

THE NERVOUS SYSTEM

By Prof. Hazem

- The nervous system is formed of two types of cells & their processes;
 - Nerve cells: called ***neurons***.
 - Supporting cells: called ***neuroglia***.

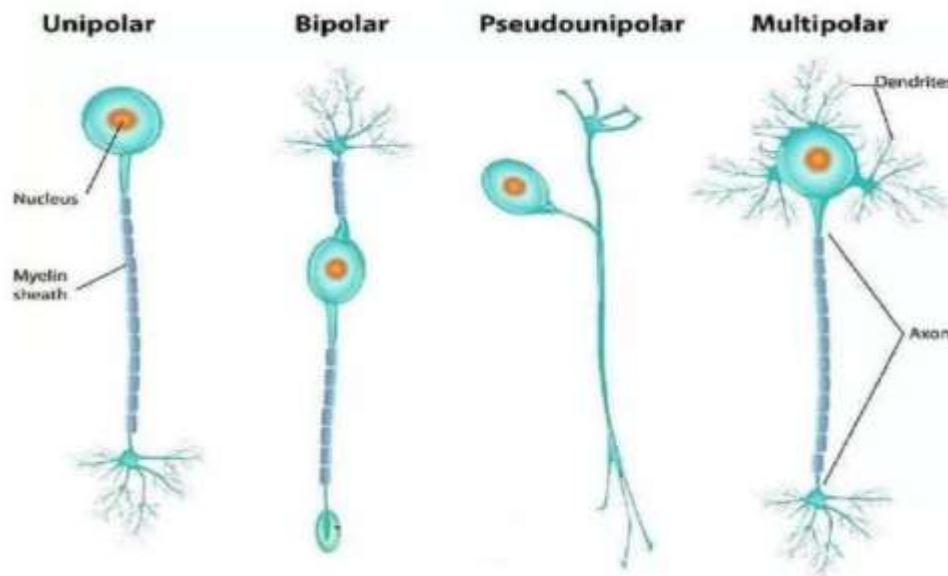
Neurone (nerve cell)

- Definition:** It is the anatomical and functional unit of the nervous system.
- Structure:** it is formed of:
 - Cell body: contains cytoplasm and nucleus.
 - Processes: which are of 2 types; axon and dendrites.

<i>Axon</i>	<i>Dendrites</i>
<ul style="list-style-type: none"> - Single. - Long. - Carries impulses away from the cell body. 	<ul style="list-style-type: none"> - Usually multiple. - Short. - Carries impulses towards the cell body.

NB: some axons are myelinated (surrounded with myelin sheath) for faster conduction while others are unmyelinated.

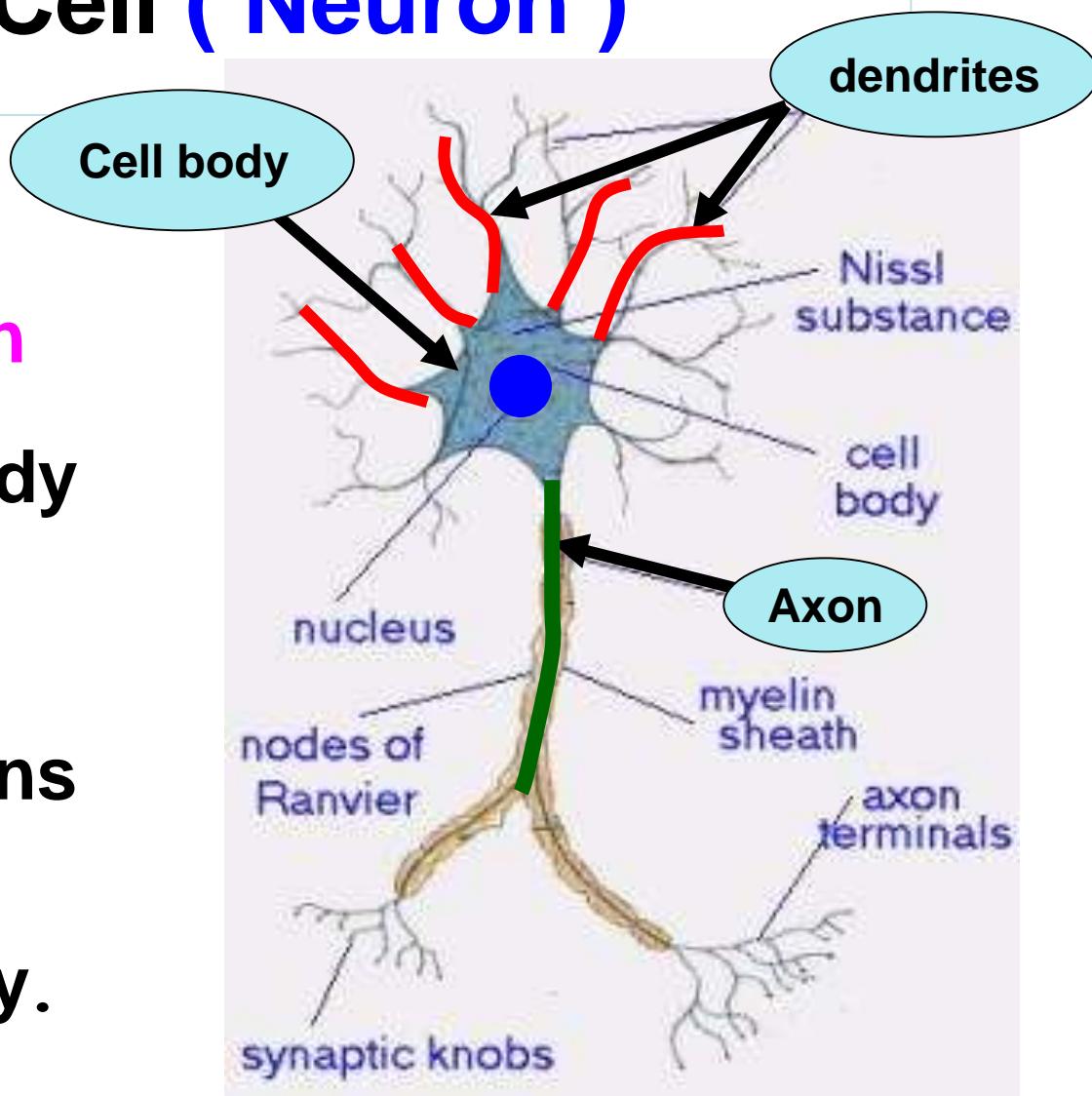
- **Classification (types):** according to the number of process there are 3 types;
1. ***Unipolar Neurons:*** they have one process. They are subdivided into;
 - A. *True unipolar neurons.*
 - B. *Pseudounipolar neurons.*
 2. ***Bipolar Neurons:*** have 2 processes (one acts as axon & the other acts as dendrite).
 3. ***Multipolar Neurons:*** one axon & several dendrites.



The Nerve Cell (Neuron)

It is formed of :

- a) **Cell Body** → contains nucleus
- b) **Processes** → **axon** carries impulses away from cell body & **dendrites** carry impulses towards cell body.
- **Outside CNS** axons run in groups forming different nerves of the body.

