INTRODUCTION TO NERVUOS SYSTEM

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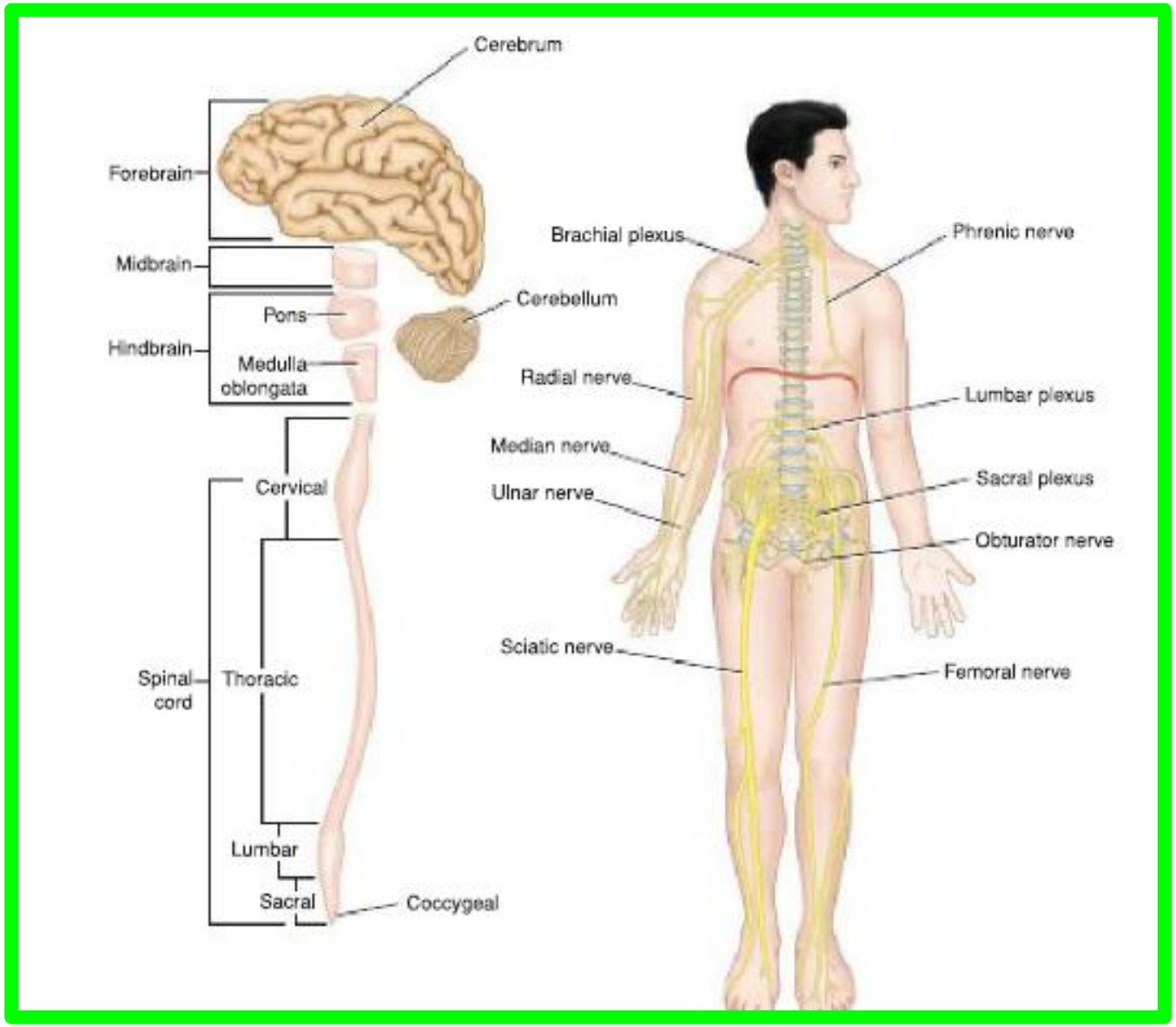
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

The nervous system is divided into two main parts, for purposes of description:

- **The central nervous system (CNS) , which consists of the brain and spinal cord**

- **The peripheral nervous system (PNS) , which consists of the cranial and spinal nerves and their associated ganglia.**



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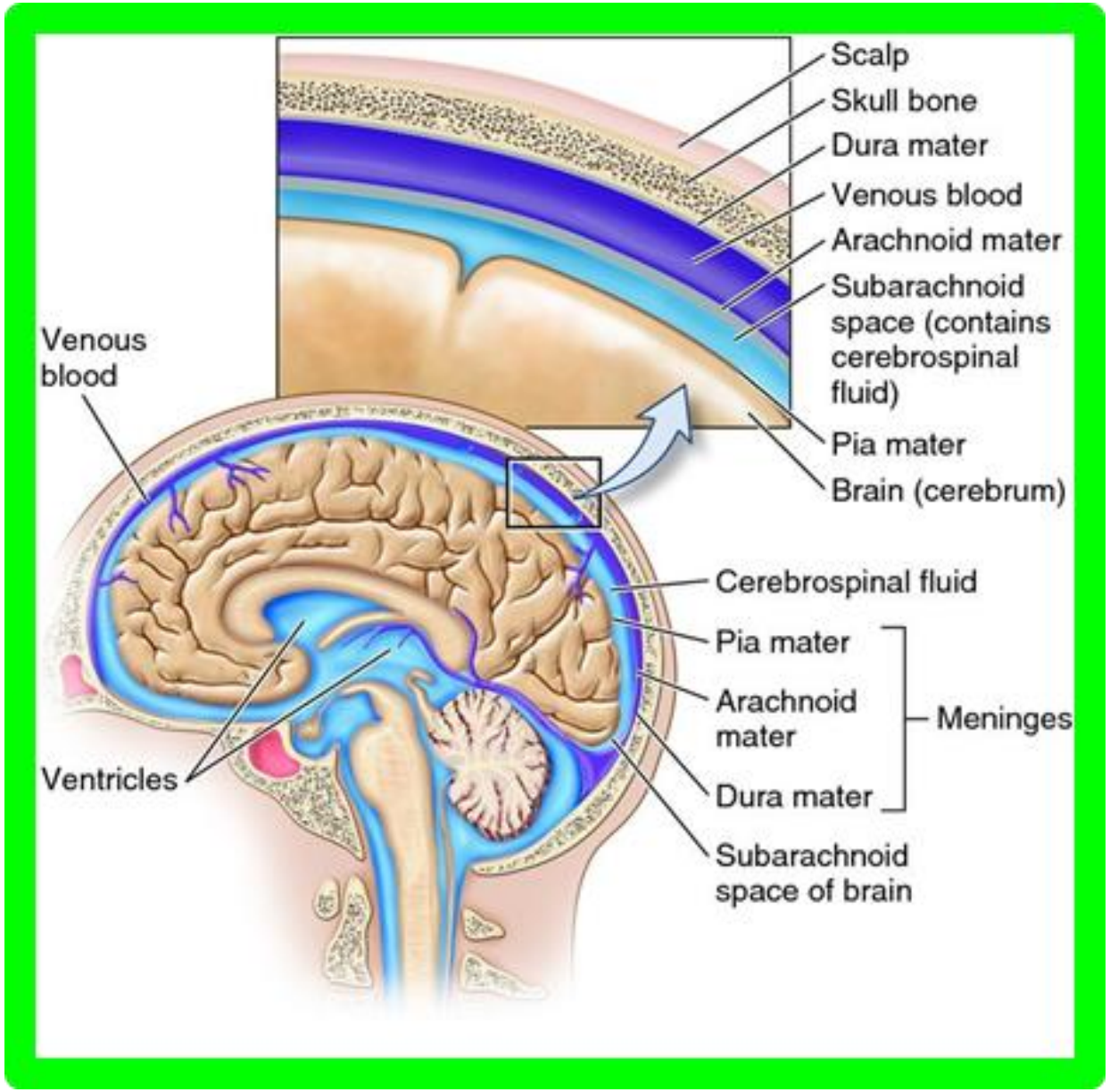
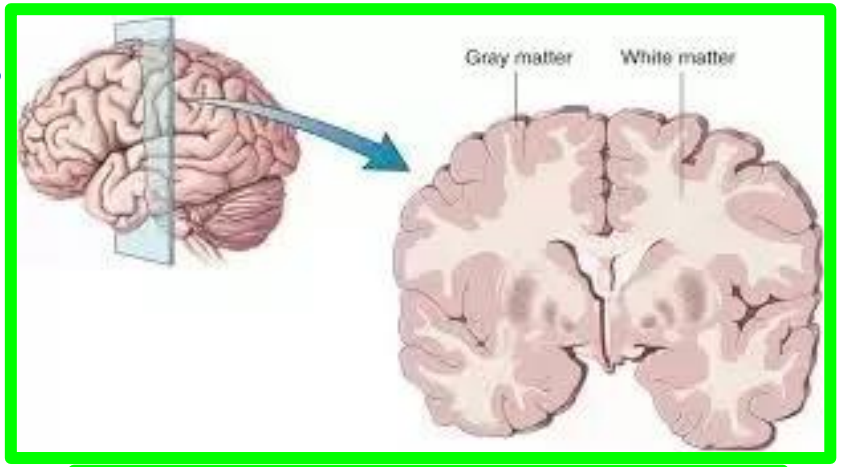
CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

- ✓ In the CNS, the brain and spinal cord are the main centers where correlation and integration of nervous information occur.
- ✓ Both the brain and spinal cord are covered with a system of membranes (meninges) and are suspended in cerebrospinal fluid (CSF).
- ✓ Meninges are further protected by the bones of the skull and the vertebral column

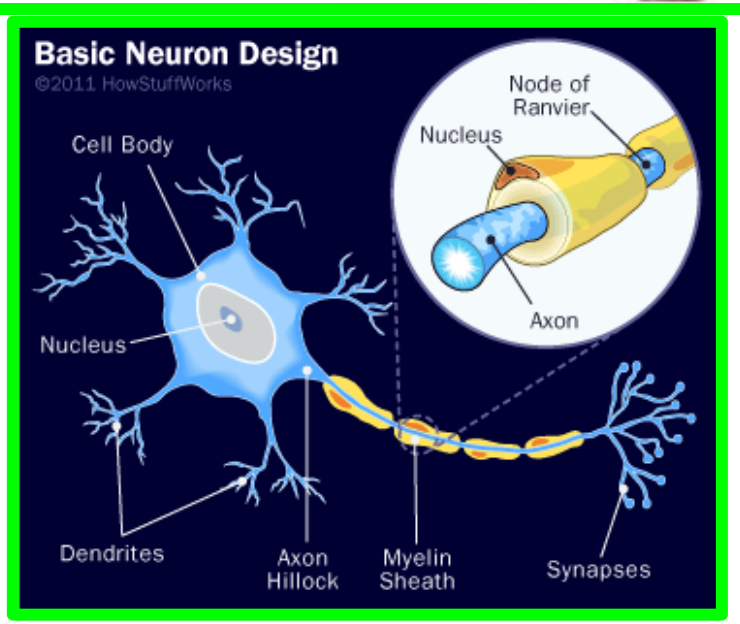


CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

The CNS is composed of large numbers of neurons, which are excitable nerve cells, and their processes known as axons or nerve fibers. Neurons are supported by specialized tissue called neuroglia.



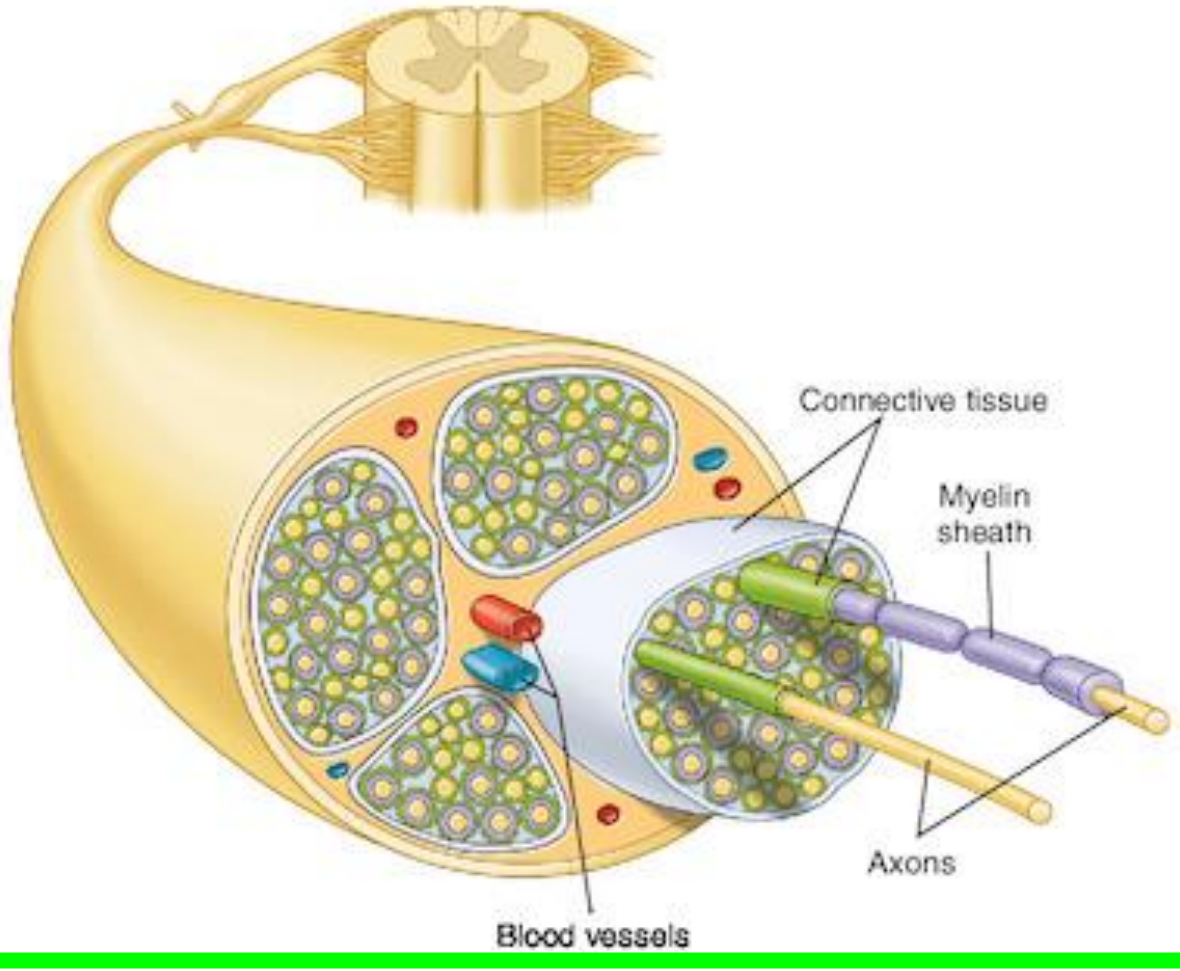
- The CNS interior is organized into gray and white matter.
- Gray matter, which is gray in color, consists of nerve cells embedded in neuroglia.
- White matter consists of nerve fibers embedded in neuroglia and is white in color because of the presence of lipid material in nerve fiber myelin sheaths



CENTRAL AND PERIPHERAL NERVOUS SYSTEMS

In the PNS, the cranial and spinal nerves, which consist of bundles of nerve fibers (or axons), conduct information to and from the CNS.

Although the nerves are surrounded by fibrous sheaths as they run to different parts of the body, they are relatively unprotected and are commonly damaged by trauma.



Autonomic Nervous System

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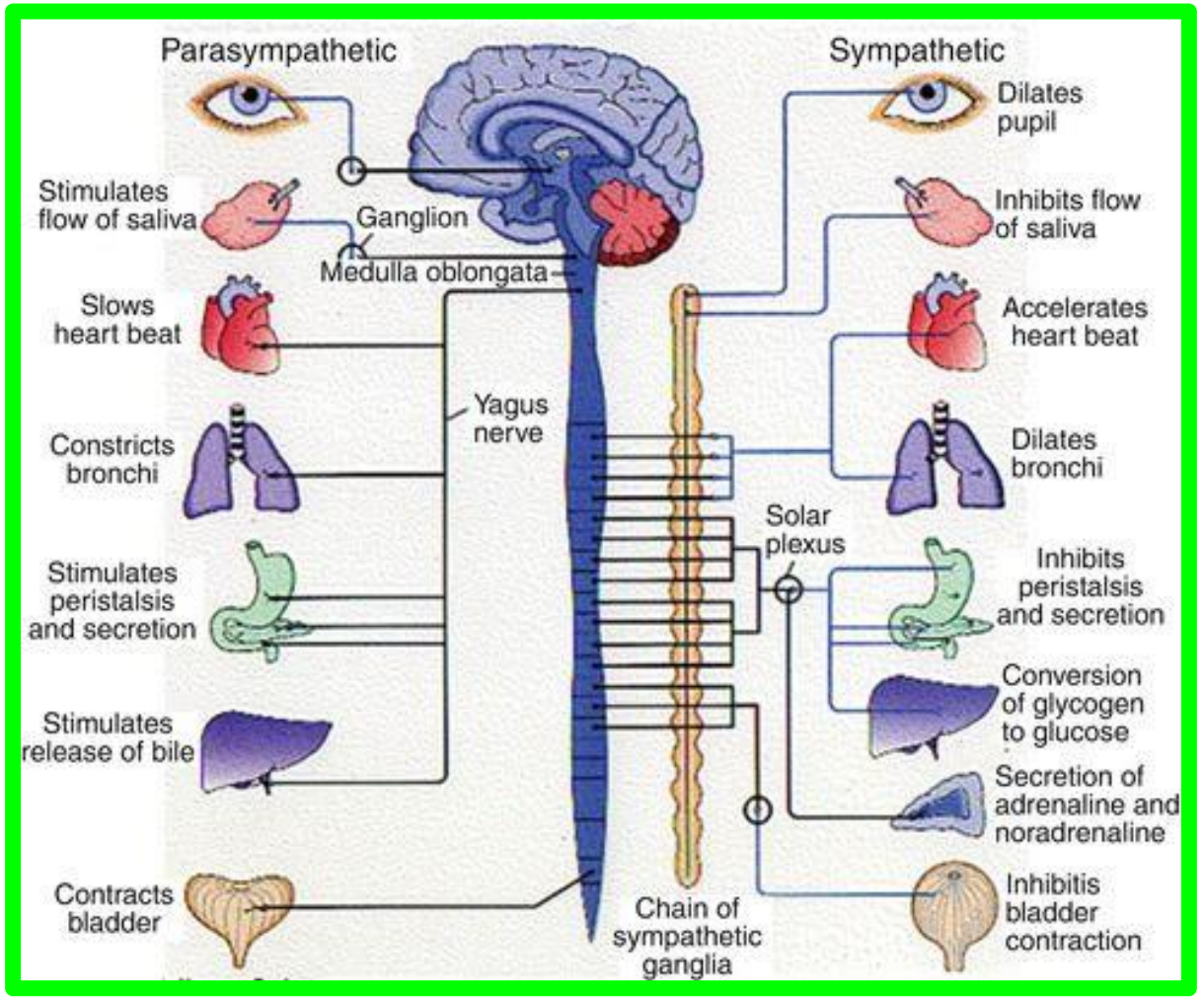
- The autonomic nervous system (ANS) is the part of the nervous system that innervates the body's involuntary structures, such as the heart, smooth muscle, and glands.

- It is distributed throughout the CNS and PNS and is divided into two parts,

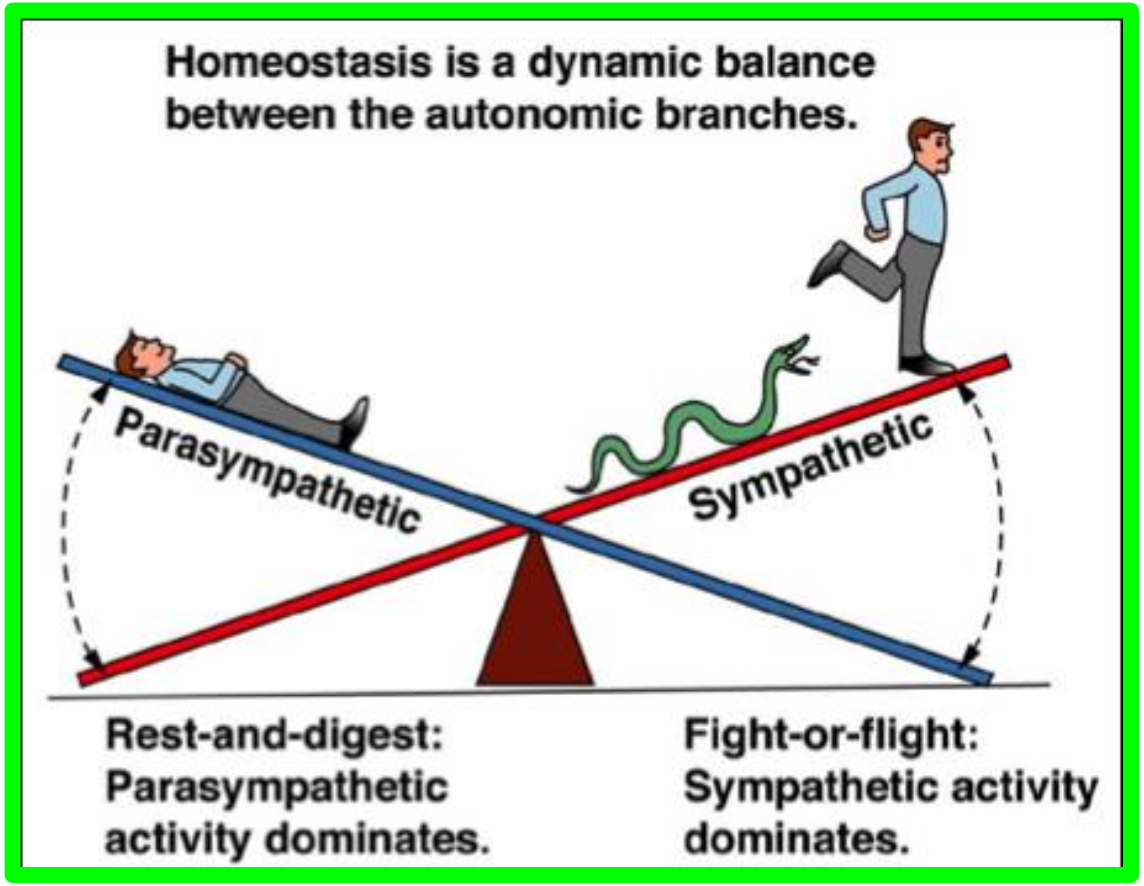
✓ THE SYMPATHETIC
✓ THE PARASYMPATHETIC

both containing afferent and efferent nerve fibers.



Autonomic Nervous System

The activities of the sympathetic part of the ANS prepare the body for an emergency, whereas those of the parasympathetic part are aimed at conserving and restoring energy.



