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DEPARTMENT : PHYSICIAN ASSISTANT

COURSE NAME : ANATOMY

UNIT : NERVOUS SYSTEM

TOPICS : BRAIN AND SPINAL CORD



NERVOUS SYSTEM



- The nervous system is the major controlling, regulatory, and communicating system in the body.
- It is the center of all mental activity including thought, learning, and memory. Together with the endocrine system, the nervous system is responsible for regulating and maintaining homeostasis.



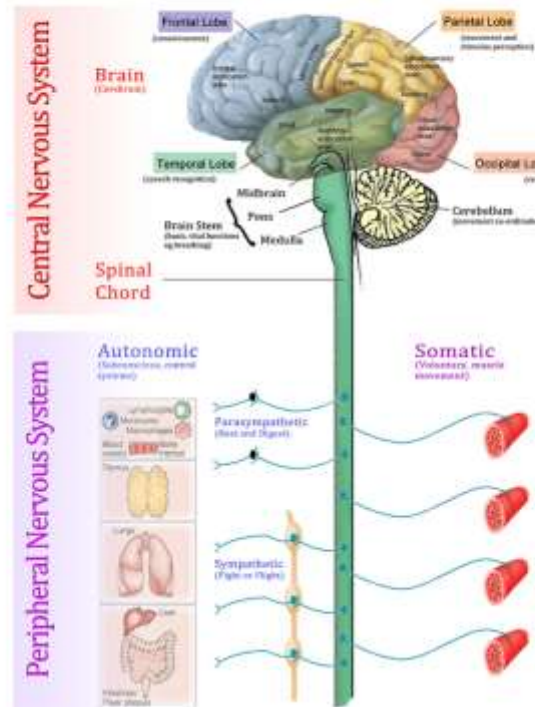
CENTRAL NERVOUS SYSTEM



- The central nervous system (CNS) is made up of the brain and spinal cord. The brain controls most body functions, including awareness, movements, sensations, thoughts, speech and memory.
- The spinal cord is connected to the brain at the brain stem and is covered by the vertebrae of the spine.



Central and Peripheral Nervous System





- The CNS consists of two organs which are continuous with each other; the brain and spinal cord. They are enveloped and protected by three layers of meninges, and encased within two bony structures; the skull and vertebral column, respectively.



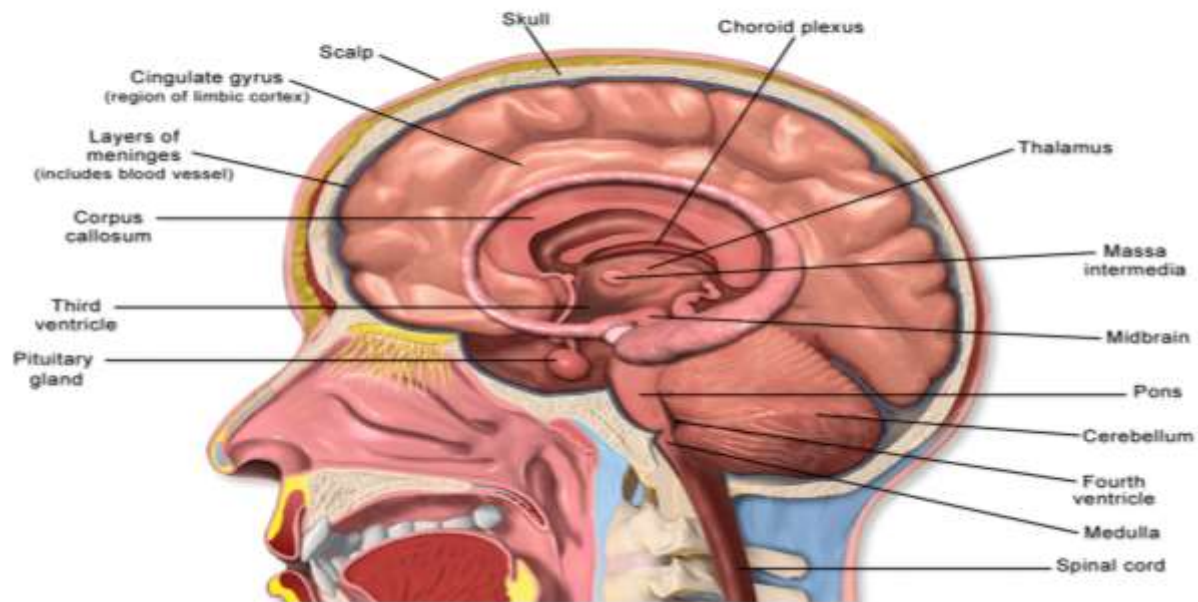
- The brain consists of the cerebrum, subcortical structures, brainstem and cerebellum. The spinal cord continues inferiorly from the brainstem and extends through the vertebral canal.
- While analyzing the information and preparing adequate body responses, the parts of the brain and spinal cord communicate with each other via many neural pathways.



