Organization of The Nervous System

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Objectives

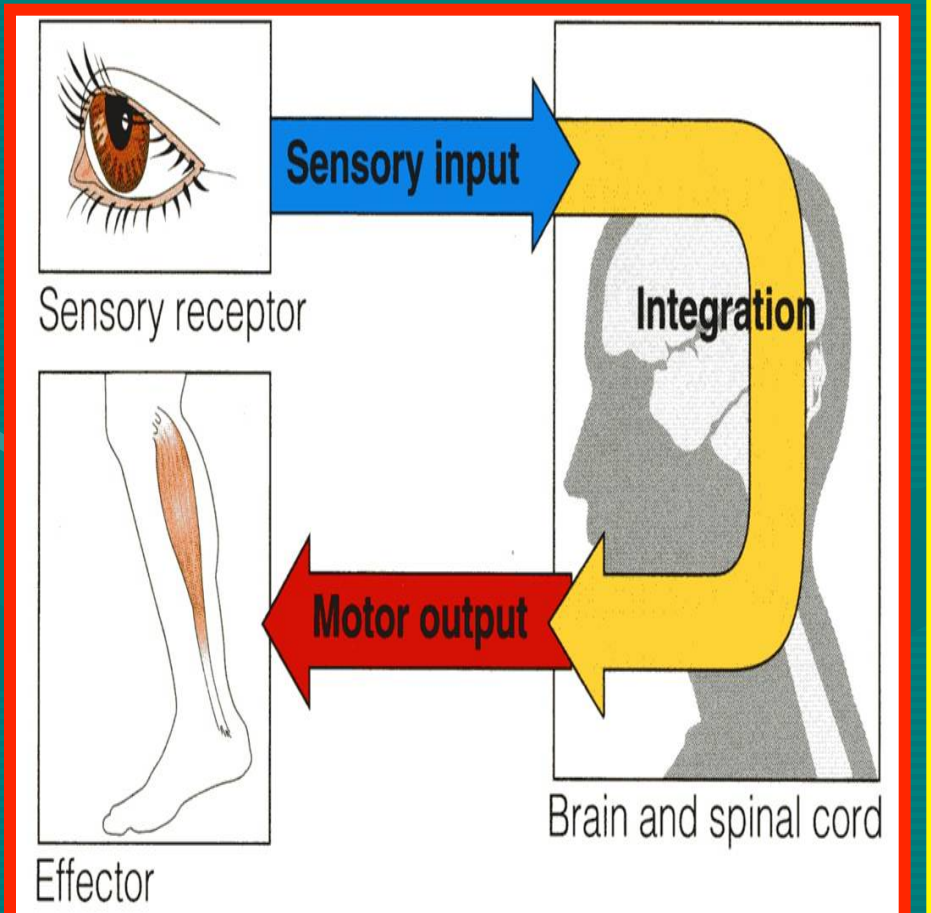
At the end of the lecture, the students should be able to:

- List the **parts** of the nervous system.
- List the **function** of the nervous system.
- Describe the **Structural & Functional Organizations.**
- **Define the terms**:

  Nervous tissue, grey matter, white matter, nucleus, ganglion, tract, nerve.
- List the **parts** of the **brain.**
- List the **structures protecting** the central nervous system.

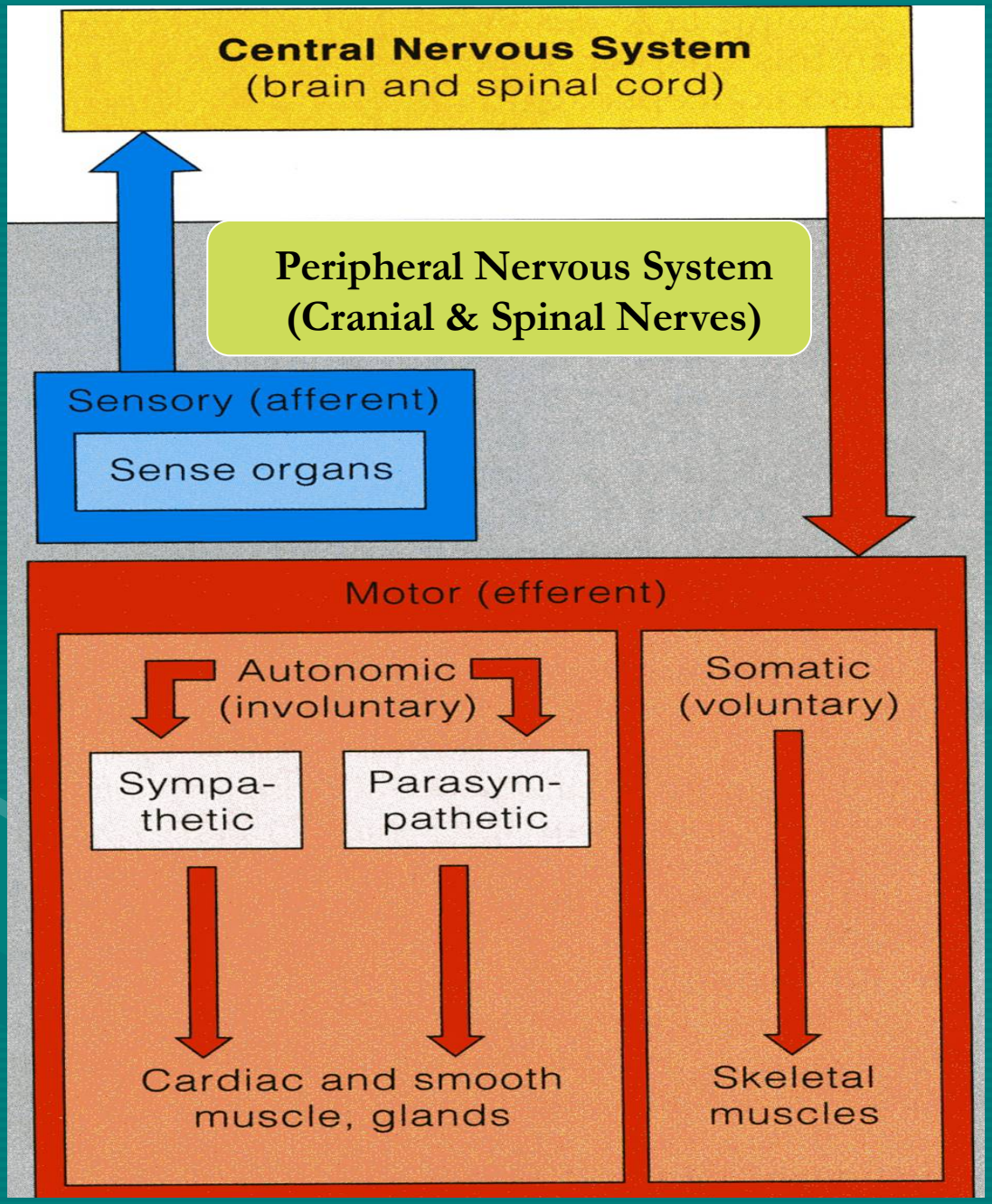
INTRODUCTION

How does the nervous system work ?



The nervous system has three functions:

- **Collection of sensory input:**
  Identifies changes occurring inside or outside the body by using sensory receptors. These changes are called stimuli.
- **Integration:**
  Processes, analyzes , and interprets these changes and makes decisions.
- **Motor output**, or response by activating muscles or glands (effectors).



CLASSIFICATION

I- Anatomical or

Structural classification:

1- Central NS

- 2- Peripheral NS

II- Physiological or

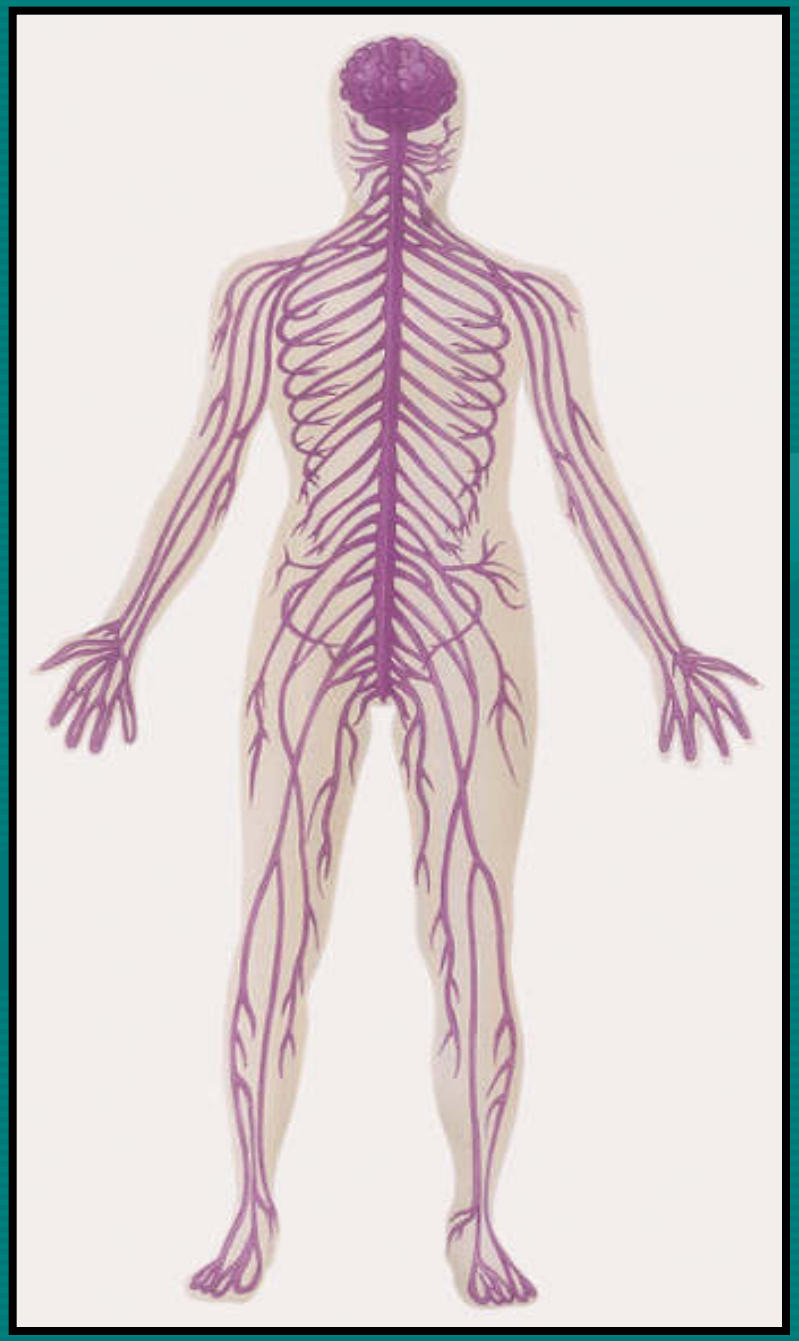
Functional classification:

- **1-Sensory division (Afferent)**
- **2-Motor division (Efferent)**
  - **Autonomic**
  - **Somatic**

Structural Organization

Two subdivisions:

- **Central Nervous System (CNS)**
  - Consists of **Brain & Spinal cord**
  - Occupies the **dorsal body cavity**
  - Acts as the integrating and command centers.
- **Peripheral Nervous System (PNS)**
  - Consists of **nerves, ganglia, receptors.**
  - **It is the** part of the nervous system **outside the CNS.**



