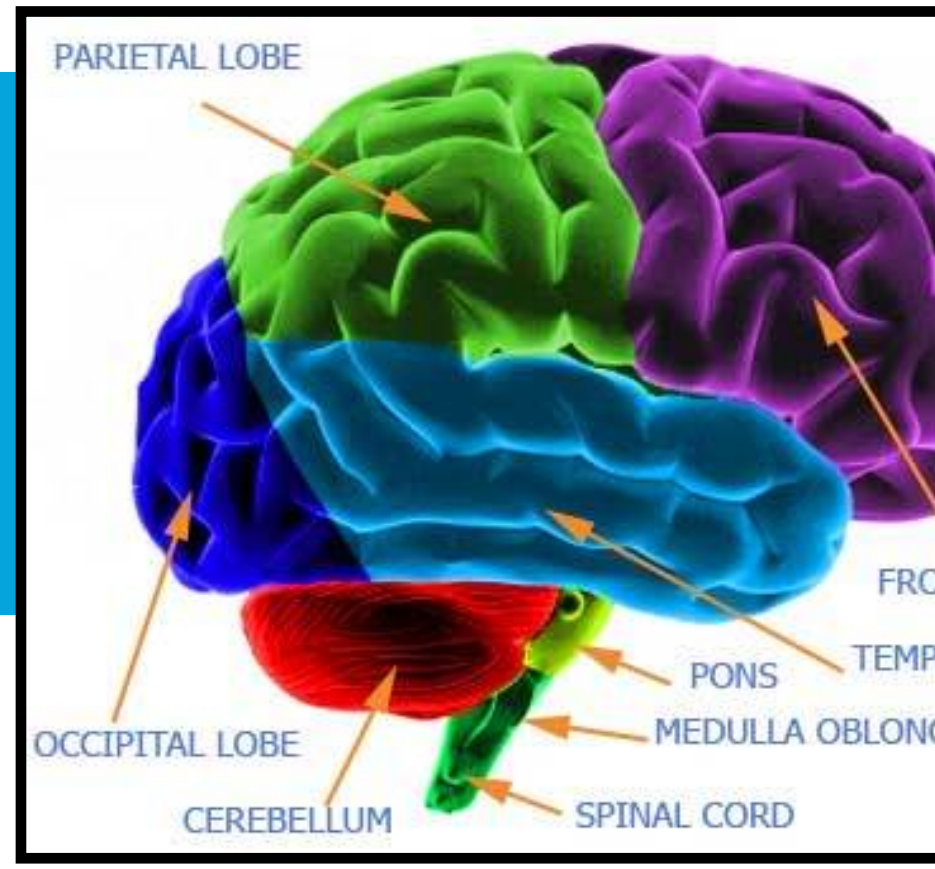
The Nervous System



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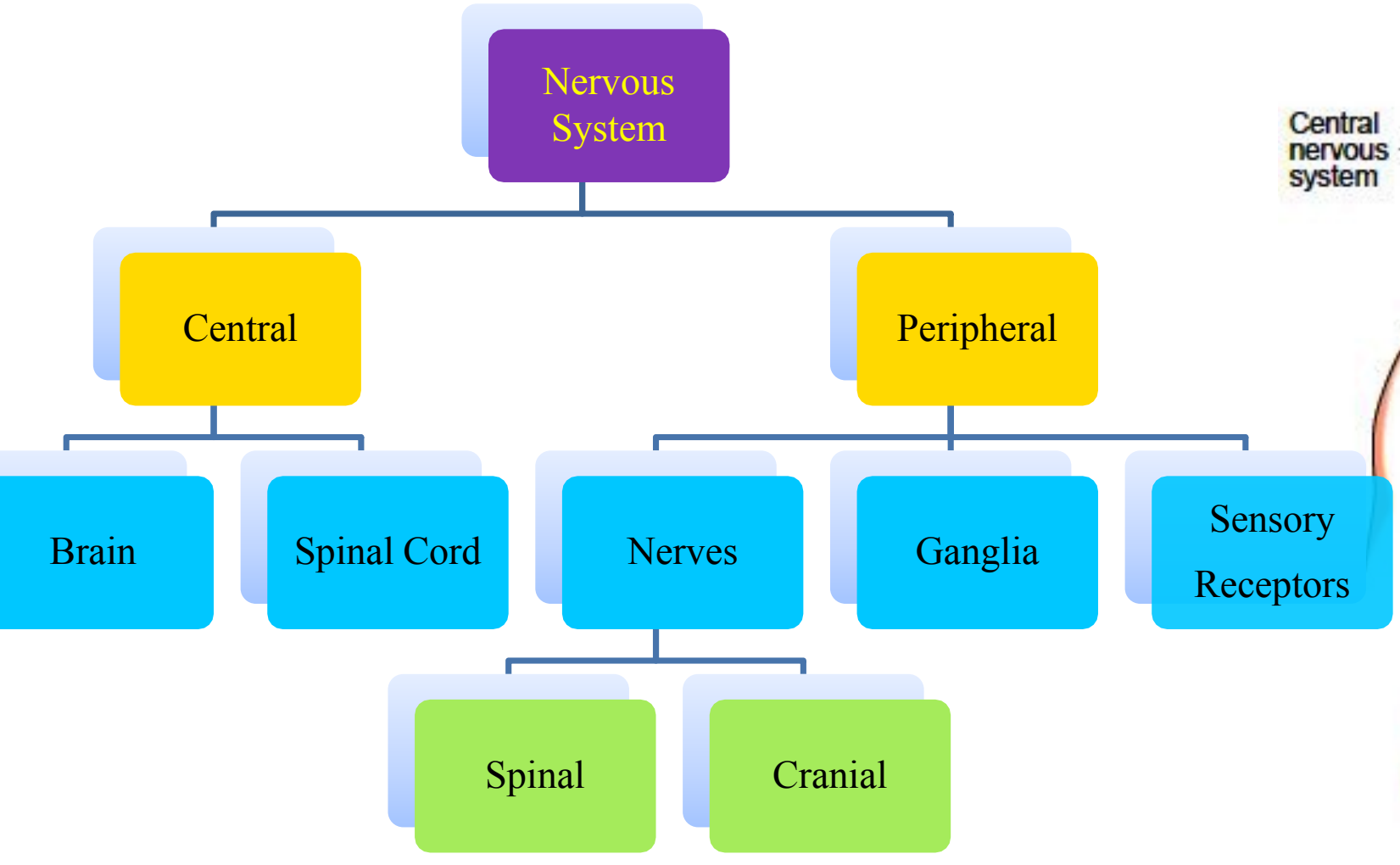
Overview

