General Anatomy Of The Nervous System

Learning objectives

After this lecture, the student should be able to:

- Know the structure and divisions of the nervous system

- Describe the components of the central and peripheral nervous system.

- Describe the formation of the spinal nerve.

- Know the autonomic nervous system (function and components).

The nervous system can be divided into two parts:

I) The central nervous system (CNS)

II) The peripheral system (PNS)

Some important definitions:

1- The neuron: It is the anatomical, embryological and functional unite of the nervous system. It is formed of a cell body which contain the nucleus and processes. The processes are of 2 types a)axon and b) denderites

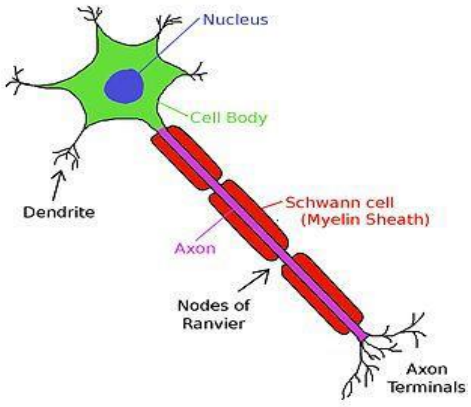
.**a) The axon**(nerve fiber): single nerve process which carries nerve impulses away from the cell body.

b) Denderites: short, multiple processes which carry impulses toward the cell body.

2- The central nervous system (CNS) consist of **grey matter**(nerve cells and unmyelinated nerve fibers) , **White matter** (myelinated nerve fibers) and **reticular formation** (a mixture of nerve cells & nerve fibers)

3-The peripheral system (PNS): It consist of nerves, nerve endings and nerve ganglia

4- Synapse : Site where impulses pass from one neuron to the another.



The neuron

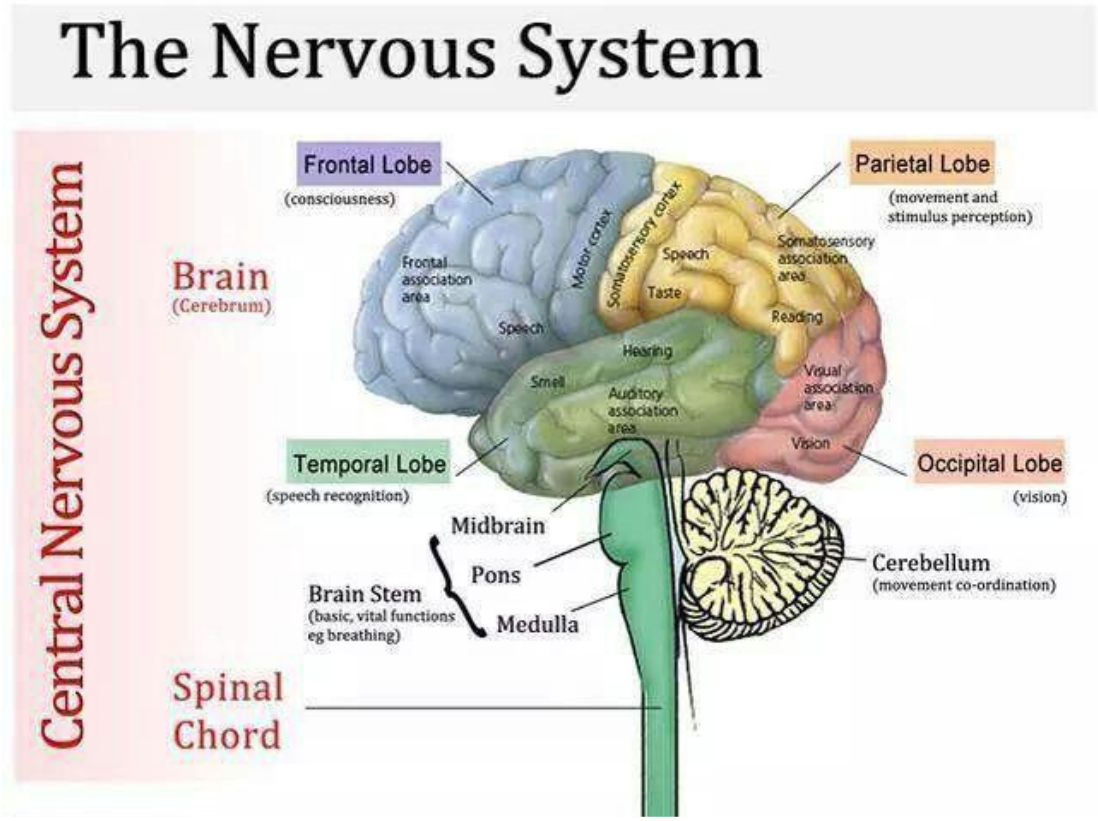
I) The central nervous system(CNS)

