Organization of The Nervous System

PROF. AHMED F. I. EL FOUHIL

Objectives

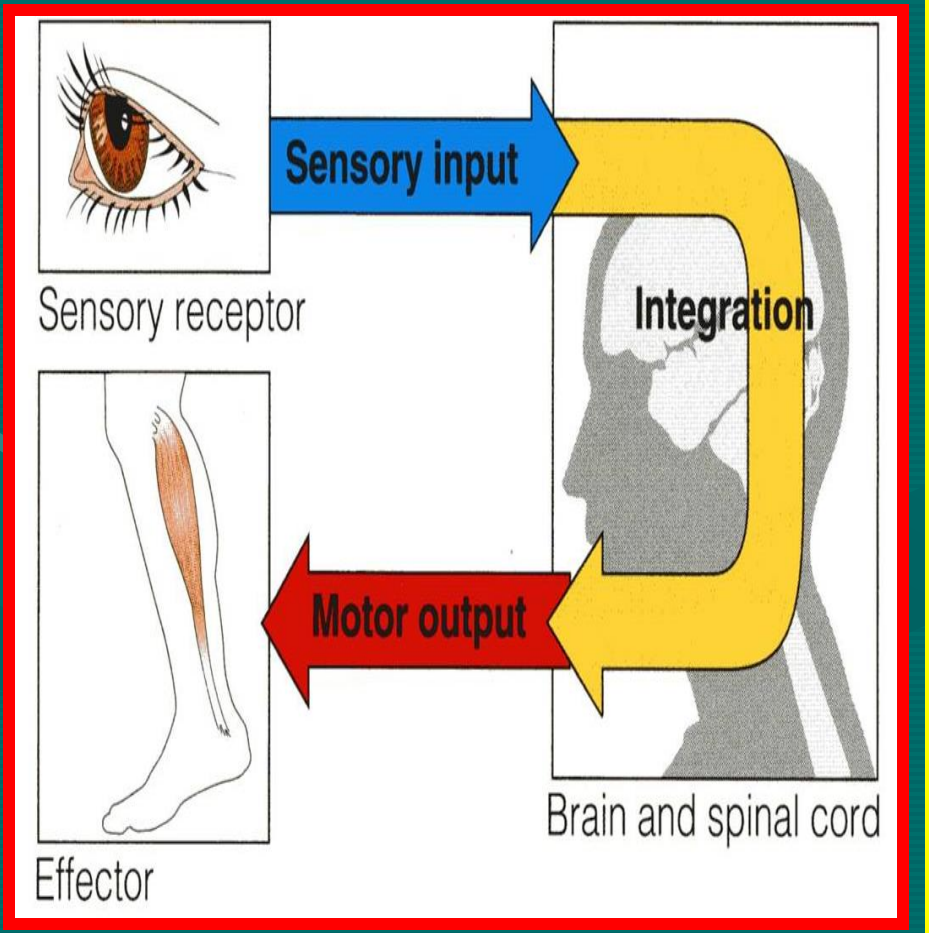
By the end of the lecture, you should be able to:

- List the parts of the Nervous System.
- List the functions of the Nervous System.
- Describe the Structural & Functional Organizations of the Nervous System.
- Describe, in brief, the nervous tissue.
- **Define the terms**:

  Nervous tissue, gray matter, white matter, nucleus, ganglion, tract and nerve.
- Describe, in brief, the **parts** of the Nervous System.
- List the structures protecting the Central Nervous System.

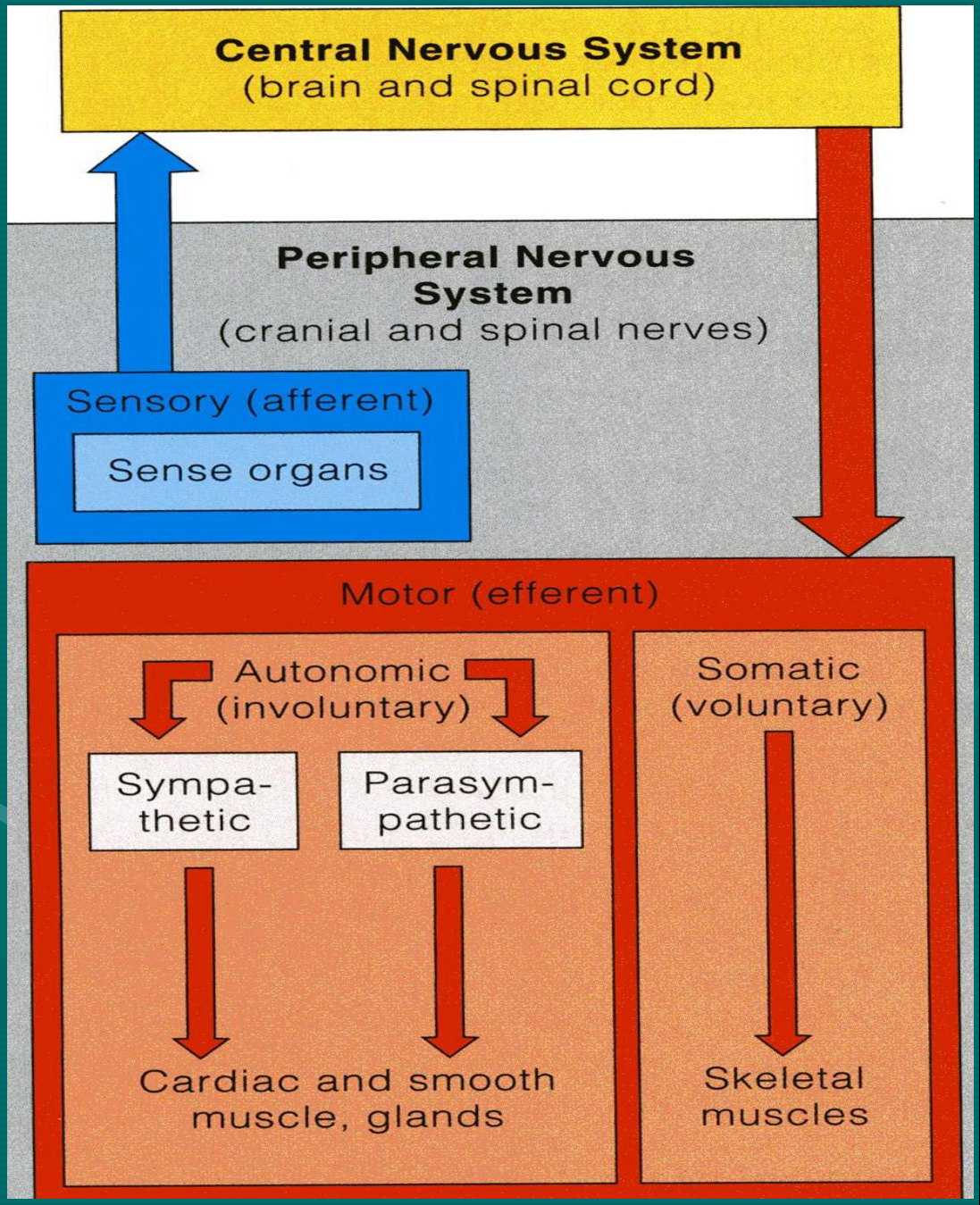
INTRODUCTION

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

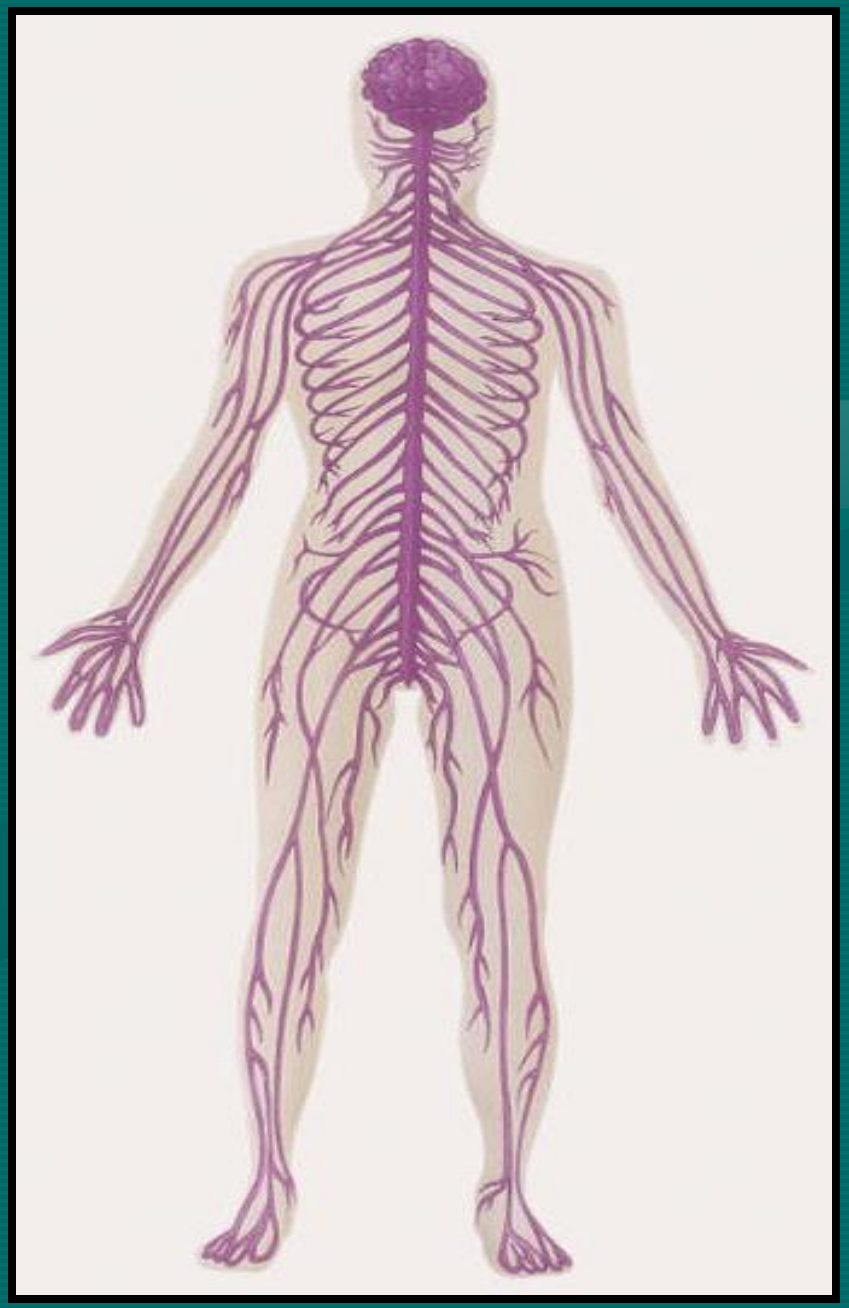
II- Physiological or **functional classification:**

- **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.
- **Peripheral Nervous System (PNS)**
  - Consists of
  - **Nerves & Ganglia: *cranial, spinal and autonomic.***
  - **Receptors.**
  - Lies outside the dorsal body cavity.



