

# Nervous Tissue

Nervous tissue, composed of as many as a trillion neurons with multitudes of interconnections, forms the complex system of neuronal communication within the body.

Certain neurons have **receptors**, elaborated on their terminals, that are specialized for receiving different types of stimuli (e.g., mechanical, chemical, thermal) and transducing them into nerve impulses that may eventually be conducted to nerve centers. These impulses are then transferred to other neurons for processing and transmission to higher centers for perceiving sensations or for initiating motor responses.

To accomplish these functions, the nervous system is organized anatomically into the :

**1-central nervous system (CNS)**, which comprises the brain and spinal cord

**2-peripheral nervous system (PNS)**. The PNS, located outside the CNS, includes cranial nerves, emanating from the brain; spinal nerves, emanating from the spinal cord; and their associated ganglia.

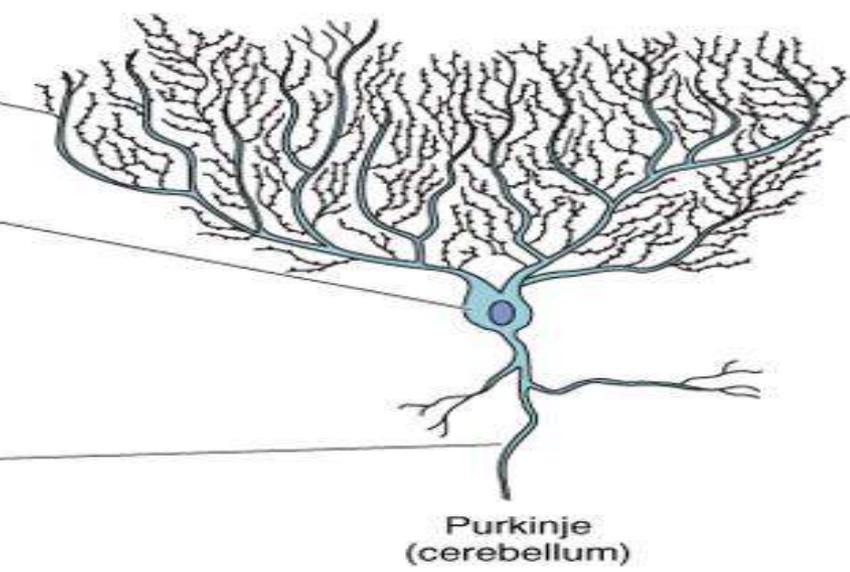
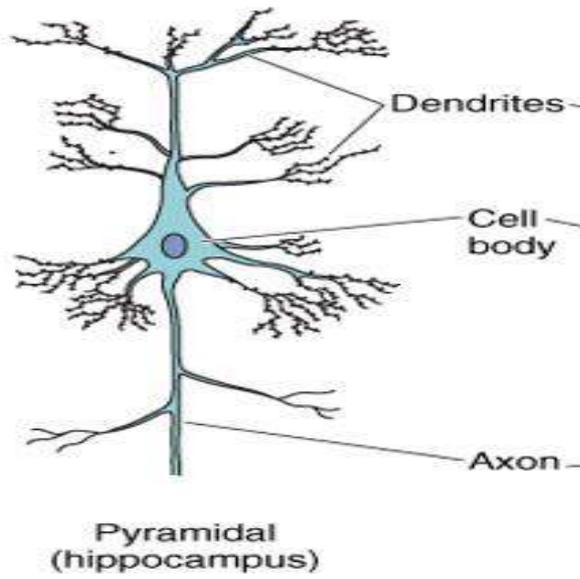
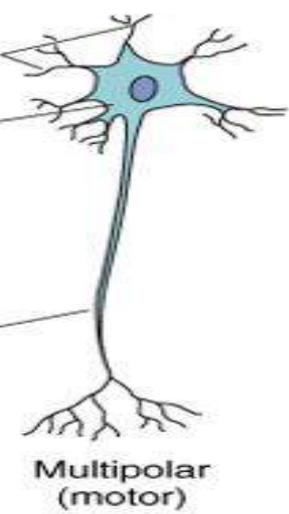
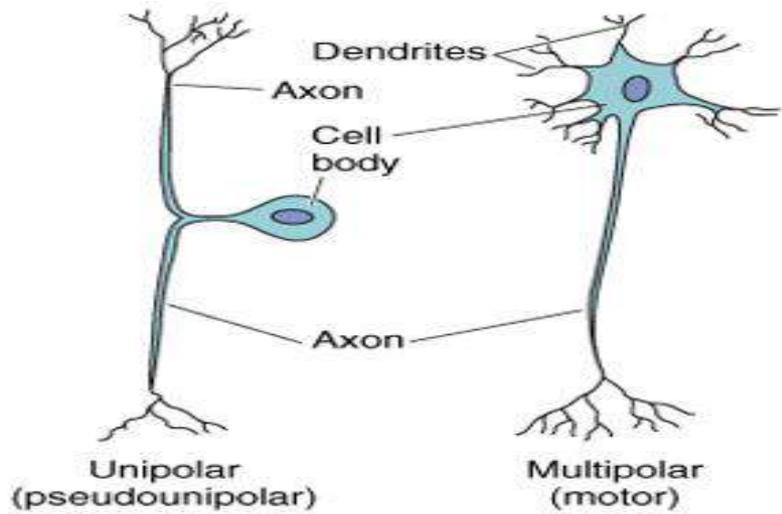
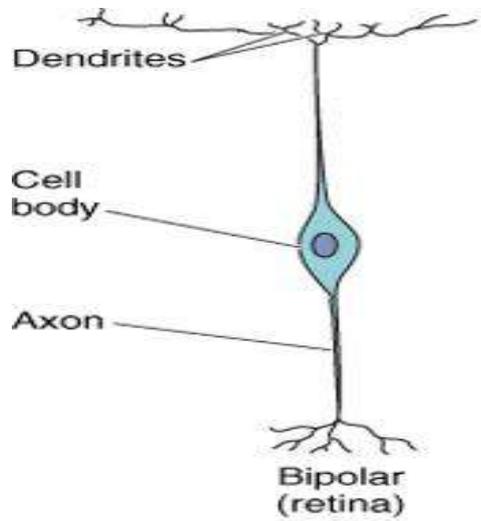
**Functionally, the PNS is divided into**