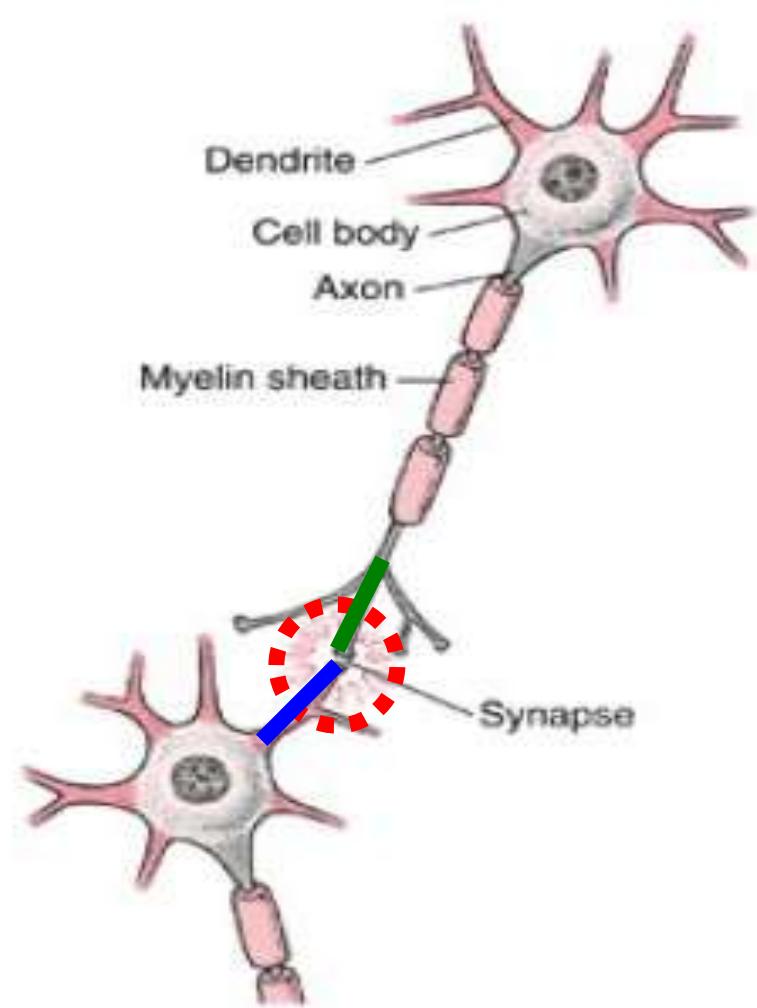


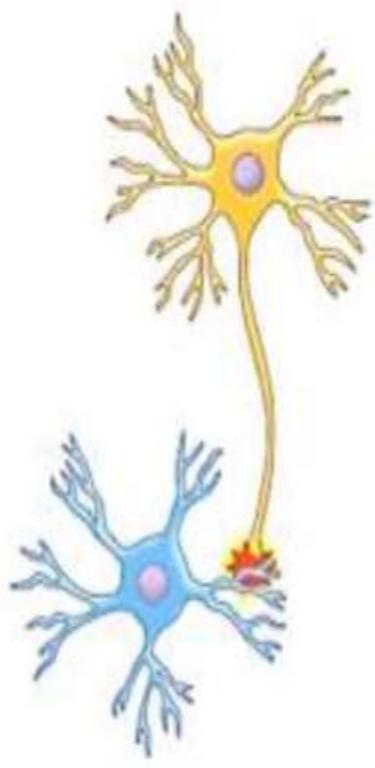
Some definitions in the nervous system

- ***Nucleus:*** aggregation of nerve cells inside the central nervous system (CNS).
- ***Ganglion:*** aggregation of nerve cells outside the C.N.S.
- ***Tract:*** collection of nerve fibers which have the same origin, termination and function.
- ***Bundle:*** collection of nerve fibers which do not all have the same origin, termination or function.
- ***Synapse:*** site of contact of the axon of one neuron and one of the following:
 - ✓ The dendrites of other neuron (***axo-dendritic***).
 - ✓ The cell body of another neuron (***axo-somatic***).
 - ✓ The axon of another neuron (***axo-axonic***).
 - ✓ Effective organ; as muscle (***motor end plate***) or gland.

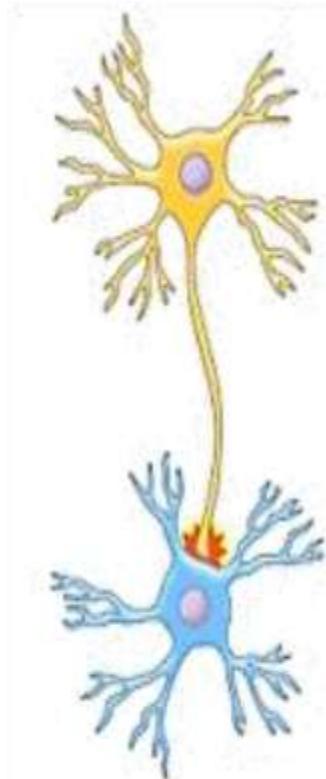
Synapse (relay)

- Impulses can pass from one neuron to another by the meeting of the axon of one neuron with the dendrites of the other.
- This meeting is called **synapse or relay**

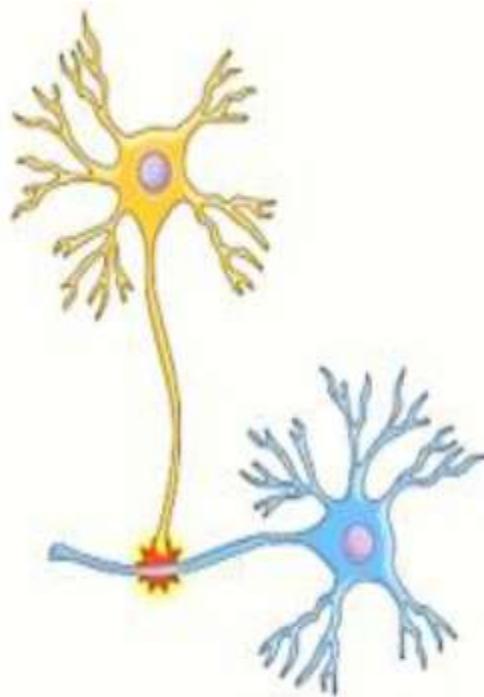




Axo-dendritic



Axo-somatic



Axo-axonic



Motor end plate

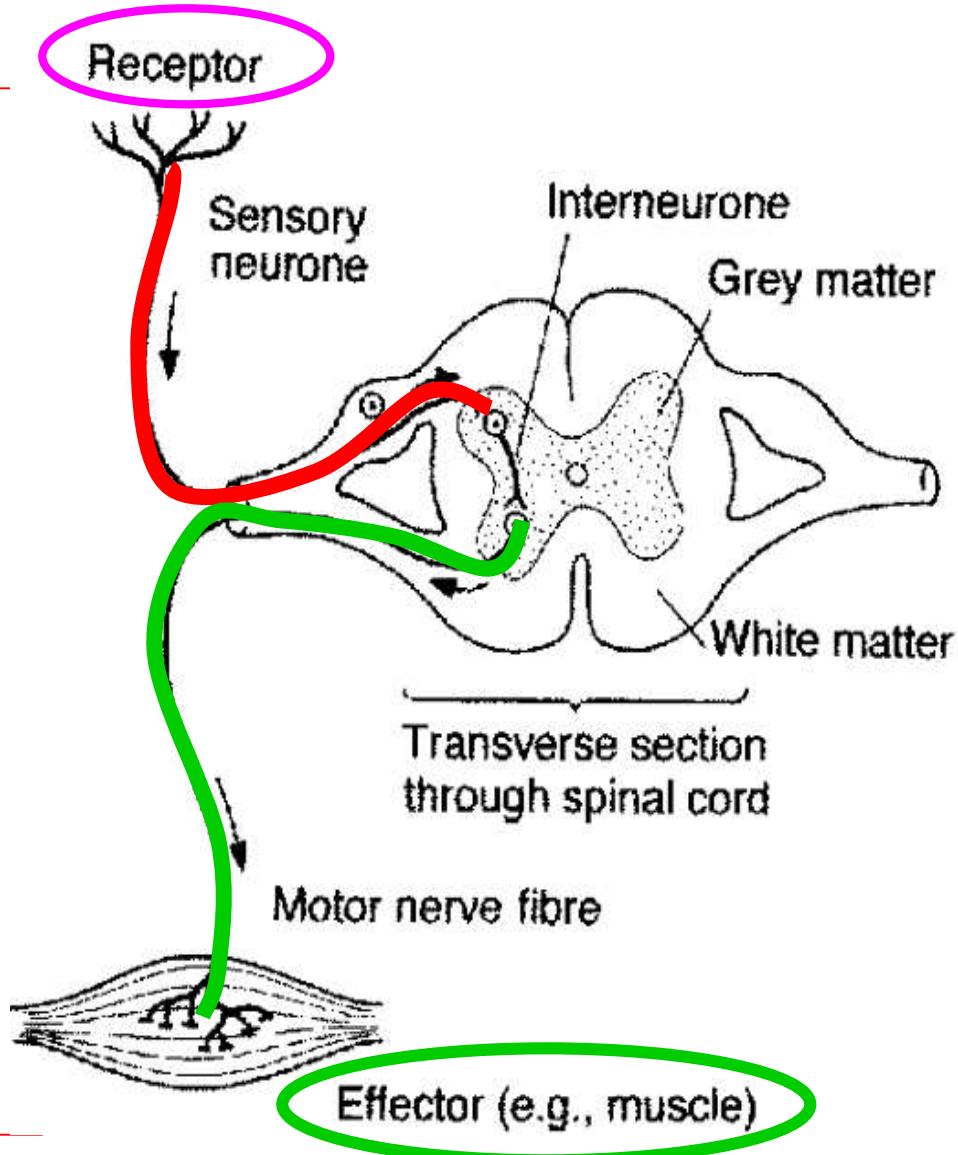
The anatomical and functional unit of CNS is the neuron

