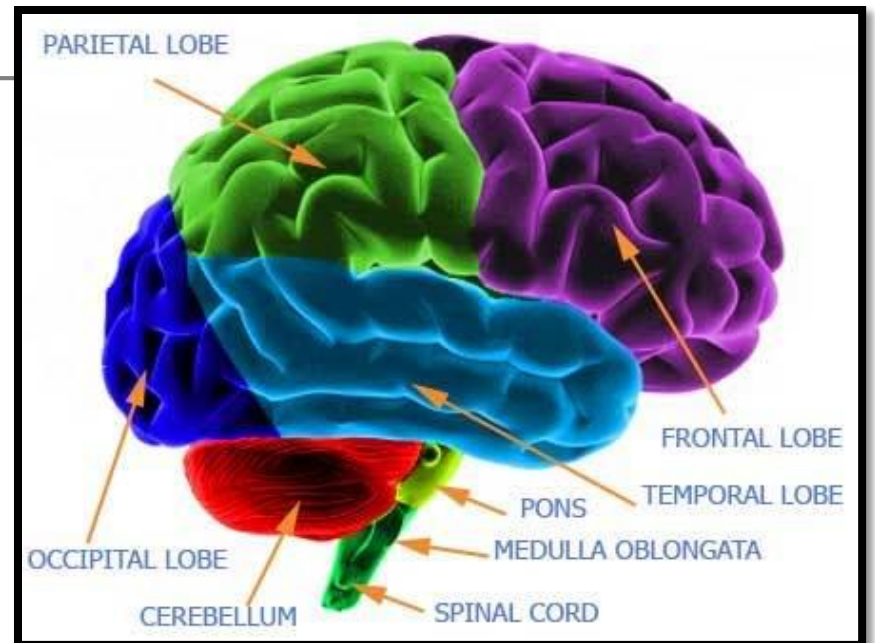


# The Nervous System

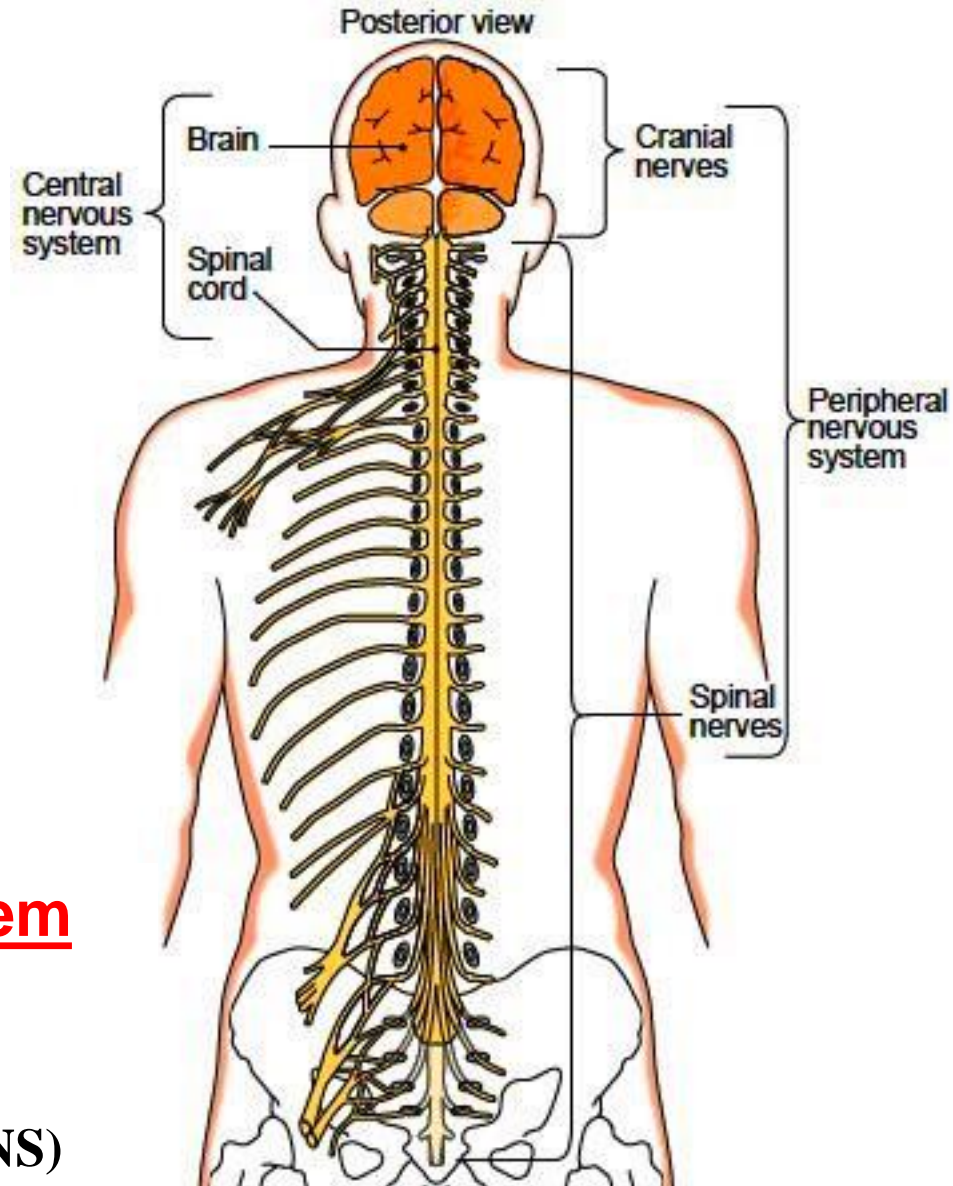


# Overview

- The nervous system is the system that **controls** the various functions of the body by the means of **electrical impulses (action potential)**
- In comparison, the endocrine system controls various functions of the body by means of **chemical substances (hormones)**

## Divisions of the nervous system

1. **Central Nervous System (CNS)**
2. **Peripheral Nervous System (PNS)**

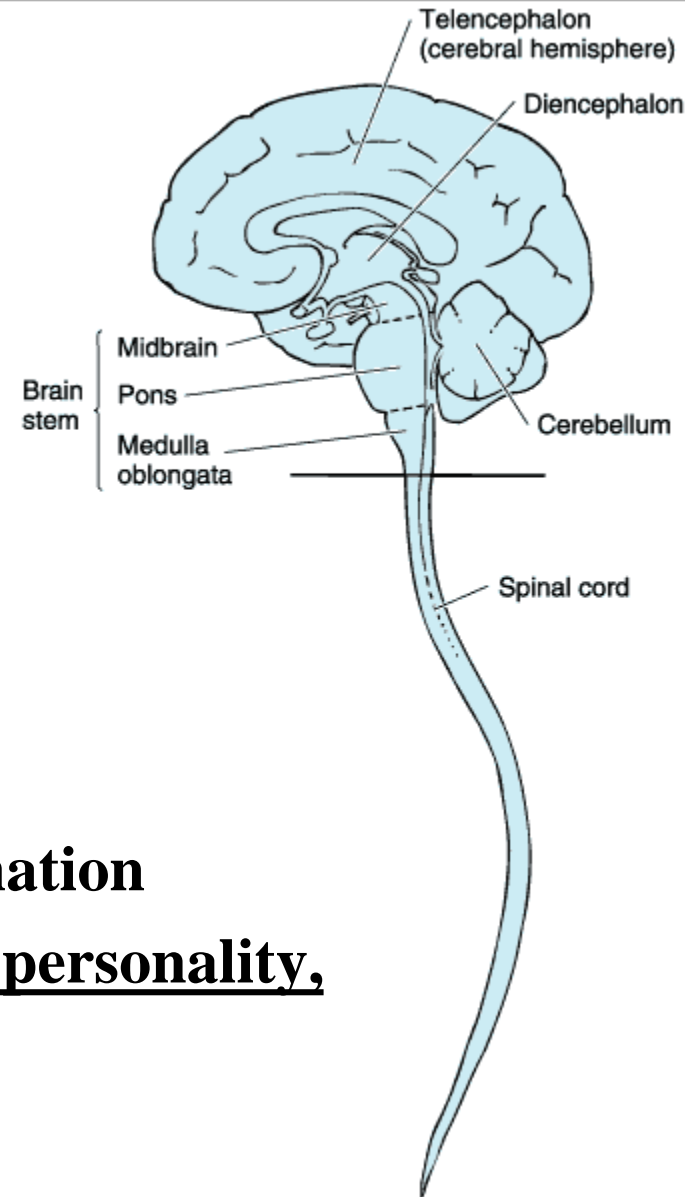


# 1- The Central Nervous System (CNS)

- Formed of the brain and spinal cord
- Formed of millions of nerve cells (**neurons**) and supporting cells (**glia** cells or **neuroglia** cells)
- Well protected within the skull and vertebral column

## ■ **Functions:**

1. Initiates motor commands
2. Receives and perceives sensory information
3. Responsible for our emotions, personality, behavior, memory and others



## 2- The Peripheral Nervous System (PNS)

**Components of the PNS include all nervous tissue outside the CNS:**

**A. Nerves** (cranial **12** and spinal **31**): a bundle of hundreds to thousands of axons of **sensory** and/or **motor neurons**

**B. Ganglia** are collection of neurons outside the central nervous system (neuron cell bodies)

**C. Sensory receptors** are parts of neurons or specialized structures that can detect changes in the internal or external environment

- **Skin:** pain, touch and heat receptors
- **Eye:** Photoreceptors
- **Nose:** Olfactory receptors
- **Muscle:** Golgi tendon organ

**D. Enteric plexuses (GIT)**

It consists of extensive networks of neurons located in the walls of organs of the gastrointestinal tract.

