PARTS OF THE NERVOUS TISSUE:

The component parts of the nervous tissue comprise:

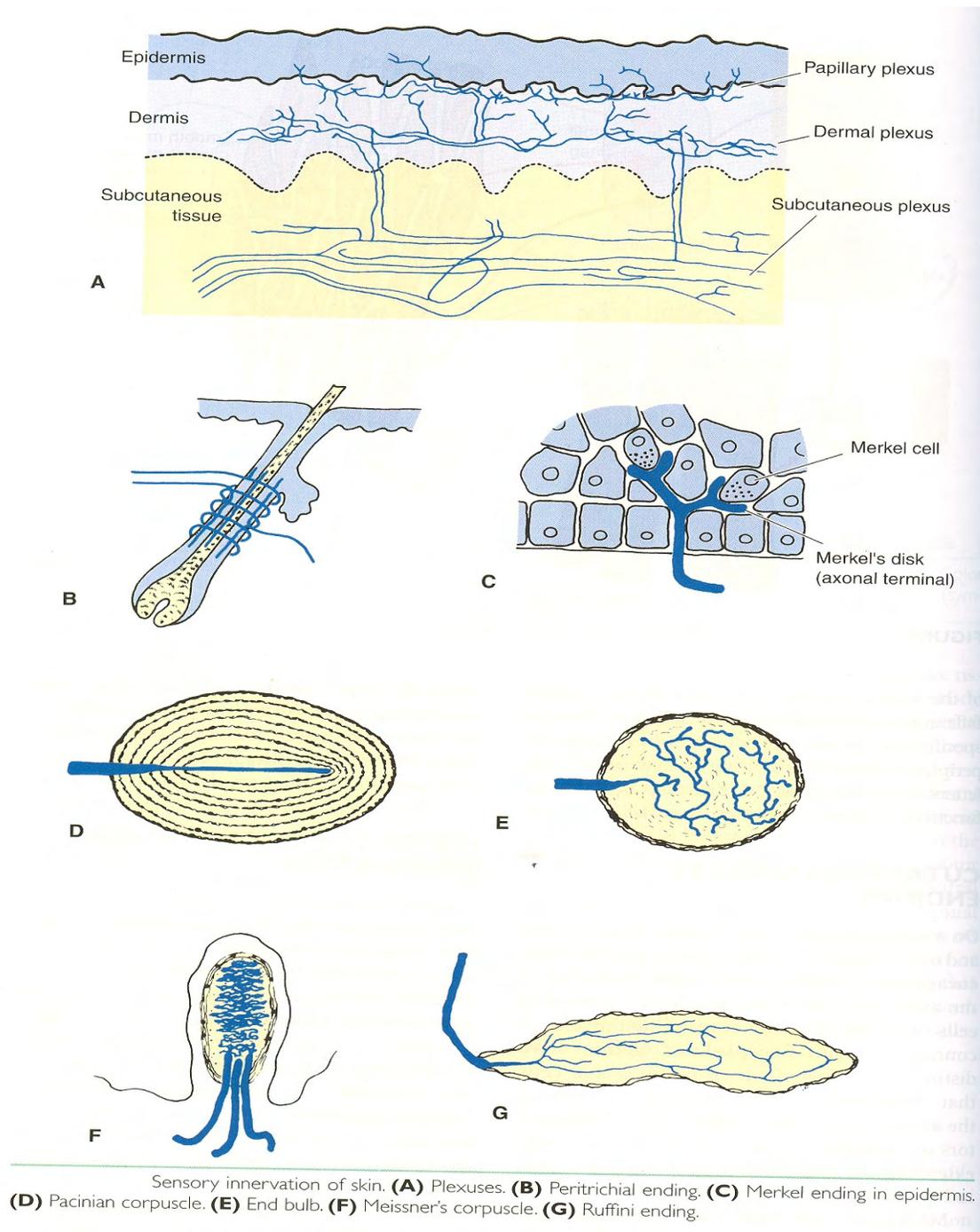
1. Nerve cells, also called Neurons.
2. Interstitial/Supportive cells, also called Neuroglia or Neuroglial cells.
3. Connective tissue proper of the nervous tissue which include:
 - a. Meninges of the brain and spinal cord
 - b. Connective tissue of the blood vessels of the nervous tissue.
 - c. Connective tissue sheath of the peripheral nerves, which include (See Diagram 1.):
 - i. Epineurium
 - ii. Perineurium
 - iii. Endoneurium, also called the sheath of Henle.
4. Peripheral receptor cells/structures. (See diagram 2.)

