

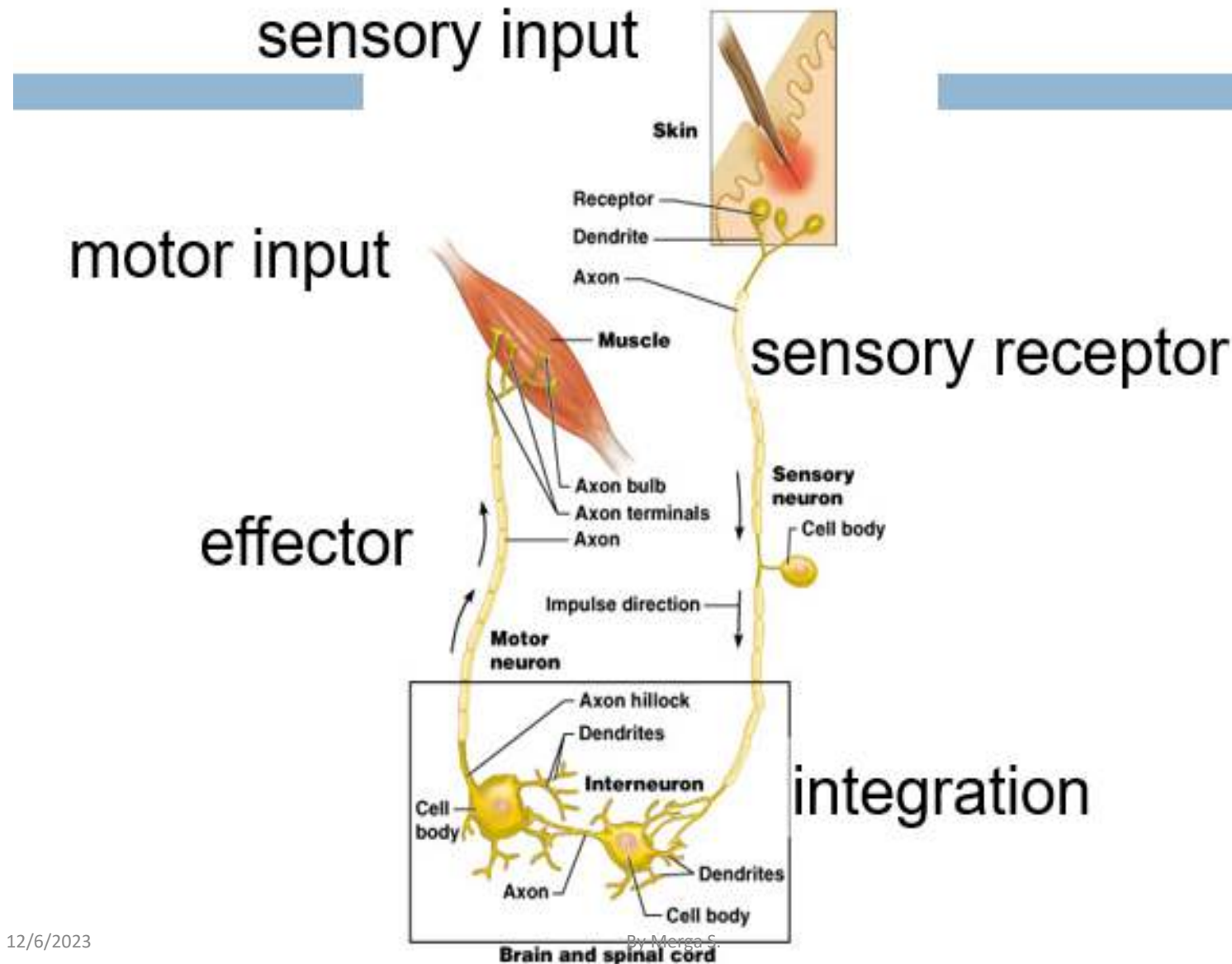
Learning objective

- Name the divisions of the nervous system and the parts of each, and state the general functions of the nervous system.
- Name the parts of a neuron and state the function of each.
- State the names and numbers of the spinal nerves and cranial nerves.

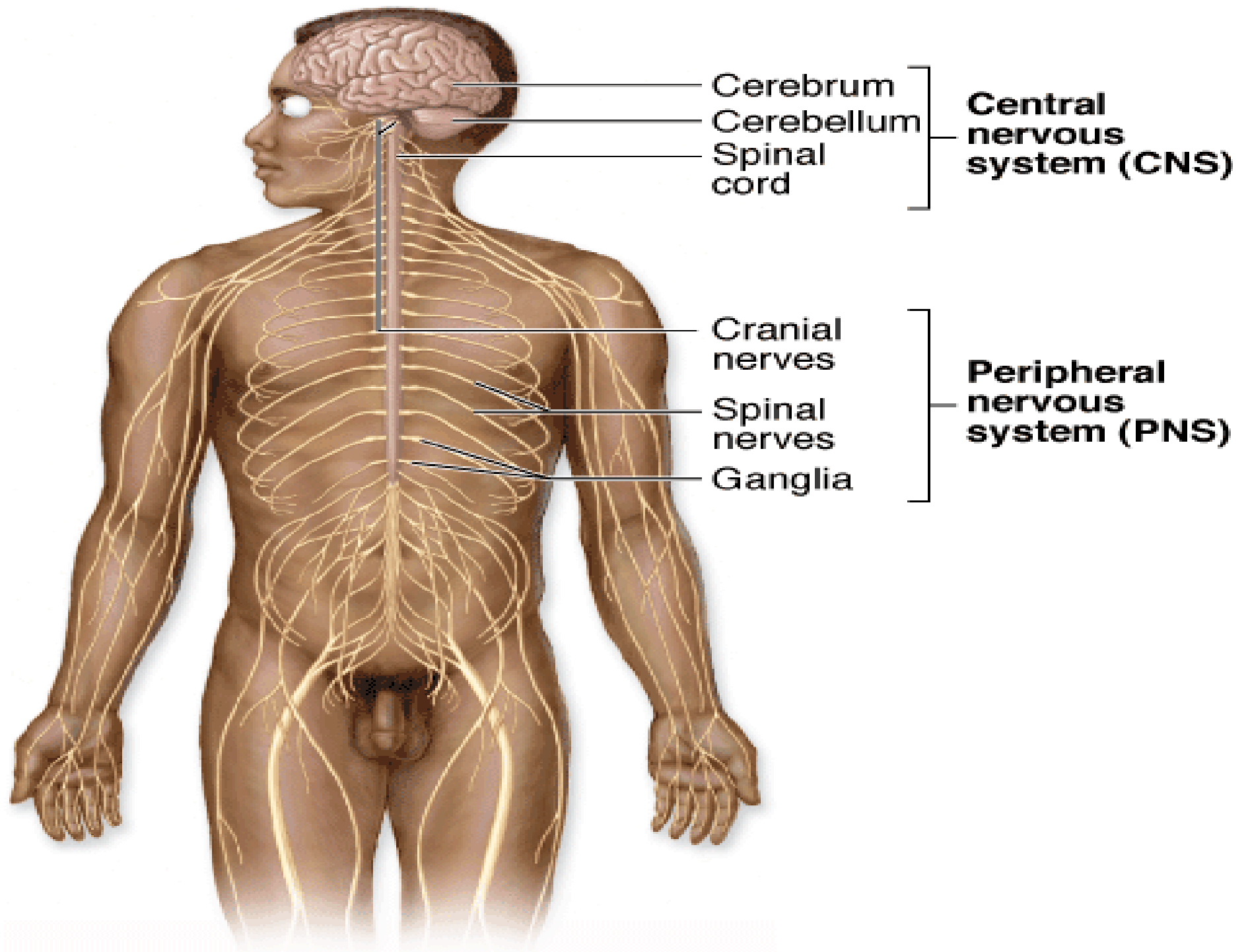
- **The nervous system** is a complex network of nerves and cells that **carry messages** to and from the brain and spinal cord to various parts of the body
- functions of the **nervous system**:
 1. To detect changes and feel sensations
 2. To initiate appropriate responses to changes
 3. To organize information for immediate use and store it for future use

The nervous system is one of the regulating systems

Function of the Nervous System

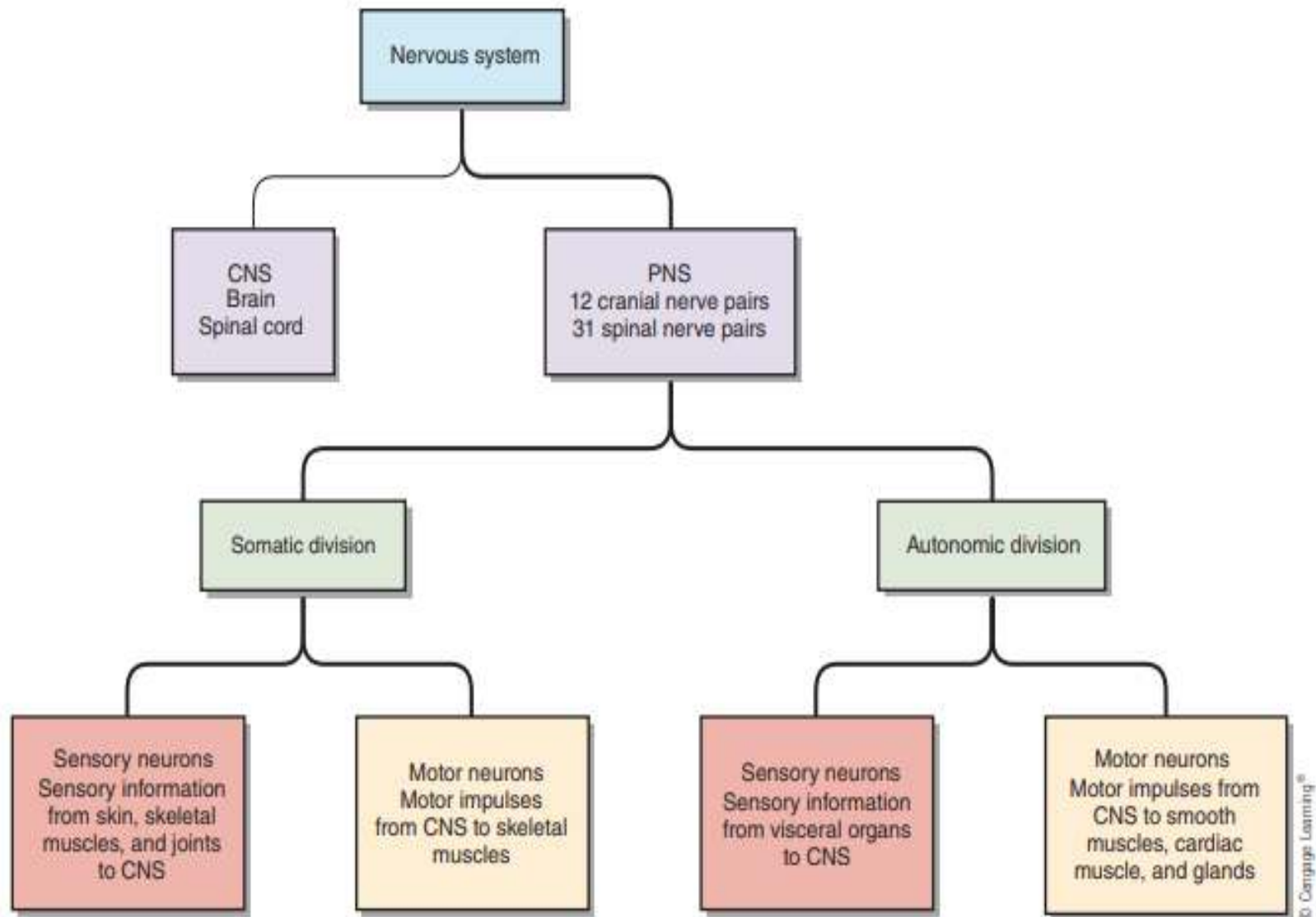


- The nervous system is divided **structurally** in to the
 - ✓ *central nervous system* and
 - ✓ *peripheral nervous system*.
- The central nervous system include the
 - ✓ *brain* and
 - ✓ *spinal cord*.
- The peripheral nervous system includes:
 - ✓ *cranial nerves* and
 - ✓ *spinal nerves*



- The peripheral nervous system is **functionally** divided into:
 - *sensory* and
 - *motor* divisions, and
 - association

General classifications of NS.



autonomic Division

1. SYMPATHETIC DIVISION

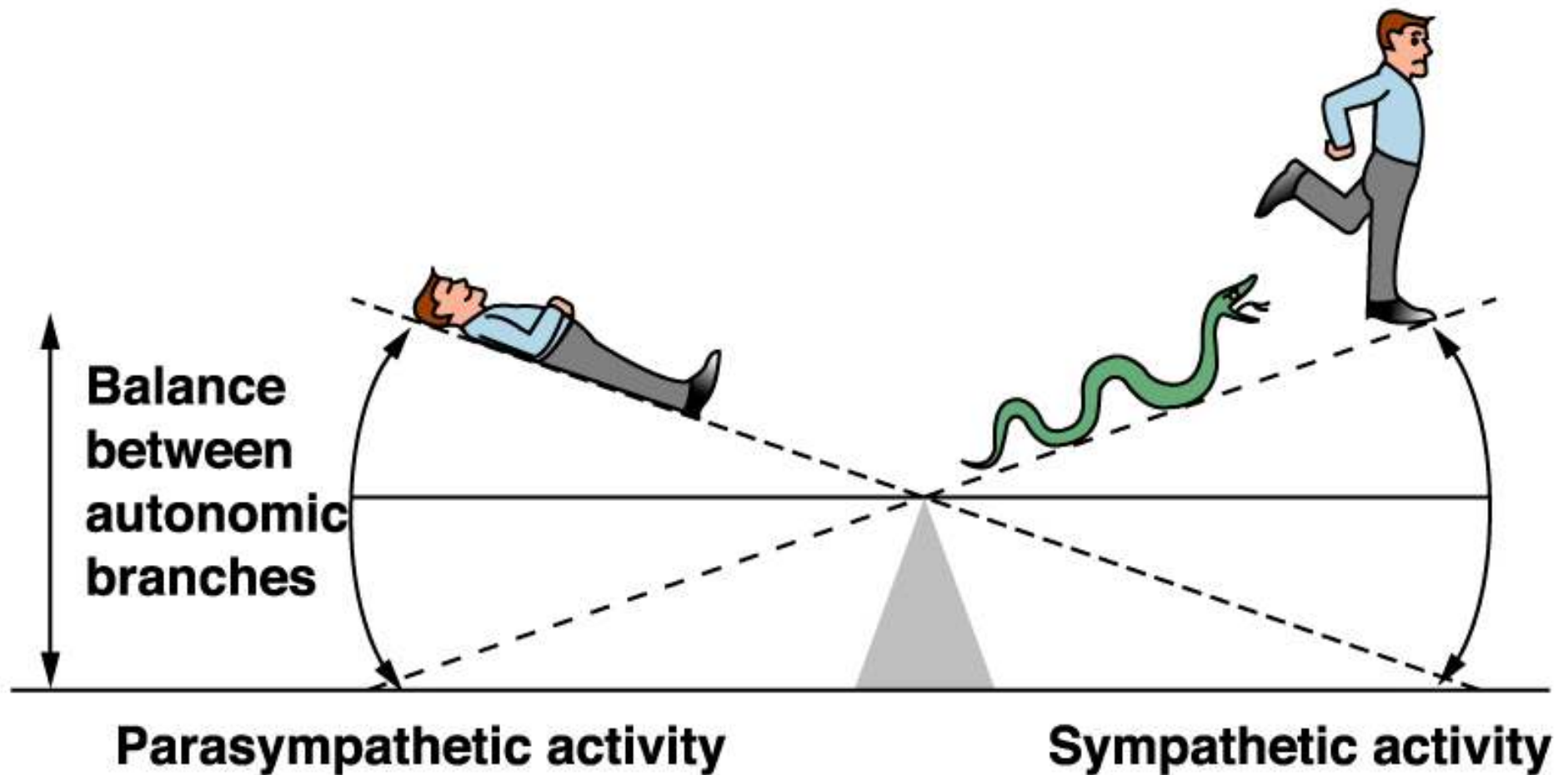
- ▶ Another name for the sympathetic division is **thoracolumbar** division,
 - which tells us where the sympathetic preganglionic **neurons** **bodies** are in **the thoracic segments** and some of the **lumbar segments** of the spinal cord originate.
- ▶ The sympathetic division is dominant in **stressful situations**, which include anger, fear, or anxiety, as well as exercise
- ▶ For our prehistoric ancestors, stressful situations often involved the need for intense physical activity—the **“fight or flight response”**

2. PARASYMPATHETIC DIVISION

- ▶ The other name for the parasympathetic division is the **cranio- sacral** division.
 - ▶ The cell bodies of parasympathetic preganglionic **neurons** are in the **brain stem** and the **sacral segments** of the spinal cord.
 - **The parasympathetic Ns** counter this, and is central during rest, sleeping, and digesting food.
 - in general, lowers metabolic rate,
 slows activity, and
 restores blood pressure and
 resting heartbeat, and so forth
- “Rest and digest principle”.