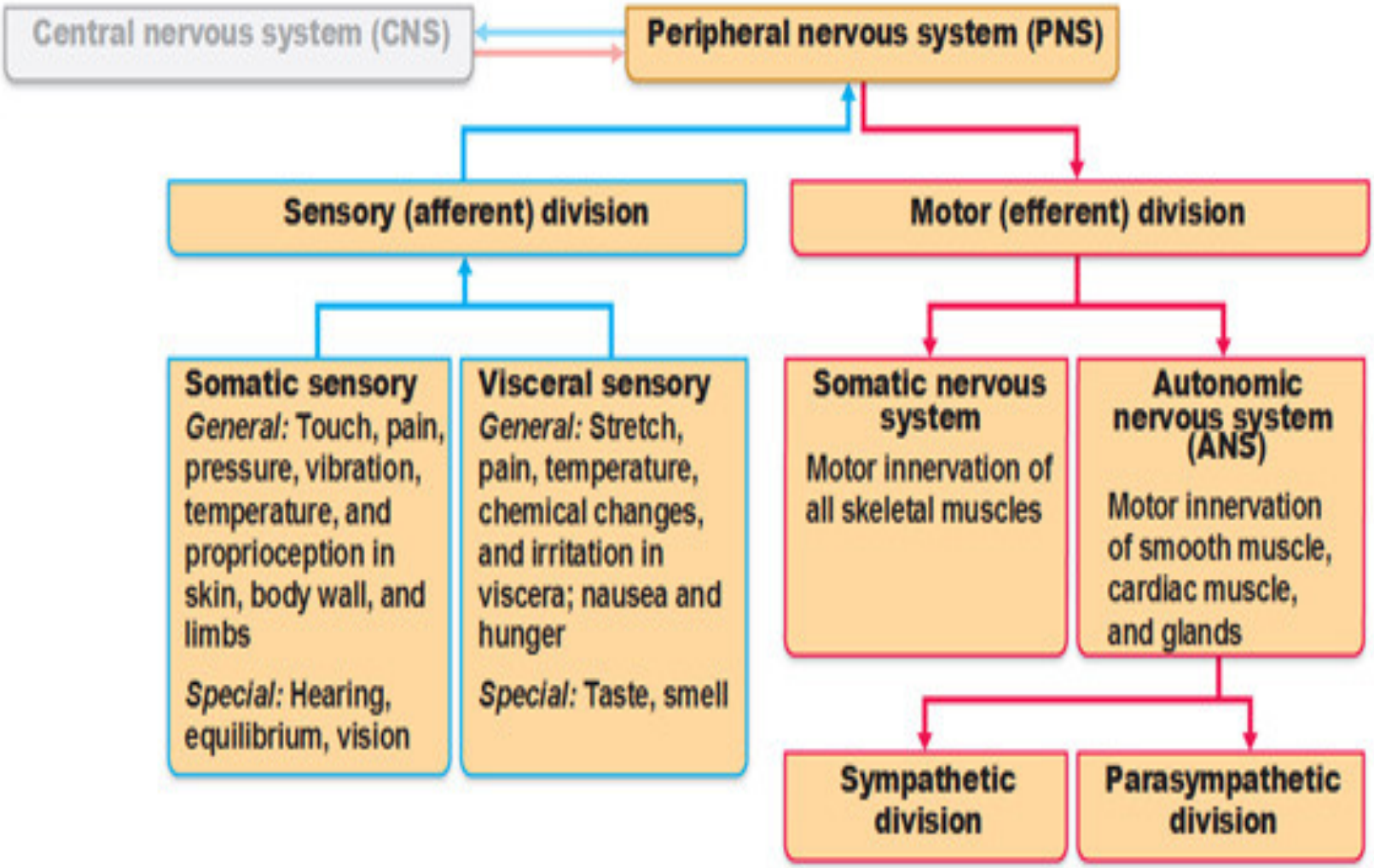
Functional Organization

- **Two subdivisions:**
  - **Sensory or Afferent** division:

    Consists of **nerve fibers** that convey impulses **from receptors** located **in various parts of the body**, **to the CNS.**
  - **Motor or Efferent** division:

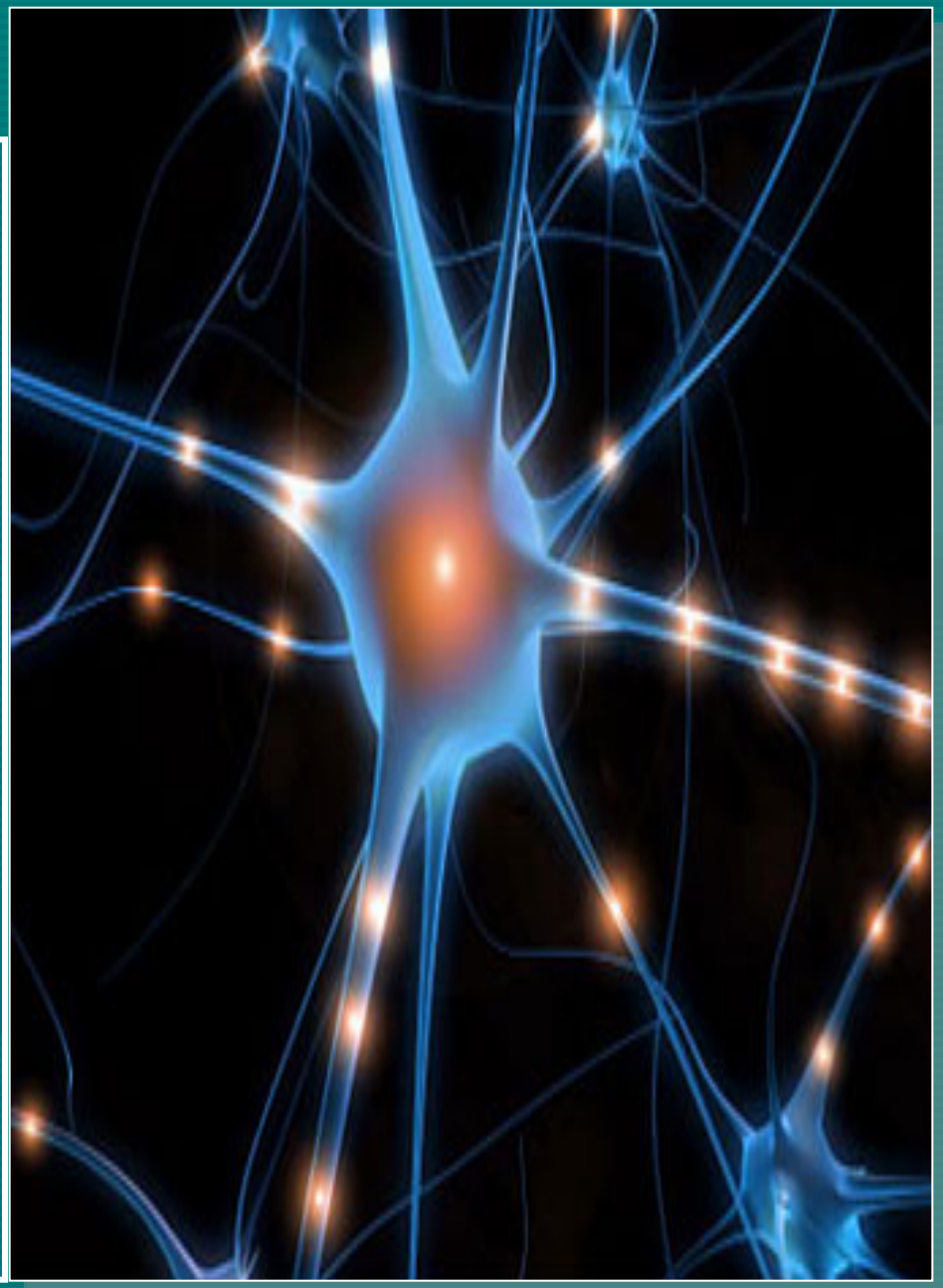
    Consists of **nerve fibers** that convey impulses **from the CNS to the effector organs, muscles and glands.**
- **Both sensory and motor subdivisions are further divided, the motor division is divided into :**
  - **Somatic** division: concerned with **skin, skeletal muscles** and **joints.**
  - **Autonomic** division: concerned with the **visceral organs.**

Functional Organization of the PNS



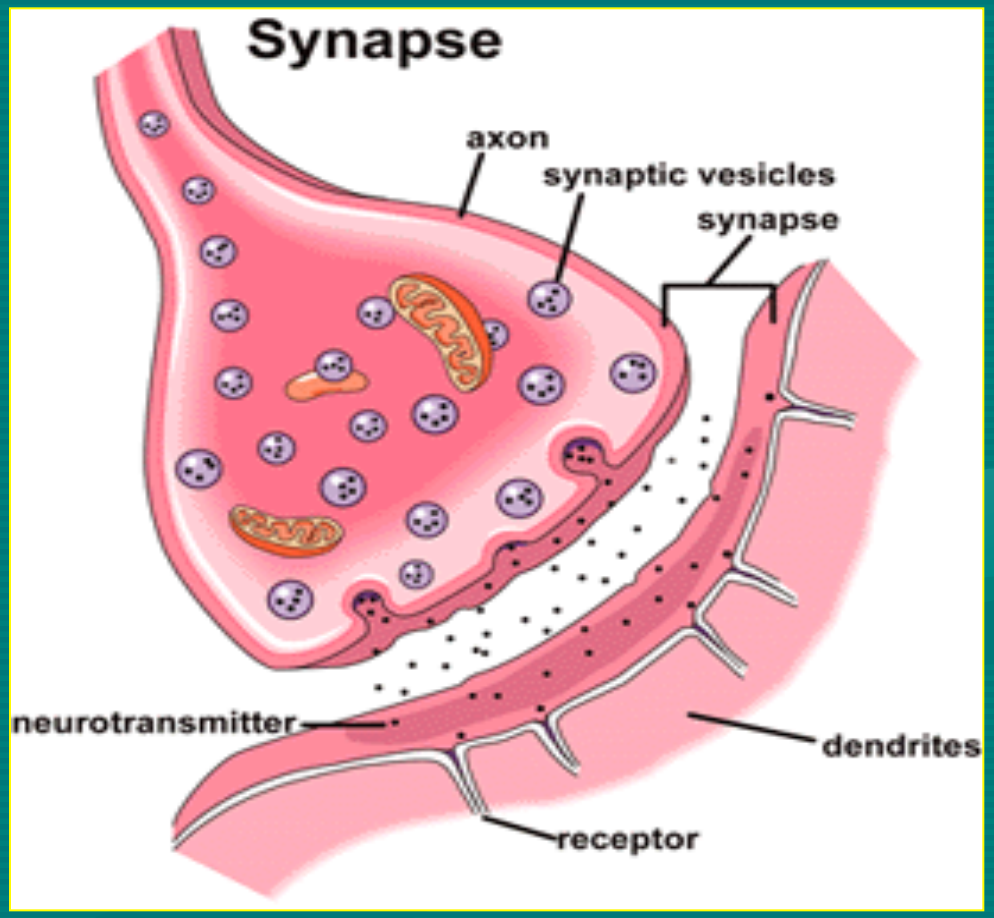
The Nervous System

- **It is the major** controlling, regulatory & communicating **system in the body.**
- **It is the center of all mental activity** including:
- **Thought,**
- **Learning,**
- **Behavior and**
- **Memory.**
- **Together with the endocrine system**, the nervous system is responsible for **regulating** and **maintaining homeostasis.**



Nervous Tissue

- Nervous system is **composed of nervous tissue**, which contains two **types of cells:**
  1- Nerve cells or **neurons**
  2- Supporting cells or **neuroglia (glia).**
- Nervous system contains millions of **neurons** that vary in their shape, size, and number of processes.