Diagram 1



The connective tissue sheaths in a transversely sectioned nerve that contains five fascicles.

Diagram 2: Peripheral Receptors

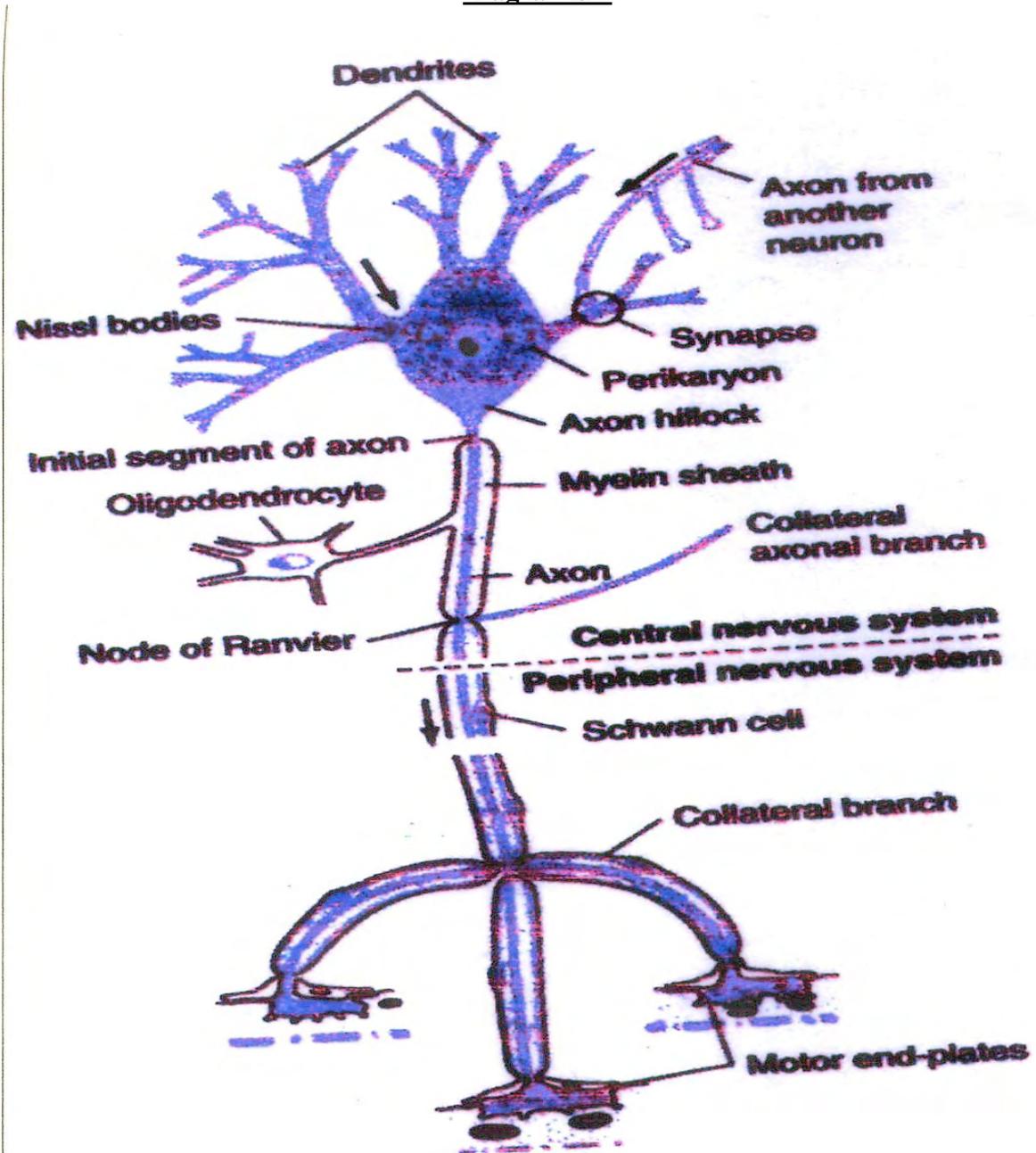


THE NEURON (See Diagram 3)

The neuron is the morphological and functional unit of the nervous tissue/system. It is highly specialized in the physiological properties of **Excitability** and **Conductivity**. On stimulation, it generates an electrical change (Action potential), which is propagated along its cell surface and along its protoplasmic extension known as the **Axon**. The propagated action potential is referred to as the **Nerve impulse**. The neuron is composed of: (See Diagram 3A.)