Functional Organization

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

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

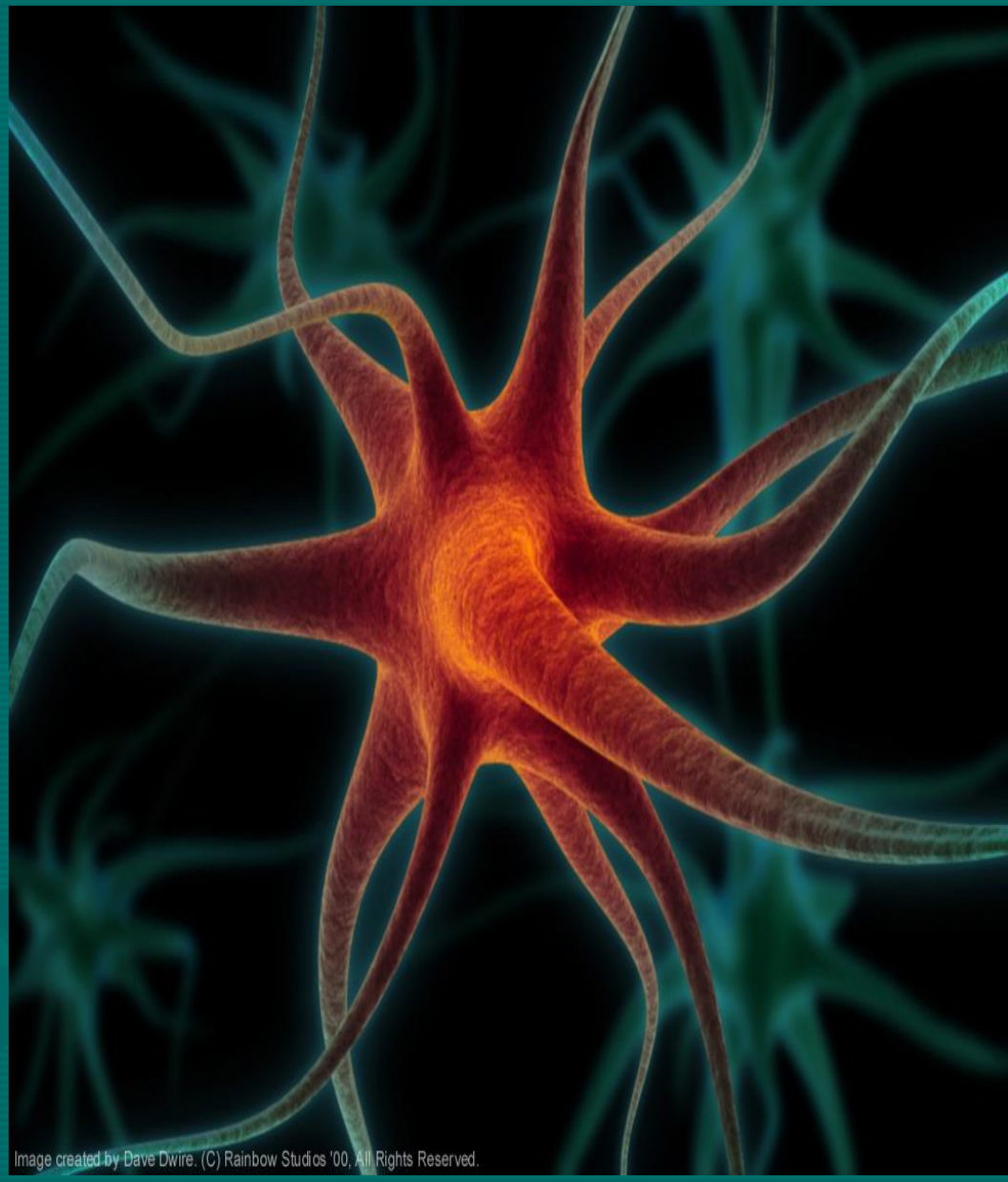
    Consists of neurons that convey impulses from the CNS to the effector organs, muscles and glands.
- **Motor division is further subdivided into:**
  - **Somatic**: concerned with **skin, skeletal muscles and joints.**
  - **Autonomic**: concerned with **visceral organs, blood vessels, heart and glands.**

The Nervous System

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

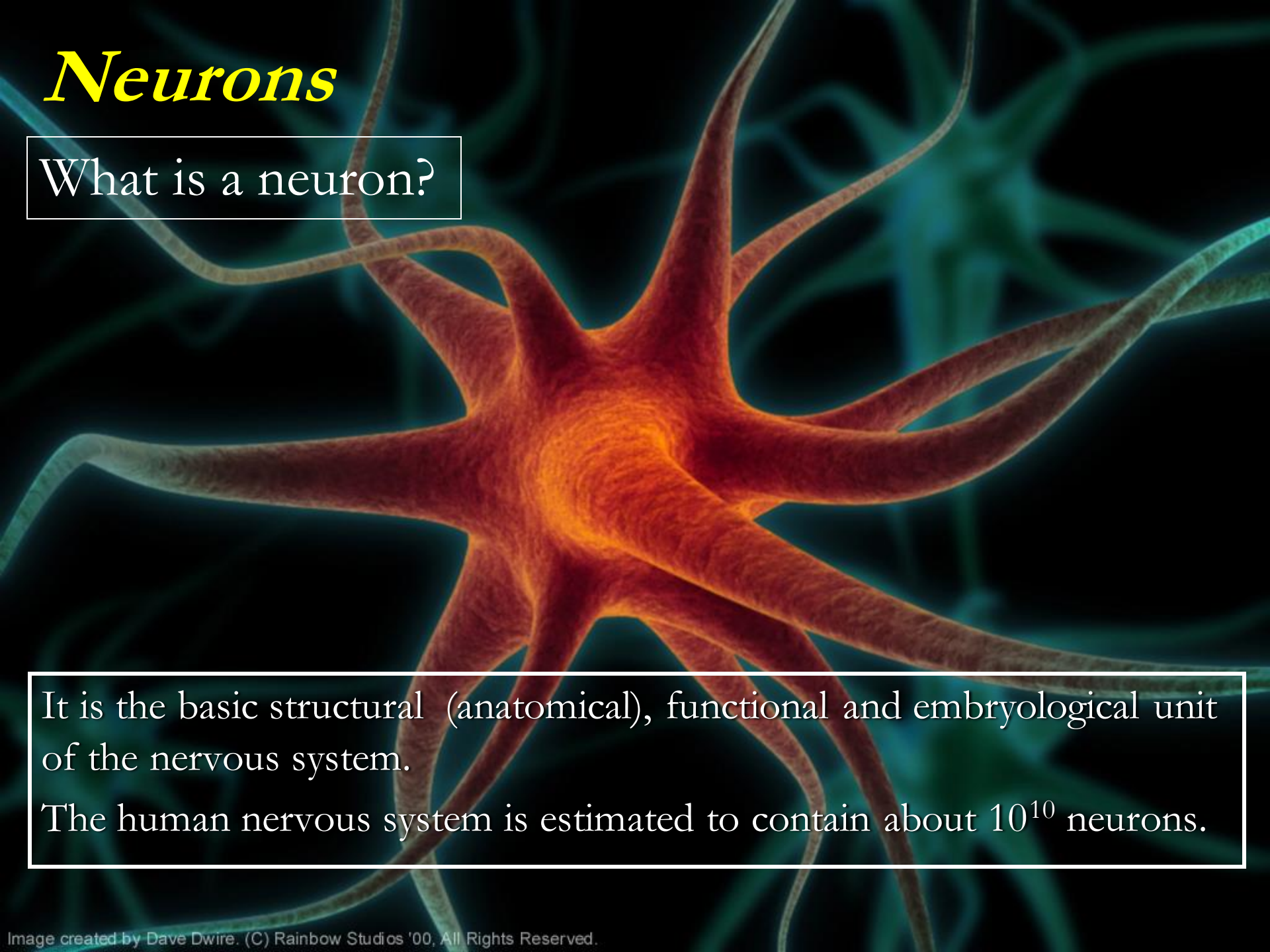
Nervous Tissue

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



Neurons

What is a neuron?

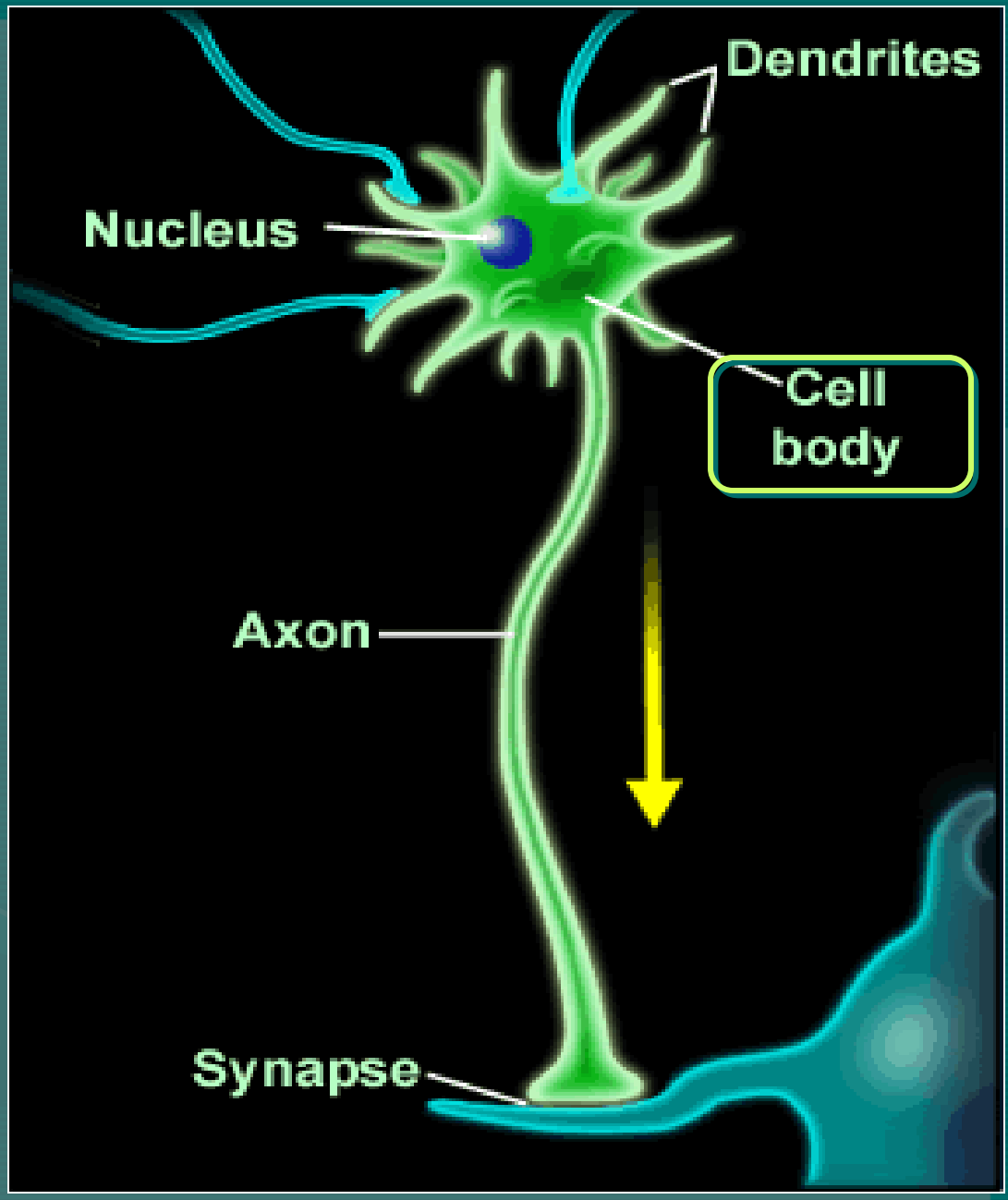


It is the basic structural (anatomical), functional and embryological unit of the nervous system.