MAJOR DIVISIONS OF THE CENTRAL NERVOUS SYSTEM

Spinal Cord

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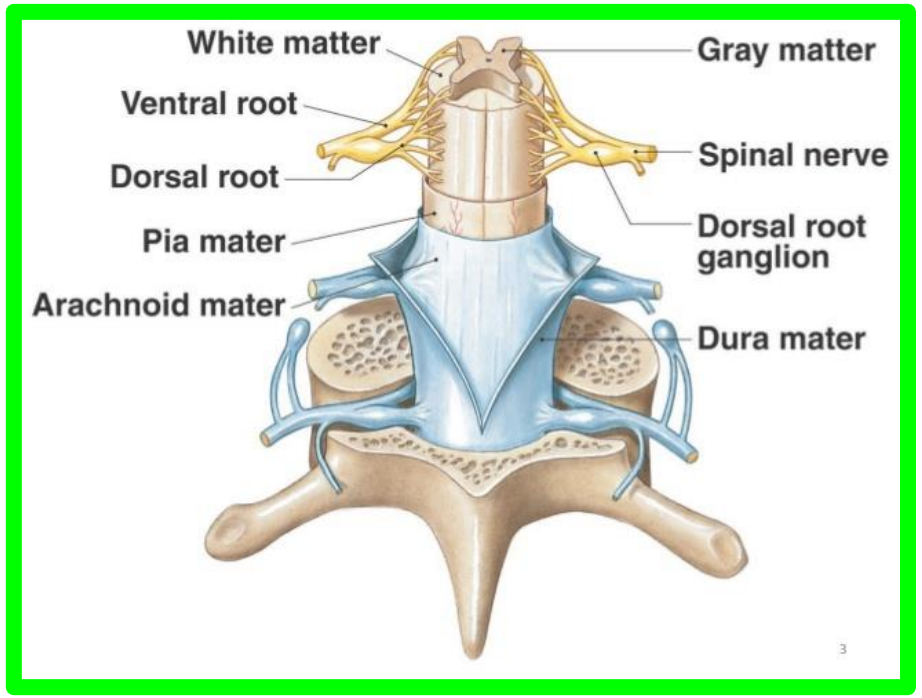
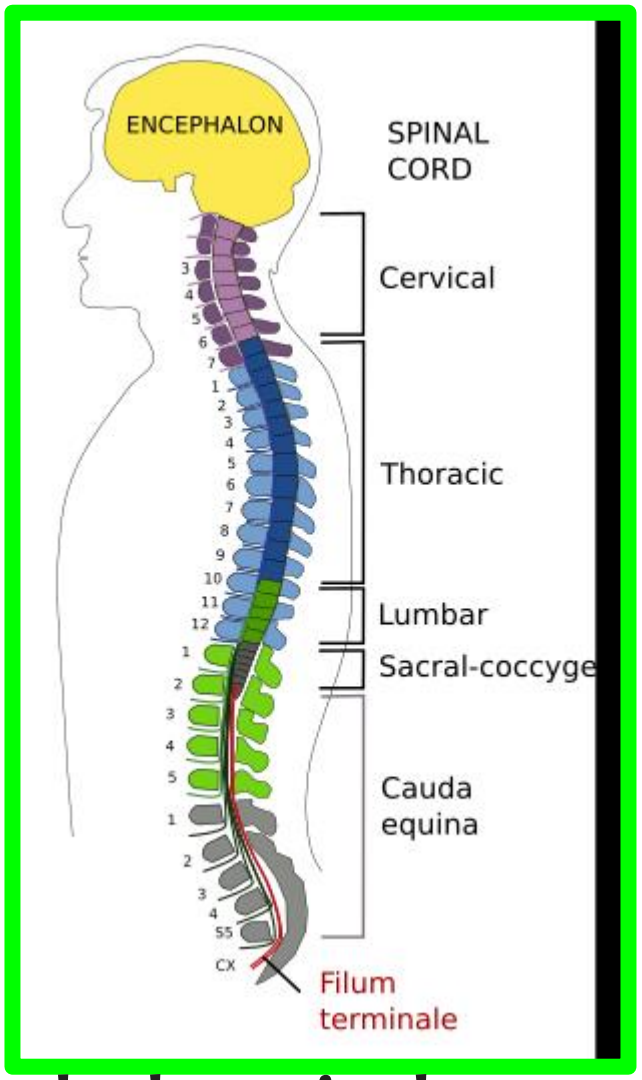
The spinal cord is situated within the vertebral canal of the vertebral column and is surrounded by three meninges:

- The dura mater,
- The arachnoid mater, and
- The pia mater.





Further protection is provided by the CSF, which surrounds the spinal cord in the subarachnoid space.

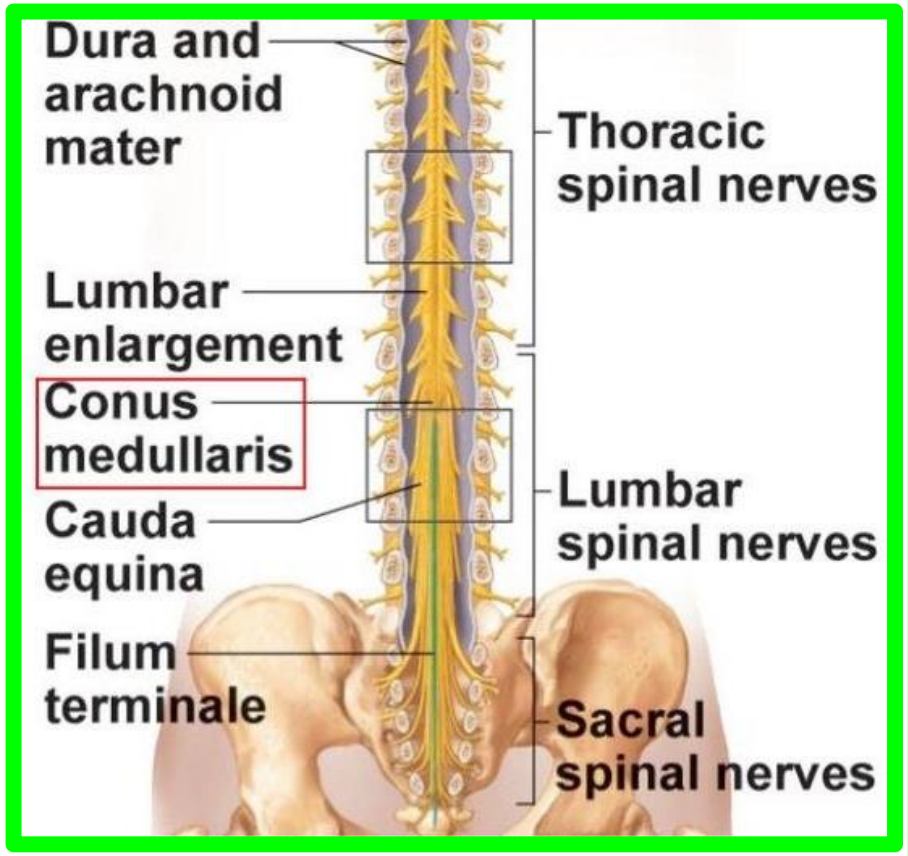
Spinal Cord

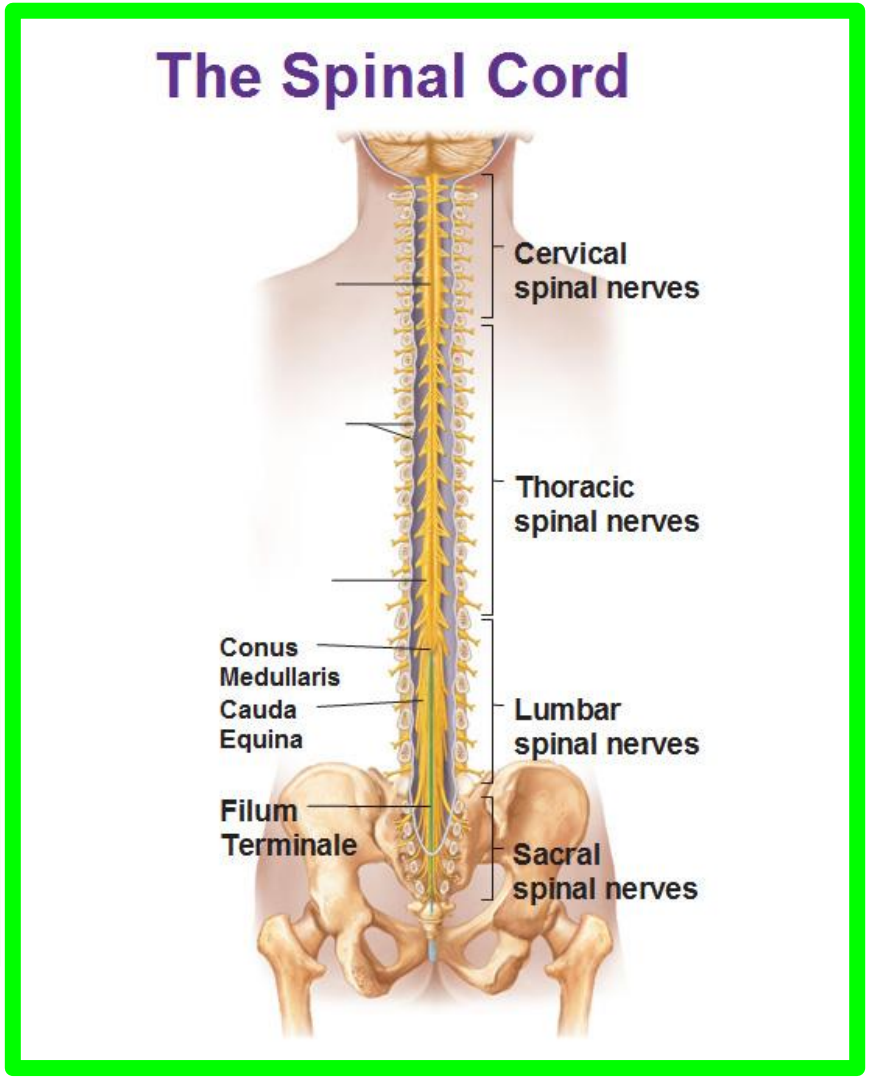
The spinal cord is roughly cylindrical and begins superiorly at the foramen magnum in the skull, where it is continuous with the medulla oblongata of the brain.

It terminates inferiorly in the lumbar region.

Below, the spinal cord tapers off into the conus medullaris, from the apex of which;

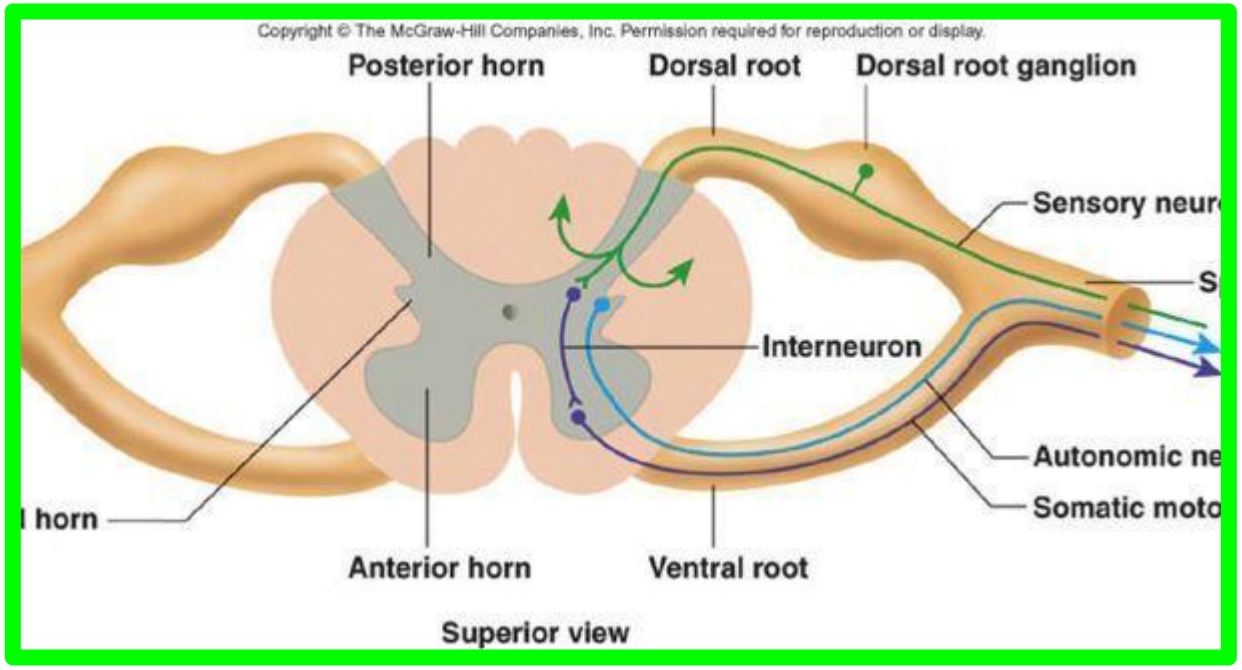
the filum terminale (a prolongation of the pia mater) descends to attach to the back of the coccyx

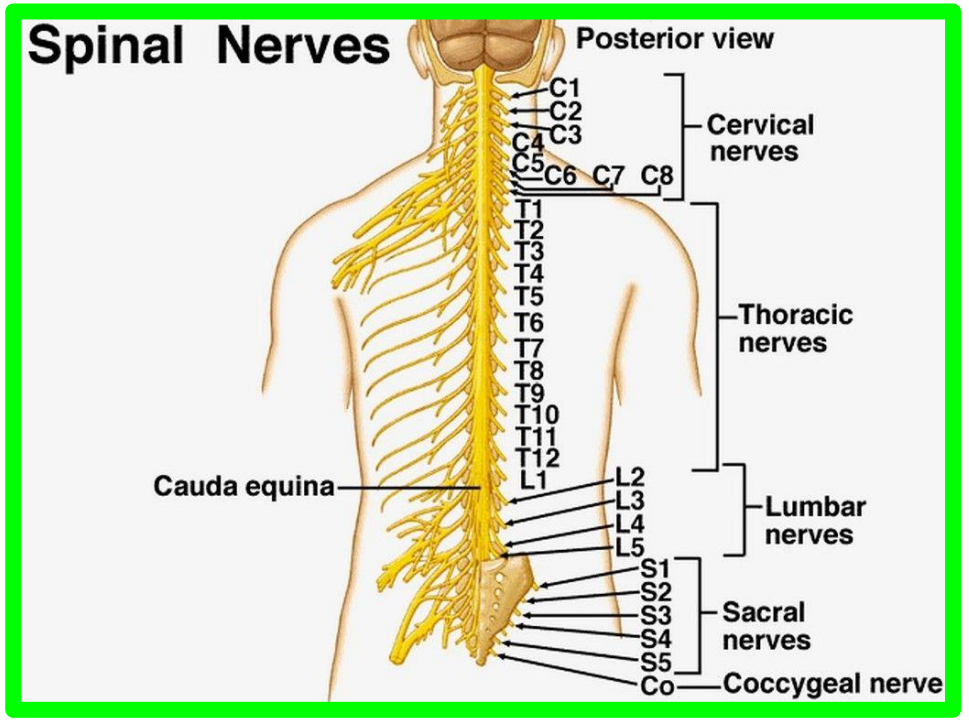




Spinal Cord

Along the entire length of the spinal cord, 31 pairs of spinal nerves are attached by the anterior or motor roots and the posterior or sensory roots.



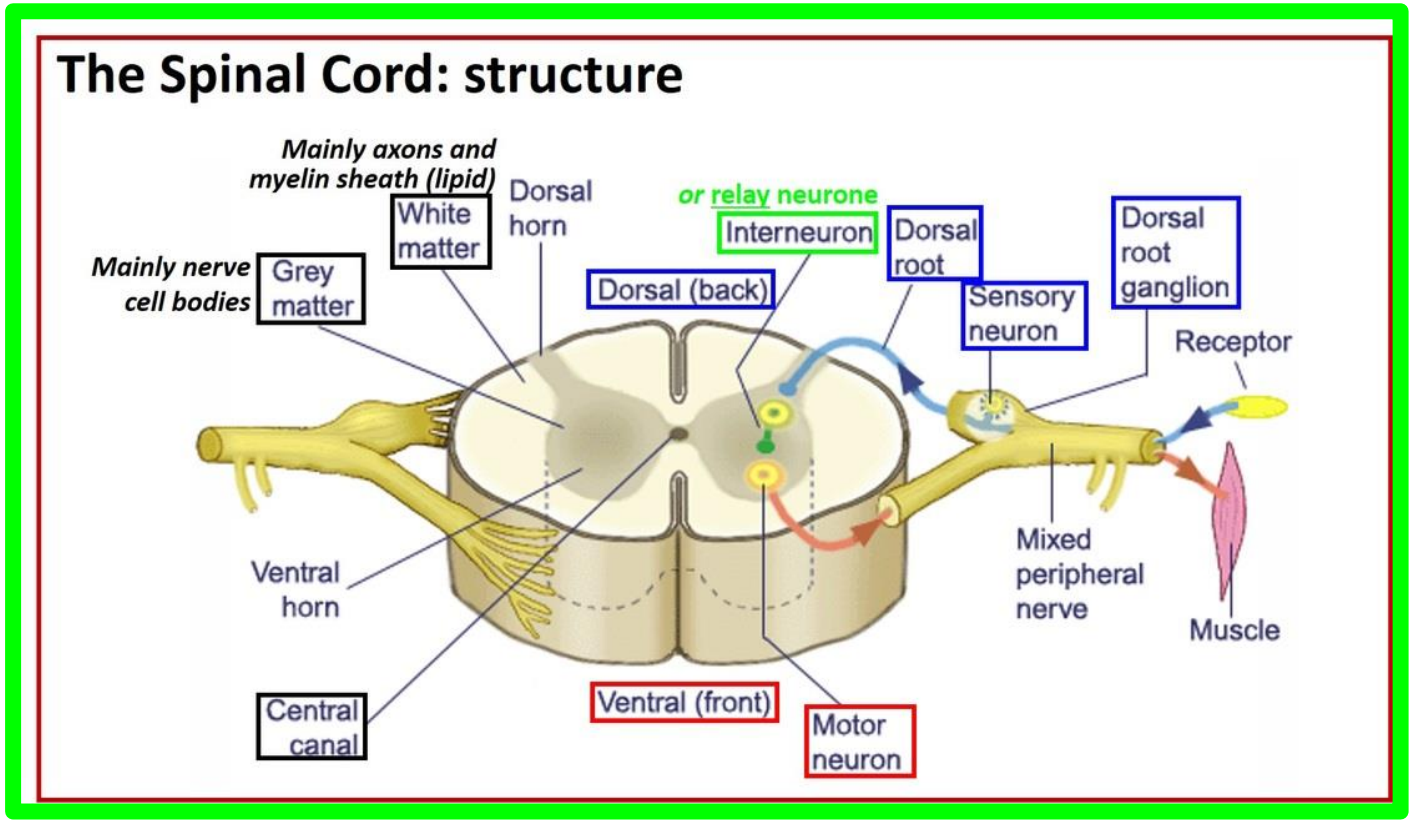


- Each root is attached to the cord by a series of rootlets, which extend the whole length of the corresponding segment of the cord.
- Each posterior nerve root possesses a posterior root ganglion, the cells of which give rise to peripheral and central nerve fibers.

Spinal Cord Structure

- ✓ The spinal cord is composed of an inner core of gray matter, which is surrounded by an outer covering of white matter.

- ✓ The gray matter is seen on cross section as an H-shaped pillar with anterior and posterior gray columns, or horns, united by a thin gray commissure containing the small central canal.

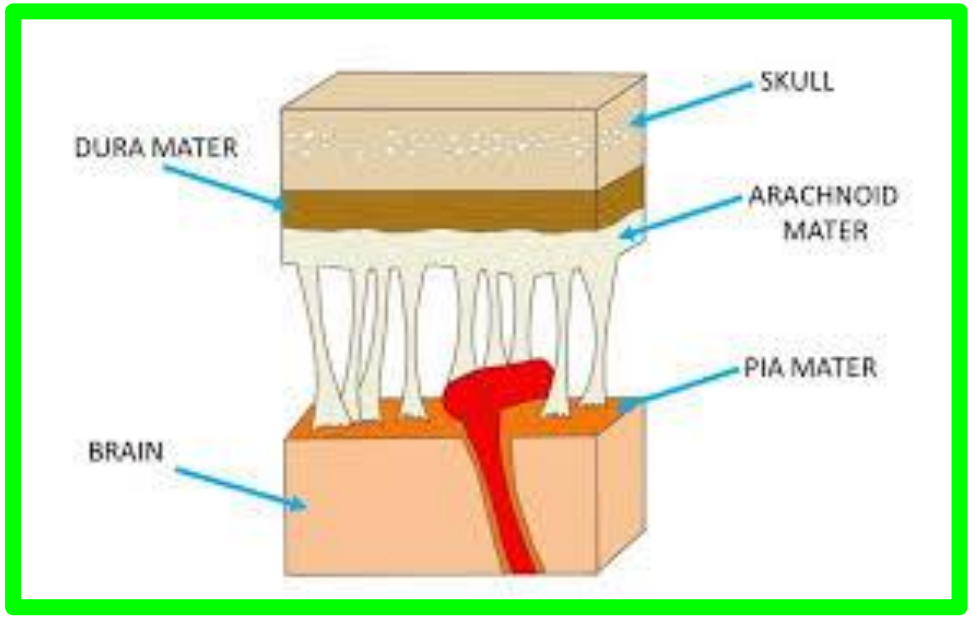


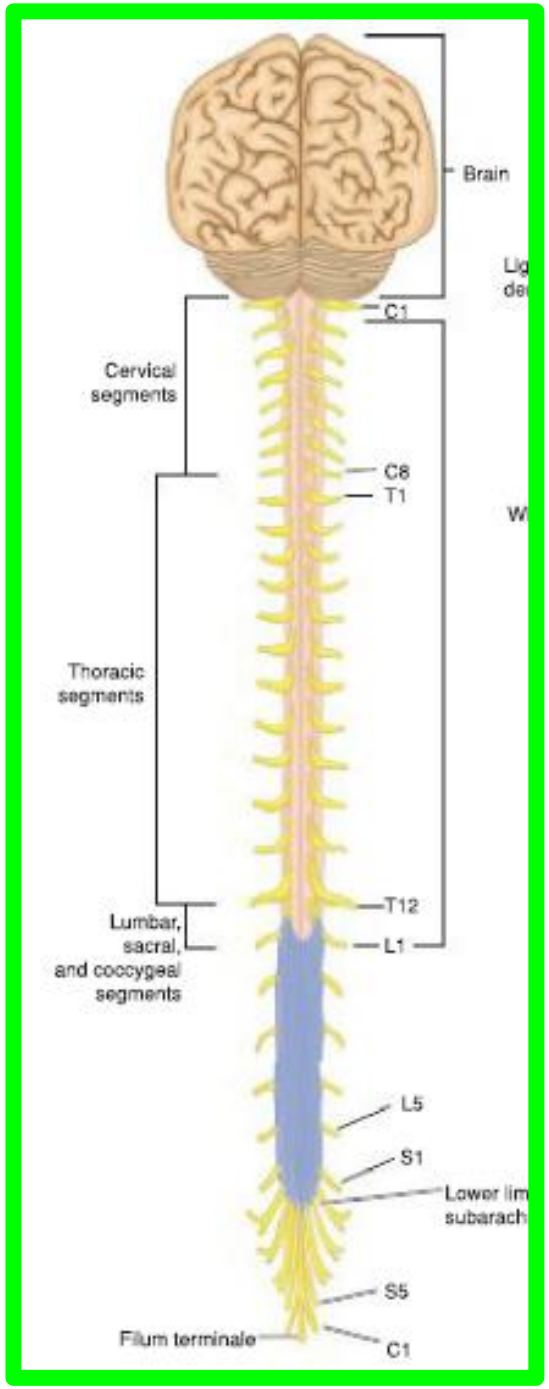
- ✓ The white matter, for purposes of description, is divided into anterior, lateral, and posterior white columns

Brain

The brain lies in the cranial cavity and is continuous with the spinal cord through the foramen magnum. It is surrounded by the dura mater, the arachnoid mater, and the pia mater.