1. The cell body (Perikaryon) which:
 - a. Accommodates a nucleus.
 - b. Is enclosed in a plasma membrane with spinous processes called Gemmules.
 - c. Accommodates a cytoplasm, which contains organelles and inclusion bodies.
2. Cytoplasmic processes (**Neurites or Neuropil**): These are projections from the surface of the perikaryon called Axon and Dendrites

Diagram 3A



A Motor Neuron

NEURONAL ORGANELLES

The neuron contains all the regular organelles of the eukaryotic cells. However, rough endoplasmic reticulum, free ribosomes and polyribosomes of the neurons are collectively referred to as the Nissl (**Chromophil**) bodies (**granules**).

These organelles are responsible for the intense basophilia of the neuronal perikaryon and are absent in the axon hillock and in the axon (See Diagram 3.).

Neurofibrils, Neurofilaments, Microtubules and Microfilaments are widely distributed in the cell body, axon and dendrites.

Golgi complex and Lysosomes are restricted to the cell body while Mitochondria are widely distributed in all parts of the neuron but are particularly abundant at the axonal terminals.

Inclusion Bodies:

The neuron also contains inclusion bodies, which have variable distribution in the nervous system, e.g.:

Melanin pigments (Neuromelanin) are found in the substantia nigra of the midbrain and locus coeruleus of the pons in the brainstem

Lipofuscin (Lipochrome) pigments are found in the spinal cord, medulla oblongata, sensory and sympathetic ganglia. They are stored in granules derived from Lysosomes. Lipofuscin appears from the age of 8 and increases with age. They may appear in other nerve cells but never found in the **Purkinje cells** of the cerebellum.

Other inclusion bodies include:

Zinc metal in the Hippocampus of the brain

Iron metal in the Oculomotor nucleus of the midbrain

Calcium and Magnesium salts (Brain sand) in the Pineal gland.

Synaptic vesicles are membrane-bound sacs of neurotransmitter located at the boutons terminaux of axons.

The Axon :(See diagram 3A and 3B)

The characteristic features of the axon are:

- a. It arises from the region of the cell body called the axon hillock
- b. It is often longer than the dendrites but of uniform diameter.
- c. A typical neuron possesses only one axon.
- d. Its plasmalemma is called the axolemma and its cytoplasm the axoplasm.
- e. It contains all neuronal organelles except Nissl bodies and Golgi complex.
- f. May have collateral branches.
- g. May be covered by myelin sheath for insulation and rapid conduction of impulses.
- h. Conducts impulses away from the cell body.
- i. Its terminal branches are called **telodendria**, which terminate in dilated terminals (**Boutons terminaux**) that are involved in formation of contact points called **Synapses**.
- j. The initial segment is often involved in inhibitory axo-axonal synapses.

The Dendrite (See diagram 3.)

The characteristic features of the dendrite are:

- a. It is often shorter than the axon and tapers from the cell body hence the diameter is not uniform.
- b. It has numerous branches.

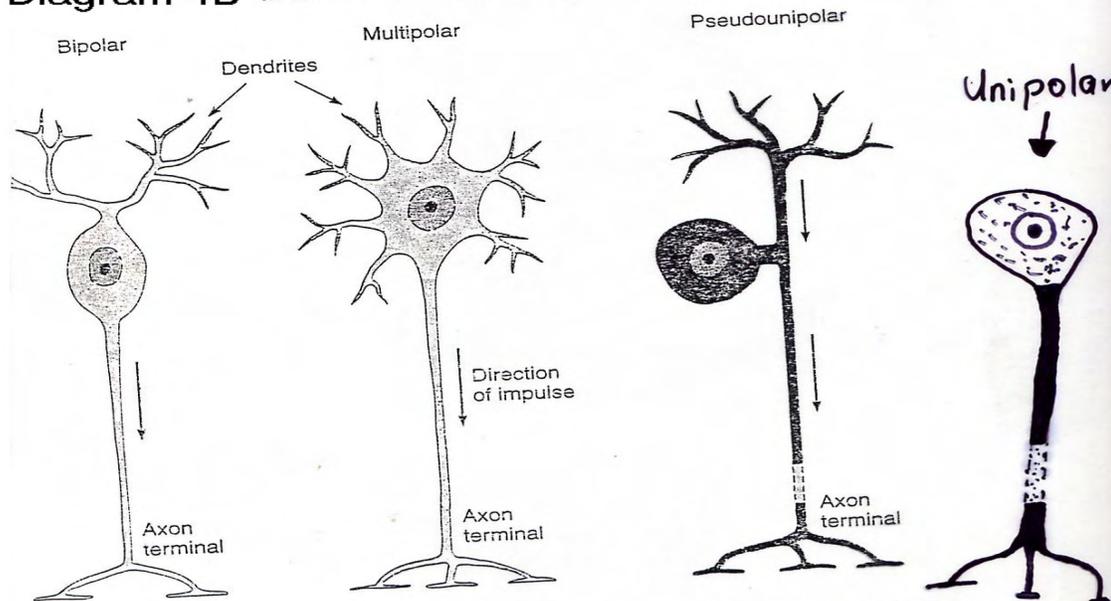
- c. Its branches bear minute projections called dendritic spines (Gemmules), which are involved in synapses.
- d. Usually conducts impulses towards the cell body.
- e. It is involved in forming contact points (Synapses).
- f. It is devoid of Golgi apparatus and Lysosomes but contains most of the other organelles found in the cell body.