- **Types of neurons:**

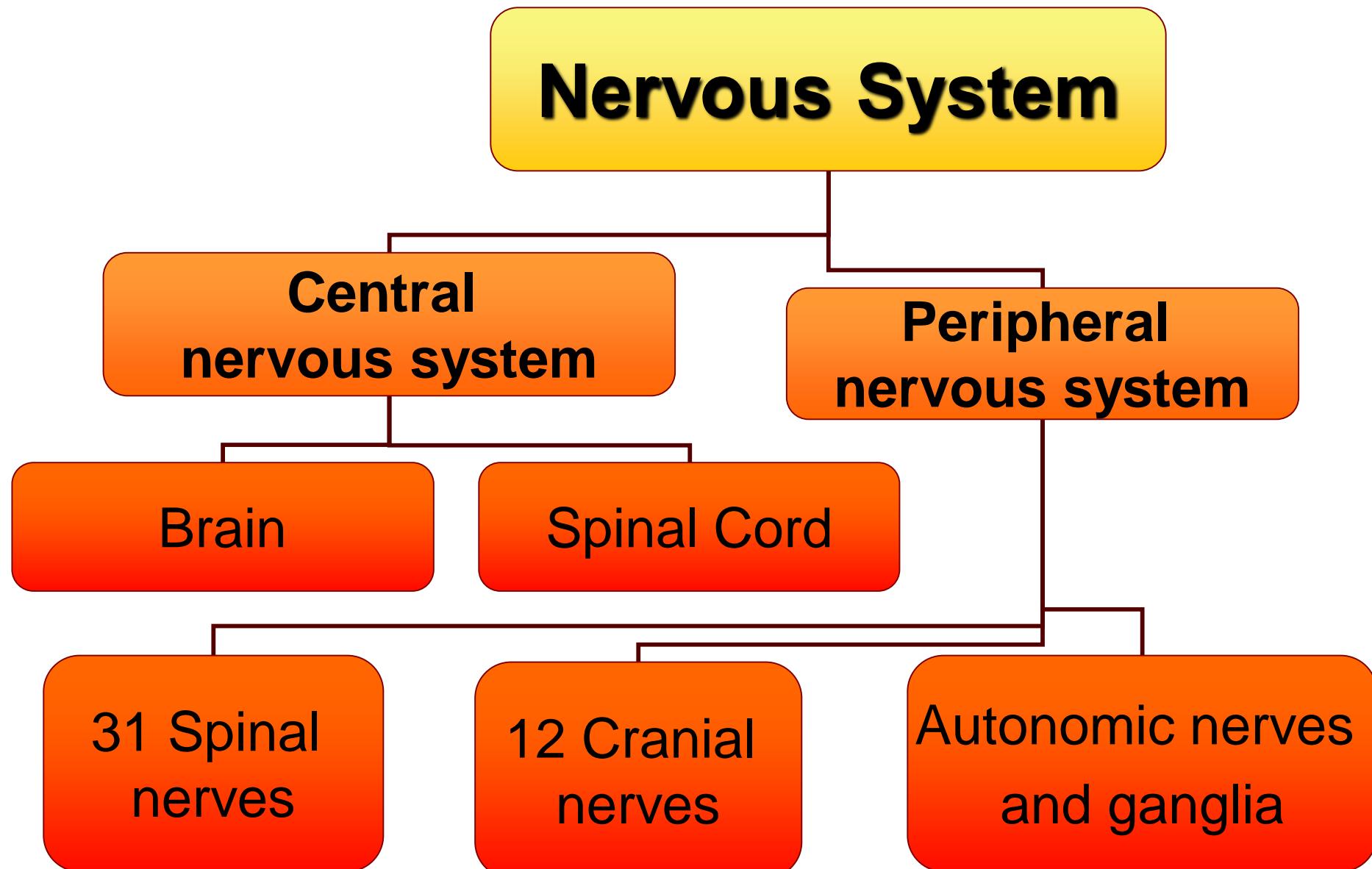
1-Sensory neurons which receive stimuli from receptors all over the body

2-Motor neurons which send the proper impulses to the effectors e.g. muscles

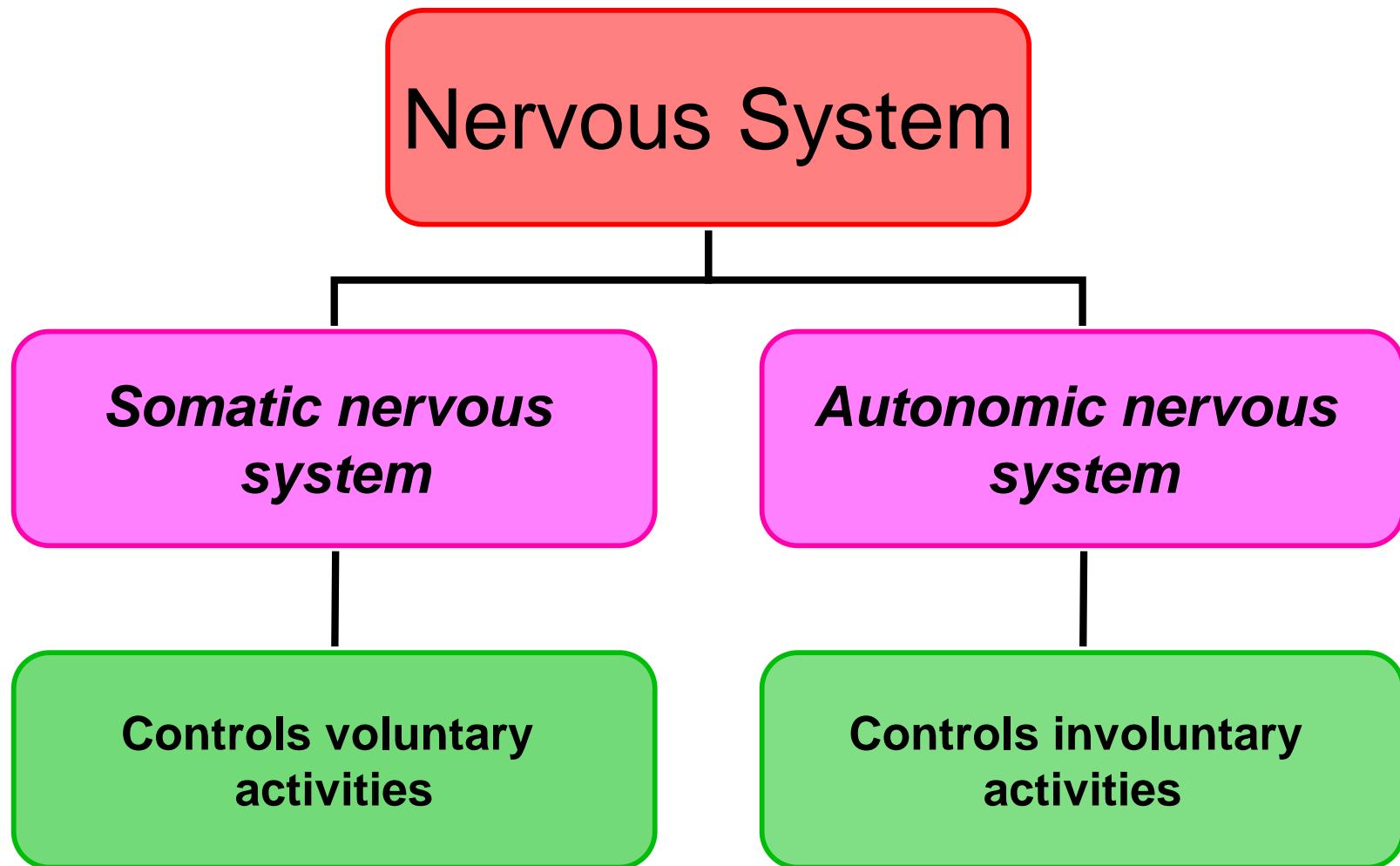
3-Connector or inter neuron



Structurally, the nervous system is divided into:

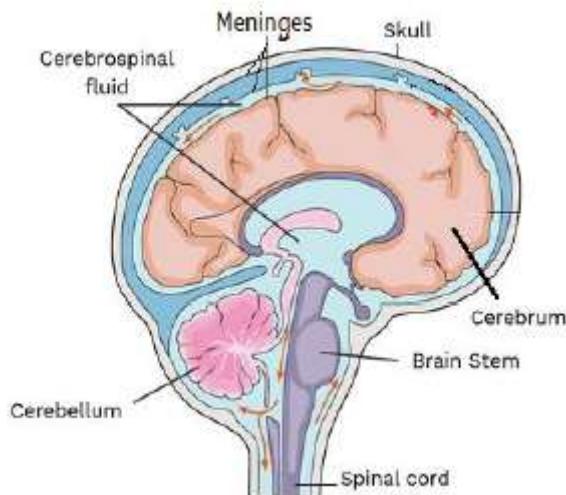


Functionally, the nervous system includes 2 main components:



Central Nervous System

- ❖ CNS consists of brain and spinal cord.
- ❖ C.N.S can't regenerate if injured. So, it is **protected by:**
 - **Bones** (The *skull* protects the brain while the *vertebral column* protects the spinal cord).
 - **Meninges** (dura [outer], arachnoid [middle] and pia [inner] matters).
 - **Cerebrospinal fluid (CSF)**: circulates around the brain and spinal cord.