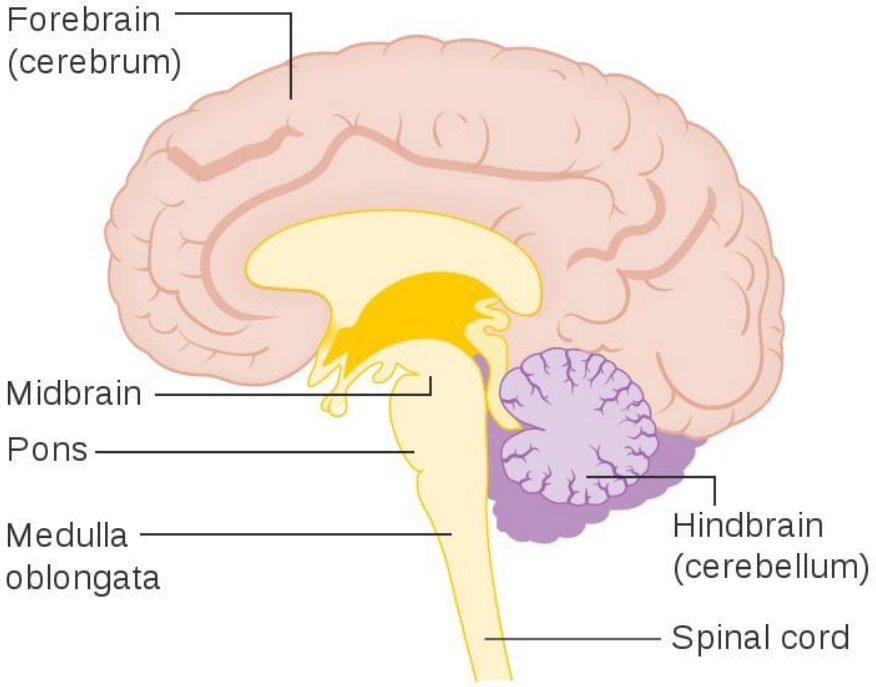
- ✓ These three meninges are continuous with the corresponding meninges of the spinal cord.
- ✓ The CSF surrounds the brain in the subarachnoid space.





Brain

- The brain is conventionally divided into three major divisions: the hindbrain, the midbrain, and the forebrain in ascending order from the spinal cord
- The brainstem (a collective term for the medulla oblongata, pons, and midbrain) is what remains after the cerebral hemispheres and cerebellum are removed.



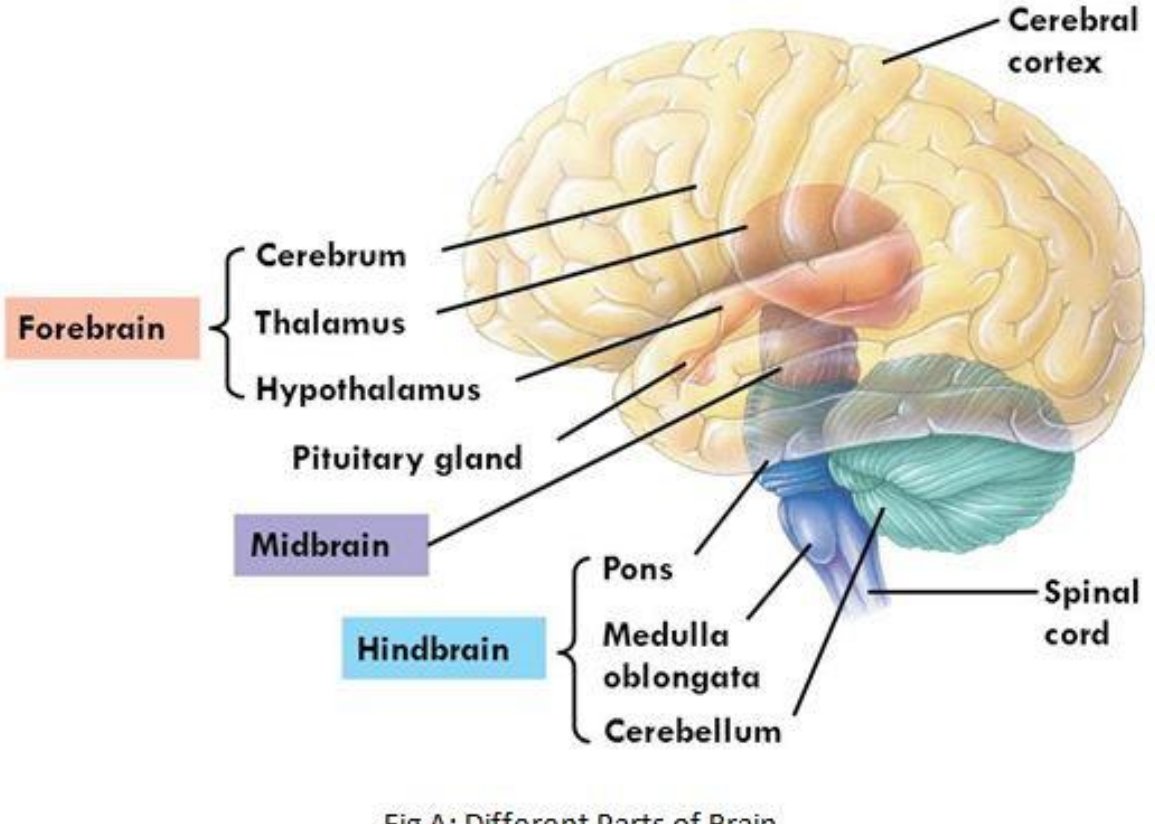


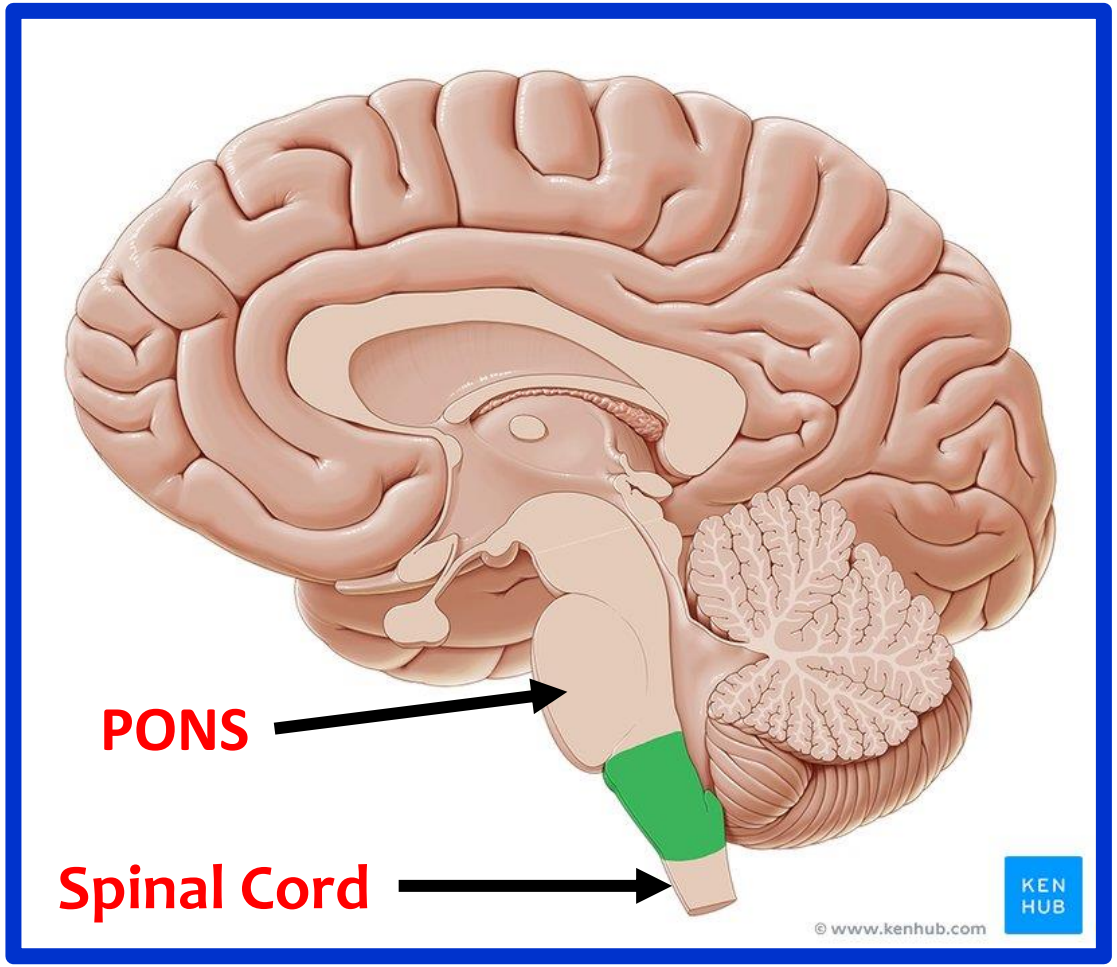
Fig A: Different Parts of Brain

Brain

Medulla Oblongata

The medulla oblongata is conical in shape and connects the pons superiorly to the spinal cord inferiorly.

It contains many collections of neurons, called nuclei, and serves as a conduit for ascending and descending nerve fibers.



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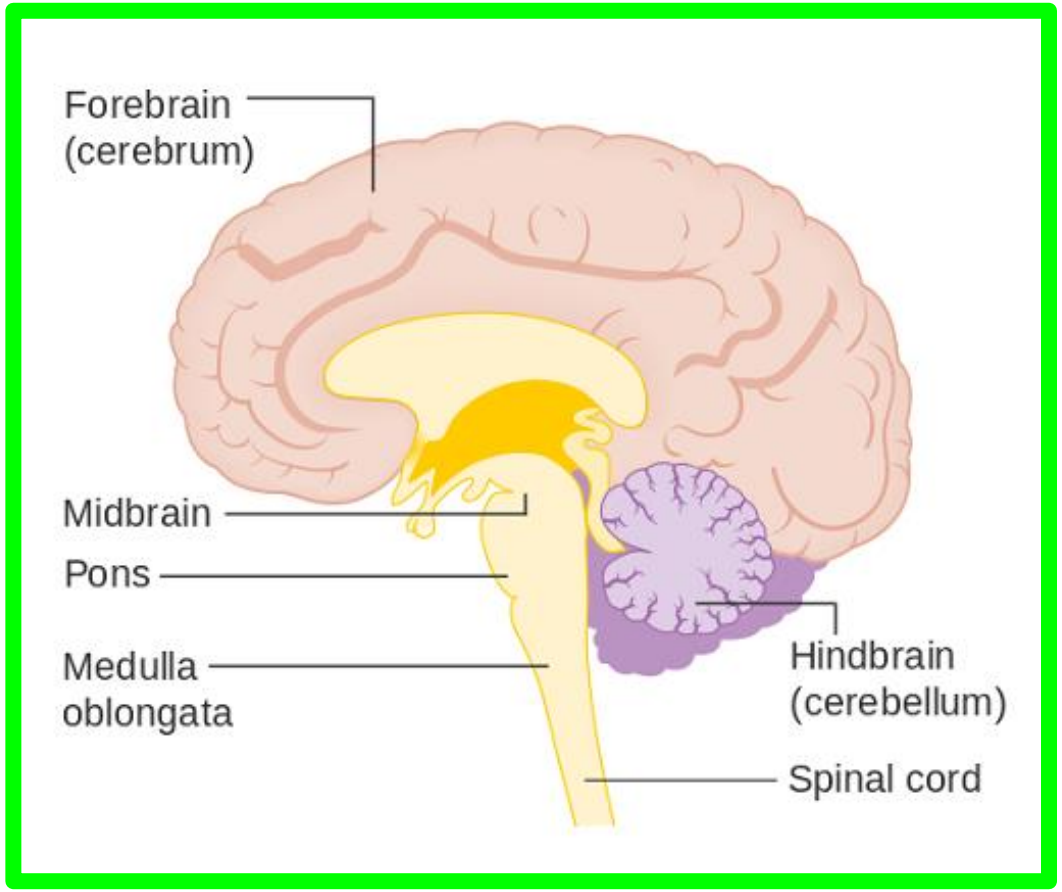
Brain

The pons

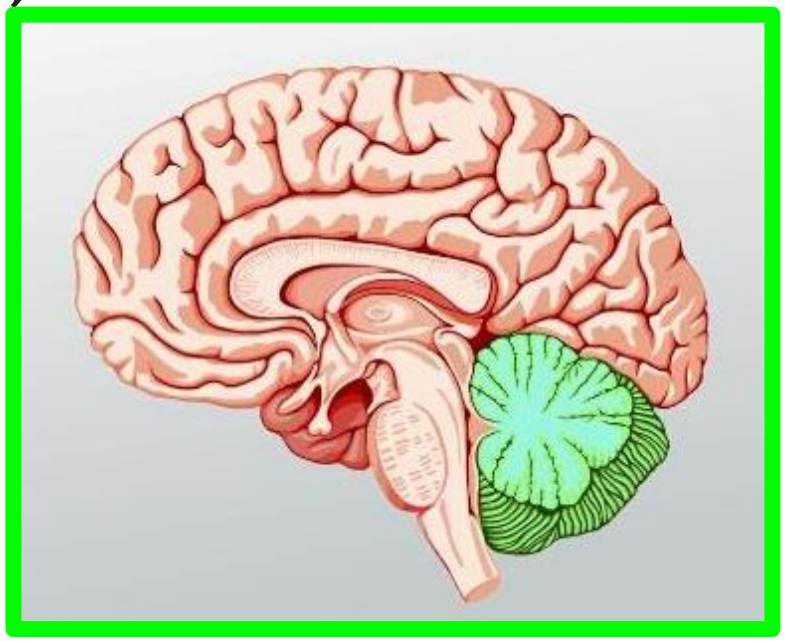
- The pons is situated on the anterior surface of the cerebellum, inferior to the midbrain and superior to the medulla oblongata.
- The pons, or bridge, derives its name from the large number of transverse fibers on its anterior aspect connecting the two cerebellar hemispheres.
- It also contains many nuclei and ascending and descending nerve fibers.

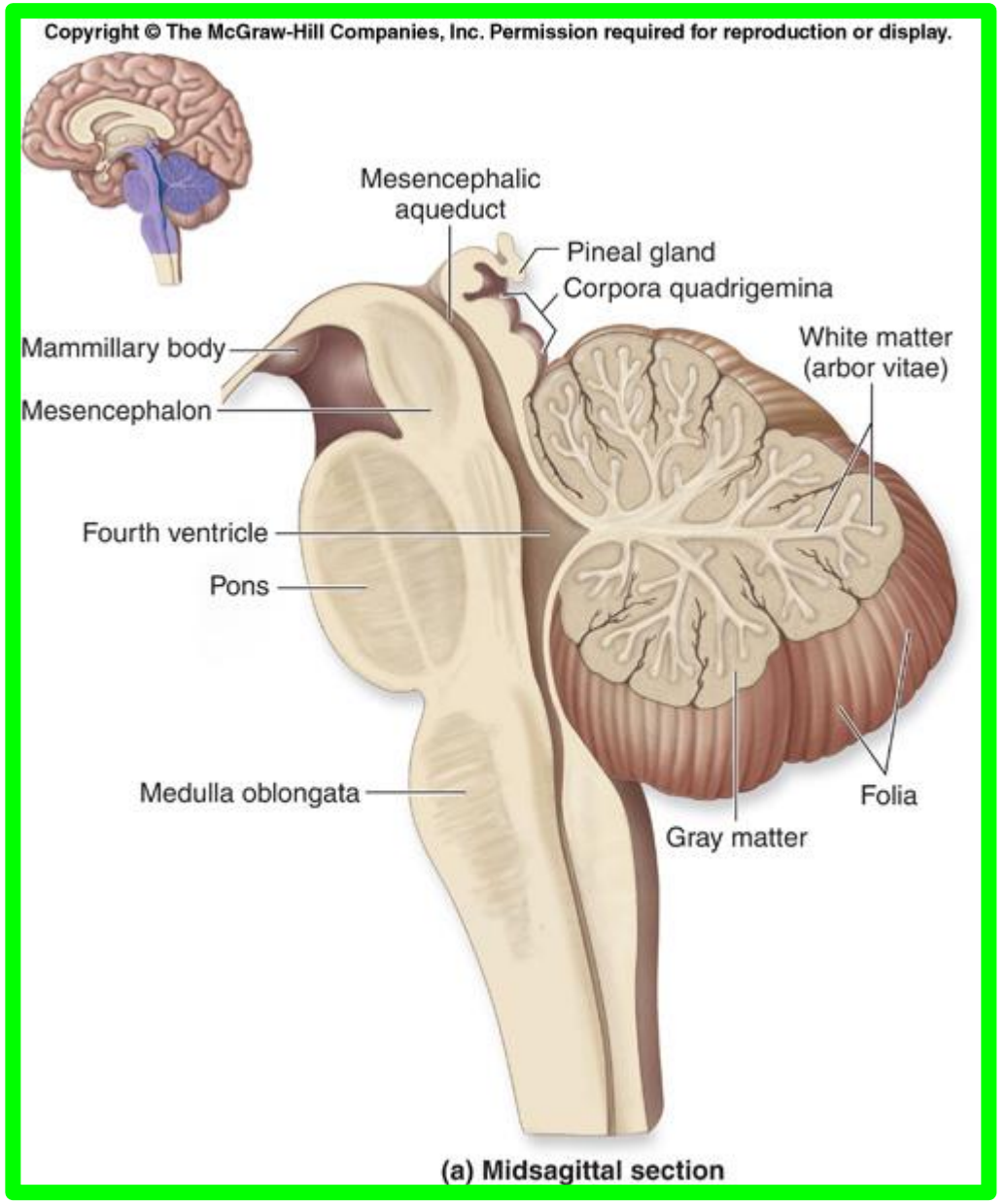


Cerebellum

- The cerebellum lies within the posterior cranial fossa of the skull posterior to the pons and the medulla oblongata.

- It consists of two laterally placed hemispheres connected by a median portion, the vermis.