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

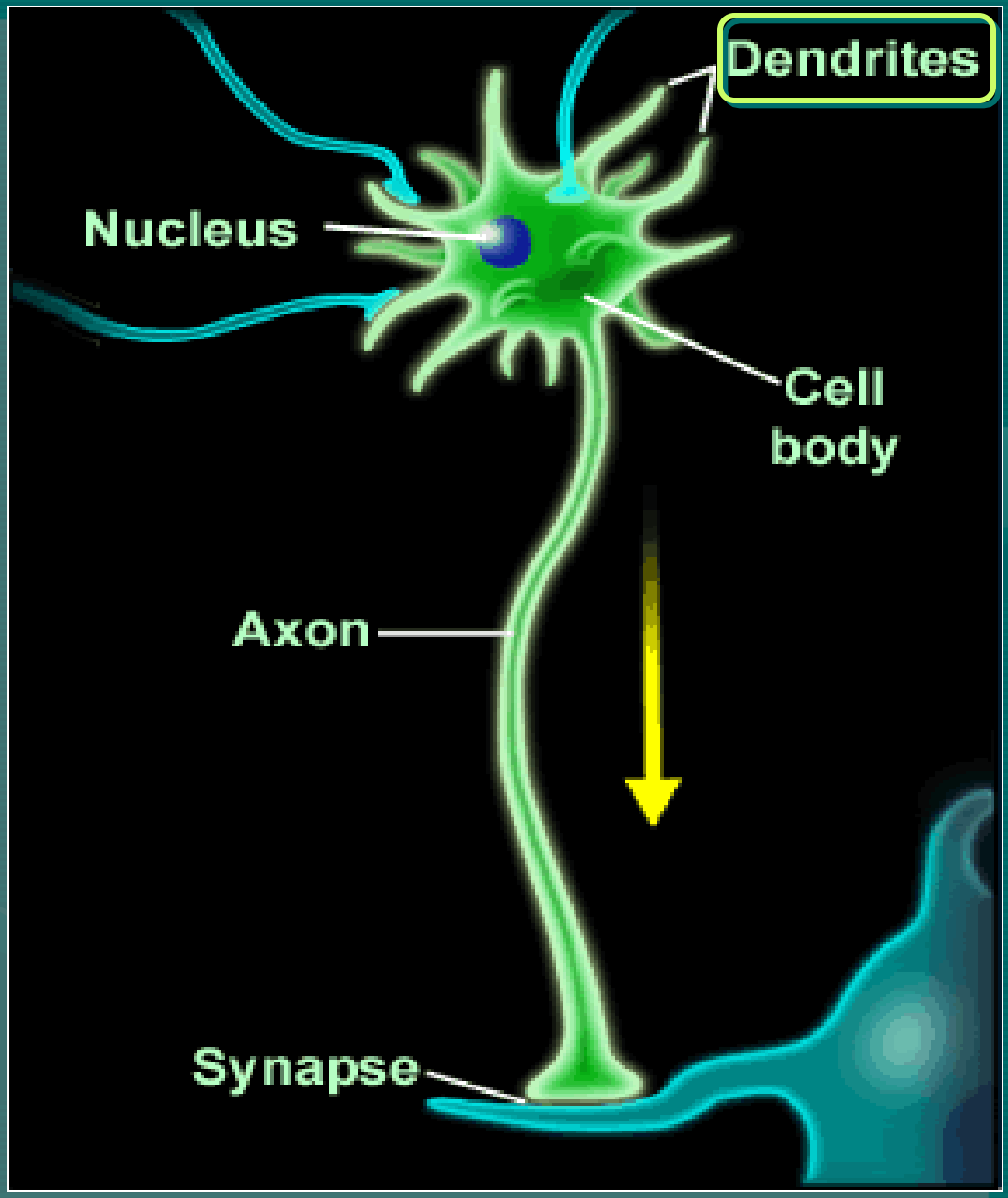
Neuron

The neuron has a cell body containing a nucleus. It possesses multiple processes; the axon and the dendrites.

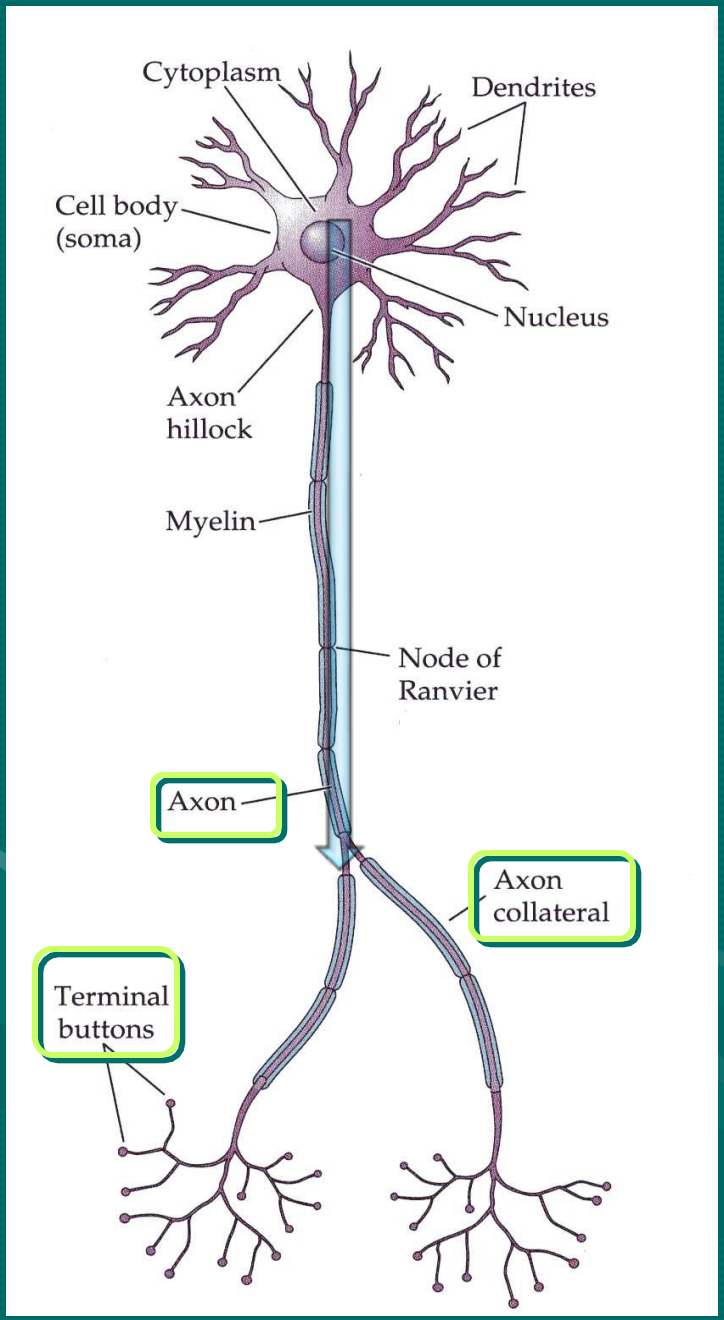


Dendrites

Dendrites are **short processes** with **variable numbers**. They carry impulses **toward the cell body**.



Axon

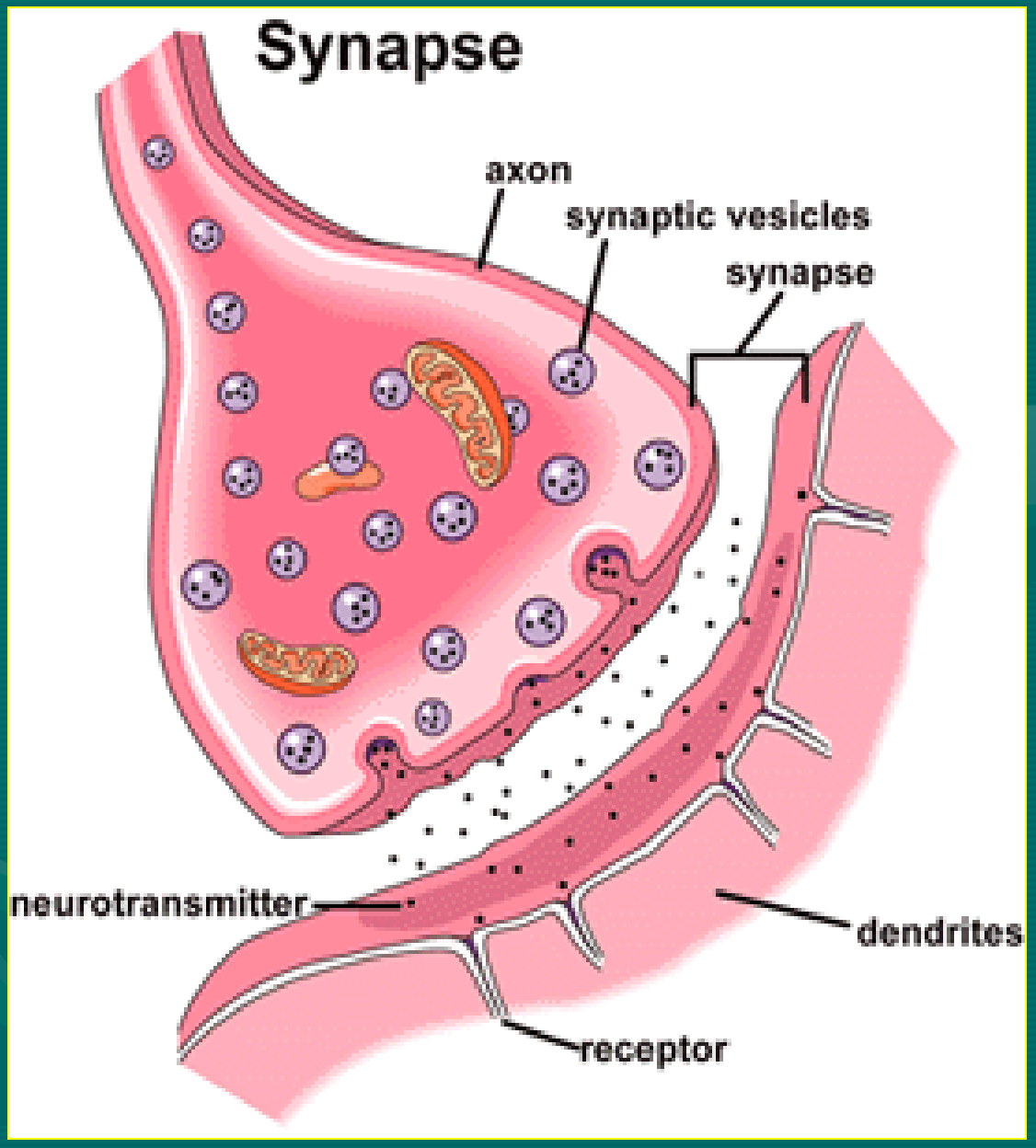


- It is a single process that carries information away from the cell body.
- The axon (or Nerve Fiber) is usually a long process that may divide into several branches or collaterals through which information can be distributed to a large number of different destinations.
- At the end of the axon, specializations called terminal buttons occur. Here information is transferred to the dendrites of other neurones.
- Coverings: myelin, neurilemma.

Synapse or Relay

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**).



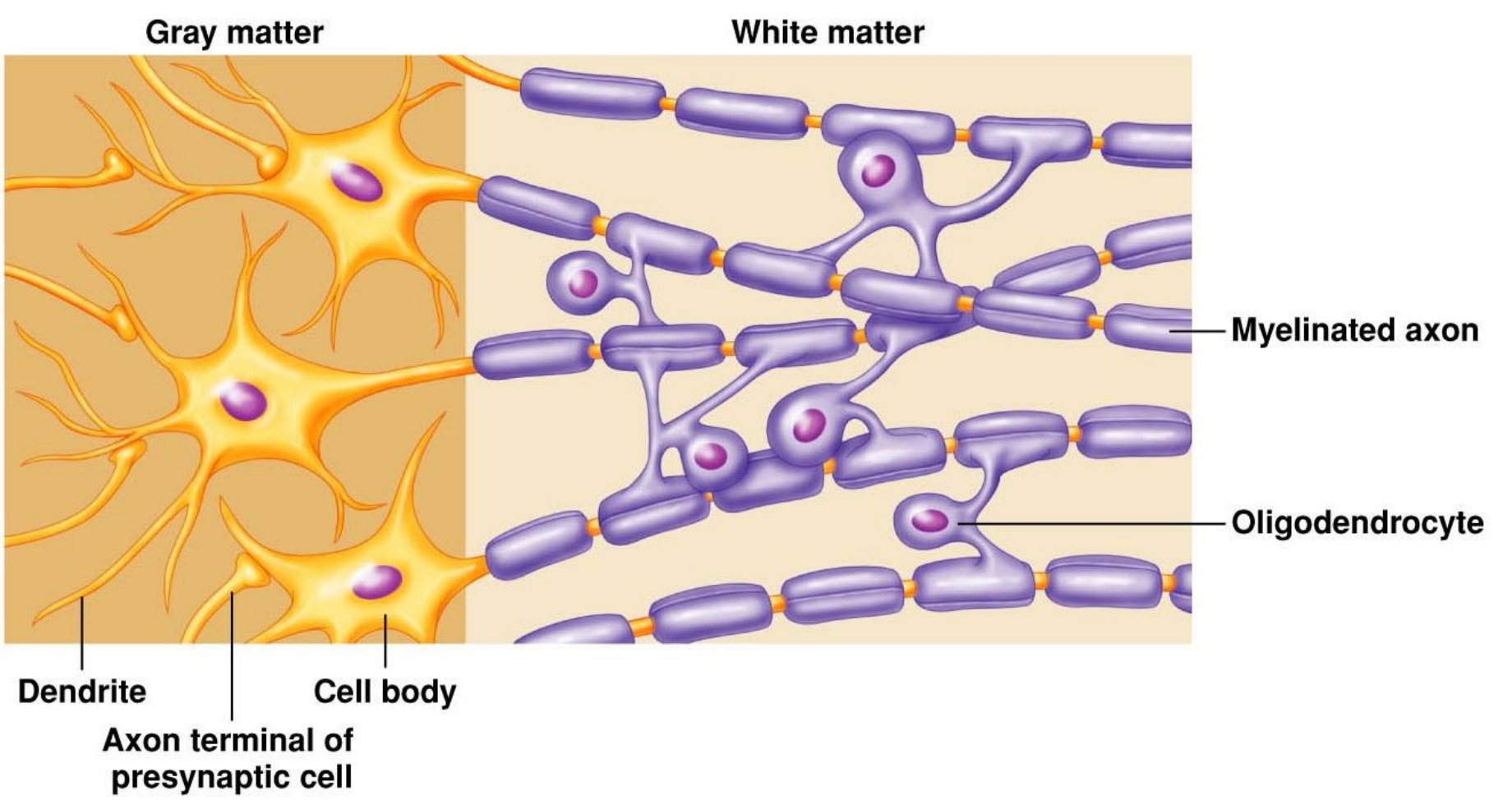
Neuroglia

- Neuroglia, or glial cells constitute the other major cellular component of the nervous tissue.
- They are specialized cells that maintain the other important components of the nervous system. Unlike neurons, ***neuroglia does not have a direct role in information processing*** but ***it is essential for normal functions of neuronal cells.***

