

# THE NERVOUS SYSTEM

By Prof. Hazem

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

### **Neurone (nerve cell)**

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

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

**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;

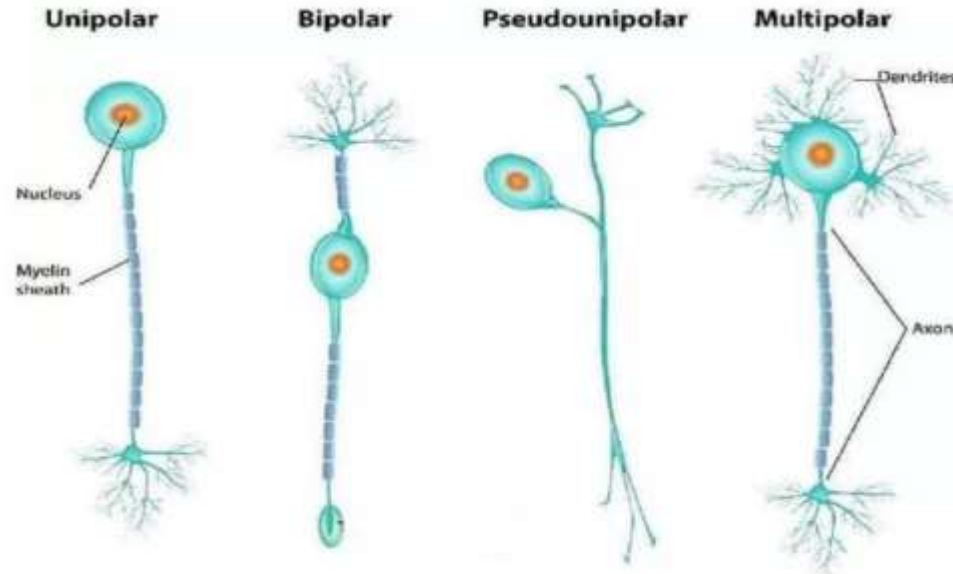
1. ***Unipolar Neurons:*** they have one process. They are subdivided into;

A. *True unipolar neurons.*

B. *Pseudounipolar neurons.*

2. ***Bipolar Neurons:*** have 2 processes (one acts as axon & the other acts as dendrite).