The junction site of two neurons is called a "**synapse or relay**".
In the synapses the membranes of adjacent cells are in close **apposition** (**contiguity**=contact, not **continuity**).

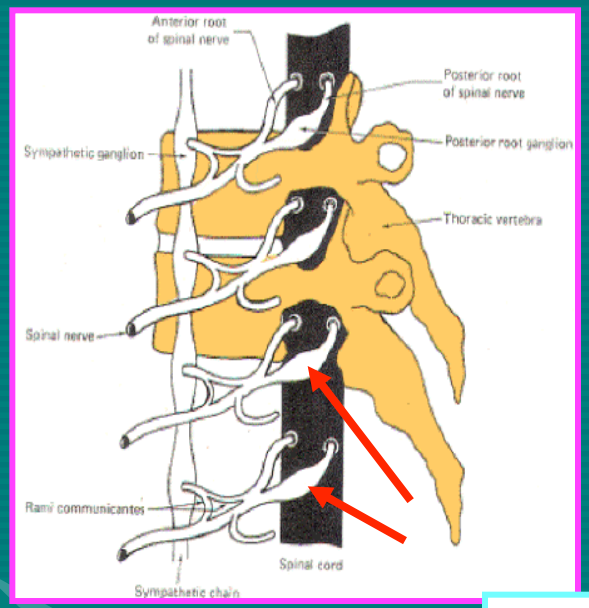
Neurons

What is neurone?

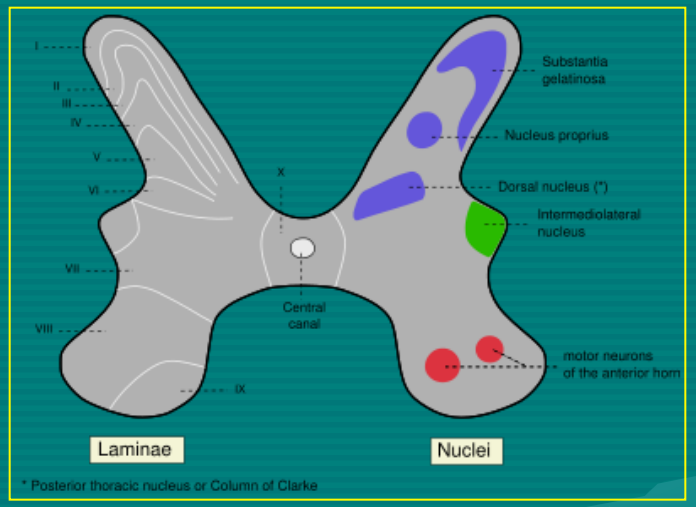
It is the **basic structural (anatomical), functional and embryological unit** of the nervous system.

The human nervous system is estimated to contain about 10^{10}.

Ganglion= A group of neurons outside the CNS

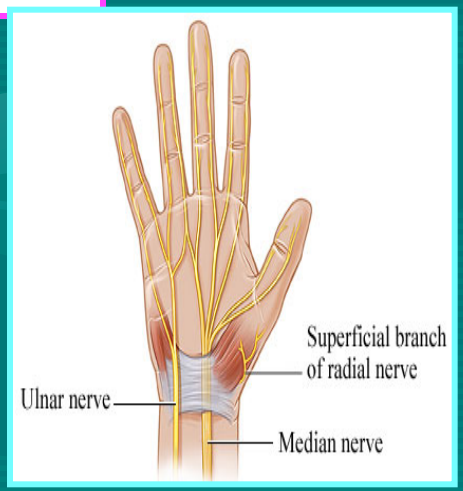


Nucleus= A group of neurons within the CNS

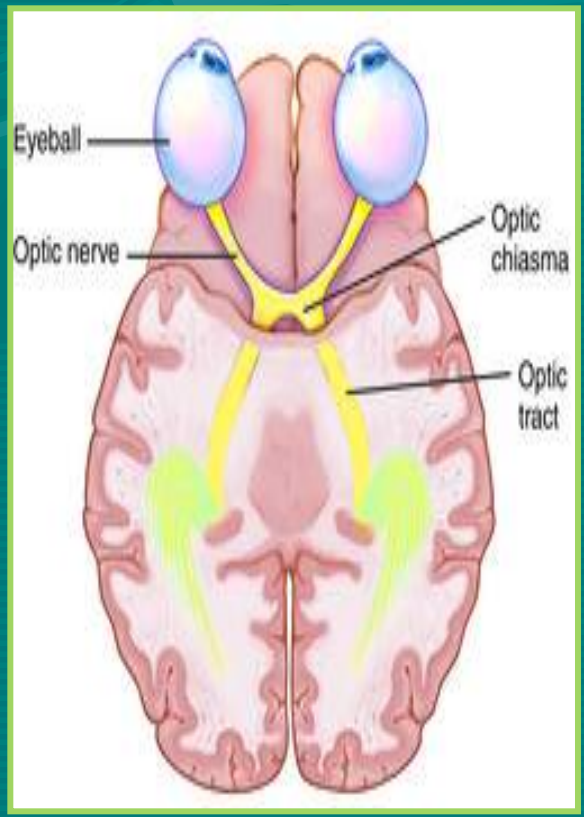


Remember...

Nerve =A group of nerve fibers (axons) outside the CNS



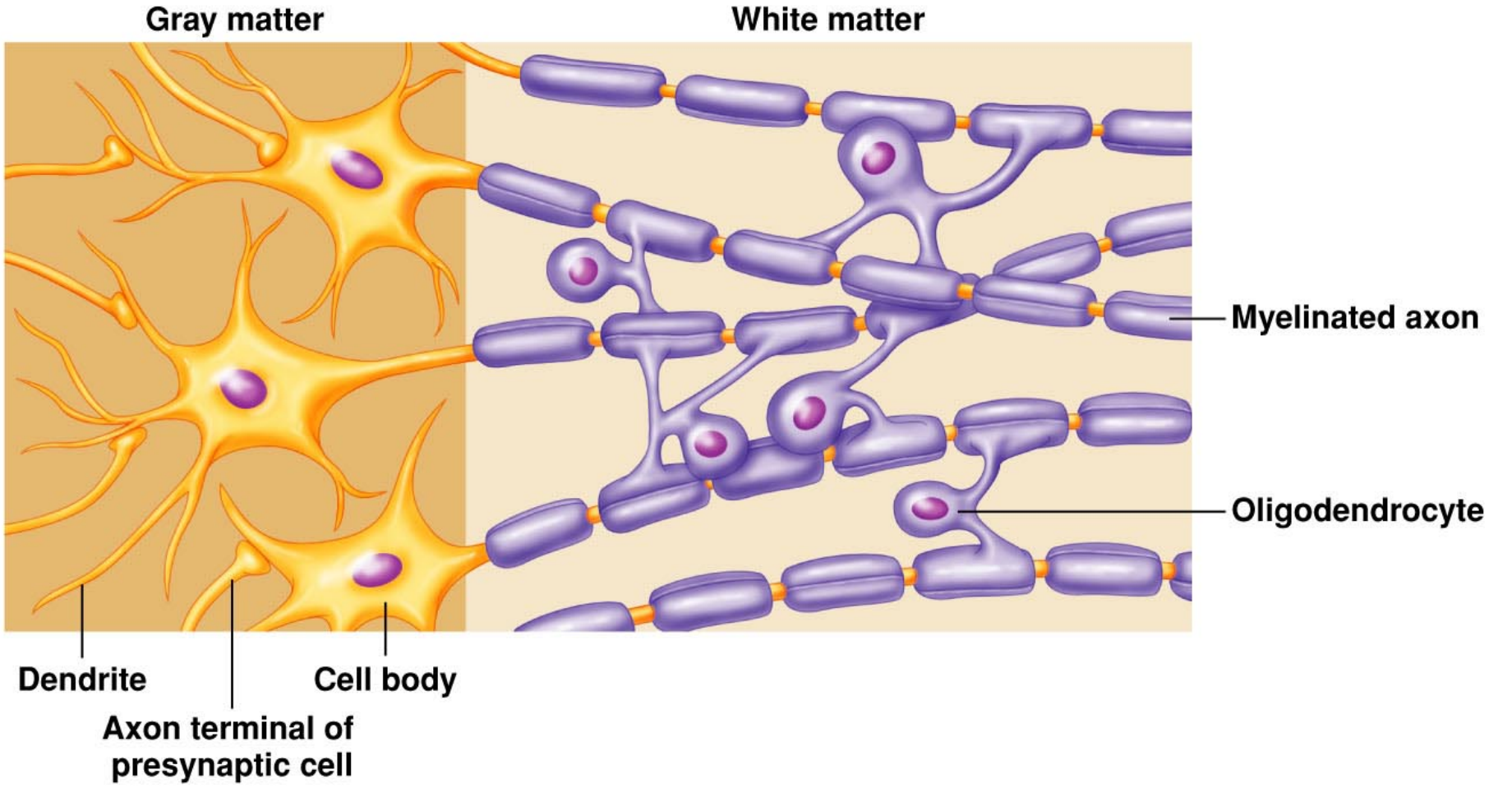
Tract =A group of nerve fibers (axons) within the CNS



Nervous tissue is organized as:

Grey matter, Which contains
1- **Cell bodies** &
2- Processes of the neurons,
3- Neuroglia and
4- Blood vessels.