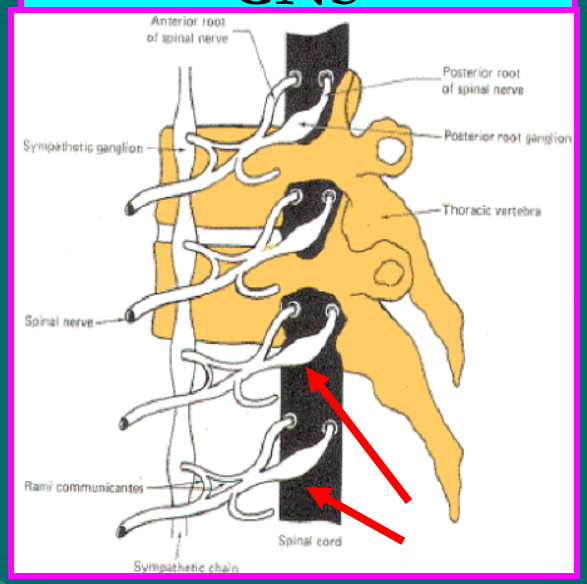
Nervous tissue is organized as:

Gray matter, formed mainly of: Cell bodies (+ dendrites) and Neuroglia

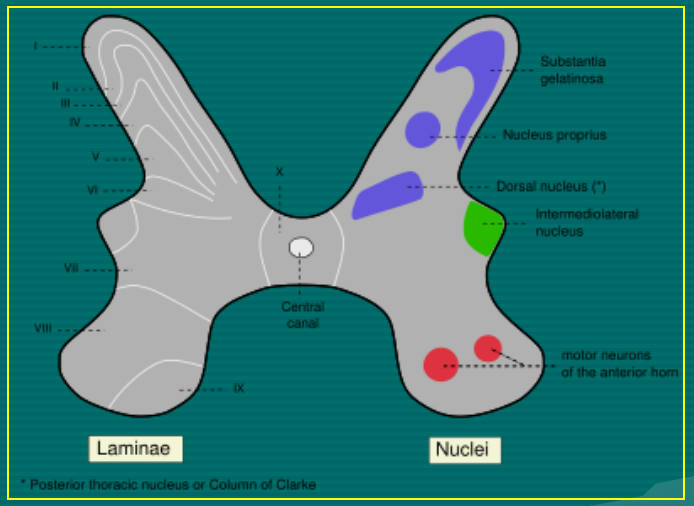
White matter, formed mainly of: Myelinated Axons and Neuroglia



Ganglion= A group of cell bodies outside the CNS

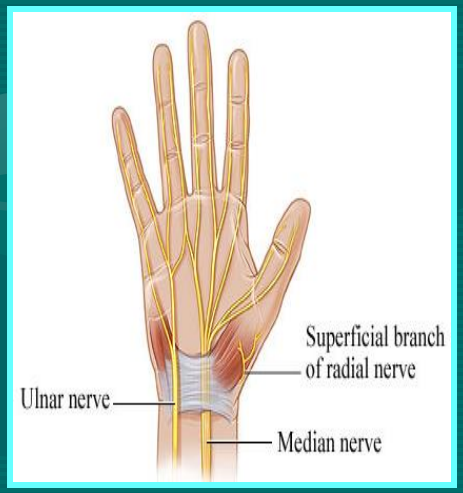


Nucleus= A group of cell bodies within the CNS

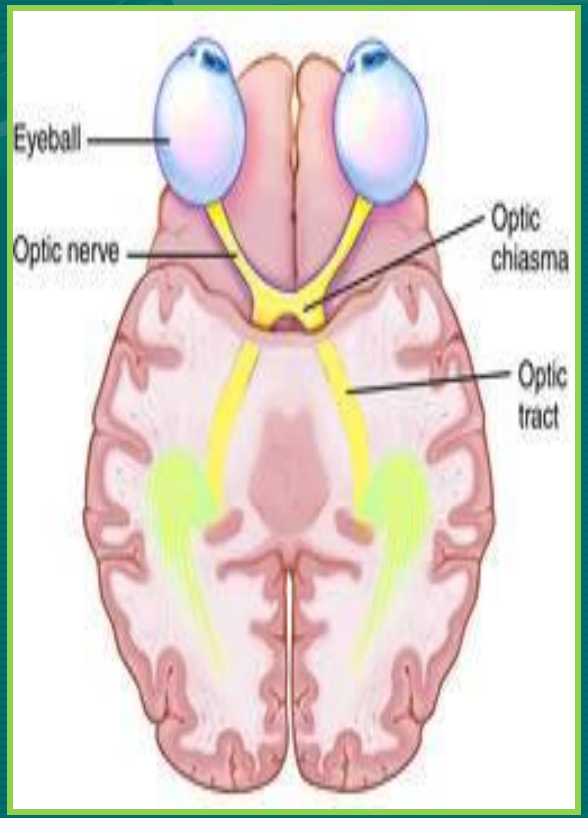


Remember...

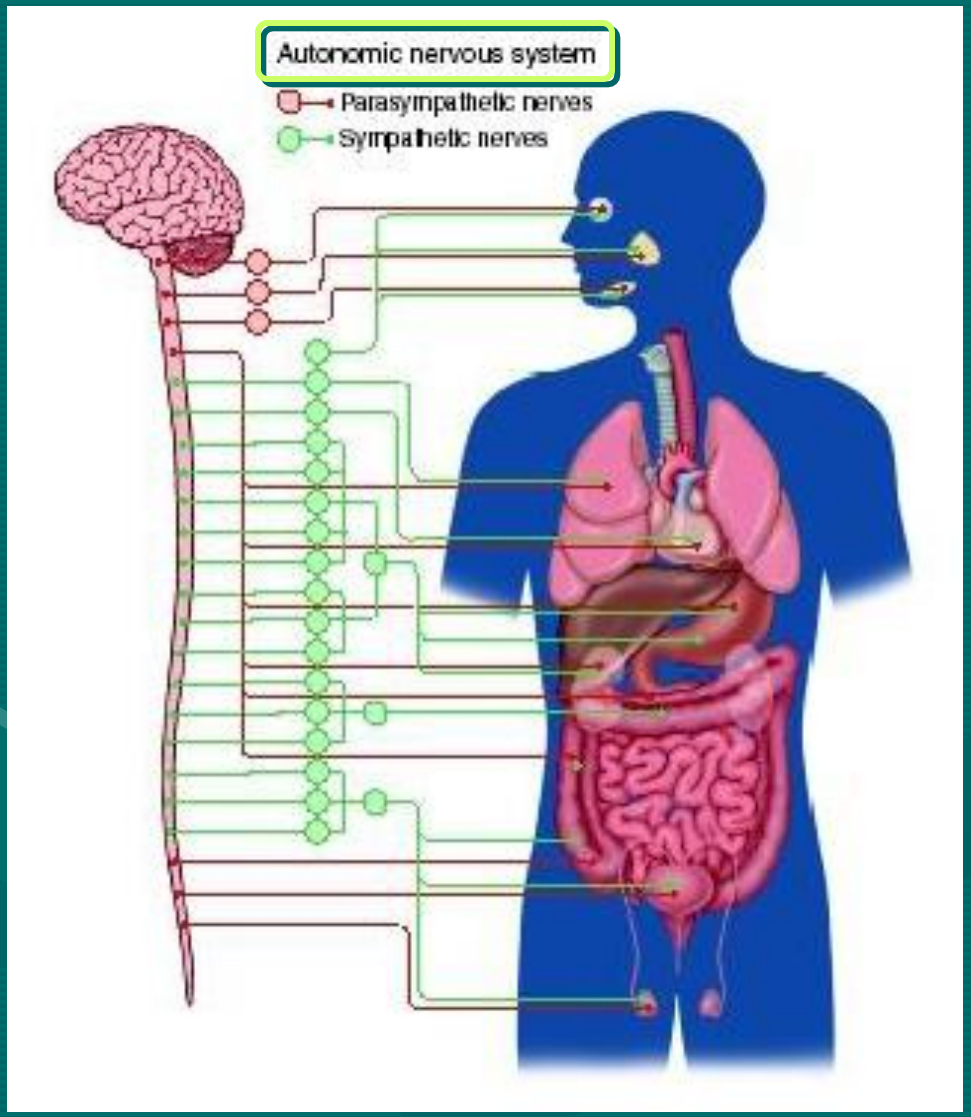
Nerve =A group of nerve fibers (axons) outside the CNS