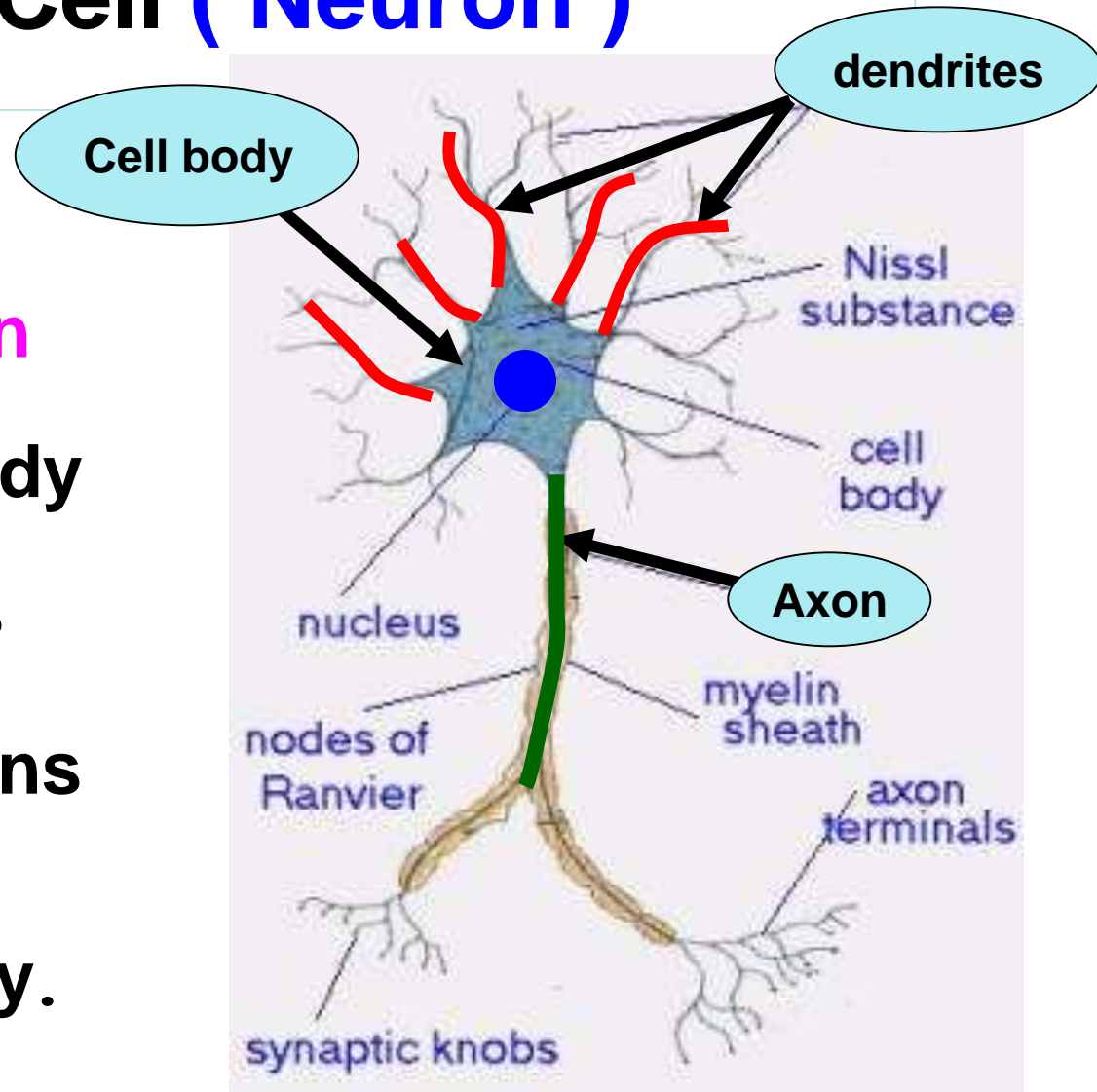
3. ***Multipolar Neurons:*** one axon & several dendrites.