Cerebellum

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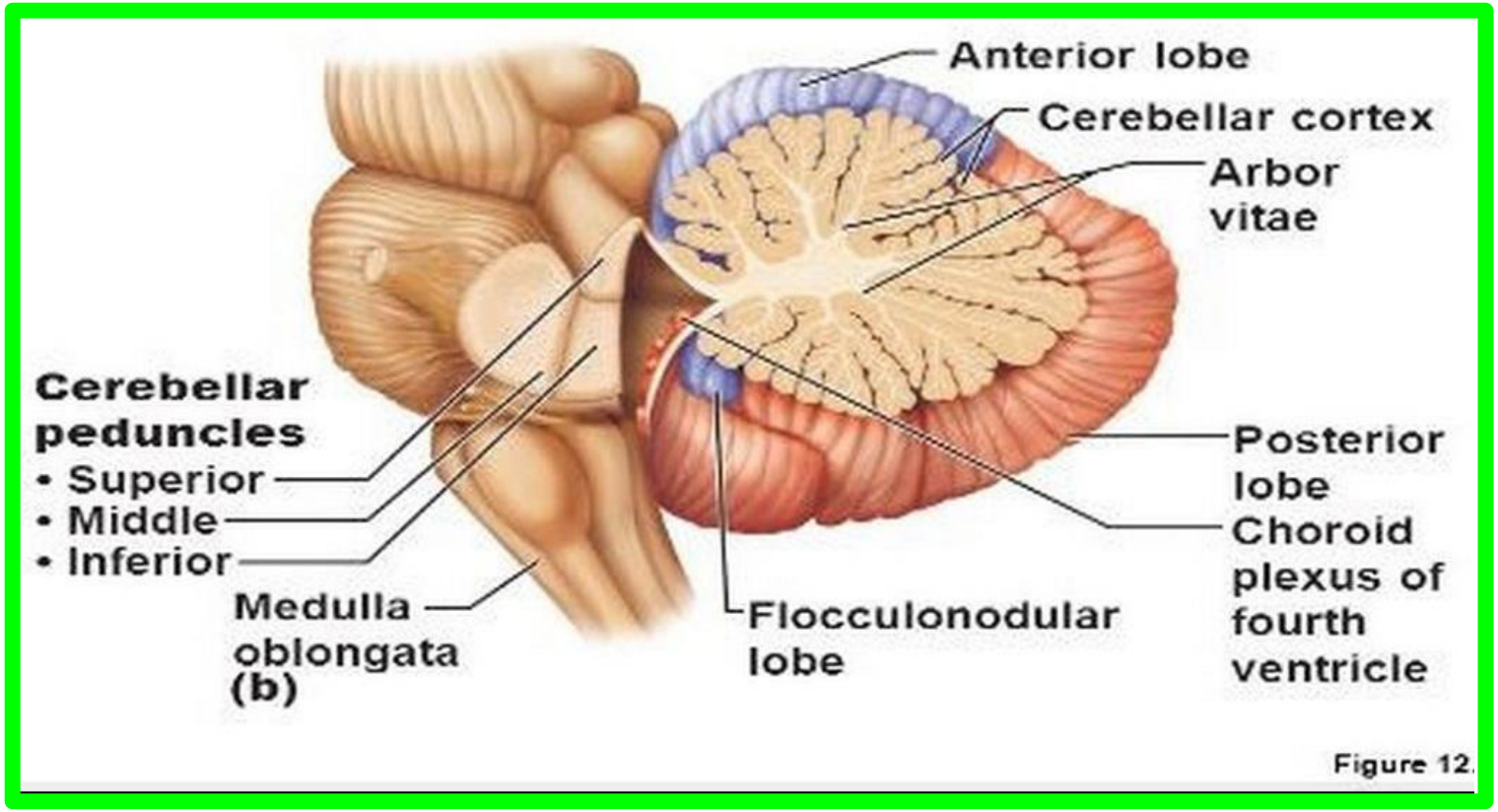
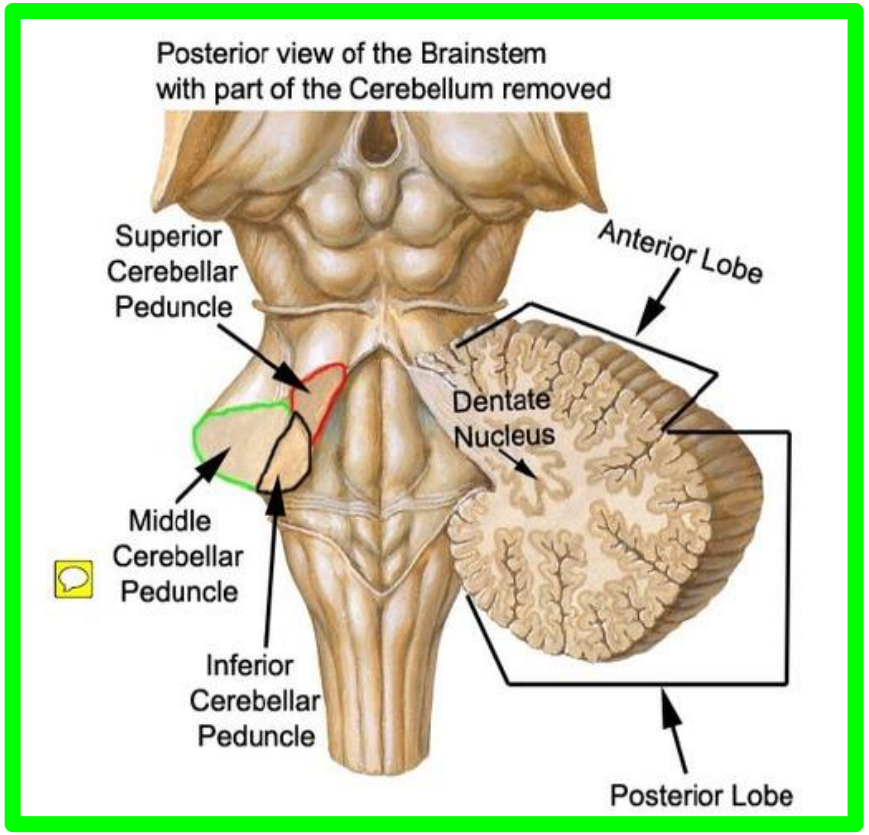
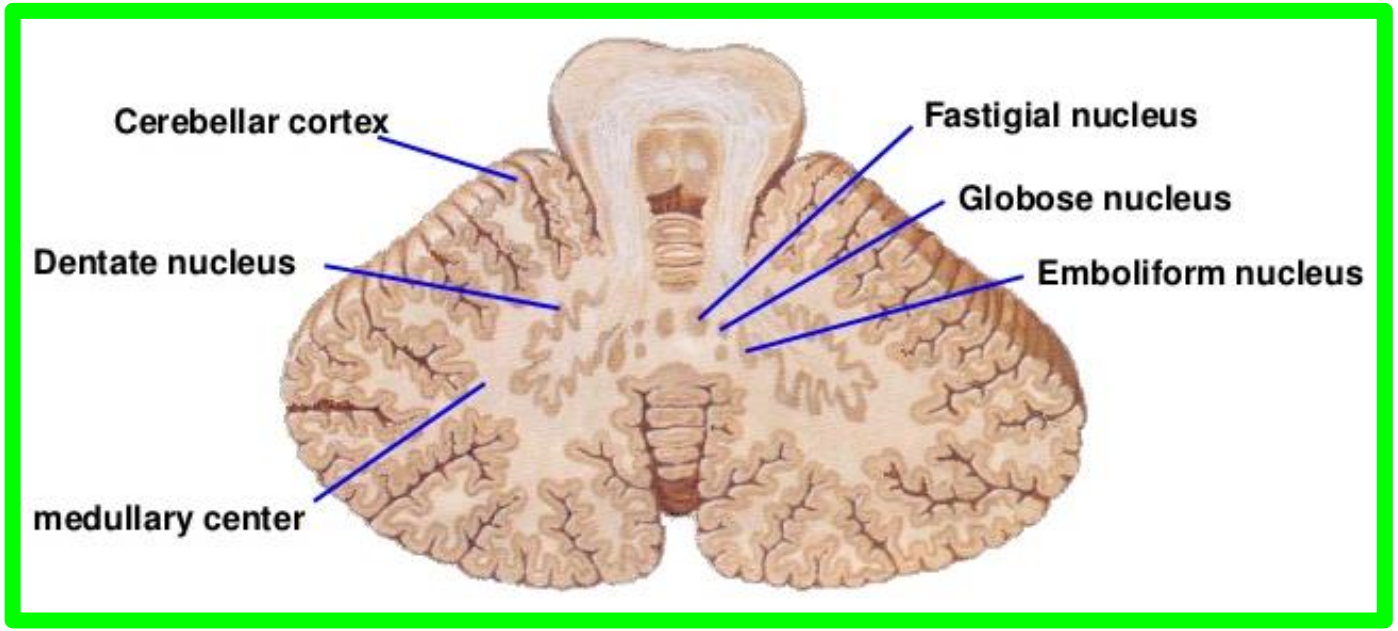
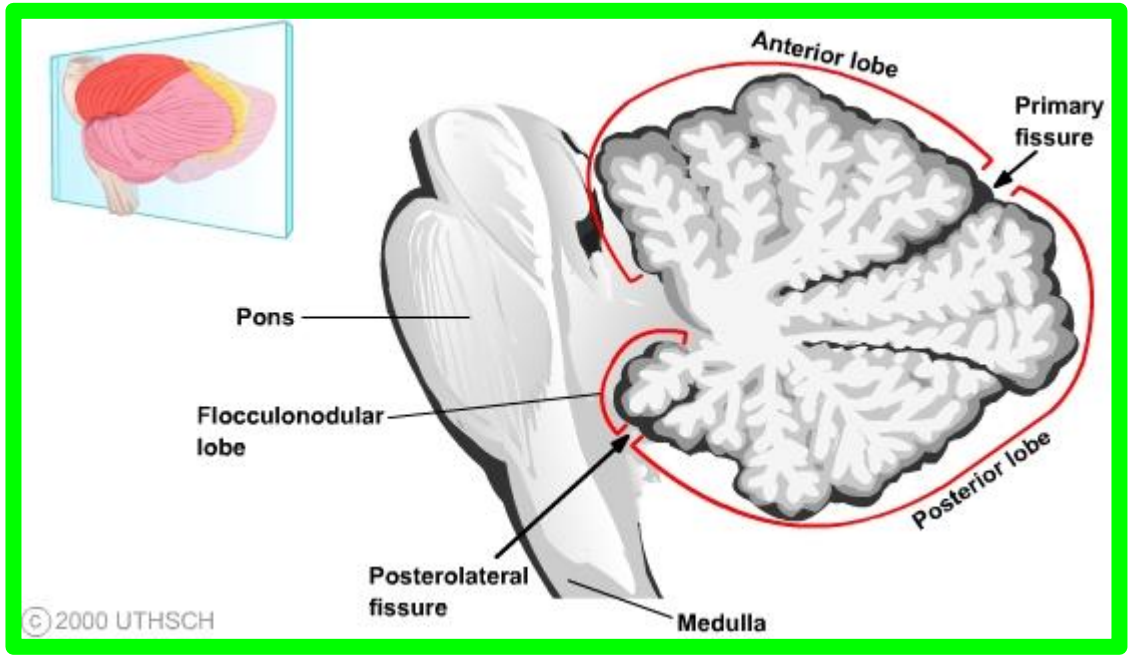
- It is connected to the midbrain by the superior cerebellar peduncles,
- to the pons by the middle cerebellar peduncles, and
- to the medulla by the inferior cerebellar peduncles
- The peduncles are composed of large bundles of nerve fibers connecting the cerebellum to the remainder of the nervous system.





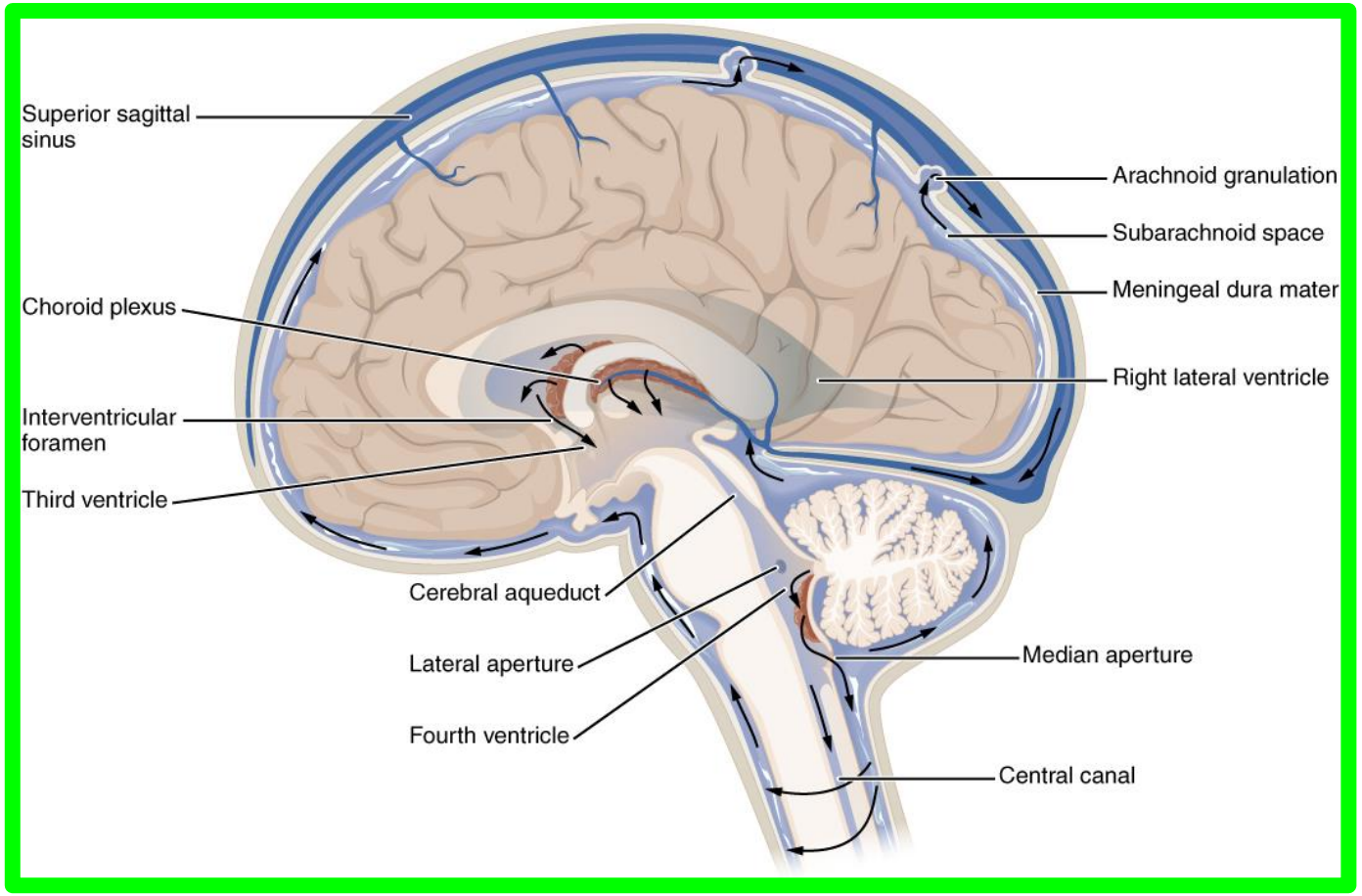
- The surface layer of each cerebellar hemisphere is called **the cortex** and is composed of gray matter.
- The cerebellar cortex is thrown into folds, or **folia**, separated by closely set **transverse fissures.**
- Certain masses of gray matter are found in the interior of the cerebellum, embedded in the white matter; the largest of these is known as **the dentate nucleus**





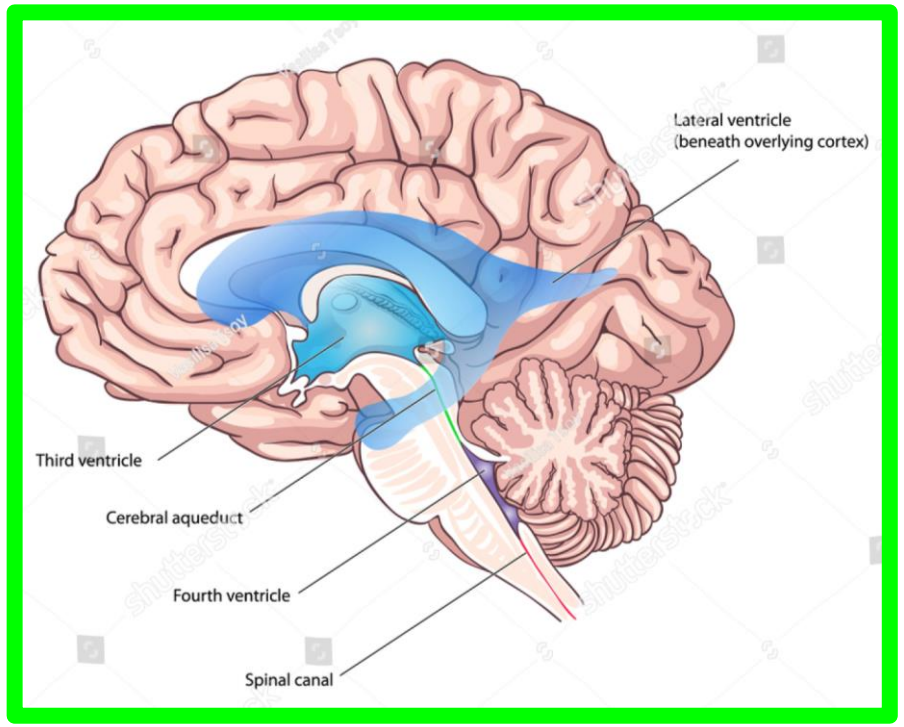
Cerebellum

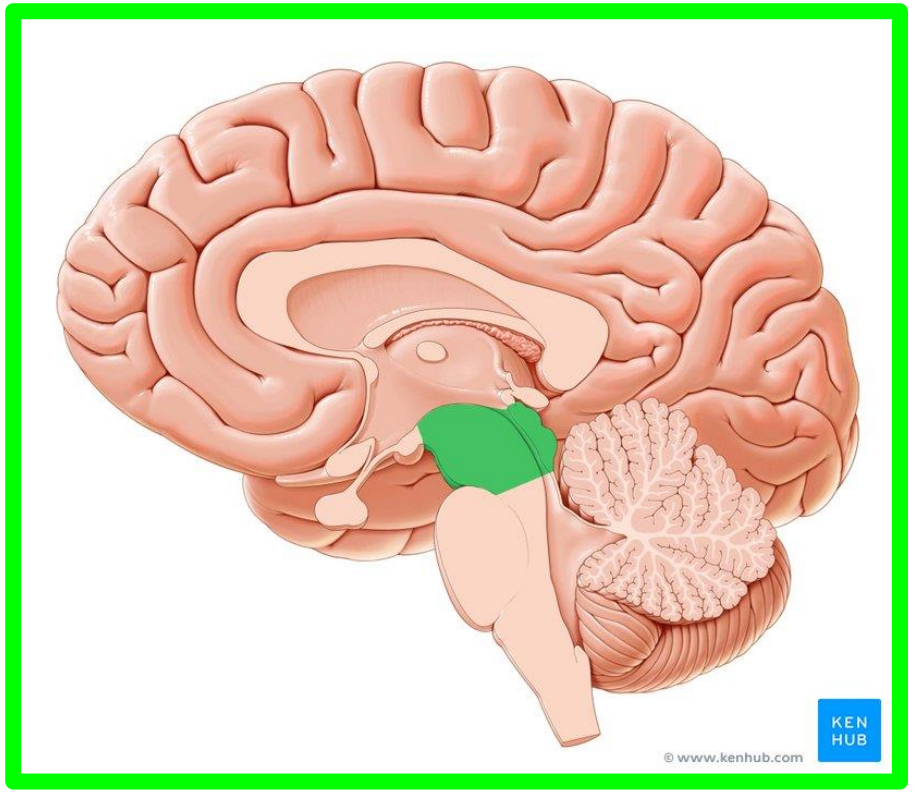
- The medulla oblongata, the pons, and the cerebellum surround a cavity filled with CSF, called the fourth ventricle.
- This is connected superiorly to the third ventricle by the cerebral aqueduct; inferiorly, it is continuous with the central canal of the spinal cord.
- It communicates with the subarachnoid space through three openings in the inferior part of the roof.
- Through these openings, the CSF within the CNS can enter the subarachnoid space.



The midbrain

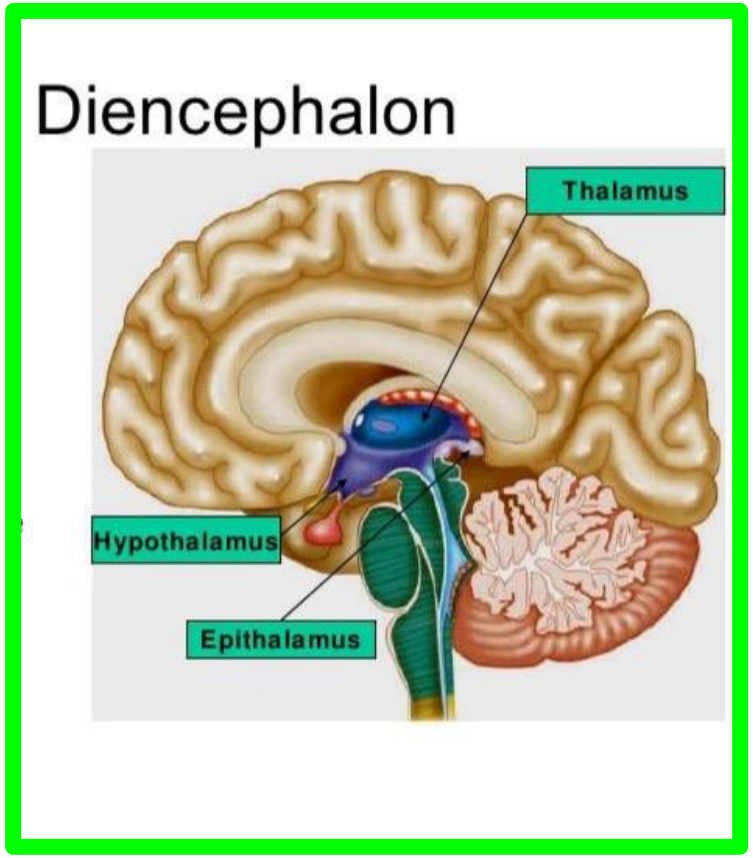
- The midbrain is the narrow part of the brain that connects the forebrain to the hindbrain
- The narrow cavity of the midbrain is the cerebral aqueduct, which connects the third and fourth ventricles.
- The midbrain contains many nuclei and bundles of ascending and descending nerve fibers.

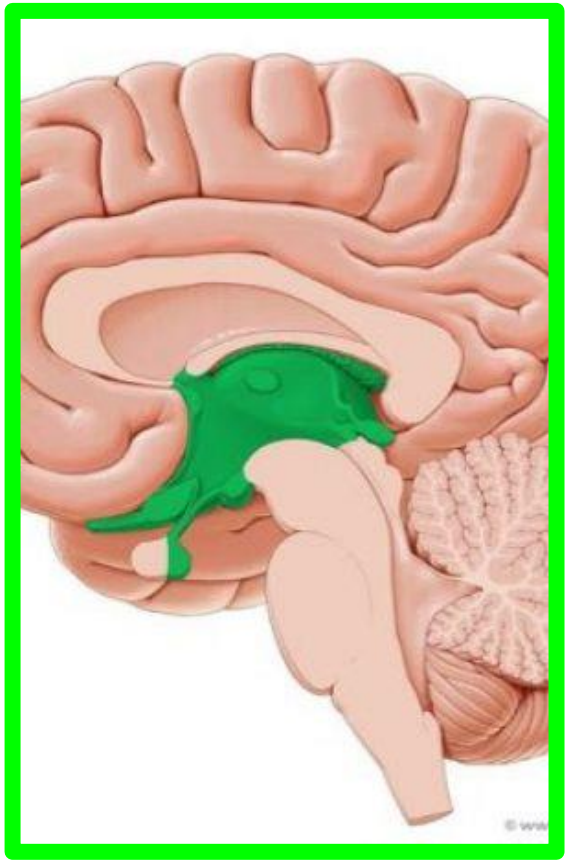


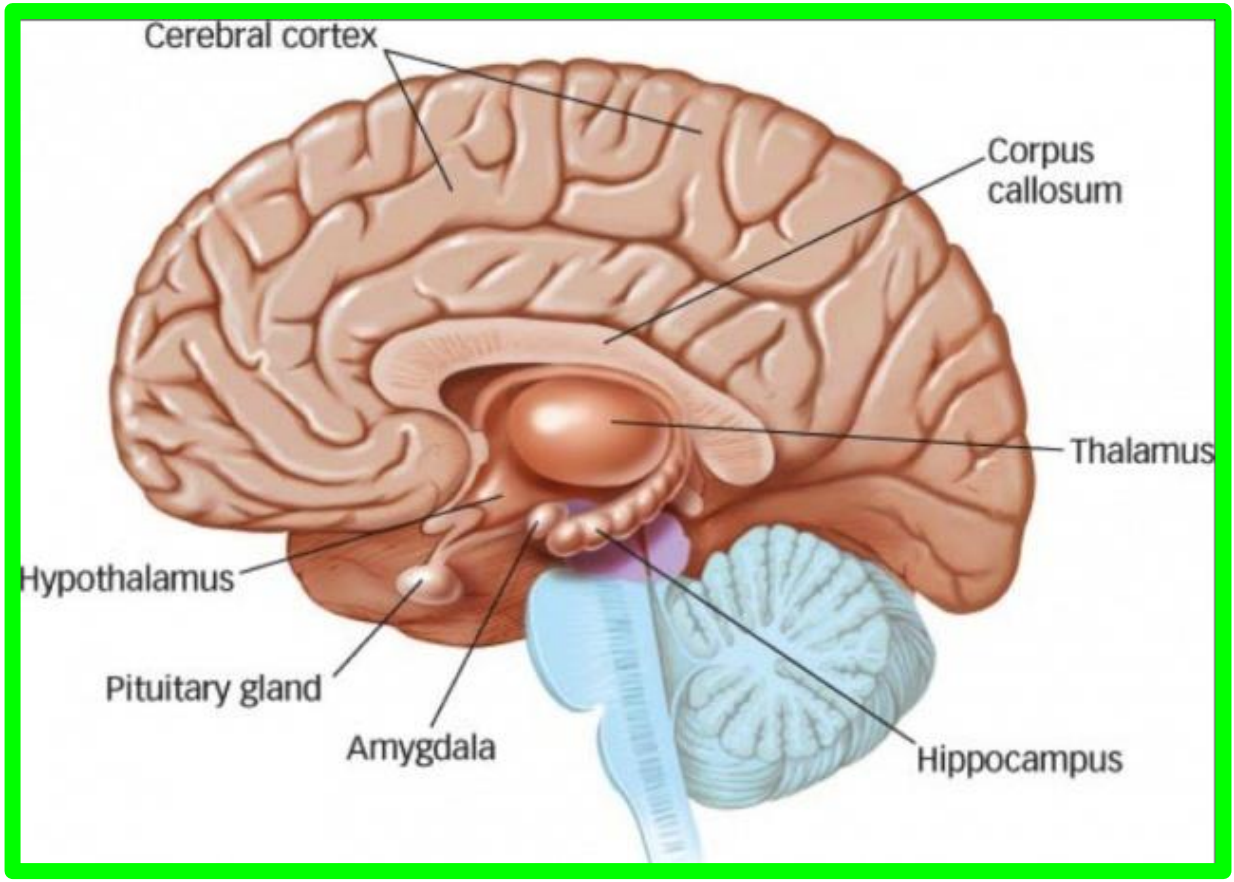


The forebrain

The forebrain comprises the diencephalon (between brain), which is the central part of the forebrain, and the cerebrum.