White matter, Which contains:
1- Processes of the neurons
2- Neuroglia and
3- Blood vessels
***NO cell bodies* in the white matter.**

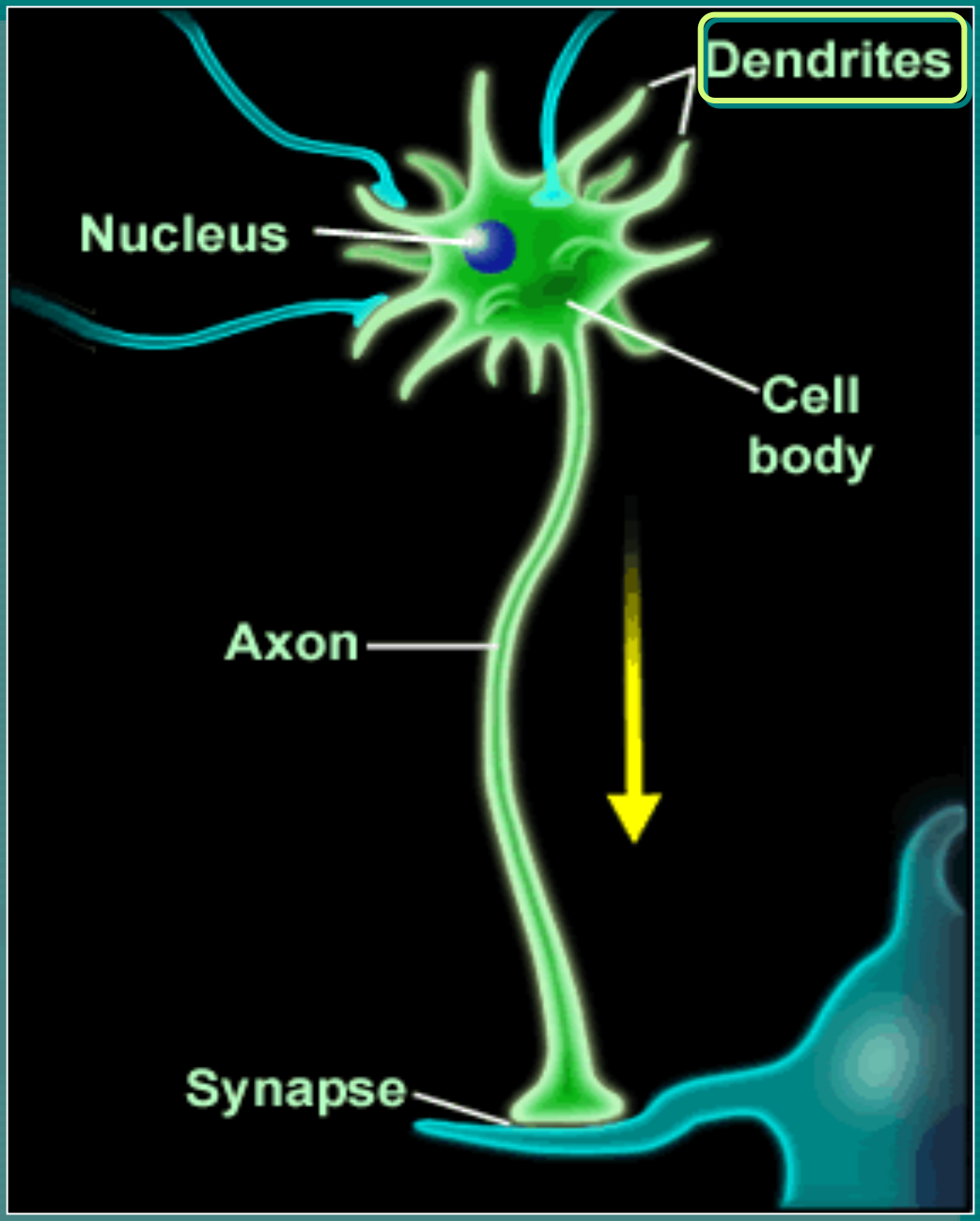


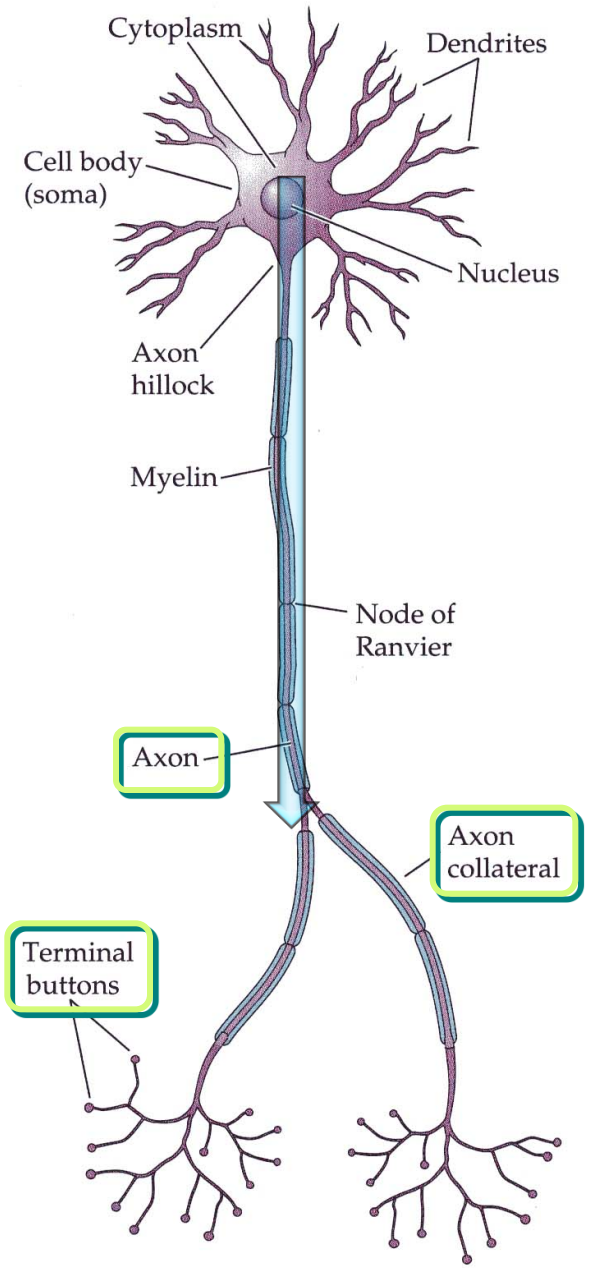
Neuroglia or glia or glial cells

- **Neuroglia, or glia cells constitute the other major cellular component of the nervous tissue.**
- **It is a specialized connective tissue supporting framework for the nervous system.**
- **Unlike neurones,** *neuroglia do not have a direct role in information processing* **but they are essential for the normal functioning of the neurons, they act as supporting and nutrition for neurons.**

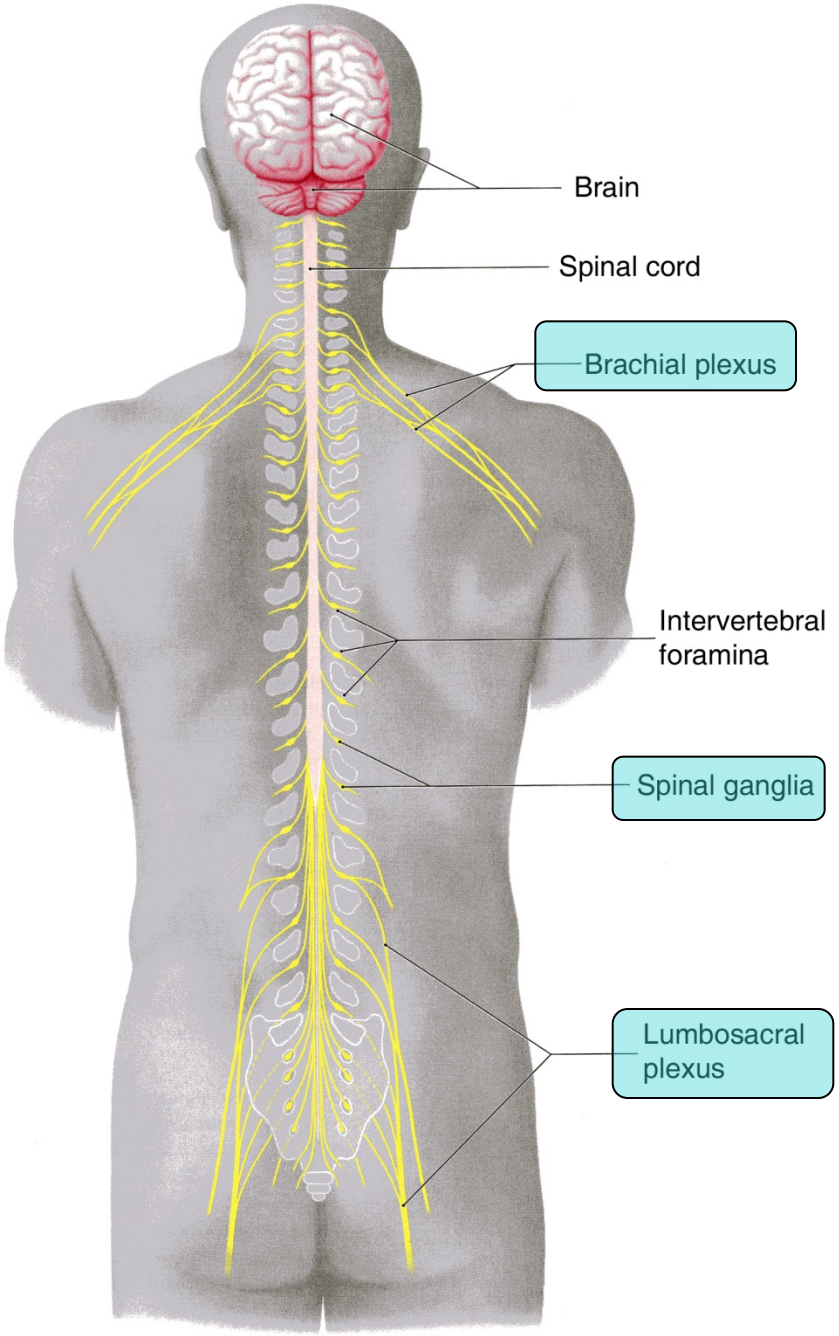
Most of the processes of the cell body are short with variable numbers and are **receptive** in function.

They **are known as Dendrites.**





- **One** of these processes leaving the cell body is called the **axon** which **carries information away from the cell body.**
- **Axons** are highly variable in length and may **divide into** several branches or **collaterals** through which information can be distributed to a number of different destinations.
- **At the end** of the axon, specializations called **terminal buttons** occur.
- **Here information is transferred to the dendrites of other neurones.**

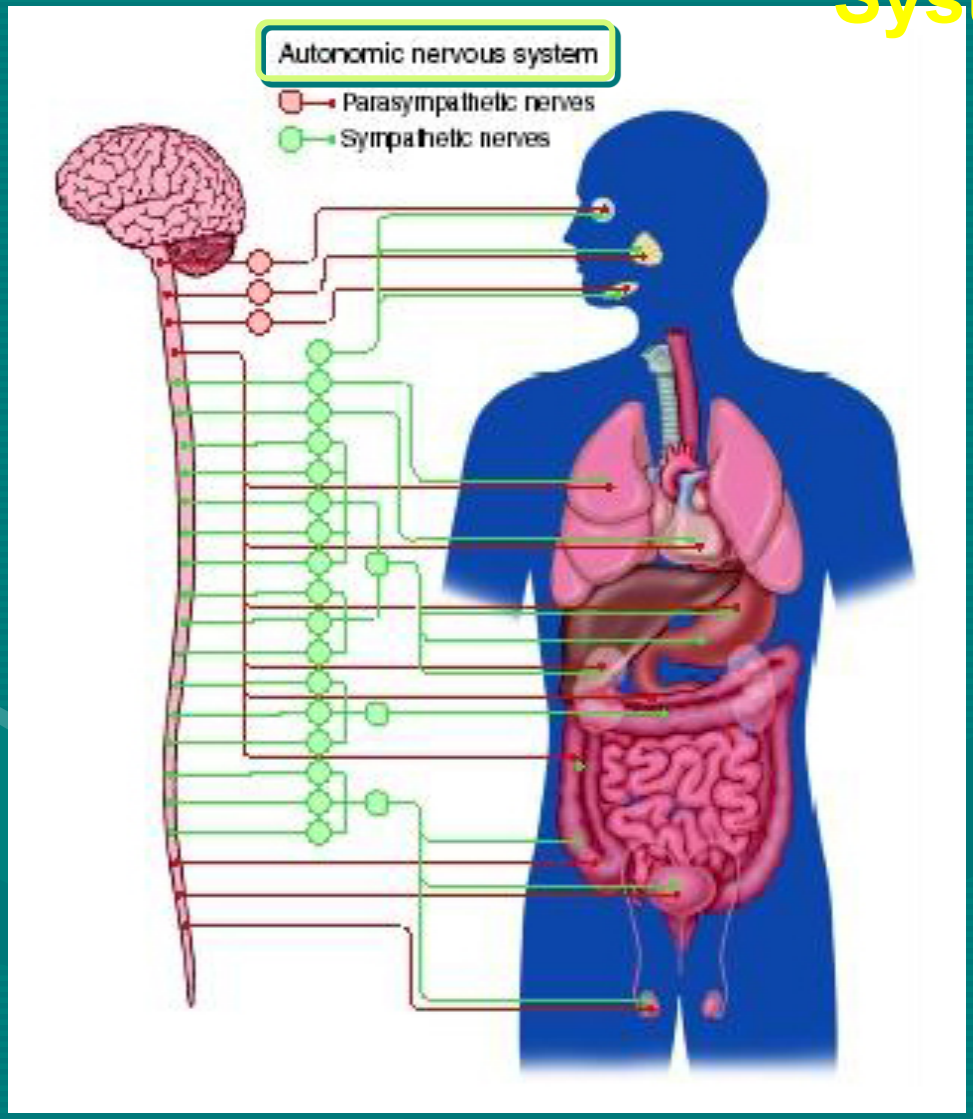


Peripheral NS

- **Spinal nerves** supplying the upper or lower limbs form **plexuses** e.g. **brachial** or **lumbar plexus.**

