HUMAN ANATOMY & PHYSIOLOGY-II- BP201T

UNIT: 1 (NERVOUS SYSTEM)

CLASS: 1

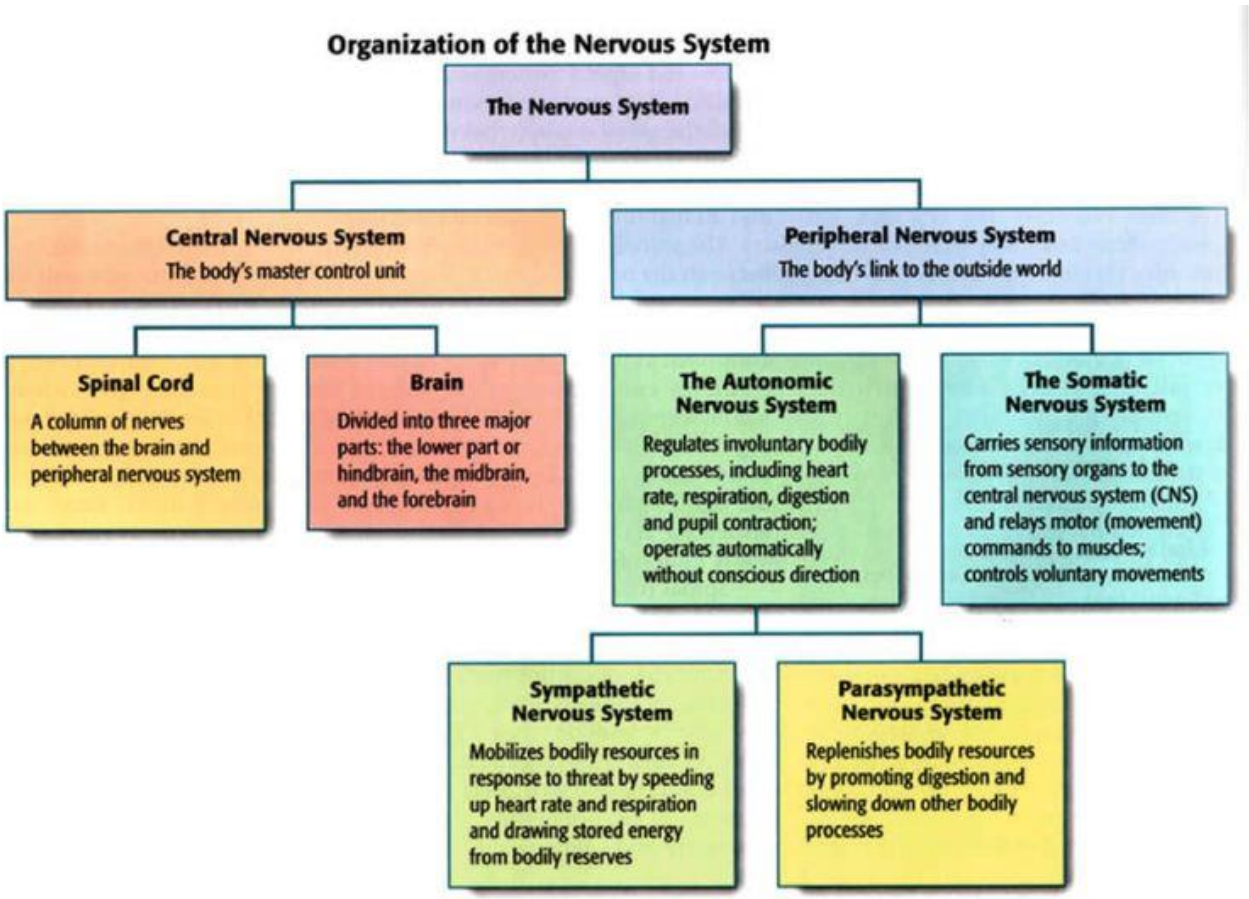
TOPIC: ORGANIZATION OF NERVOUS SYSTEM, NEURON

Nervous system controls all the activities of the body. It is quicker than other control system in the body, namely endocrine system. Primarily, nervous system is divided into two parts: 1. Central nervous system 2. Peripheral nervous system.