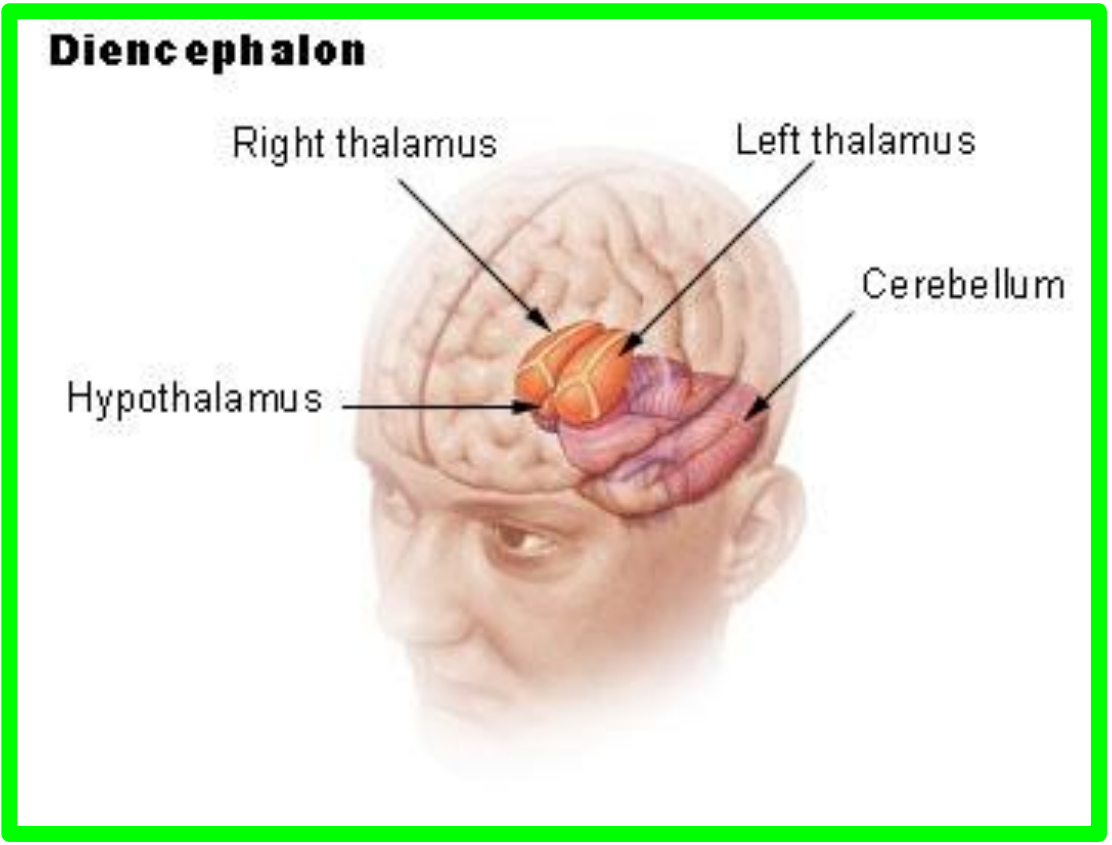


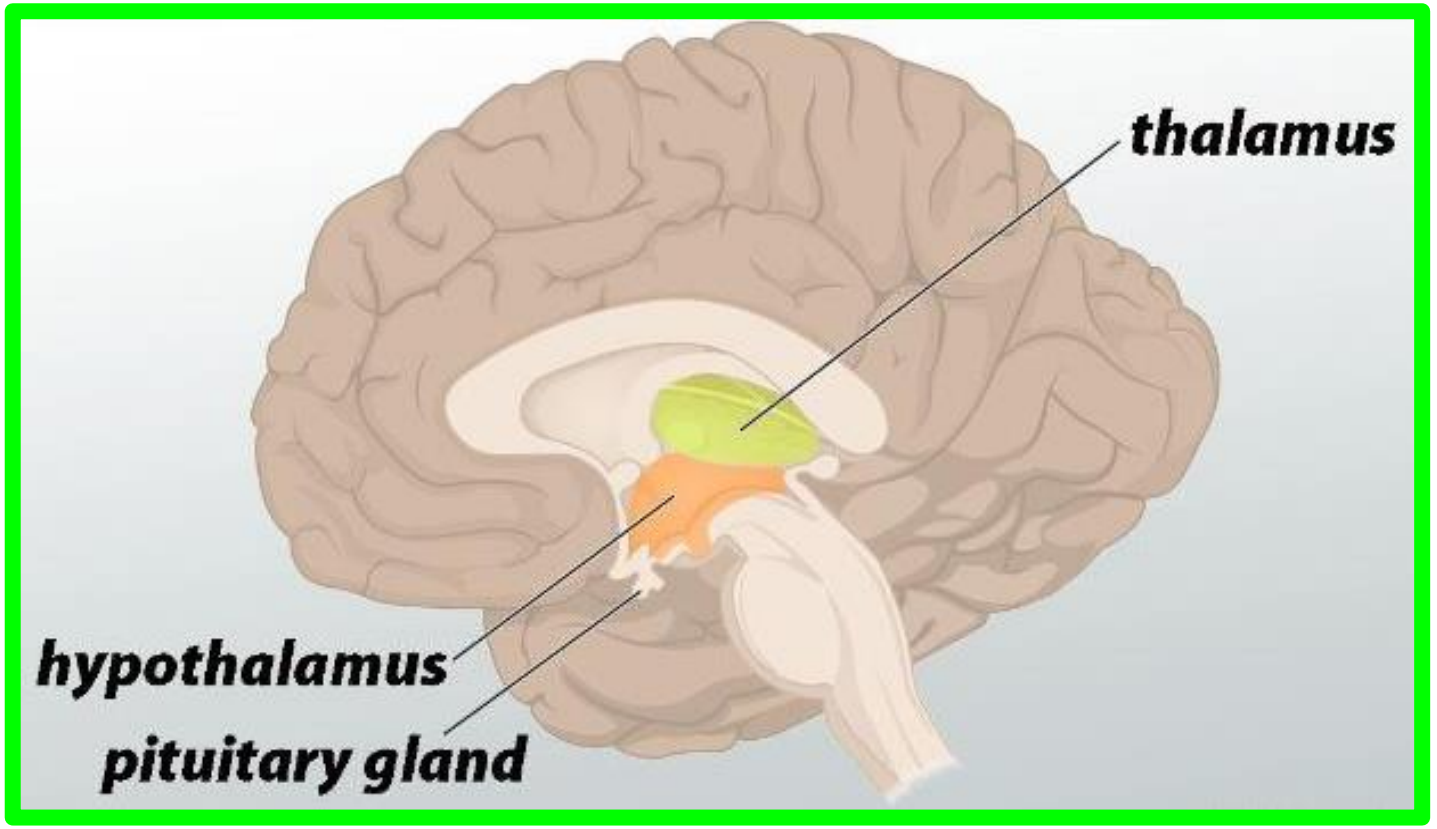




Diencephalon

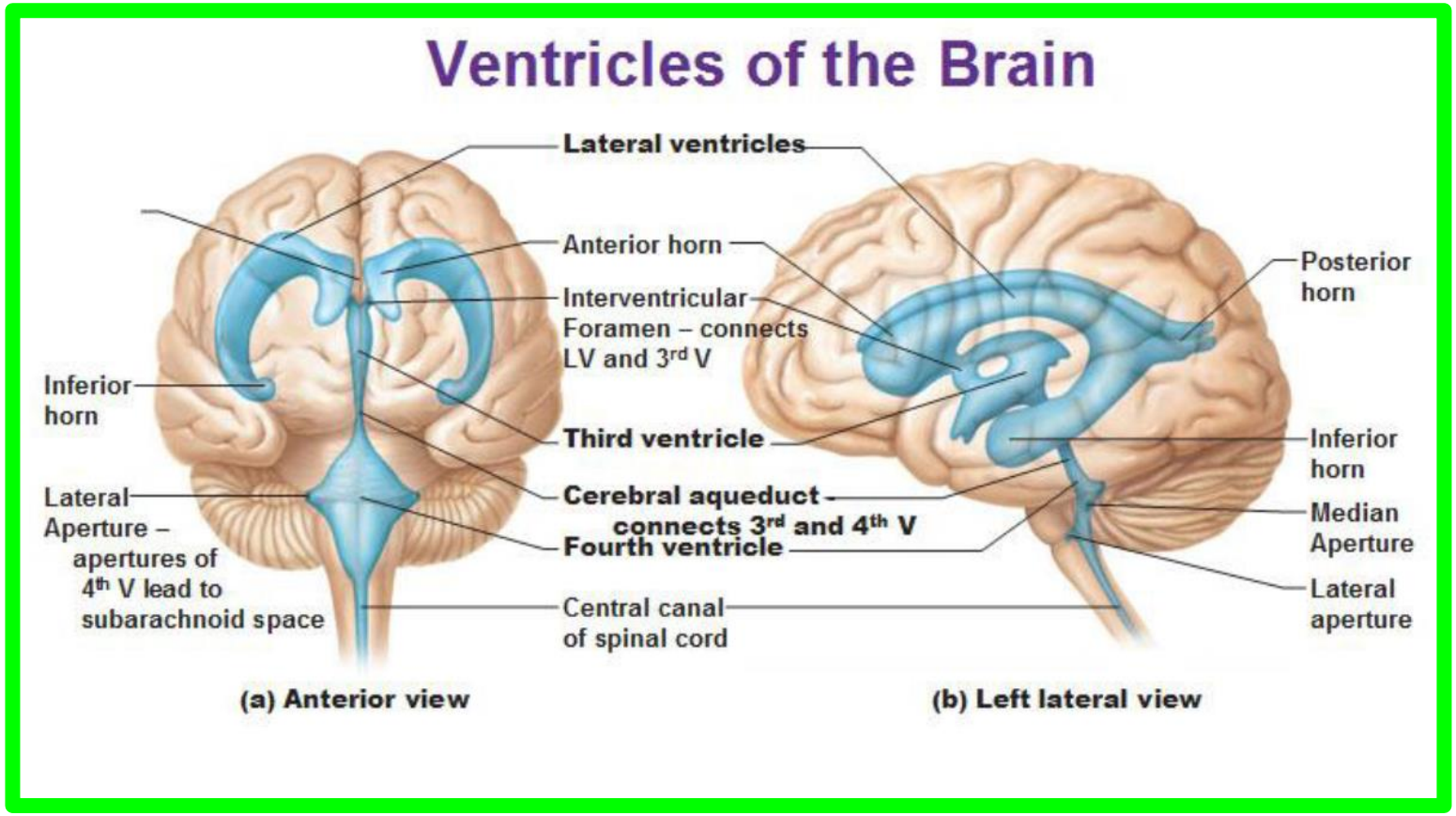
- The diencephalon is almost completely hidden from the surface of the brain.
- It consists of a dorsal **thalamus** and a ventral **hypothalamus**
- **The thalamus** is a large, egg-shaped mass of gray matter that lies on either side of **the third ventricle**.





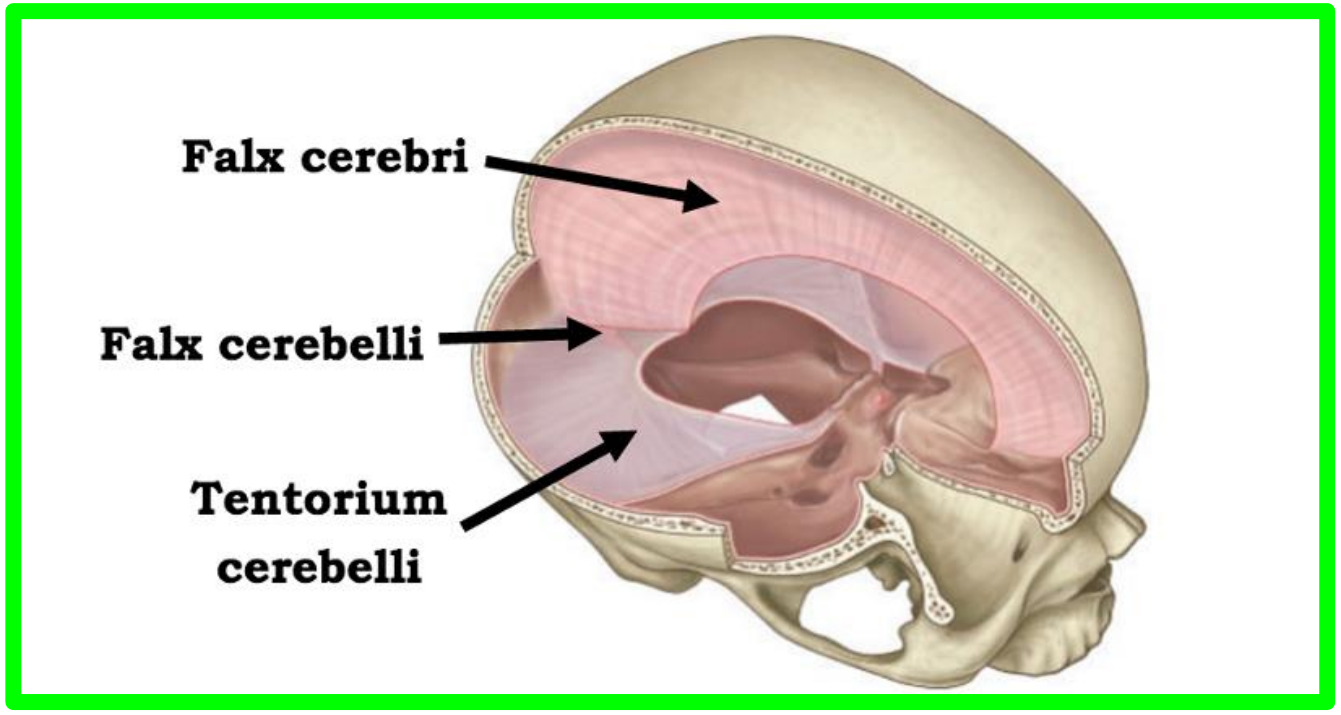
Diencephalon

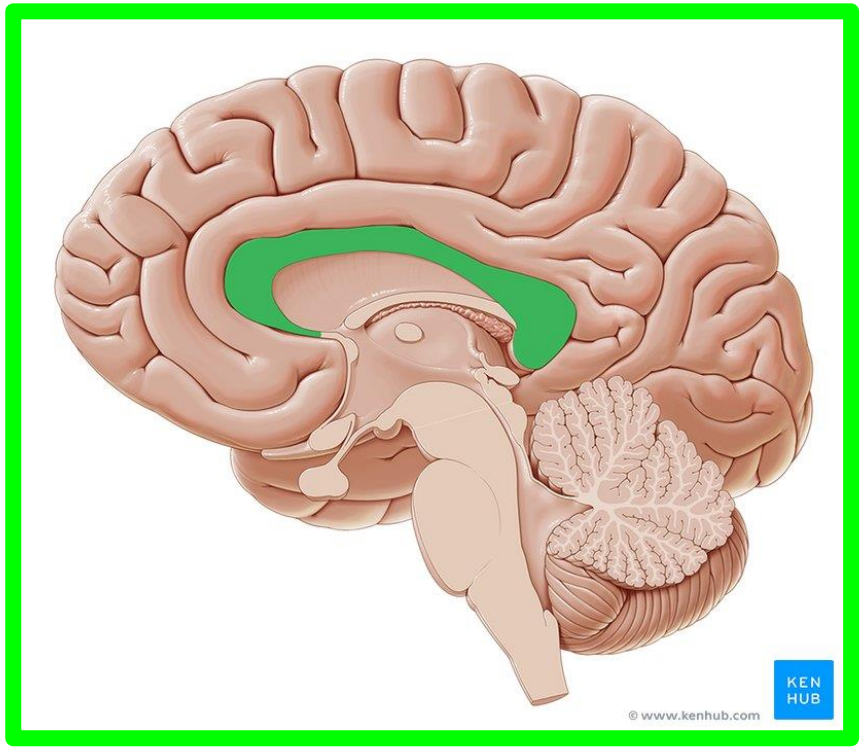
- The anterior end of the thalamus forms the posterior boundary of the interventricular foramen, the opening between the third and lateral ventricles.
- The hypothalamus forms the lower part of the lateral wall and floor of the third ventricle.



Cerebrum

- The cerebrum, the largest part of the brain, consists of two cerebral hemispheres, which are connected by a mass of white matter called the corpus callosum
- Each hemisphere extends from the frontal to the occipital bones in the skull, superior to the anterior and middle cranial fossae; posteriorly, the cerebrum lies above the tentorium cerebelli
- The hemispheres are separated by a deep cleft, the longitudinal fissure, into which projects the falx cerebri

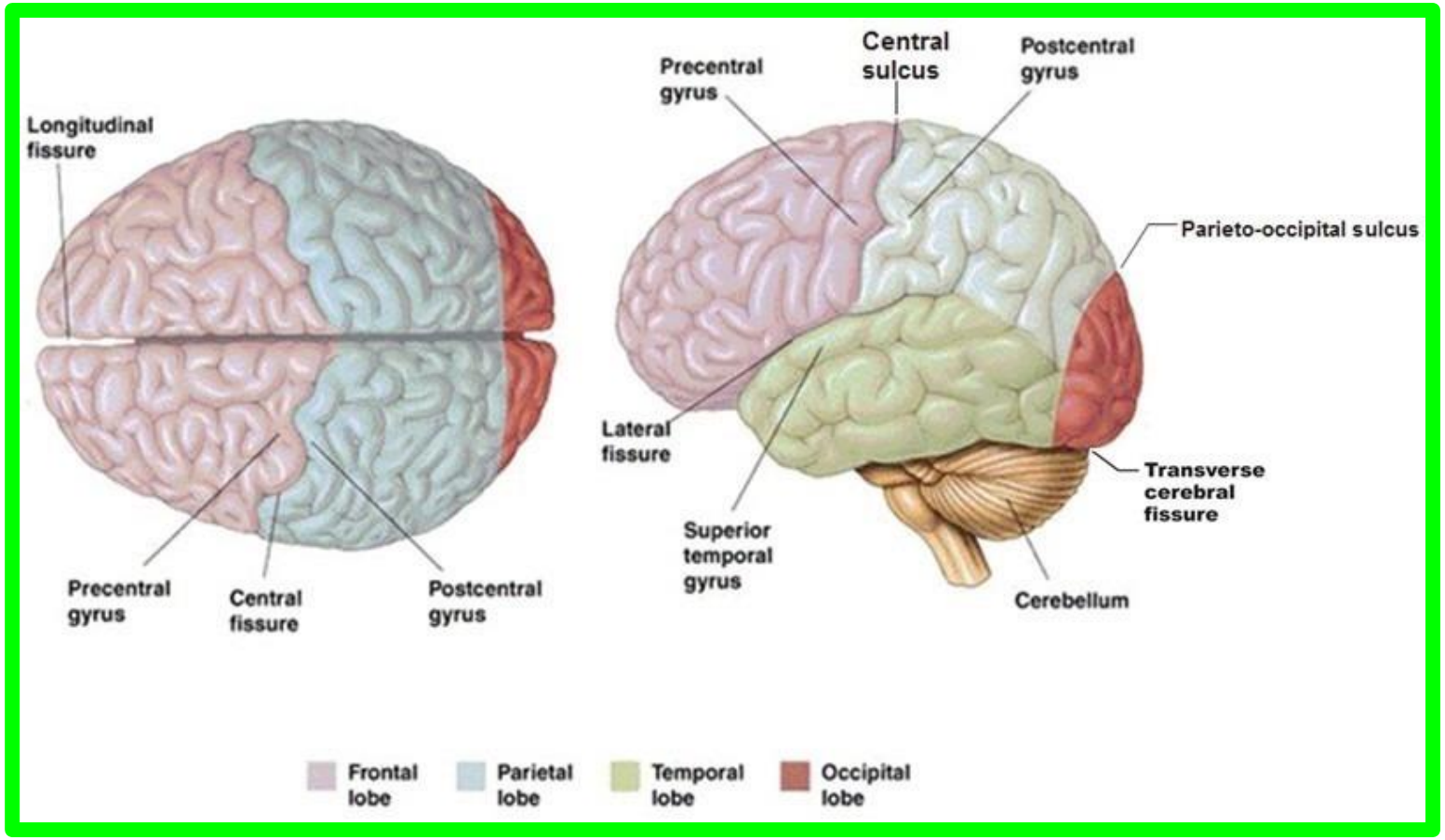




Cerebrum

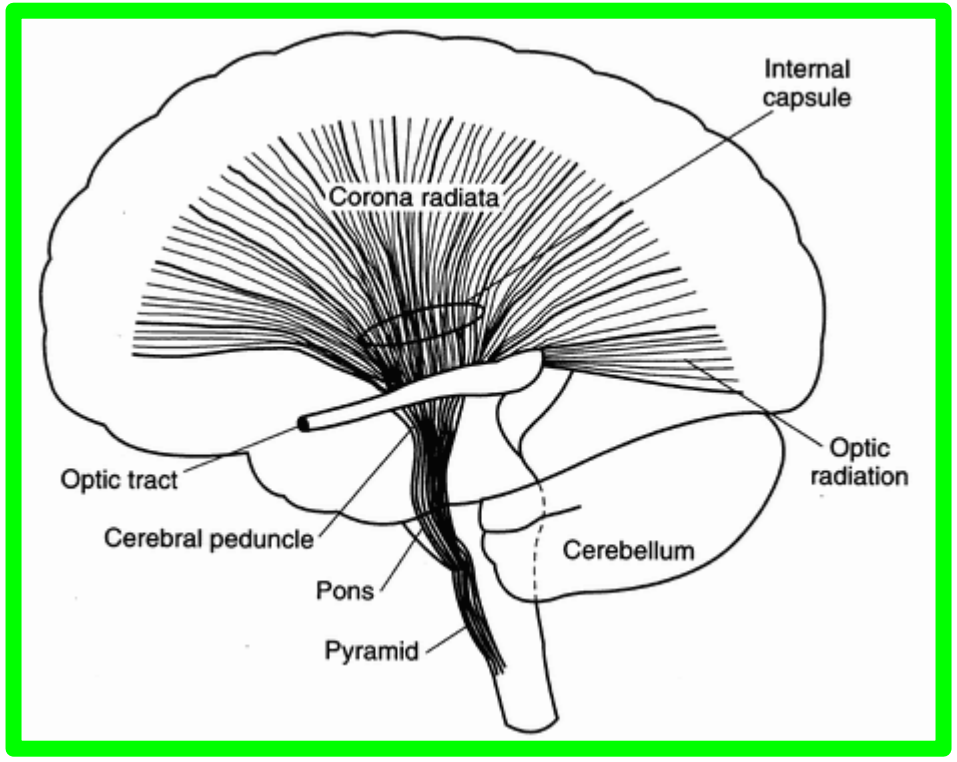
- The surface layer of each hemisphere, the cortex, is composed of gray matter.
- The cerebral cortex is thrown into folds (gyri) separated by fissures, or sulci
- This arrangement greatly increases the surface area of the cortex.