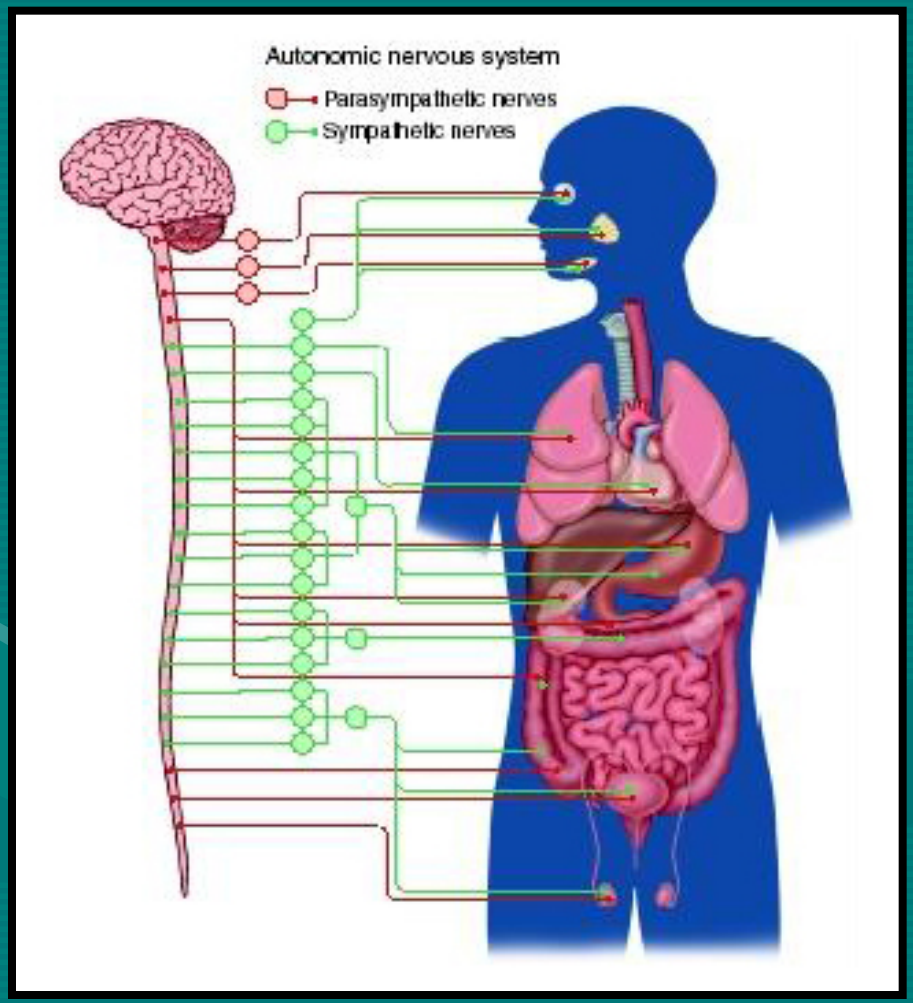
- **Nerve cell bodies** that are aggregated outside the CNS are called **GANGLIA**

Autonomic Nervous System

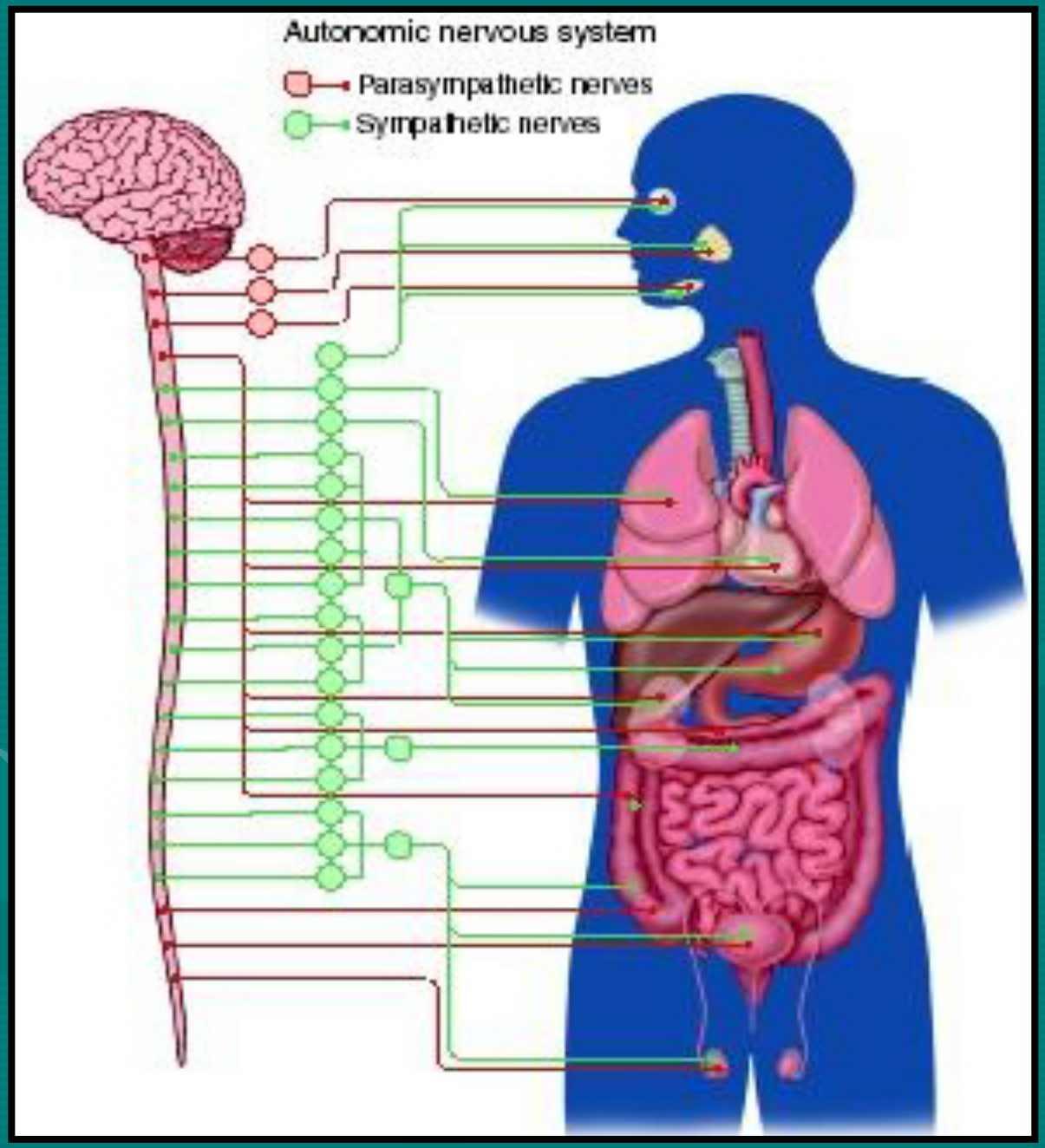


- Neurones that detect changes and **control the activity of the viscera** are collectively referred to as the **autonomic nervous system.**
- Its components are **present in both the central and peripheral nervous systems.**

SYMPATHETIC & PARASYMPATHETIC SYSTEMS

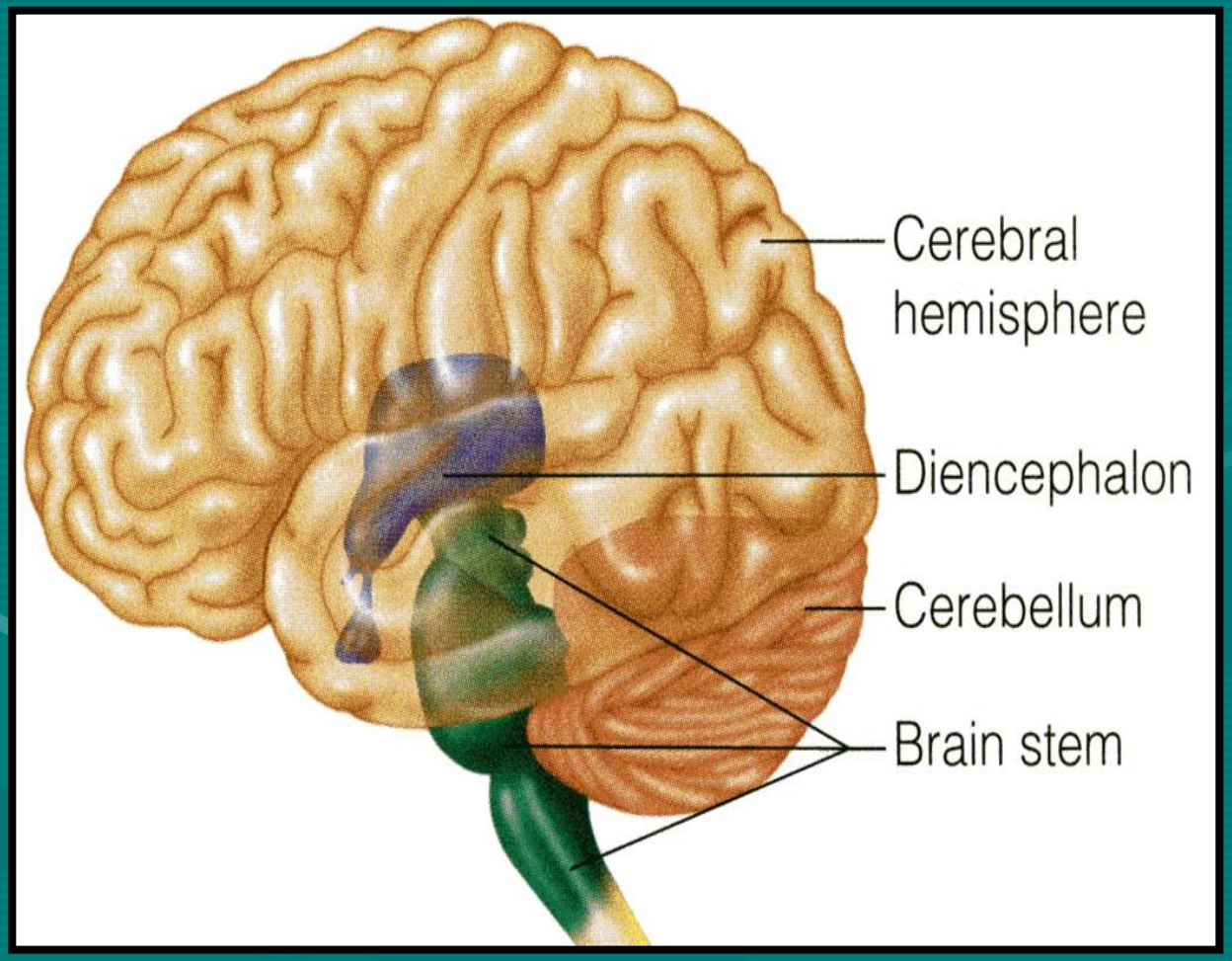


- The autonomic nervous system is divided into two anatomically and functionally distinct parts:
- **Sympathetic:** Or
- **Thoracolumbar outflow**
- **Parasympathetic**: Or
- **Craniosacral outflow.**
- **Sympathetic** and **parasympathetic** , divisions are generally have **antagonistic** effects on the structures that they innervate.
- E.g. Sympathetic increases the heart rate, while the parasympathetic decreases the heart rate.