# 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.

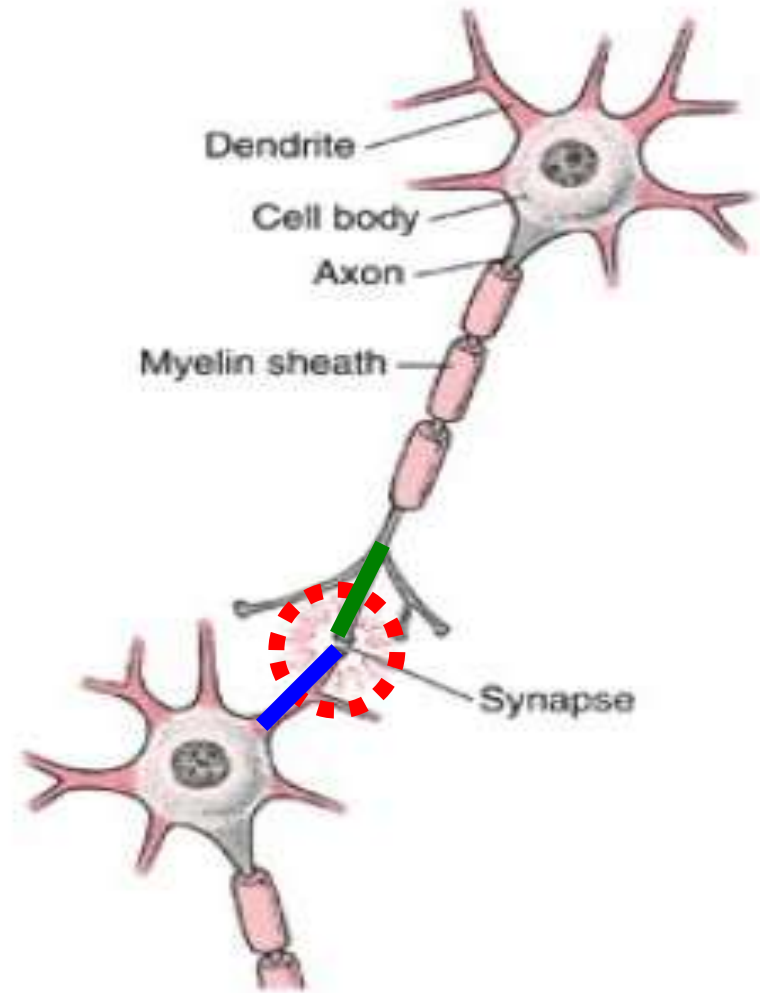


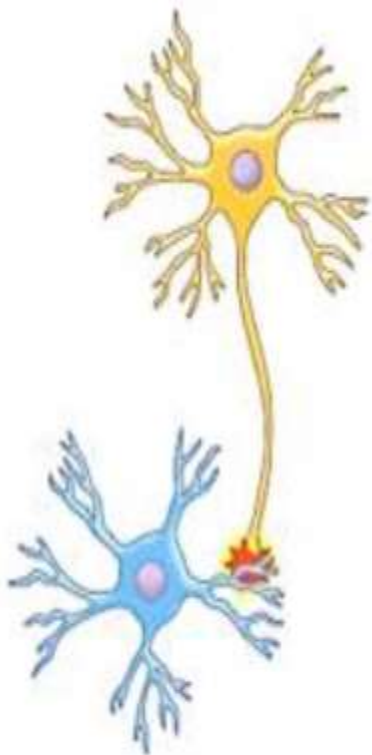
## Some definitions in the nervous system