**CNS:**

Brain

Spinal cord

**PNS:**

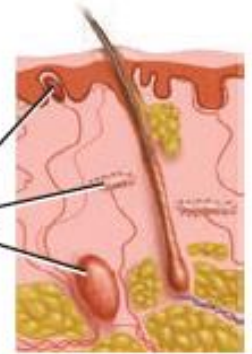
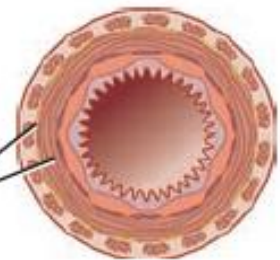
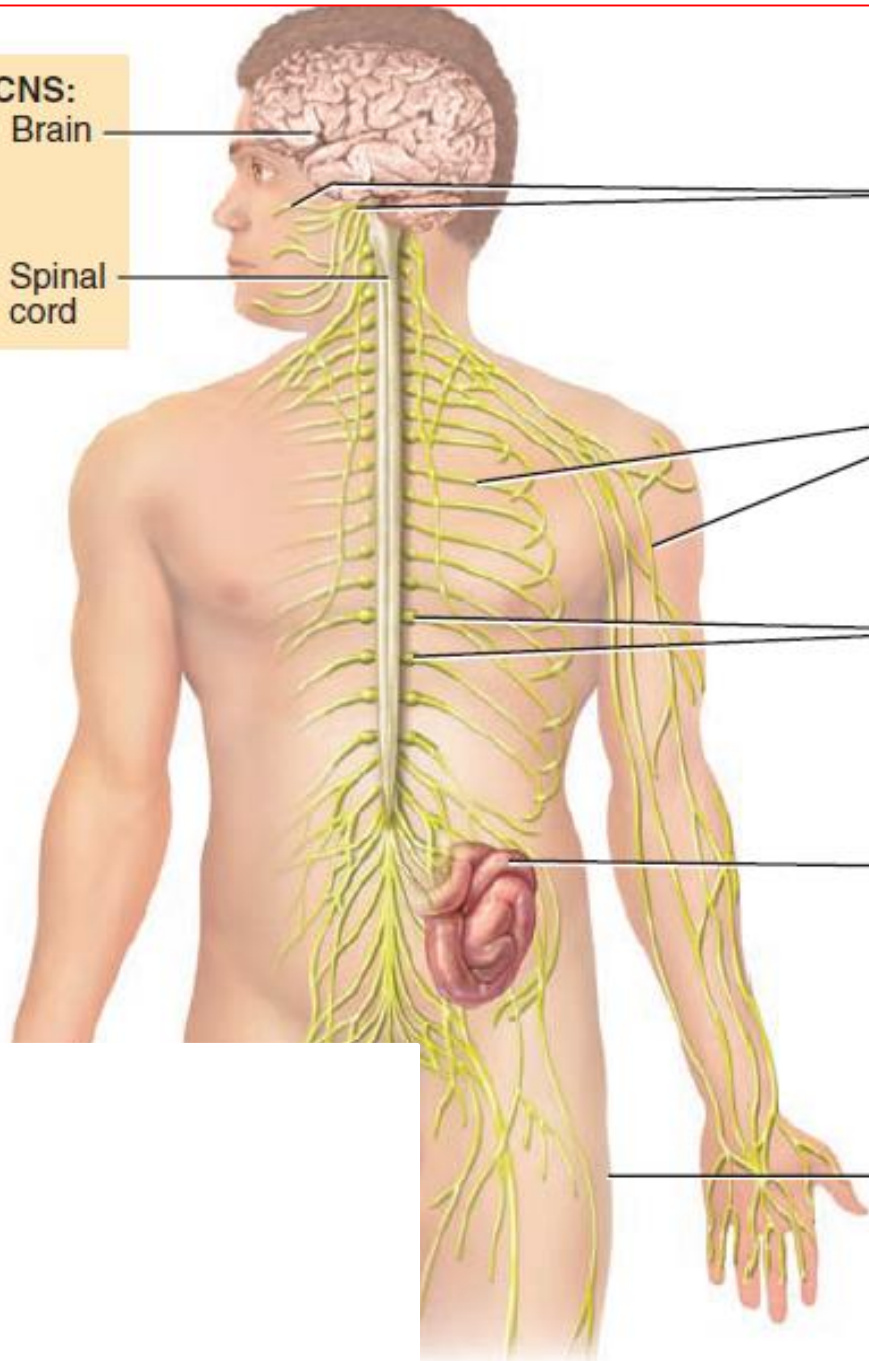
Cranial nerves

Spinal nerves

Ganglia

Enteric plexuses in small intestine

Sensory receptors in skin

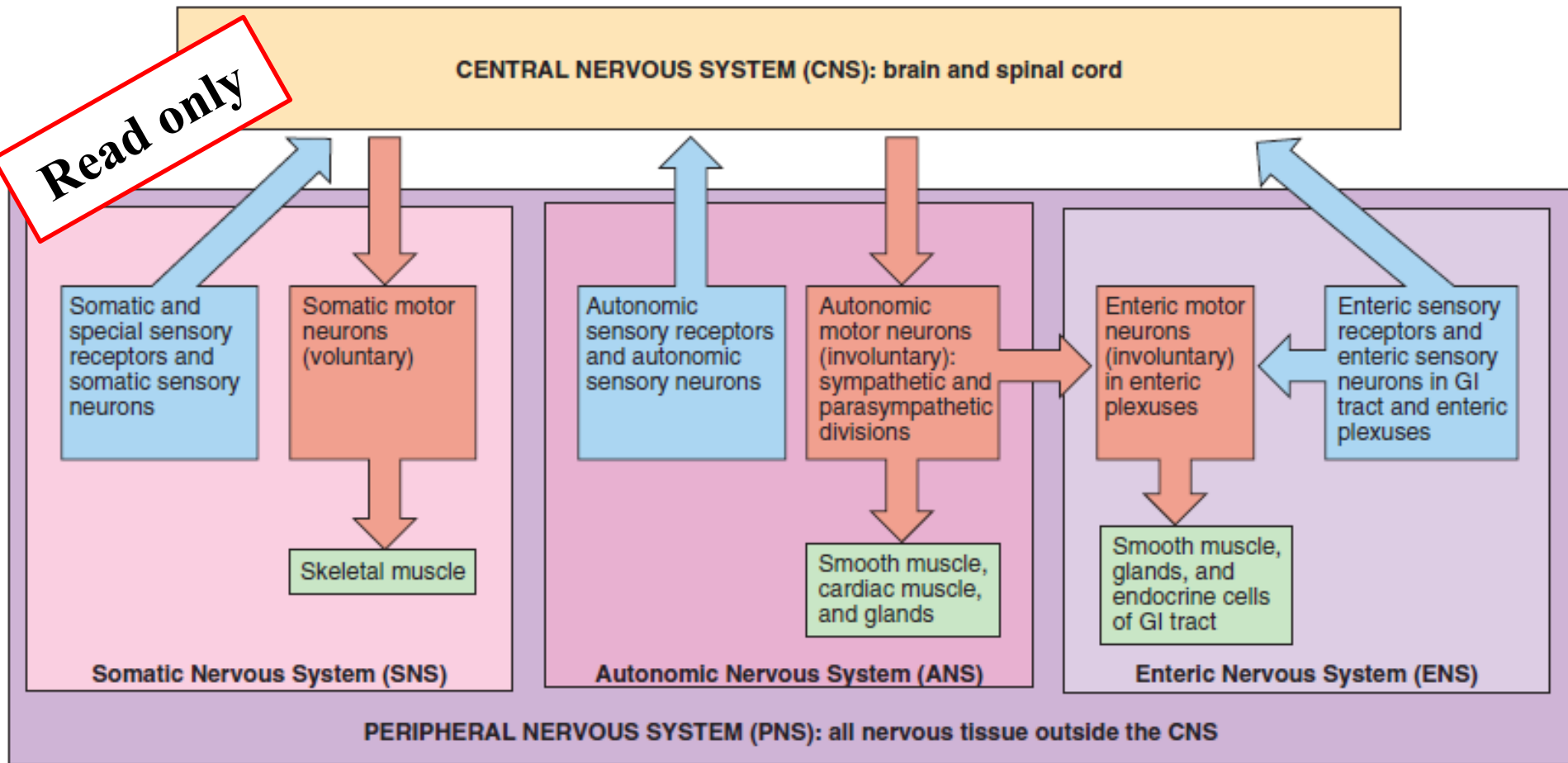


# Functionally, PNS can be divided into:

1. Somatic Nervous system SNS: connected to **skin, skeletal muscles, joints and the special senses (vision, hearing, taste, and smell)**. We are fully conscious of this part. Our voluntary movements (**Skeletal muscles**) and our sensation of pain and touch are controlled by this part
2. Autonomic Nervous System ANS: we are not conscious of this part, because it controls all of our involuntary actions, like our heart rate, respiratory rate and blood pressure (**Visceral organs**)
  - Acts on **smooth muscles, cardiac muscles and glands**.