- sensory (afferent) component, which receives and transmits impulses to the CNS for processing.

-motor (efferent) component, which originates in the CNS and transmits impulses to effector organs throughout the body. The motor component is further subdivided as follows

- In the somatic system, impulses originating in the CNS are transmitted directly, via a single neuron, to skeletal muscles.

- In the autonomic system, in contrast, impulses from the CNS first are transmitted to an autonomic ganglion via one neuron; a second neuron originating in the autonomic ganglion then transmits the impulses to smooth muscles, cardiac muscles, or glands.



# **CELLS OF THE NERVOUS SYSTEM**

The cells of the nervous system are divided into two categories:

1-neurons, which are responsible for the receptive, integrative, and motor functions of the nervous system; and

2- neuroglial cells, which support and protect neurons.

## **Neurons**

The cells responsible for the reception and transmission of nerve impulses to and from the CNS are the neurons. Ranging in diameter from 5 to 150  $\mu\text{m}$ .

Neurons are composed of a cell body, dendrites, and an axon.

## **Neuroglial Cells**

Neuroglial cells function in the physical and metabolic support of neurons.

## *PERIPHERAL NERVOUS SYSTEM*

The peripheral nervous system includes the peripheral nerves and nerve cell bodies located outside the central nervous system (CNS).

### Functional Classification of Nerves

Functionally, nerve fibers are classified as sensory (afferent) or motor (efferent).

Nerve fibers are segregated functionally into sensory (afferent) fibers and motor (efferent) fibers.

Sensory nerve fibers carry sensory input from the cutaneous areas of the body and from the viscera back to the CNS for processing.

Motor nerve fibers originate in the CNS and carry motor impulses to the effector organs.

The sensory roots and motor roots of the spinal cord unite to form mixed peripheral nerves, the spinal nerves, which carry both sensory and motor fibers.

# Nervous Tissue

## SOMATIC MOTOR AND AUTONOMIC NERVOUS SYSTEMS

*Functionally, the motor component is divided into:*

*The somatic and autonomic nervous systems.*

The somatic nervous system provides motor impulses to the skeletal muscles. The autonomic nervous system provides motor impulses to the smooth muscles of the viscera, cardiac muscle of the heart, and secretory cells of the exocrine and endocrine glands, thus helping to maintain homeostasis.