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

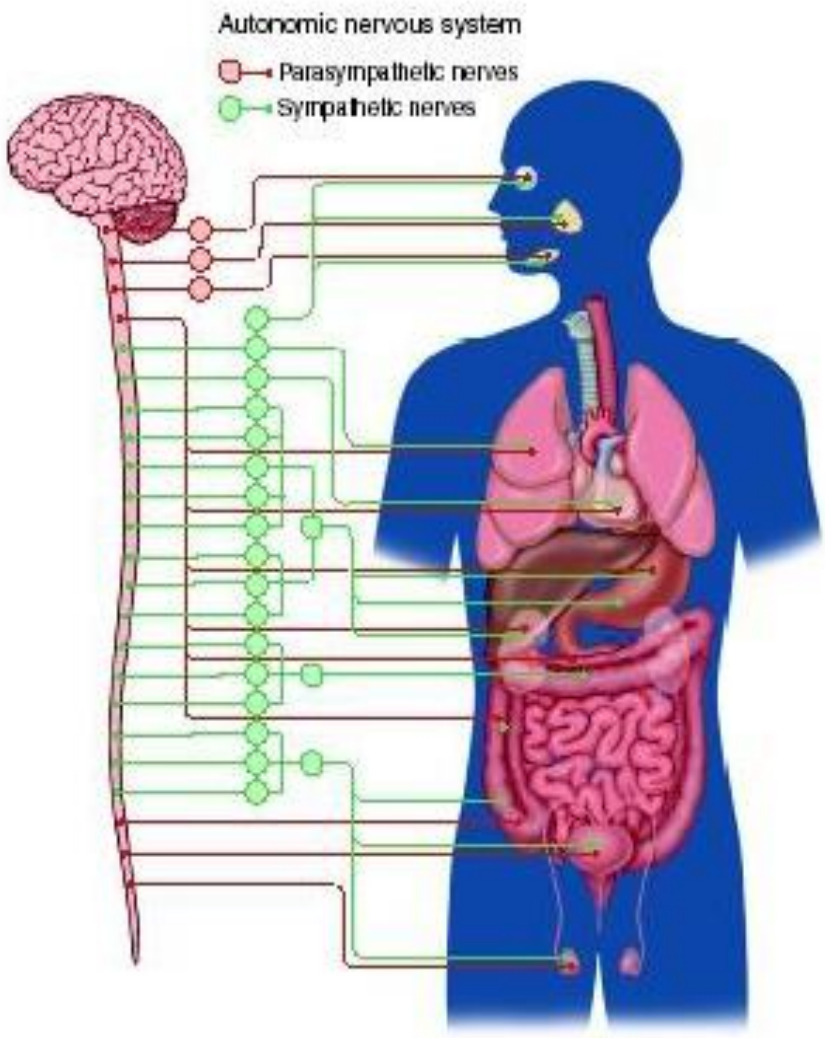


Autonomic Nervous System

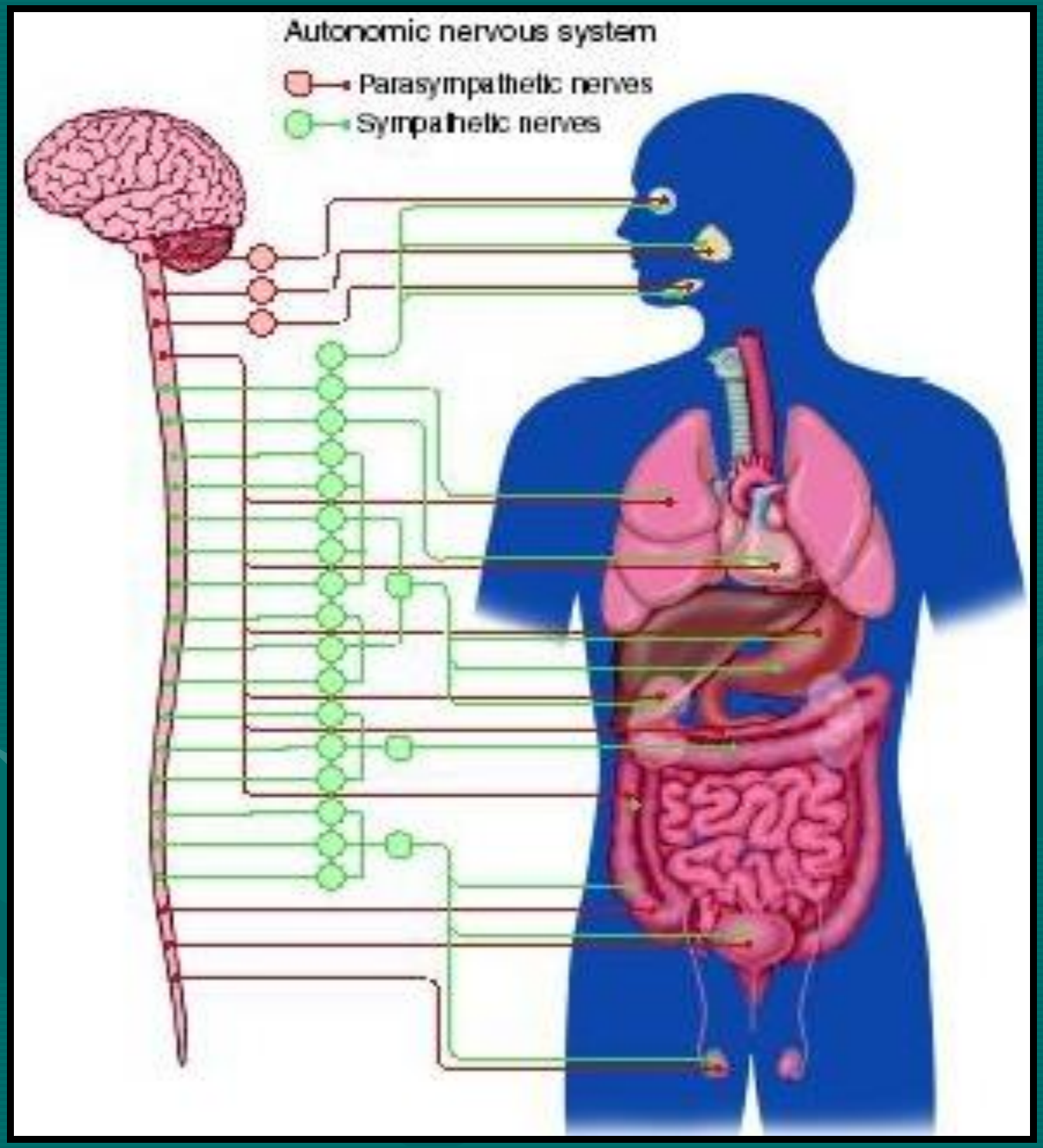


- Neurons that innervate **involuntary structures.**
- Its components are **present in both the central and peripheral nervous systems.**

SYMPATHETIC & PARASYMPATHETIC SYSTEMS



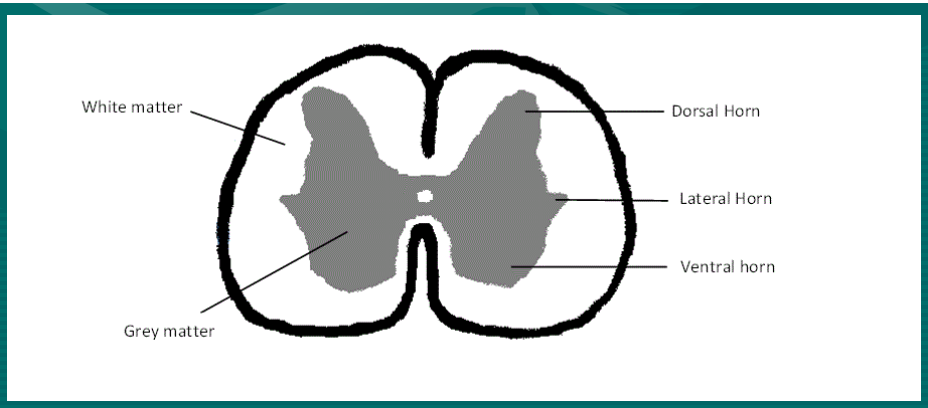
- The autonomic nervous system is divided into two anatomically and functionally distinct parts:
- **Sympathetic:** Or
- **Thoracolumbar outflow**
- **Parasympathetic**: Or
- **Craniosacral outflow**
- **Sympathetic** and **parasympathetic** , divisions are generally have **antagonistic** effects on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

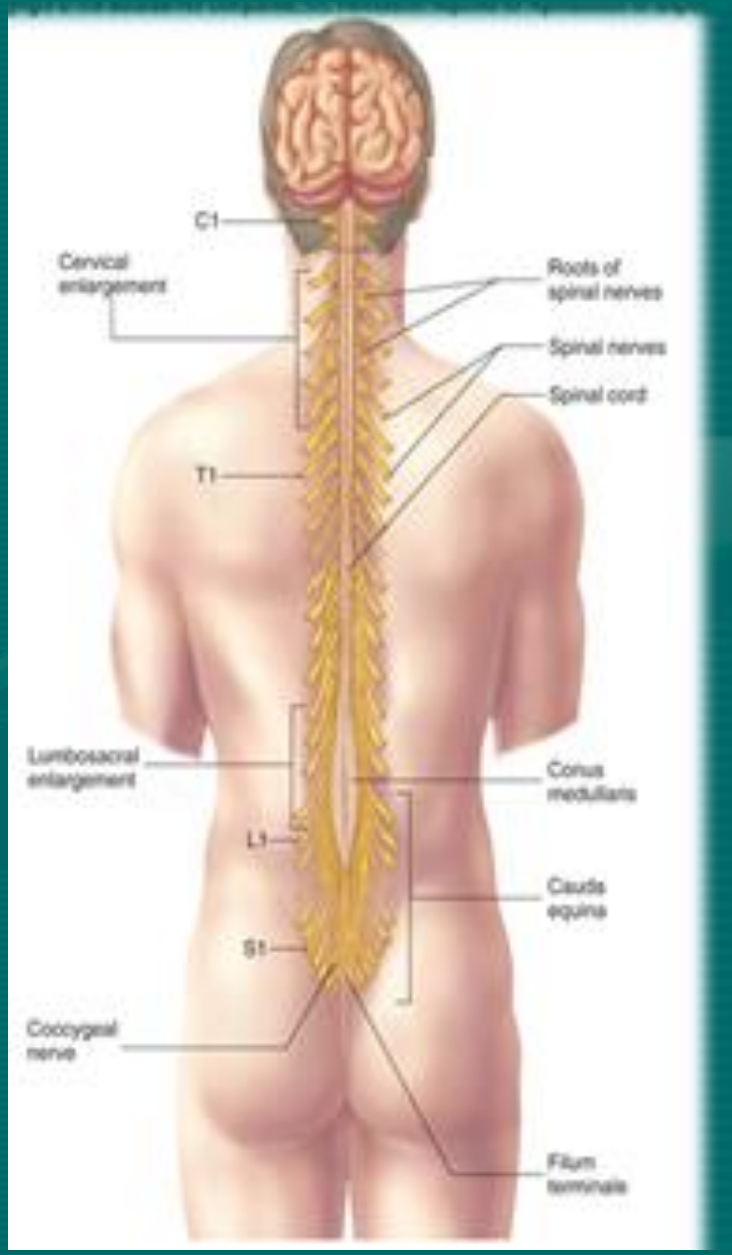


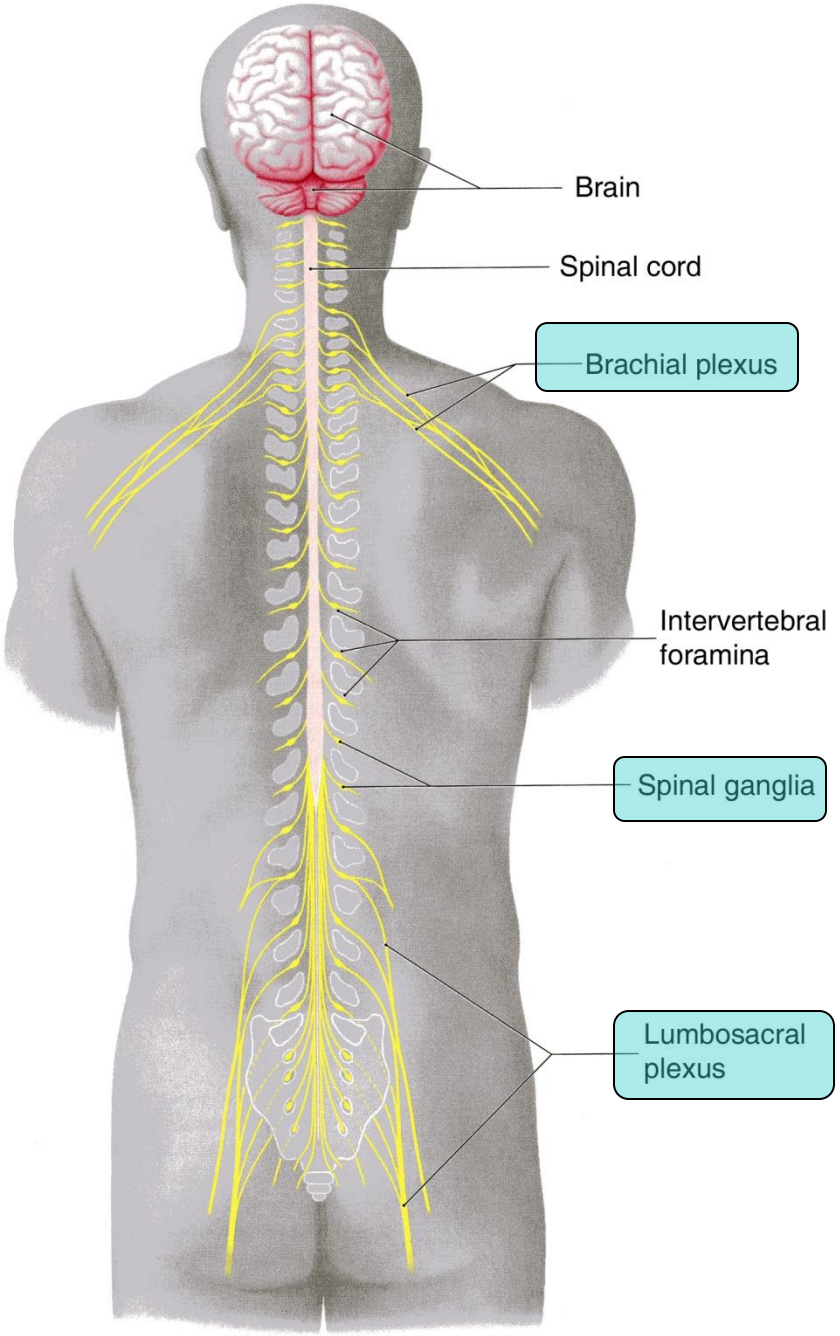
- <u>The autonomic nervous system **innervates:**</u>
- Smooth muscles,
- Cardiac muscle,
- Secretory glands.
- It is an important part of **the homeostatic mechanisms** that control the internal environment of the body.