- **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**

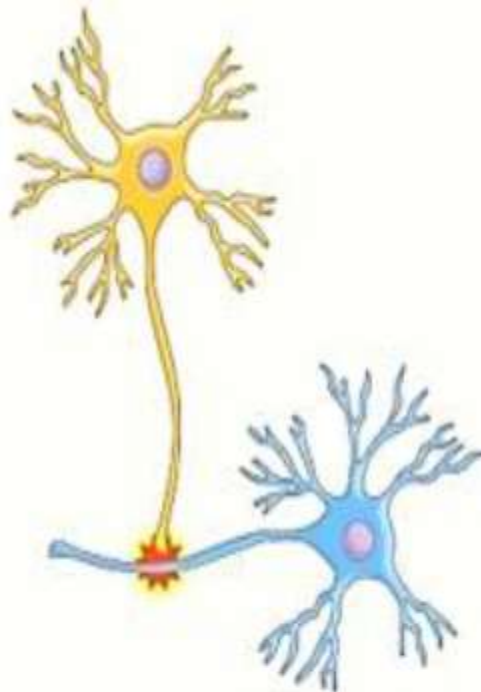




**Axo-dendritic**



**Axo-somatic**



**Axo-axonic**



**Motor end plate**



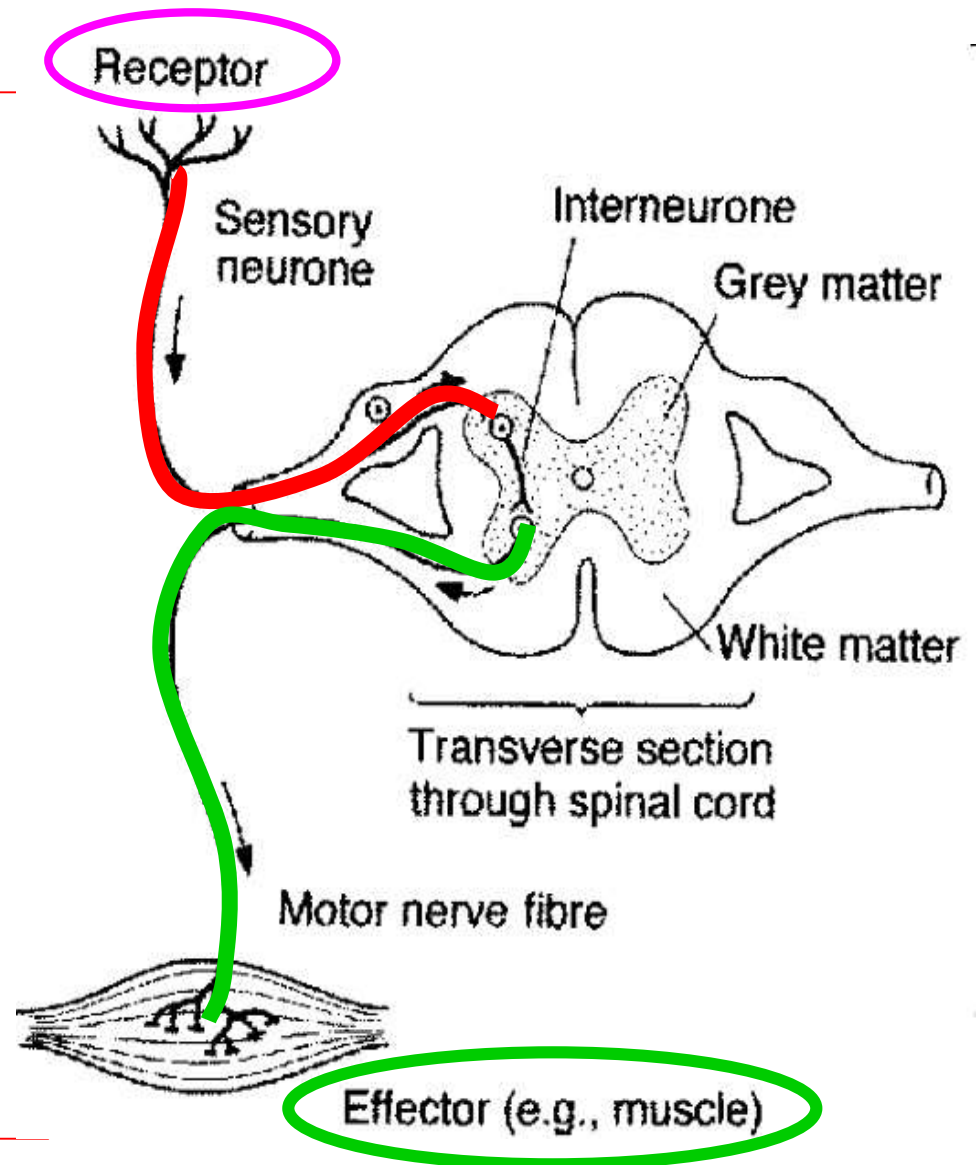
The *anatomical and functional unit* of CNS is the neuron

- Types of neurons:

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

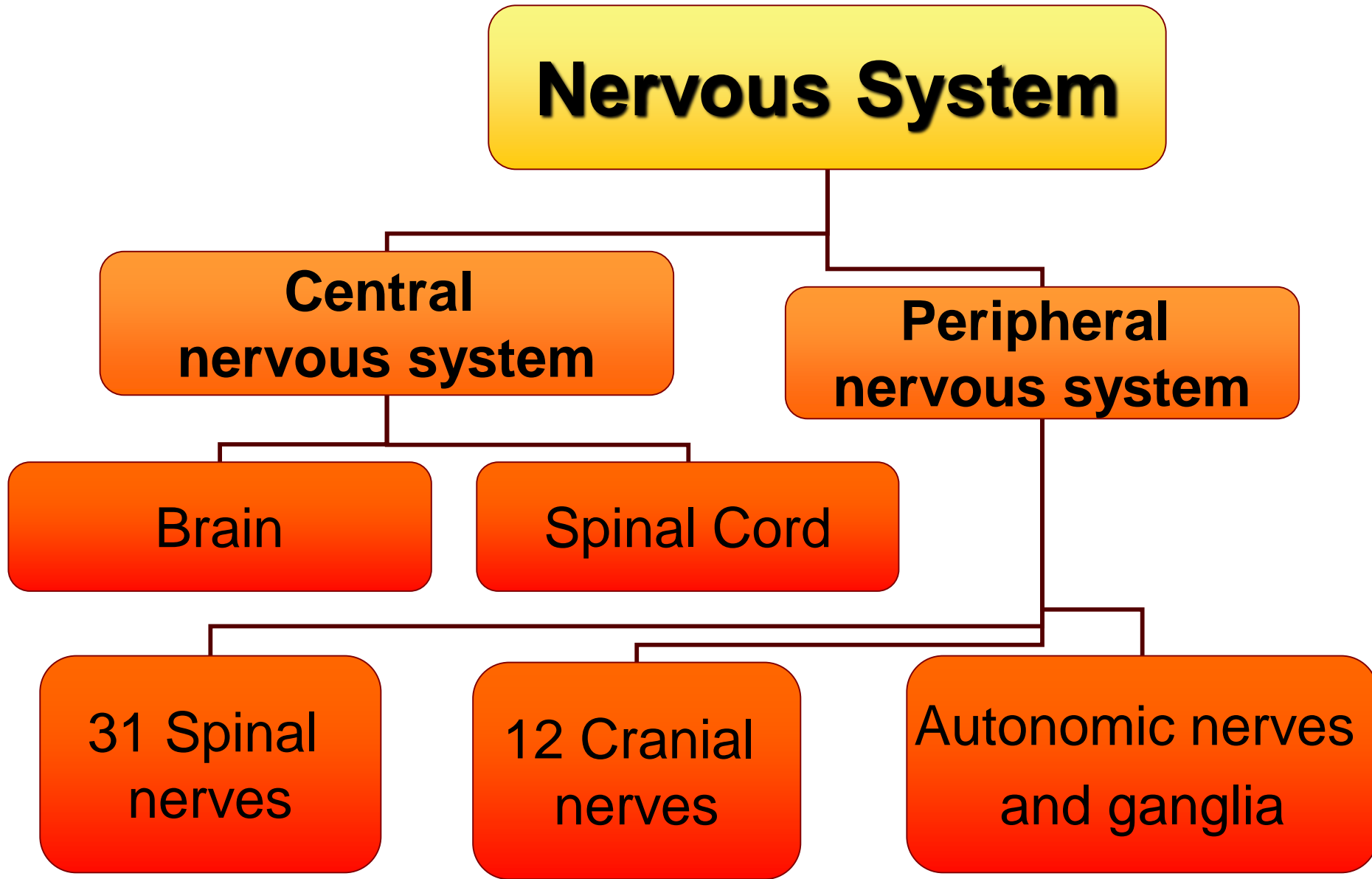
2-Motor neurons which send the proper impulses to the effectors e.g. muscles