- *The nervous system is the system that* ***controls*** *the various functions of the body by the means of* ***electrical impulses.***



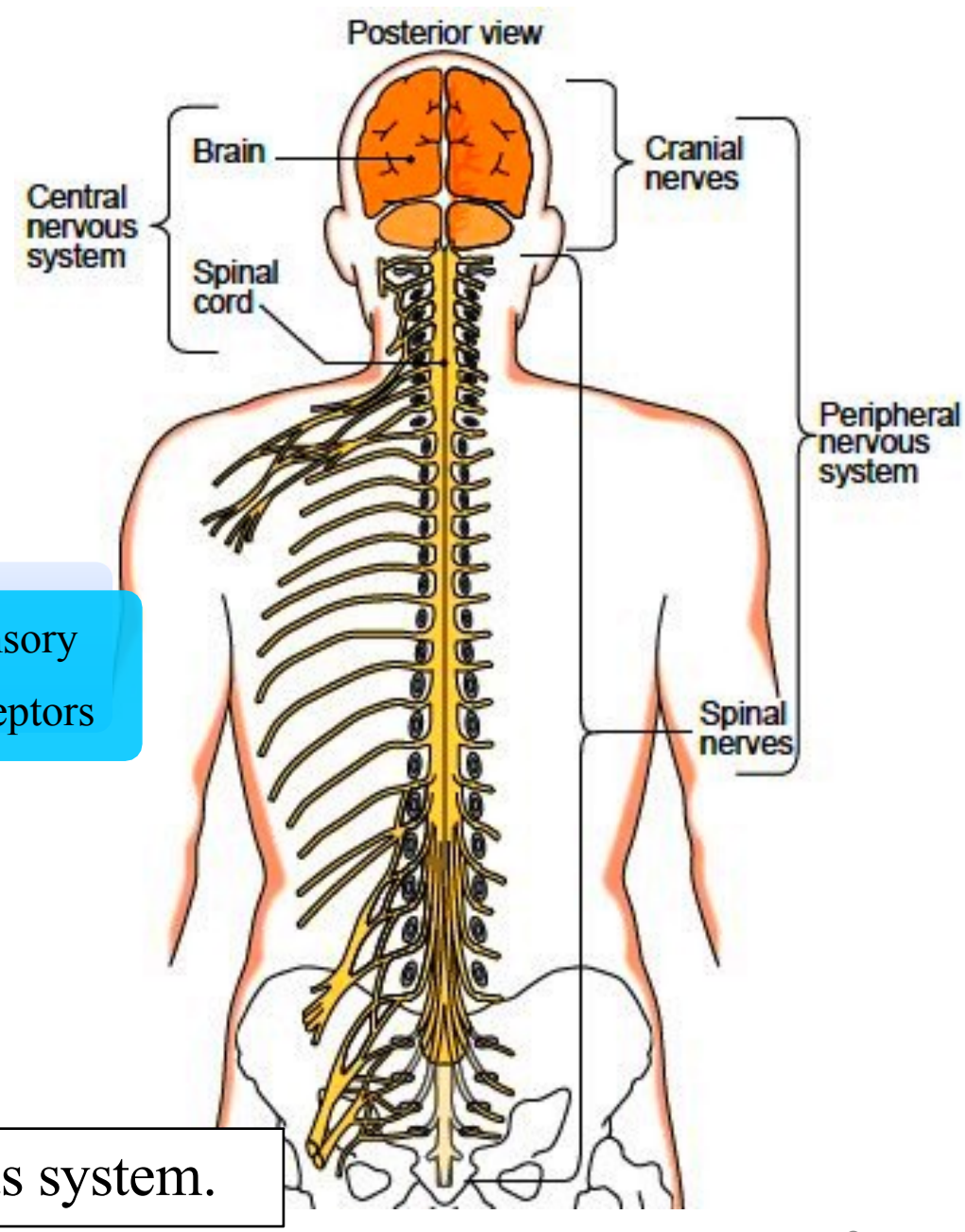


Fig.1: Divisions of the nervous system.

The Central Nervous System (CNS)