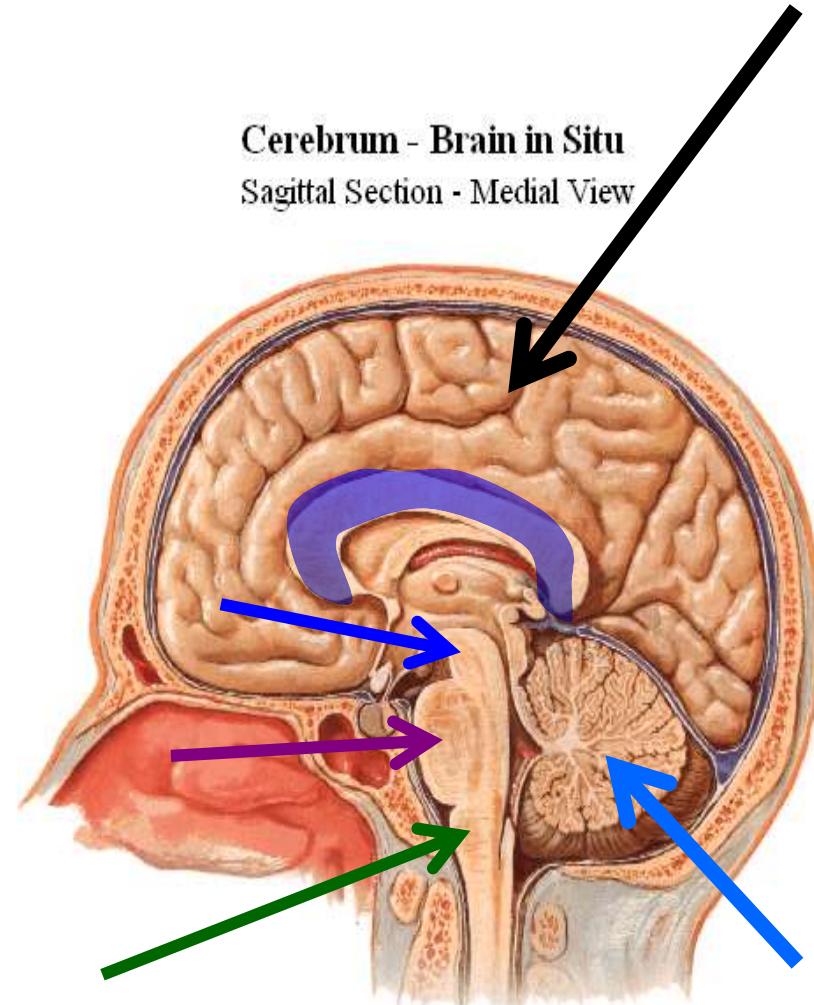


THE BRAIN

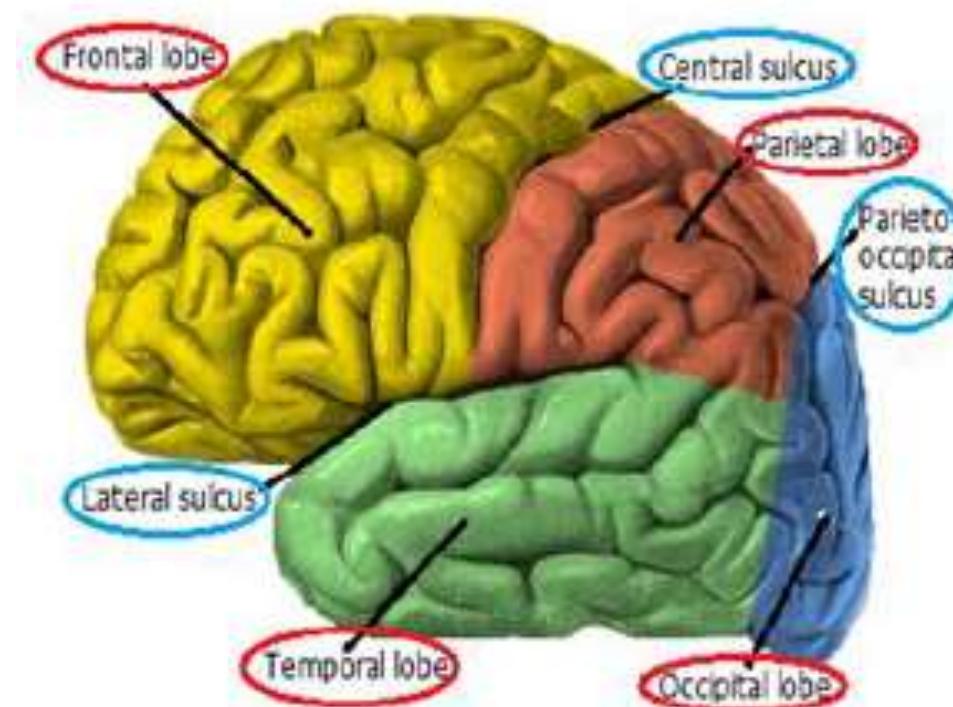
Formed of :

- **Cerebrum** (2 cerebral hemispheres + diencephalon)
- **Brain stem** → midbrain, pons & medulla oblongata
- **Cerebellum** → formed of 2 cerebellar hemispheres (equilibrium and coordination of movements)

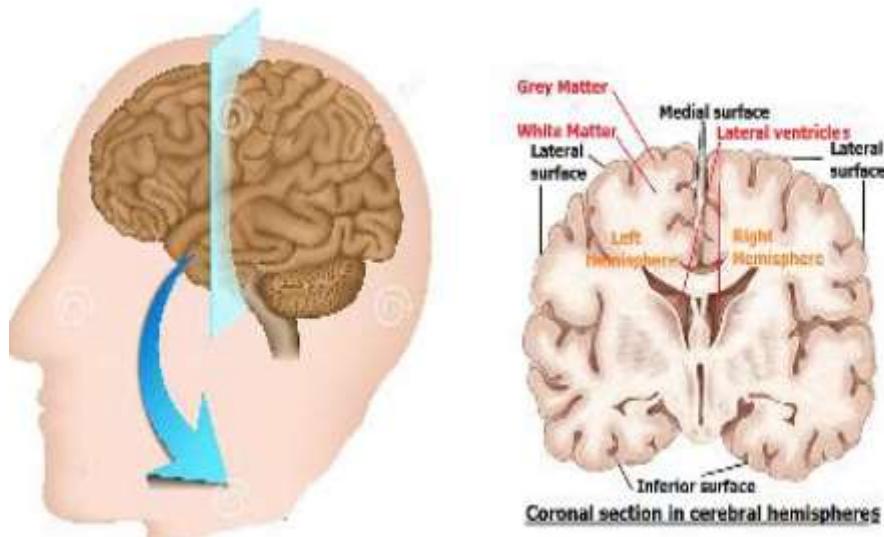
Cerebrum - Brain in Situ
Sagittal Section - Medial View



- *Cerebrum*: formed of 2 hemispheres which contain different motor and sensory cortical areas. It has:
 - ✓ 3 surfaces; medial, lateral and inferior.
 - ✓ 4 major sulci; lateral, central, calcarine and parieto-occipital.
 - ✓ 4 lobes; frontal, parietal, temporal and occipital.