- The brain gives off 12 cranial nerves that innervate the head, neck and thoracic and abdominal viscera, while the spinal cord gives off 31 pairs of spinal nerves.



Brain Anatomy





GREY AND WHITE MATTER



- The chief cells of the brain and spinal cord are the neurons, which receive and transmit neural impulses. Each neuron has a body which is its micro-command center, and it has a gray color when observed microscopically.
- The neurons possess two or more neural processes that stem from the body and relay the neural information.



- The neural processes are divided into short (dendrites) and long (axons). Most of the axons are ensheathed by a substance called myelin, which gives them a distinguishable white color.
- The parts of neurons comprise what we call gray and white matter. The gray matter is made up of clusters of neuronal bodies, while the white matter is composed of their myelinated axons.



CORTEX AND BRAIN LOBES



- The cerebrum, or forebrain, is the most prominent part of the brain. It consists of two cerebral hemispheres interconnected by the corpus callosum. The surface of the cerebrum is highly irregular, being composed of sulci (ridges) and gyri (folds).



- The sulci and gyri increase the surface area of the cerebrum, providing it with the highest processing power and cognitive ability in the entire nervous system. Each hemisphere is composed of five regions called cerebral lobes: frontal, parietal, temporal, occipital and insular.



SUBCORTICAL STRUCTURES



- The subcortical structures are a neural group of structures embedded deep within the brain. They include the diencephalon, basal ganglia, limbic system and pituitary gland.



DIENCEPHALON



The diencephalon is located deep within the white matter of the brain. It is a collection of four cerebral structures located on each side of the midline, bilaterally to the third ventricle of the brain. These include:



- **Thalamus**, which is an ovoid nuclear mass that consists of four groups of nuclei: anterior, medial, lateral and intralaminar nuclei of thalamus. The thalamus relays sensory and motor information to and from the cerebral cortex.



- **Epithalamus**, which represents the most posterior part of the diencephalon. It consists of the pineal body, stria medullaris and habenular trigone. The epithalamus is involved in the control of the sleep-wake cycle (circadian rhythm) and movement initiation and control.



- **Subthalamus**, which is located ventral to the thalamus. It comprises the subthalamic nucleus, zona incerta (of Forel) and peripeduncular nucleus. The role of the subthalamus is in the control, integration and accuracy of motor activity.



- **Hypothalamus**, which is positioned inferoanterior to the thalamus. It is divided into three groups of nuclei (anterior, middle, posterior) and three zones (periventricular, medial, lateral). The hypothalamus regulates the stress response, metabolism and reproduction through various hypothalamic axes and the hypophyseal portal system.



BASAL GANGLIA



- The basal ganglia are a group of nuclear masses of grey matter spread out throughout the lower part of cerebrum, diencephalon and midbrain. These nuclei include the caudate nucleus, putamen, globus pallidus, substantia nigra and subthalamic nucleus.
- The caudate nucleus and putamen collectively form the striatum. The putamen and globus pallidus form the lentiform nucleus.



LIMBIC SYSTEM



- The limbic system is a set of structures spanning the cerebrum, subcortex and brainstem. It consists of two divisions called the limbic cortex and deep limbic structures. The limbic cortex is formed by various cerebral sulci and gyri of the frontal, temporal and parietal lobes.
- The deep part of the limbic system is formed by the hippocampal formation, amygdala, diencephalon, olfactory cortex, basal ganglia, basal part of the cerebrum and brainstem.



BRAINSTEM



- The brainstem is the inferior-most part of the brain. It sits in the posterior cranial fossa and consists of three parts: midbrain, pons and medulla oblongata.
- Internally, it is divided into the basal area, tegmentum and tectum.



MIDBRAIN



- The midbrain is the most superior part of the brainstem. It is located between the thalamus superiorly and the pons inferiorly.
- The midbrain is involved in visual and auditory reflexes, alertness and temperature control. It is supplied by the mesencephalic branches of basilar artery.