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

- **Functions:**

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

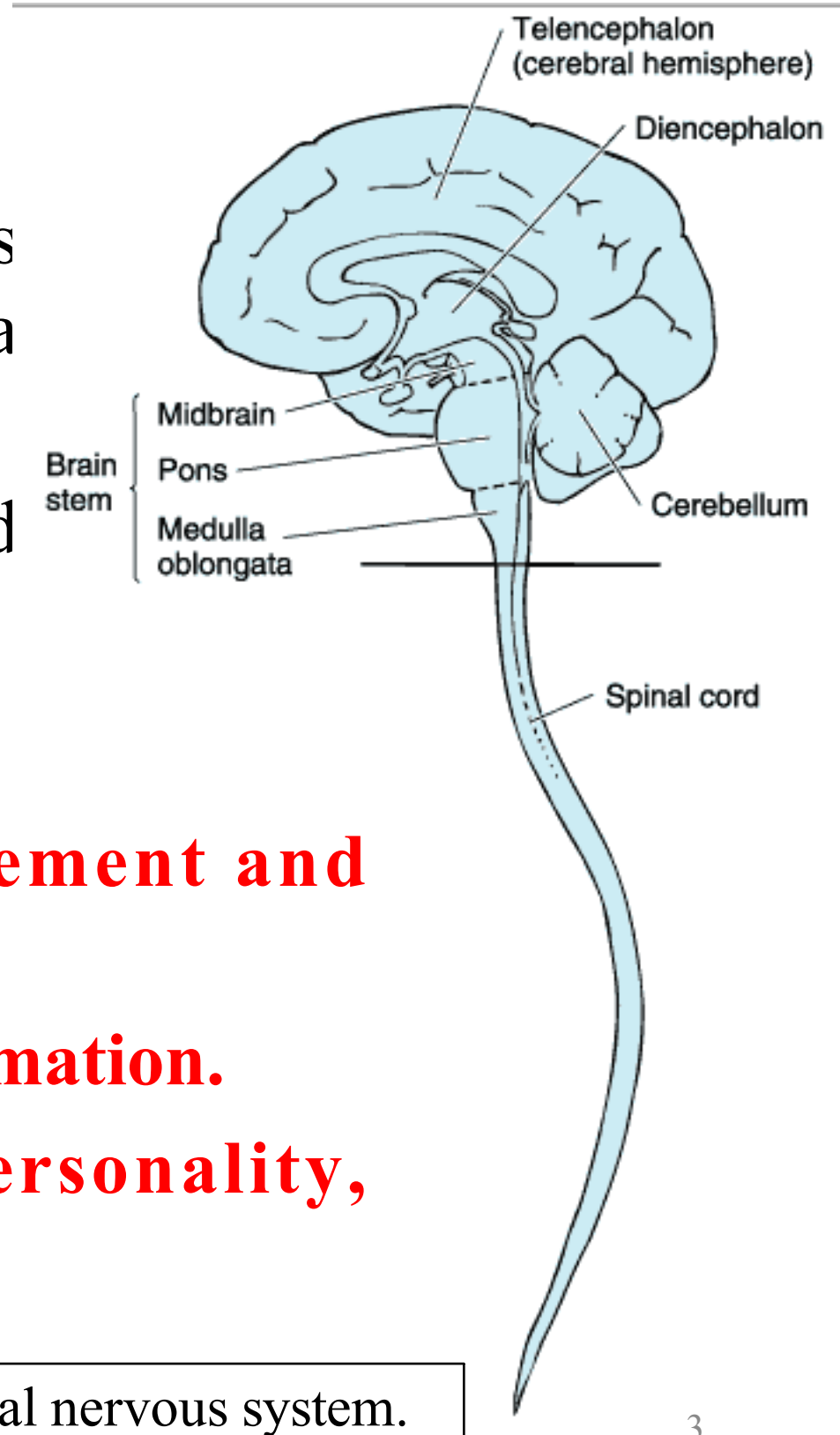


Fig.2: The central nervous system.

The Peripheral Nervous System (PNS)

- Formed of the peripheral nerves (cranial and spinal), the ganglia, and the sensory receptors.

- The nerves may be sensory (carry information to CNS) or motor (carry orders from the CNS)

- **Ganglia** are collection of neurons outside the central nervous system.
- **Sensory receptors** are parts of neurons or specialized structures that can detect changes in the internal or external environment. The skin, for example, contains several types of receptors that detect pain, touch and heat.

- Functionally, the PNS can be divided into:

- **Somatic part**: connected to skin, muscles, joints and the special senses. We are fully conscious of this part. Our voluntary movements and our sensation of pain and touch are controlled by this part.

- **Autonomic Nervous System**: this part usually operates without conscious control, as it controls all of our involuntary actions, like our heart rate, respiratory rate and blood pressure.

- **Enteric part**: controls the secretions and movements of the various parts of the digestive system unconsciously.

Histology Of The Nervous System

- The nervous tissue is formed of two types of cells:

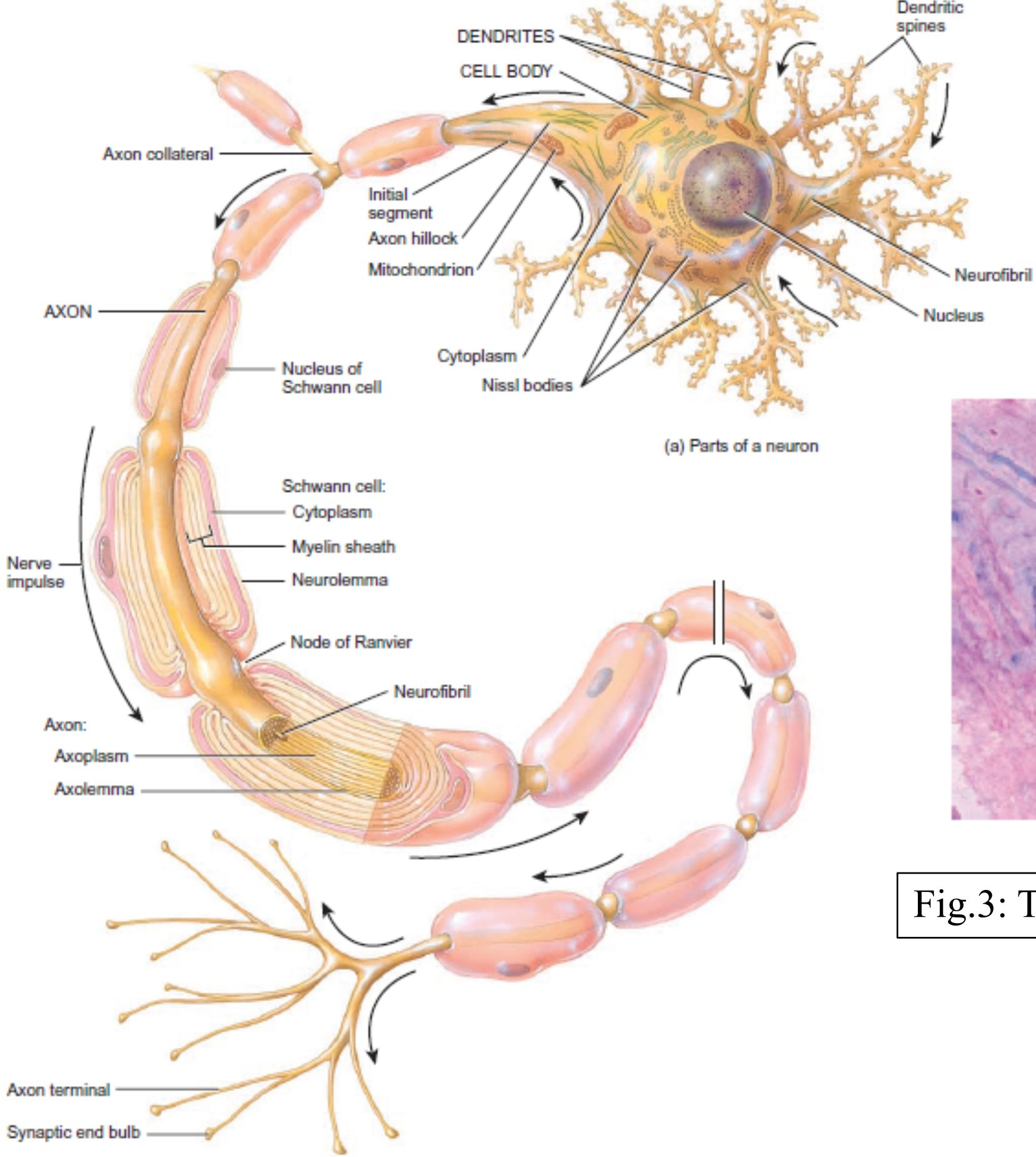
1. The nerve cell – Neurons
2. Supporting cells –Neuroglia or Glia cells