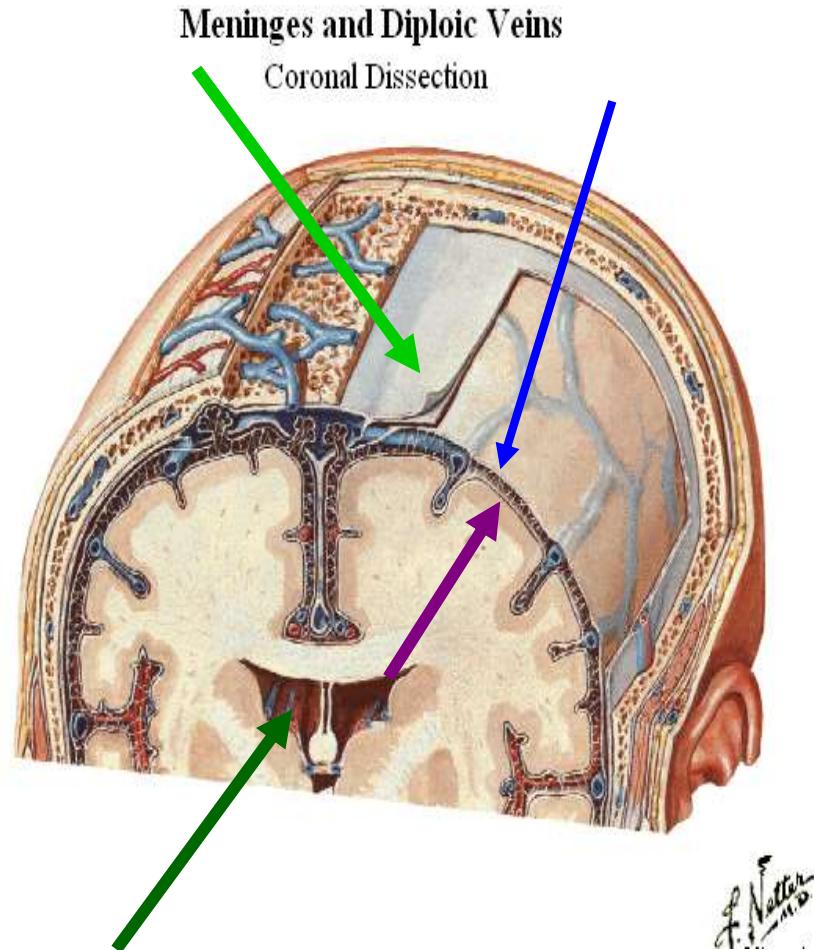


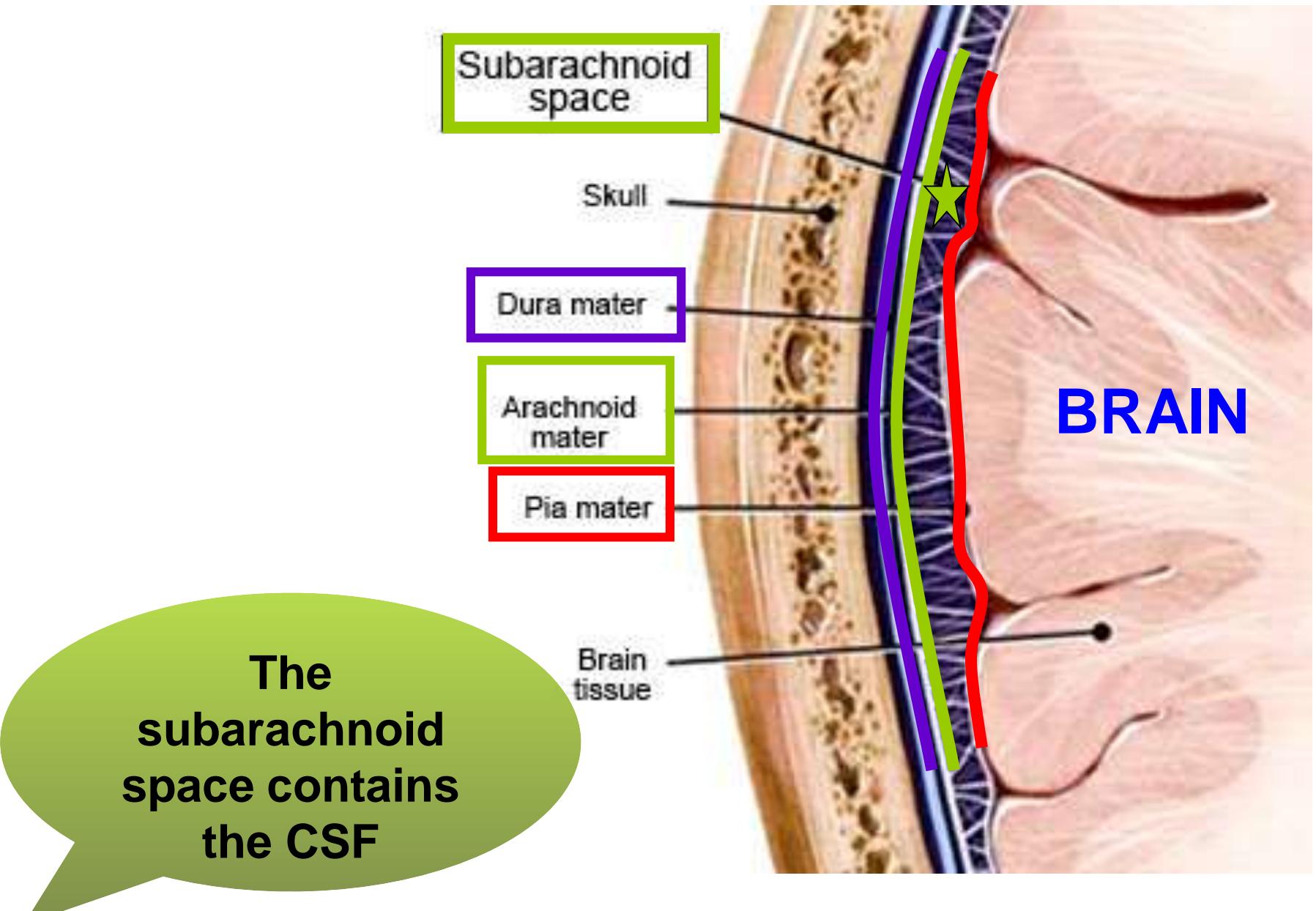
- In cross sections, the cerebrum and the cerebellum shows:
 1. *Grey matter (cortex)*: dark outer areas which contain the cell bodies.
 2. *White matter*: light inner areas which contain nerve fibers (axons) and collections of nerve cells (nuclei).
 3. *Cavities*: the brain contains cavities called ventricles (2 lateral, 3rd and 4th) which contain CSF.



The Brain

- Covered by 3 meninges → dura mater, arachnoid mater & pia mater
- Contains cavities called ventricles

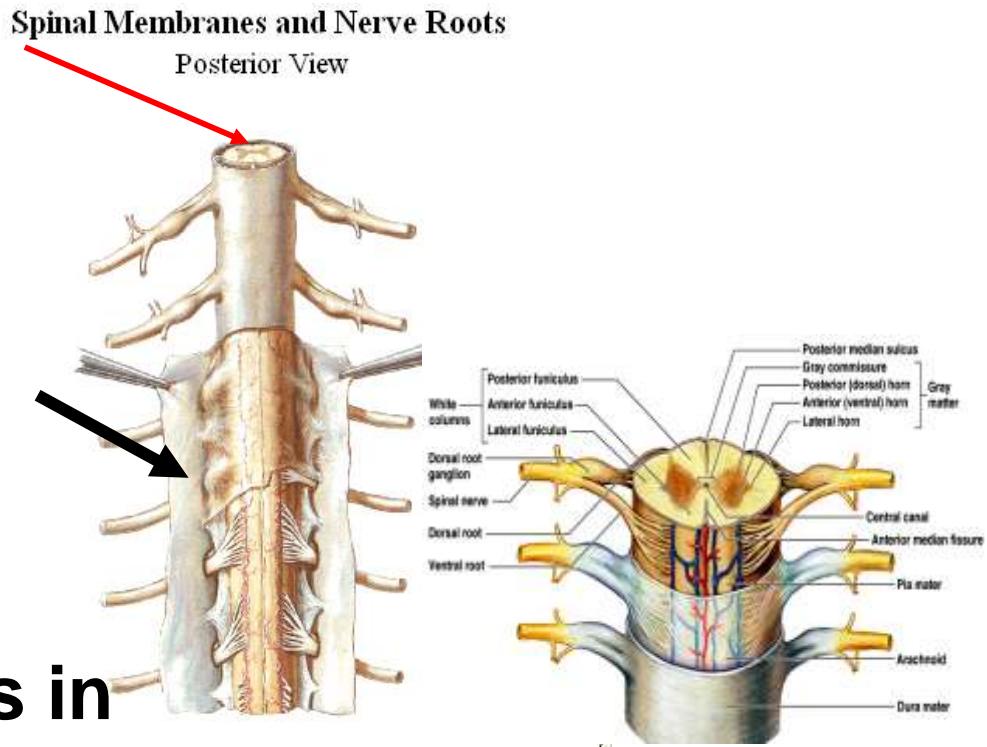




THE SPINAL CORD

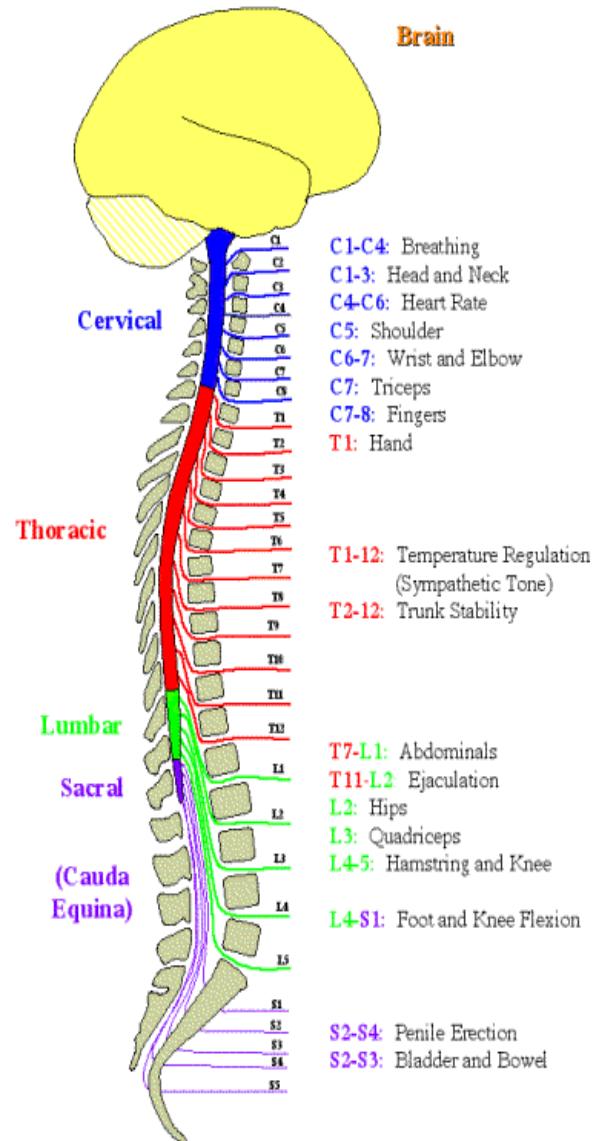
- **Covered by 3 meninges**
- **Contains a cavity called the **central canal****

It is about 45 cm, ends in adults at the level of **lower border of first lumbar vertebra.**



THE SPINAL CORD

- The spinal cord is divided into **31 segments** :
- 8 cervical segments**
- 12 thoracic segments**
- 5 lumbar segments**
- 5 sacral segments**
- 1 coccygeal segment**