Classification of Neurons:

The classification of neuron is based on various criteria, which include:

1. **Functions** (See Diagram 4A.)
 - a. Motor (Efferent).
 - b. Sensory (Afferent).
 - c. Interneurons (Internuncial).
2. **Morphology:** (See Diagram 4B.)
 - a. Multipolar.
 - b. Bipolar.
 - c. Unipolar.
 - d. Pseudounipolar. (Dorsal root ganglion & Mesencephalic nucleus of the trigeminal nerve)
3. **Distribution:**
 - a. Somatic (Supplying the body wall or skin) e.g. A typical spinal nerve.
 - b. Visceral (Autonomic or supplying internal organs) e.g. the vagus nerve (a cranial nerve).
4. **Axonal size/Length:**
 - a. Golgi type I (Possesses a long axon).
 - b. Golgi type II (Possesses a short axon).

Diagram 4B MAIN TYPES OF NEURONS



Simplified view of the three main types of neurons, according to their morphology.

Neuronal Junctional Points (SYNAPSES): (See Diagram. 5)

Synapses are contact points between neurons or between neurons and non-neuronal cells/non-neuronal structures.

Classification of Synapses: This is based on the [structures](#) at the contact point as well as the [mode/mechanism of transmission of impulse](#) at the contact point. Thus synaptic types include:

a. **Morphological Synapses:**

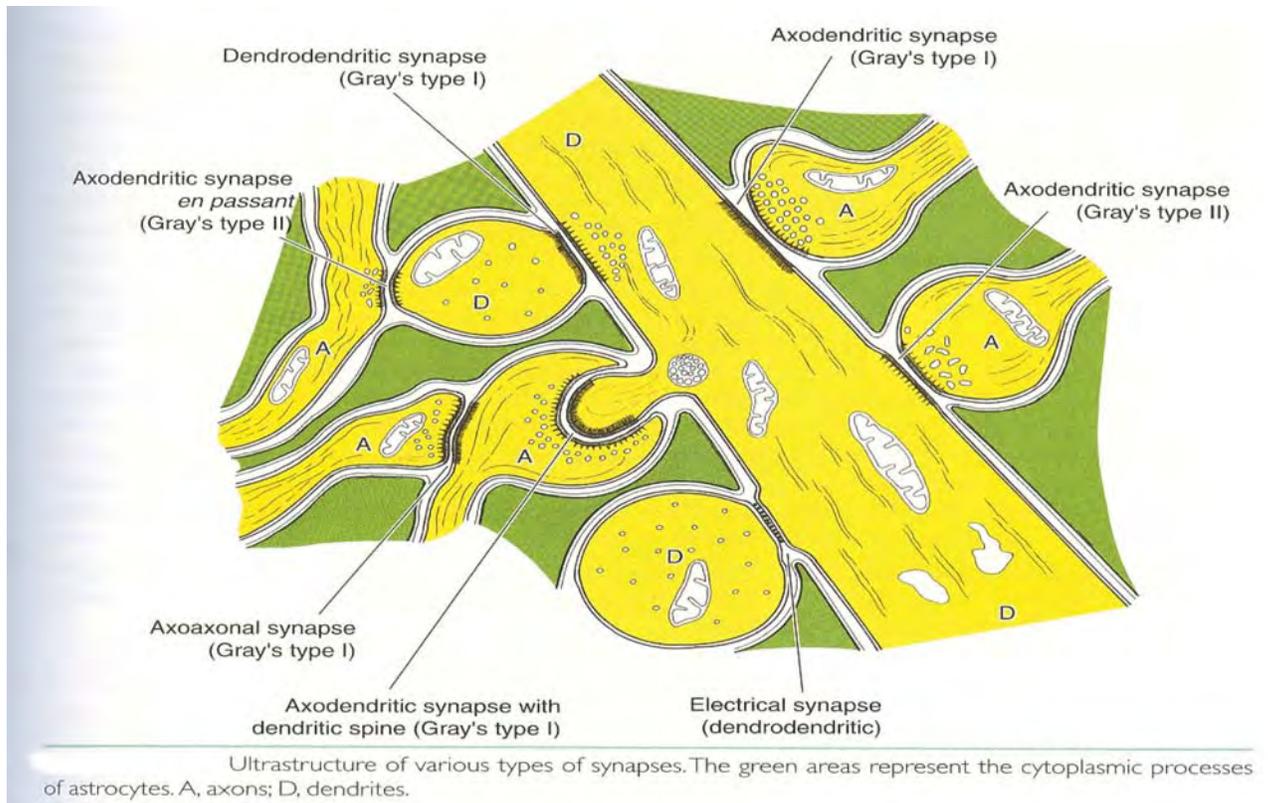
- i. Axo-somatic
- ii. Axo-axonal.
- iii. Axo-dendritic.
- iv. Dendro-dendritic