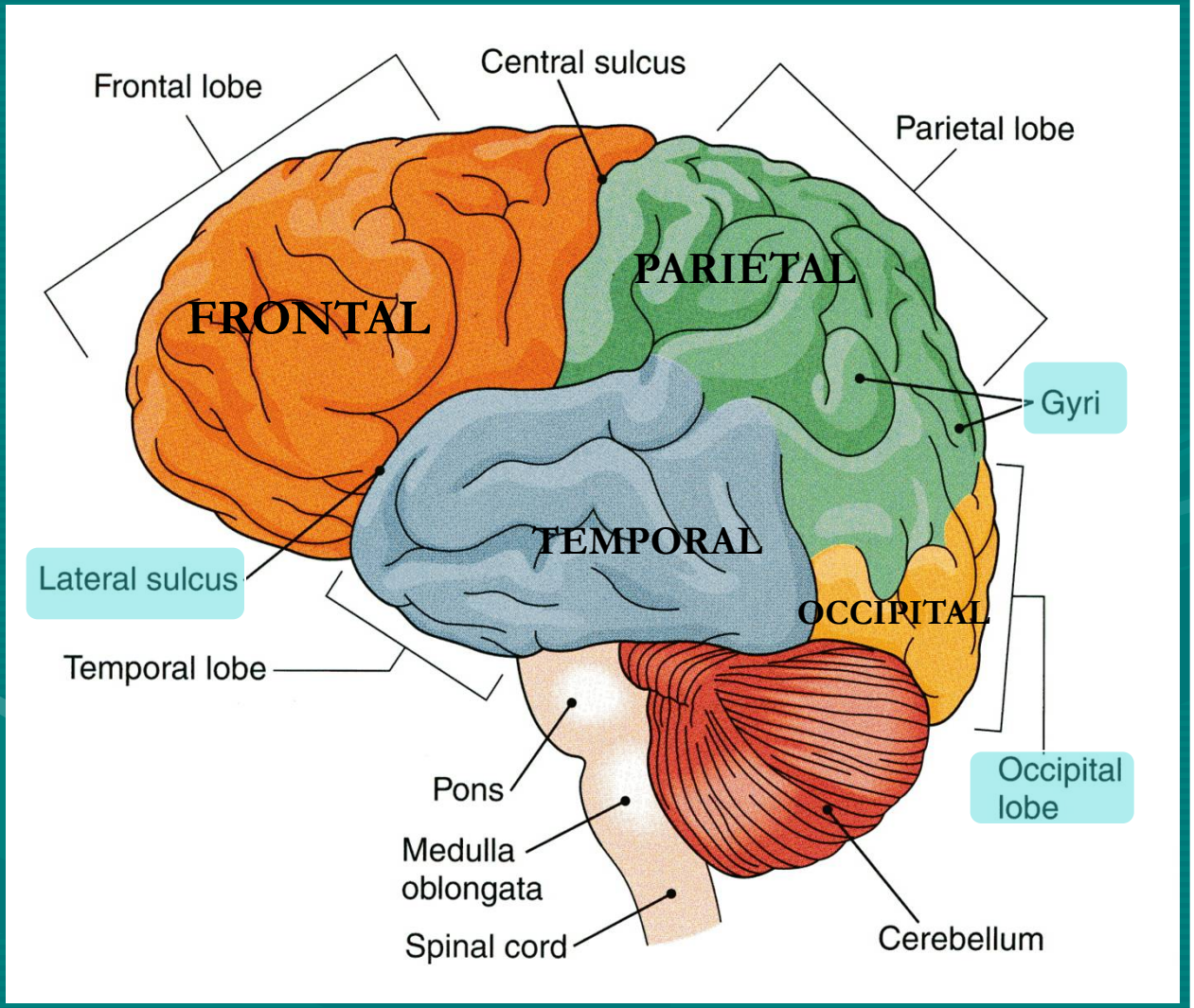
- **The autonomic nervous system innervates:**
- Smooth muscles,
- Cardiac muscle,
- Secretory glands.
- It is an important part of the homeostatic mechanisms that control the internal environment of the body with the endocrine system.

PARTS OF THE BRAIN



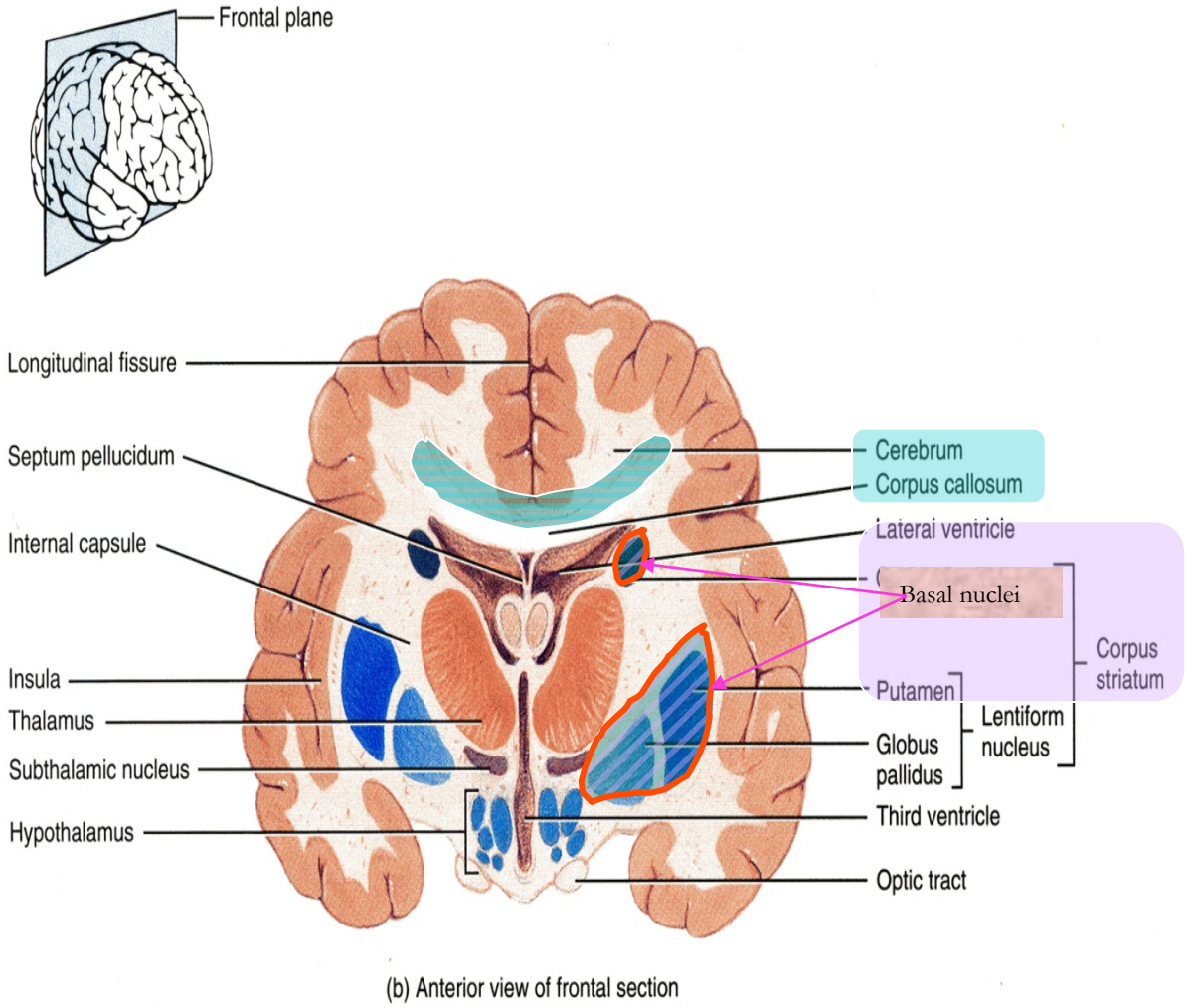
- **The brain composed of 4 parts:**
- Cerebral hemispheres
- Diencephalon
- Cerebellum
- Brain stem

CEREBRAL HEMISPHERES



- The largest part of the brain.
- They have elevations, called gyri.
- Gyri are separated by depressions called sulci.
- Each hemisphere is divided into 4 lobes named according to the bone above.
- Lobes are separated by deeper grooves called fissures or sulci.