THE SPINAL CORD

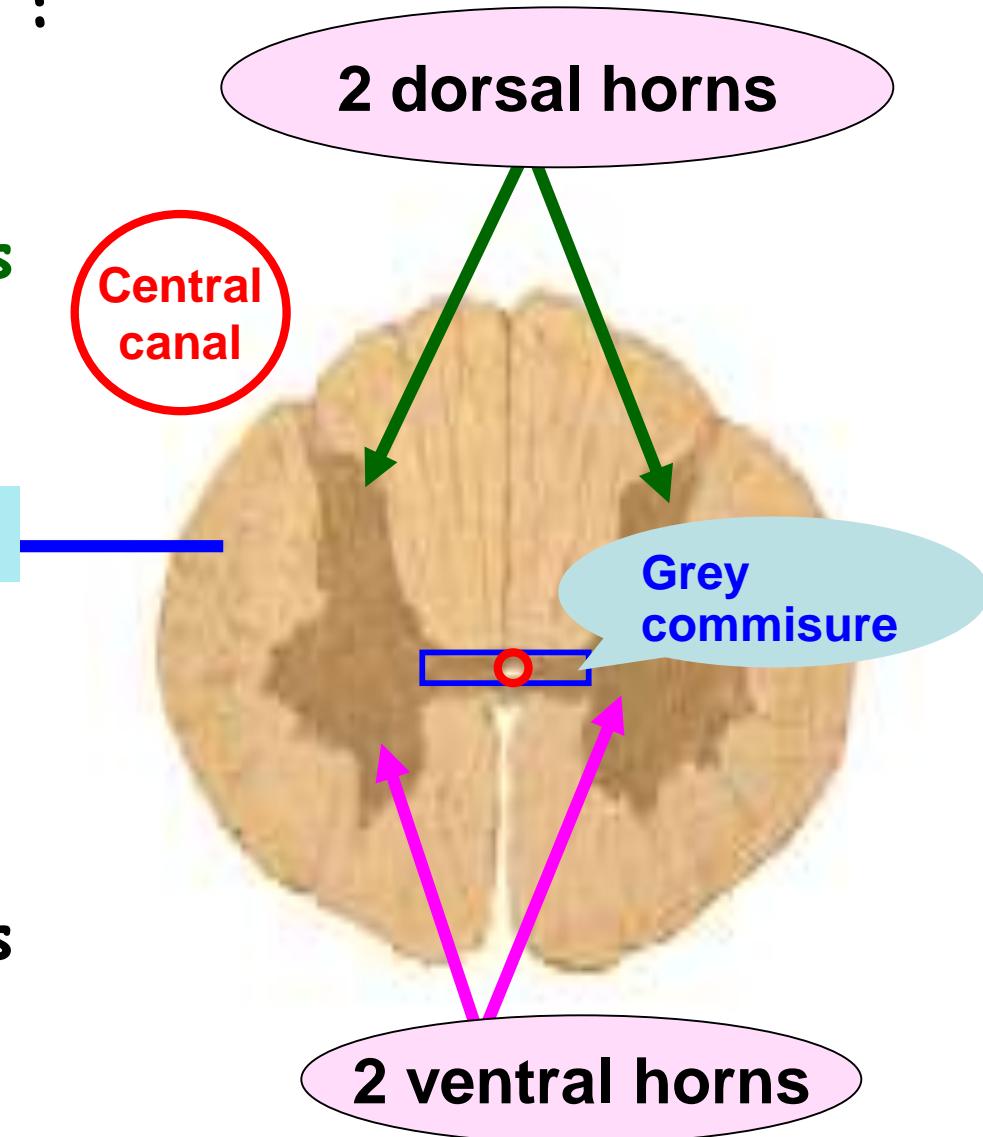
- In cross section, it shows :

Grey mater → the inner part. Has **2 dorsal horns containing sensory neurons** & **2 ventral horns containing motor neurons**

White mater

Some of the spinal cord segments have **two lateral horns** for autonomic nervous system.

White mater → surrounds the grey mater & contains nerve fibers which run as tracts



THE PERIPHERAL NERVOUS SYSTEM

- Formed of :
 1. **Cranial nerves** → 12 pairs which arise from the brain
 2. **Spinal nerves** → 31 pairs which arise from the spinal cord



Brainstem
Anteriorinferior View



31 pairs of spinal nerves

Cervical nerves

Thoracic nerves

Lumbar nerves

Sacral/ coccygeal nerves

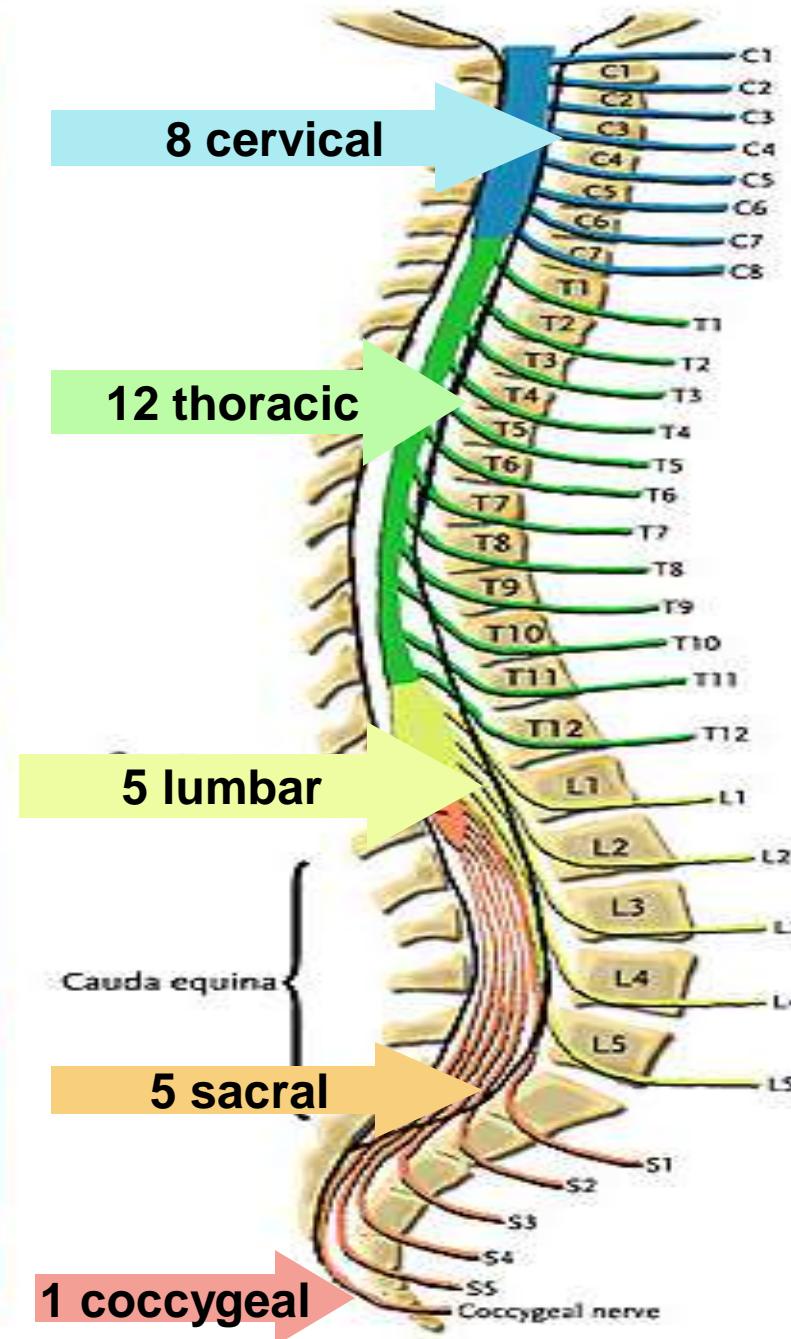
8 cervical

12 thoracic

5 lumbar

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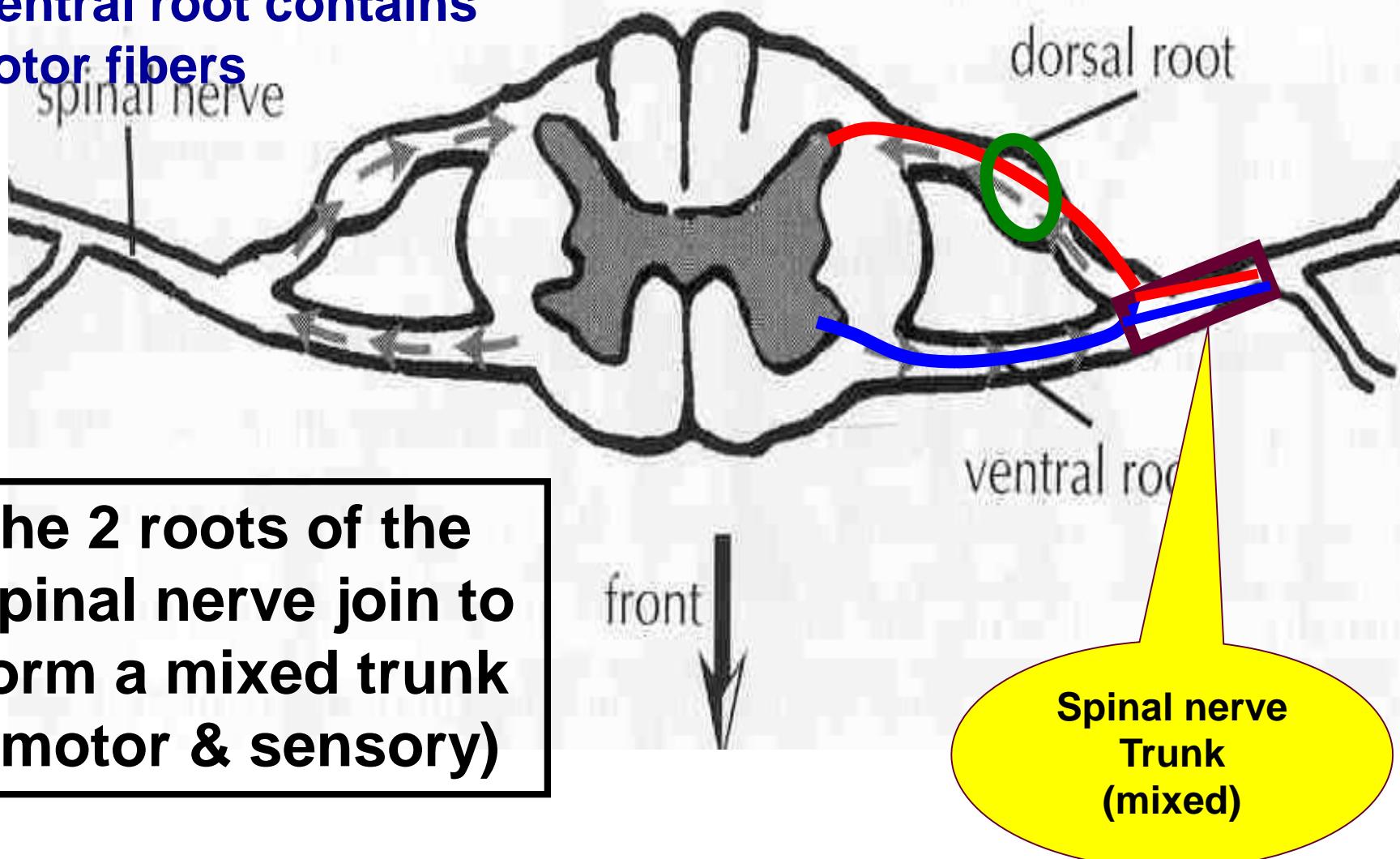