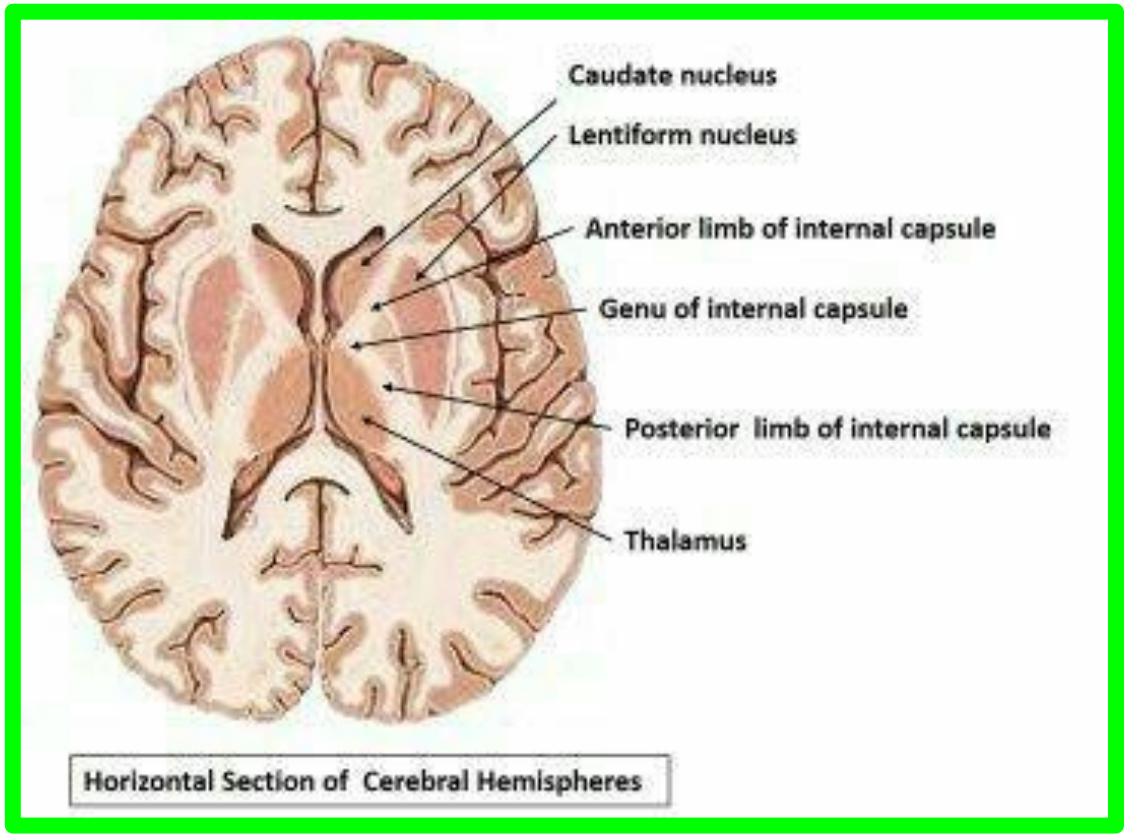
- A number of the large sulci are conveniently used to subdivide the surface of each hemisphere into lobes, which are named from the bones of the cranium they lie under.



Cerebrum

- Within the hemisphere is a central core of white matter containing several large masses of gray matter, the basal nuclei or ganglia.
- A fan-shaped collection of nerve fibers, the corona radiata , passes in the white matter to and from the cerebral cortex to the brainstem.
- The corona radiata converges on the basal nuclei and passes between them as the internal capsule .





Cerebrum

- ✓ The tailed nucleus situated on the medial side of the internal capsule is **the caudate nucleus** and
- ✓ the lens-shaped nucleus on the lateral side of the internal capsule is **the lentiform nucleus.**
- ✓ Within each cerebral hemisphere is a cavity called **the lateral ventricle**

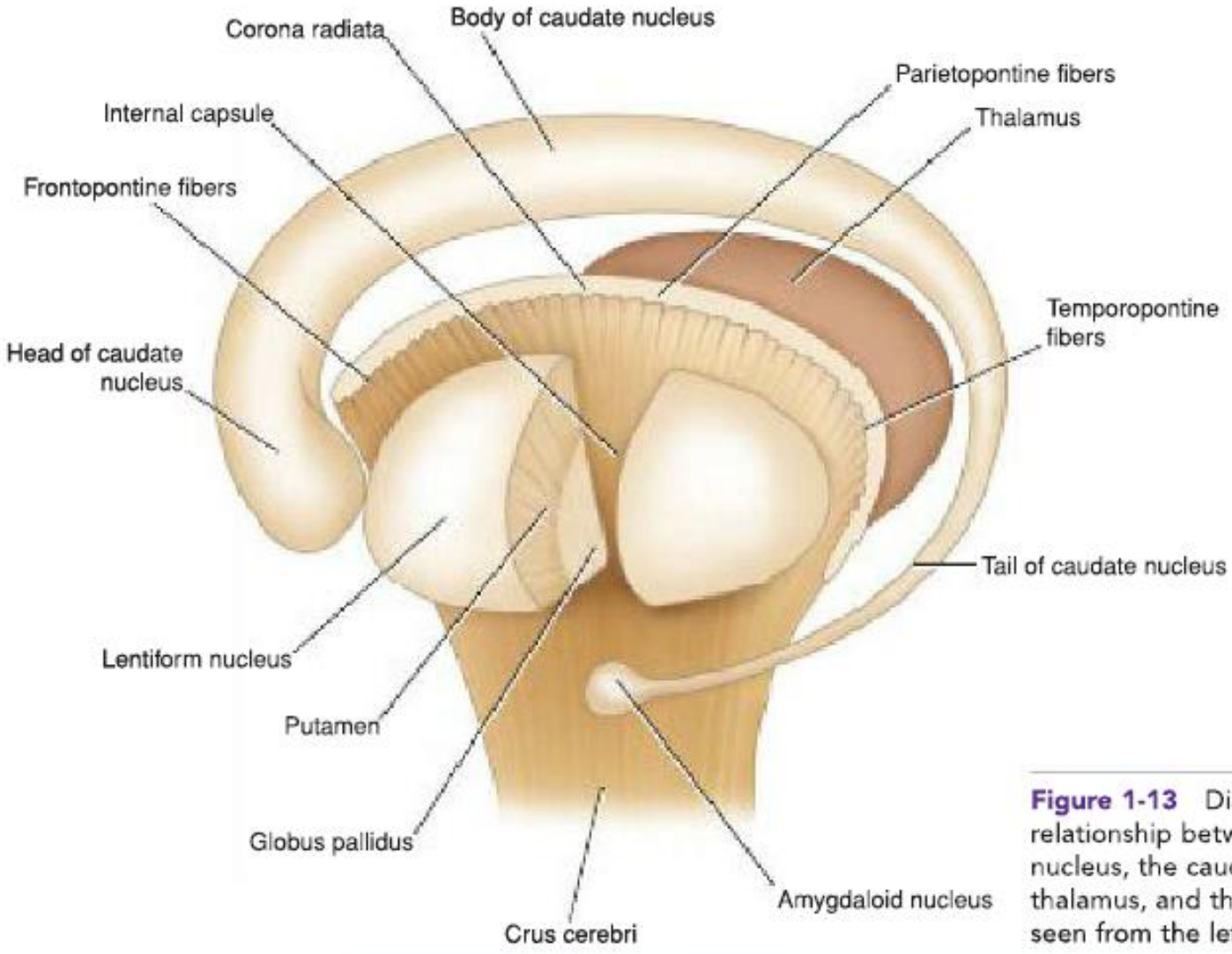
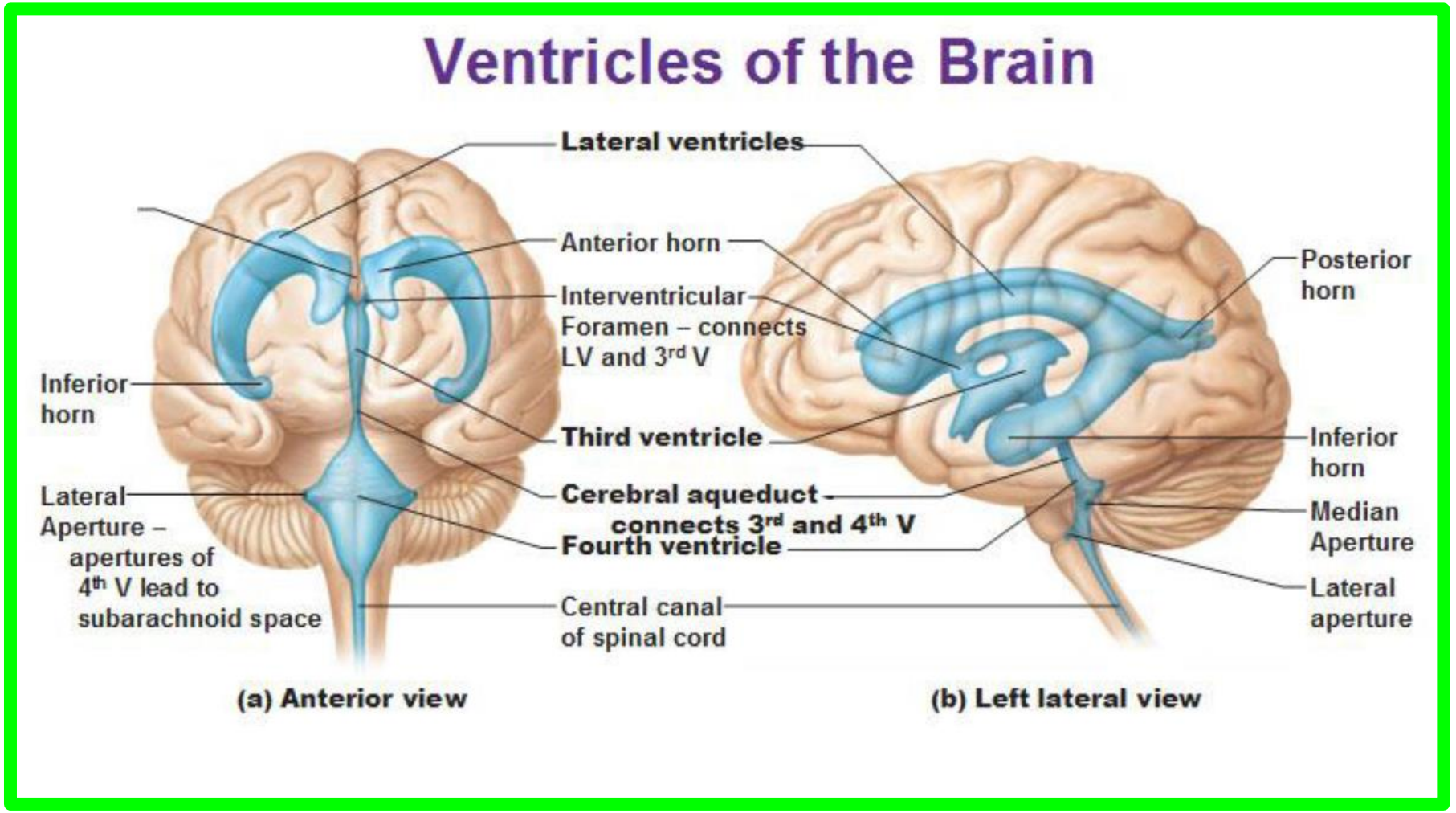


Figure 1-13 Diagram showing the relationship between the lentiform nucleus, the caudate nucleus, the thalamus, and the internal capsule, as seen from the left lateral side.

- The lateral ventricles communicate with the third ventricle through the interventricular foramina.



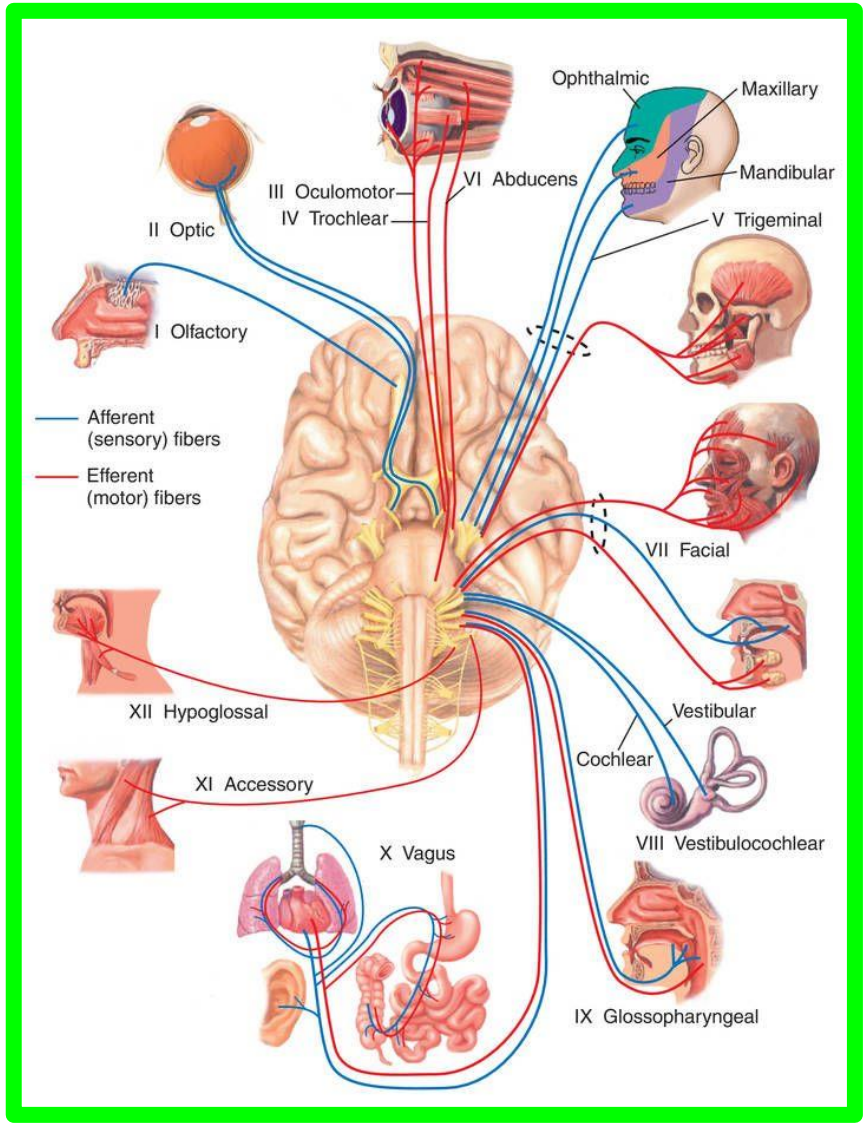
MAJOR DIVISIONS OF THE PERIPHERAL NERVOUS SYSTEM

The PNS comprises the cranial and spinal nerves and their associated ganglia.

Cranial and Spinal Nerves

The cranial and spinal nerves are made up of bundles of nerve fibers supported by connective tissue.

The 12 pairs of cranial nerves leave the brain and pass through foramina in the skull..

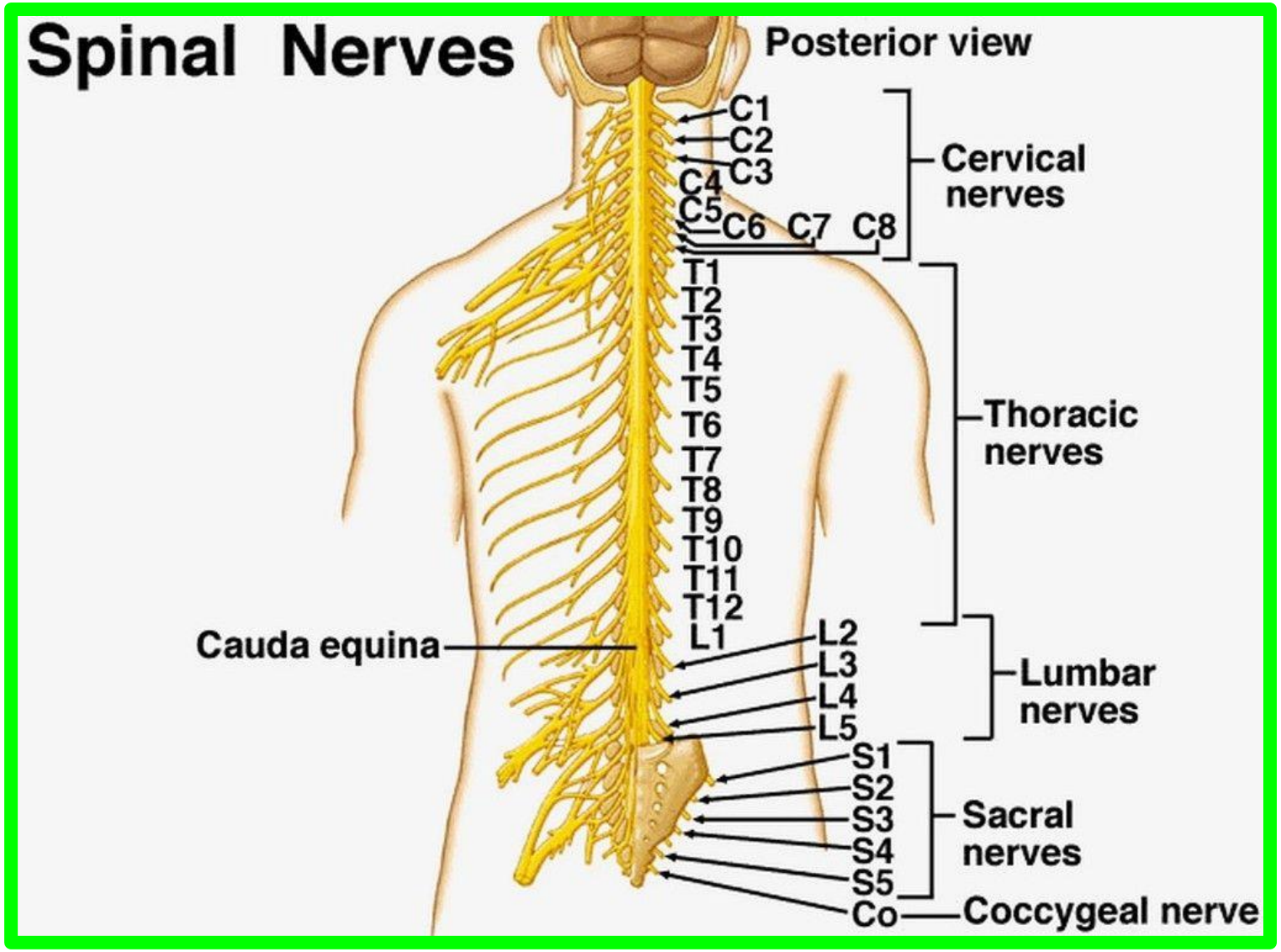


Cranial and Spinal Nerves

The 31 pairs of spinal nerves leave the spinal cord and pass through intervertebral foramina in the vertebral column.

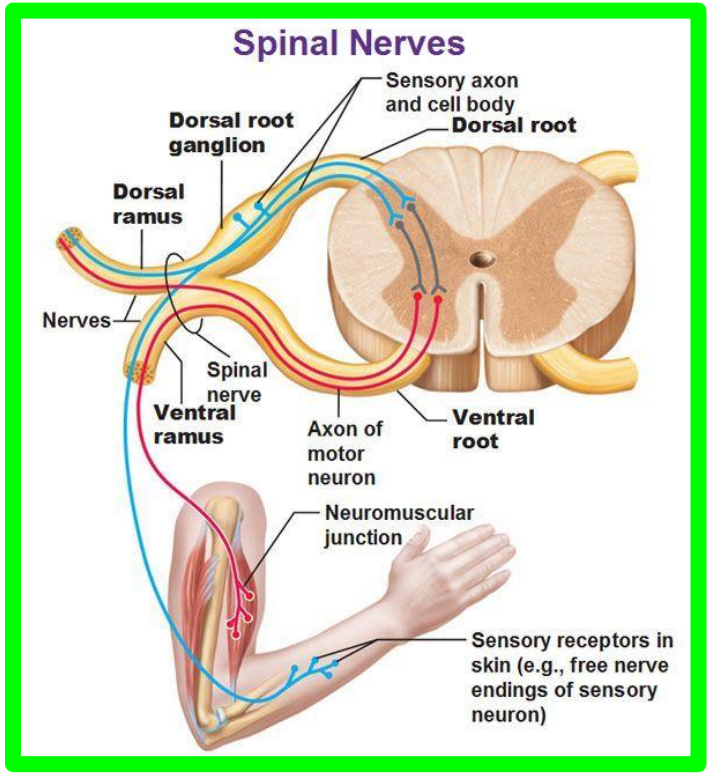
The spinal nerves are associated with regions of the spinal cord:
8 cervical,
12 thoracic,
5 lumbar,
5 sacral, and
1 coccygeal.