TISSUE OF THE CEREBRAL HEMISPHERES

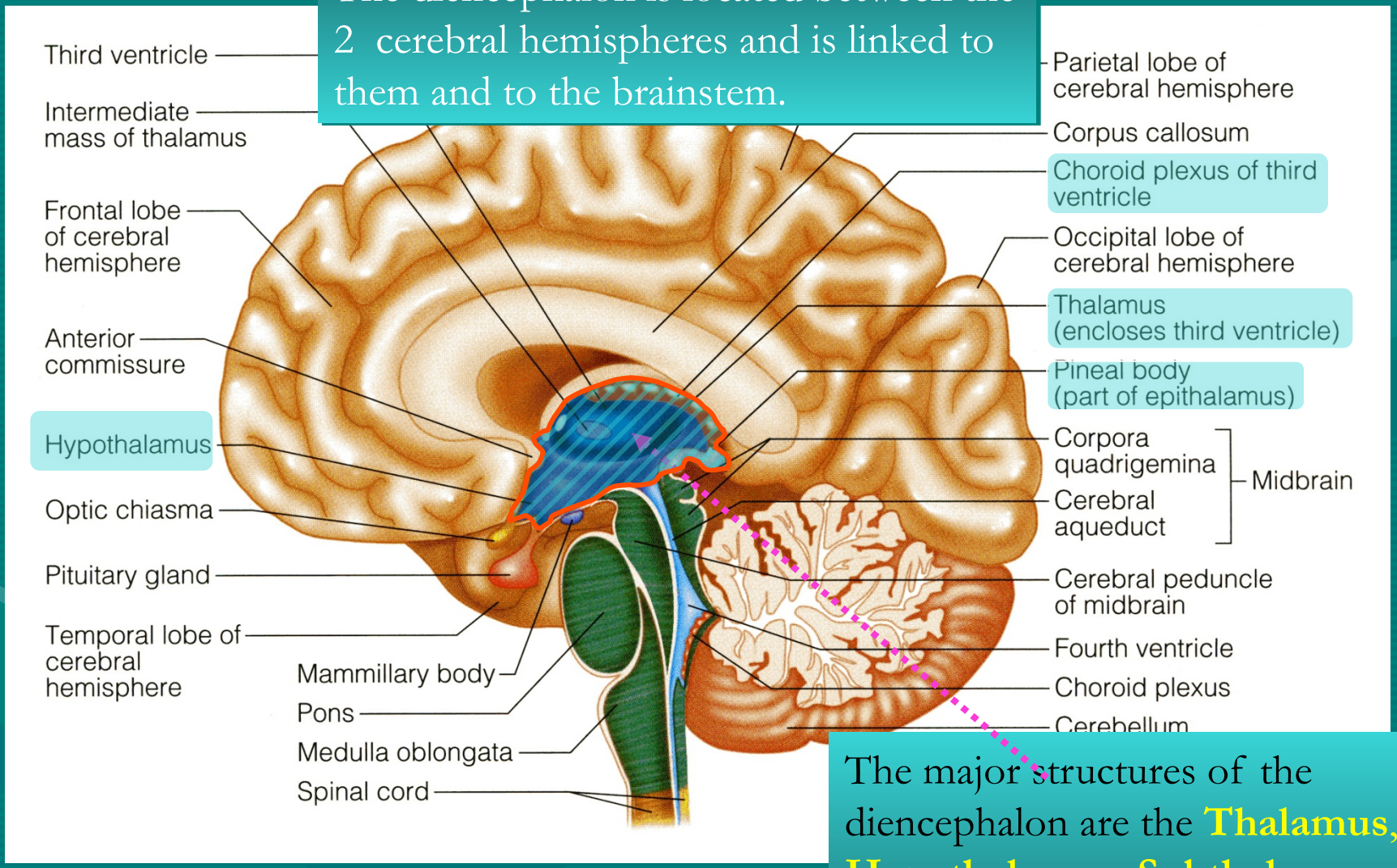


(b) Anterior view of frontal section

- **The outer layer** is the **gray matter** or **cortex**
- **Deeper** is located the **white matter, or medulla,** composed of bundles of nerve fibers, carrying impulses **to and from** the cortex
- **Basal nuclei** are **gray matter** that are located deep within the white matter
- They help the motor cortex in regulation of *voluntary motor activities*.

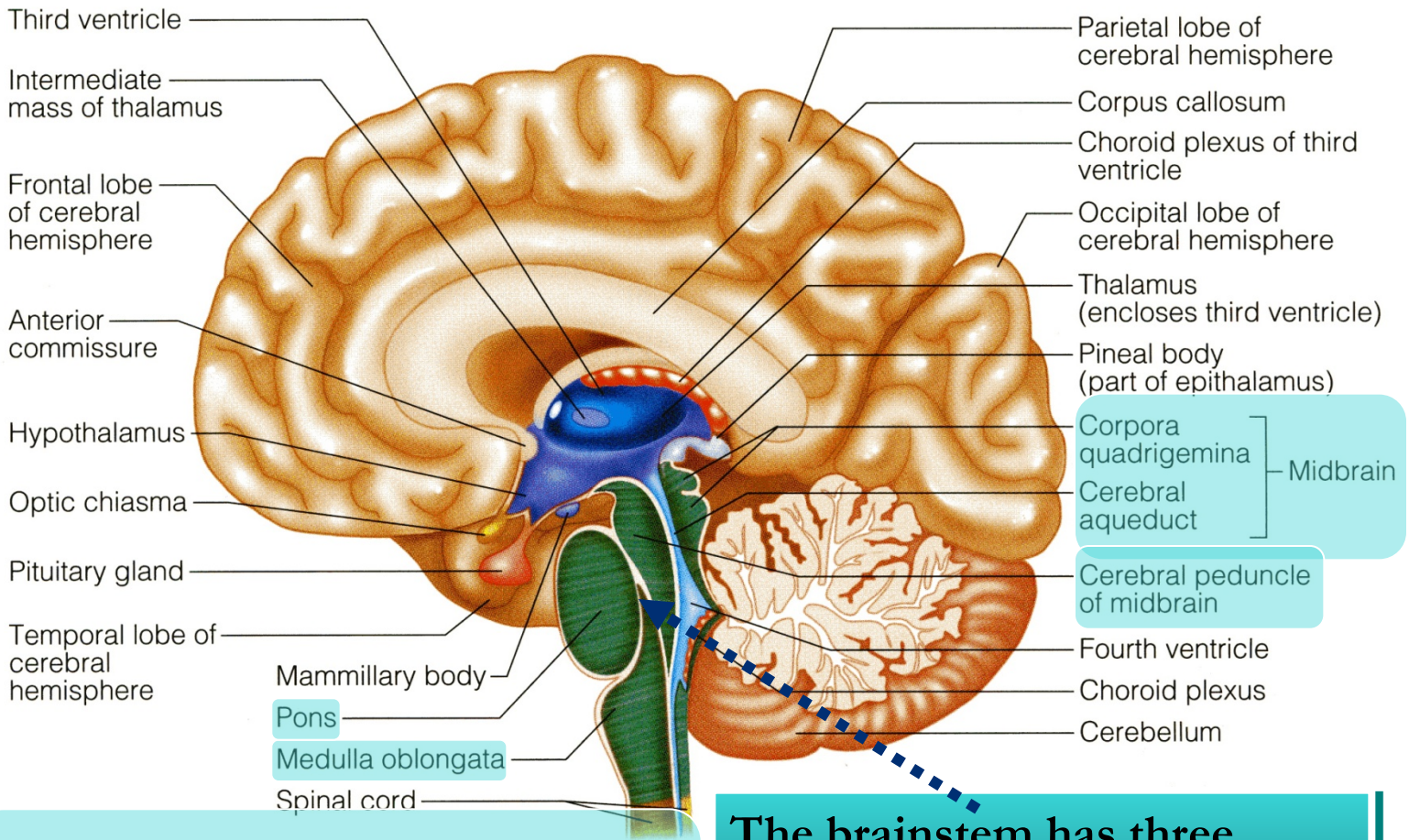
DIENCEPHALON

The diencephalon is located between the 2 cerebral hemispheres and is linked to them and to the brainstem.



The major structures of the diencephalon are the **Thalamus**, **Hypothalamus**, **Subthalamus** and **Epithalamus**.

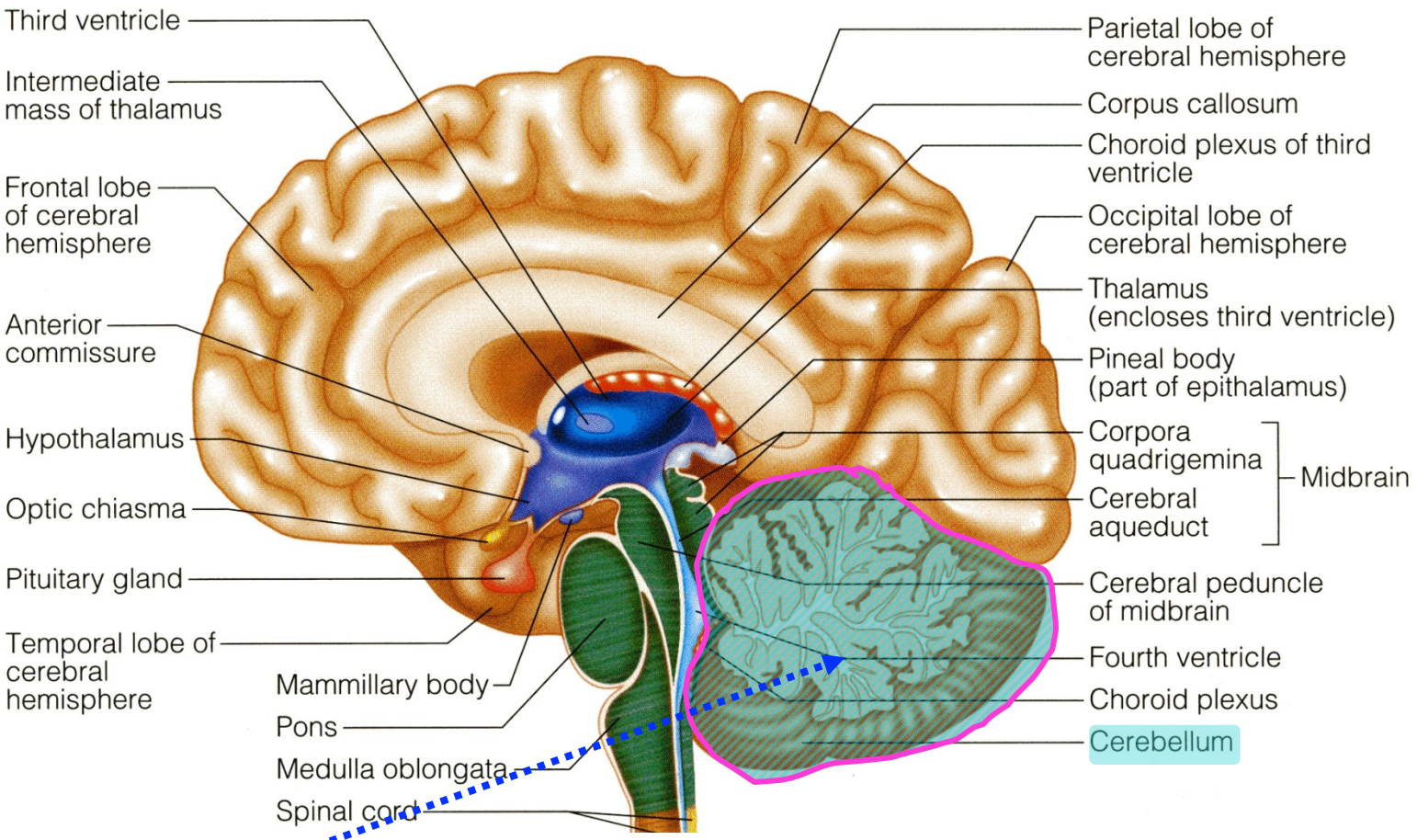
BRAIN STEM



It is connected to the cerebellum with 3 paired **peduncles**
Superior, middle and inferior

The brainstem has three parts: midbrain, Pons and medulla oblongata.