It is formed of **the brain and the spinal cord** both are centrally located and protected by bones The brain is protected by the skull and the spinal cord is protected by the vertebral column.
The central nervous system is the part of the nervous system which is covered by 3 coverings called meninges(dura mater, arachnoid mater and pia mater).
The function of (CNS): It receives the different sensations, associates, intergrates and elaborates them, selects the motor neurons which can send motor orders to the proper muscles or glands ,so that a proper response is obtained.

Brain

The brain is formed of the following parts, **A) Cerebrum ,**

B) The cerebellum and C) The brain stem:



A) Cerebrum

Which is formed if two hemispheres connected by fibers called the corpus callosum. Each cerebral hemisphere is formed of an outer gray matter and an inner white matter. The gray matter is formed mainly of nerve cells with some nerve fibers. It is called the cerebral cortex. The cerebral cortex contains the motor and sensory areas as well as memory and psychic areas. The inner white matter is formed mainly of nerve fibers within the white matter masses of gray matter appears forming the basal ganglia. The most important basal ganglia are the caudate and lentiform nuclei. The surface of the cerebral cortex show convolution known as gyri separated by sulei. This increases the surface area of the cortex. The cerebral cortex contains about 14 billion nerve cells. On gyri of the cerebral cortex different areas which control activities of the body are present.

Each cerebral hemisphere is divided into lobes which are:

1. The frontal lobe: It is located anteriorly in the anterior cranial fossa. It contains the motor area of the brain.

2. The parietal lobe: It is located posterior to the frontal lobe. It contains the sensory area of the brain.

3. The occipital lobe: It is located posteriorly. It contains the visual area.

4. The temporal lobe: It is located inferiorly in the middle cranial fossa. It contains the auditory area (hearing).

B) The cerebellum

It is located inferior to the occipital lobe in the posterior cranial fossa. It consists of two cerebellar hemispheres on each side connected together by a median part called the vermis. The cerebellum is separated from the medulla and pons by the cavity of the fourth ventricle.

Like the cerebrum, the cerebellum has an outer cortex (gray matter) and inner medulla (white matter). The medulla contains masses of gray matter called the nuclei of the cerebellum (e.g. the dentate nucleus). The cerebellum is connected to the brain stem by masses of fibers (white matter) called peduncles. Three pairs of peduncles are present:

* The superior cerebellar peduncles connect the cerebellum with the midbrain.
* The middle cerebellar peduncles connect the cerebellum with the pons.
* The inferior cerebellar peduncles connect the cerebellum with the medulla.

Through its connections cerebellum performs 3 main functions

1. Controls muscle tone.
2. Maintains equilibrium
3. Coordinates muscle movement

C) The brain stem:

It is stalk-like structure which connects the brain with the spinal cord. It is formed of three different parts:

1. The midbrain:

It connects the cerebrum with the pons. It is connected with the cerebellum by superior cerebellar peduncle.

2. Pons:

It connects the midbrin with the medulla oblongata and with the cerebellum by the middle cerebellar peduncle.

3. Medulla oblongata:

It connects the pons with the spinal cord. It is connected with the cerebellum by inferior cerebellar peduncle.

The brain stem contains important brain centres e.g. cranial nerve nuclei, reticular formation, red nucleus, olivary nuclei and other important centers.

Spinal cord

It begins as the downward continuation of the medulla oblongata at the foramen magnum of the skull and ends at the level of lower border of 1st or upper border of 2nd lumber vertebra .It has a central narrow cavity called central canal It is divided into 31segments.