Spinal Cord

- It is **cylindrical** in shape.
- **In adult**, it is **45 cm long** and extends from **the foramen magnum** to **the level of the disc between the 1st and the 2nd lumbar vertebrae**.
- **It is continuous above with the medulla oblongata.**
- Its lower end is called **conus medullaris**.
- It has a cavity called **central canal**.
- It is composed of **an inner gray matter** and **an outer white matter**.





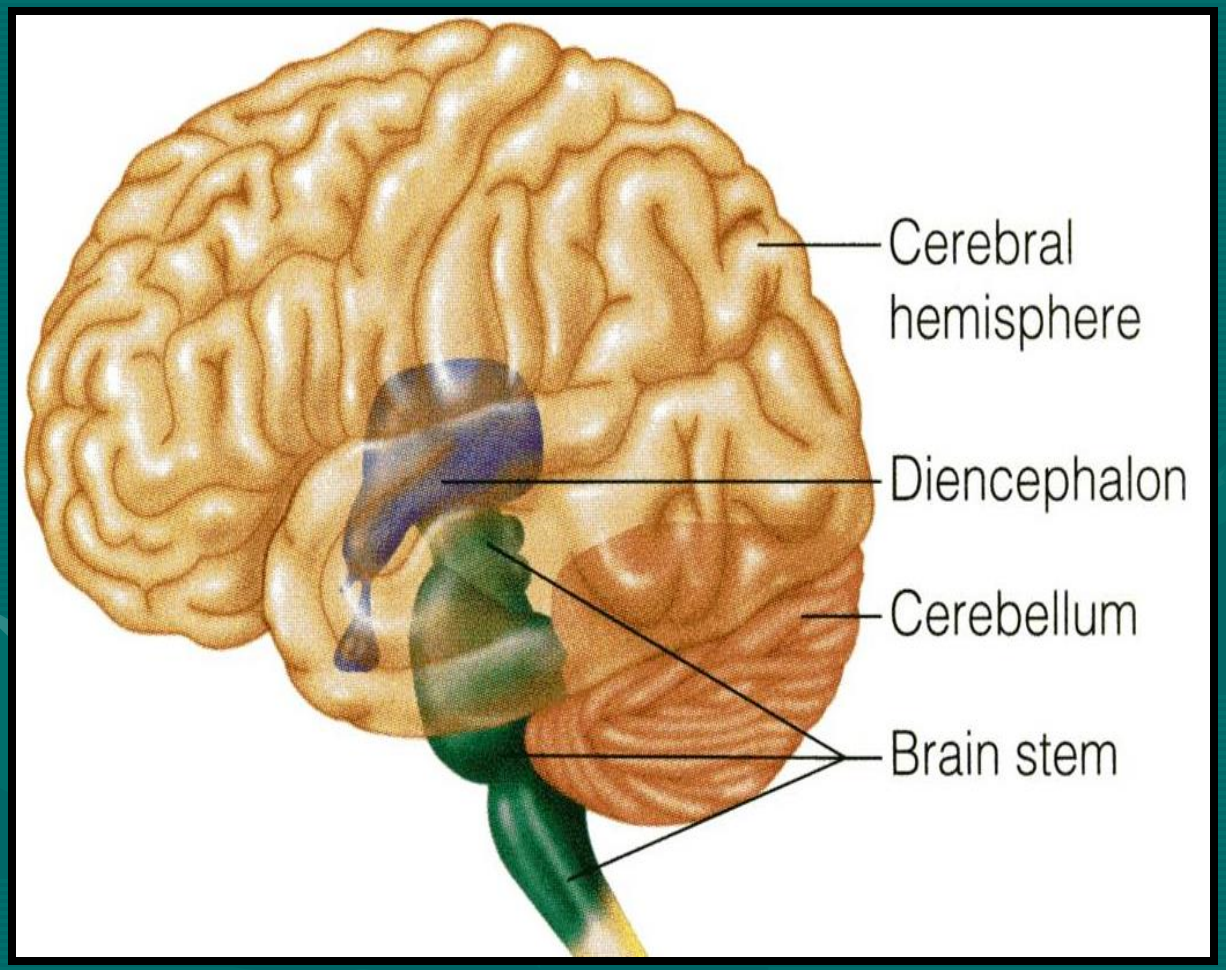


- The spinal cord gives rise to **31 pairs** of spinal nerves:

  8 Cervical, **12** Thoracic, **5** Lumbar, **5** Sacral and **ONE** Coccygeal.

- Spinal nerves **supplying the upper limb** form **the brachial plexus.**
- Spinal nerves **supplying the lower limb** form **the lumbosacral plexus.**

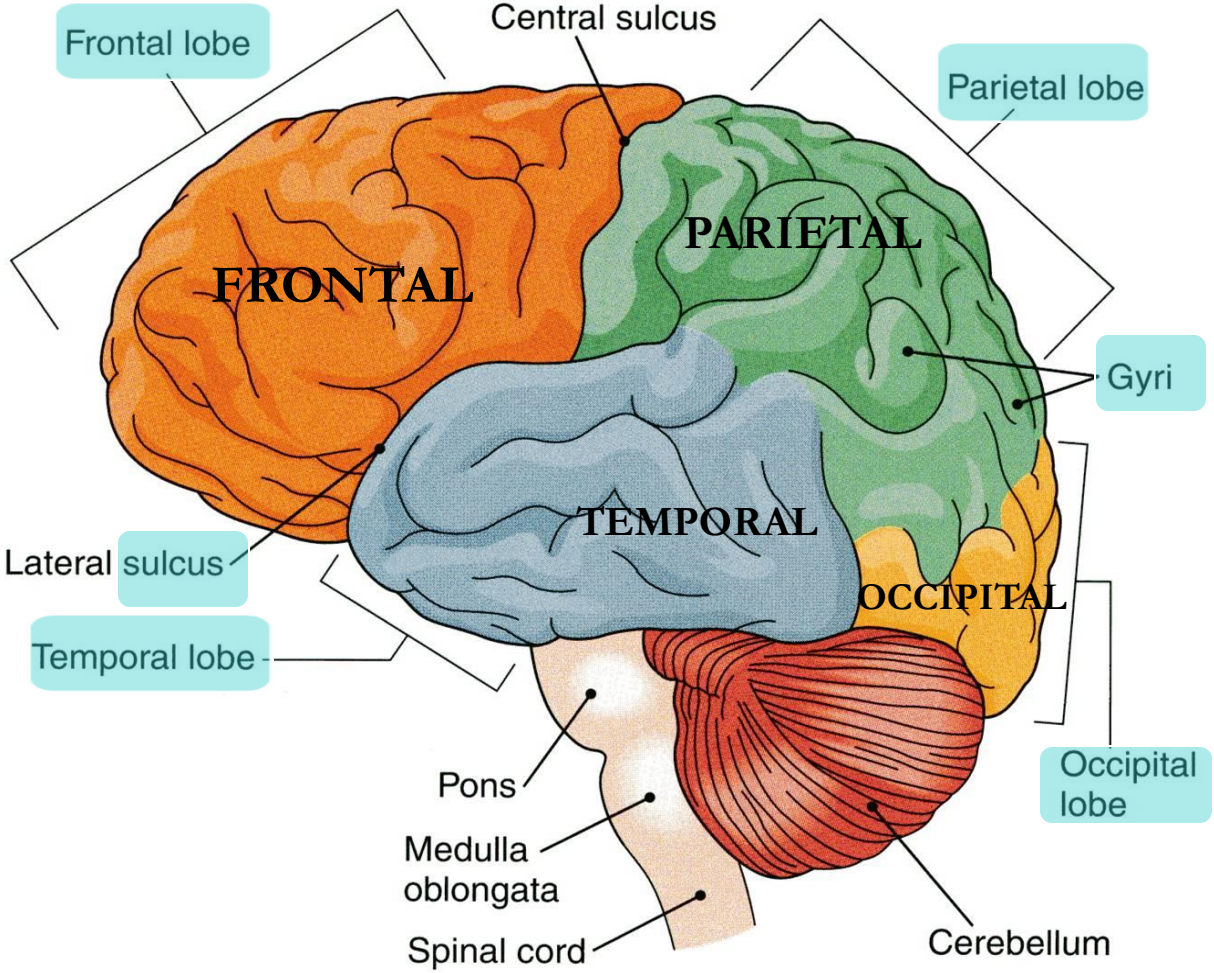
PARTS OF THE BRAIN



- **The brain is composed of:**

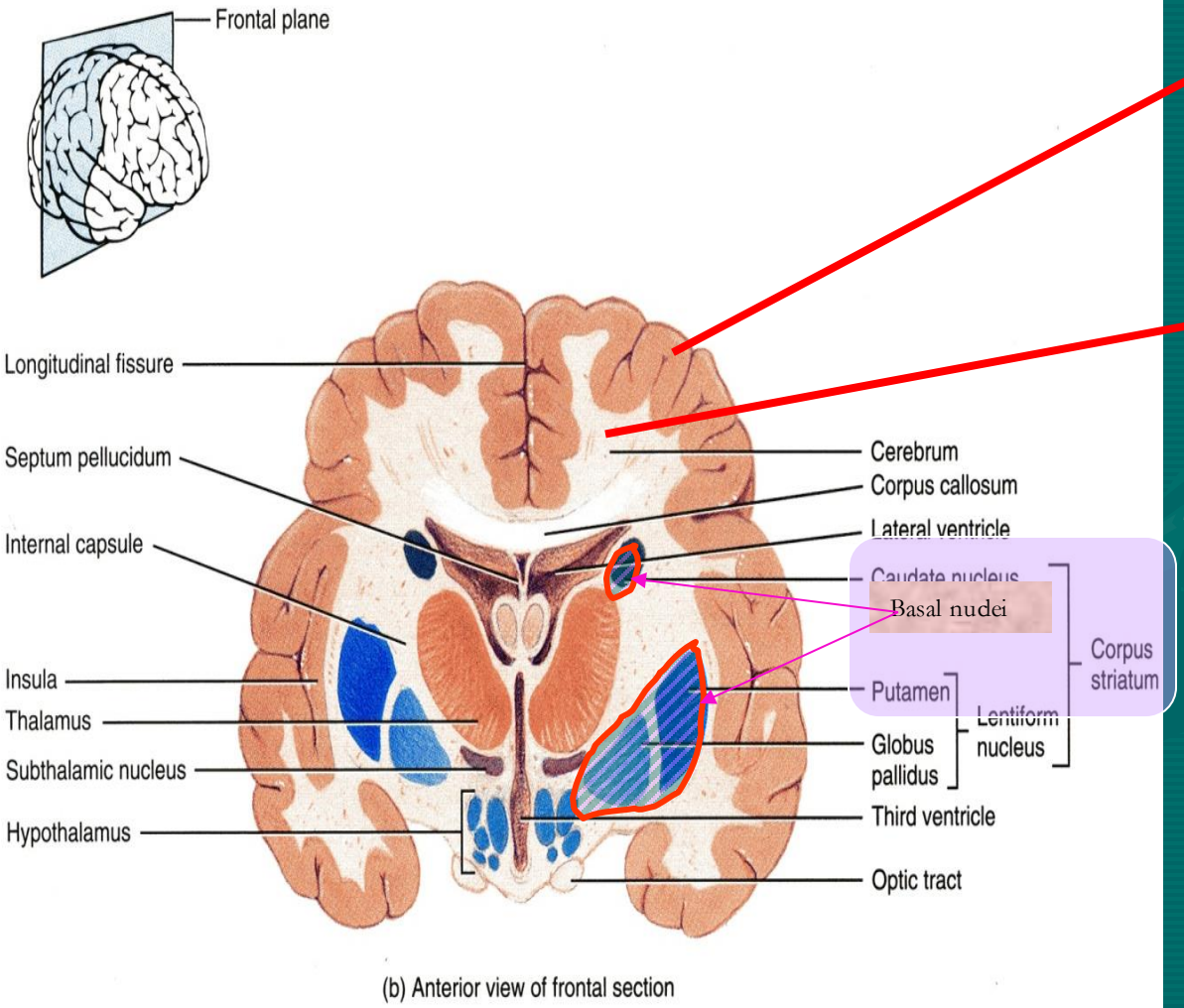
1. Cerebrum.
2. Diencephalon.
3. Cerebellum.
4. Brain stem.