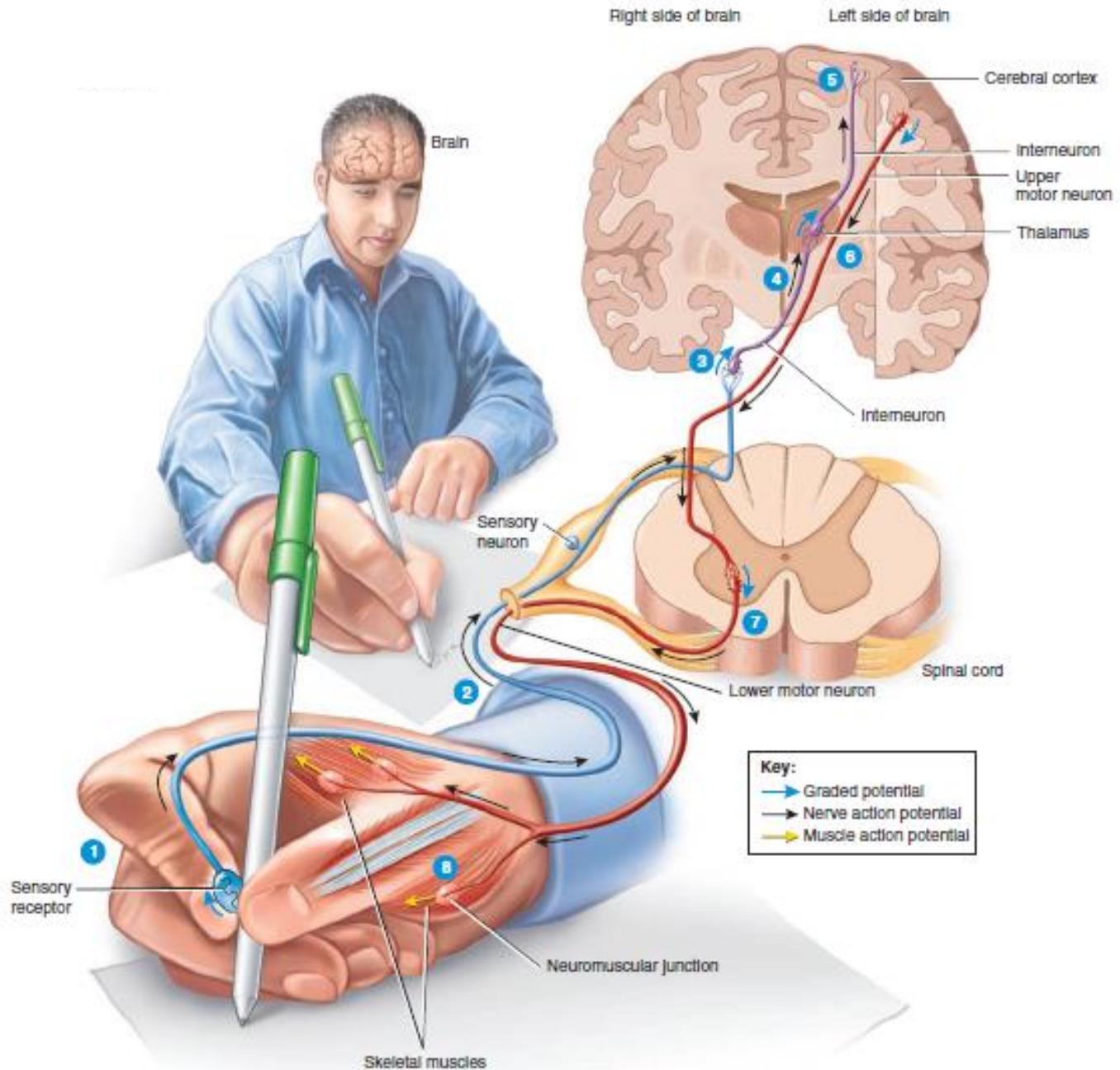
## Divided (motor part) into:

- A. **Sympathetic** helps support exercise of emergency actions, the “fight-or-flight” responses
  - B. **Parasympathetic** takes care of “rest-and-digest” activities.
3. Enteric part: controls the secretions and movements of the various parts of the digestive tract unconsciously



## Nervous system organizational chart

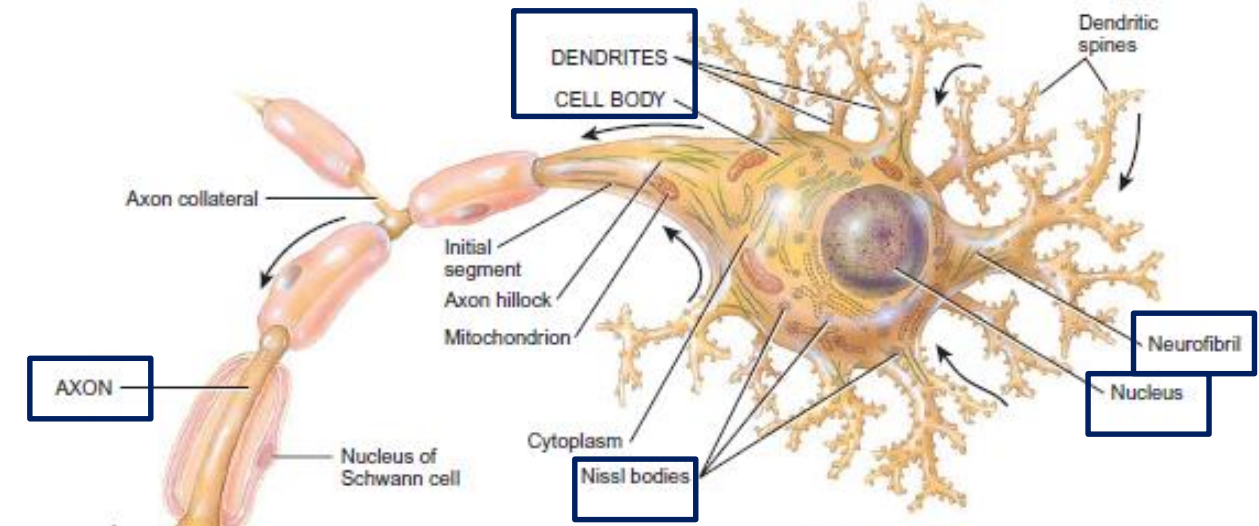
1. Blue boxes represent sensory components of the PNS
2. Red boxes represent motor components of the PNS
3. Green boxes represent effectors (muscles and glands).



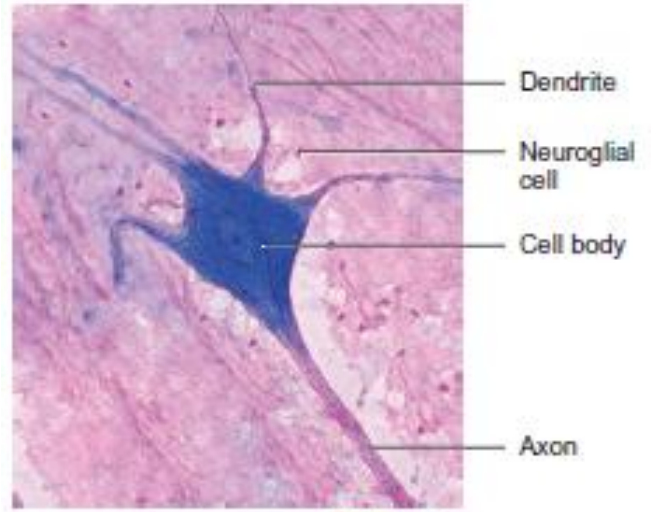
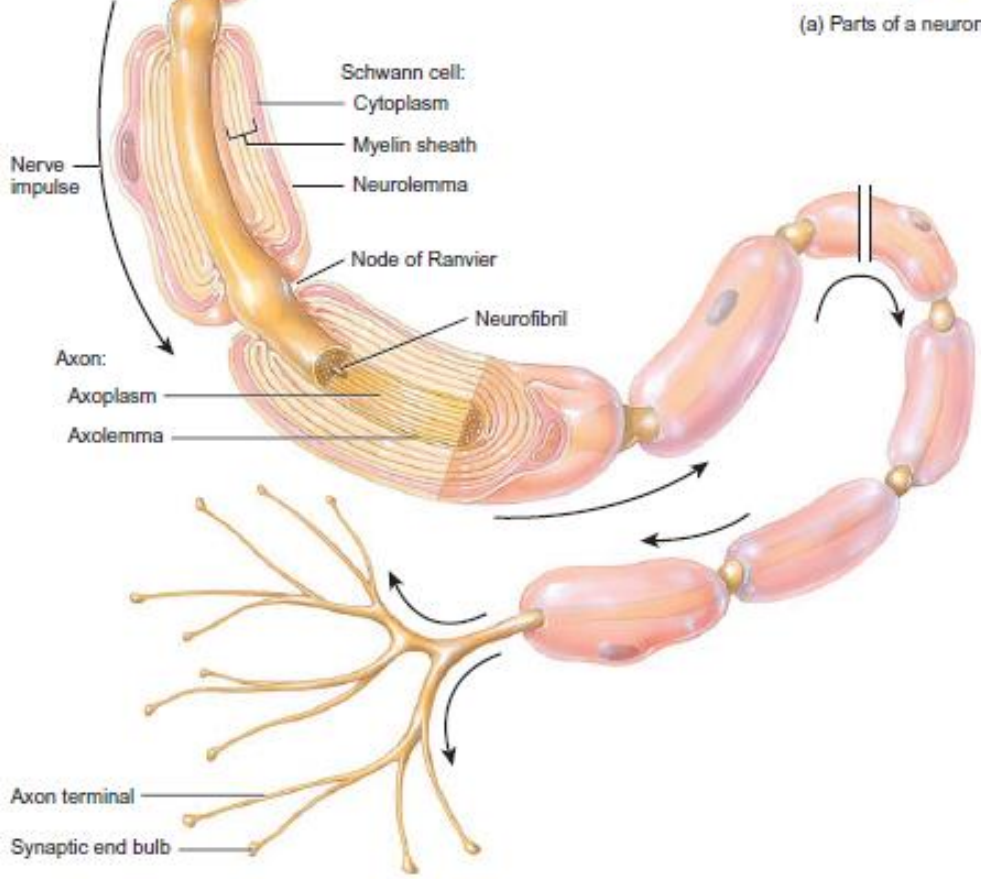


# Histology Of The Nervous System

- The nervous tissue is formed of two types of cells:
  1. The nerve cell – Neurons
  2. Supporting cells – Neuroglia or Glia cells
  
- In the nervous tissue there is ***no extracellular matrix***
- The space between the cells is called **neuropil** and is formed of the processes of both neurons and glia cells and some fluid
- ***Mature neurons cannot divide. A damaged neurons cannot be repaired and is replaced by fibrous tissue***