CENTRAL NERVOUS SYSTEM Central nervous system (CNS) includes brain and spinal cord. It is formed by neurons and supporting cells called neuroglia. Structures of brain and spinal cord are arranged in two layers, namely gray matter and white matter.

In brain, white matter is placed in the inner part and gray matter is placed in the outer part. In spinal cord, white matter is in the outer part and gray matter is in the inner part.

Brain is situated in the skull. It is continued as spinal cord in the vertebral canal through the foramen magnum of the skull bone. Brain and spinal cord are surrounded by three layers of meninges called the outer dura mater, middle arachnoid mater and inner pia mater. The space between arachnoid mater and pia mater is known as subarachnoid space. This space is filled with a fluid called cerebrospinal fluid. Brain and spinal cord are actually suspended in the cerebrospinal fluid.



Brain consists of three major divisions: 1. Prosencephalon 2. Mesencephalon 3. Rhombencephalon

1. Prosencephalon

Prosencephalon is otherwise known as forebrain. It is further divided into two parts: i. Telencephalon, which includes cerebral hemispheres, basal ganglia, hippocampus and amygdaloid nucleus ii. Diencephalon, consisting of thalamus, hypo thalamus, metathalamus and subthalamus.

2. Mesencephalon

Mesencephalon is also known as midbrain

3. Rhombencephalon

Rhombencephalon or hindbrain is subdivided into two portions: i. Metencephalon, formed by pons and cerebellum ii. Myelencephalon or medulla oblongata. Midbrain, pons and medulla oblongata are together called the brainstem.

Peripheral nervous system (PNS) is formed by neurons and their processes present in all regions of the body. It consists of cranial nerves, arising from brain and spinal nerves, arising from the spinal cord. It is again divided into two subdivisions: 1. Somatic nervous system 2. Autonomic nervous system.

Neuron

Neuron or nerve cell is defined as the structural and functional unit of nervous system. Neuron is similar to any other cell in the body, having nucleus and all the organelles in cytoplasm. However, it is different from other cells by two ways: 1. Neuron has branches or processes called axon and dendrites 2. Neuron does not have centrosome. So, it cannot undergo division.

„ CLASSIFICATION OF NEURON

Neurons are classified by three different methods. A. Depending upon the number of poles B. Depending upon the function C. Depending upon the length of axon.

DEPENDING UPON THE NUMBER OF POLES

Based on the number of poles from which the nerve fibers arise, neurons are divided into three types: 1. Unipolar neurons 2. Bipolar neurons 3. Multipolar neurons.

Unipolar Neurons

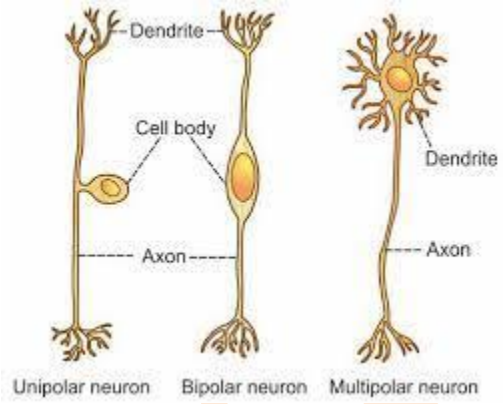
Unipolar neurons are the neurons that have only one pole. From a single pole, both axon and dendrite arise. This type of nerve cells is present only in embryonic stage in human beings.

Bipolar Neurons

Neurons with two poles are known as bipolar neurons. Axon arises from one pole and dendrites arise from the other pole.

Multipolar Neurons

Multipolar neurons are the neurons which have many poles. One of the poles gives rise to axon and all other poles give rise to dendrites.