## **● GANGLIA**

Ganglia are aggregations of cell bodies of neurons located outside the CNS. There are two types of ganglia: sensory and autonomic.

### **• Sensory Ganglia**

Sensory ganglia house cell bodies of sensory neurons

### **•Autonomic Ganglia**

Autonomic ganglia house cell bodies of postganglionic autonomic nerves.

## ■ CENTRAL NERVOUS SYSTEM

The CNS, composed of the brain and the spinal cord, consists of white matter and gray matter without intervening connective tissue elements; therefore, the CNS has the consistency of a semifirm gel.

- White matter is composed mostly of myelinated nerve fibers along with some unmyelinated fibers and neuroglial cells; its white color results from the abundance of myelin surrounding the axons.
- Gray matter consists of aggregations of neuronal cell bodies, dendrites, and unmyelinated portions of axons as well as neuroglial cells; the absence of myelin causes these regions to appear gray in live tissue

## ◇ Meninges

The three connective tissue coverings of the brain and spinal cord are the meninges. The outermost layer of the meninges is the dura mater, the intermediate layer is the arachnoid, and the innermost or intimate layer of the meninges is the pia mater .

### ■ Dura Mater

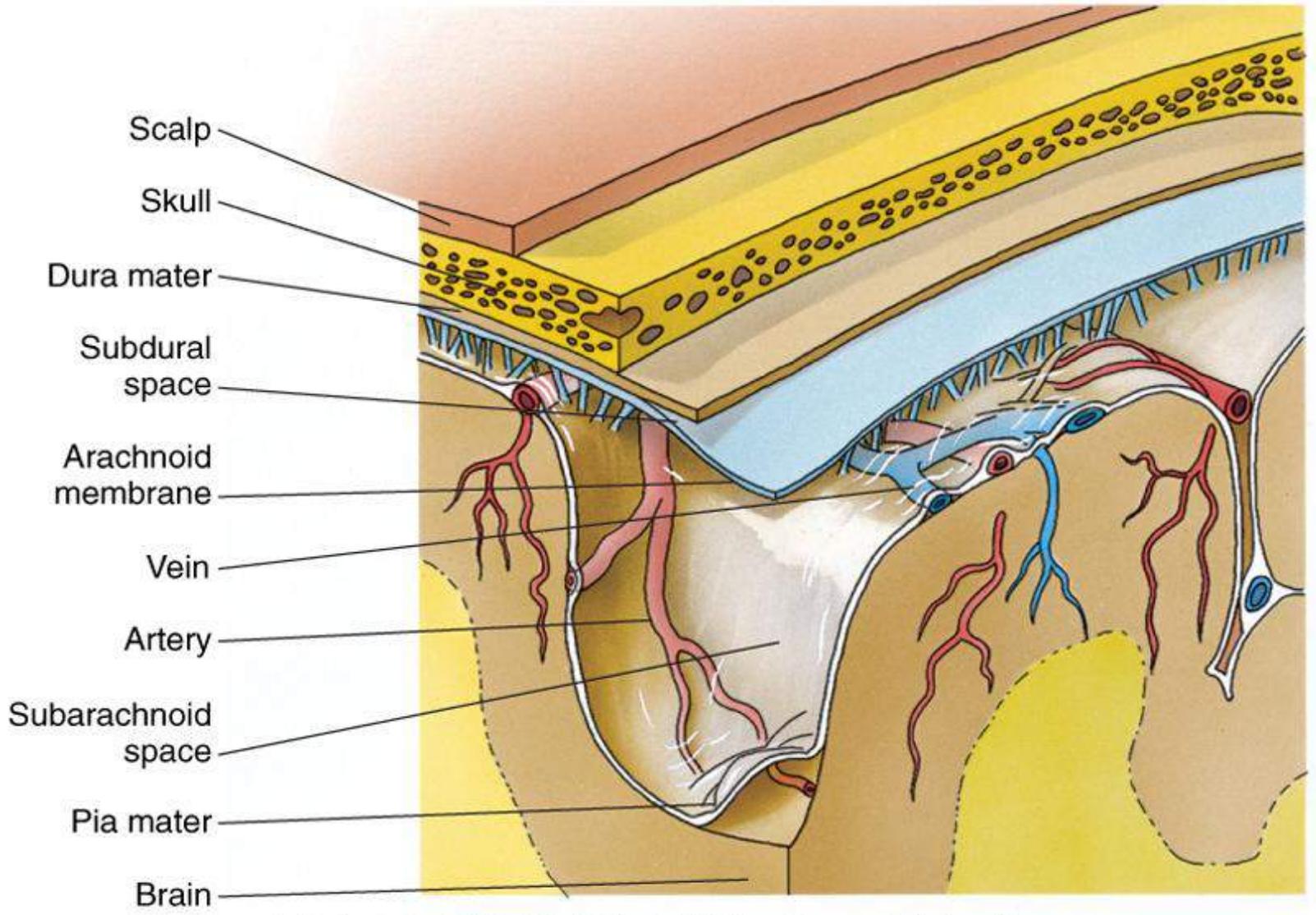
The dura mater is the dense outermost layer of the meninges