Typical spinal nerve

- Dorsal root contains sensory fibers

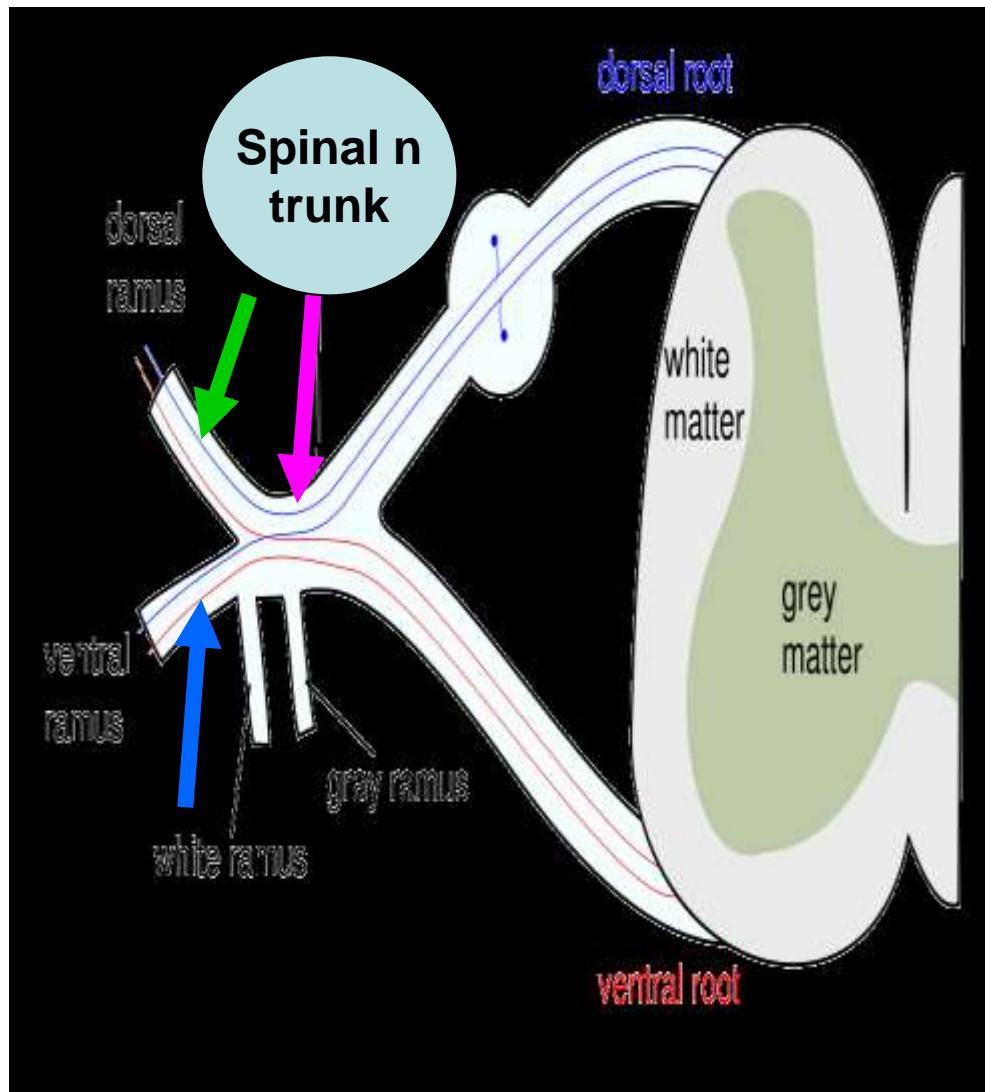
- Ventral root contains motor fibers

- Each dorsal root has a dorsal root ganglion (a nodule on the dorsal root formed of cell bodies of neurons)



Spinal nerve

- The 2 roots of the spinal nerve join to form a **mixed trunk** (motor & sensory)
- The trunk passes through intervertebral foramen & divides into **2 rami** → 1st **dorsal ramus** & 1st **ventral ramus**



Primary Rami

1. Dorsal primary ramus (small) :

- Small mixed nerve
- Supplies muscles & skin of back
- Do not form nerve plexuses

2. Ventral primary ramus (large) :

- Large mixed nerve
- Supplies skin & muscles of the rest of the body
- Form nerve plexuses with neighboring rami
- Connected to sympathetic chain

CRANIAL NERVES

(12 Pairs)

Number	Name	Number	Name
I	Olfactory	VII	Facial
II	Optic	VIII	Vestibulo-cochlear
III	Oculomotor	IX	Glossopharyngeal
IV	Trochlear	X	Vagus
V	Trigeminal	XI	Accessory
VI	Abducent	XII	Hypoglossal

The cranial nerves

There are **12 pairs** of cranial nerves .

First: Olfactory nerve.I

- It is a **sensory** nerve concerned with olfaction (smell).

Second: Optic nerve. II

- It is a **sensory** nerve concerned with vision.

Third: Oculomotor nerve.III

- It contains motor and **parasympathetic fibers**.
- Its motor fibers for eye-ball movements.

Fourth: Trochlear nerve.IV

- It is motor for eye-ball movements (single muscle).

Fifth: Trigeminal nerve.V

- for sensations of the face, muscles of mastication and some autonomic functions.

Sixth: Abducent.VI

- Motor for eye-ball movements (single muscle).

Seventh: Facial nerve. VII

- for movements of the facial expression, taste and some autonomic functions

Eighth: Vestibulo-cochlear. VIII

- It is totally **sensory** and formed from two divisions.
- Cochlear for **hearing**.
- Vestibular for **equilibrium..**

Ninth: Glossopharyngeal. IX

- It is a **mixed** nerve for sensory, taste and autonomic functions in the head and neck region.

Tenth: Vagus nerve. X

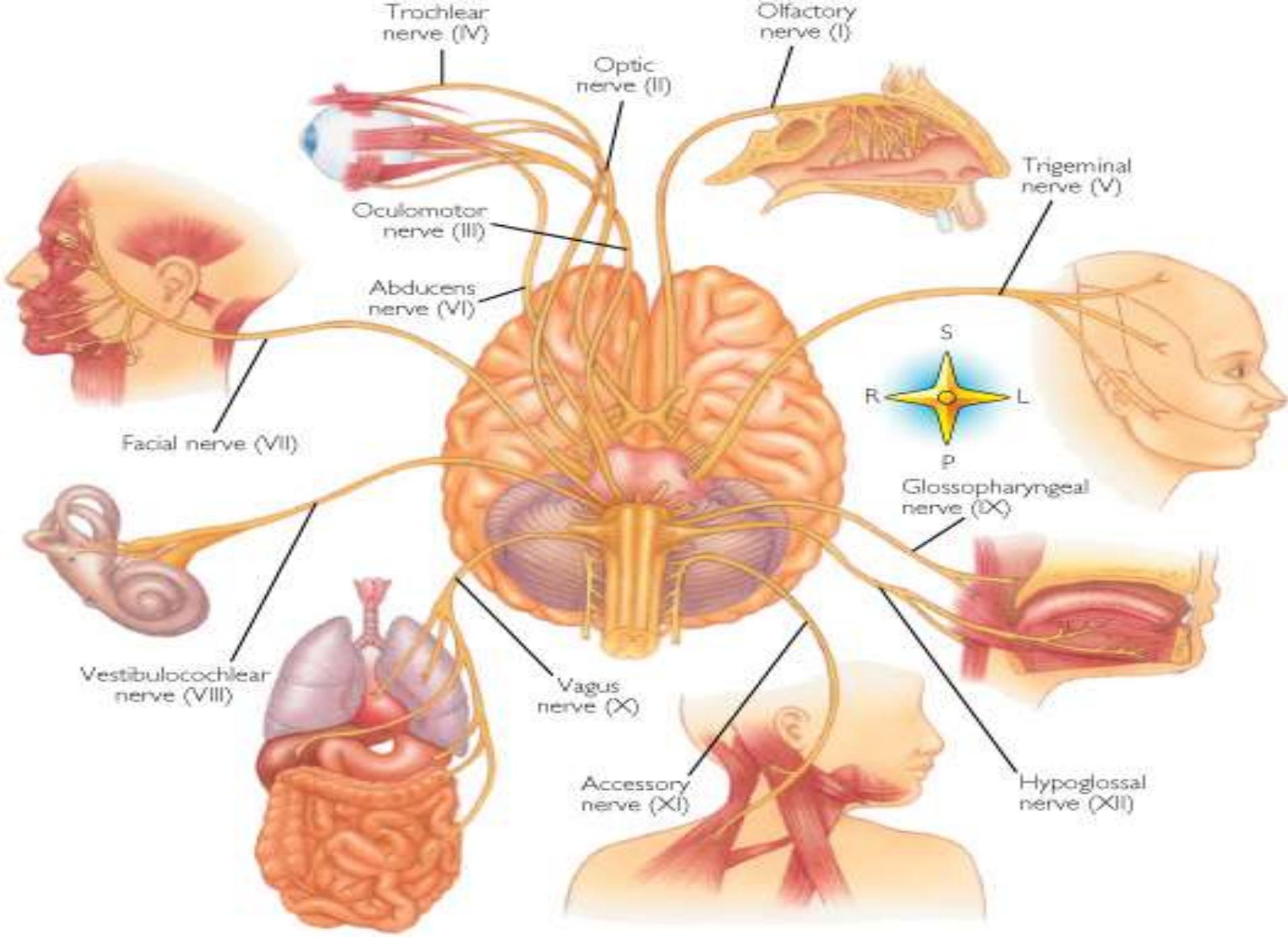
- It is a **mixed nerve** controls the heart, respiratory tract, digestive tube regarding their autonomic functions.