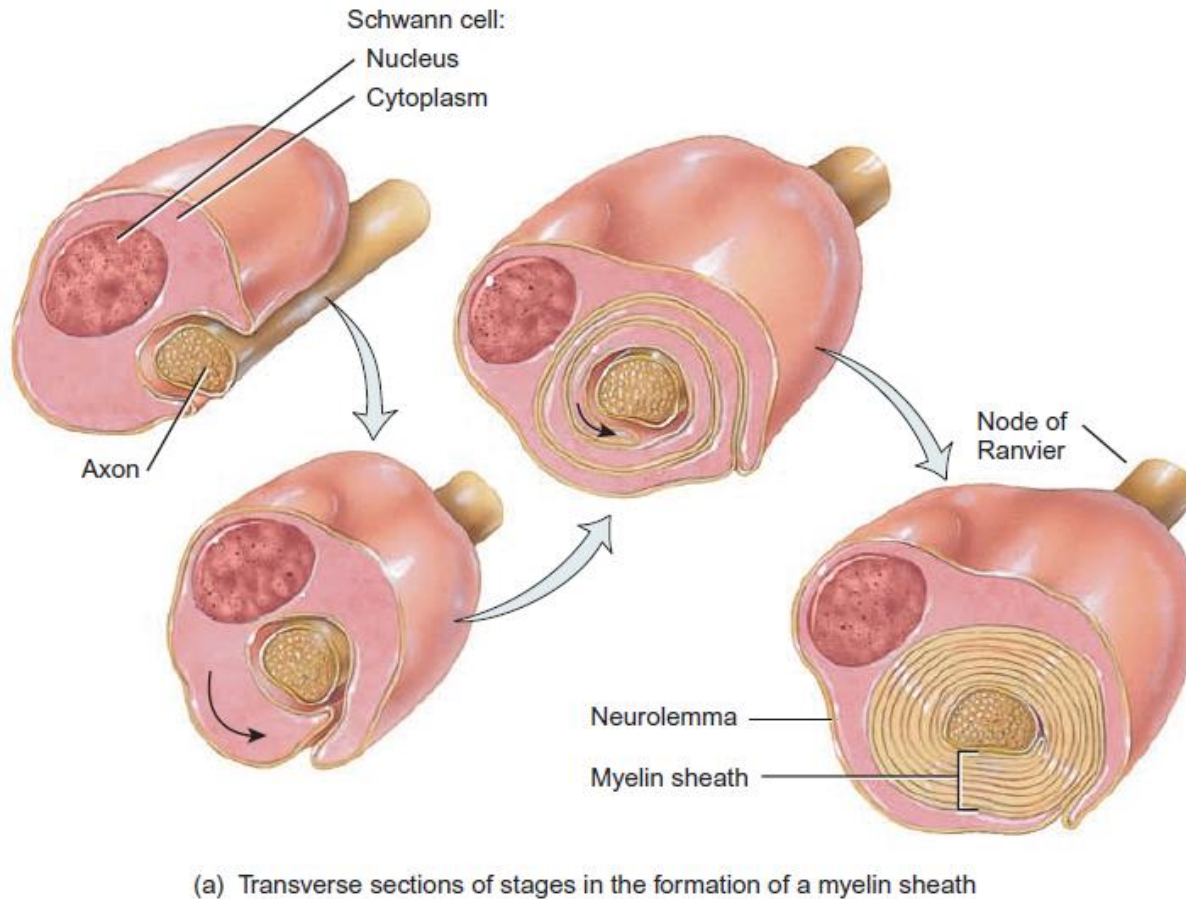
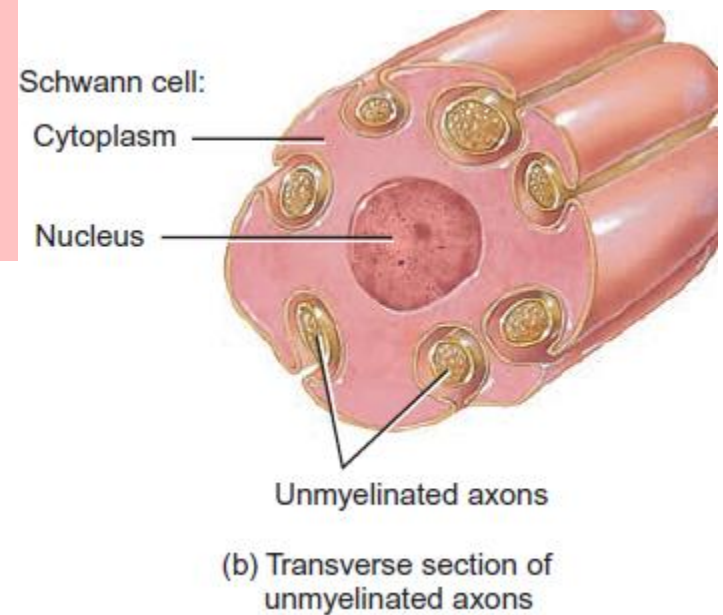
(a) Parts of a neuron



LM 400x

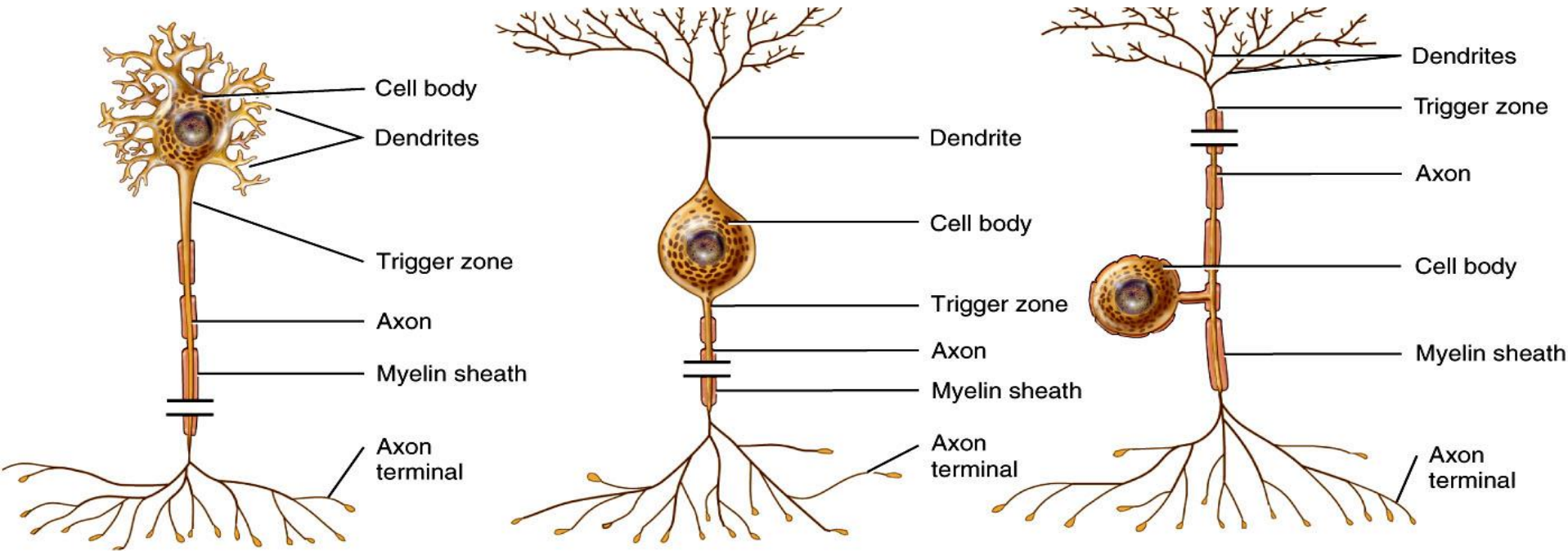
# Myelination

*Myelin = multiple layers of cell membrane*



**In the PNS, Schwann cells surround both myelinated and unmyelinated fibers. In the CNS, oligodendrocytes surround myelinated fibers only**

# Types of Neurons: Structural Classification



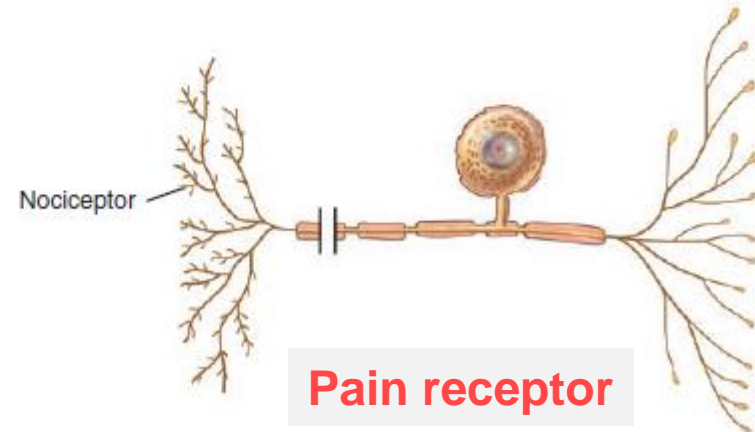
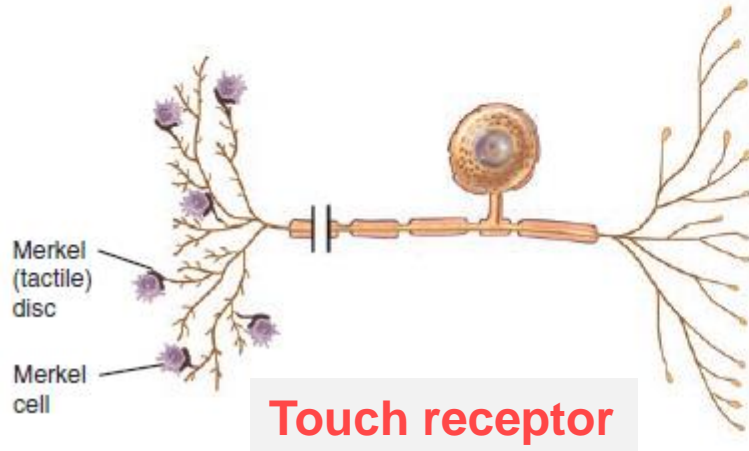
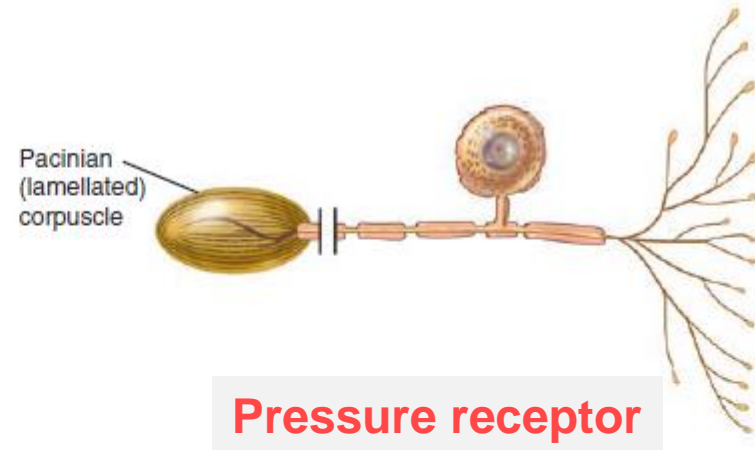
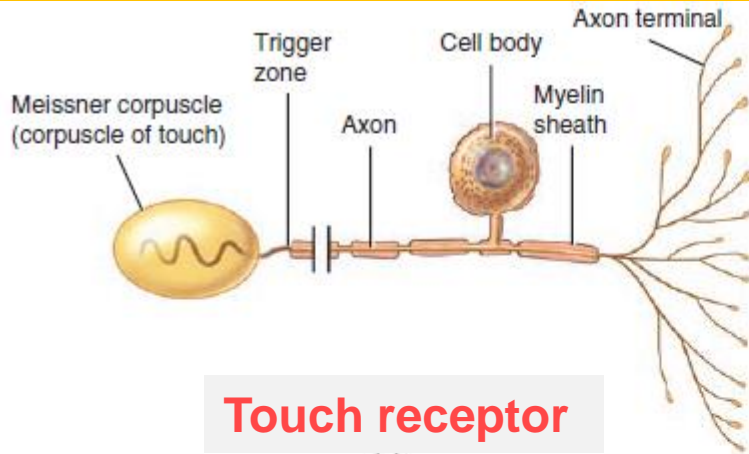
(a) Multipolar neuron

