NEURON

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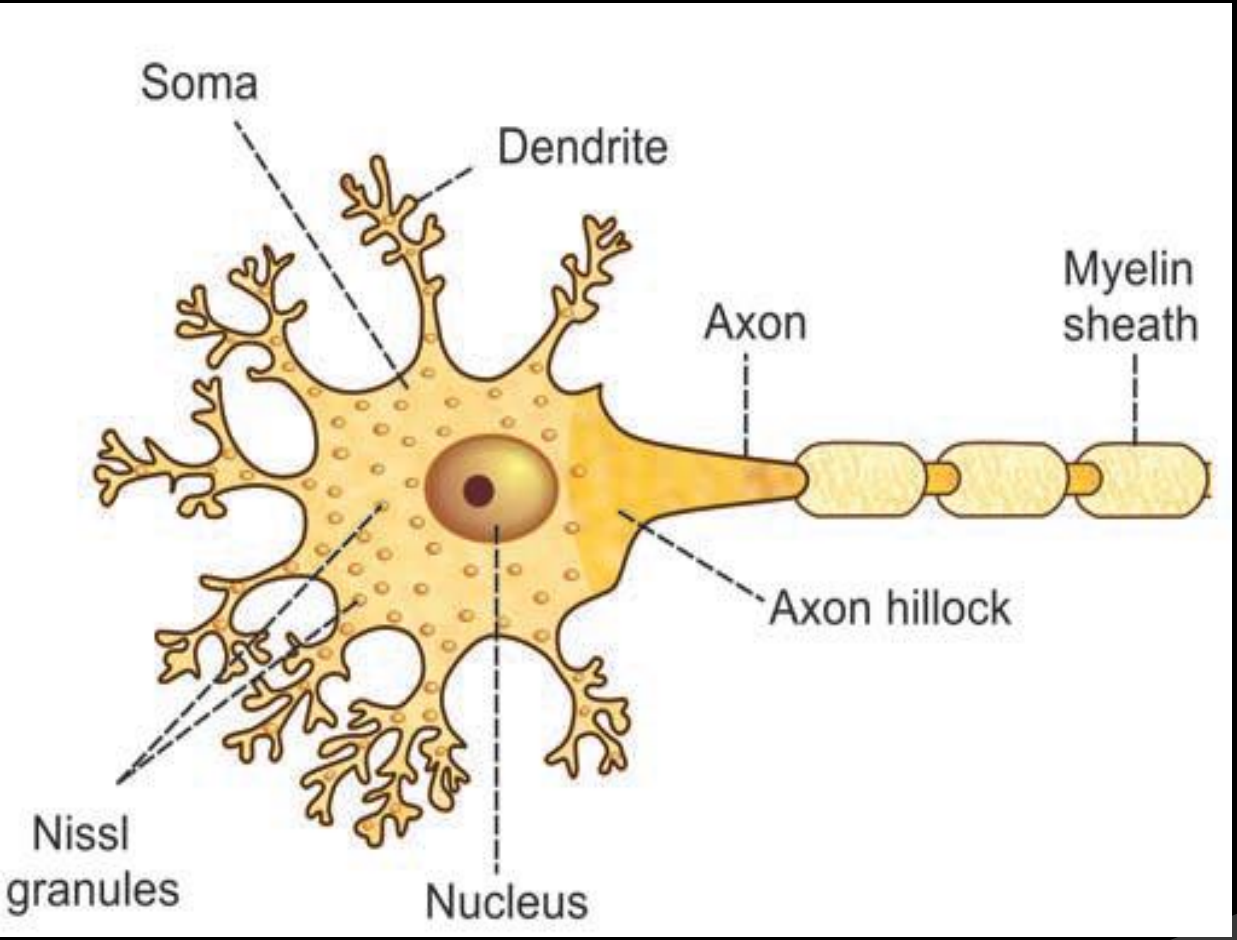
INTRODUCTION

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.


Soma
Dendrite
Myelin sheath
Axon
Axon hillock
Nissl granules
Nucleus

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.