3-Connector or interneuron

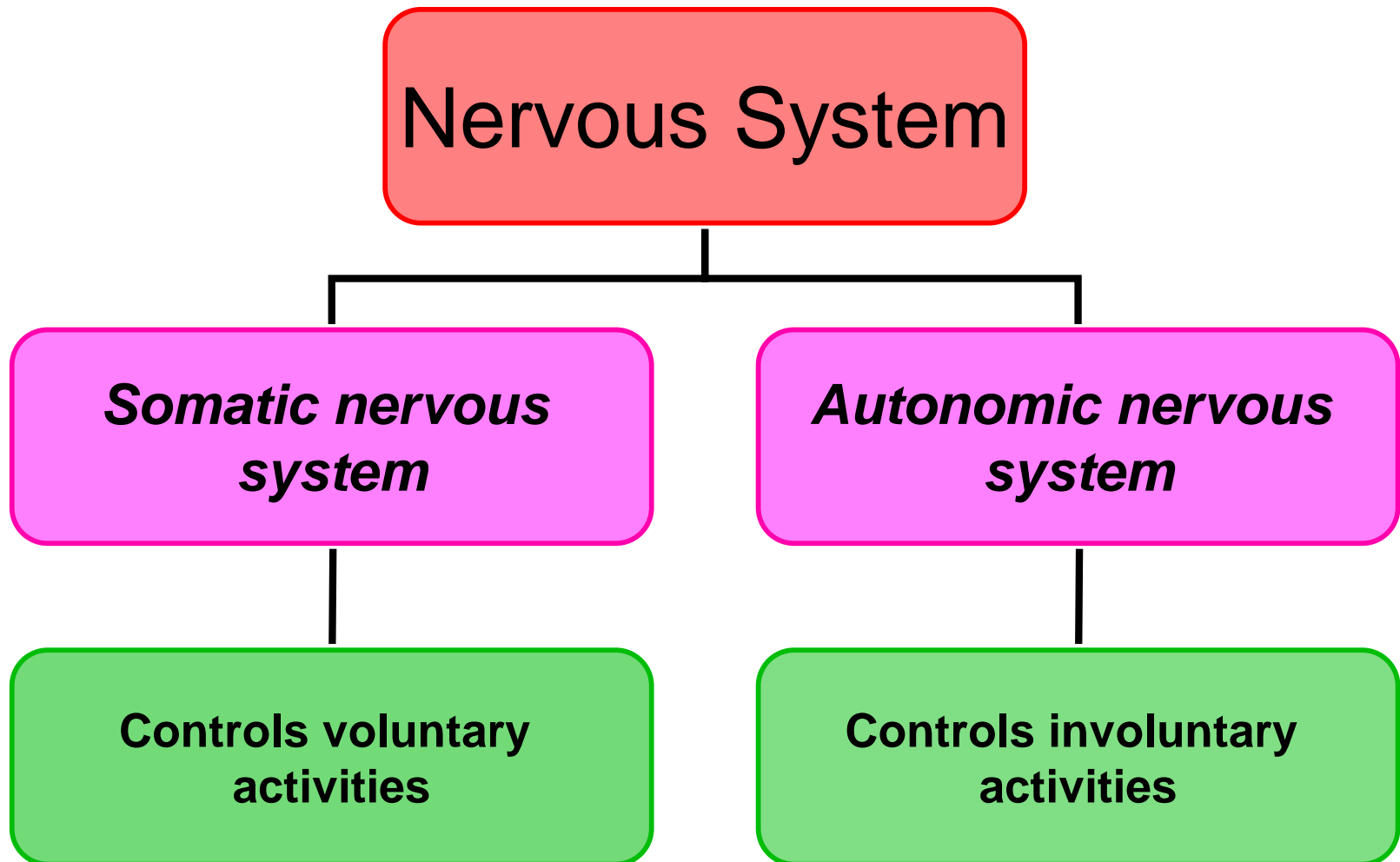




**Structurally, the nervous system is divided into:**

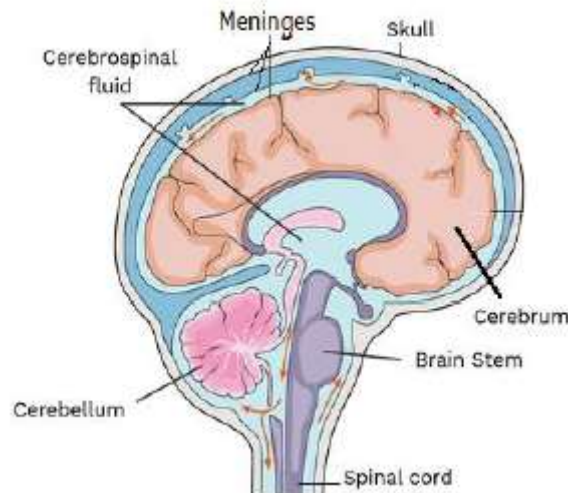


**Functionally, the nervous system includes 2 main components:**



## **Central Nervous System**

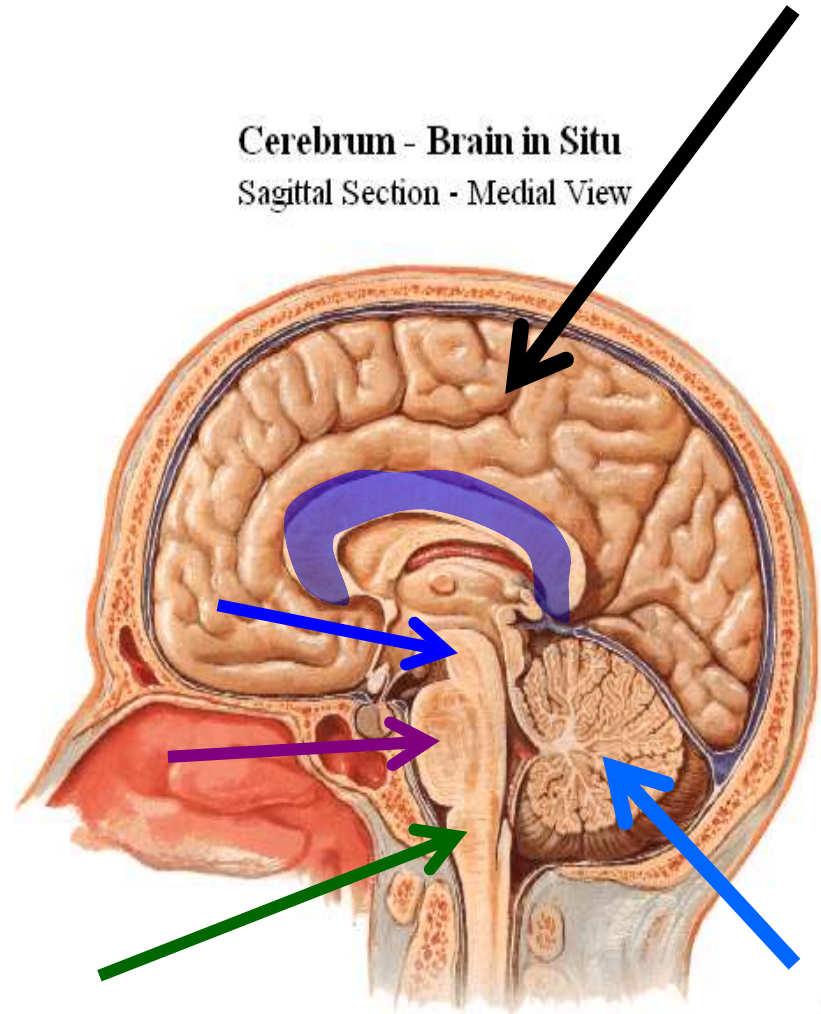
- ❖ CNS consists of brain and spinal cord.
- ❖ C.N.S can't regenerate if injured. So, it is **protected** by:
  - **Bones** (The *skull* protects the brain while the *vertebral column* protects the spinal cord).
  - **Meninges** (dura [outer], arachnoid [middle] and pia [inner] matters).
  - **Cerebrospinal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