- In the nervous tissue, there is ***a very small amount of extracellular matrix*** found around the blood vessels.
- The space between the cells is filled with **neuropil** which is formed of the processes of both neurons and glia cells and some fluid.

Neurons

- Functional unit of nervous system.
- Have capacity to produce action potentials.
- ***Cell body:***
  - Single nucleus with prominent nucleolus
  - *Nissl bodies* formed of rough endoplasmic reticulum & free ribosomes for protein synthesis.
  - Neurofilaments give cell shape and support
- ***Cell processes*** = dendrites & axons

- ***Mature neurons cannot divide. A damaged neuron cannot be repaired and is replaced by fibrous tissue.***



(a) Parts of a neuron

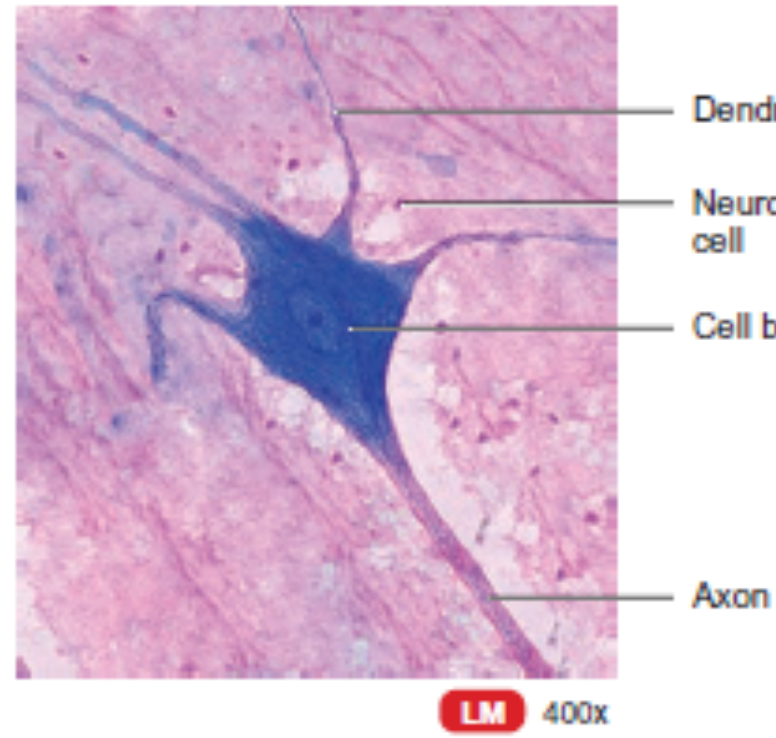


Fig.3: The neuron and its parts.

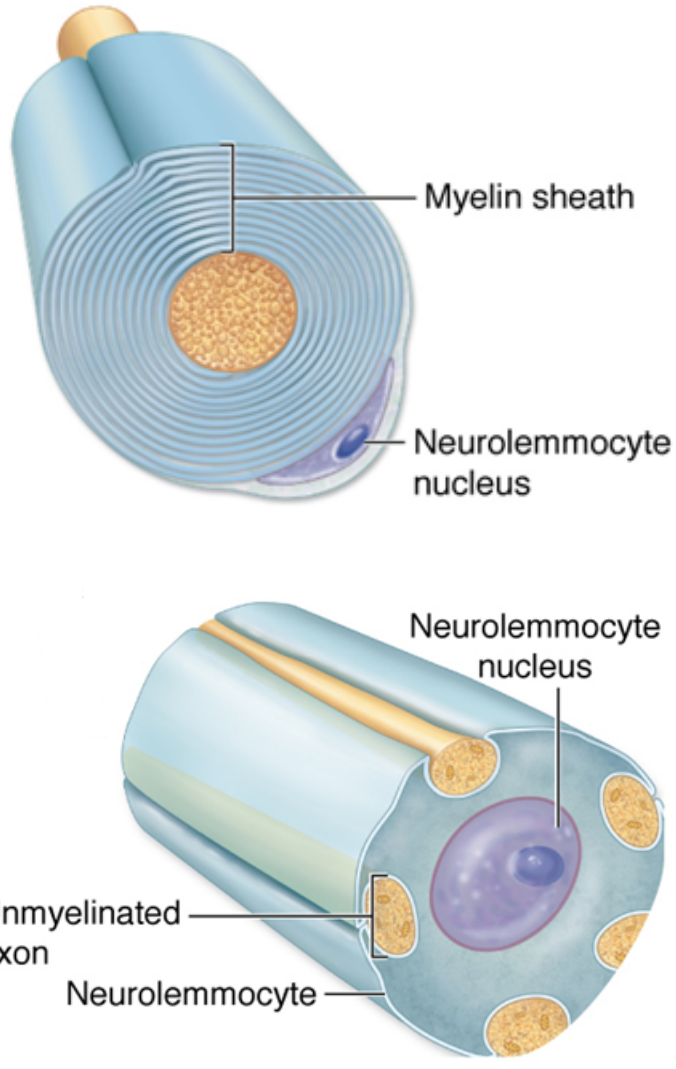
	Dendrites	Axon
1	Mostly multiple branches	A Single branch
2	Usually short	Usually the longest branch and is called ***nerve fiber***
3	Taper as they extend away from cell body	Has a fixed diameter
4	Branch profusely	? No branches near cell body ? Collateral branches along course ? Terminal branches
5	Not covered by a myelin sheath	Some are covered by a myelin sheath
6	Conduct impulse towards cell body	Conducts impulse away from cell body