Rest-and-digest

Fight-or-flight



Nervous tissue

The majority of the NS is tissue made up of two classes of cells:

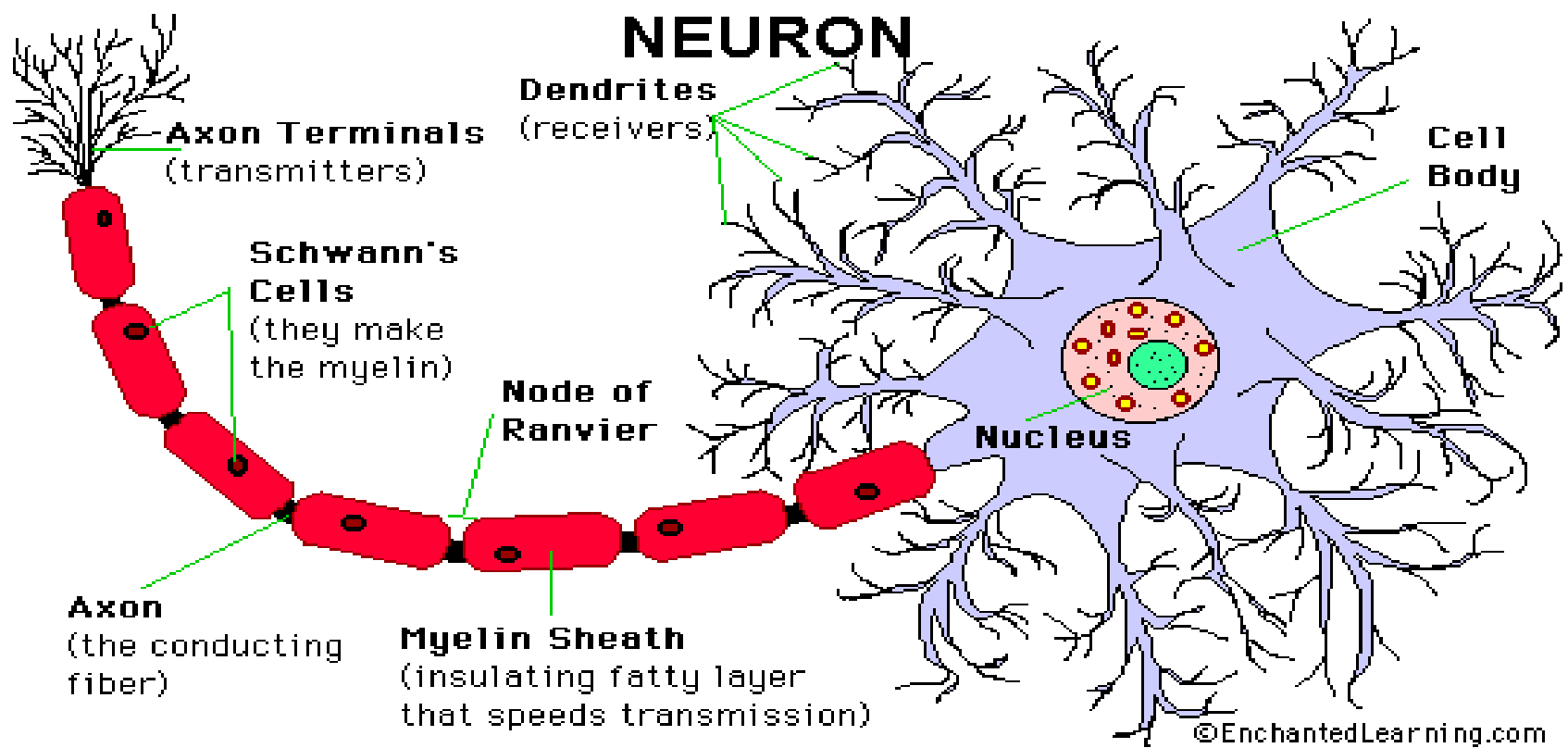
- ✓Neurons (Nerve cells) and
- ✓Supportive cells (Neuroglial cells)
- **Neurons:** also known as nerve cells, communicate within the body by transmitting electrochemical signals.
- **Neuroglia:** also known as glial cells, act as the “helper” cells of the CNS.

Neurons have three principal component,

- *cell body,*
- *dendrites and*
- *axons.*

1.The cell body-

- is the enlarged portion contains the **nucleus** and *nucleolus* surrounded by cytoplasm.
- The cytoplasm of cell body contains *organelles* which are found in other cells.



2. dendrites-

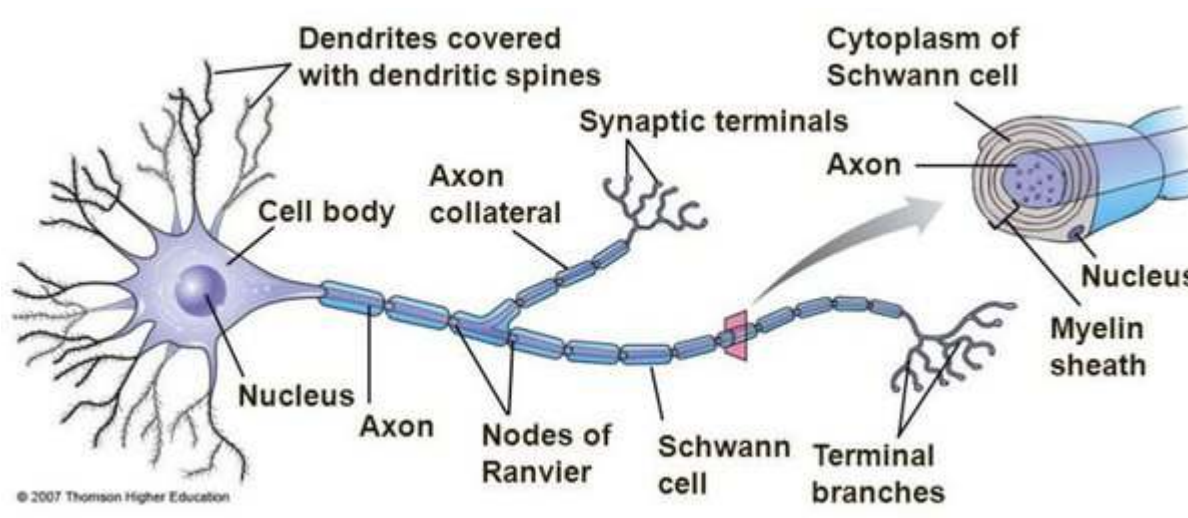
They are generally branched process that extend from the cytoplasm of cell body.

- Its function is to receive stimuli and conduct impulses toward the cell body.
- *Dendritic spinules* cover dendrites to increase surface

3.Axon-It is an elongated cylindrical process

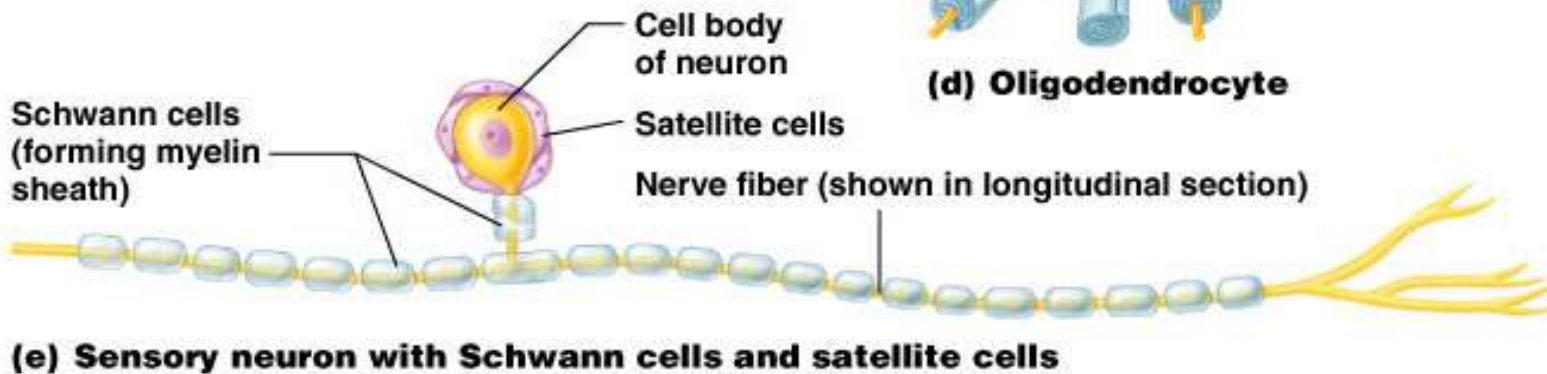
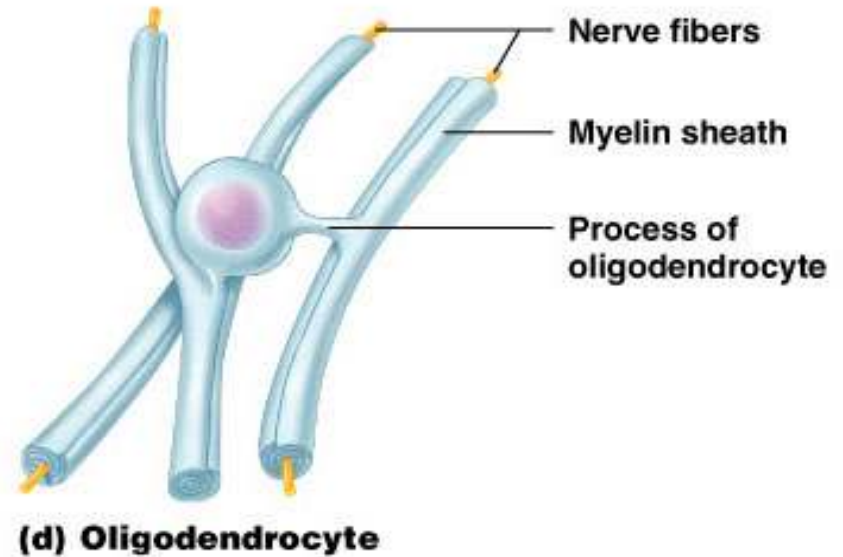
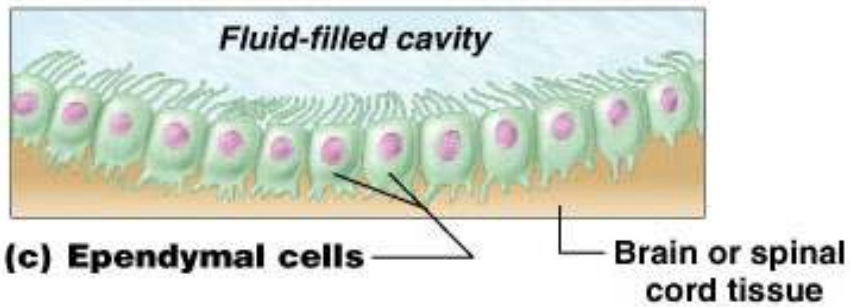
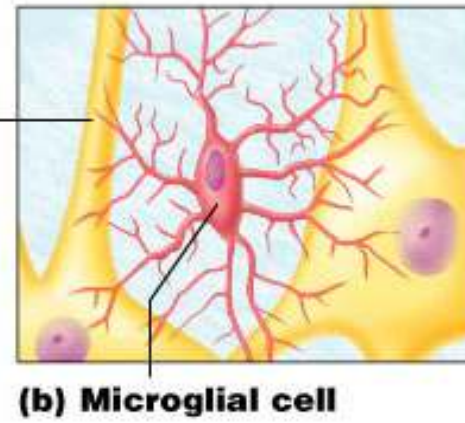
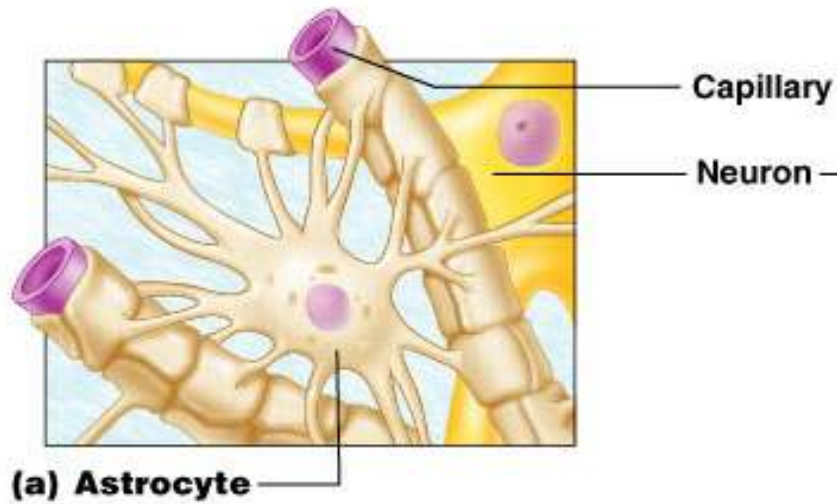
that conduct impulses **away** from the cell body .

- Axons vary in length, in CNS few mm & in PNS greater than **One meter**.
- It gives some collateral branches (at right angle) and many **terminal branches (axon terminals)**.
- It is surrounded with a membrane called **axolemma** and its cytoplasm is called **axoplasm**



neuroglial cells – glial cells

- Are supportive cells of in nervous system that aid function of neurons
- They are more abundant than neuron cells
- Have mitotic ability
- There are **six** neuroglial cells identified
- **Two** types of neuroglia based on their location:
central(**in CNS**) and peripheral(**in PNS**)



- *Glial cells in the CNS....4 in numbers.*

- ❖ *Oligodendrocytes* –

- form **myelin** layers around axons in the CNS

found only in the brain and spinal cord

- ❖ *Microglia*-

- are **phagocytic** cells that migrate through the CNS
constantly moving, phagocytizing cellular debris,
damaged cells, and pathogens.