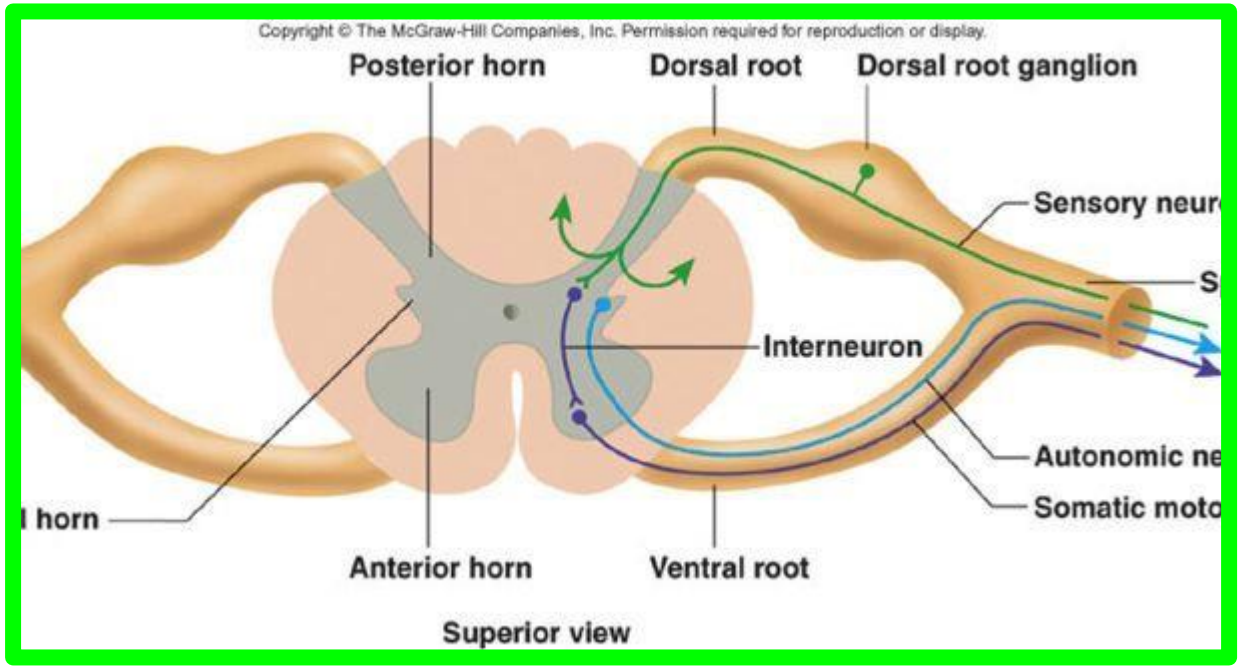
Note that there are 8 cervical nerves yet only 7 cervical vertebrae and that there is 1 coccygeal nerve but 4 coccygeal vertebrae



Cranial and Spinal Nerves

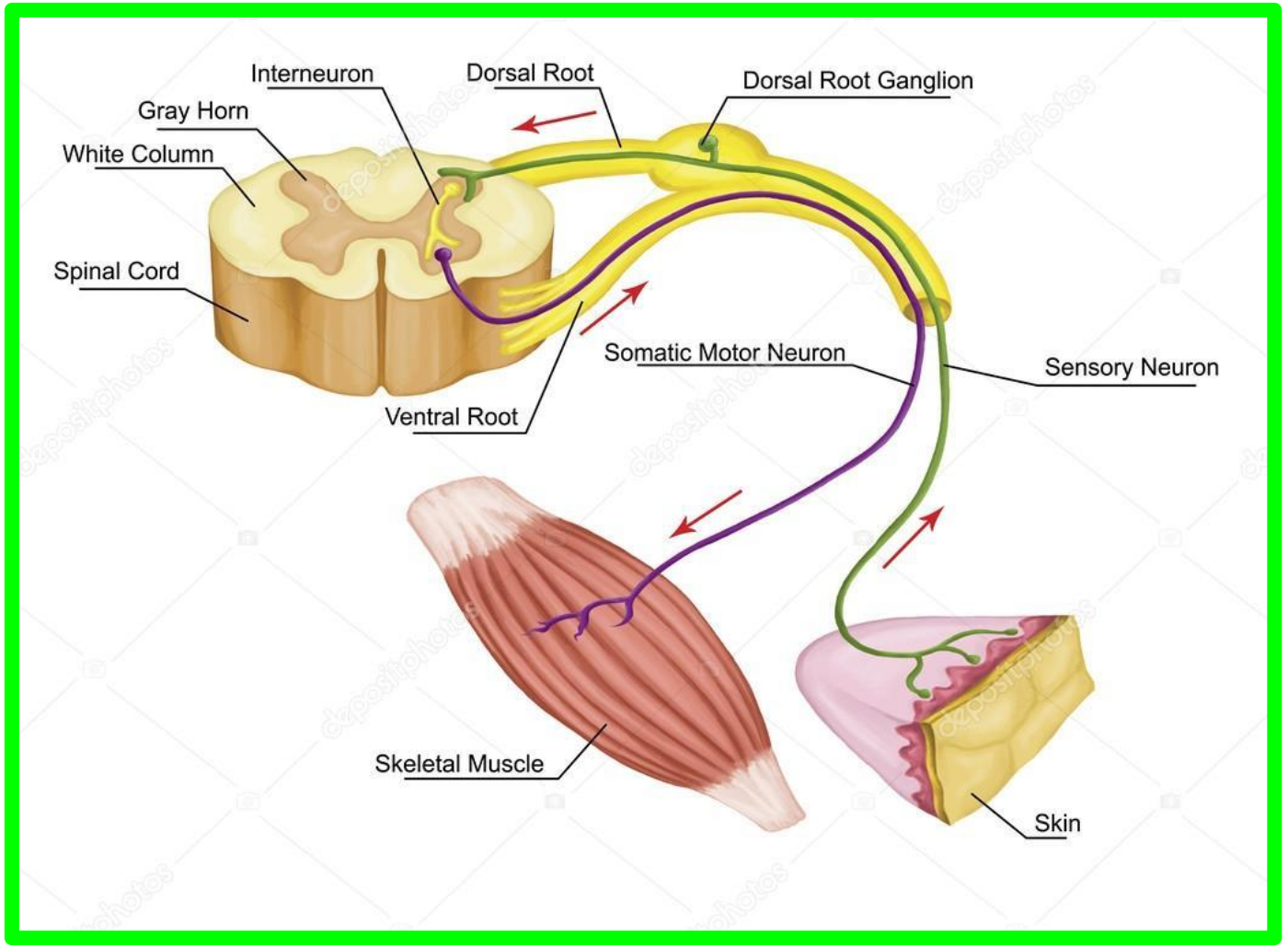
- Each spinal nerve is connected to the spinal cord by two roots: the anterior root and the posterior root
- The anterior root consists of bundles of nerve fibers carrying nerve impulses away from the CNS—efferent fibers.
- Those that go to skeletal muscles and cause them to contract are motor fibers.
- Their cells of origin lie in the anterior gray horn of the spinal cord





Cranial and Spinal Nerves

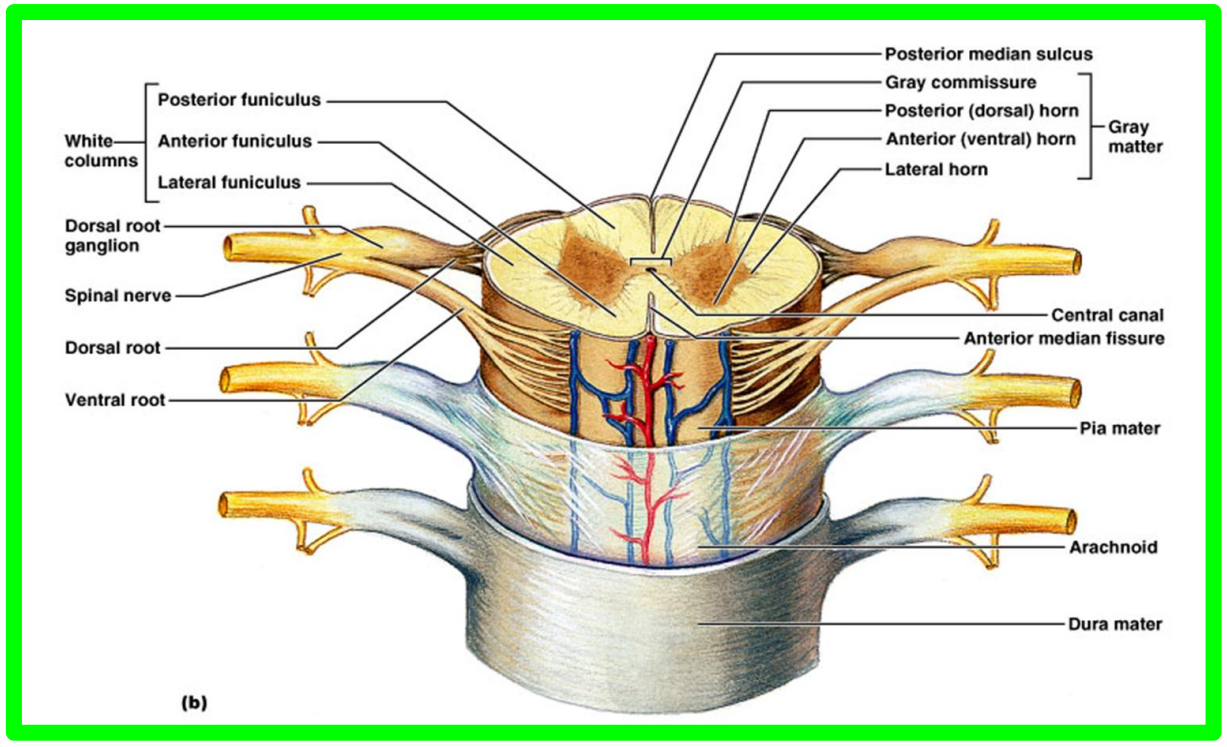
- **The posterior root** consists of bundles of afferent fibers that carry nervous impulses to the CNS.
- Because these fibers convey information about sensations of **touch, pain, temperature, and vibration, they are called sensory fibers.**
- The cell bodies of these nerve fibers are situated in a swelling on the posterior root called **the posterior root ganglion**

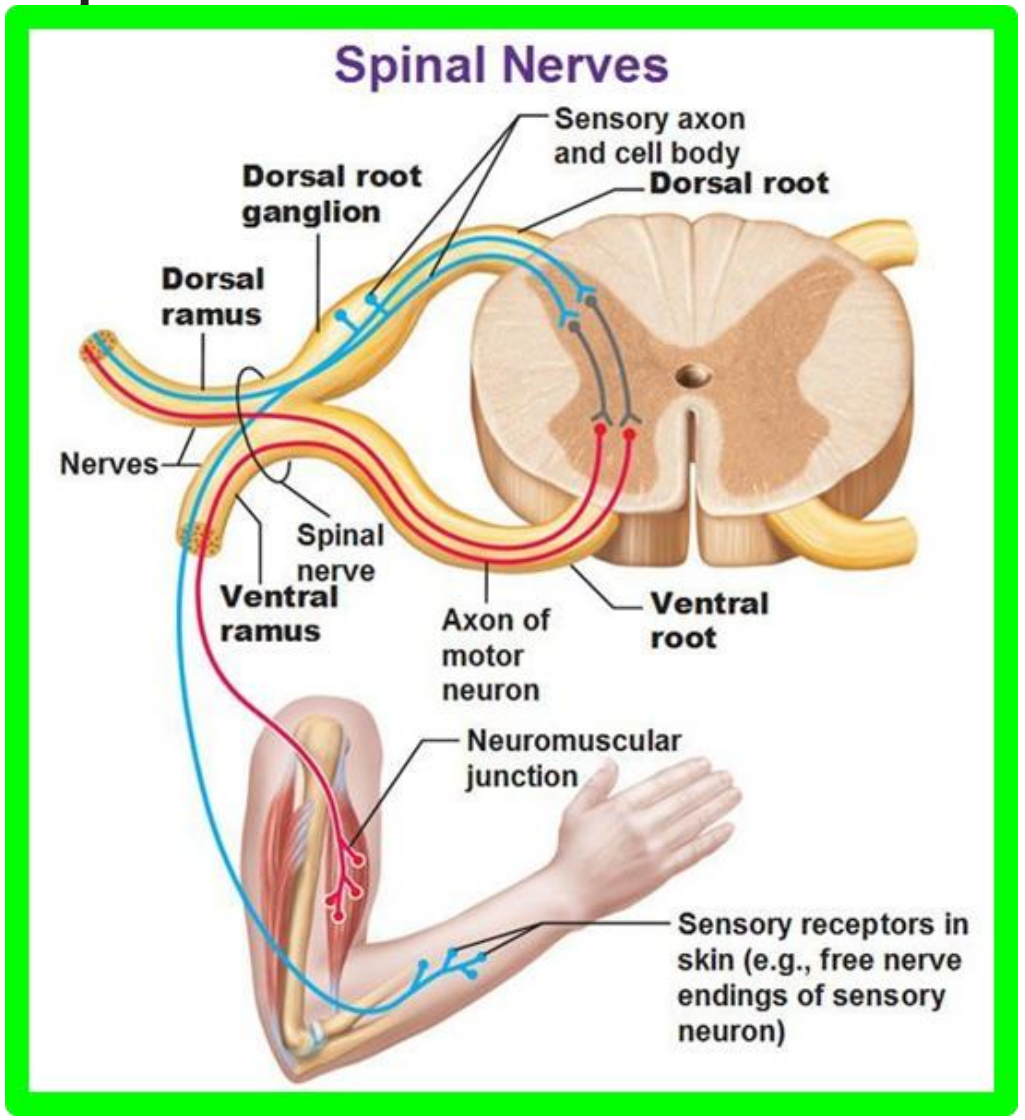


Cranial and Spinal Nerves

- The spinal nerve roots pass from the spinal cord to the level of their respective intervertebral foramina, where they unite to form a spinal nerve

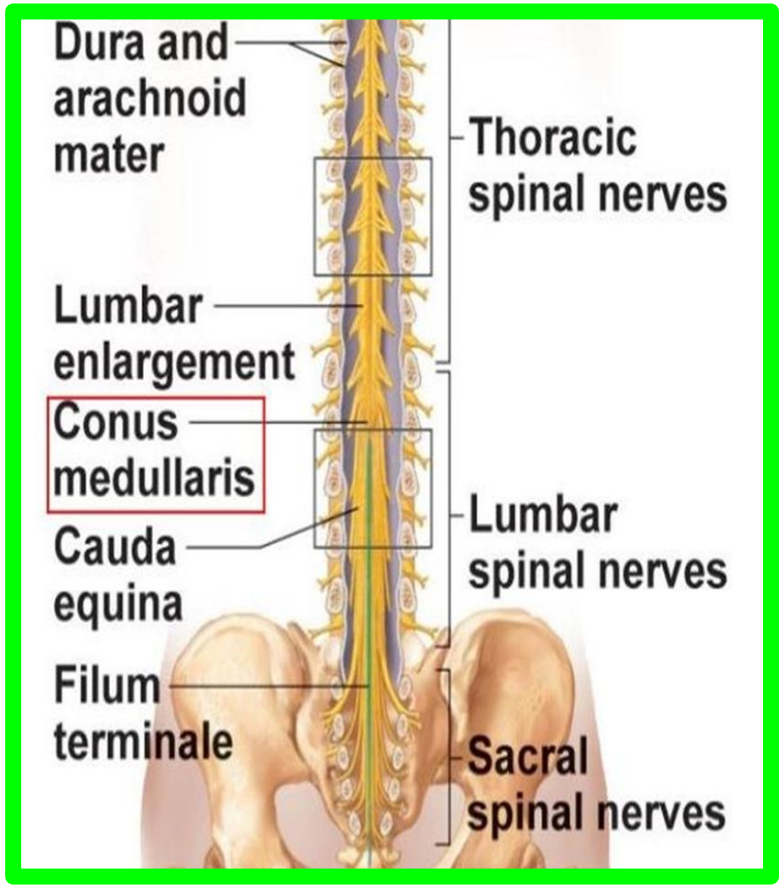
- Here, the motor and sensory fibers mix together; thus, a spinal nerve comprises both motor and sensory fibers

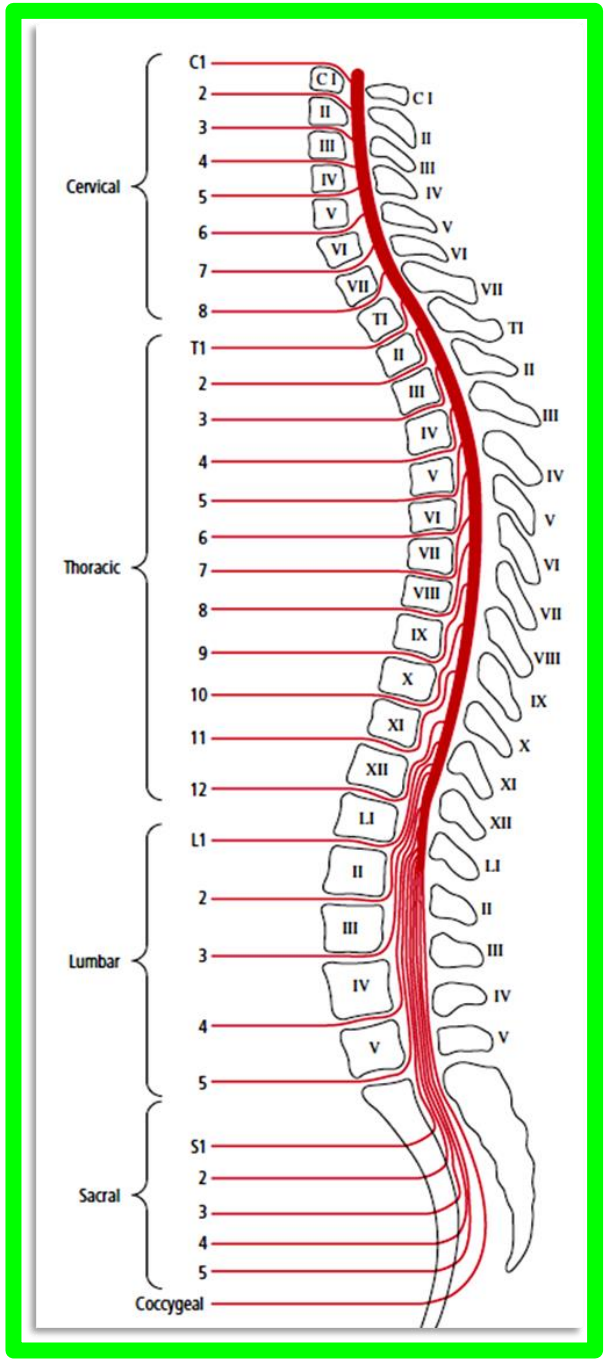




Cranial and Spinal Nerves

Because of the disproportionate growth in length of the vertebral column during development, compared with that of the spinal cord, the length of the roots increases progressively from above downward.





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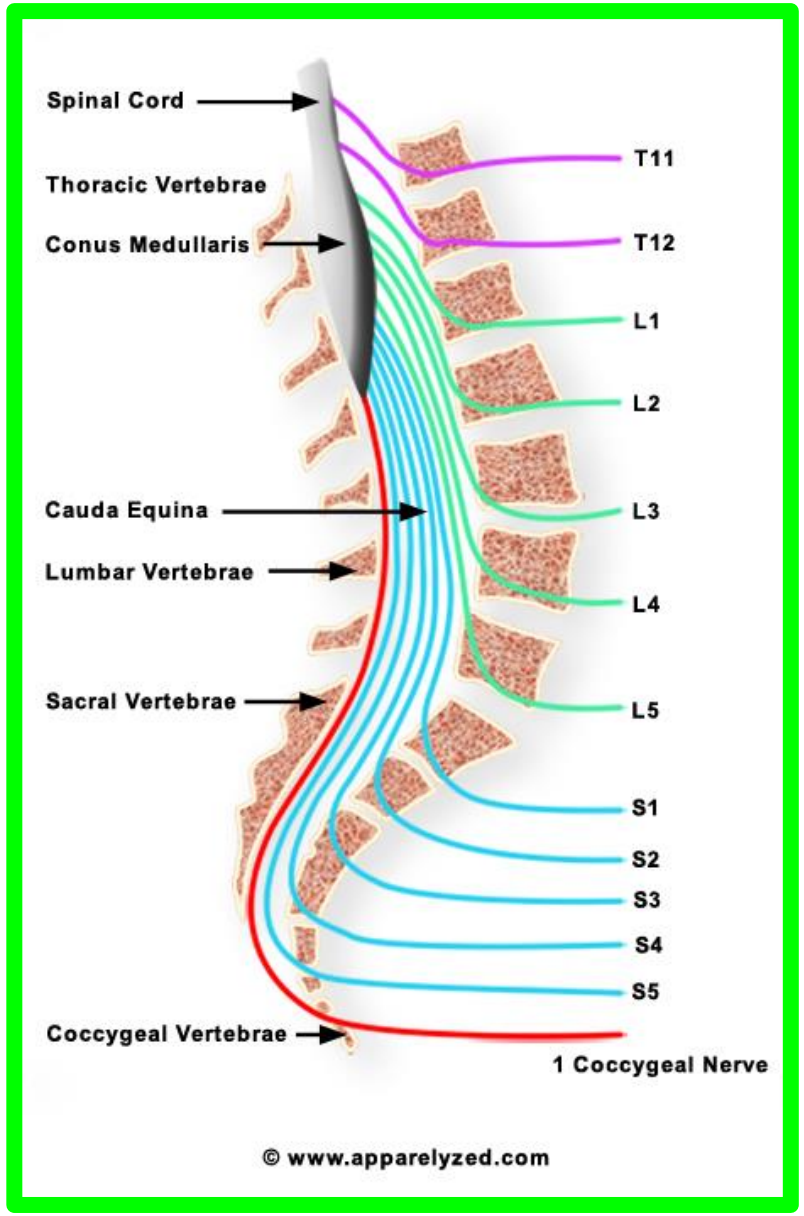
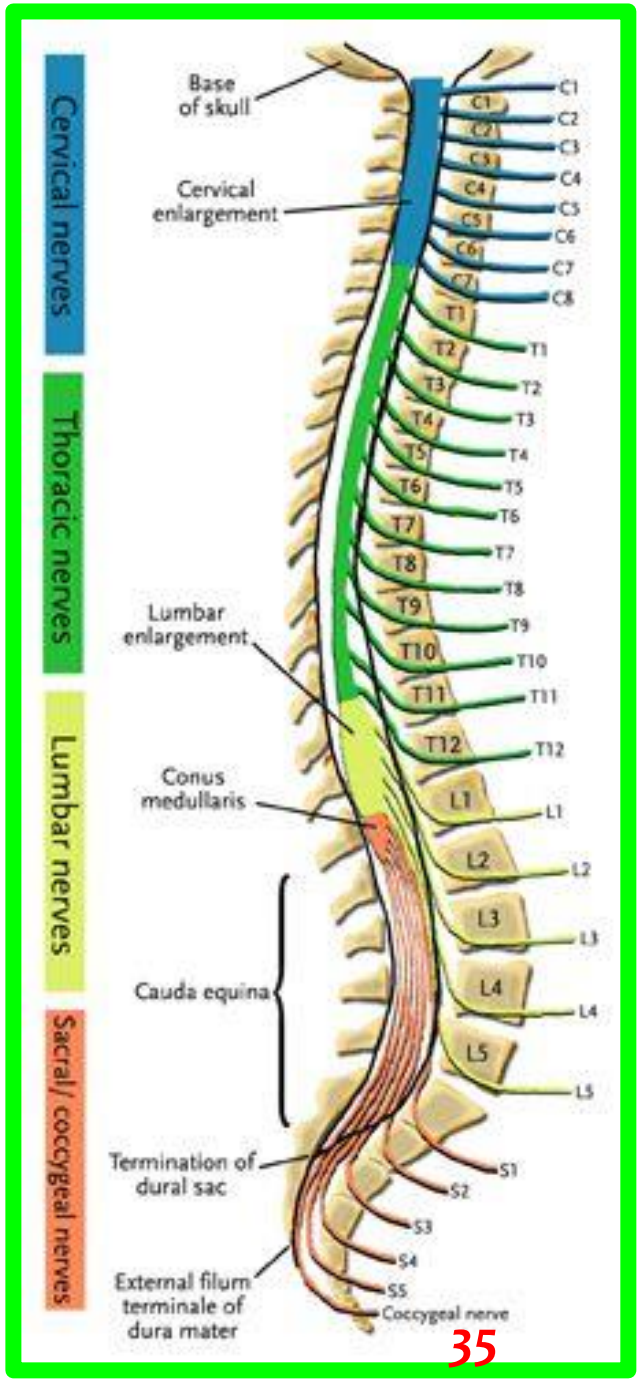
Cranial and Spinal Nerves