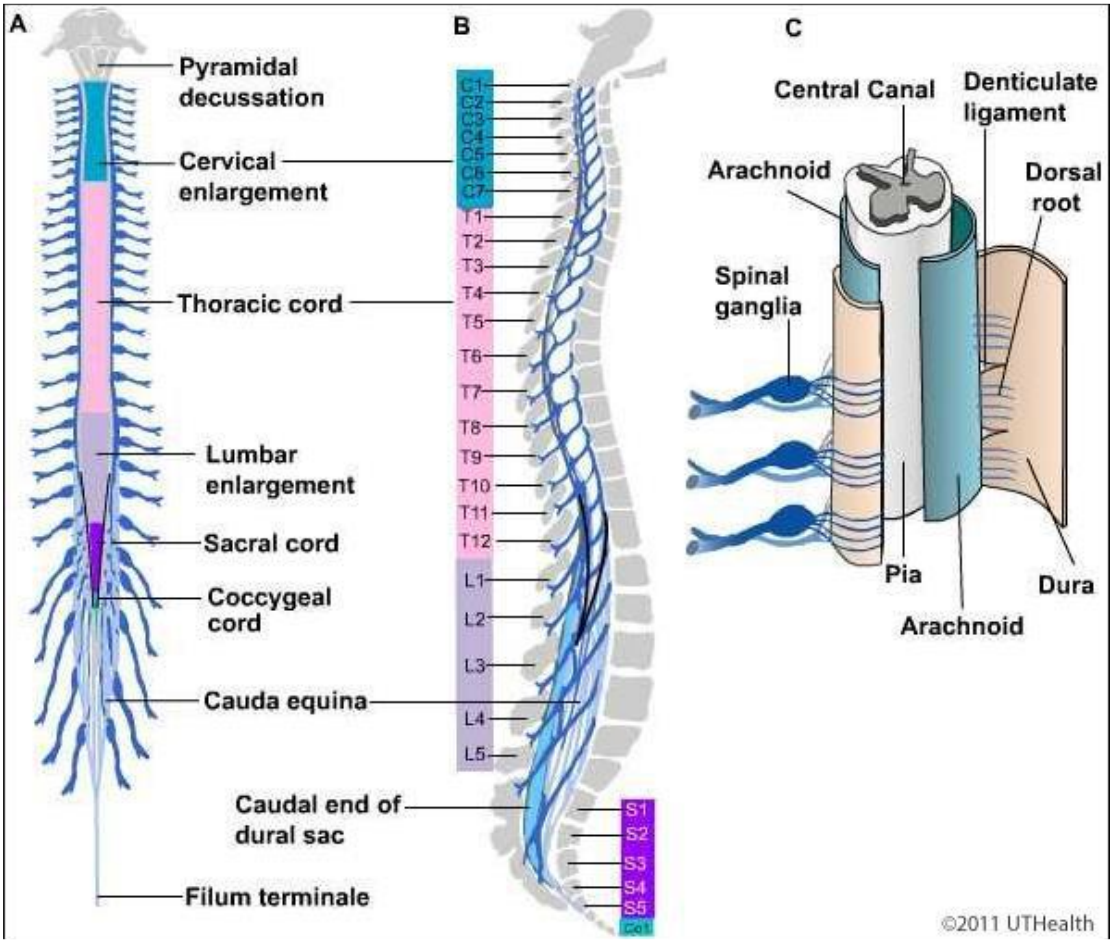
8 Cervical segments

12 Thoracic segments

5 Lumber segments

5 Sacral segments

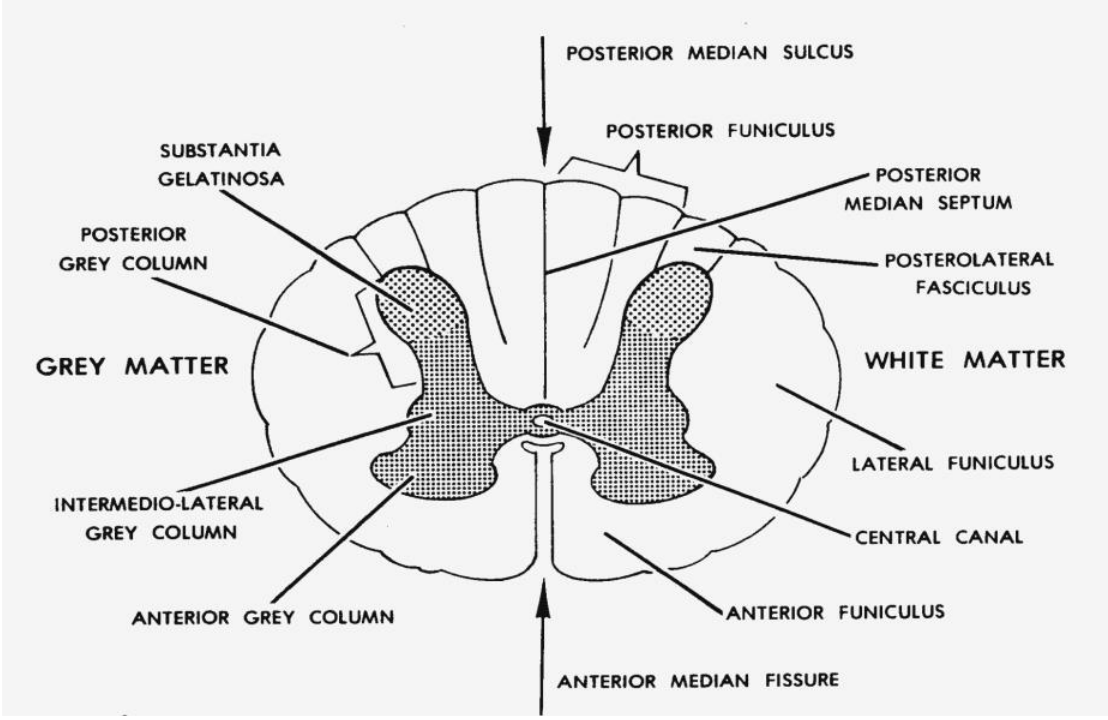
1 Coccygeal segments



A pair of spinal nerves arise from each segment of the spinal cord. The spinal cord is formed of an outer layer of white matter and an inner layer of gray matter.

In tansverse section the spinal cord it shows:
-<u>Outer white matter</u>: sensory &motor tracts
Sensory tracts carry sensations to the brain while motor tracts carry the higher motor orders to the brain.