Glia cells

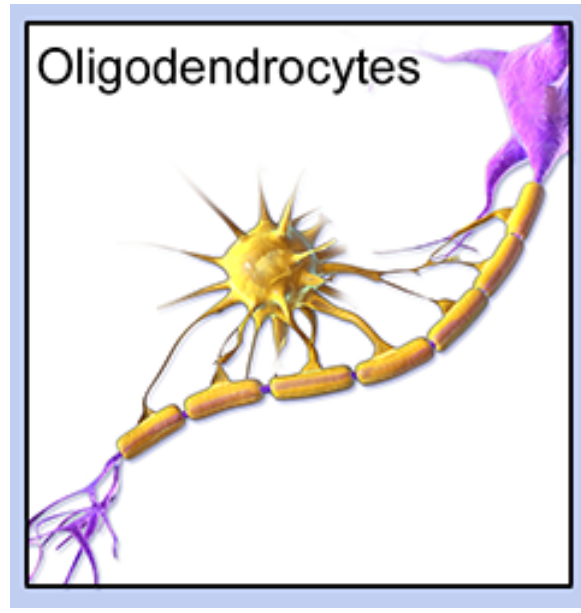
Location	Cell	Function
CNS	Astrocytes	• Part of blood-brain barrier • Provide nutrients for neurons • Form scar tissue after injury
	Oligodendrocytes	Form myelin sheath
	Microglia cells	Defense (by phagocytosis)
	Ependymal cells	Line cavities
PNS	Schwann cells (Neurolemmocytes)	Form myelin sheath
	Satellite cells	Support neurons in dorsal root ganglia

Myelination

- The process by which a nerve fiber (axon) is surrounded by multiple layer of cell membrane (myelin sheath)



PNS	CNS
Done by Schwann cells	Done by oligodendrocyte
The entire cell wraps around the axon	The process of the cell wraps around the axon
Unmyelinated axons are also surrounded by cell membrane of Schwann cell	Unmyelinated fibers are not surrounded by anything



Histology of a nerve

- **Nerve**: a group of bundles of nerve fibers and their covering connective tissue layers.
- The whole nerve is surrounded by the **epineurium.**
- Each bundle is surrounded by the **perineurium,** which forms a blood-nerve barrier.
- Each nerve fiber (axon) is surrounded by myelin sheath and an areolar connective tissue **endoneurium.**

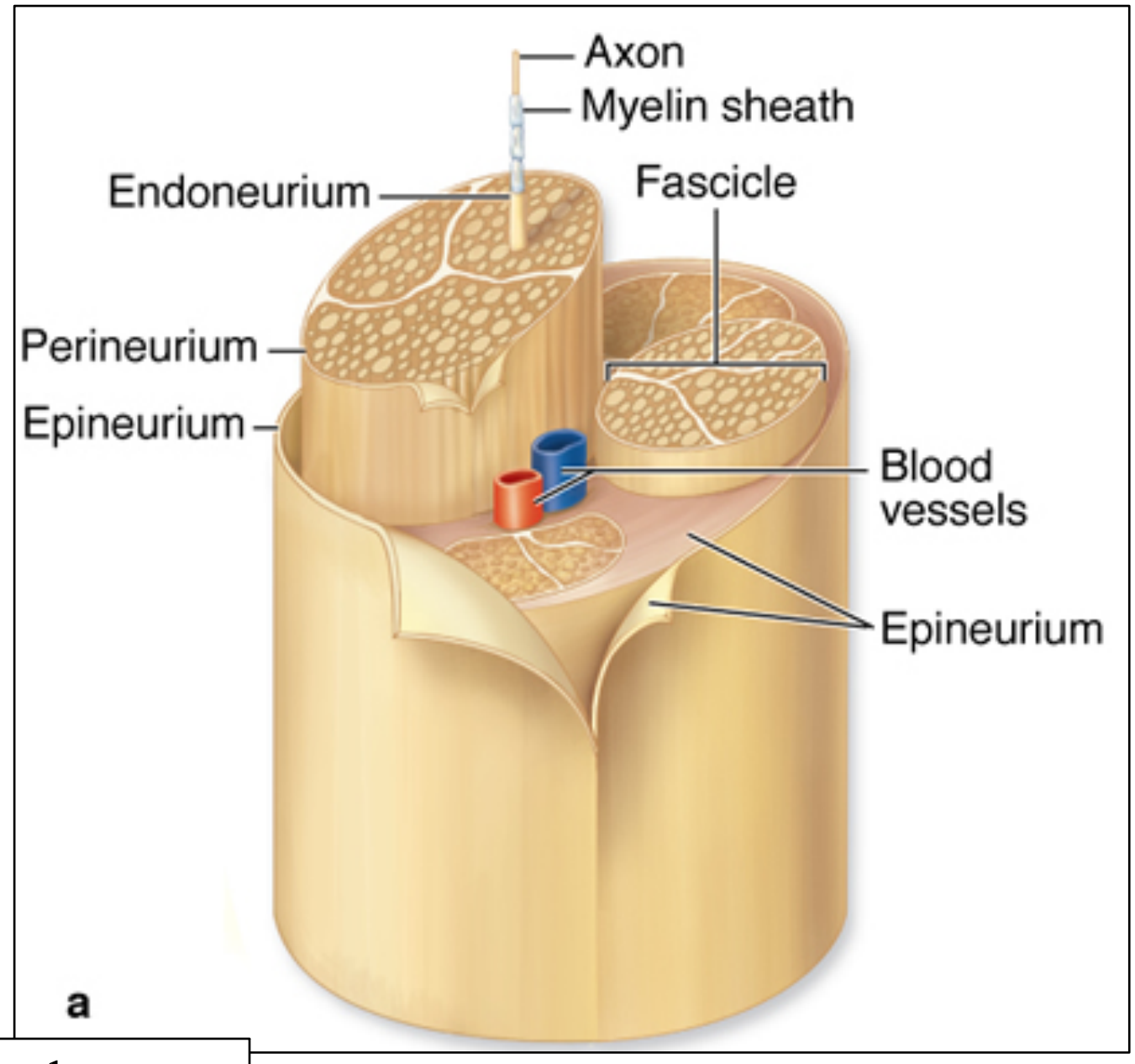


Fig.4: Peripheral nerve and its covering layers.