(b) Bipolar neuron

(c) Unipolar neuron

<b>Multipolar</b>	<b>One Axon + Multiple dendrites</b>	<b>Most motor neurons Most CNS neurons</b>
<b>Purkinje cells (cerebellum) and Pyramidal cells (cerebral cortex)</b>		
<b>Bipolar</b>	<b>One Axon + One Dendrite</b>	<b>Special sense organs (ear - nose – eye)</b>
<b>Unipolar</b>	<b>One Axon divides into a central and peripheral branch</b>	<b>Most sensory neurons</b>

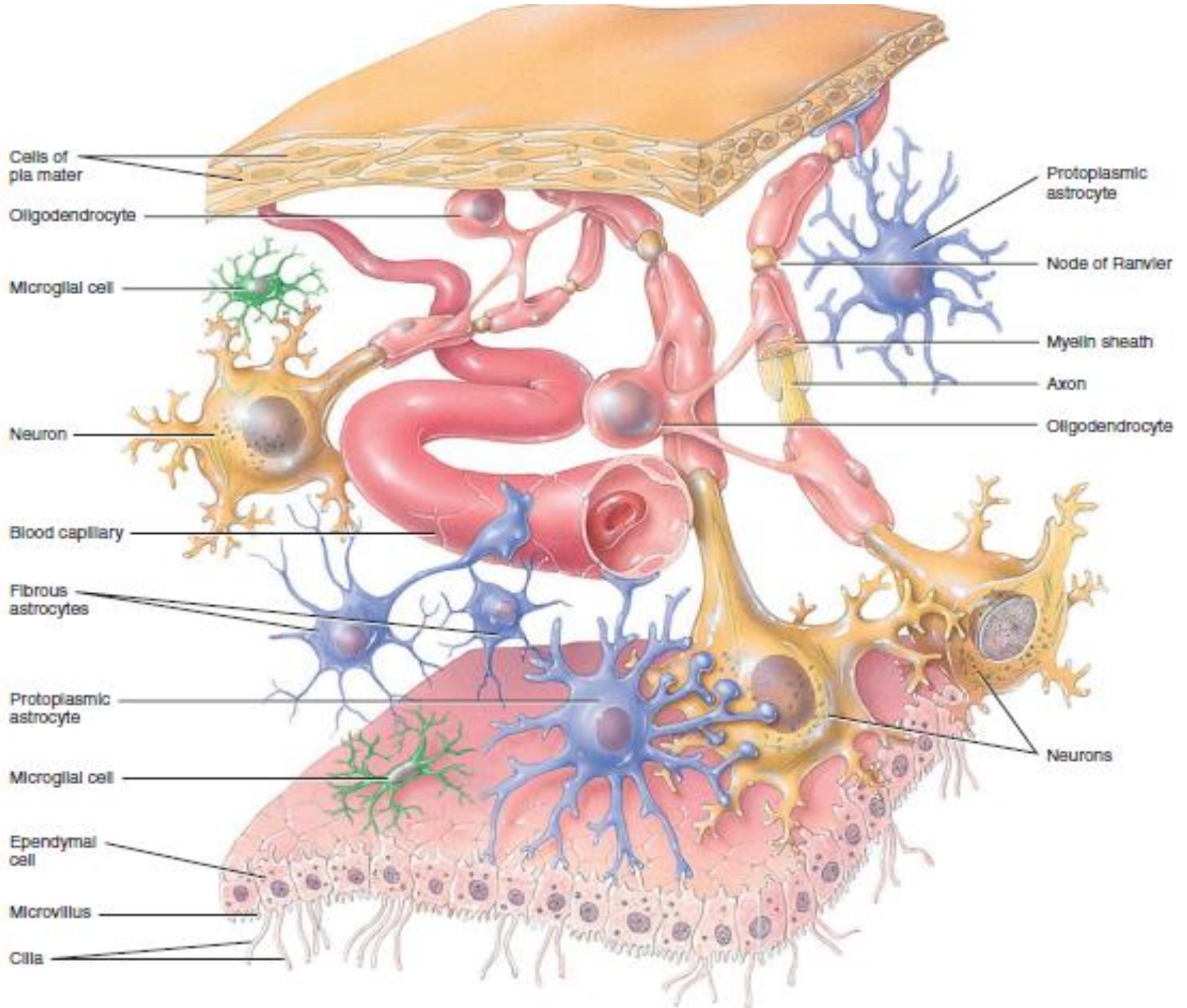
# Examples of sensory receptors



The site of communication between two neurons or between a neuron and an effector cell is called **a synapse**  
**Neurotransmitter is a chemical released at synapse.**

# Types of Neurons: Functional Classification

- 1. Sensory or afferent neurons:** convey action potentials into the CNS through cranial or spinal nerves. Most sensory neurons are unipolar in structure.
- 2. Motor or efferent neurons:** convey action potentials away from the CNS to effectors (muscles and glands) in the periphery (PNS) through cranial or spinal nerves. Motor neurons are multipolar in structure.
- 3. Interneurons or association neurons:** mainly located within the CNS between sensory and motor neurons. Most interneurons are multipolar in structure.



# The Central Nervous System

## The Brain

- The brain is the part of the nervous system present within the skull. The brain is formed of two halves which are similar to each other grossly. The two halves are connected with each by a number of nerve bundles

### The brain is formed of:

- 1) The Cerebrum
- 2) The Diencephalon
- 3) The Brainstem (midbrain and pons and medulla oblongata)
- 4) The Cerebellum

#### Major Parts of the Brain

Forebrain — { Cerebrum  
Diencephalon

Midbrain

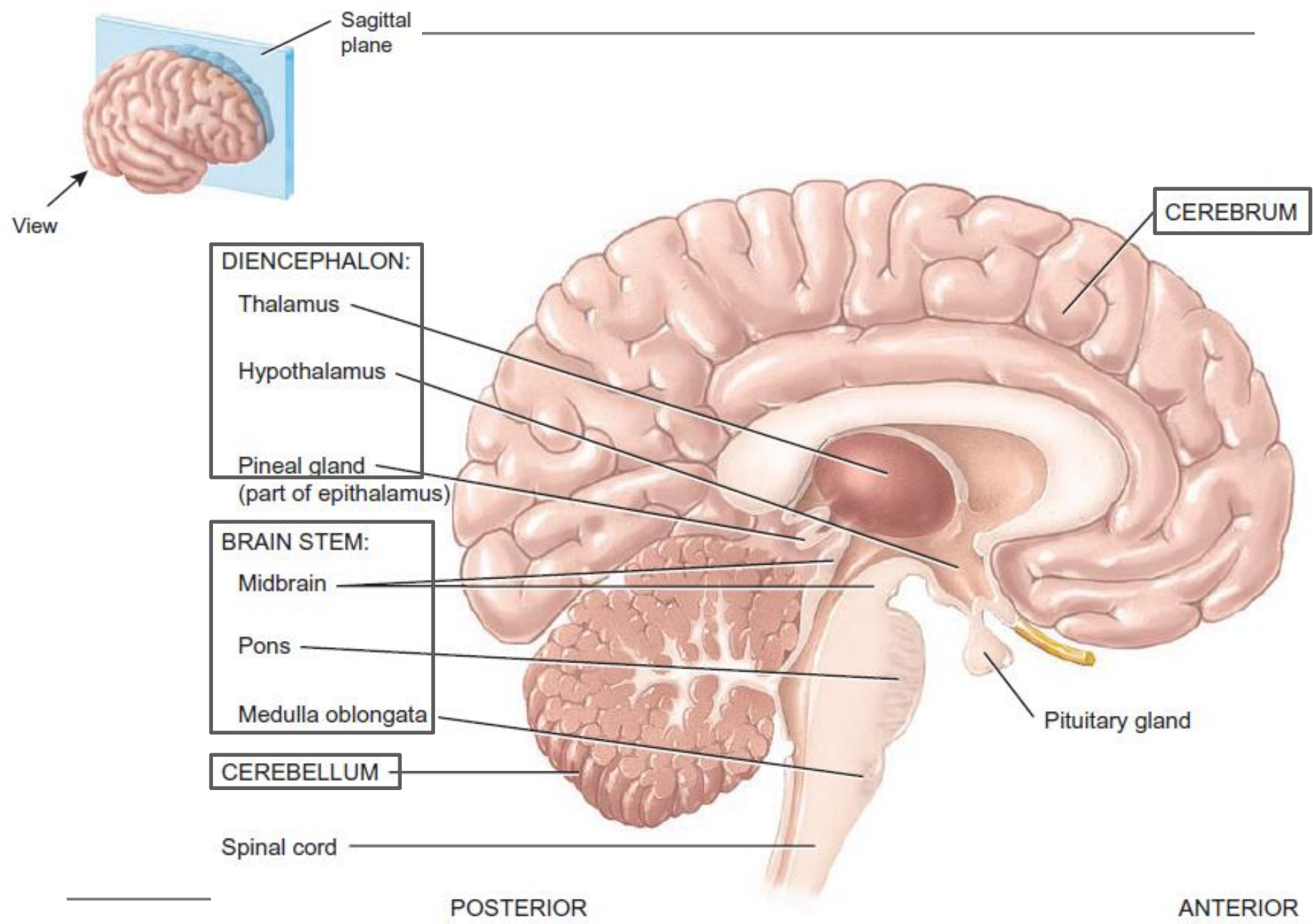
Hindbrain — { Pons  
Medulla oblongata  
Cerebellum