- <u>Inner gray matter</u>: The gray matter is H shaped.**.** The two anterior horns contain motor neurons and the two posterior horns contain sensory neurons.
The lateral horn is present in the thoracic and upper two lumber segments. It is only source of sympathetic fibers.



The Meninges

These are coverings of the brain and spinal cord. It is formed of three layers:

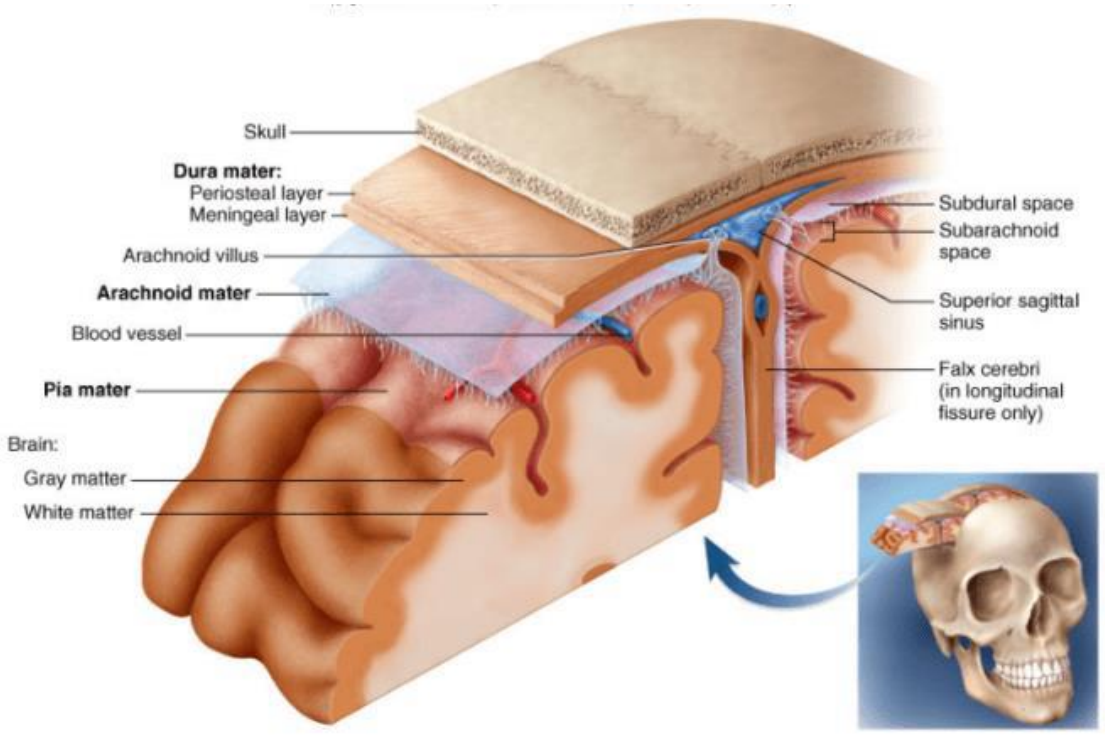
1. **The dura mater** (the outer fibrous layer).