The Central Nervous System - The Brain

- The brain is the part of the nervous system present within the skull. It's covered by protective layers called the meninges.

- The brain is formed of:

1) The Cerebrum
2) The Diencephalon
3) The Cerebellum
4) The Brainstem

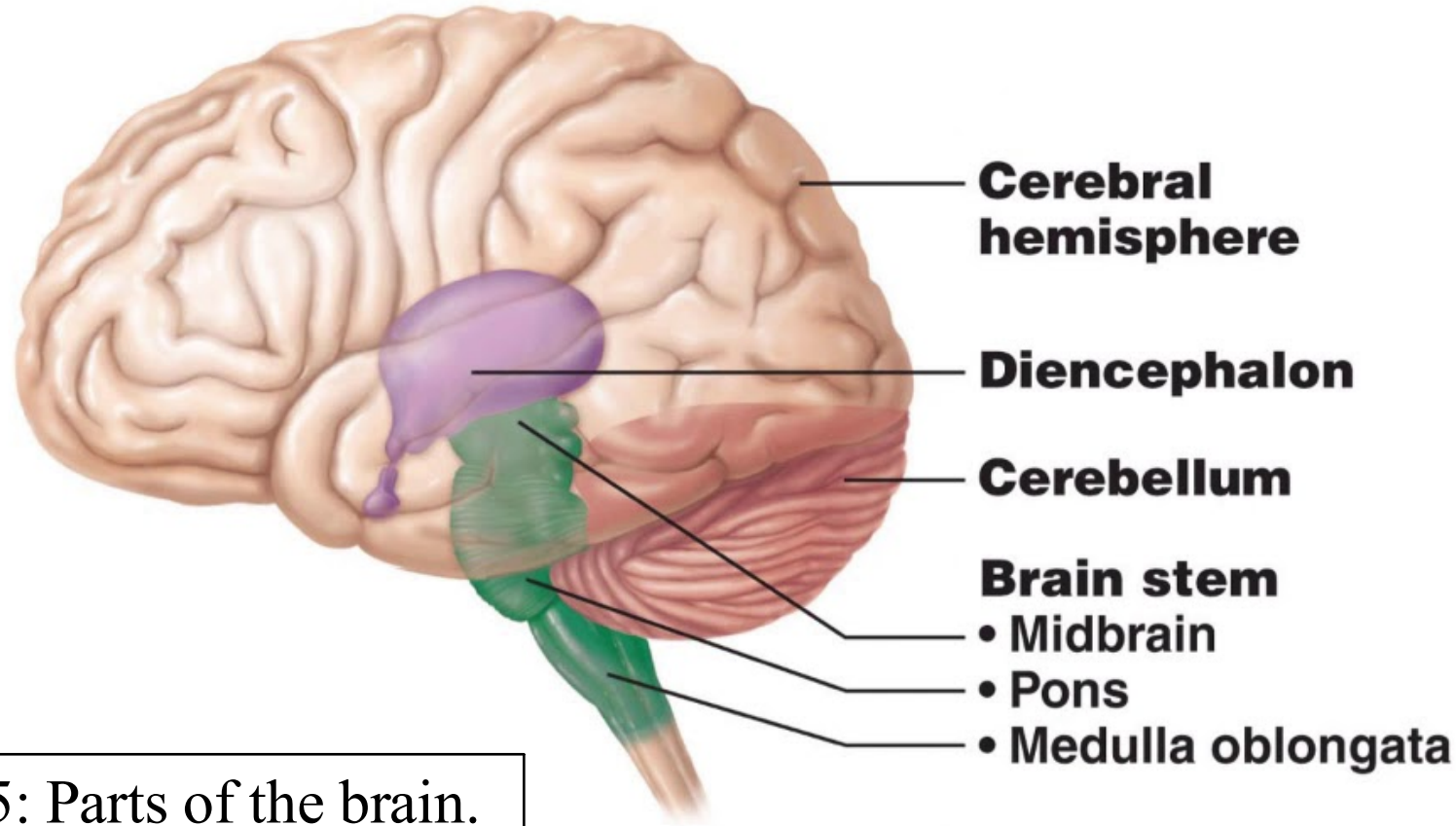


Fig.5: Parts of the brain.

Ventricular system

- Within the different parts of the brain, there are several cavities lined by ependymal cells and filled with cerebrospinal fluid.