b. **Chemical Synapses:** The features of chemical synapses are:

- i. They are associated with the release of neurotransmitters.
- ii. They are associated with receptors on the post-synaptic membrane.
- iii. Some synapses are associated with the presence of enzymes, which inactivate neurotransmitters at the synaptic cleft.
- iv. They are associated with synaptic cleft, which is about 20 nanometers wide (1 nanometer is 1billionth of 1 metre).
- v. Their telodendria are characterizes by the presence of synaptic vesicles and numerous mitochondria.
- vi. They exist in two common types, viz. Gray Type I (Asymmetrical) and Gray Type II (Symmetrical)

c. **Electrical Synapses:** These are characterized by the following features:

- i. They are encountered in invertebrates and the lower vertebrates.
- ii. They are associated with narrow synaptic cleft (2 nanometers).
- iii. The contacting membranes are joined by tubular protein molecules, which facilitate movement of water, small ions and small molecule across the cleft.
- iv. They serve as low resistance pathway between contacting neurons.
- v. At electrical synapses, transmission of impulse occurs either way.



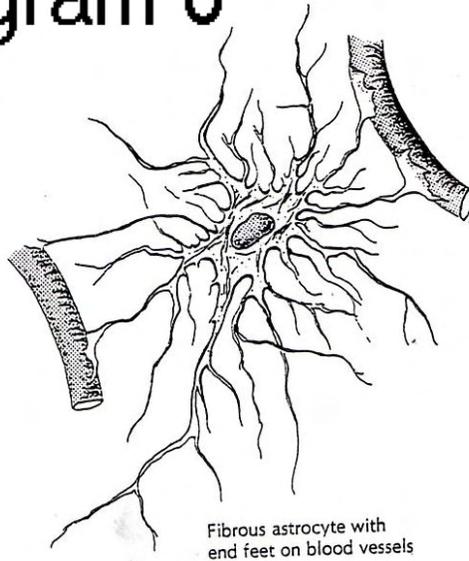
NEUROGLIAL CELLS (See Diagram 6.)

These are the supportive cells of the nervous tissue. They provide physical support, nutrients, defense, insulation and re-absorption of neurotransmitters in the nervous system. They exist in various forms and are widely distributed throughout the peripheral and central parts of the nervous system. They include:

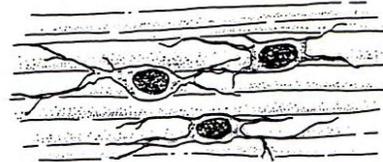
1. Fibrous Astrocytes (Astroglia) – Distributed within the white matter of the central nervous system (CNS)
2. Protoplasmic (Velate) Astrocytes – Distributed within the gray matter of the CNS. (Muller cells of the retina & Pituicytes of the Pituitary gland)
3. Oligodendrocytes (Oligodendroglia) Interfascicular and satellite types – Form myelin sheaths in the central nervous system and facilitate rapid conduction of impulses.
4. Schwann cells – Form myelin sheaths around axons in the peripheral nervous system.
5. Satellite cells- Found amongst neurons in the peripheral ganglia
6. Resting microglia (Microgliocytes) – These are the phagocytic cells of the Central nervous system.
7. Ependymal cells – These are the epithelial cells, which line the ventricular cavities and the choroid plexuses of the central nervous system. These cells facilitate fluid exchange between the neural tissue, blood and the Cerebrospinal fluid (CSF). Modified forms of ependymal cells include, Tanycytes and choroidal epithelial cells