Eleventh: Accessory nerve. XI

- for movements of the pharynx and some somatic muscles.

Twelfth: Hypoglossal.XII

- It is **motor** to muscles of the tongue.



Autonomic nervous system

The autonomic nervous system innervates the **involuntary muscles** of the heart and the smooth muscles of the gastrointestinal and respiratory tracts.

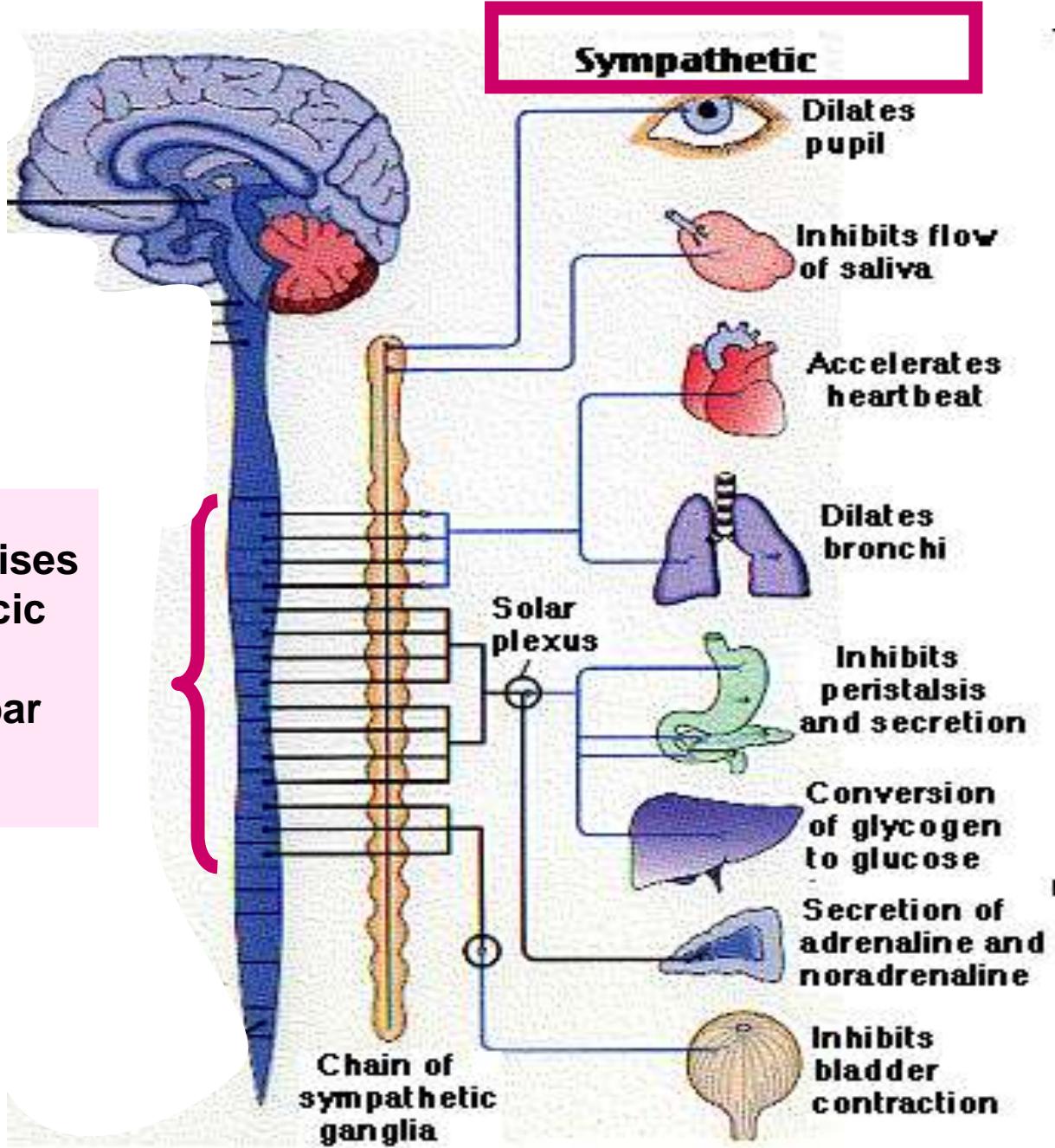
- It is divided into **sympathetic** and **parasympathetic** parts.

Autonomic nervous system

Sympathetic nervous system: present in the lateral horn cells of **all thoracic and upper two lumbar segments** of the spinal cord (thoraco-lumbar outflow).

- It prepares the body **for emergencies** so it increases the blood supply to the heart, skeletal muscles and the brain on the expense of the blood flow to the skin and the intestine which is reduced.
- It raises the blood pressure, accelerates the heart rate, decreases peristalsis and closes the sphincters.

Sympathetic arises
from all thoracic
&
Upper 2 lumbar
segments



Autonomic nervous system

The parasympathetic nervous system:

- It is present in two sites:

Cranial part: lies in the brainstem in the nuclei of 3rd, 7th, 9th and 10th cranial nerves.

Spinal part present in the lateral horn cells of the **middle three sacral segments** of the spinal cord.

- **(Craniosacral outflow)**

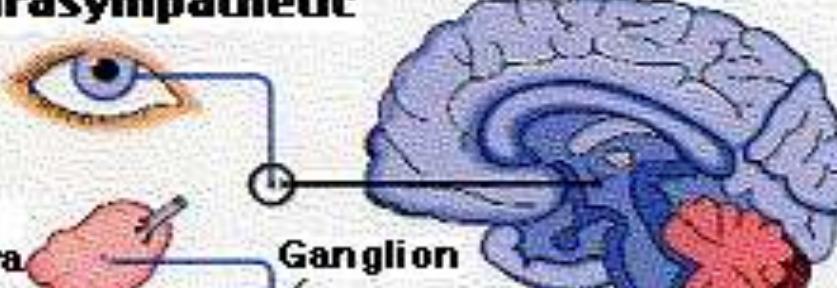
The **parasympathetic nervous system:**

- The parasympathetic nervous system aims to restore energy.
- It slows the heart rate, increase peristalsis and opens the sphincters and increases the glandular activity.

	Sympathetic (Thoracolumbar)	Parasympathetic (Craniosacral)
Origin:	- Lateral horn cells of (T1 to L3) spinal cord segments.	- Cranial Outflow: from the brainstem. - Sacral Outflow: from spinal cord segments S2, 3, 4.
Ganglia:	- Lateral: on both sides of vertebral column. - Collateral: between the spinal cord and the organs.	- Terminal: located near or at the organs. - Collateral: between the spinal cord and the organs.
Function:	- <i>Fight and flight.</i> - Inhibitory to everything except the heart. - Decrease glandular secretion & peristalsis of the gut. - Contraction of the sphincters. - Bronchodilatation.	- <i>Rest and digest.</i> - Excitatory to everything except the heart - Increases glandular secretion & peristalsis of the gut. - Relaxation of the sphincters. - Bronchoconstriction.

Parasympathetic

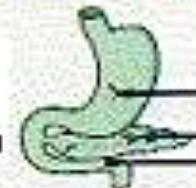
Stimulates flow of saliva



Slows heartbeat

Constricts bronchi

Stimulates peristalsis and secretion



Stimulates release of bile

Contracts bladder



Sympathetic

Dilates pupil

Inhibits flow of saliva

Accelerates heartbeat

Dilates bronchi

Inhibits peristalsis and secretion



Conversion of glycogen to glucose

Secretion of adrenaline and noradrenaline

Inhibits bladder contraction

Chain of sympathetic ganglia

THANK YOU