DEPENDING UPON THE FUNCTION

On the basis of function, nerve cells are classified into two types:

1. Motor or efferent neurons 2. Sensory or afferent neurons.

1. Motor or Efferent Neurons Motor or efferent neurons are the neurons which carry the motor impulses from central nervous system to peripheral effector organs like muscles, glands, blood vessels, etc. Generally, each motor neuron has a long axon and short dendrites.

2. Sensory or Afferent Neurons Sensory or afferent neurons are the neurons which carry the sensory impulses from periphery to central nervous system. Generally, each sensory neuron has a short axon and long dendrites.

DEPENDING UPON THE LENGTH OF AXON

Depending upon the length of axon, neurons are divided into two types:

1. Golgi type I neurons 2. Golgi type II neurons.

1. Golgi Type I Neurons Golgi type I neurons have long axons. Cell body of these neurons is in different parts of central nervous system and their axons reach the remote peripheral organs.

2. Golgi Type II Neurons Neurons of this type have short axons. These neurons are present in cerebral cortex and spinal cord.

STRUCTURE OF NEURON

Neuron is made up of three parts: 1. Nerve cell body 2. Dendrite 3. Axon.

Dendrite and axon form the processes of neuron. Dendrites are short processes and the axons are long processes. Dendrites and axons are usually called nerve fibers.

NERVE CELL BODY

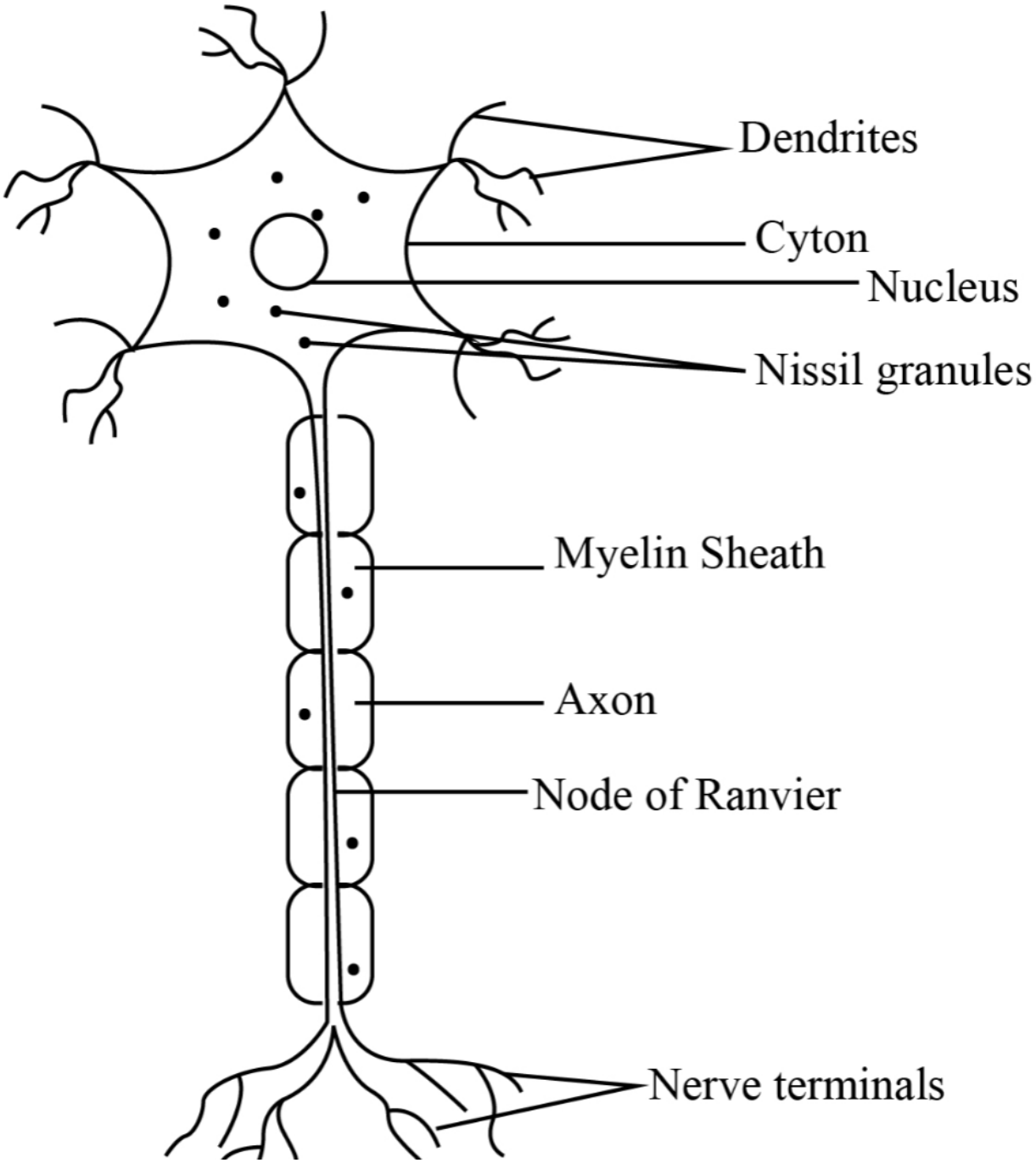
Nerve cell body is also known as soma or perikaryon. It is irregular in shape. Like any other cell, it is constituted by a mass of cytoplasm called neuroplasm, which is covered by a cell membrane. The cytoplasm contains a large nucleus, Nissl bodies, neurofibrils, mitochondria and Golgi apparatus. Nissl bodies and neurofibrils are found only in nerve cell and not in other cells.