#### Cavities of the Brain

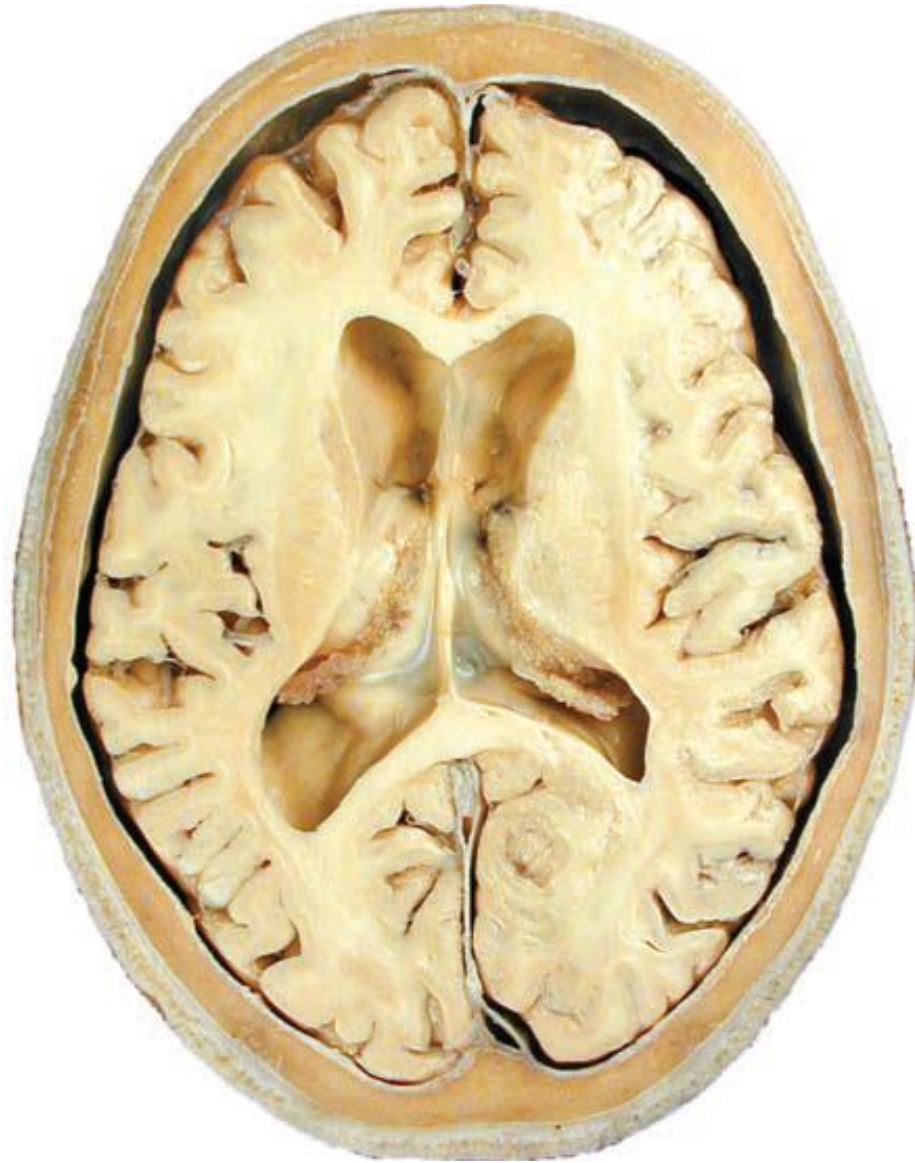
Right and left lateral ventricles  
Third ventricle

Cerebral aqueduct  
Fourth ventricle  
and central canal



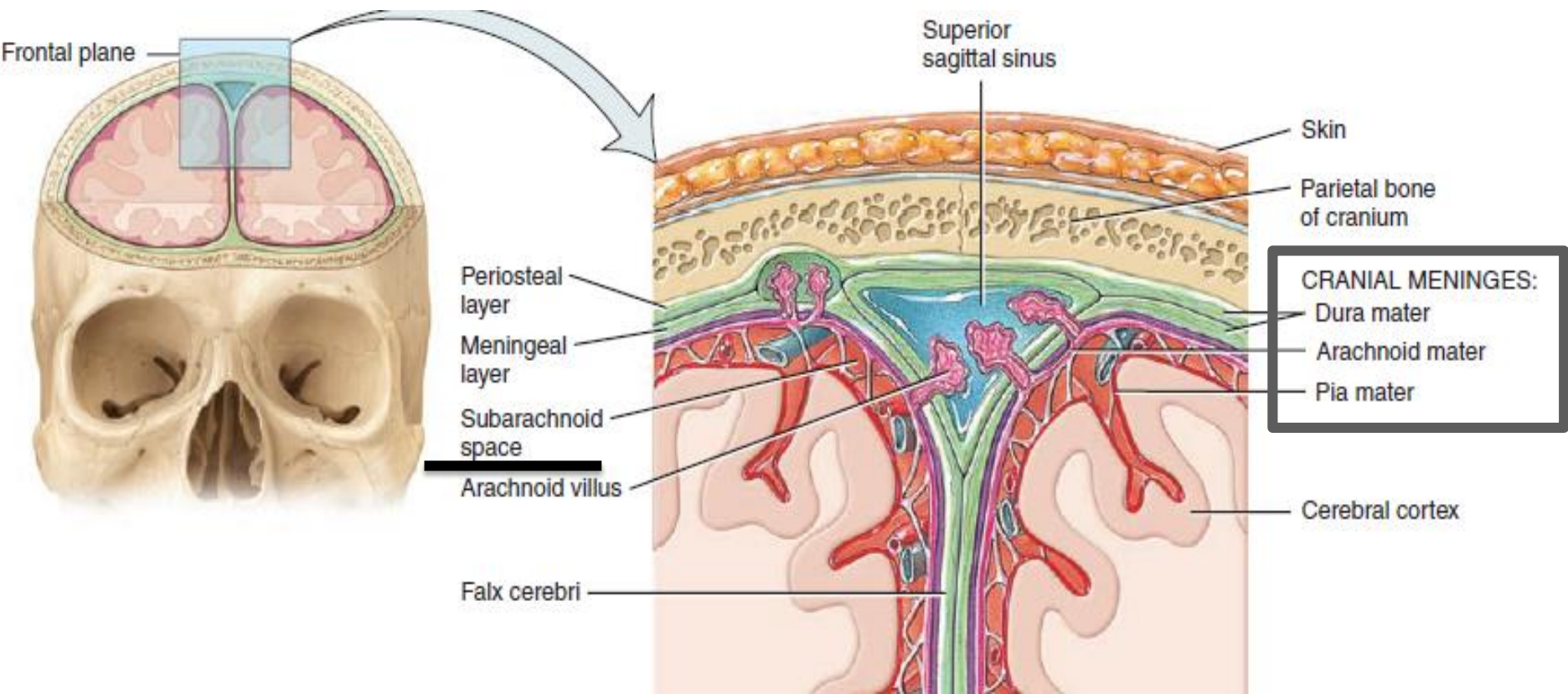


(a) Sagittal section, medial view



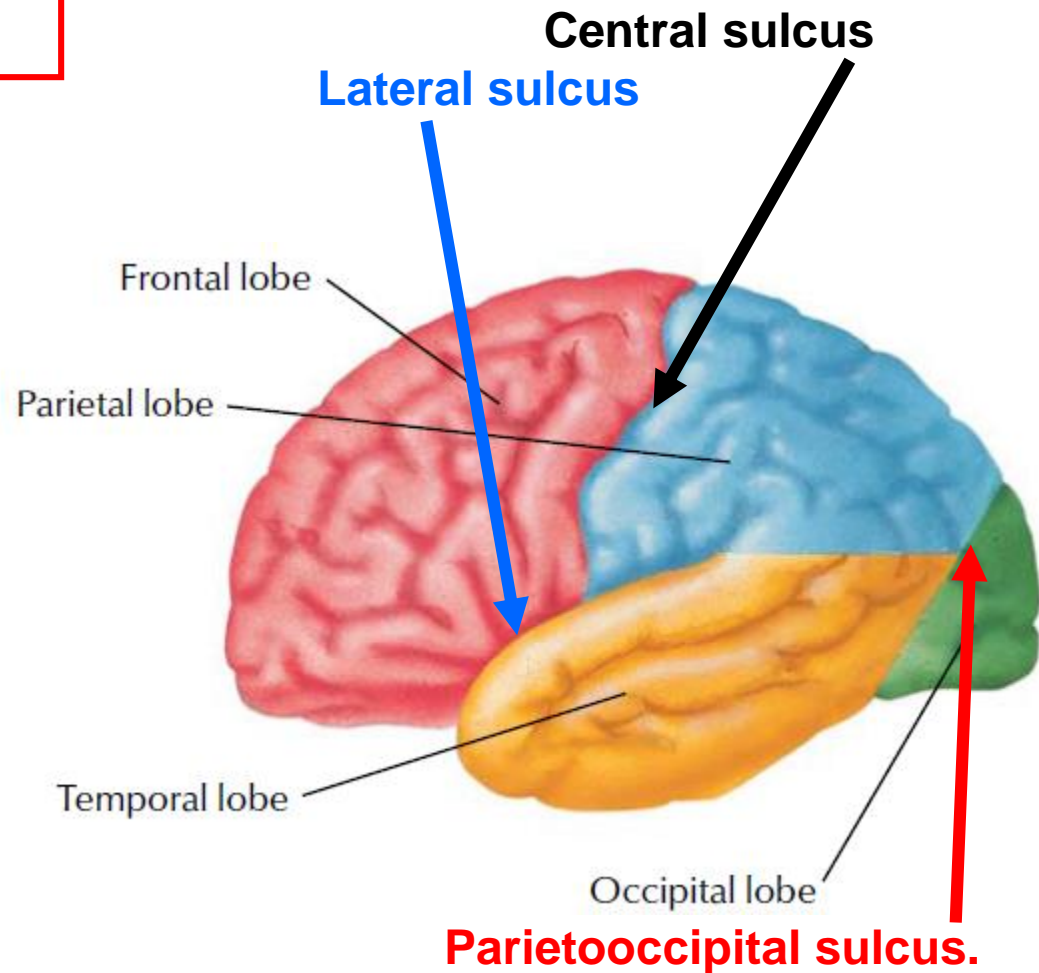
# Protective coverings of the brain

1. **The cranium**
2. **Cranial meninges**
  - ❑ **Dura mater**: the hard outermost layer. The **venous sinuses** of the brain are located within the dura mater
  - ❑ **Arachnoid mater** : the thin middle layer. Beneath the arachnoid, we have the **Subarachnoid space**
  - ❑ **Pia mater**: thin innermost layer. Covers the brain.