2-The arachnoid mater (the middle layer).

3-**The pia mater** which is attached to the brain and spinal cord.

Note: The pia mater is separated from the arachnoid mater by the subarachnoid space.

Meninges protects the brain and spinal cord. The subarachnoid space contains blood vessels that supply the brain and spinal cord as well as a watery fluid known as the cerebrospinal fluid C.S.F. The C.S.F. circulates inside the brain cavities (ventricles) and the central canal of the spinal cord.



II)The peripheral nervous system (PNS)

It is formed of the peripheral nerves **(12 pairs of cranial nerves and 31 pairs of spinal nerves)**. Spinal nerves tend to form plexuses which are the cervical, the brachial, the lumbar and the sacral plexuses.

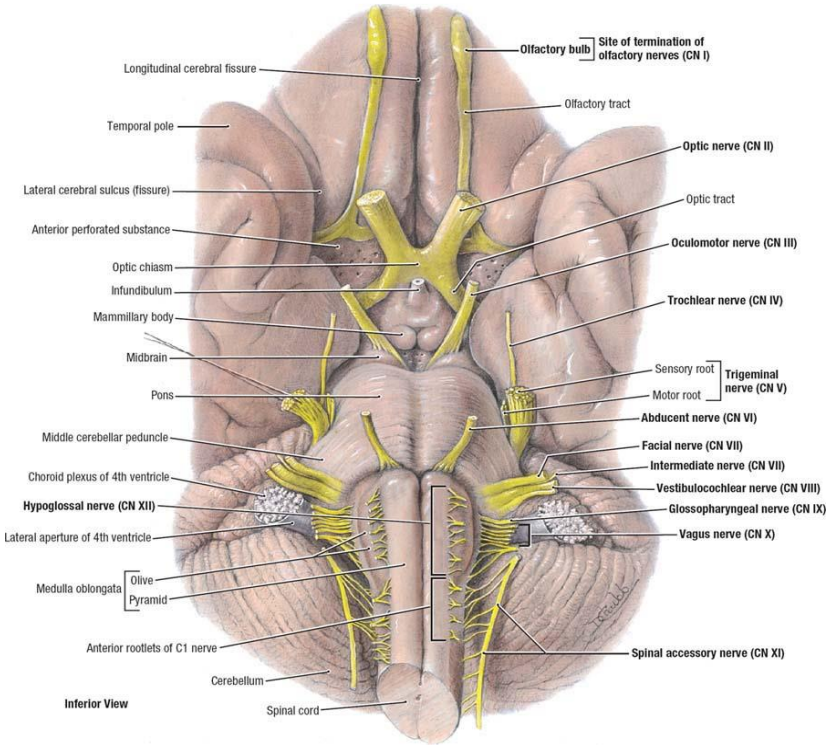
The function of the **(PNS)** : It receives sensations from the sense organs (called receptors)and by way of sensory nerve fibers it transmits these sensations to the central nervous system. I t also carries motor orders from the CNS to the muscles and the glands of the body (called effectors) by means of motor nerve fibers.

Cranial nerves:

They are 12 pairs of nerves connected with the brain. They give nerve supply to the head and neck. They are either purely motor , purely sensory or mixed.