Nucleus

Each neuron has one nucleus, which is centrally placed in the nerve cell body. Nucleus has one or two prominent nucleoli. Nucleus does not contain centrosome. So, the nerve cell cannot multiply like other cells.

Nissl Bodies

Nissl bodies or Nissl granules are small basophilic granules found in cytoplasm of neurons and are named after the discoverer. These bodies are present in soma and dendrite but not in axon and axon hillock. Nissl bodies are called tigroid substances, since these bodies are responsible for tigroid or spotted appearance of soma after suitable staining. Dendrites are distinguished from axons by the presence of Nissl granules under microscope.


Dendrites
Cyton
Nucleus
Nissil granules
Myelin Sheath
Axon
Node of Ranvier
Nerve terminals

Nissl bodies are membranous organelles containing ribosomes. So, these bodies are concerned with synthesis of proteins in the neurons. Proteins formed in soma are transported to the axon by axonal flow. Number of Nissl bodies varies with the condition of the nerve. During fatigue or injury of the neuron, these bodies fragment and disappear by a process called chromatolysis. Granules reappear after recovery from fatigue or after regeneration of nerve fibers.

Neurofibrils

Neurofibrils are thread-like structures present in the form of network in the soma and the nerve processes. Presence of neurofibrils is another characteristic feature of the neurons. The neurofibrils consist of microfilaments and microtubules.

Mitochondria

Mitochondria are present in soma and in axon. As in other cells, here also mitochondria form the powerhouse of the nerve cell, where ATP is produced.

Golgi Apparatus Golgi apparatus of nerve cell body is similar to that of other cells. It is concerned with processing and packing of proteins into granules.

DENDRITE

Dendrite is the branched process of neuron and it is branched repeatedly. Dendrite may be present or absent. If present, it may be one or many in number. Dendrite has Nissl granules and neurofibrils. Dendrite transmits impulses towards the nerve cell body. Usually, the dendrite is shorter than axon.

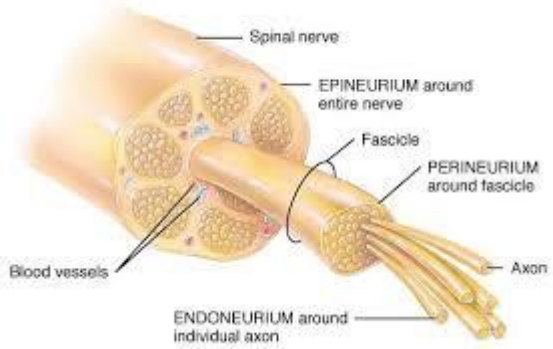
AXON

Axon is the longer process of nerve cell. Each neuron has only one axon. Axon arises from axon hillock of the nerve cell body and it is devoid of Nissl granules. Axon extends for a long distance away from the nerve cell body. Length of longest axon is about 1 meter. Axon transmits impulses away from the nerve cell body. Organization of Nerve Each nerve is formed by many bundles or groups of nerve fibers. Each bundle of nerve fibers is called a fasciculus.