A. 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.**

1. Unipolar Neurons:

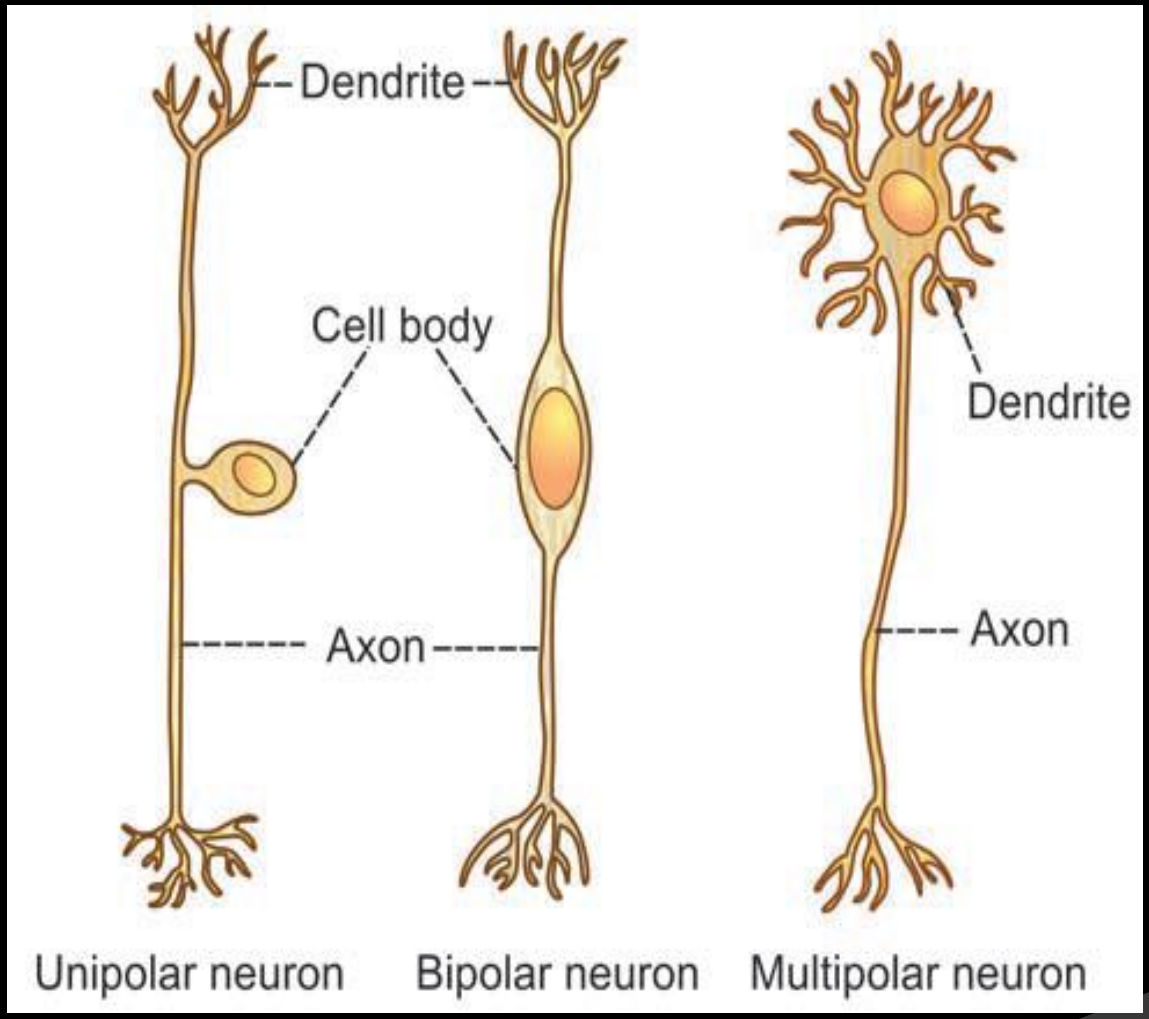
Uni-polar neurons are the neurons that have only one pole. From a single pole, both axon and dendrite arise This type of nerve cells is present only in embryonic stage in human beings.