CEREBRUM



- The largest & highest part of the brain.
- Composed of 2 hemispheres connected by a thick bundle of nerve fibers (corpus callosum)
- Its surface shows elevations, called (gyri) separated by depressions (sulci).
- Each hemisphere is divided into 4 lobes named according to the bone above.

TISSUE OF THE CEREBRAL HEMISPHERES

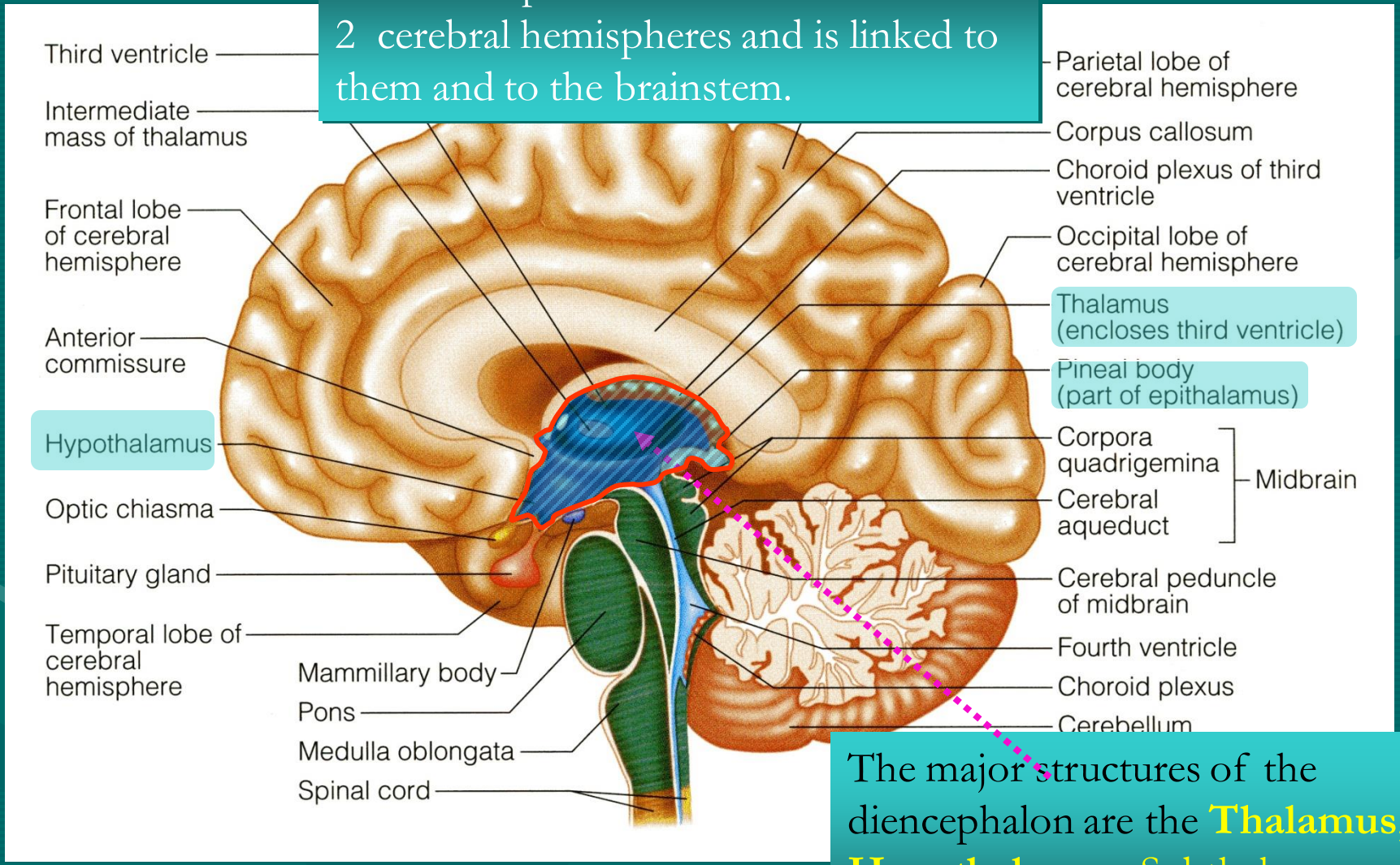


(b) Anterior view of frontal section

- **The outer layer** is the **gray matter** or **cortex formed of nuclei.**
- The inner layer is the **white matter** or **medulla composed of tracts** carrying impulses **to and from** the cortex.
- **Basal nuclei: gray matter located within the white matter.**

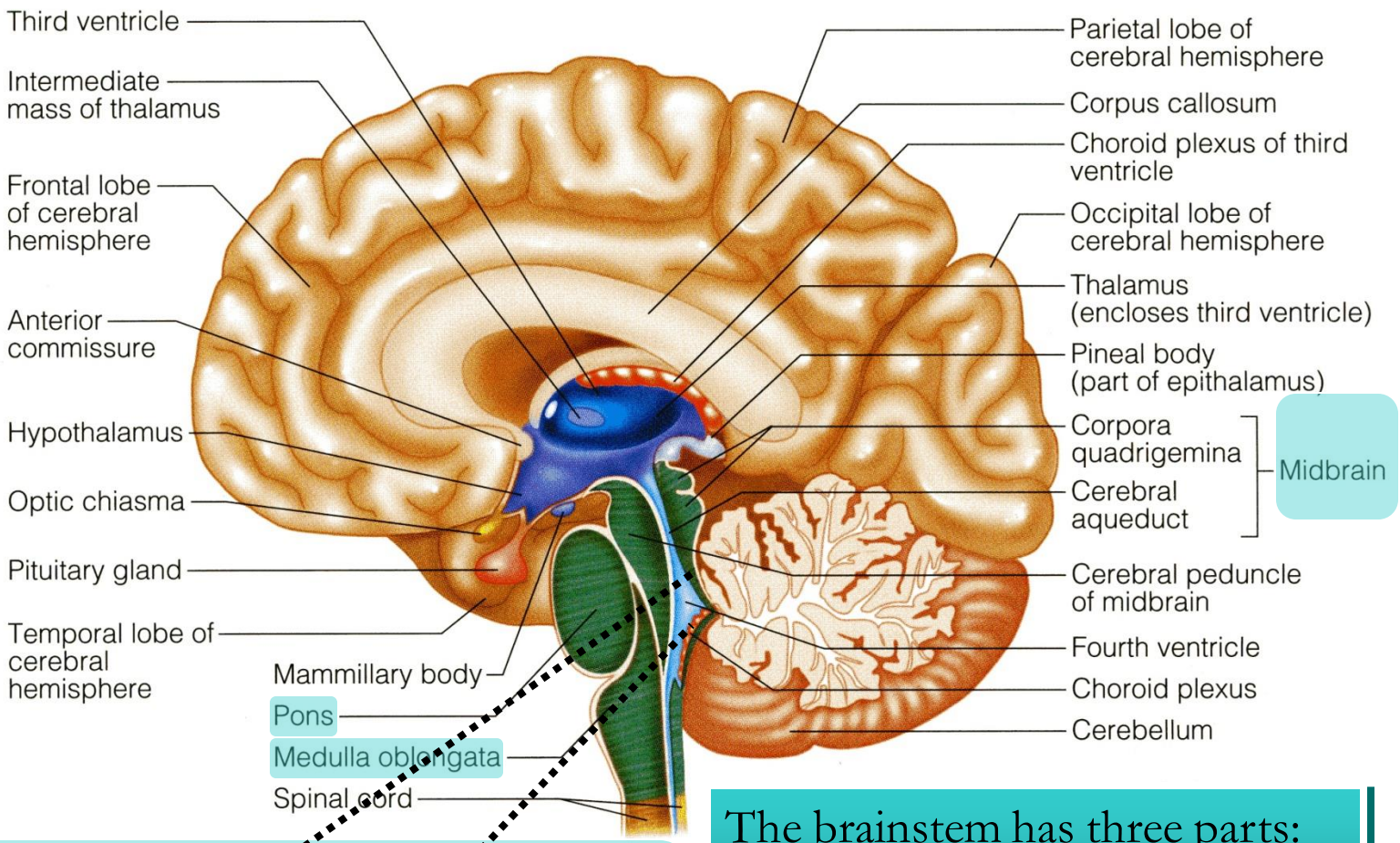
DIENCEPHALON

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**.

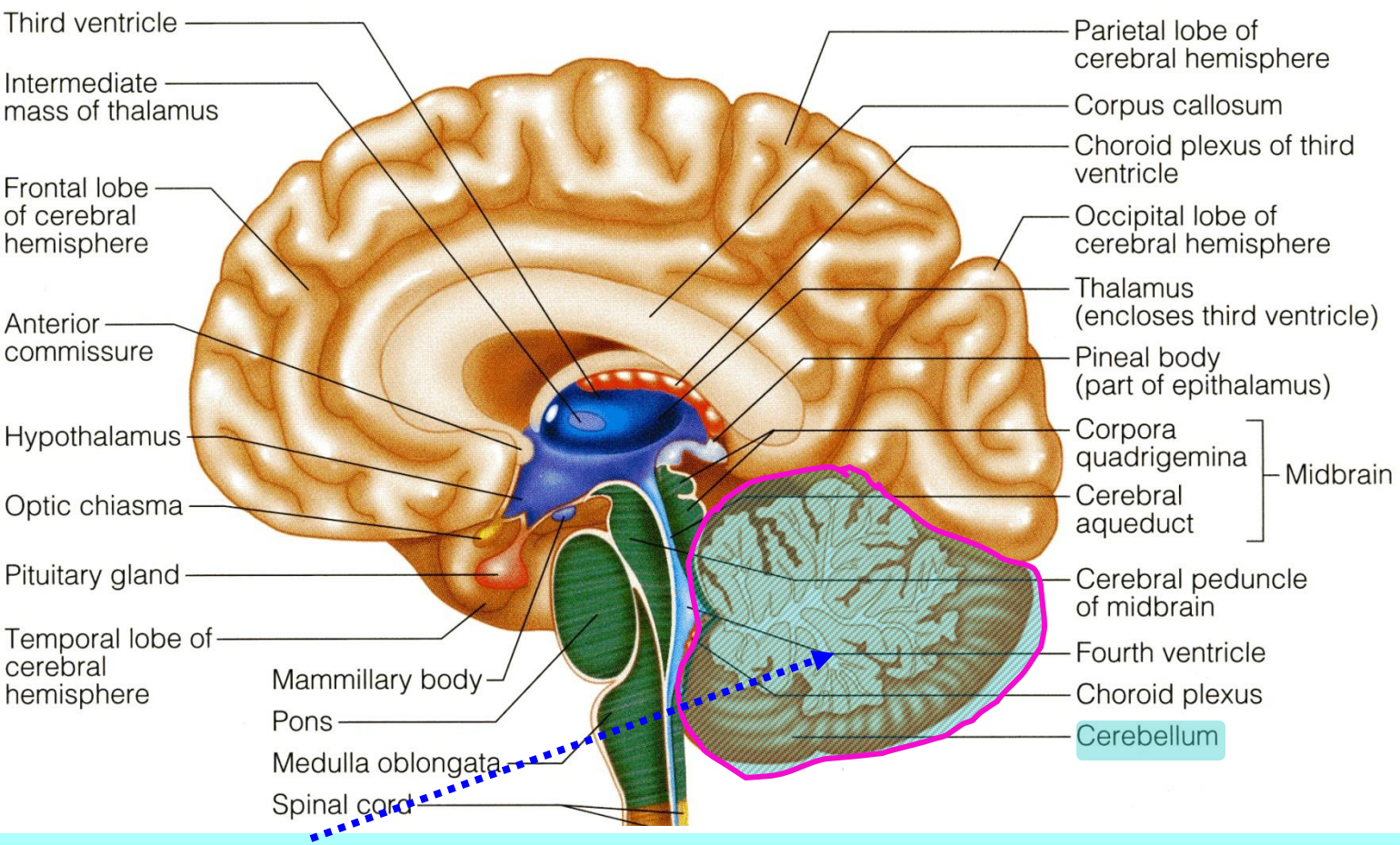
BRAIN STEM



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

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

CEREBELLUM



Cerebellum has 2 cerebellar hemispheres with convoluted surface.
Each hemisphere has an outer cortex of gray matter, an inner medulla of white matter and deep cerebellar nuclei (gray matter located within the medulla).
It provides precise coordination for body movements and helps maintain equilibrium.