❖ *Astrocytes-*

- help regulate the passage of molecules from the blood to the brain(BBB.)
- wrapped around brain capillaries prevents potentially harmful waste products in the blood from diffusing out into brain tissue
- disadvantage of the blood–brain barrier is that some useful medications cannot cross it.

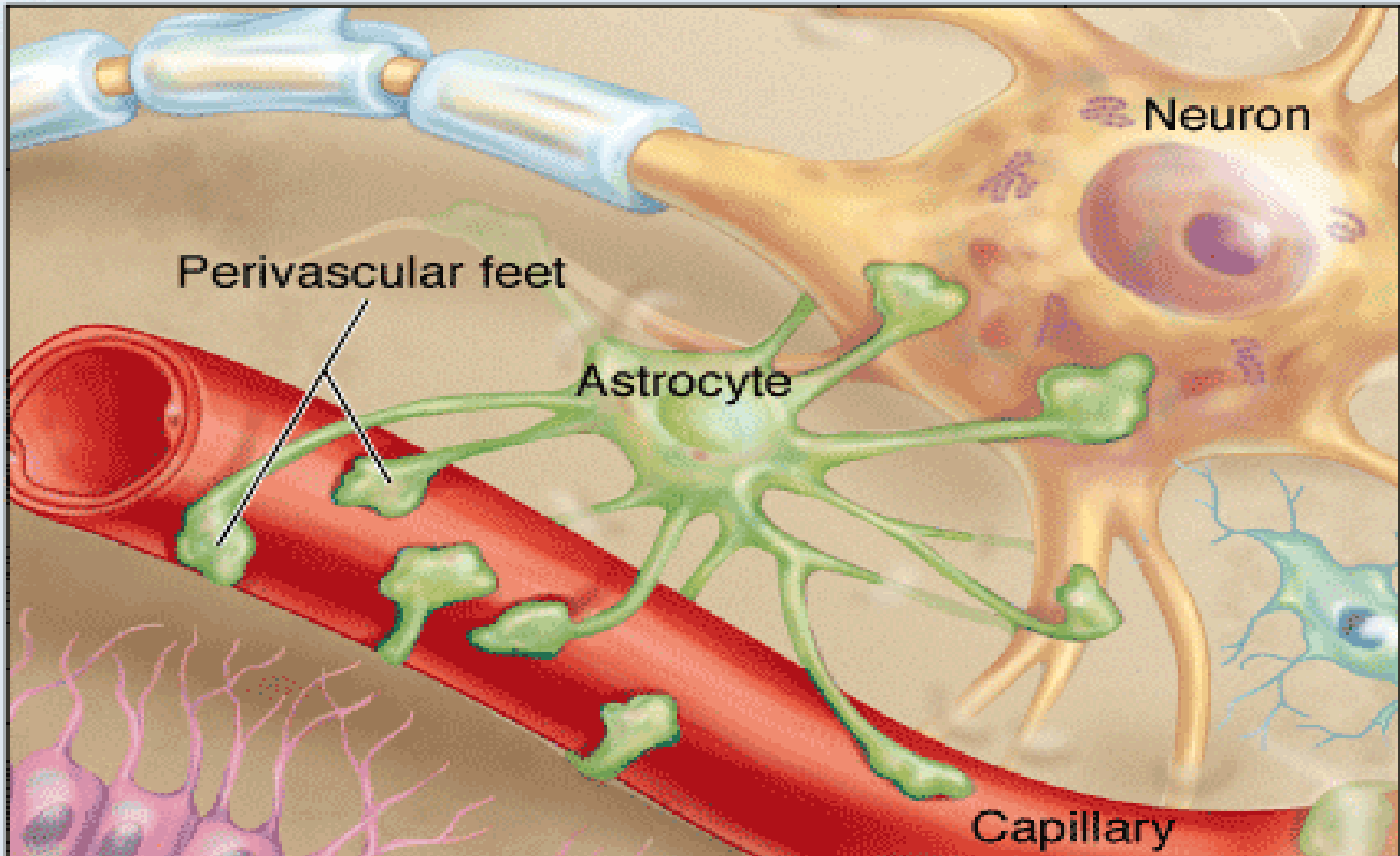
❖ *Ependymal cells* –

- lines ventricles of the brain and the central canal of spinal cord many of the cells have **cilia**; involved in circulation of cerebrospinal fluid

Glial cells in PNS

Are found in the peripheral nervous system:

- Schwann cells, satellite cells
- *Neurolemmocytes-*
- (Schwann cells) - form myelin layers around axons in the PNS
- *Ganglionic gliocytes- / satellite cell*
- support neurons cell bodies within the ganglia of PNS.



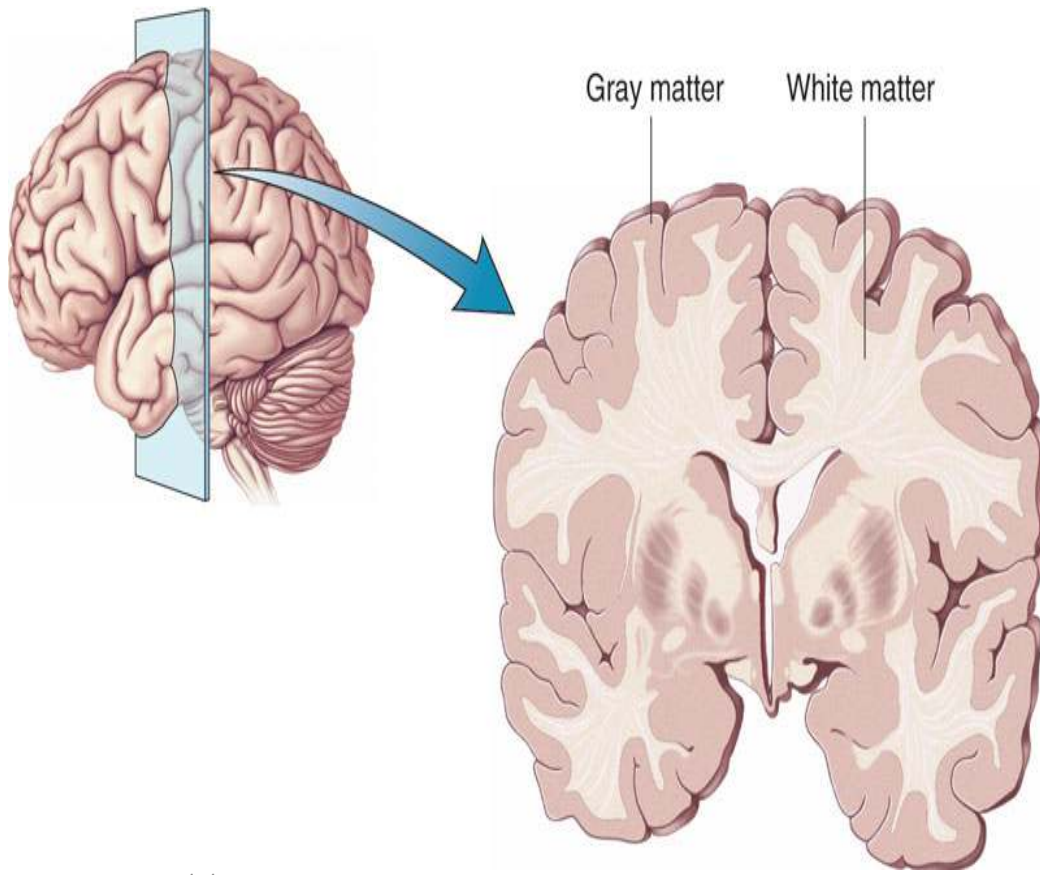
b Astrocyte

Astrocytes have multiple processes and form perivascular feet that completely enclose all capillaries (only a few such feet are shown here to allow their morphology to be seen).

Nervous tissue...

- In CNS, two fundamental types of nervous tissue called **white** and **gray matter**.
- **White matter**: consists of bundles of nerve fibers called **tracts**.
 - Many fibers of these tracts are myelinated;
- **Gray matter**: is where the neurosomas, dendrites, and synapses are located.
 - There is relatively little myelin here, so this tissue has a duller color in fresh nervous tissue.
- **In the spinal cord:**
 - white matter forms the surface tissue and the gray matter forms the inner core.
- **In the brain;**
 - white matter forms most of the deep tissue,
 - whereas gray matter forms a surface layer as well as a few deep masses embedded in the white matter.

White and gray matter in CNS



Lumbar spinal cord

CENTRAL NERVOUS SYSTEM

The entire CNS is protected by a **bony** encasement

- The spinal cord is surrounded by
 - vertebral column &
 - brain by cranium.
- The meninges are connective tissue encasements that form a protective membrane between the soft tissue of the CNS.

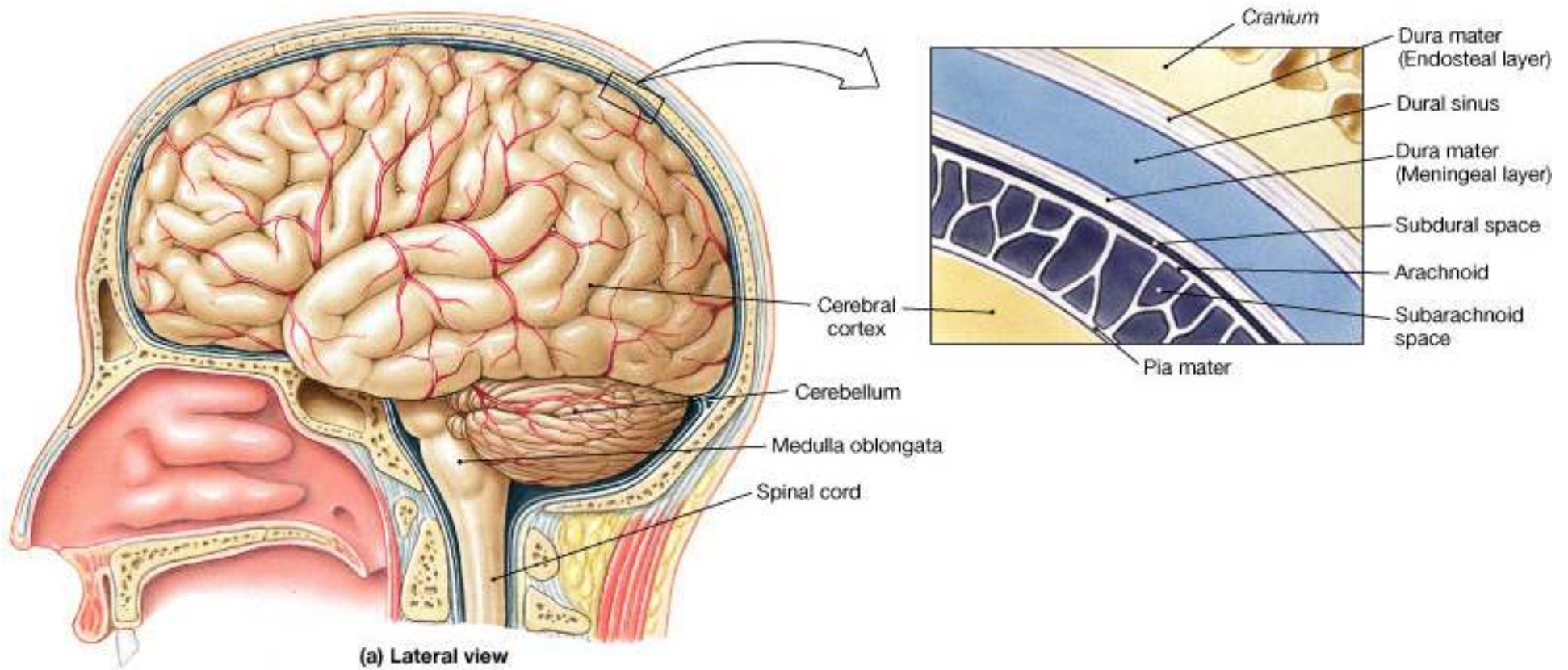
Structure protect the brain

1. The skull is the rigid structure, which protects the brain from injury.

- The major bones of the skull are the frontal, temporal, parietal, and occipital bones.
- These bones join at the suture lines.

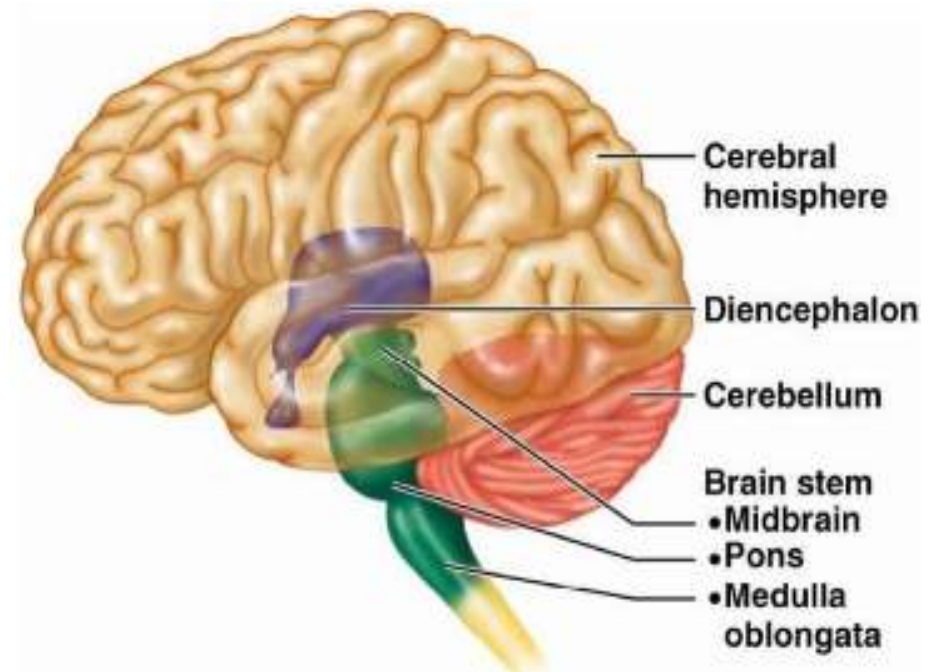
2. The meninges (fibrous connective tissues that cover the brain and spinal cord) provide protection, support, and nourishment to the brain and spinal cord.

- The layers of the meninges are the dura, arachnoid, and pia mater.