Diagram 6: NEUROGLIAL TYPES

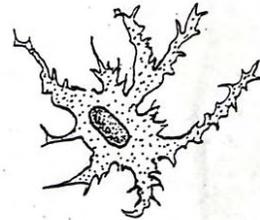
Diagram 6



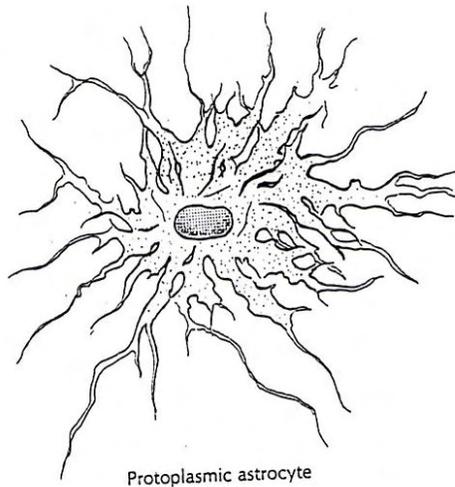
Fibrous astrocyte with end feet on blood vessels



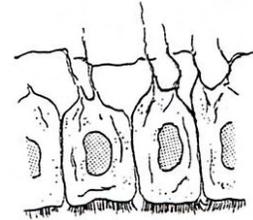
Interfascicular oligodendrocytes



Resting microglial cell in gray matter



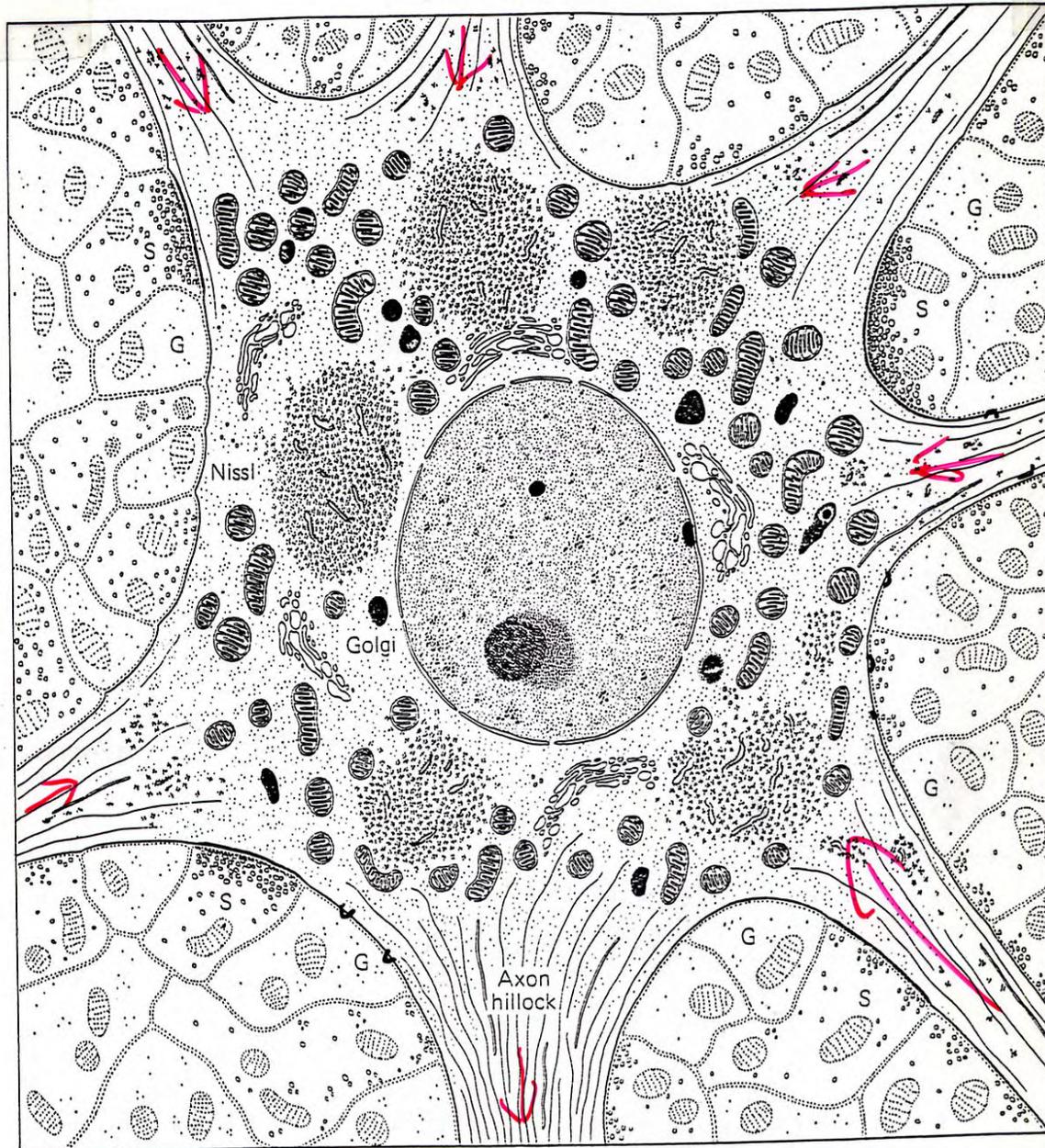
Protoplasmic astrocyte



Ependymal cells

Neuroglial cells of the central nervous system.