2. Bipolar Neurons:

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

3. Multipolar Neurons:

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


Dendrite
Cell body
Axon
Dendrite
Axon
Unipolar neuron
Bipolar neuron
Multipolar neuron

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:

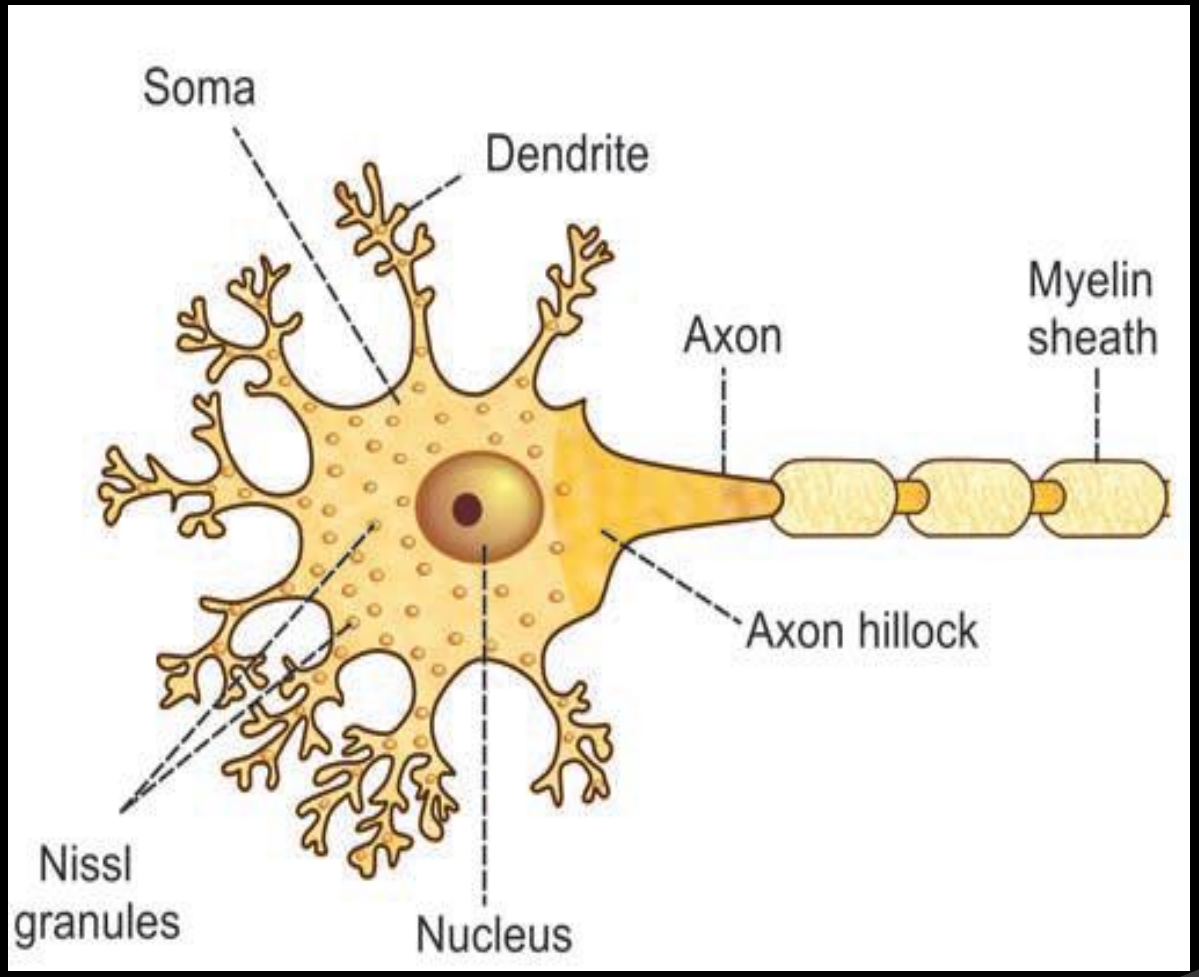
Neurons of this type have **short axons. These neurons** are present in cerebral cortex and spinal cord.

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.**


Soma
Dendrite
Myelin sheath
Axon
Axon hillock
Nissl granules
Nucleus

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.

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.