PONS



- The pons is the middle component of the brainstem, situated between the midbrain and medulla oblongata. The pons is involved in various functions like sleep, hearing, swallowing, taste, respiration, equilibrium and motor actions.
- Its blood supply is from the pontine branches of basilar artery.



MEDULLA OBLONGATA



- The medulla oblongata is the most inferior part of the brainstem. It regulates autonomic activities related to cardiac, respiratory, reflex, and vasomotor functions.
- The medulla oblongata is supplied by the inferior cerebellar arteries and anterior spinal artery.



CEREBELLUM



- The cerebellum is located in the posterior cranial fossa, posterior to the brainstem and fourth ventricle. It is separated from the cerebrum by the tentorium cerebelli.
- In addition, the cerebellum is anchored to and communicates with the brainstem via the superior, middle and inferior cerebellar peduncles.



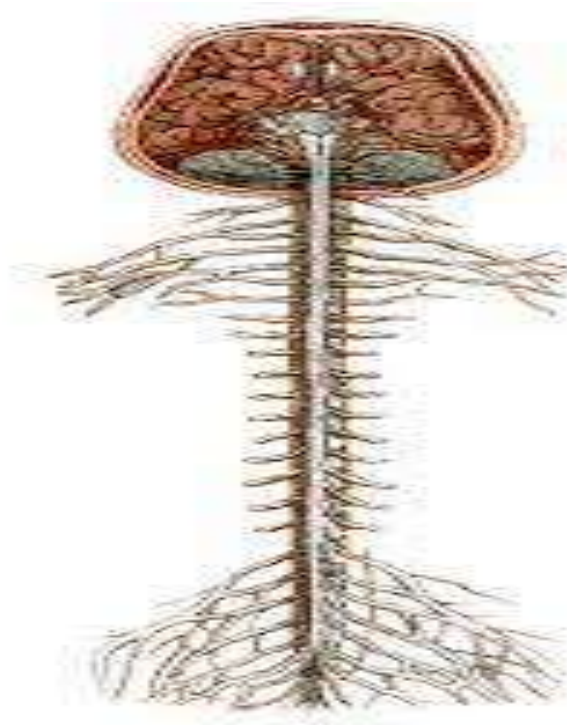
- The cerebellum consists of three parts; a middle vermis flanked by two hemispheres. The superior (tentorial) surface points superiorly and the inferior (occipital) surface faces inferiorly.
- The cerebellum is divided horizontally into three lobes (anterior, posterior, flocculonodular) and approximately ten lobules (I-X).



SPINAL CORD

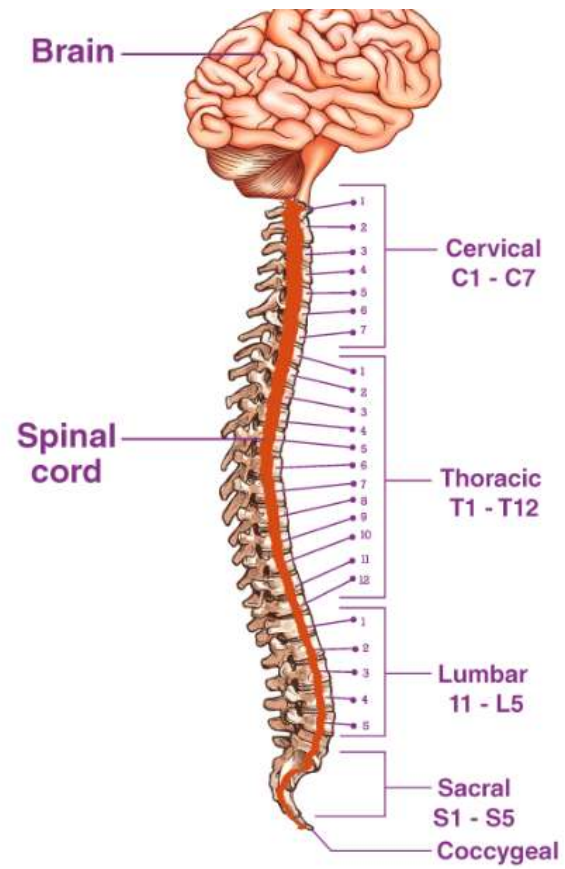


- The spinal cord continues inferiorly from the medulla oblongata. It extends from the foramen magnum of the skull to the level of the L1/L2 vertebrae.
- The spinal cord consists of five segments (cervical, thoracic, lumbar, sacral, coccygeal) and a total of 31 pairs of spinal nerves emerging out of them.