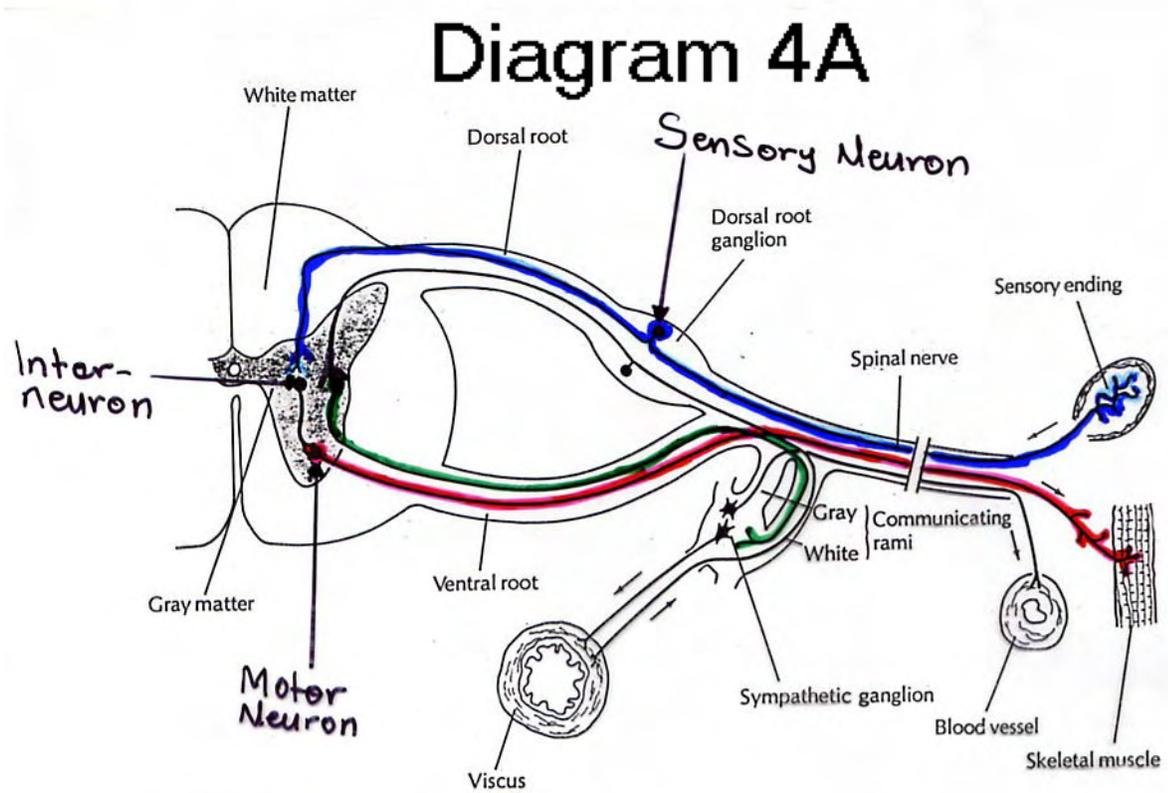


Ultrastructure of a neuron. The neuronal surface is completely covered either by synaptic endings of other neurons (S) or by processes of glial cells (G). At synapses, the neuronal membrane is thicker and is called the postsynaptic membrane. The neuronal process devoid of ribosomes (lower part of figure) is the axon hillock. The other processes of this cell are dendrites.