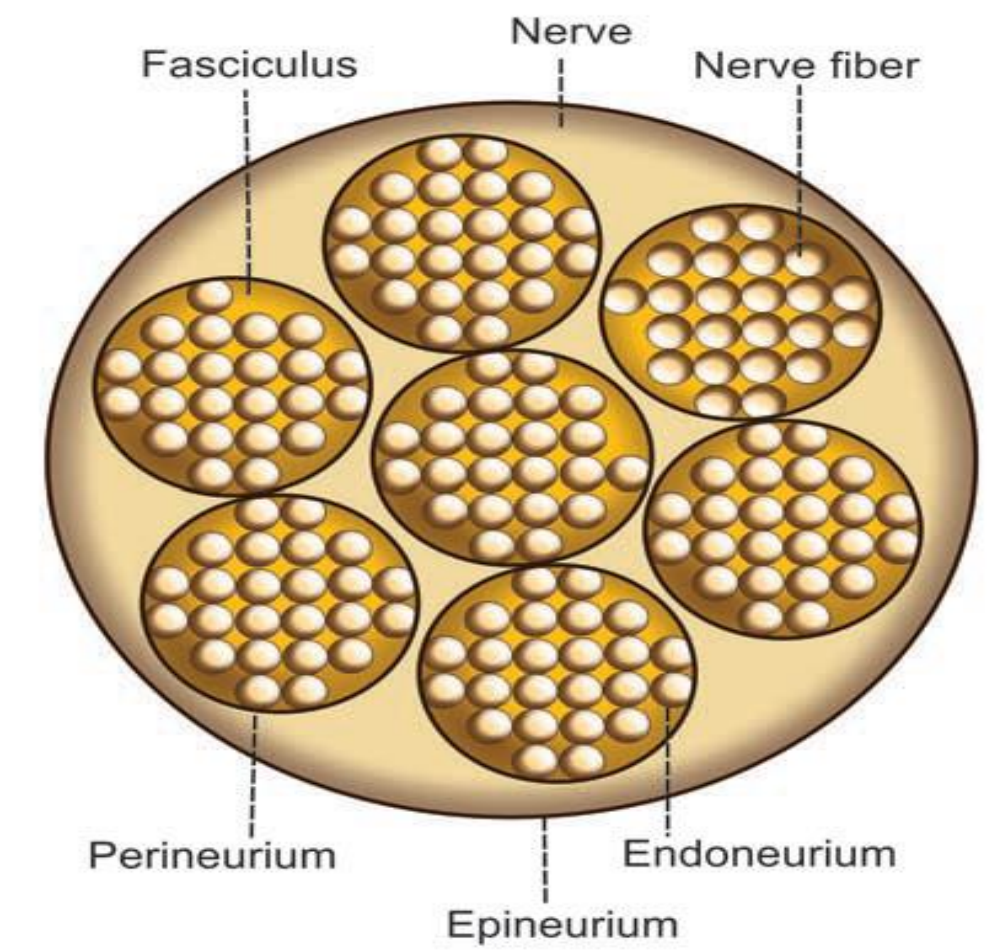
Axon extends for a long distance away from the nerve cell body. Length of longest axon is about 1 meter. **Axon transmits impulses away from the nerve cell body.**

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 (Outer).** Each **fasciculus is covered by perineurium (Middle)** and each **nerve fiber (axon) is covered by endoneurium (Inner).**


Nerve
Fasciculus
Nerve fiber
Perineurium
Endoneurium
Epineurium

Internal Structure of Axon – Axis Cylinder:

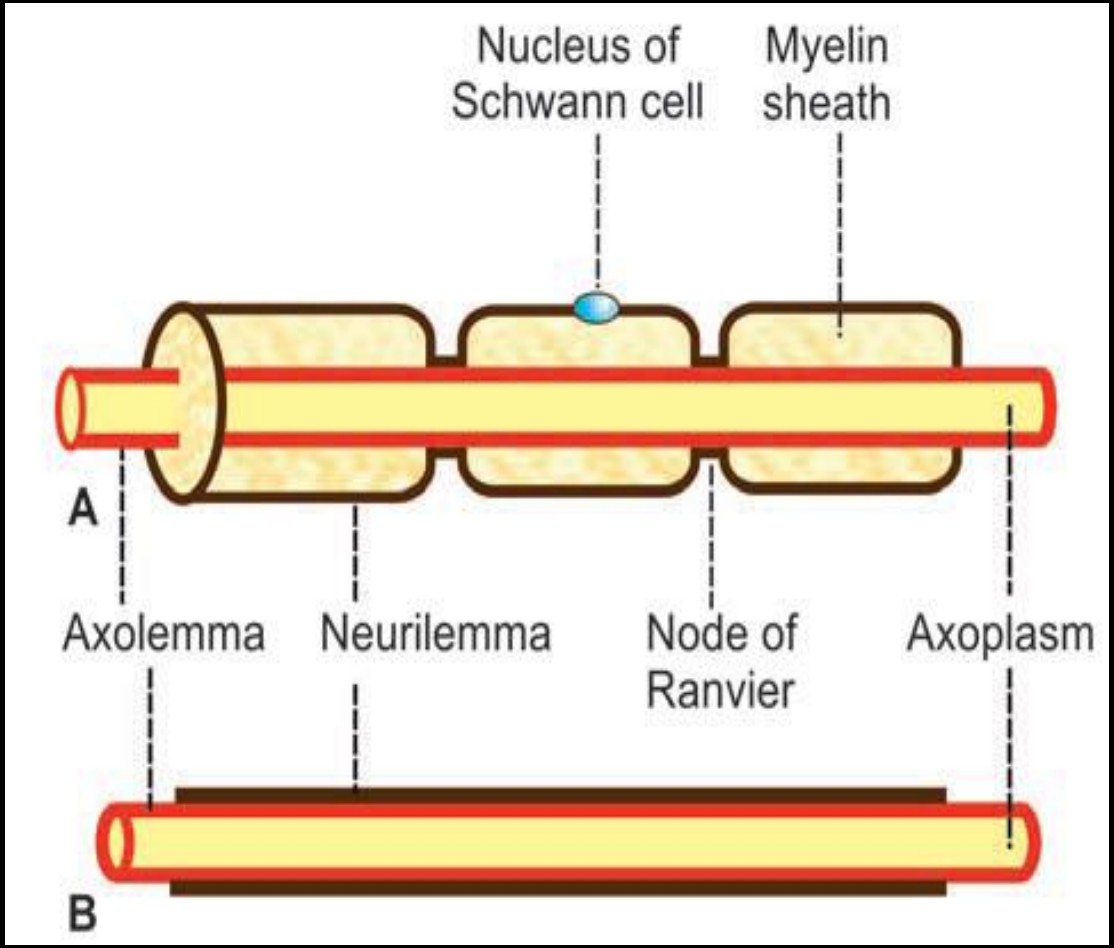
Axon has a long central core of cytoplasm called **axoplasm. Axoplasm is covered by the tubular sheath like** membrane called **axolemma.**

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**


Nucleus of Schwann cell
Myelin sheath
A
Axolemma
Neurilemma
Node of Ranvier
Axoplasm
B

Non-myelinated Nerve Fiber:

Nerve fiber described is the nonmyelinated 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.

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.

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 neighbouring 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.

Cytoplasm is thin and modified to form the thin sheath of neurilemma. One nucleus is present in each internode of the axon. Nucleus is situated between myelin sheath and neurilemma.

In non-myelinated nerve fiber, the neurilemma surrounds axolemma continuously. In myelinated nerve fiber, it covers the myelin sheath. At the node of Ranvier (where myelin sheath is absent), neurilemma invaginates and runs up to axolemma in the form of a finger-like process.

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.

NEUROTROPHINS – NEUROTROPHIC FACTORS

Neurotrophins or neurotrophic factors are the protein substances, which play an important role in growth and functioning of nervous tissue.

Source of Secretion

Neurotrophins are secreted by many tissues in the body, particularly muscles, neuroglial cells called astrocytes and neurons.

Functions

1. Facilitate initial growth and development of nerve cells in central and peripheral nervous system

2. Promote survival and repair of the nerve cells

3. Play an important role in the maintenance of nervous tissue and neural transmission.

Mode of Action

Neurotrophins act via neurotrophin receptors, which are situated at the nerve terminals and nerve cell body.

Types

Nerve growth factor (NGF) was the first protein substance identified as neurotrophin. Now, many types of neurotophic factors are identified.

NERVE GROWTH FACTOR

Nerve growth factor (NGF) is a neurotrophin found in many peripheral tissues.

Functions

1. NGF promotes early growth and development of neurons. Its major action is on sympathetic and sensory neurons, particularly the neurons concerned with pain. Because of its major action on sympathetic neurons, it is also called **sympathetic NGF. NGF also promotes the growth of cholinergic** neurons in cerebral hemispheres.

2. NGF plays an important role in treating many nervous disorders such as Alzheimer disease, neuron degeneration in aging and neuron regeneration in spinal cord injury.

OTHER NEUROTROPHINS

1. Brain-derived Neurotrophic Growth Factor
2. Ciliary Neurotrophic Factor (CNTF)
3. Glial Cell Line-derived Neurotrophic Factor (GNDF)
4. Fibroblast Growth Factor (FGF)
5. Neurotrophin-3 (NT-3)