### ■ Arachnoid

The arachnoid is the intermediate layer of the meninges

### ■ Pia Mater

Pia mater, the innermost highly vascular layer of the meninges, is in close contact with the brain.



## **Blood-Brain Barrier**

A highly selective barrier, known as the blood-brain barrier, exists between specific blood-borne substances and the neural tissue of the CNS. This barrier is established by the endothelial cells lining the **continuous capillaries** that course through the CNS.

## **Choroid Plexus**

The choroid plexus, composed of folds of pia mater within the ventricles of the brain, produces CSF

The choroid plexus produces cerebrospinal fluid (CSF), which fills the ventricles of the brain and central canal of the spinal cord.

## **Cerebrospinal Fluid**

Cerebrospinal fluid bathes, nourishes, and protects the brain and spinal cord.

CSF is produced by the choroid plexus at the rate of about 14 to 36 mL/hour, replacing its total volume about four to five times daily.

CSF circulates through the ventricles of the brain, the subarachnoid space, the perivascular space, and the central canal of the spinal cord. CSF is low in protein but rich in sodium, potassium, and chloride ions. It is clear and has a low density. Consisting of about 90% water and ions, it may also contain a few desquamated cells and occasional lymphocytes.

# **Cerebral Cortex**

The cerebral cortex is responsible for learning, memory, sensory integration, information analysis, and initiation of motor responses.

Gray matter at the periphery of the cerebral hemispheres is folded into many gyri and sulci called the cerebral cortex. This portion of the brain is responsible for learning, memory, information analysis, initiation of motor response, and integration of sensory signals.

The cerebral cortex is divided into six layers composed of neurons that exhibit a morphology unique to the particular layer. The most superficial layer lies just deep to the pia mater; the sixth, or deepest, layer of the cortex is bordered by white matter of the cerebrum. The six layers and their components are as follows:

- 1 The molecular layer is composed mostly of nerve terminals originating in other areas of the brain, horizontal cells, and neuroglia.
- 2 The external granular layer contains mostly granule (stellate) cells and neuroglial cells.
- 3 The external pyramidal layer contains neuroglial cells and large pyramidal cells.
- 4 The internal granular layer is a thin layer characterized by closely arranged, small granule cells (stellate cells), pyramidal cells, and neuroglia. This layer has the greatest cell density of the cerebral cortex.
- 5 The internal pyramidal layer contains the largest pyramidal cells and neuroglia. This layer has the lowest cell density of the cerebral cortex.
- 6 The multiform layer consists of cells of various shapes (Martinotti cells), and neuroglia

## Cerebellar Cortex

The cerebellar cortex is responsible for balance, equilibrium, muscle tone, and muscle coordination.

Histologically, the cerebellar cortex is divided into three layers:

- 1 The molecular layer lies directly below the pia mater and contains superficially located stellate cells, dendrites of Purkinje cells, basket cells, and unmyelinated axons from the granular layer.
- 2 The Purkinje cell layer contains the large, flask-shaped Purkinje cells, which are present only in the cerebellum .
- 3 The granular layer (the deepest layer) consists of small granule cells and glomeruli (cerebellar islands). Glomeruli are regions of the cerebellar cortex where synapses are taking place between axons entering the cerebellum and the granule cells