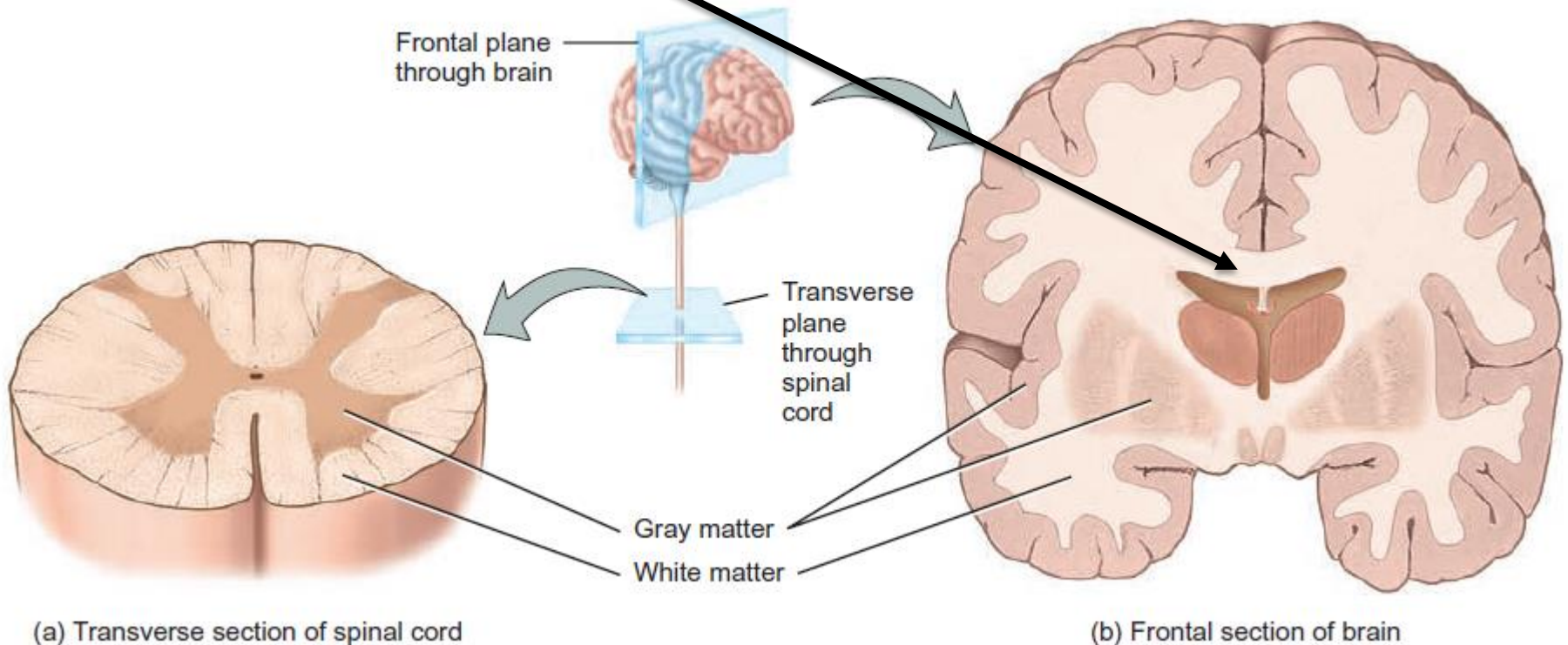
# The Cerebrum

- All **motor** commands issue from the cerebrum.
- All **sensations** are perceived here. In addition, this part is responsible for **emotions, behavior and memory**
- Each cerebrum is formed of four lobes: **frontal lobe, parietal lobe, temporal lobe and occipital lobe.**



- It's characterized by the presence of **fissures, sulci** and protrusions called **gyri**.
- The cavity within it is the **lateral ventricle**

- The outer layer of the cerebrum is called the **cerebral cortex**. It's formed mainly of the **body of neurons** and therefore it's called the **gray matter**.
- Inside it, we have the **white matter** formed mainly of **nerve fibers (AXONS)** (called tracts in CNS) (three types). **corpus callosum**



# Important Sulci and Gyri

## Brodmann's map.

Superior  
Middle  
Inferior  
Frontal gyri

Precentral sulcus  
Precentral gyrus – *main motor area*

Central sulcus (green)

Postcentral gyrus – *main sensory area*

Postcentral sulcus

Read only

4

1-2-3

9-10-11-12

44 - 45

22-39-40

17

Occipital lobe - *vision*

Prefrontal cortex – *emotion and behavior*

*Motor speech (Broca's) area = Opercular + Triangular gyri*

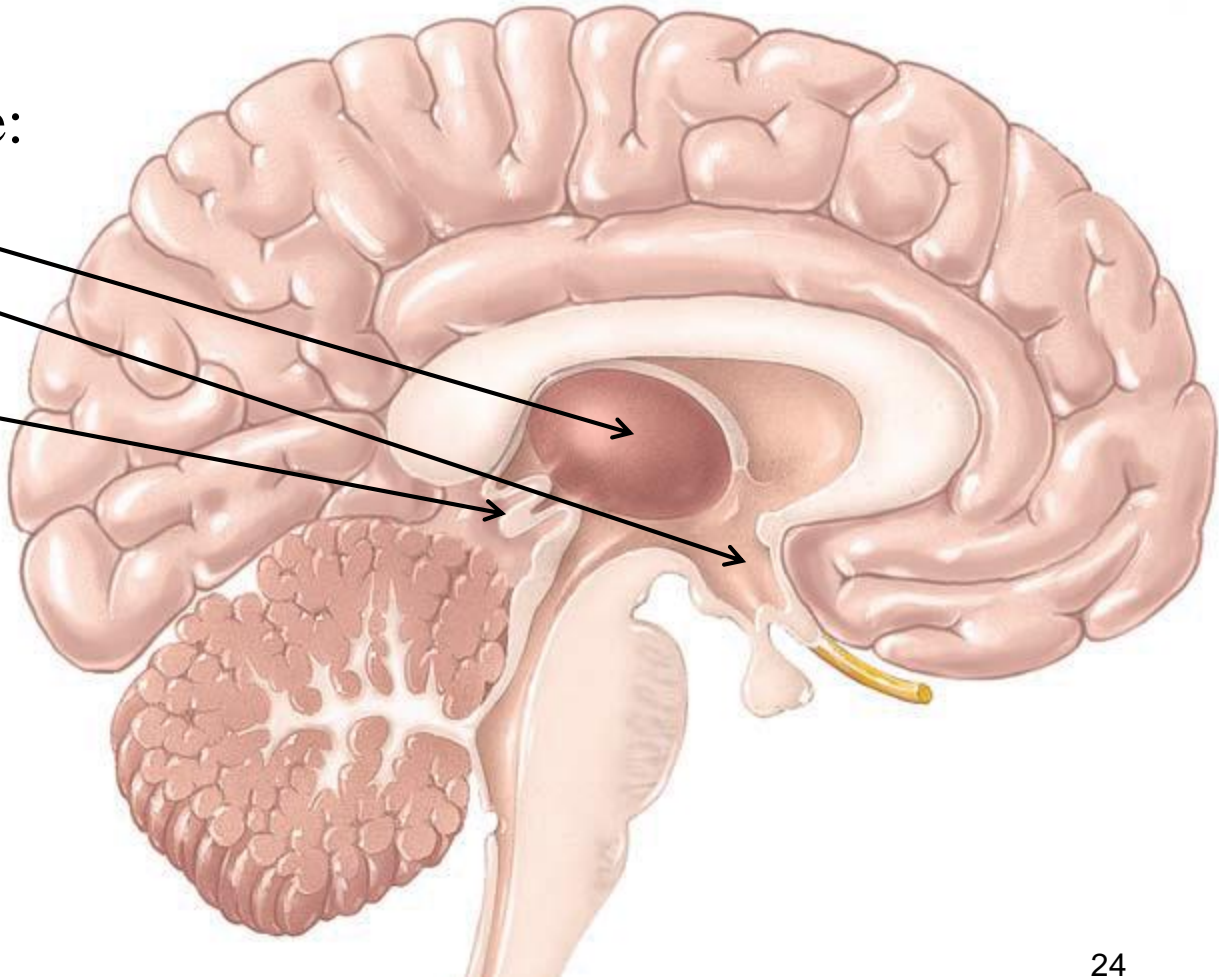
Lateral sulcus

Superior  
Middle  
Inferior  
Temporal gyri

left

# The Diencephalon

- This part of the brain is located on the medial aspect of the cerebrum. The cavity here is the 3<sup>rd</sup> ventricle
- It's formed of the:
  1. Thalamus
  2. Hypothalamus
  3. Epithalamus



