

VI Semester
PHYSIOLOGICAL PSYCHOLOGY
Unit III

NERVOUS SYSTEM

The nervous system consists of the brain and the spinal cord which constitutes the central nervous system (CNS), and the cranial nerves, spinal nerves, and peripheral ganglia, which constitutes the peripheral nervous system (PNS). The CNS is encased in bone: the brain is covered by the skull, and the spinal cord is encased by the vertebral column. The brain is a large mass of neurons, glia and supporting cells. It is the most protected organ of the body, encased in tough, bony skull and floating in a pool of cerebrospinal fluid. The brain receives a copious supply of blood and is chemically guarded by the blood-brain barrier.

The entire nervous system – brain, spinal cord, cranial and spinal nerves and peripheral ganglia – is covered by tough and protective connective tissue called the meninges. The meninges consists of three layers. The outer layer dura mater, means “hard mother is thick, tough, and flexible but unstretchable. The middle layer of the meninges, the arachnoid membrane, is soft and spongy, and lies beneath the dura mater. Closely attached to the brain and spinal cord lies the pia mater, which is thin and delicate. The smaller surface blood vessels of the brain and spinal cord are contained within this layer. Between the pia mater and the arachnoid membrane is a gap called the subarachnoid space. This space is filled with a liquid called the cerebrospinal fluid (CSF). The PNS is covered with only the dura mater and pia mater.

The brain consists of a series of hollow, interconnected chambers called the ventricles (little bellies). The largest chambers are the lateral ventricles, third ventricles and the fourth ventricles. The CSF is produced in the lateral plexus of the lateral, third and fourth ventricles.

CENTRAL NERVOUS SYSTEM

BRAIN

The brain consists of three major divisions: the forebrain, the midbrain and the hindbrain.

FOREBRAIN

The forebrain which surrounds the lateral and third ventricles consists of the telencephalon and diencephalons.

1. Telencephalon - The telencephalon contains the cerebral cortex, the limbic system and the basal ganglia.

- a) Cerebral cortex – The cerebral cortex is organized into the frontal, parietal, temporal and the occipital lobes. The cerebral cortex is heavily convoluted consisting of sulci, fissures and gyri. It consists mostly of glia and cell bodies, dendrites and axons of neurons. Because cells predominate, it has a grayish brown appearance and therefore called gray matter. Beneath the cerebral cortex, there is a large concentration of myelin around the axon which gives the tissue an opaque white appearance and therefore called white matter. The central sulcus divides the frontal lobe, which deals specifically with movement and planning of movement, from the other three lobes which deal primarily with perceiving and learning. Three regions of the cerebral cortex receive information from the sensory organs: primary visual cortex, primary auditory cortex and primary somatosensory cortex.
 - b) Limbic system – this includes the limbic cortex, hippocampus and the amygdala. This area is involved in emotion, motivation and learning.
 - c) Basal ganglia – This area is a collection of subcortical nuclei in the forebrain that lie beneath the anterior portion of the lateral ventricles and include the caudate nucleus, the putamen and the globus pallidus. Its main function is in the control of movement.
2. Diencephalon – the diencephalon is situated between the telencephalon and the mesencephalon and includes the thalamus and the hypothalamus.
- a) Thalamus – The thalamus lies in the dorsal part of the diencephalon. It is divided into different nuclei which directs information to and from the cerebral cortex.
 - b) Hypothalamus – it lies near the base of the brain, under the thalamus. The hypothalamus is small but important. It controls the autonomic nervous system, endocrine system and organizes behaviour related to the survival of the species.

MIDBRAIN

The midbrain is also called the mesencephalon. It surrounds the cerebral aqueduct and consists of the tectum and tegmentum.

- 1. Tectum – The tectum or the roof is located in the dorsal portion of the mesencephalon. Its principal structures are the superior colliculi, which is a part of the visual system; and the inferior colliculi which is a part of the auditory system.
- 2. Tegmentum – The tegmentum or the covering consists of the portions of the mesencephalon beneath the tectum. It includes the reticular formation, which is important in sleep, arousal, and movement; the periaqueductal gray matter, which

controls various species-typical behaviours; and the red nucleus and substantia nigra, both of which are parts of the motor system.

HINDBRAIN

The hindbrain, which surrounds the fourth ventricle, contains the metencephalon, which consists of the cerebellum and pons; and myelencephalon which consists of the medulla oblongata.

1. Metencephalon

- a) Cerebellum – Also known as little brain, is covered by the cerebellar cortex and has a set of deep cerebellar nuclei. It is important in integrating and coordinating movements.
- b) Pons – It is large bulge in the brainstem and lies between the mesencephalon and medulla oblongata. It contains some nuclei that are important in sleep and arousal.

2. Myelencephalon

- a) Medulla oblongata – this is the most caudal portion part of the brainstem. It is involved in sleep and arousal, but also plays a role in control of movements and in control of vital functions such as heart rate, breathing and blood pressure.

SPINAL CORD

The spinal cord is a long, conical structure, approximately as thick as an adult's little finger. Its principal function is to distribute motor fibers to the effectors organs of the body (glands and muscles) and to collect somatosensory information to be passed on to the brain. The spinal cord is protected by the vertebral column which is composed of 24 individual vertebrae of the cervical (neck), thoracic (chest) and lumbar (lower back) regions of the sacral and coccygeal portion of the column (located in the pelvic region). The spinal cord passes through a hole in each of the vertebrae. Like the brain, the spinal cord consists of white matter and gray matter. Unlike the brain, it's white matter is on the outside and the gray matter is on the inside.

PERIPHERAL NERVOUS SYSTEM

The peripheral nervous system (PNS) contains the somatic nervous system, which consists of the cranial nerves and the spinal nerves; and the autonomic nervous system which consists of the sympathetic nervous system and the parasympathetic nervous system. The brain and the spinal cord communicate with the rest of the body via the cranial nerves and the spinal nerves. They convey sensory information to the CNS and conveys messages from the CNS to the body's muscles and glands.

1. Somatic nervous system – the SNS receives sensory information from the sensory organs and controls the movement of skeletal muscles.

- a) Spinal nerves – the spinal nerves begin at the junction of the dorsal and ventral roots of the spinal cord. The nerves leave the vertebrae column towards the muscles and sensory receptors they innervate, branching repeatedly as they go.
 - b) Cranial nerves – there are 12 pairs of cranial nerves that are attached to the ventral surface of the brain. Most of these nerves serve sensory and motor functions of the head and neck region.
2. Autonomic nervous system – the ANS is concerned with regulation of smooth muscles, cardiac muscles and glands. It has two divisions: the sympathetic nervous system and the parasympathetic nervous system.
- a) Sympathetic nervous system – the SNS is mostly involved in activities associated with expenditure of energy reserves that are stored in the body. For example, when an organism is excited, the SNS increases blood flow to skeletal muscles, stimulates the secretion of epinephrine; resulting in increased heart rate, increased blood sugar level and causes piloerection (erection of fur in mammals that have it and goose bumps in human). The cell bodies of SNS are located in the gray matter of the thoracic and lumbar regions of the spinal cord.
 - b) Parasympathetic nervous system – the PNS supports activities that are involved in the body's supply of stored energy. It includes salivation, gastric and intestinal motility, secretion of digestive juices, increased blood flow to the gastrointestinal system. The cell bodies that give rise to PNS are located in two regions; the nuclei of some of the cranial nerves and intermediate horn of the gray matter of the sacral region.

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