The cranial nerves are

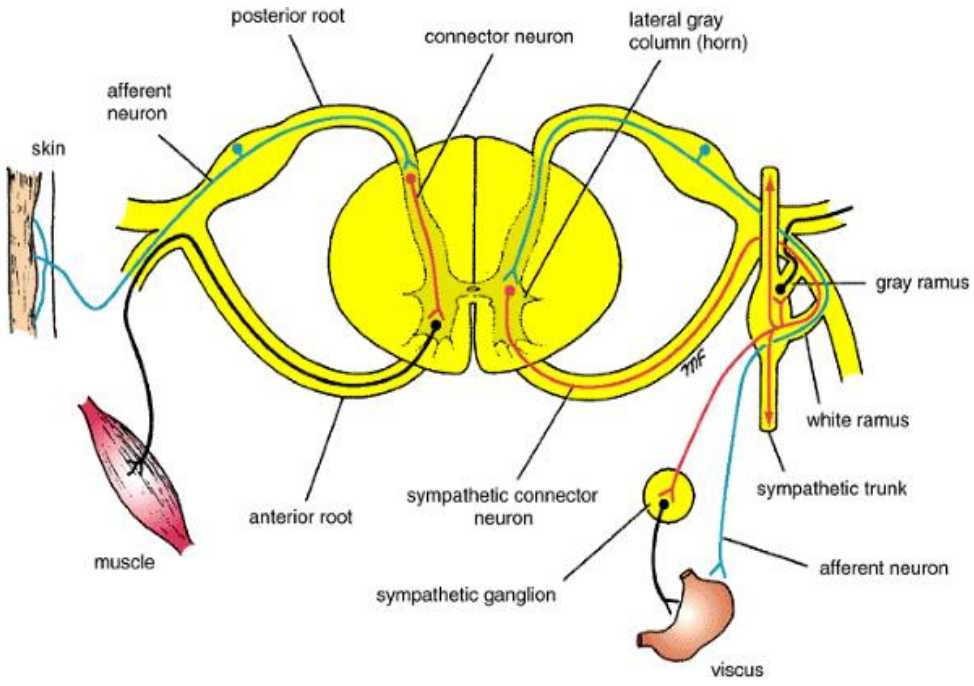
1. The first (I) is the **alfactory** nerve.
2. The second (II) is the ***optic***
3. The third (III) is the **aculomotor** nerve.
4. The fourth (IV) is the ***trochlear*** nerve.
5. The fifth (V) is the ***trigeminal*** nerve.
6. The sixth (VI) is the ***abducent*** nerve.
7. The seventh (VII) is the ***facial*** nerve.
8. The eight (VIII) is the ***vestibulocochlear*** nerve.
9. The ninth (IX) is the ***glossopharyngeal*** nerve.
10. The tenth (X) is the ***vagus*** nerve
11. The eleventh (XI) is the ***accessory*** nerve.
12. The twelfth (XII) is the ***hypoglossal*** nerve,



The inferior aspect of the brain, showing the origins of the cranial nerves

Spinal Nerves

There are 31 pairs of spinal nerves each is connected to one segment of the spinal cord. Each nerve is formed of an anterior root (Motor arising from anterior horn cells) and posterior root (sensory reaching the posterior horn cells). The two roots unite to form the trunk of the nerve which is mixed. The nerve trunk is divided into an anterior ramus and a posterior ramus. Each ramus is mixed. Each spinal nerve carries different sensations from the skin, muscles and deeper structure as well as motor fibers to skeletal muscles. Sensory fibers relay in spinal ganglia before entering the cord.



The composition of a peripheral nerve

THE AUTONOMIC NERVOUS SYSTEM

The autonomic nervous system is the part of the nervous system concerned with the innervation of involuntary structures such as the heart, smooth muscles and glands throughout the body.

It is formed of peripheral nervous which have central connection.

The autonomic nervous system is divided into two parts, the sympathetic and the parasympathetic.

a) <u>The sympathetic system</u>, prepares the body for emergency.

It is connected centrally to the spinal cord segments from the first thoracic to the third lumbar (thoraco-lumbar) The sympathetic fibers are connected to sympathetic ganglia (paravertebral ganglia) of the sympathetic trunk .

b) <u>The parasympathetic system</u>: (cranio-sacral) It is divided into:

1. Cranial part in the cranial nervous 3, 7, 9 and 10.
2. The sacral which is connected centrally with the sacral segments 2, 3 and 4 of the spinal cod.

Activities of the parasympathetic system aim at conserving and restoring energy of the body .