- In the upper cervical region, the spinal nerve roots are short and run almost horizontally,
- but the roots of the lumbar and sacral nerves below the level of the termination of the cord (lower border of the lst lumbar vertebra in the adult) form a vertical leash of nerves around the filum terminale

- Together, these lower nerve roots are called the cauda equina

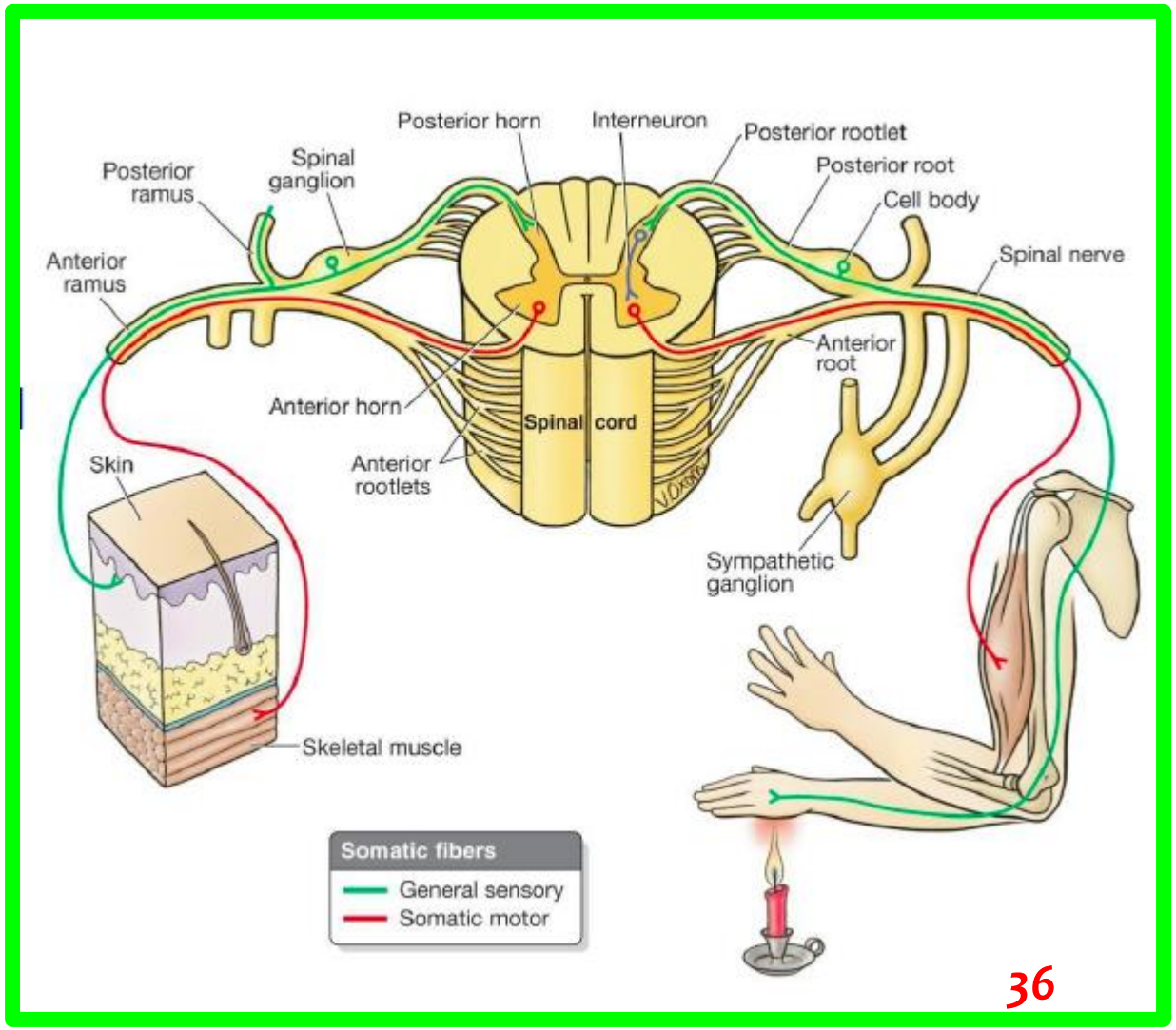




Cranial and Spinal Nerves

After emerging from the intervertebral foramen, each spinal nerve immediately divides into a large anterior ramus and a smaller posterior ramus, each containing both motor and sensory fibers.

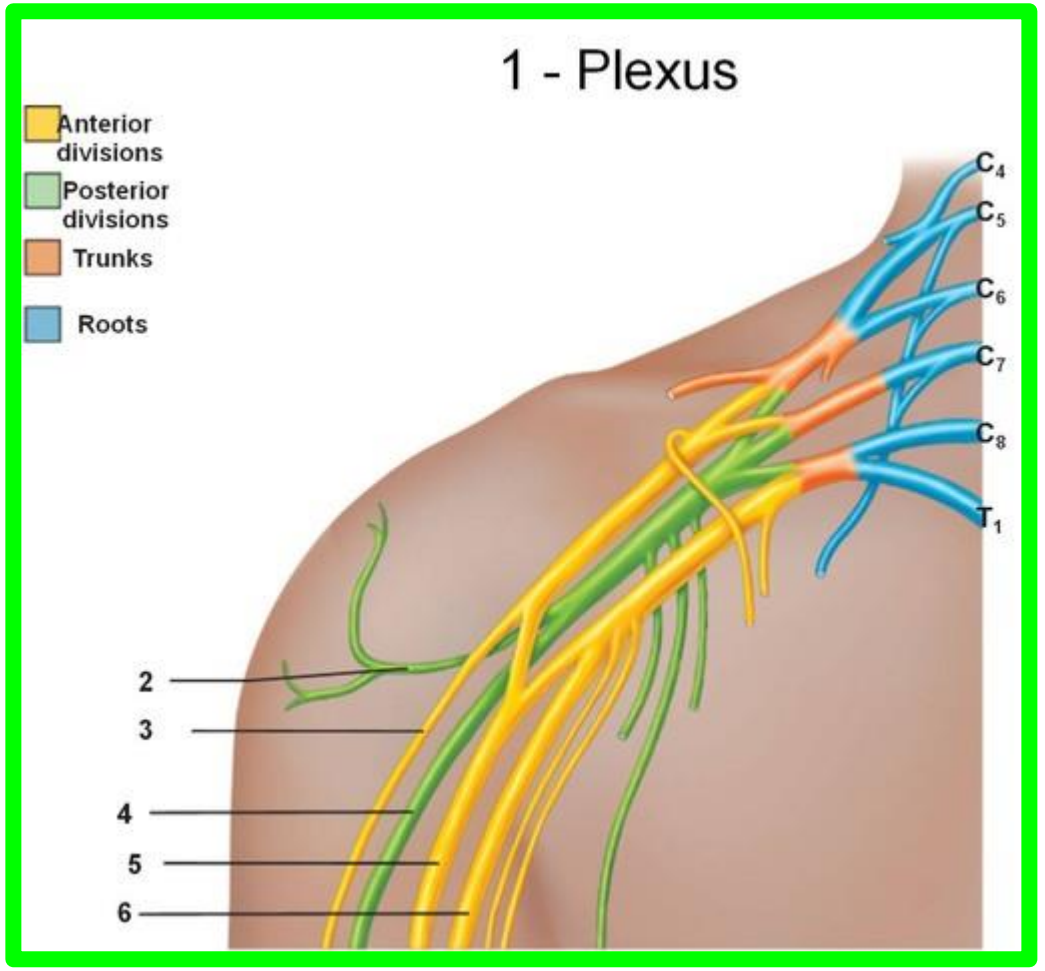
- The posterior ramus passes posteriorly around the vertebral column to supply the muscles and skin of the back.
- The anterior ramus continues anteriorly to supply the muscles and skin over the anterolateral body wall and all the muscles and skin of the limbs.



Cranial and Spinal Nerves

The anterior rami join one another at the root of the limbs to form complicated **nerve plexuses**.

The cervical and brachial plexuses are found at the root of the upper limbs, and **the lumbar and sacral plexuses** are found at the root of the lower limbs.



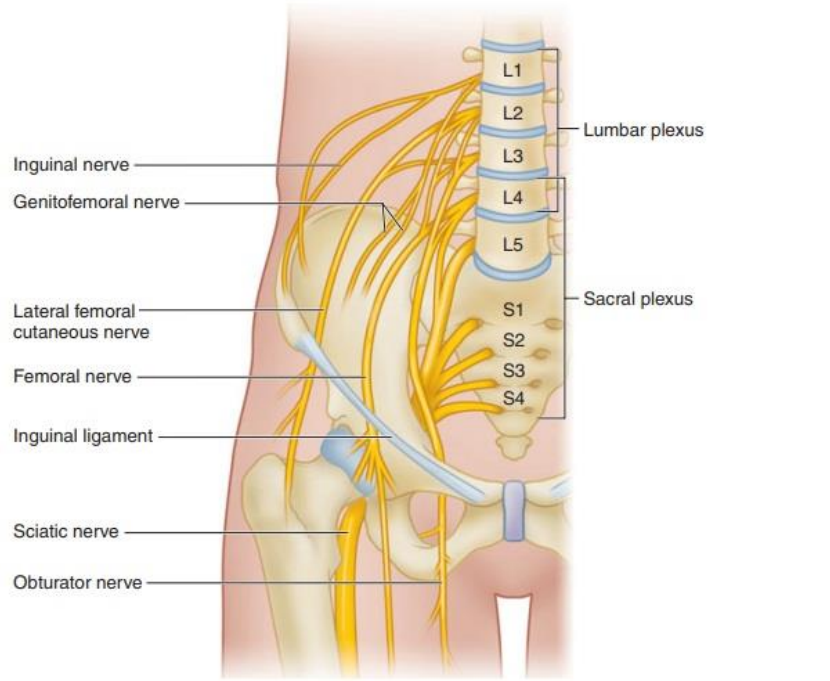


FIGURE 46–38 The ventral rami of L1–5 and S1–4 form the lumbosacral plexus, which provides innervation to the lower extremities.

Cranial and Spinal Nerves

Ganglia

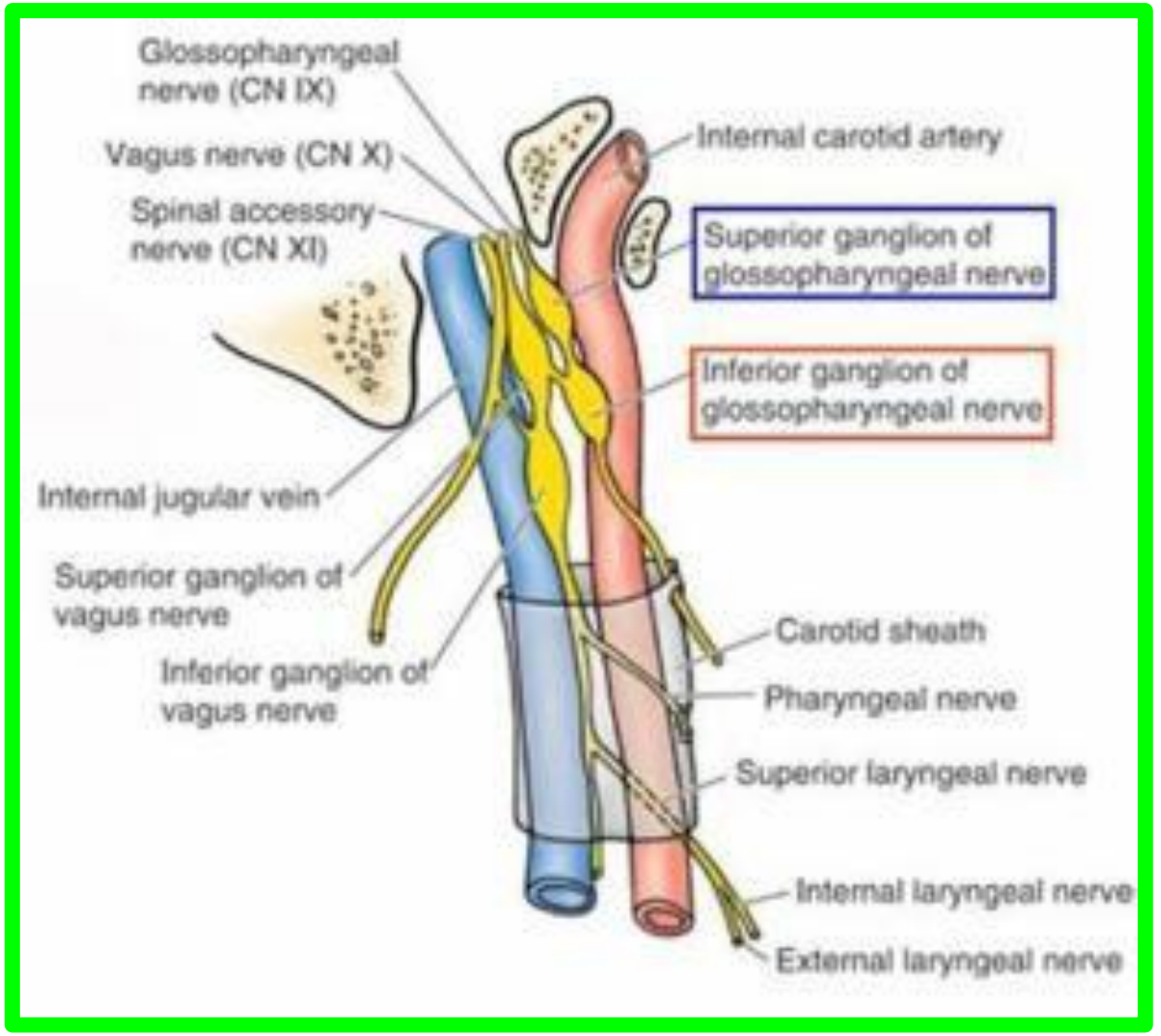
Ganglia can be divided into sensory ganglia of spinal nerves (posterior root ganglia) and cranial nerves and autonomic ganglia.

Sensory ganglia

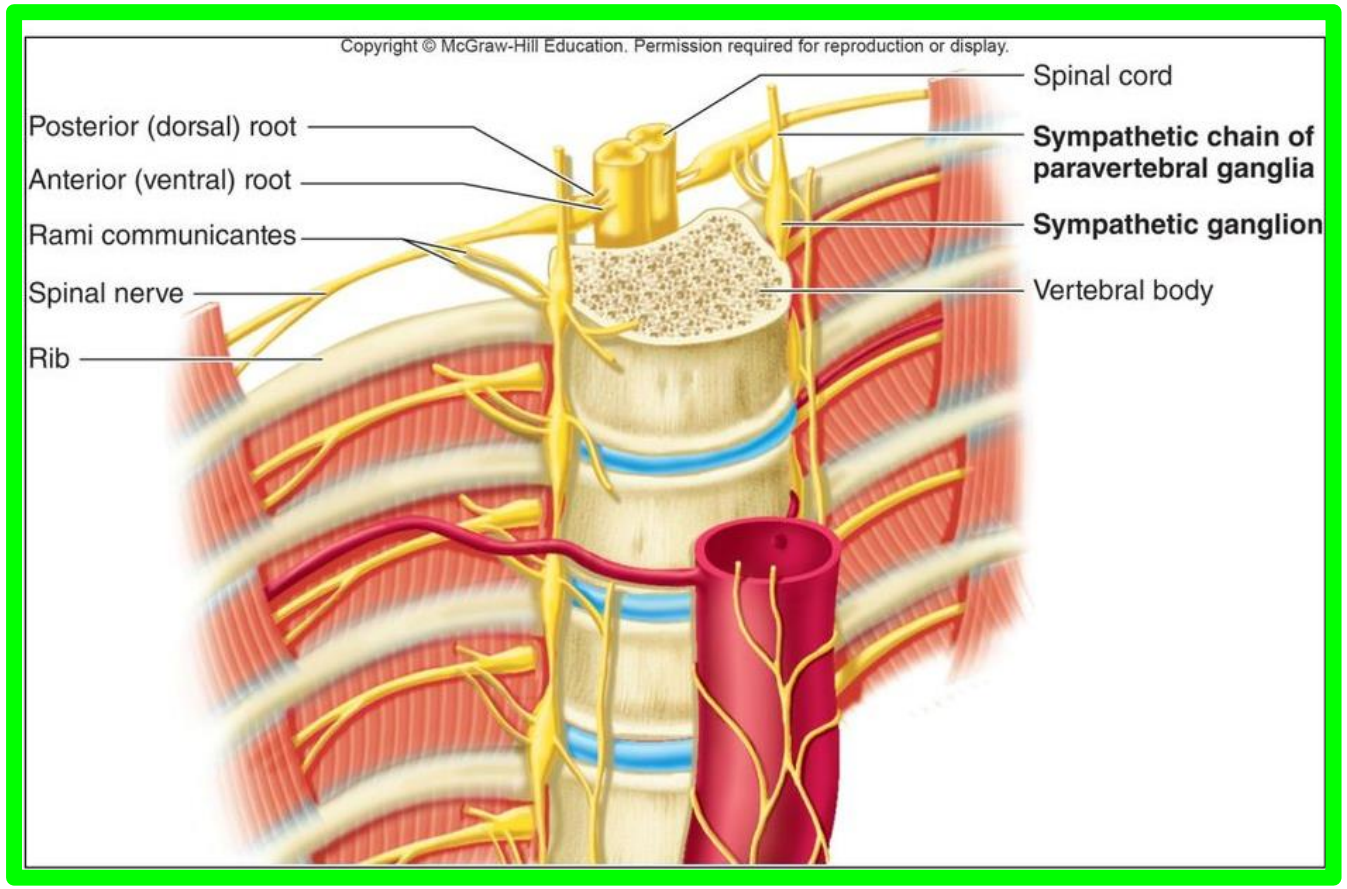
Sensory ganglia are **fusiform swellings on the posterior root of each spinal nerve** just proximal to the root's junction with a corresponding anterior root.

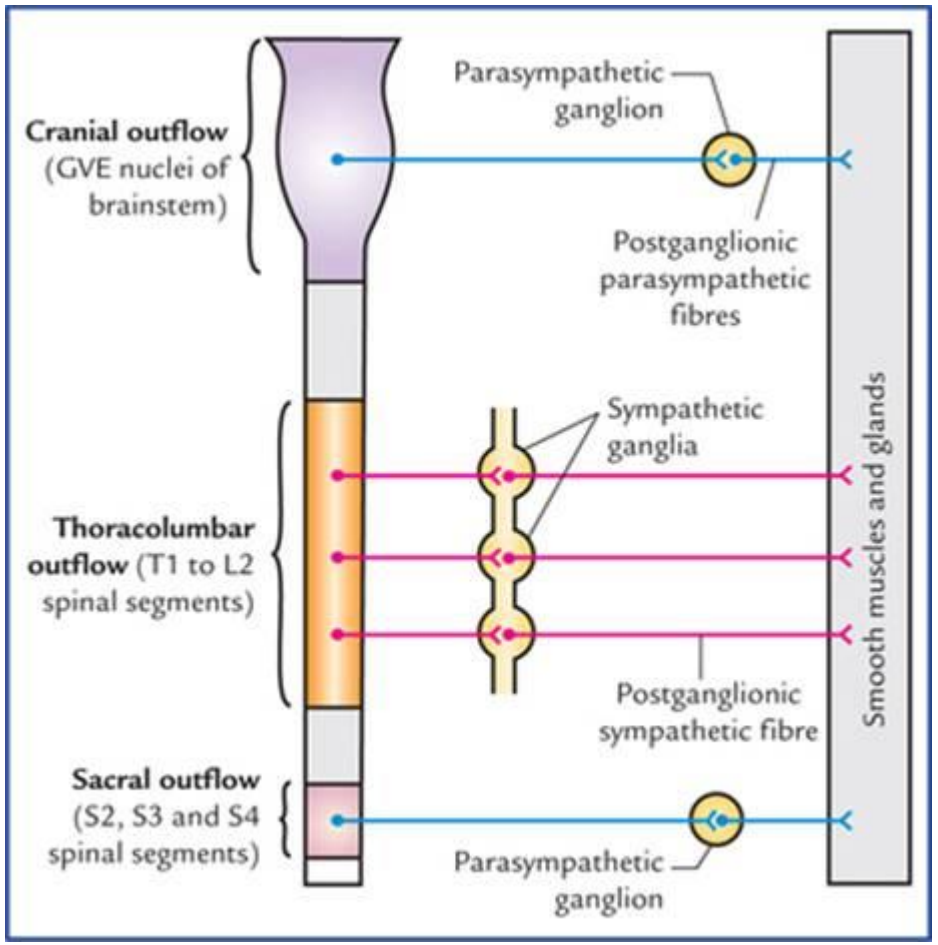
They are referred to as **posterior root ganglia.**

Similar ganglia found along the course of **cranial nerves V, VII, VIII, IX, and X** are the sensory ganglia of these nerves.



Autonomic ganglia, which are often irregular in shape, are situated along the course of efferent nerve fibers of the ANS. They are found in the **paravertebral sympathetic chains** around the roots of the great visceral arteries in the abdomen and **close to, or embedded within, the walls of various viscera**



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