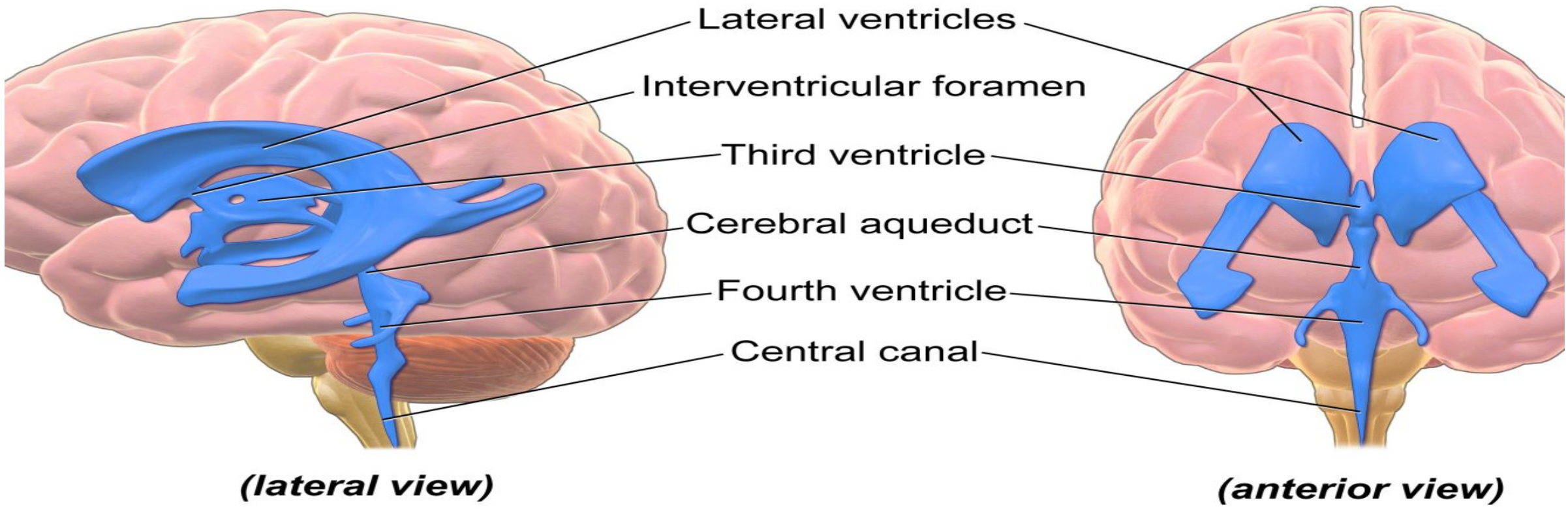


Fig.6: Ventricles of the brain.

Cranial meninges

1. **Dura mater**: the hard outermost layer. Separated from the skull bones by the epidural space. The venous sinuses of the brain are located within the dura mater.
2. **Arachnoid mater** : the thin middle layer. Separated from the dura by the subdural space. Beneath the arachnoid, we have the large subarachnoid space.
3. **Pia mater**: thin innermost layer. Directly covers the brain.

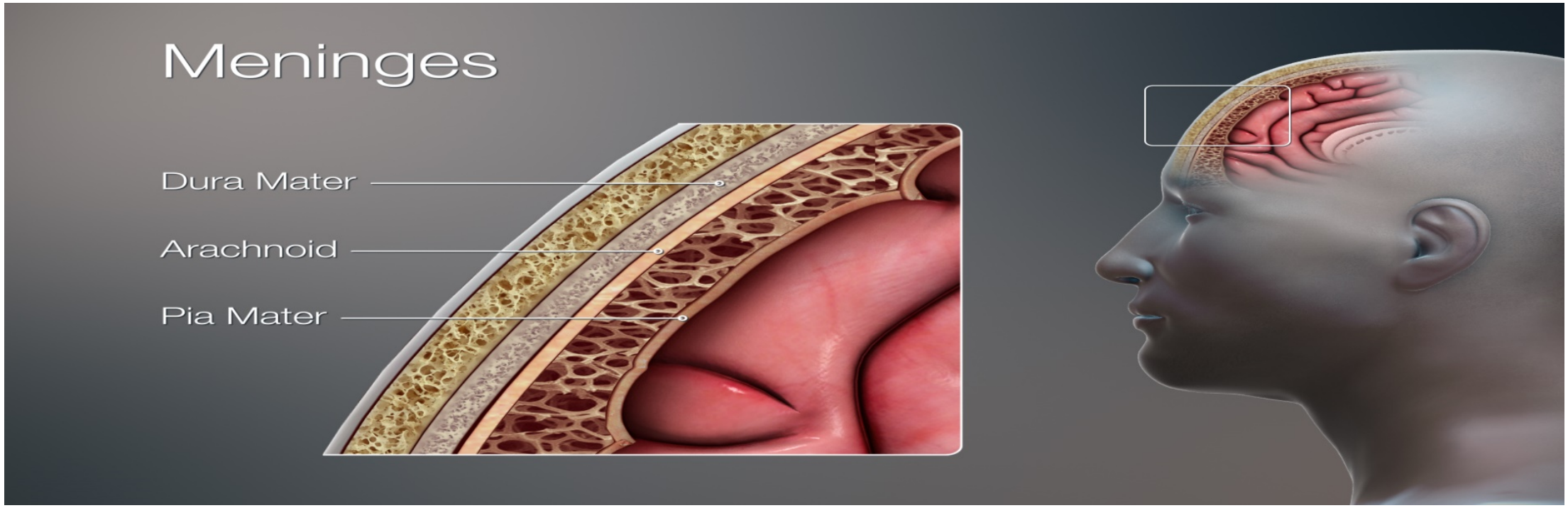


Fig.7: The cranial meninges.

The Cerebrospinal Fluid (CSF)

- Clear fluid.
- Circulates through cavities in the brain (ventricles) and the spinal cord (central canal) and also in the subarachnoid space.

- ***Functions:***

1. ***Absorbs shock and protects the brain and the spinal cord.***
2. ***Helps transport nutrients and wastes between the blood and the nervous tissue.***

The Blood-Brain Barrier

- This include a number of structures that control the passage of substances from blood to the nervous tissue to protect it against harmful agents.

- It's formed of:

1) Endothelium of capillaries
2) Pericytes: cells present around the capillaries beneath its basal lamina
3) Basal lamina
4) Processes of astrocytes