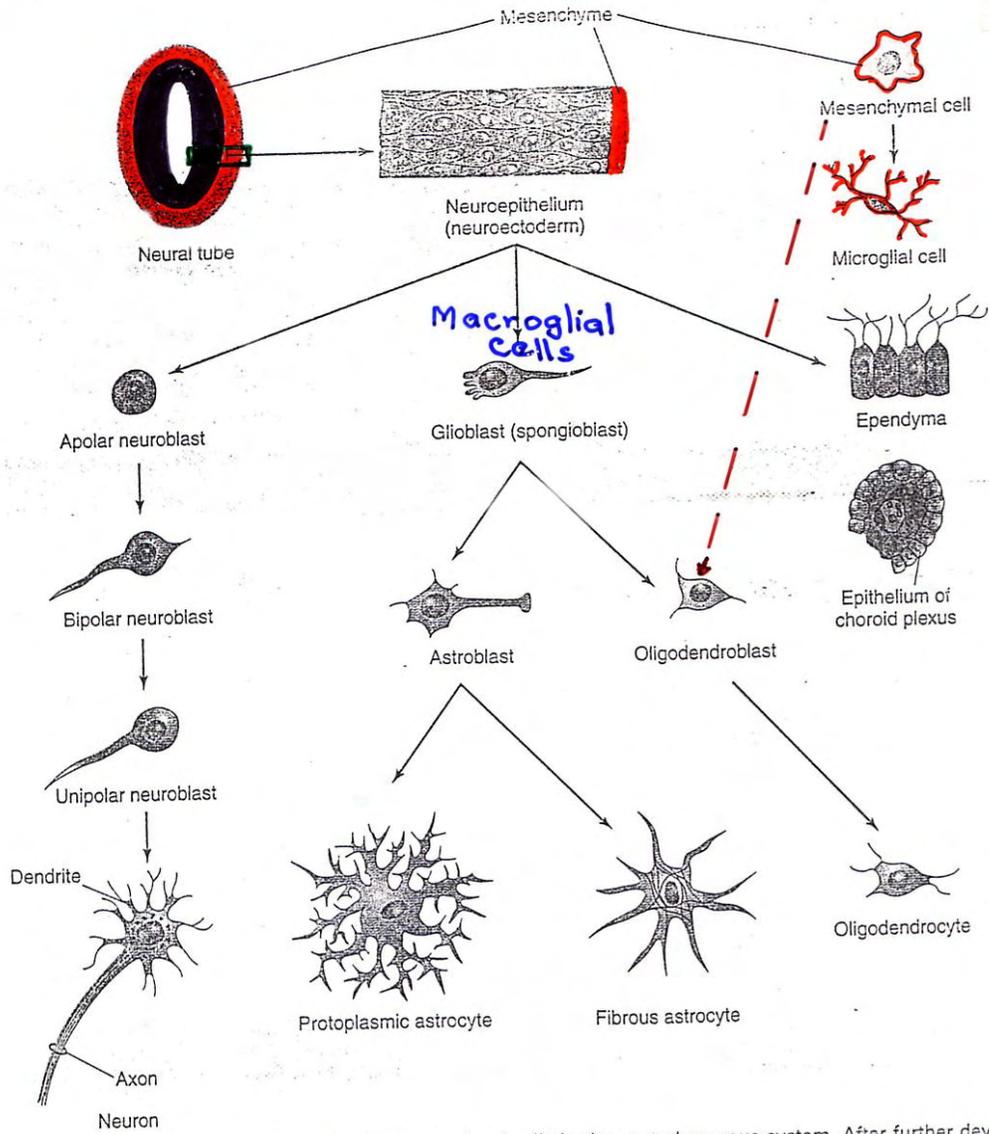
DIAG. 3.

Diagram 3B: The Nueron

Diagram 4A: Components of the spinal nerve



Components of a spinal nerve between the first thoracic and second lumbar segments.



Schematic diagrams illustrating histogenesis of cells in the central nervous system. After further development the multipolar neuroblast (*lower left*) becomes a nerve cell or neuron. Neuroepithelial cells give rise to all neurons and macroglial cells. Microglial cells are derived from mesenchymal cells that invade the developing nervous system with the blood vessels.