Coverings of Nerve

The whole nerve is covered by tubular sheath, which is formed by a areolar membrane. This sheath is called epineurium. Each fasciculus is covered by perineurium and each nerve fiber (axon) is covered by endoneurium.

Internal Structure of Axon – Axis Cylinder Axon has a long central core of cytoplasm called axoplasm. Axoplasm is covered by the tubular sheath like membrane called axolemma. Axolemma is the continuation of the cell membrane of nerve cell body. Axoplasm along with axolemma is called the axis cylinder of the nerve fiber. Axoplasm contains mitochondria, neurofibrils and axoplasmic vesicles. Because of the absence of Nissl bodies in the axon, proteins necessary for the nerve fibers are synthesized in the soma and not in axoplasm. After synthesis, the protein molecules are transported from soma to axon, by means of axonal flow. Some neurotransmitter substances are also transported by axonal flow from soma to axon. Axis cylinder of the nerve fiber is covered by a membrane called neurilemma. Non-myelinated Nerve Fiber Nerve fiber described above is the non-myelinated nerve fiber, which is not covered by myelin sheath.



Myelinated Nerve Fiber Nerve fiber which is insulated by myelin sheath is called myelinated nerve fibers.

MYELIN SHEATH

Myelin sheath is a thick lipoprotein sheath that insulates the myelinated nerve fiber. Myelin sheath is not a continuous sheath. It is absent at regular intervals. The area where myelin sheath is absent is called node of Ranvier. Segment of the nerve fiber between two nodes is called internode. Myelin sheath is responsible for white color of nerve fibers.

Chemistry of Myelin Sheath

Myelin sheath is formed by concentric layers of proteins, alternating with lipids. The lipids are cholesterol, lecithin and cerebroside (sphingomyelin).

Formation of Myelin Sheath – Myelinogenesis

Formation of myelin sheath around the axon is called the myelinogenesis. It is formed by Schwann cells in neurilemma. In the peripheral nerve, the myelinogenesis starts at 4th month of intrauterine life. It is completed only in the second year after birth. Before myelinogenesis, Schwann cells of the neurilemma are very close to axolemma, as in the case of unmyelinated nerve fiber. The membrane of the Schwann cell is double layered. Schwann cells wrap up and rotate around the axis cylinder in many concentric layers. The concentric layers fuse to produce myelin sheath but cytoplasm of the cells is not deposited. Outermost membrane of Schwann cell remains as neurilemma. Nucleus of these cells remains in between myelin sheath and neurilemma.

Functions of Myelin Sheath

1. Faster conduction Myelin sheath is responsible for faster conduction of impulse through the nerve fibers. In myelinated nerve fibers, the impulses jump from one node to another node. This type of transmission of impulses is called saltatory conduction.

2. Insulating capacity Myelin sheath has a high insulating capacity. Because of this quality, myelin sheath restricts the nerve impulse within single nerve fiber and prevents the stimulation of neighboring nerve fibers.

NEURILEMMA

Neurilemma is a thin membrane, which surrounds the axis cylinder. It is also called neurilemmal sheath or sheath of Schwann. It contains Schwann cells, which have flattened and elongated nuclei.

Functions of Neurilemma

In non-myelinated nerve fiber, the neurilemma serves as a covering membrane. In myelinated nerve fiber, it is necessary for the formation of myelin sheath (myelinogenesis). Neurilemma is

absent in central nervous system. So, the neuroglial cells called oligodendroglia are responsible for myelinogenesis in central nervous system.