- The spinal cord has four surfaces, one anterior fissure and three sulci. Internally, it consists of a central grey matter surrounded by white matter.
- Blood supply to the spinal cord originates from the vertebral and segmental arteries.





MENINGES



- The meninges represent three membranes that envelop the brain and spinal cord. The meninges of the brain are referred to as the cranial meninges, while the meninges of the spinal cord are called the spinal meninges.
- The cranial and spinal meninges are continuous with each other through the foramen magnum.



- Dura mater - it is a two-layered sheath consisting of the periosteal and meningeal dura mater. Dura mater of the brain is firmly attached to the skull by its periosteal layer.
- The spinal dura (theca) envelops the spinal cord and is separated from the vertebral column by the epidural space. The layers of the cranial dura diverge from each other in several sites, forming a space that contains the dural venous sinuses.



Arachnoid mater - the cranial and spinal arachnoid lie underneath the dura mater. The space between the dura and the arachnoid is called the subdural space.



- Pia mater - the cranial and spinal pia mater tightly adhere to the surfaces of the brain and spinal cord, respectively. Pia mater is highly vascular, containing numerous blood vessels that nourish the surfaces of the CNS.
- The cranial pia mater envelops the whole brain, and is inferiorly continued by the spinal pia. The spinal pia overlies the spinal cord and terminates as the filum terminale past the S2 vertebra.



- The space between the arachnoid and pia mater is called the subarachnoid space. It contains the CSF and superficial blood vessels of the brain and spinal cord.
- Moreover, it shows mushroom-like protrusions through the overlying dura mater called the arachnoid granulations, whose purpose is to enable the main route for CSF elimination.



BRAIN VENTRICLES AND CEREBROSPINAL FLUID



- The cerebrospinal fluid (CSF) is a colorless fluid that bathes the brain and spinal cord. It is produced by the specialized tissue called the choroid plexus which is found within the walls of the brain ventricles.
- The CSF circulates sequentially through the ventricles and subarachnoid cisterns to finally be reabsorbed into the venous system through the subarachnoid granulations.



- The brain ventricles are the CSF filled cavities embedded deep within the brain parenchyma.
- Within the brain, there are four ventricles: the two lateral ventricles within the lobes of the cerebrum, a single third ventricle in the midline between the hemispheres, and a fourth ventricle situated posterior to the brainstem.



- The ventricles communicate via five foramina, which ensure that the CSF can circulate through the ventricular system:
- Interventricular foramen (of Monro) between the lateral ventricles and the third ventricle.



- Cerebral aqueduct (of Sylvius) between third and fourth ventricles.
- Two lateral apertures (of Luschka) between the fourth ventricle and cerebellopontine cistern.
- Median aperture (of Magendie) between the fourth ventricle and cisterna magna of the subarachnoid space



NEURAL PATHWAYS AND SPINAL CORD TRACTS



- The neural pathways are the bundles of axons that interconnect different neurons.
- The pathways can be found exclusively within the brain connecting its different parts, or they can connect the brain and the spinal cord.



- The pathways within the brain are referred to as the tracts
- Neural pathways that connect the brain and the spinal cord are called the ascending (sensory) and descending (motor) tracts.



Spinal cord tracts are classified as follows:

- Ascending tracts, consisting of dorsal column (fine touch, proprioception), spinothalamic (crude touch, pressure, pain, temperature), spinocerebellar (proprioception, coordination, posture), spino-tectal (spinovisual reflex), spino-reticular (consciousness) and spino-olivary (cutaneous, proprioception) pathways.



- Descending tracts, including the corticospinal (voluntary movements), corticobulbar (influences activity of cranial nerves), reticulospinal (facilitation or inhibition of voluntary and reflex actions), tectospinal (auditory and visual reflexes), rubrospinal (fine involuntary movement) and vestibulospinal (balance) pathways.



APPLIED ANATOMY



- Multiple Sclerosis (MS)
- Parkinson's Disease
- Alzheimer's Disease
- Meningitis
- Epilepsy
- Stroke
- Huntington's Disease



ASSESSMENT



- What all are the Structures in CNS ?
- What all are the Meninges of Brain ?