Four major areas of the brain:

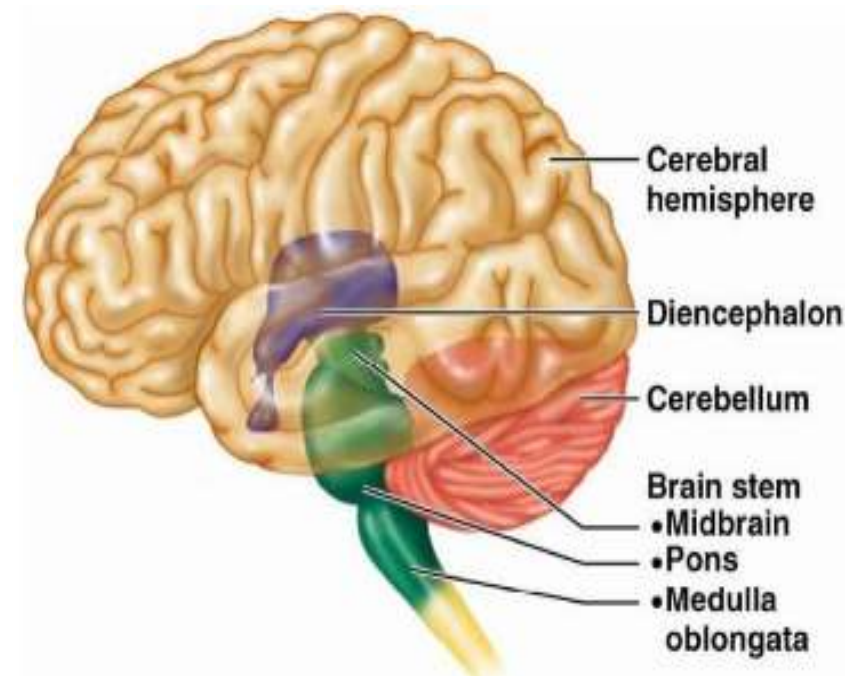
- ✓ The cerebrum
- ✓ brain stem, =
- ✓ cerebellum and
- ✓ Diencephalon



Telencephalon

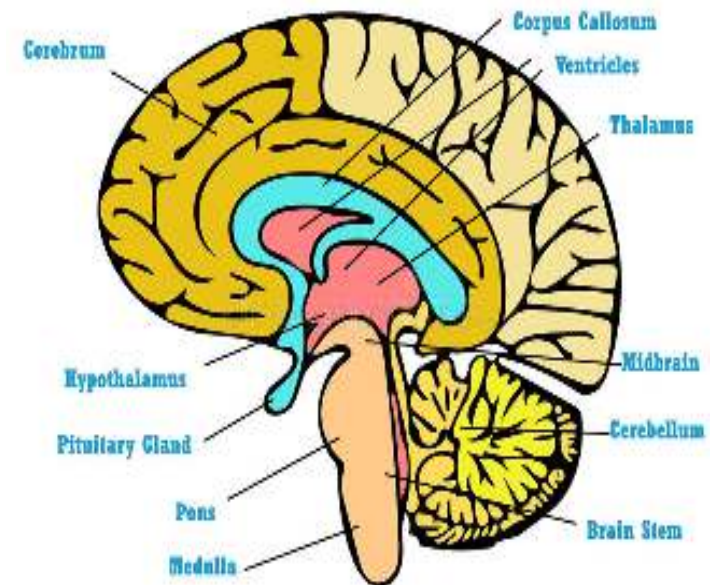
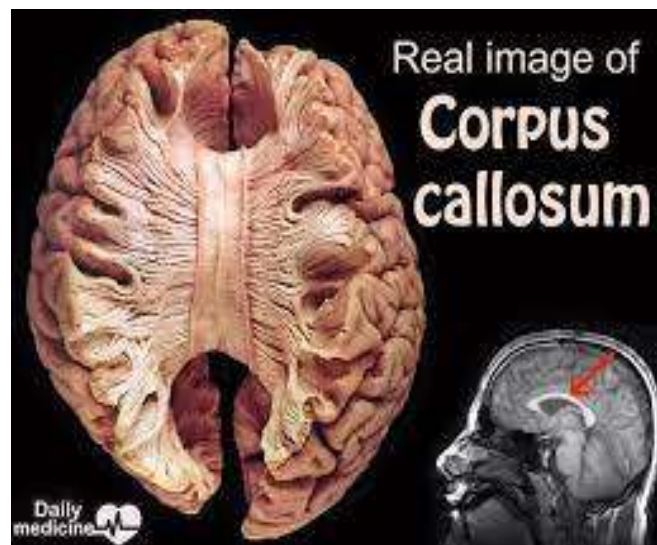
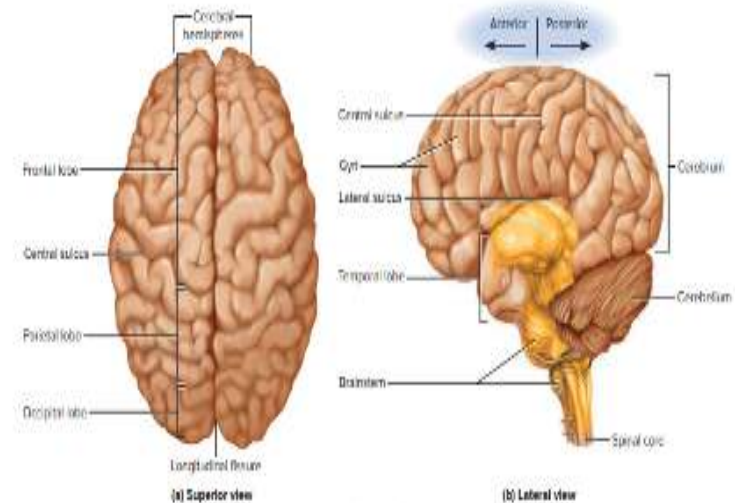
1.The cerebrum

- is the largest and most developmentally advanced part of the human brain.



Structure of cerebrum

- It accounts 80% of the mass of the brain and is *responsible for higher mental function*.
- The cerebrum consists of the *left* and *right hemispheres*
- separated by *longitudinal cerebral fissure*.
- The two hemisphere are connected internally by *corpus callosum* (*large tract of white matter*)



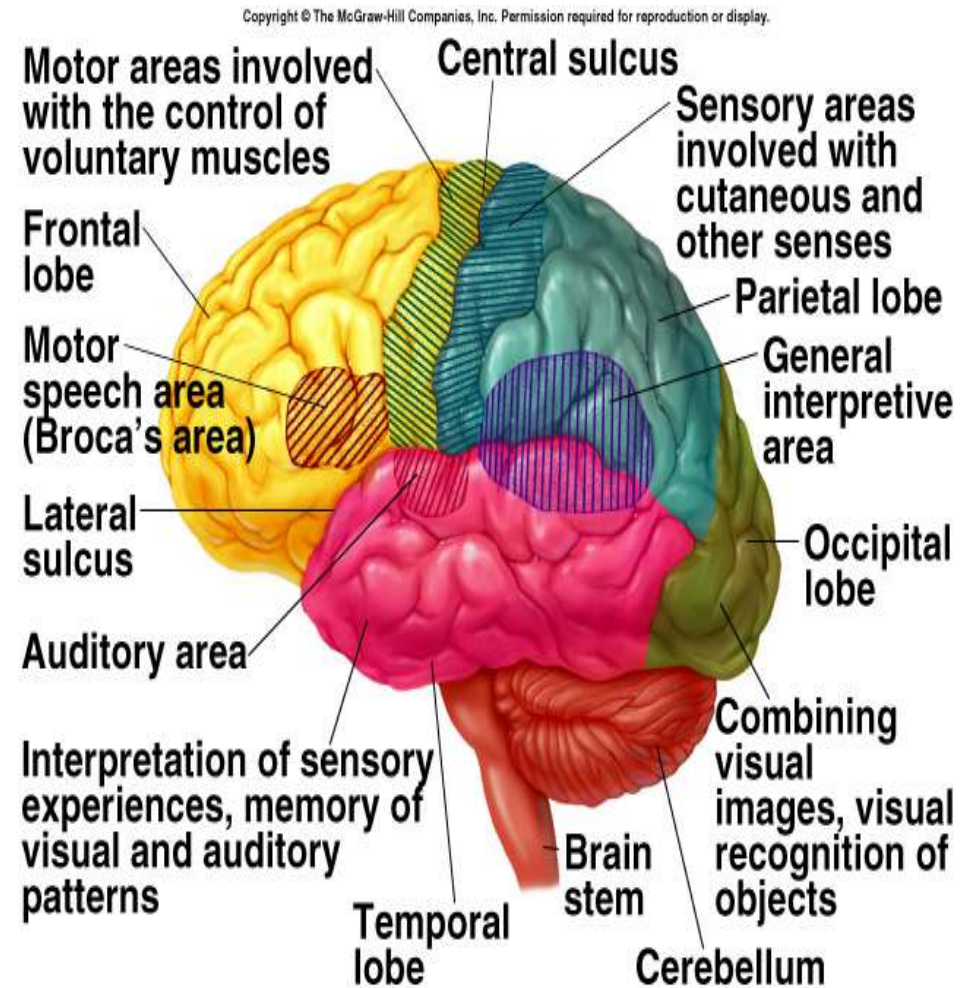
- **The left hemisphere** controls the majority of functions on the **right side** of the body, while the **right hemisphere** controls most of functions on the **left side** of the body.
- The crossing of nerve fibers takes place in the **brain stem**.
- Thus, injury to the left cerebral hemisphere produces **sensory and motor** deficits on the right side, and vice versa.

- Right-handed people and
- some left-handed people have cerebral dominance on the **left side** of the brain for:
 - verbal, linguistic,
 - Arithmetical calculating, and
 - analytic functions.
- Thus, problems in the **left hemisphere** will be more likely to produce **aphasia** and other **language deficits**.

- The cerebral cortex has convolutions - **folds** and **grooves**.
- The elevated folds of the convolutions are *cerebral gyri* & the depressed grooves are the *cerebral sulci*.

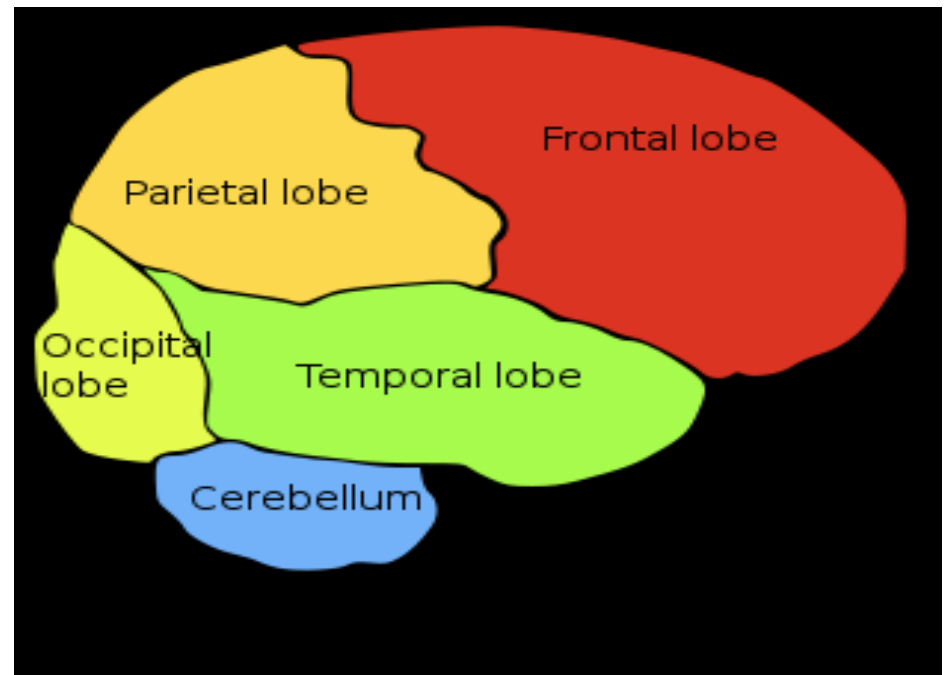


❖ It is responsible for several higher functions, including higher intellectual function, speech, emotion, integration of sensory stimuli of all types, initiation of the final common pathways for movement, and fine control of movement.



lobes of cerebrum

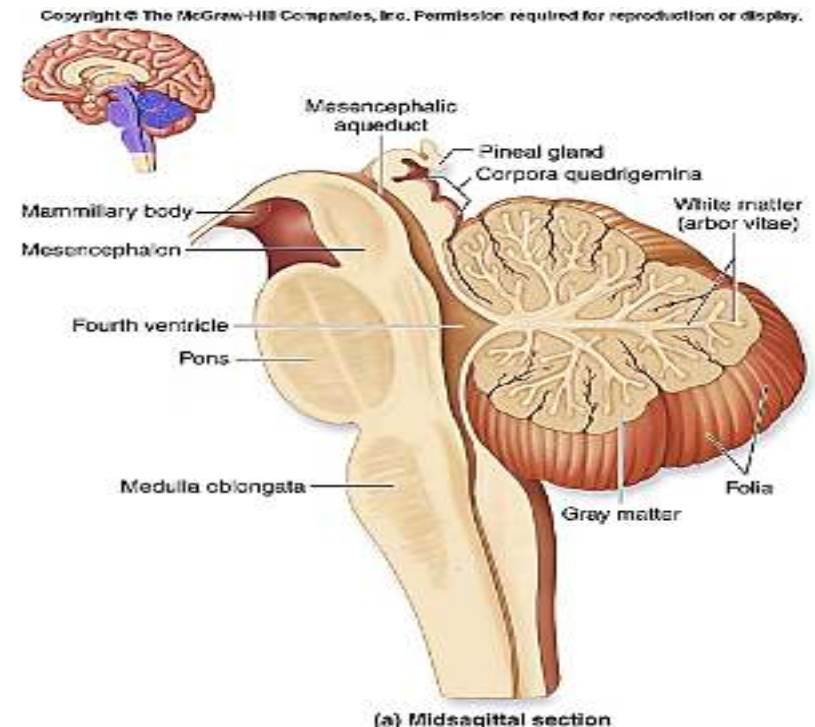
- Each cerebral hemisphere is subdivided into 4 lobes separated by deep sulci called *fissures*.
- Each lobe has its own specific function.



2. The cerebellum

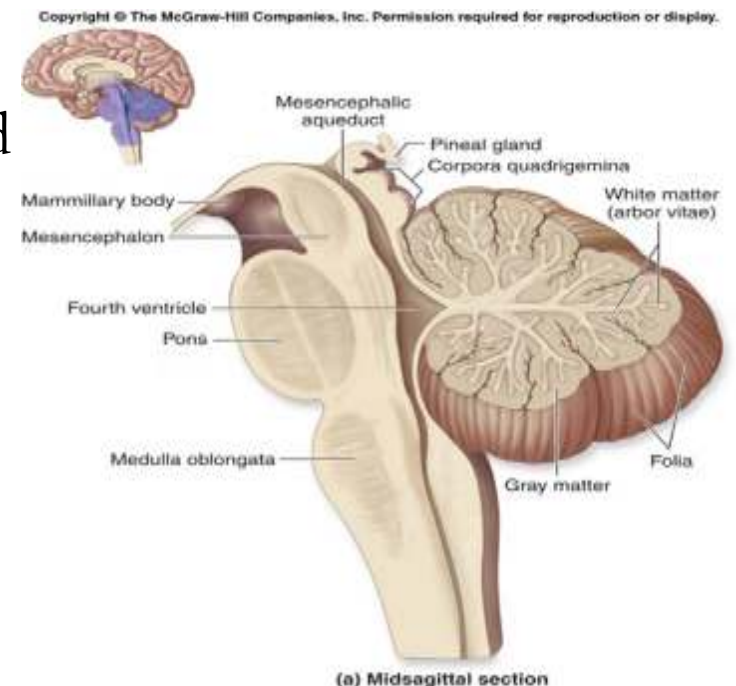
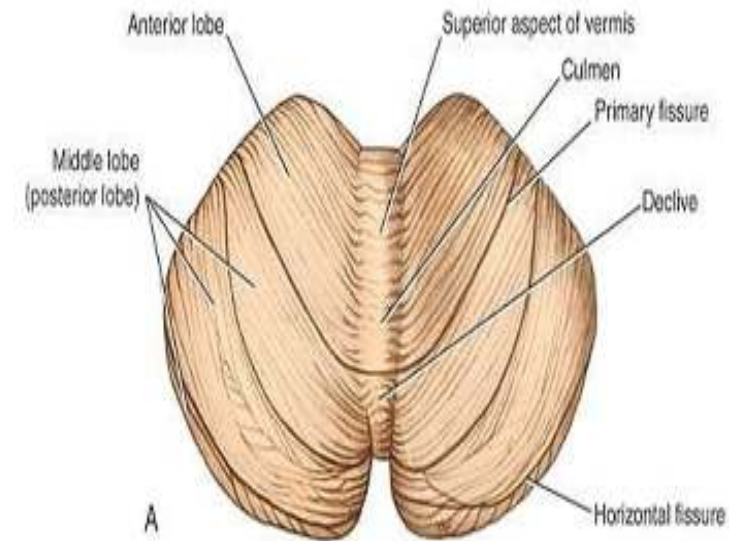
is the second largest area, is responsible for maintaining **balance** and further control of **movement** and **coordination**