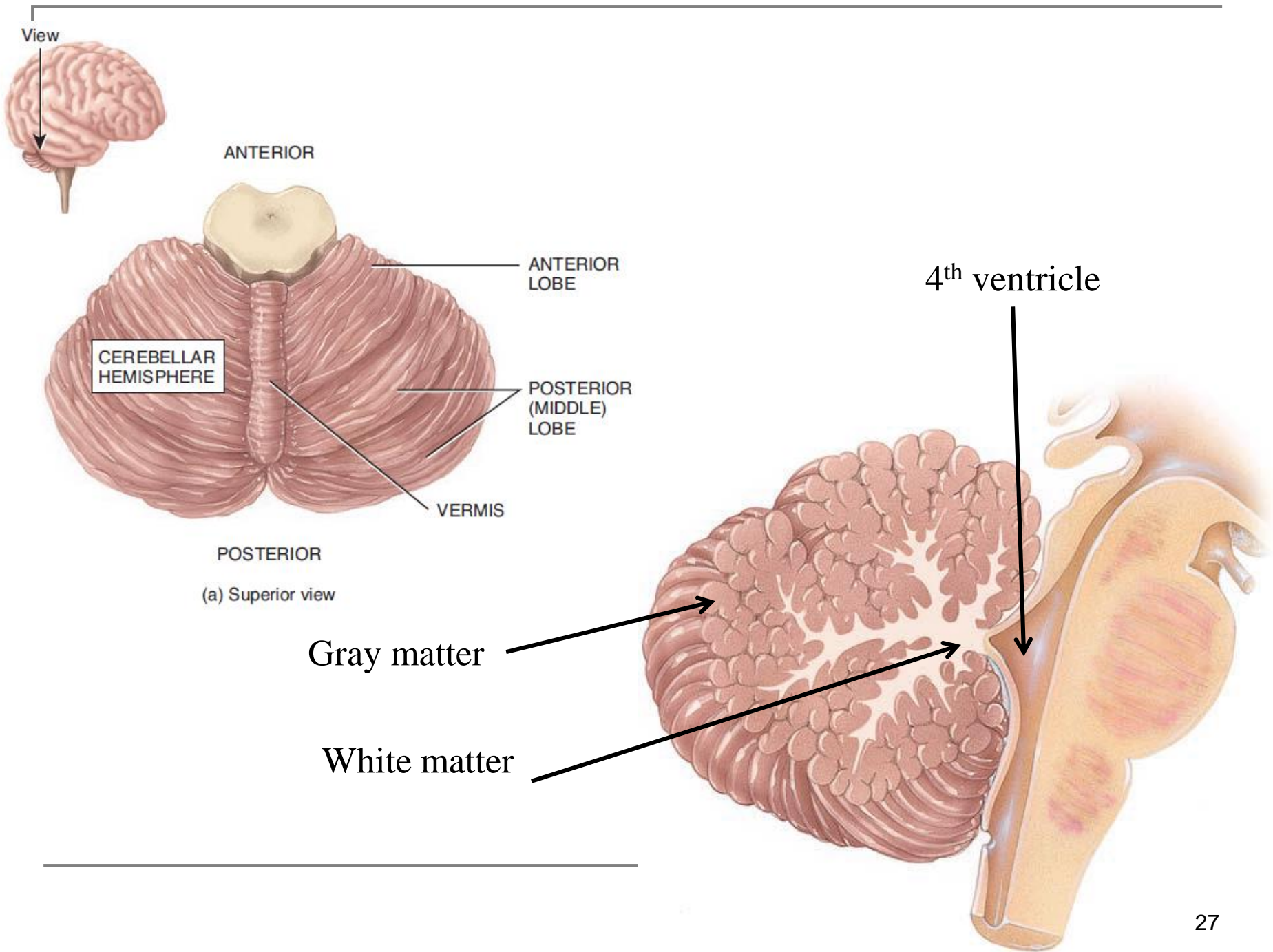


Part	Main Function
Thalamus	Relay station for most sensation to cerebral cortex.
Hypothalamus Related to <b>(anterior and posterior pituitary gland lobes)</b>	<ol style="list-style-type: none"> <li><b>1. Controls and integrates activities of ANS</b></li> <li>2. Controls hormone secretions of all endocrine glands in the body (maestro gland)</li> <li>3. Controls body temperature (<b><u>thermostat</u></b>)</li> <li>4. Controls eating and satiety, and drinking centers</li> </ol>
Pineal gland of the epithalamus	Secrete melatonin hormone which regulates sleep

**Hypothalamus: Body's internal biological clock**  
**Circadian (daily) rhythms**

# The Cerebellum

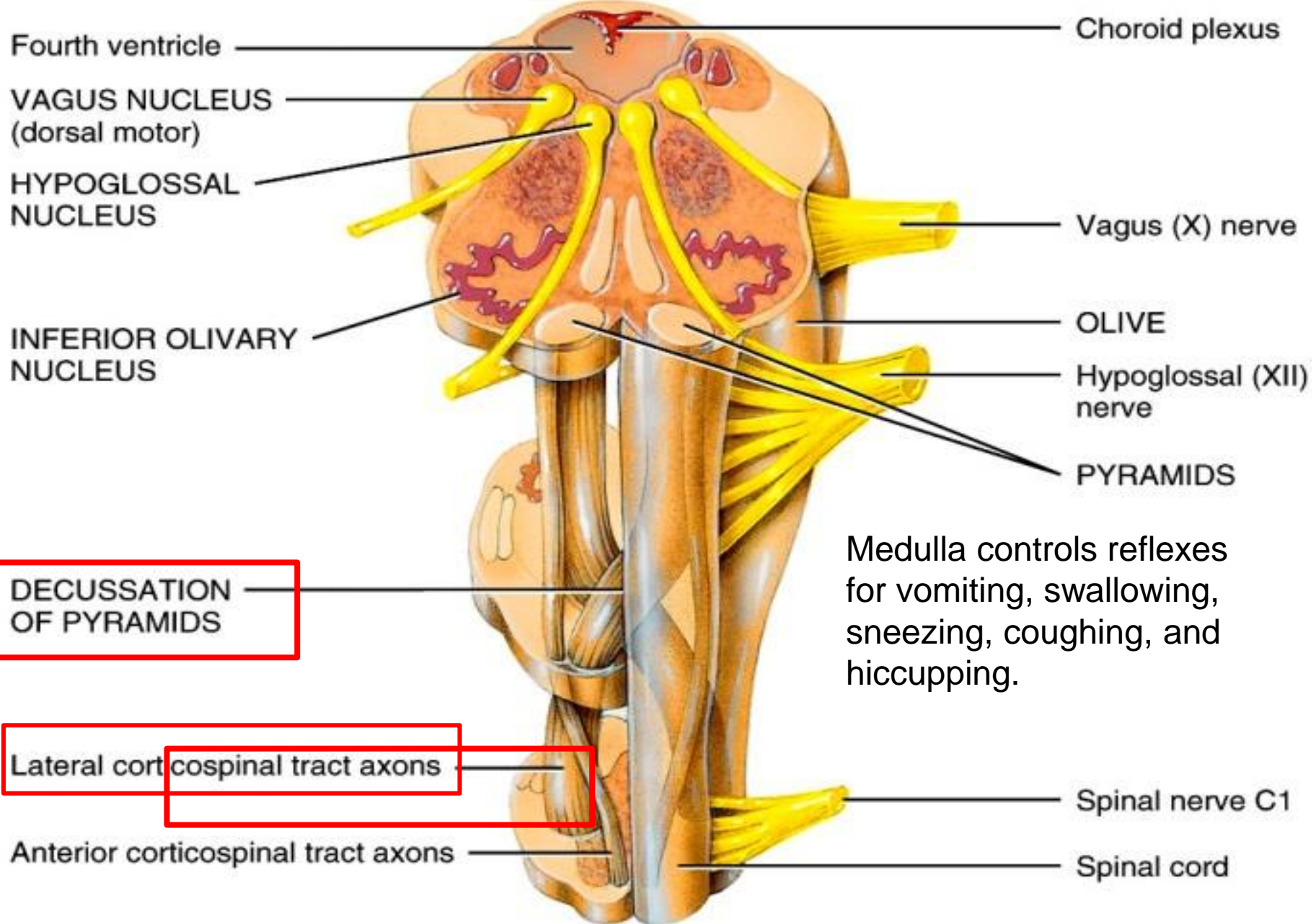
- Second largest part of the brain.
- The central constricted area is the **vermis**. On each side of the vermis, we have the expanded **cerebellar hemispheres**
- The cerebellum is located inferior to the occipital lobe and posterior to the brainstem. It's separated from the brainstem by **the 4<sup>th</sup> ventricle**
- *The function of the cerebellum is the coordination of movement and the maintaining of balance on the same side of the body.*
  1. **Smooths and coordinates contractions of skeletal muscles**
  2. **Regulates posture and balance.**



# The Brainstem

- ✓ The part of the brain that connects the diencephalon with the spinal cord
- ✓ Formed of 3 parts: midbrain, pons and the medulla oblongata
- ✓ Contains several important **control centers** and the **origin of several cranial nerves (nuclei = Cell bodies in CNS)**
- ✓ **Several sensory and motor tracts**

Part	Important Centers	Notes
Midbrain	<ul style="list-style-type: none"> <li>❖ Substantia nigra</li> <li>❖ Red nucleus</li> </ul>	The cavity here is the cerebral aqueduct
Pons	<ul style="list-style-type: none"> <li>❖ Pontine nuclei</li> <li>❖ Tracts</li> </ul>	<b>Relays between cerebrum and cerebellum</b>
Medulla oblongata	<ul style="list-style-type: none"> <li>❖ Cardiovascular center</li> <li>❖ Respiratory center</li> <li>❖ <b>Pyramids</b>: site of decussation of motor tract <b>90%</b></li> </ul>	Exits the skull through the foramen magnum to become continuous with the spinal cord



Medulla controls reflexes for vomiting, swallowing, sneezing, coughing, and hiccupping.

Transverse section and anterior surface of medulla oblongata

شكرًا