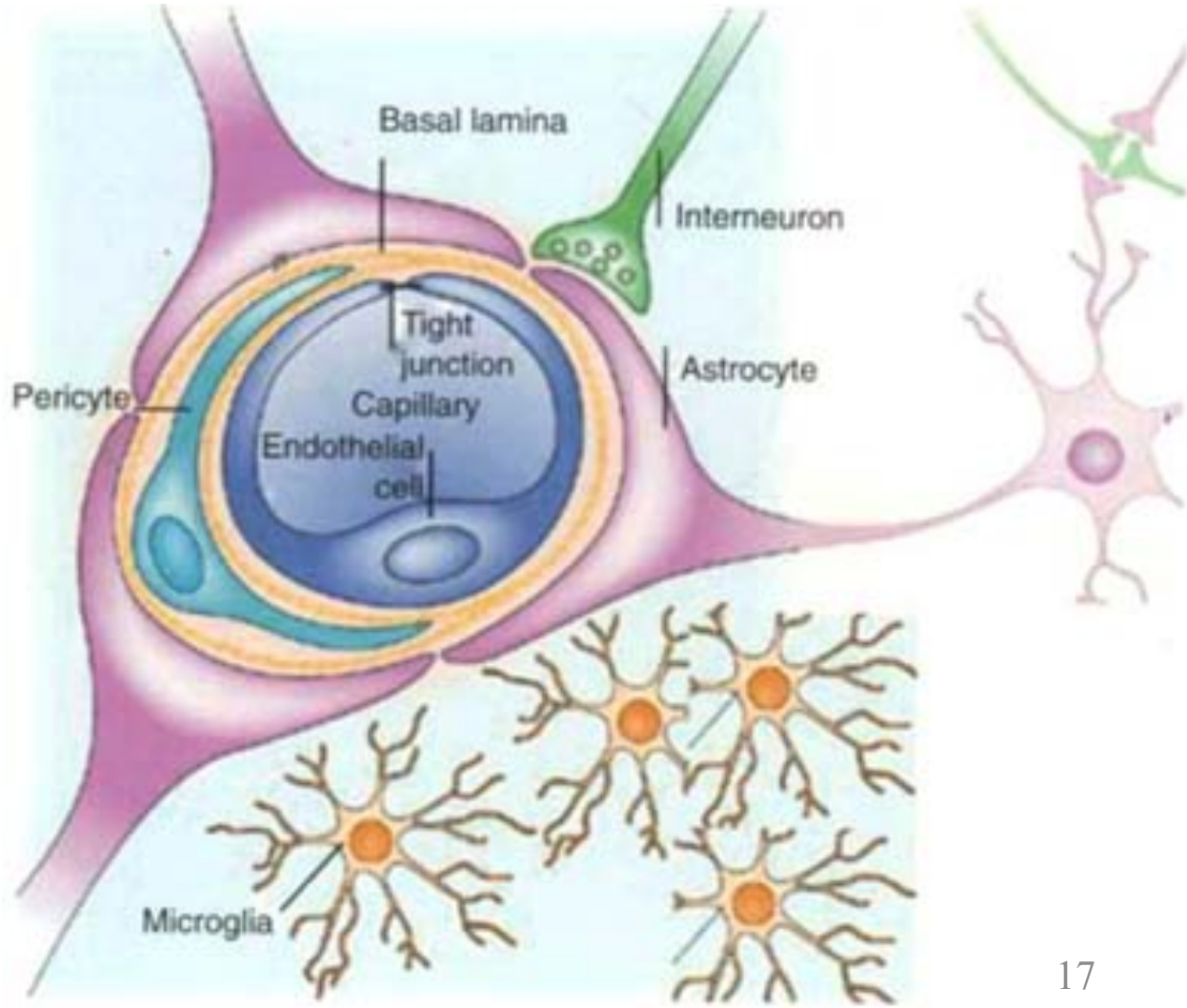
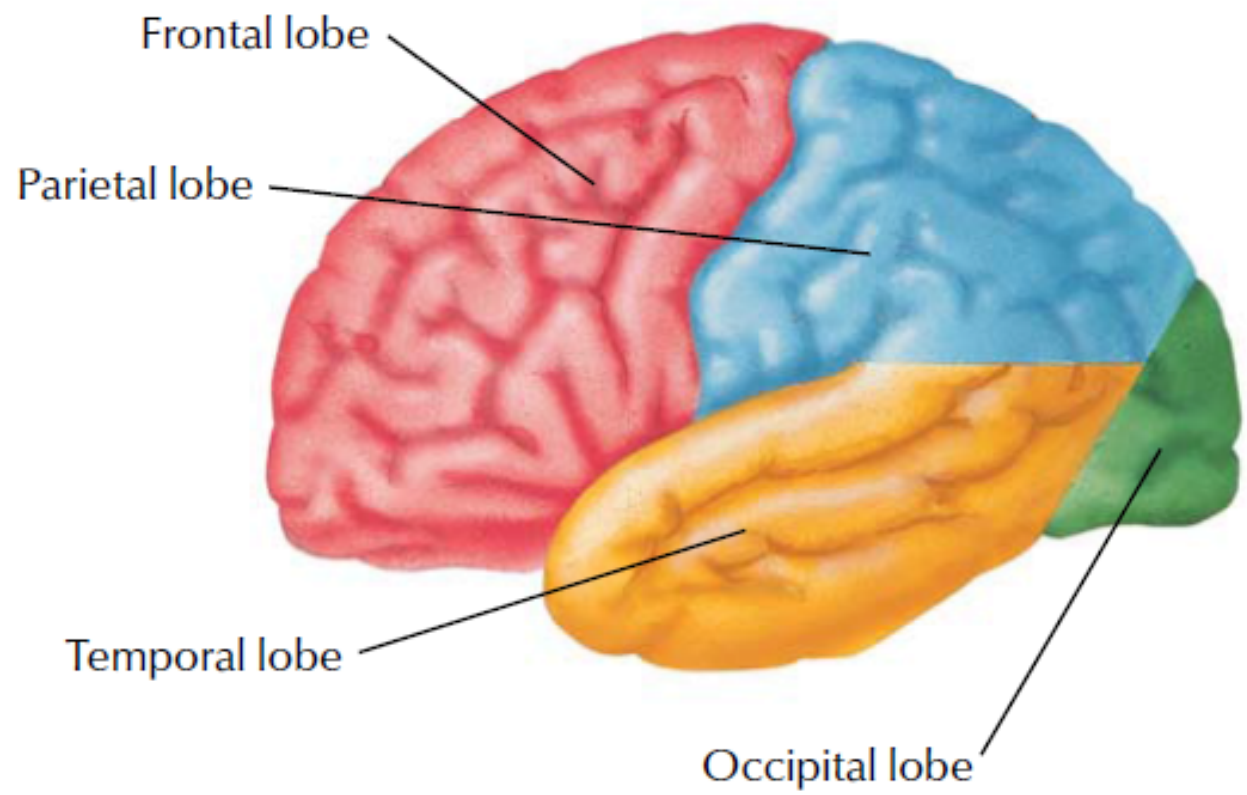


Fig.8: The blood-brain barrier.

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.

Fig.9: The Cerebrum (lateral view).



- The cerebrum is the largest part of the brain. It's formed of two parts (called hemispheres) each of which is formed of four lobes: frontal lobe, parietal lobe, temporal lobe, and occipital lobe.
- It's characterized by the presence of fissures called sulci and protrusions called gyri (Fig.11). The cavity within it is the lateral ventricle.