- Coordinate skeletal **muscle tone**.
- Maintains **equilibrium** by bringing modification of muscle tone

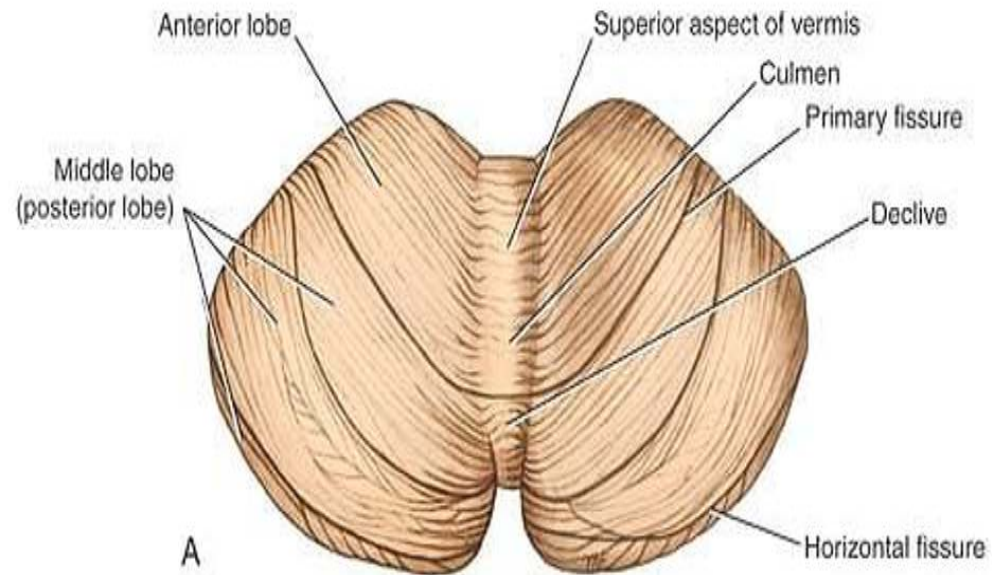


Cerebellum

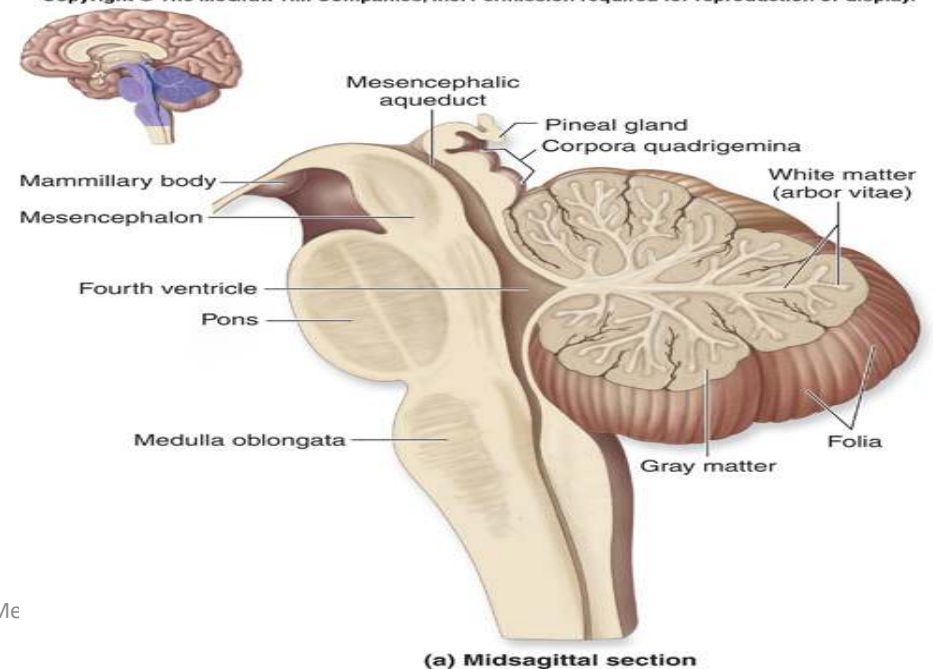
- composed of **right and left hemispheres**.
- It is marked by slender gyri, here called **folia**, separated by shallow **sulci**.
- The cerebellum has two hemispheres and a centrally constricted area called **vermis**.
- It has a thin outer layer of **gray matter** called cerebellar cortex and a deeper thick layer called **white matter**.



- It has a thin outer layer of gray matter called *cerebellar cortex* and a deeper thick layer called *white matter*.
- The cerebellum is convoluted in to series of slender parallel fold called *folia*.



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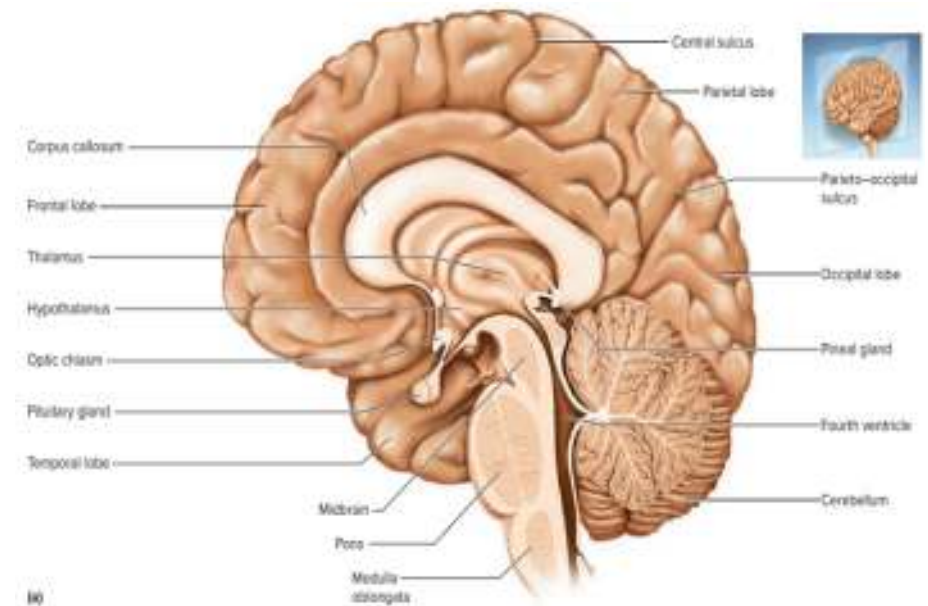


- The cerebellum can be permanently damaged by **trauma** or **stroke** or temporarily affected by drugs such as **alcohol**.
- These alterations can produce **ataxia** – a disturbance in balance.
- lack of voluntary coordination of muscle movements.



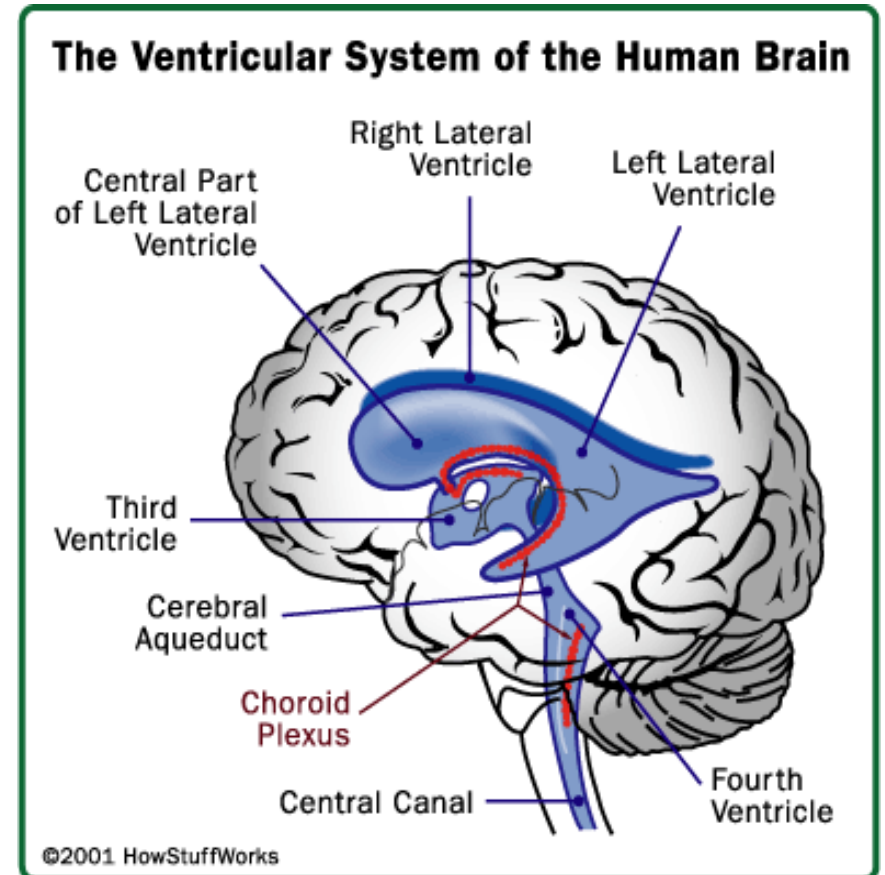
3. The brain stem

- is the final pathway between cerebral structures and the spinal cord.
- It is responsible for a variety of **automatic functions**, such as control of **respiration, heart rate, and blood pressure, wakefulness, arousal and attention**



A) MESENCEPHALON-midbrain

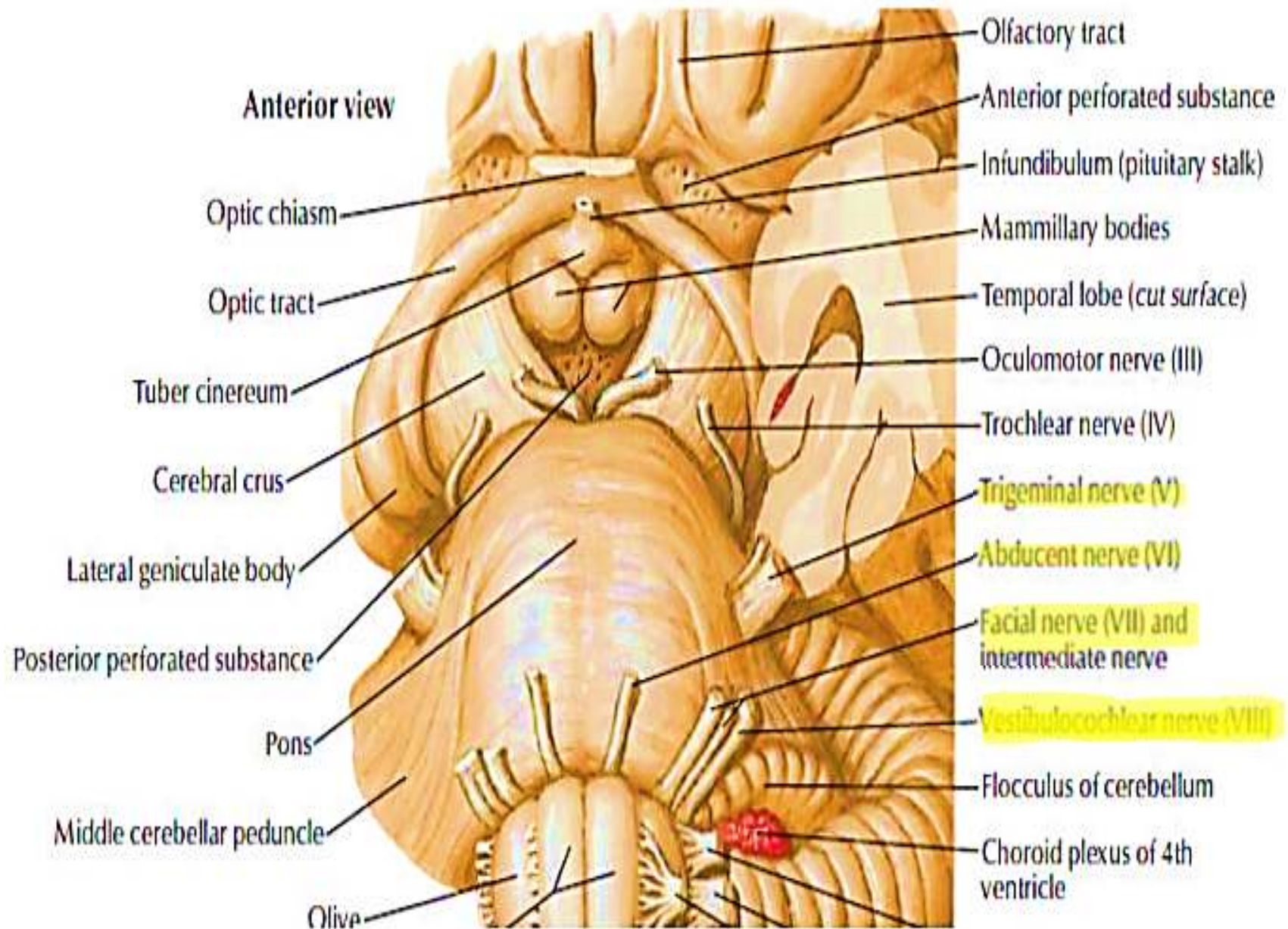
- The mid brain or mesencephalon is a portion of the brainstem between the **diencephalon** and the **pons**.
- It contains the **mesencephalic aqueduct** or **aqueduct of Sylvius** that connects the 3rd and 4th ventricles.



- The upper two elevation or eminences are the *superior colliculi* which are concerned **visual reflexes**.
- The lower two elevation are the *inferior colliculi* which are involved in **auditory reflexes**.

B. PONS

- It forms the upper floor of 4th ventricle
- It possesses certain cranial nerve **nuclei**.
 - 5. CN V—trigeminal*
 - 6. CN VI—abducens*
 - 7. CN VII—facial nerve*
 - 8. CN VIII—vestibulocochlear*
- It also serve as a conduit for ascending and descending tracts.
- It consists also nuclei which **regulate respiration** -
-



C) MYELECEPHALON (MEDULLA OBLONGATA)

□ It makes the inferior roof of the 4th ventricle.

- *The 4th ventricle is continuous with the central canal of the spinal cord.*
- *Respiratory center- (rythmicity center) controls the rate & depth of breathing and function with respiratory centers in Pons.*
- **Other center-non-** vital respiratory movement- sneezing, coughing and swallowing.

- It is composed of *white matter* & *gray matter*.
- The **white matter** forms all of the **descending** and **ascending** tracts communicating between the spinal cord and various parts of the brain.