CEREBELLUM



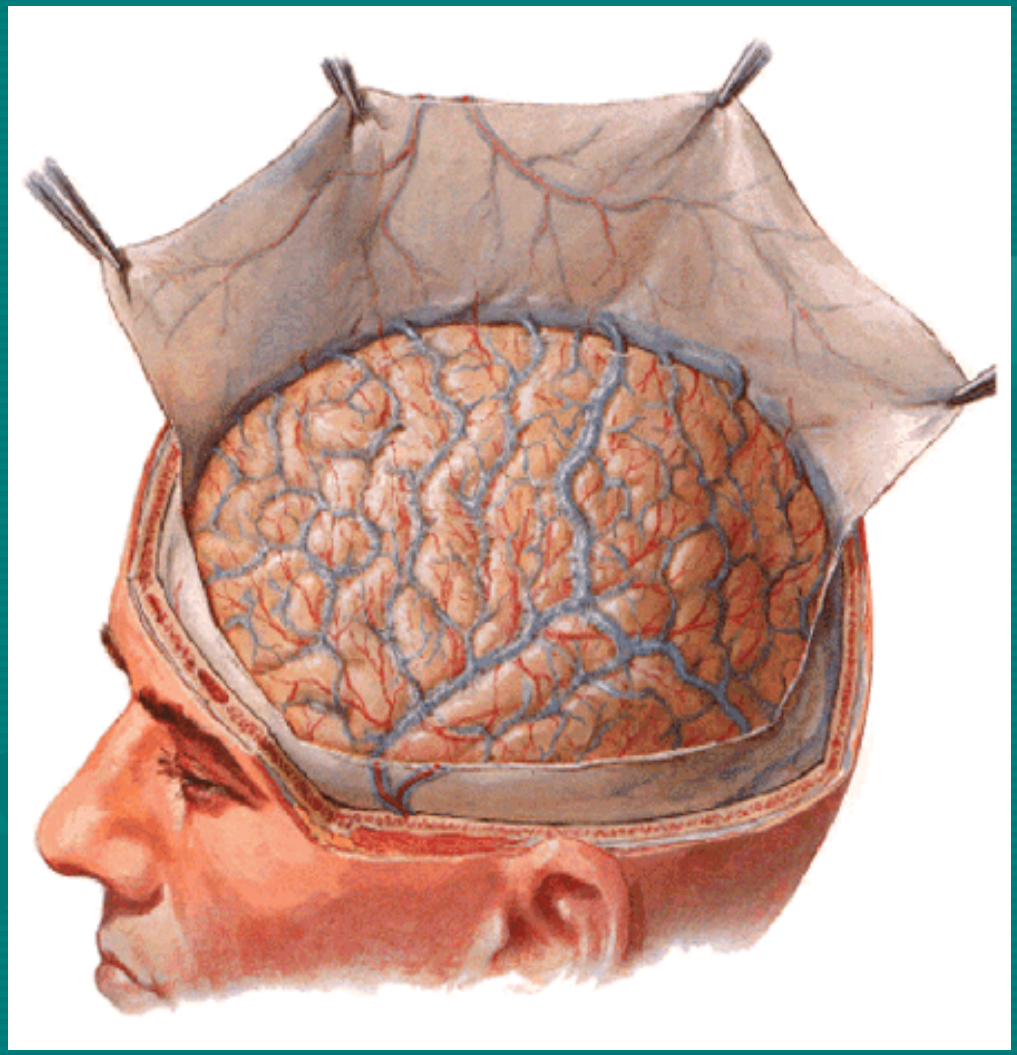
Cerebellum has 2 cerebellar hemispheres with convoluted surface.

It has an **outer cortex of gray matter** and an **inner region of white matter.**

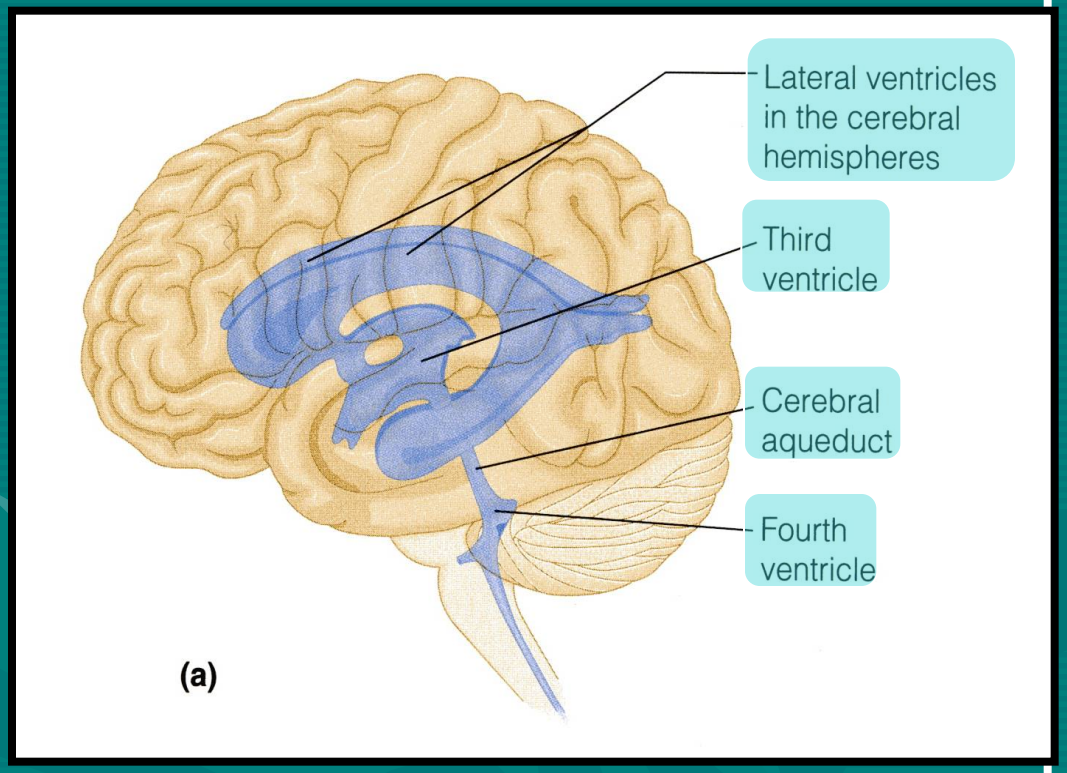
It provides precise coordination for body movements and helps maintain equilibrium.

MENINGES

- There are **three** connective tissue membranes invest the brain and the spinal cord.
- These are from outward to inward are:
- **1- Dura mater.**
- **2- Arachnoid mater.**
- **3- Pia mater.**



BRAIN VENTRICLES

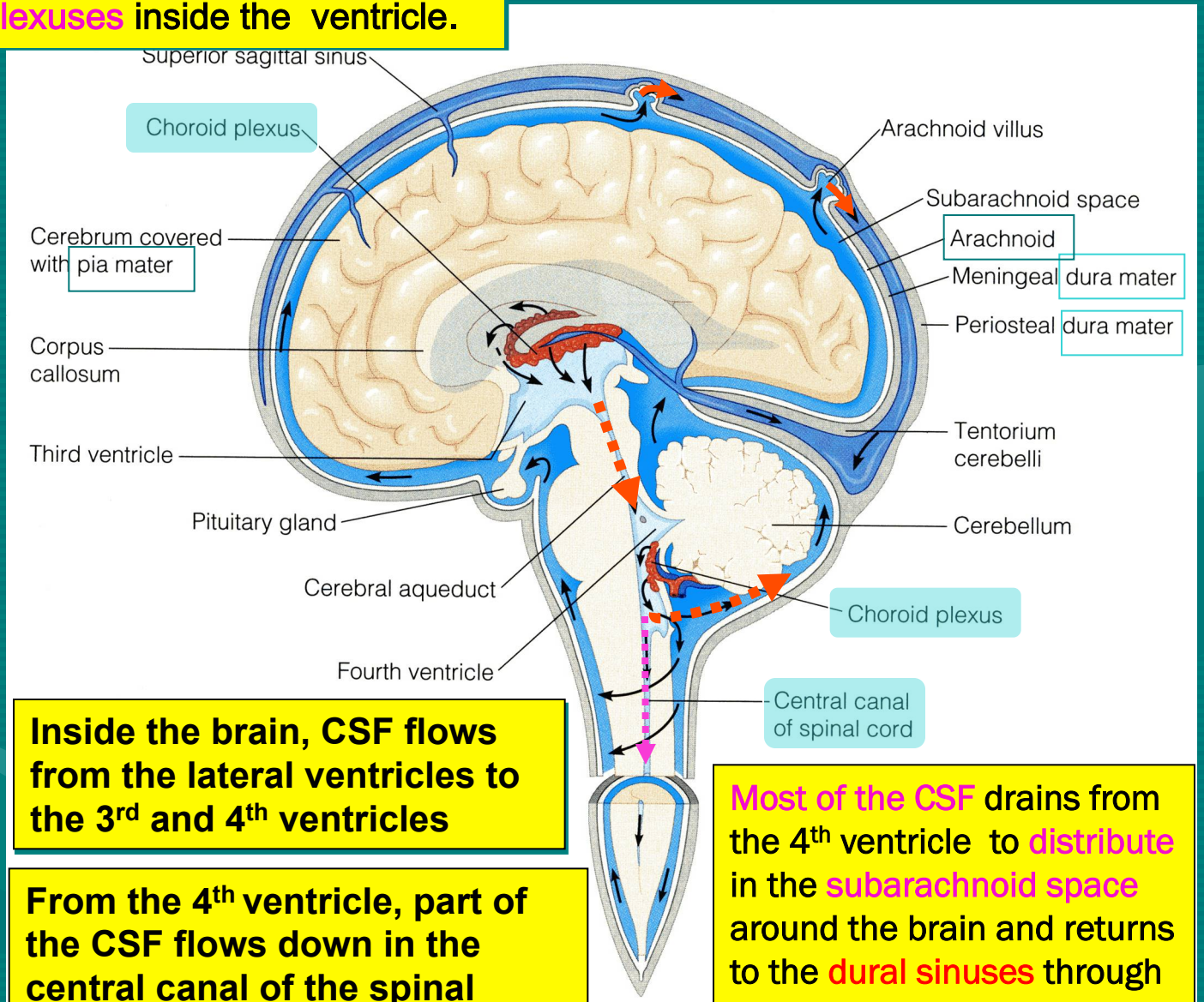


- Brain is bathed by the cerebrospinal fluid (CSF).
- Inside the brain, there are 4 ventricles filled with CSF.
- The 4 ventricles are:
  - **2 lateral ventricles:**
    One in each hemispheres.
  - **3rd ventricle:**
    in the Diencephalon.
  - **4th ventricle:**
    between Pons, Medulla oblongata & Cerebellum.

N.B. Cerebral aqueduct: connects the 3rd to the 4th ventricle.

CEREBROSPINAL FLUID

CSF is constantly produced by the choroid plexuses inside the ventricle.



Inside the brain, CSF flows from the lateral ventricles to the 3rd and 4th ventricles

From the 4th ventricle, part of the CSF flows down in the central canal of the spinal cord.

Most of the CSF drains from the 4th ventricle to distribute in the subarachnoid space around the brain and returns to the dural sinuses through the arachnoids villi.

- **Arachnoid villi** are small protrusions of the arachnoid.
- Villi absorb cerebrospinal fluid and return it finally to the **dural venous circulation.**

GOOD LUCK

Examine Yourself

- **Which one of the following is related to the tract?**
- Neurons outside the CNS.
- Neurons inside the CNS.
- Nerve fibers within the CNS. ⟸
- Nerve fibers outside the CNS.
- **Which structure is concerning with formation of CSF ?**
- The arachnoid villi.
- The choroid plexus. ⟸
- The subdural space.
- The dural venous sinus.
- **The peripheral nervous system involves :**
- The spinal ganglia. ⟸
- The spinal cord.
- The brain.
- The tracts.
- **The lateral ventricle lies in :**
- The cerebrum. ⟸
- The diencephalon.
- The midbrain.
- The cerebellum.