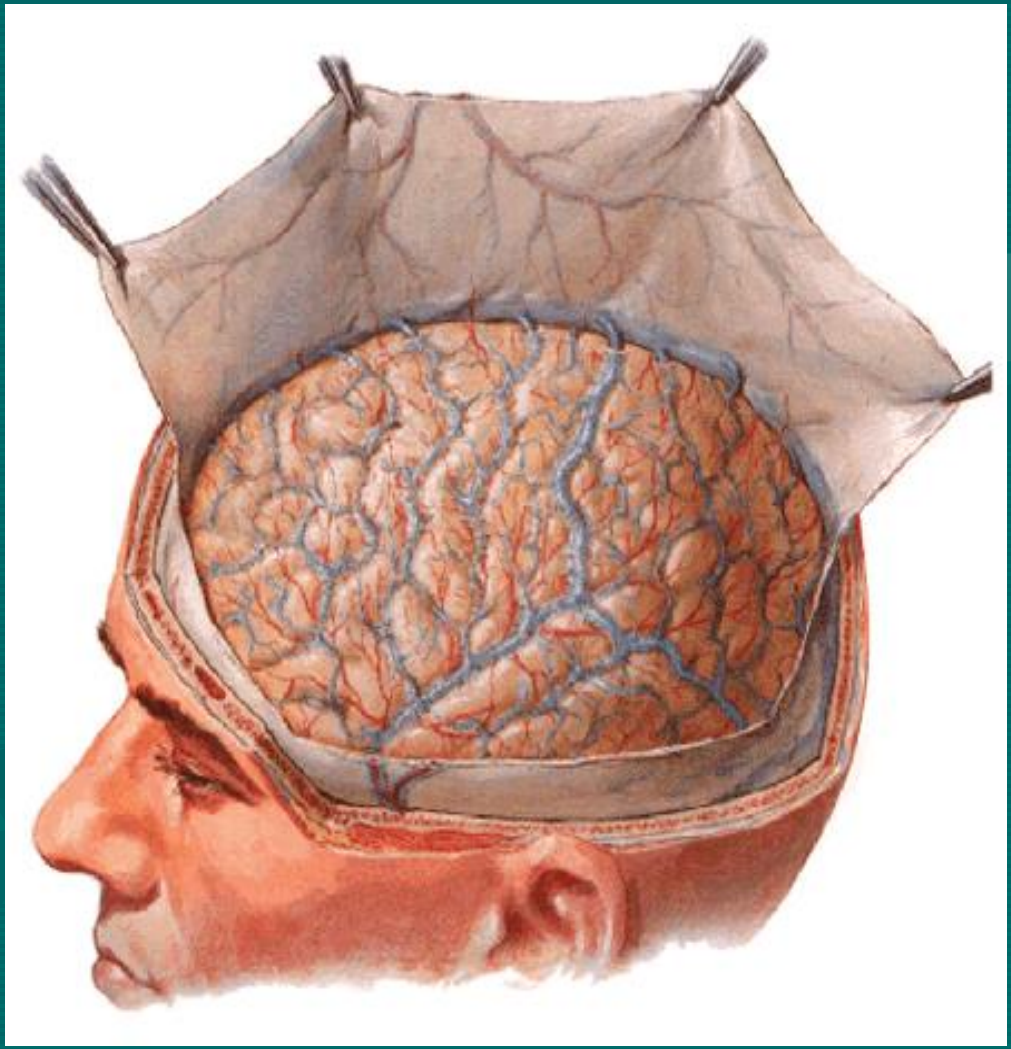
MENINGES

- There are three membranes investing the brain and the spinal cord.
- These are, from outward to inward,

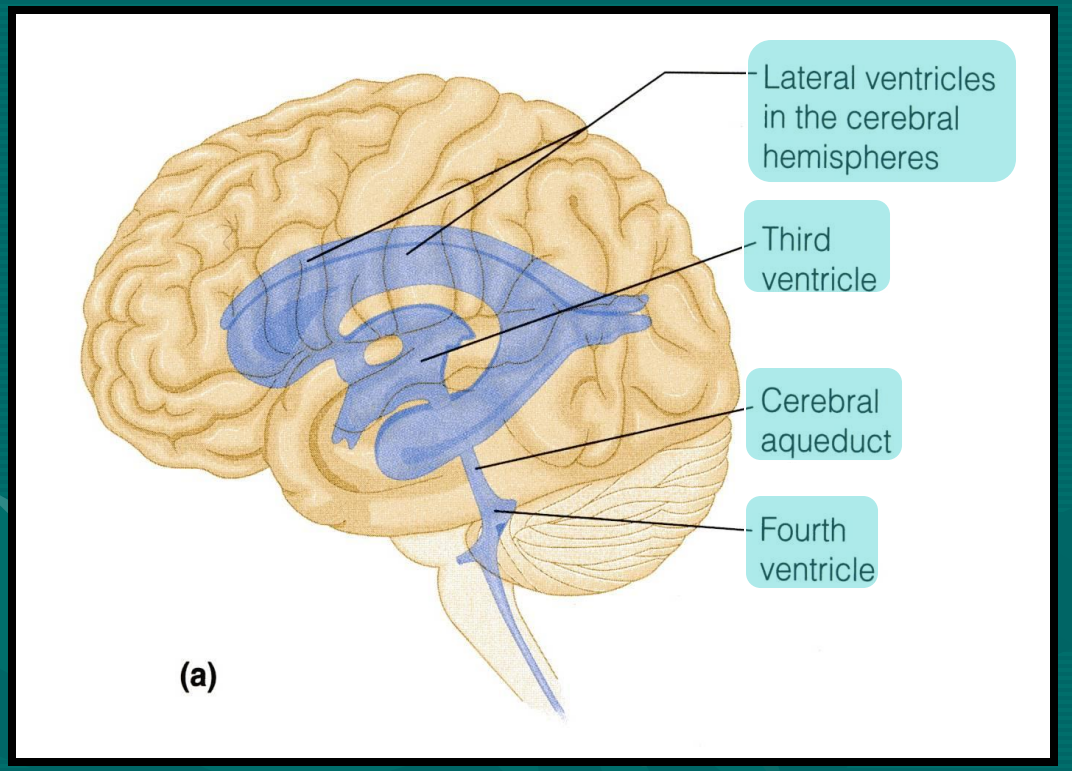
1- Dura mater.

2- Arachnoid mater.

3- Pia mater.



BRAIN VENTRICLES



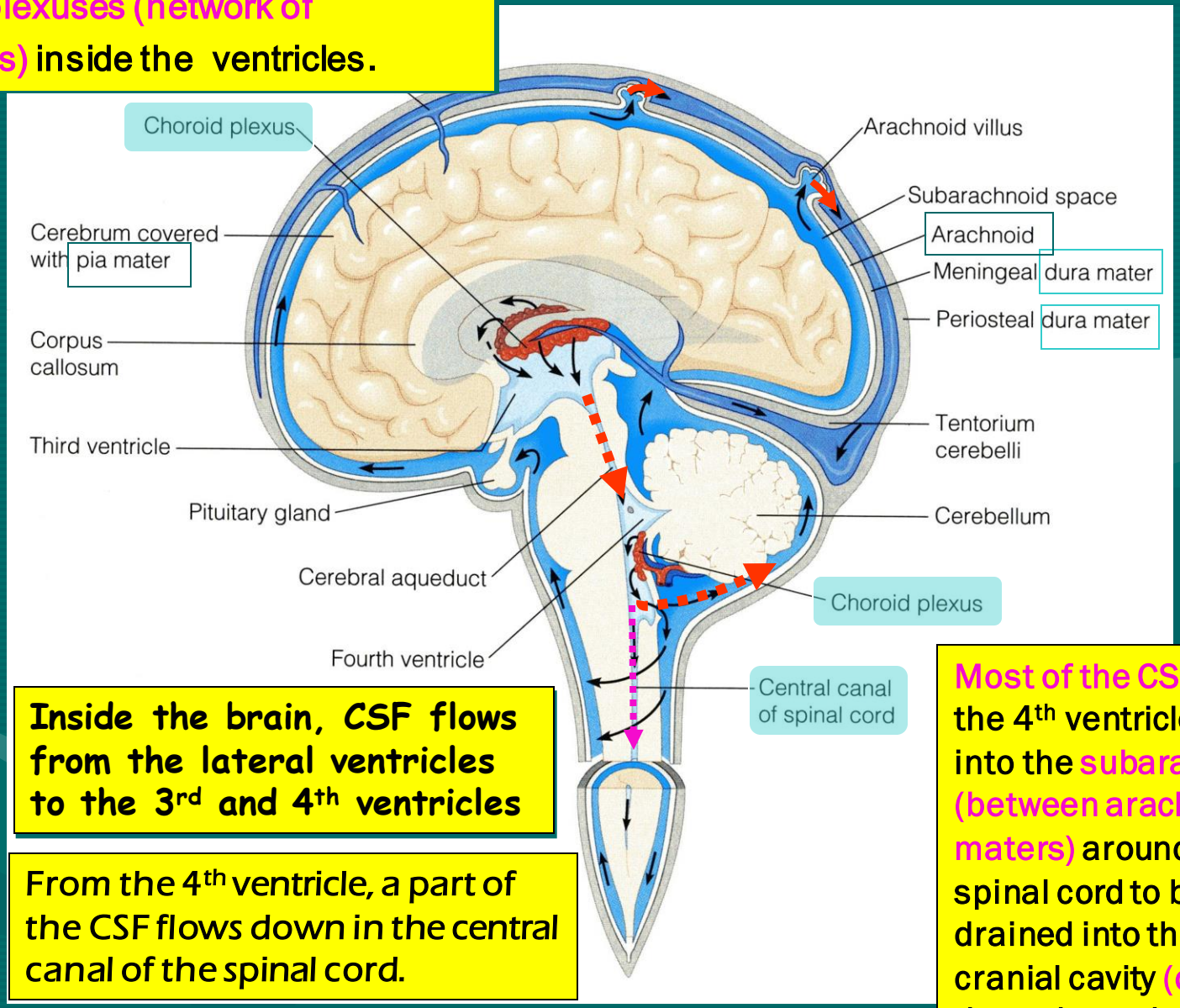
- Inside the brain, there are **4 large cavities (ventricles)** filled with CSF.
- The 4 ventricles are:
  - **2 lateral ventricles:**
    One in each hemispheres.
  - **3rd ventricle:**
    in the Diencephalon.
  - **4th ventricle:**
    between Pons, Medulla oblongata & Cerebellum.

N.B.:

- **Cerebral aqueduct (in the midbrain):** connects 3rd & 4th ventricle.
- The 4th ventricle is continuous with central canal of spinal cord.

CEREBROSPINAL FLUID

CSF is constantly produced by the choroid plexuses (network of capillaries) inside the ventricles.



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

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

Most of the CSF drains from the 4th ventricle and flows into the subarachnoid space (between arachnoid & pia maters) around the brain & spinal cord to be finally drained into the veins of the cranial cavity (dural sinuses) through arachnoid villi.

THANK YOU AND GOOD LUCK