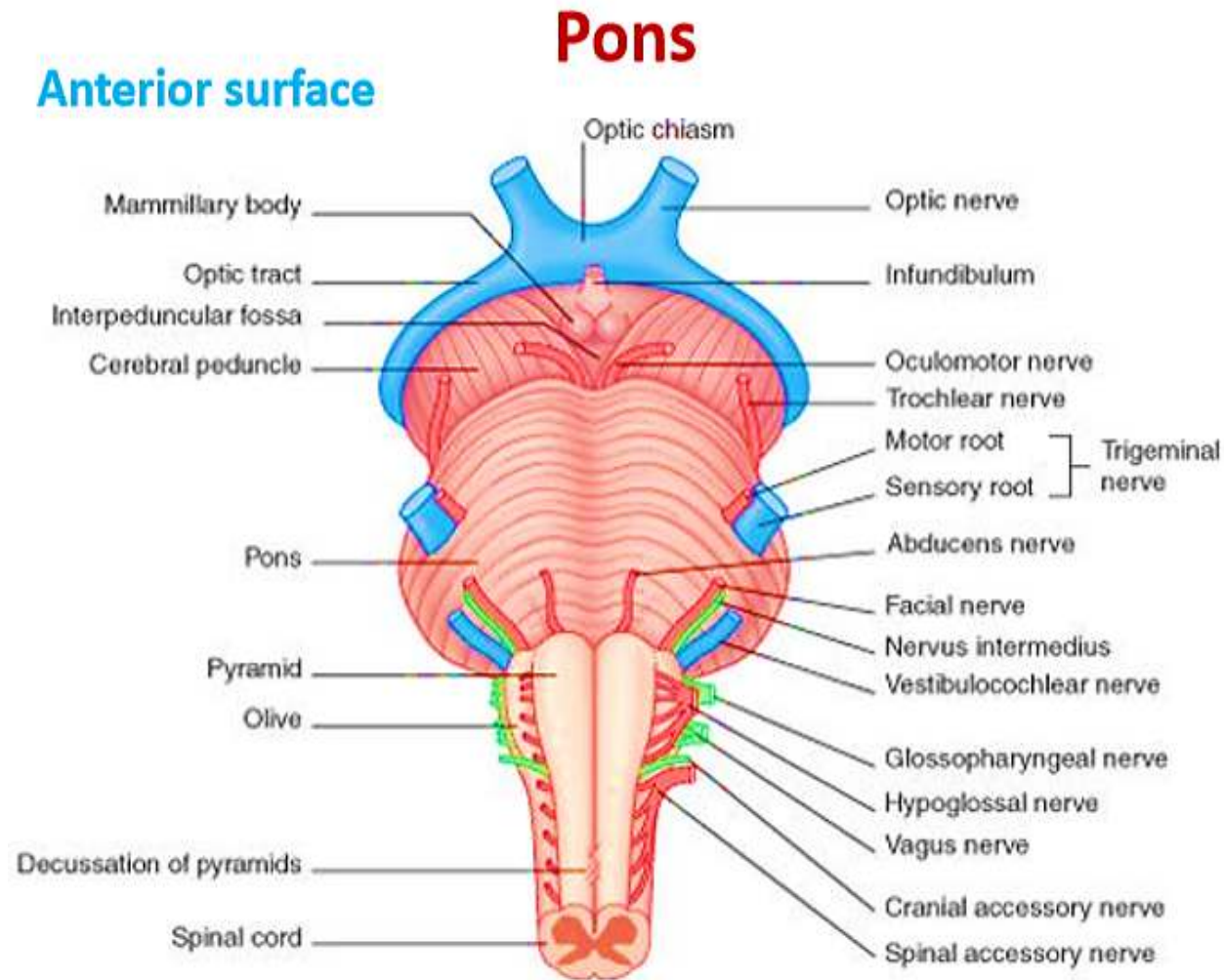
The gray matter of the medulla oblongata consists of several nuclei.

- *Cranial nerve VIII --- vestibulocholear*
- *Cranial nerve IX --- glosso pharyngeal*
- *Cranial nerve X--- vagus*
- *Cranial nerve XI --- accessory nerve*
- *Cranial nerve XII --- hypoglossal nerve*

Nuclei for autonomic function

- **Cardiac center-** inhibitory fibers through vagus nerve & excitatory fibers through spinal nerves T1 - T5.
- **Vasomotor center** - send impulse through spinal nerve innervations.

Medulla oblongata and pons



4. The diencephalon

- The diencephalon is also known as the fore brain stem.
- It includes the epithalamus, thalamus and hypothalamus.
- The thalamus is where sensory and other impulses go and coalesce.
- The hypothalamus is a smaller part of the diencephalon

- THALAMUS

- *Its principal function is to act as relay center for all sensory impulses, except smell to the cerebral cortex.*

- It responds to general sensory stimuli and provide crude awareness whiteness whereas the **cerebral cortex discriminate** pain and tactile stimulus precisely.

HYPOTHALAMUS

- The hypothalamus is a small portion of the diencephalons located below the thalamus.
- It consists of several masses of *nuclei* interconnected with other parts of the nervous system main center.

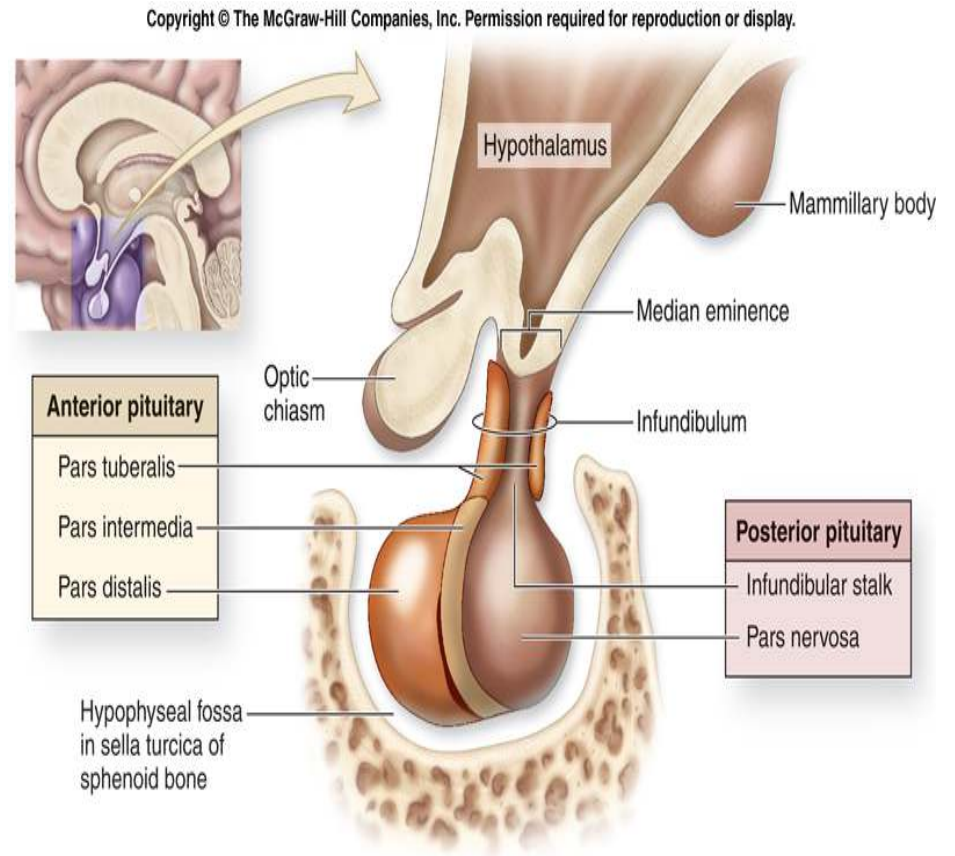
Functions

- Cardiovascular regulation- increase or decrease heart rate and arterial blood pressure.
- Body temperature regulation
- Regulation of electrolyte balance
- Regulation of sleeping and wakefulness
- Sexual response
- Emotions
- Control of endocrine functions

Pituitary gland

- It's positioned under the hypothalamus.
- It's attached to hypothalamus by stalk like structure called *infundibulum*.
- It's located on the depression of the sphenoid bone called *sella turcica*
- It's covered by extension of dura matter called *diaphragmatic sella*.

Part and functions refer Endocrine part???



Cerebro spinal Fluid (CSF)

Cerebro spinal Fluid (CSF)

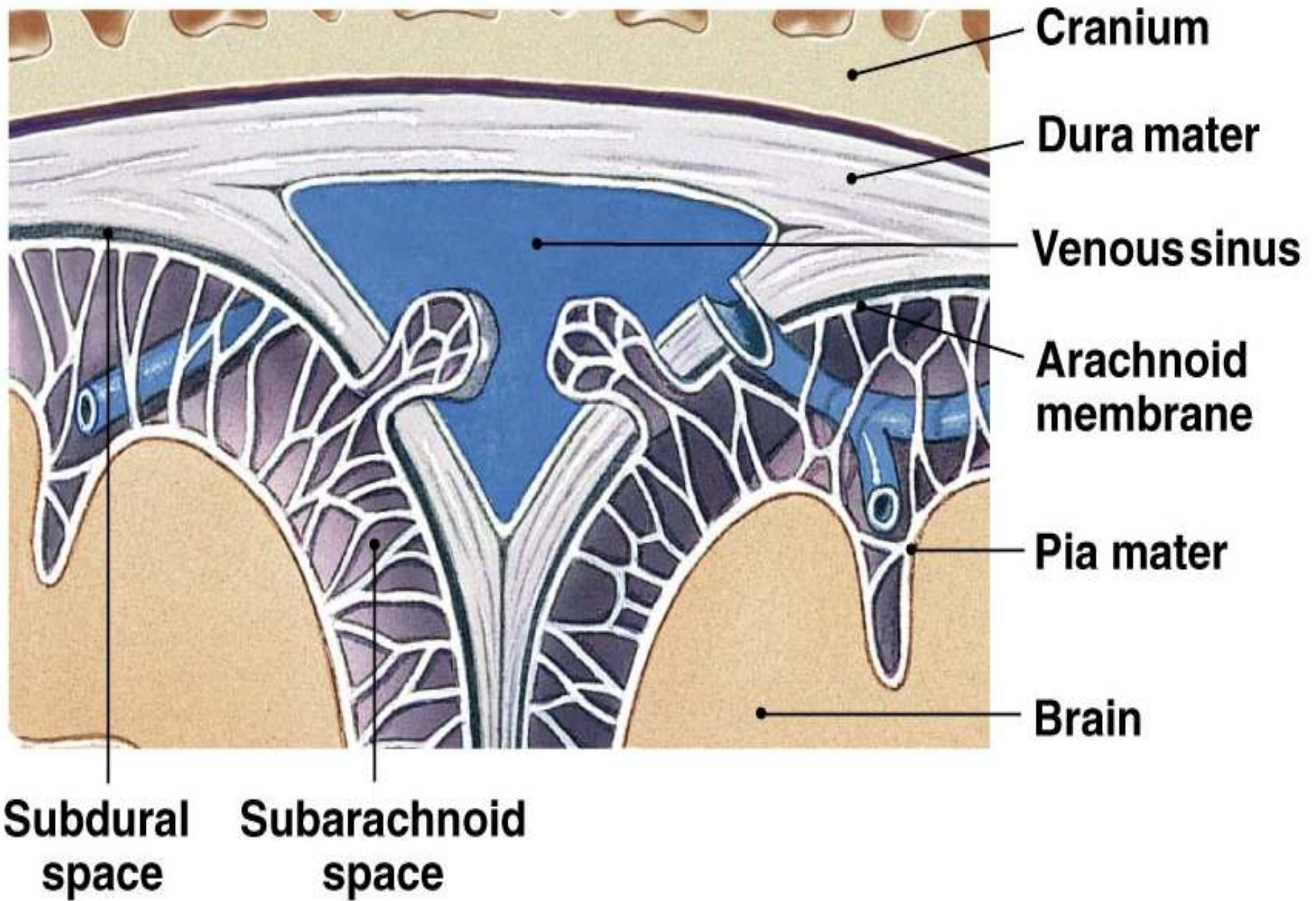
- It is a clear colorless fluid similar to plasma
- It is formed by the *chroids plexus* which are specialized capillaries at the roof of ventricles.
- It is absorbed by *arachnoid villi*— an extension of arachnoid space to the dura matter.

Functions

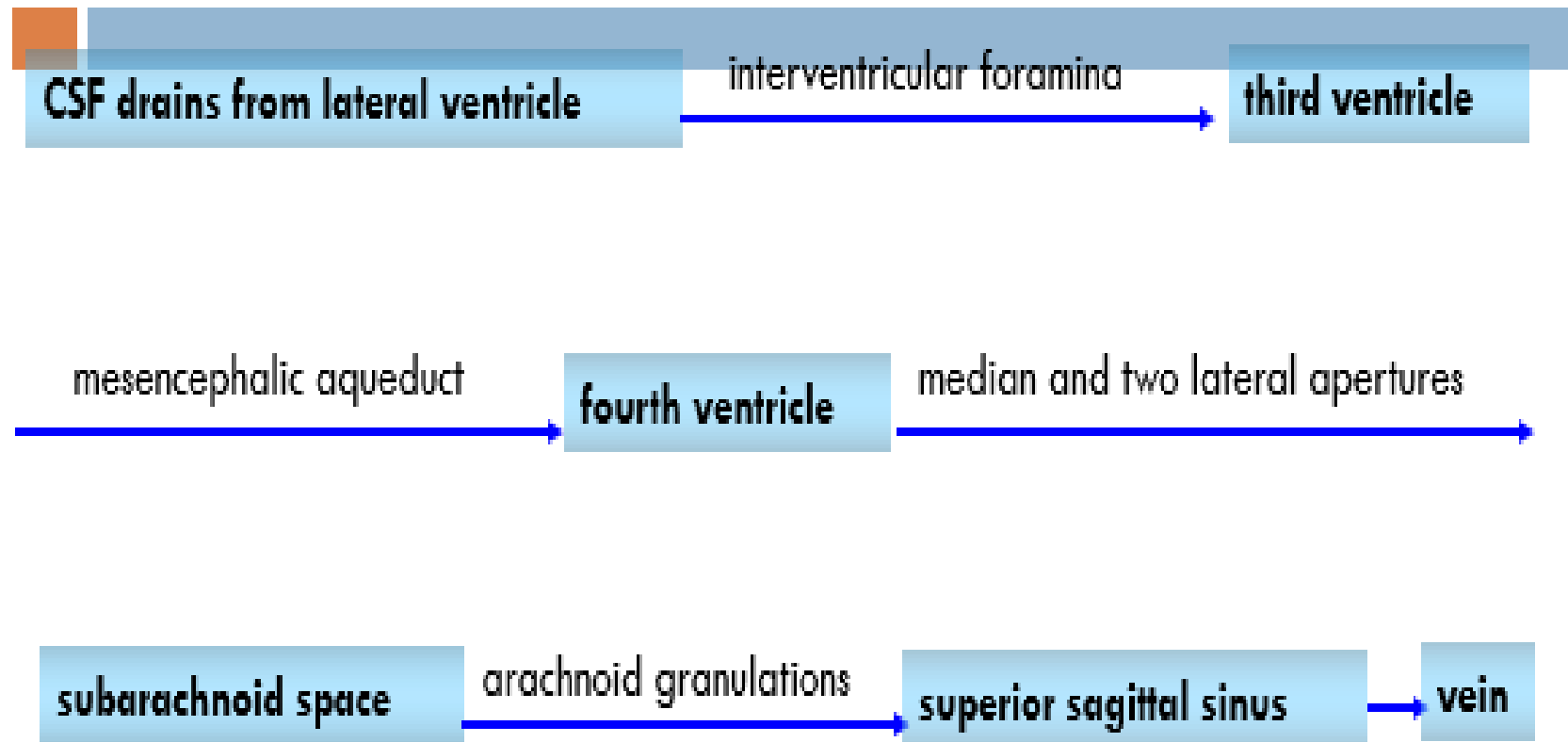
- Cushions & protect the CNS from trauma
- Provides mechanical buoyancy & support the brain.
- Nourishes the CNS.
- Removes metabolites from CNS.

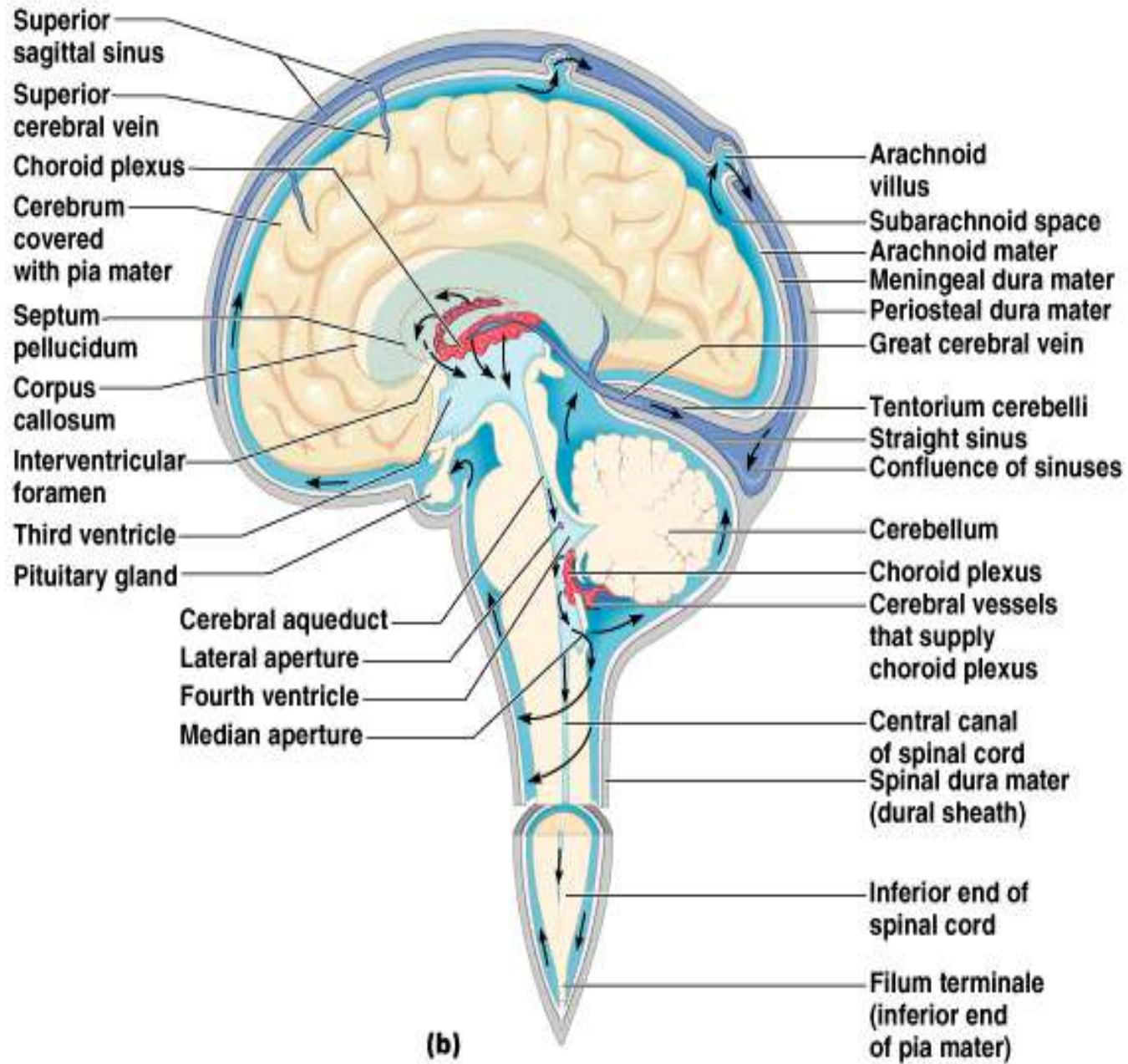
Locations

- The CSF occupies the:
 - ▣ **subarachnoid space-** between pia and archnoid
 - ▣ **ventricular system** around and inside the brain
and
 - ▣ **central canal-in** spinal cord



Circulation of cerebrospinal fluid





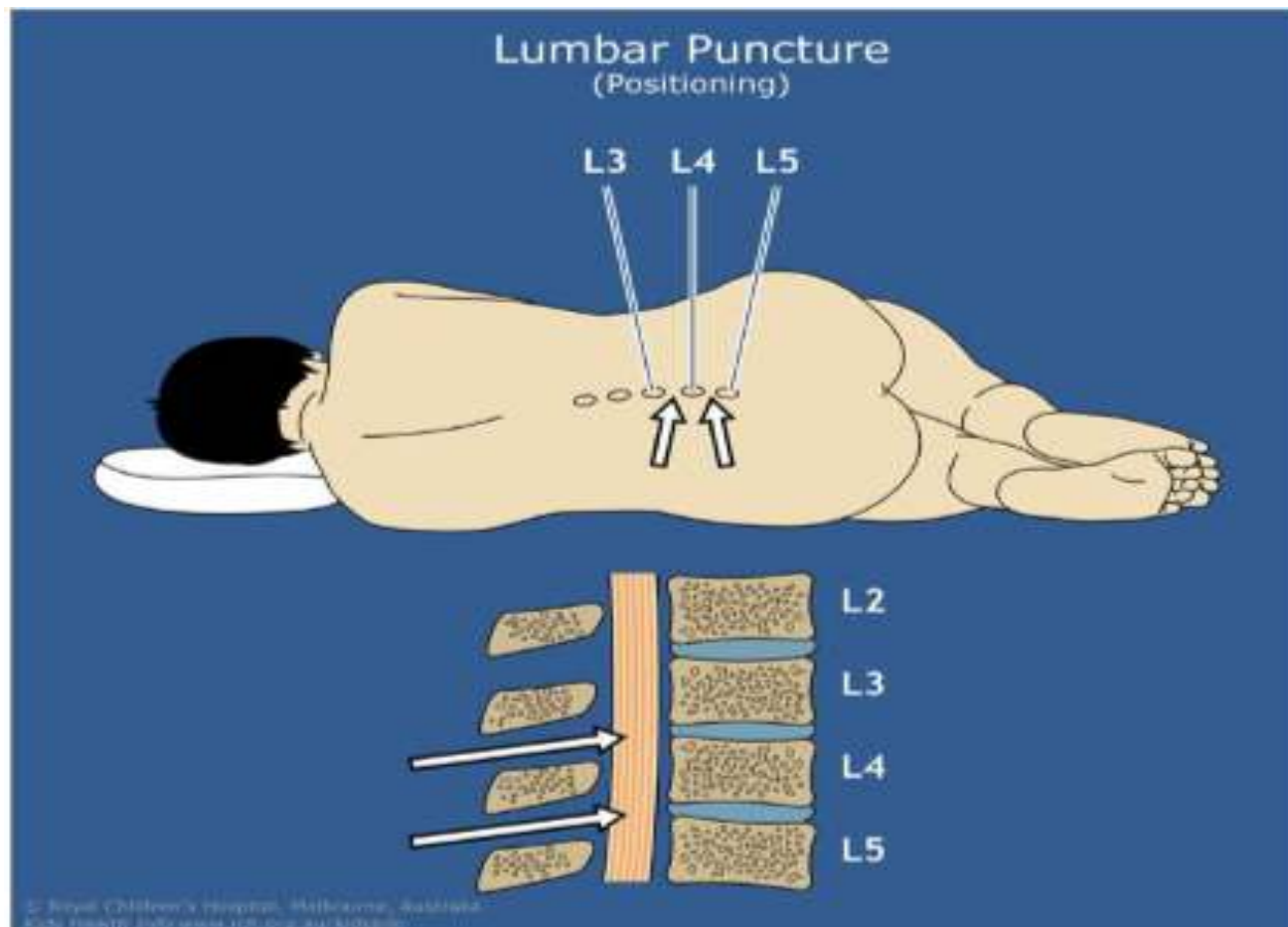
Clinical applications

- **Hydrocephalus**

- The term is derived from Greek hydro-, meaning "water", and kephalos, meaning "head".
- It was once informally called "Water on the brain."
- is a medical condition in which there is an **abnormal accumulation of cerebrospinal fluid (CSF)** in the brain.
- This causes increased intracranial pressure inside the skull and may cause progressive enlargement of the head.
- if it occurs in childhood, potentially causing convulsion, tunnel vision, and mental disability.

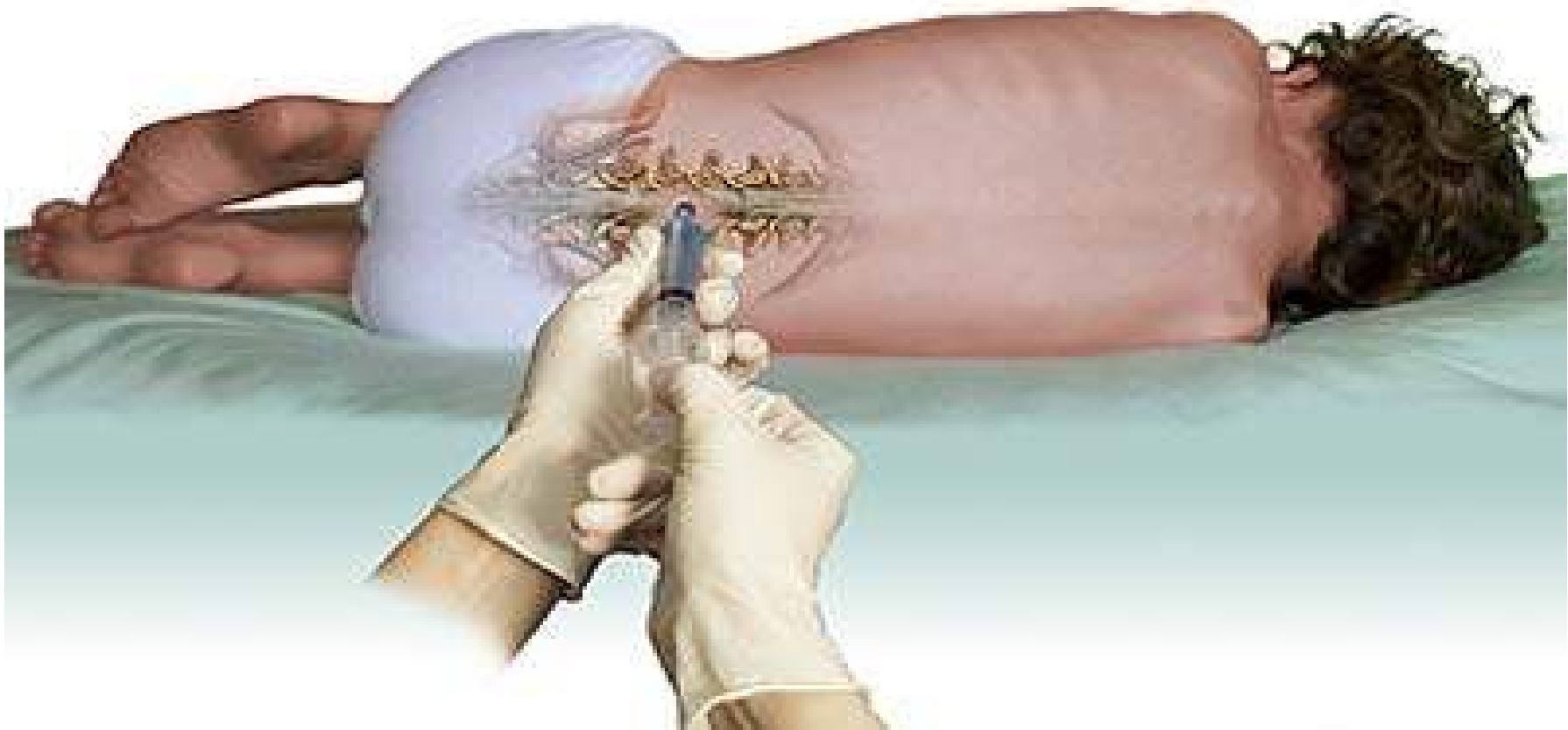


- **Applied Anatomy** ---Spinal tap (lumbar puncture) – cerebrospinal fluid – the needle is inserted at the lower lumbar level, avoiding the lower end of the cord – done between L3 and L4 or L4 and L5.



CSF sampling

Cerebrospinal fluid drawn
from between two vertebrae

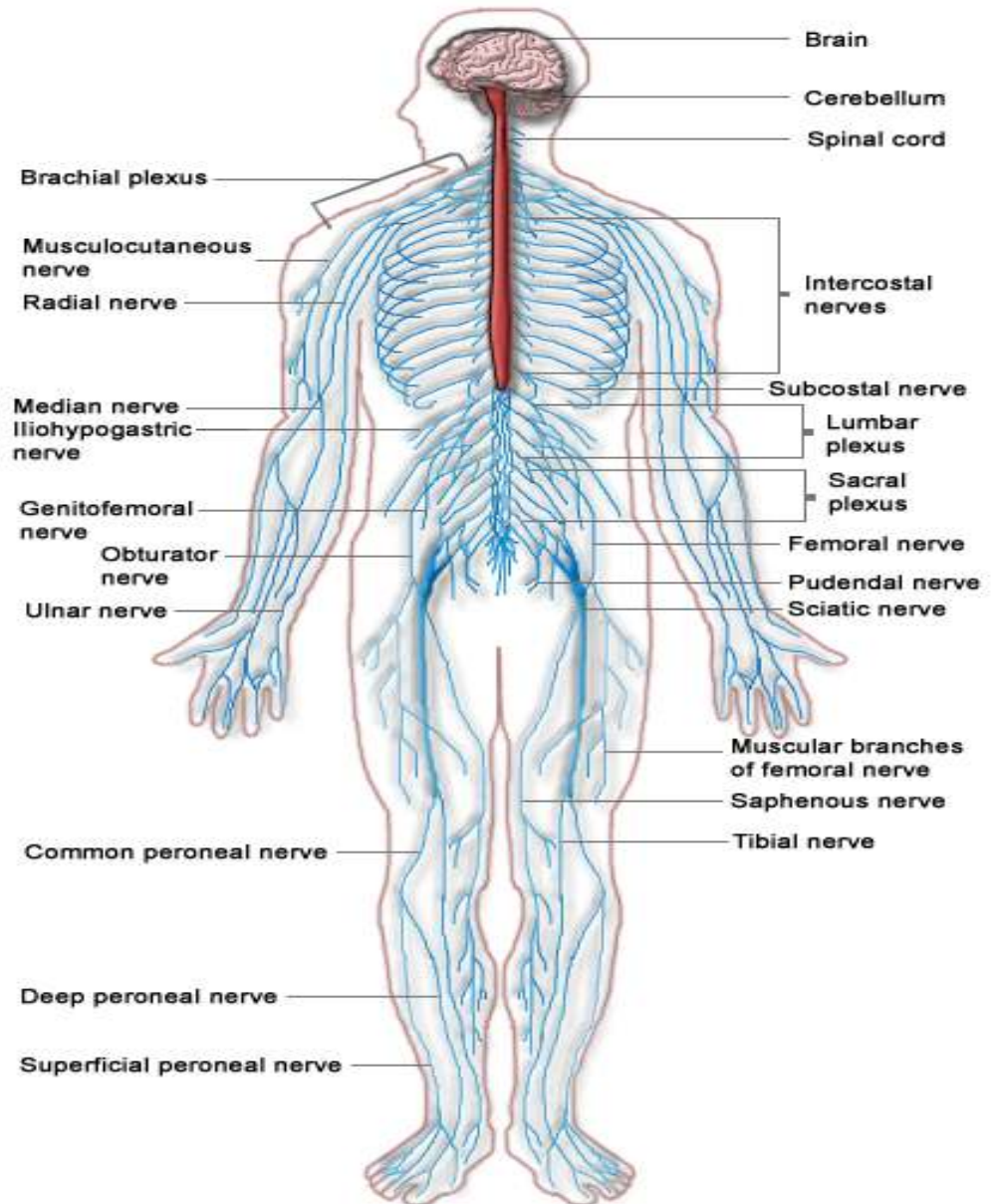


PERIPHERAL NERVOUS SYSTEM

- The PNS includes receptors that respond to stimuli and nerves that convey impulses to and from CNS are **cranial nerves & spinal nerves**

CRANIAL NERVES

- There are 12 cranial nerves



- The cranial nerves are numbered **I to XII** starting with the most anterior pair.
- Each nerve also has a descriptive name
- Most of these nerves arise from the base of the brain
 - ✓ exit the skull through its foramina, and lead to **muscles** and **sense organs** located mainly in the **head and neck**.
- One **exception** to this pattern is the vagus nerve (X),
 - which descends to reach many organs in the thoracic and abdominal cavities

Cranial nerves numbers and functions

- **I. Olfactory** Sensory: Smell
- **II. Optic** Sensory: Vision
- **III. Oculomotor** Motor: Eye movements
- **IV. Trochlear** Motor: Eye movements
- **V. Trigeminal** (three branches, V1, V2, V3)
 - Motor: Chewing
 - Sensory: Touch, temperature, and pain from face
- **VI. Abducens** Motor: Eye movements
- **VII. Facial**
 - Motor: Facial expression; secretion of tears, saliva, and nasal and oral mucus
 - Sensory: Taste

- **VIII. Vestibulocochlear**
 - **Motor: Cochlear tuning**
 - Sensory: Hearing and equilibrium
- **IX. Glossopharyngeal**
 - Motor: Salivation, swallowing, gagging
 - Sensory: Taste; sensations of touch, pressure, pain, and temperature in tongue and outer ear; regulation of blood pressure and respiration
- **X. Vagus**
 - Motor: Swallowing, speech, regulation of heart rate and bronchial airflow, gastrointestinal secretion and motility
 - Sensory: Taste; sensations of hunger, fullness, and gastrointestinal discomfort
- **XI. Accessory**
 - Motor: Swallowing; head, neck, and shoulder movements
- **XII. Hypoglossal**
 - Motor: Tongue movements

SPINAL NERVES

- *There are 31 pairs of nerve*

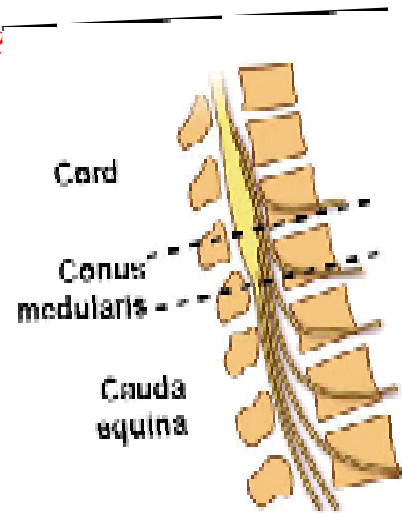
- 8 cervical

12 thoracic

5 lumbar

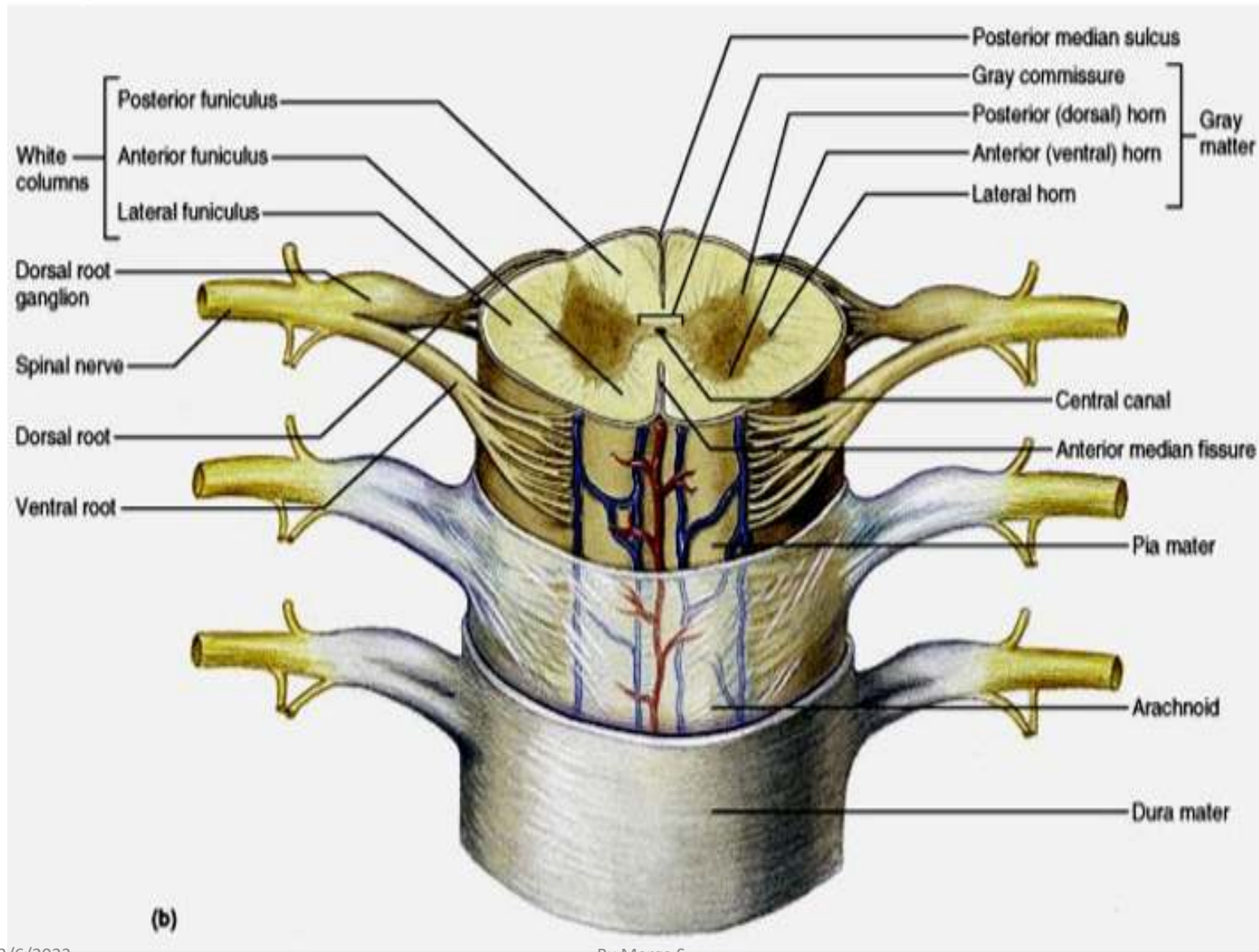
5 sacral &

1 coccygeal



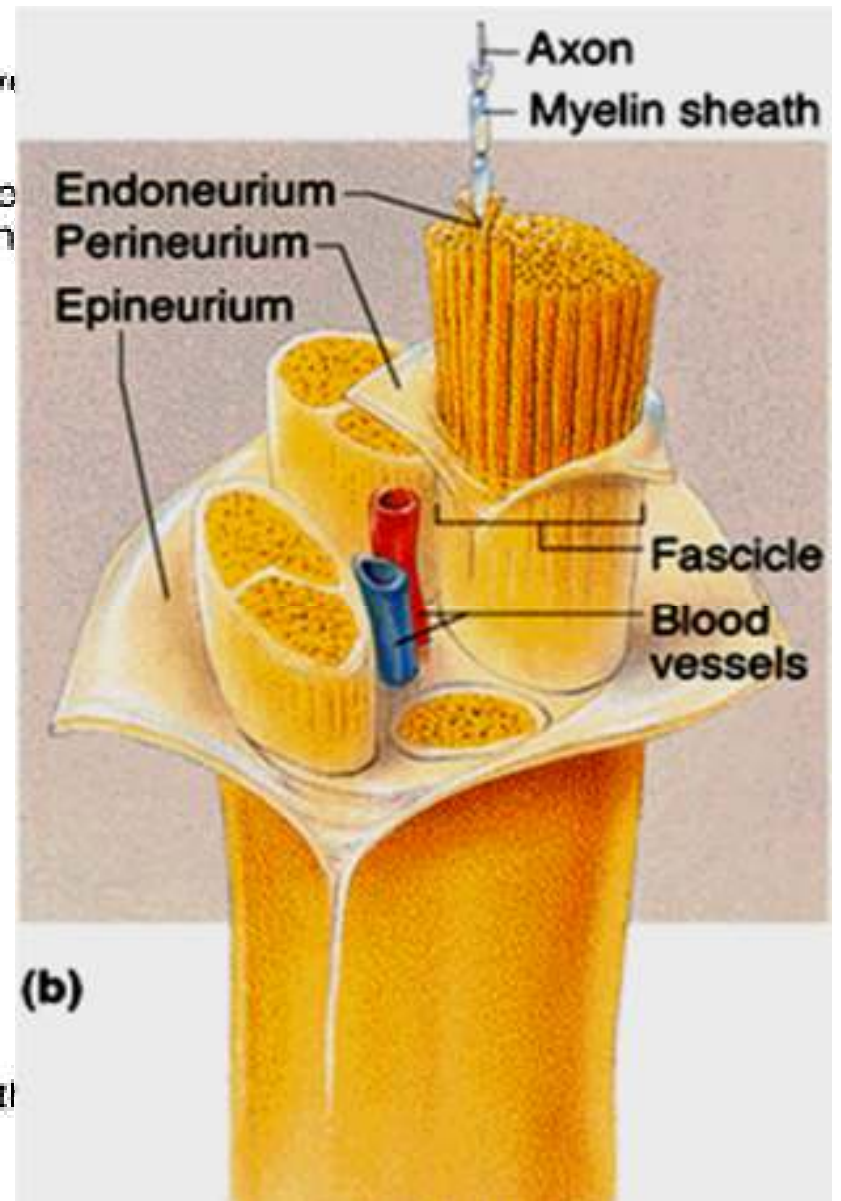
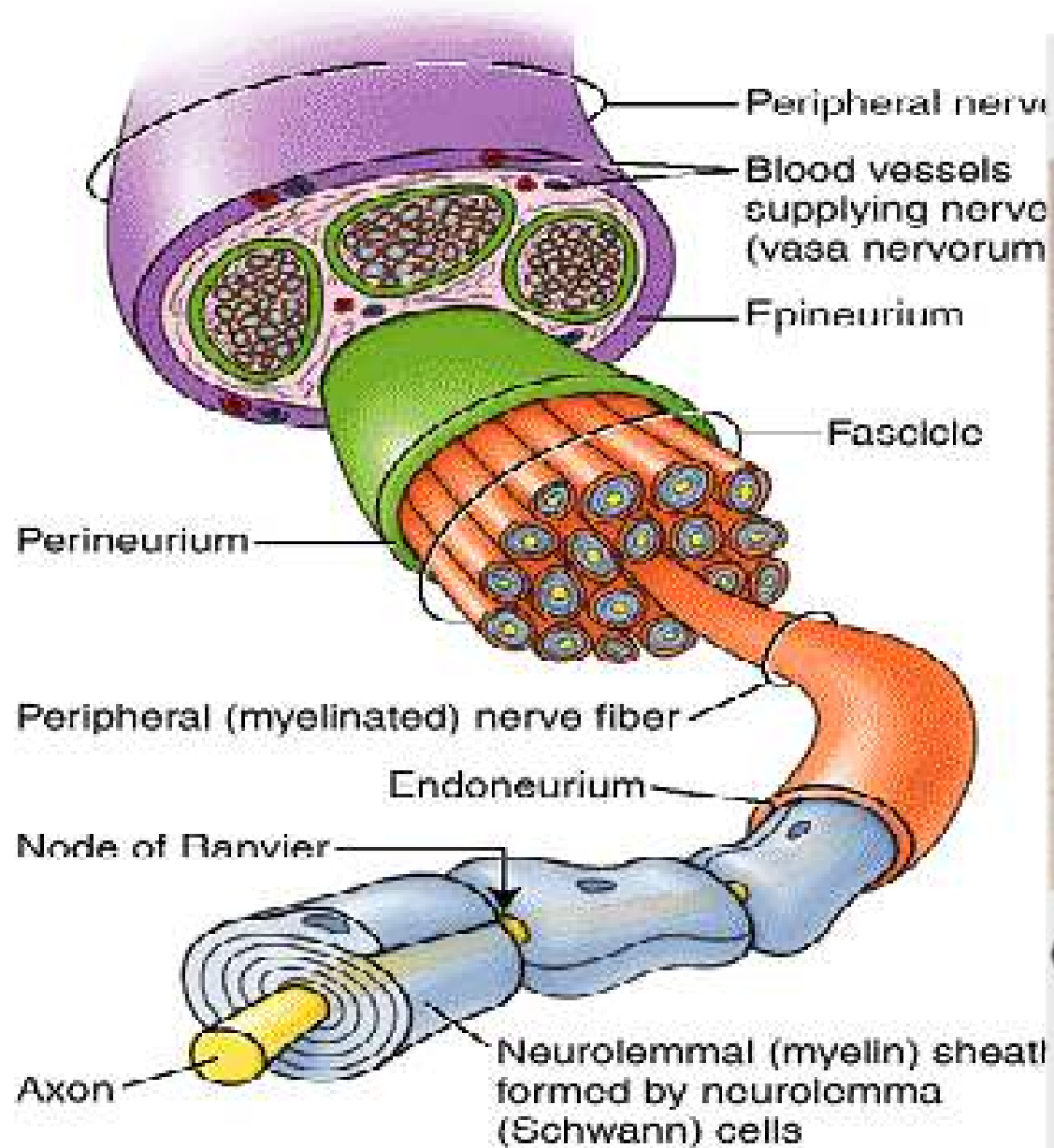
- It is a **mixed nerve** attached to the spinal cord by a **posterior root composed of sensory fibers** and an **anterior root** which consists **motor fibers**
- The posterior root has enlargement called **spinal or sensory ganglion**- cell bodies of sensory nerves are located and their axons go to the spinal cord.

- **Spinal nerves**



Connective tissue sheath

- **Endoneurium:** inner most
- a **delicate** connective tissue sheath that surrounds the neurolemma cells and axons
 - between individual nerve fibers of fasciculus
- **Perineurium:** a layer of dense connective tissue that encloses a fascicle (bundle)
 - surrounds each fascicle
- **Epineurium**
- a thick connective tissue encloses a bundle of fascicles, forming the outermost covering of the nerve;
 - NB: it includes fatty tissues, blood vessels, and lymphatics
 - Has extensions



THE END!