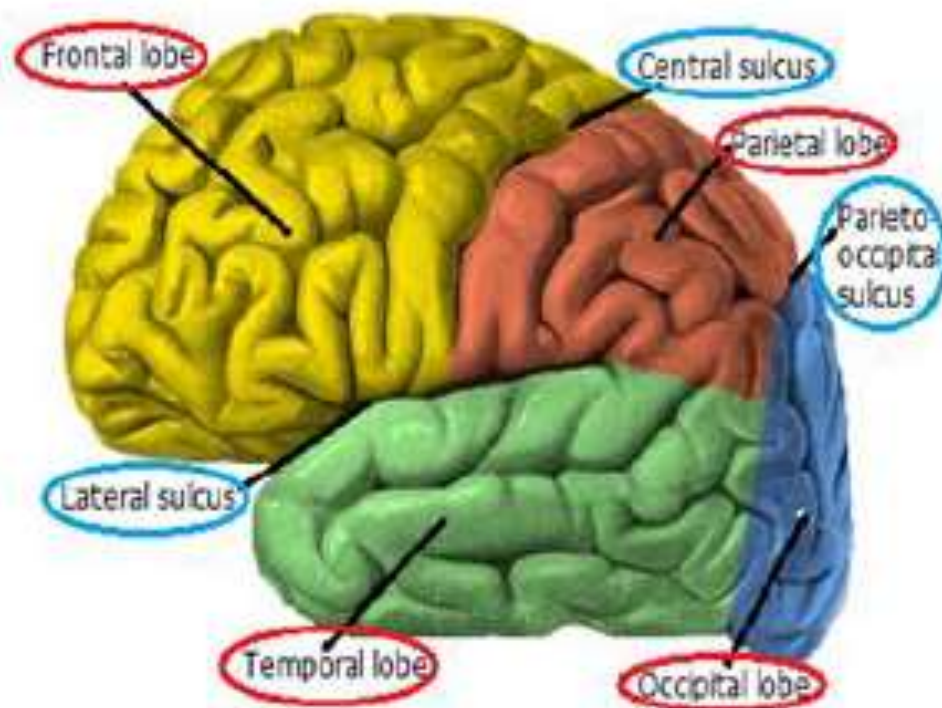
# THE BRAIN

Formed of :

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

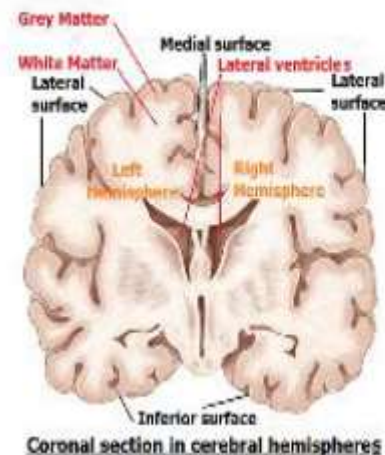
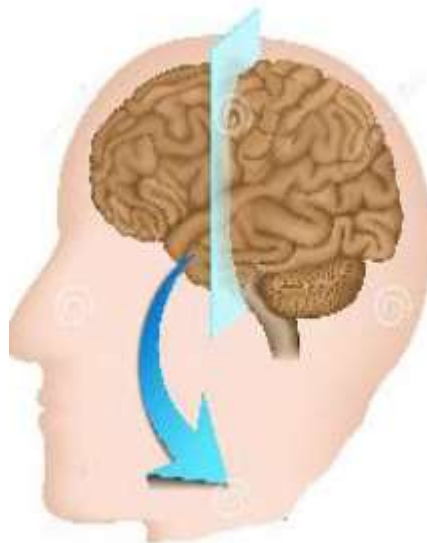


- *Cerebrum*: formed of 2 hemispheres which contain different motor and sensory cortical areas. It has:
  - ✓ 3 surfaces; medial, lateral and inferior.
  - ✓ 4 major sulci; lateral, central, calcarine and parieto-occipital.
  - ✓ 4 lobes; frontal, parietal, temporal and occipital.



➤ In cross sections, the cerebrum and the cerebellum shows:

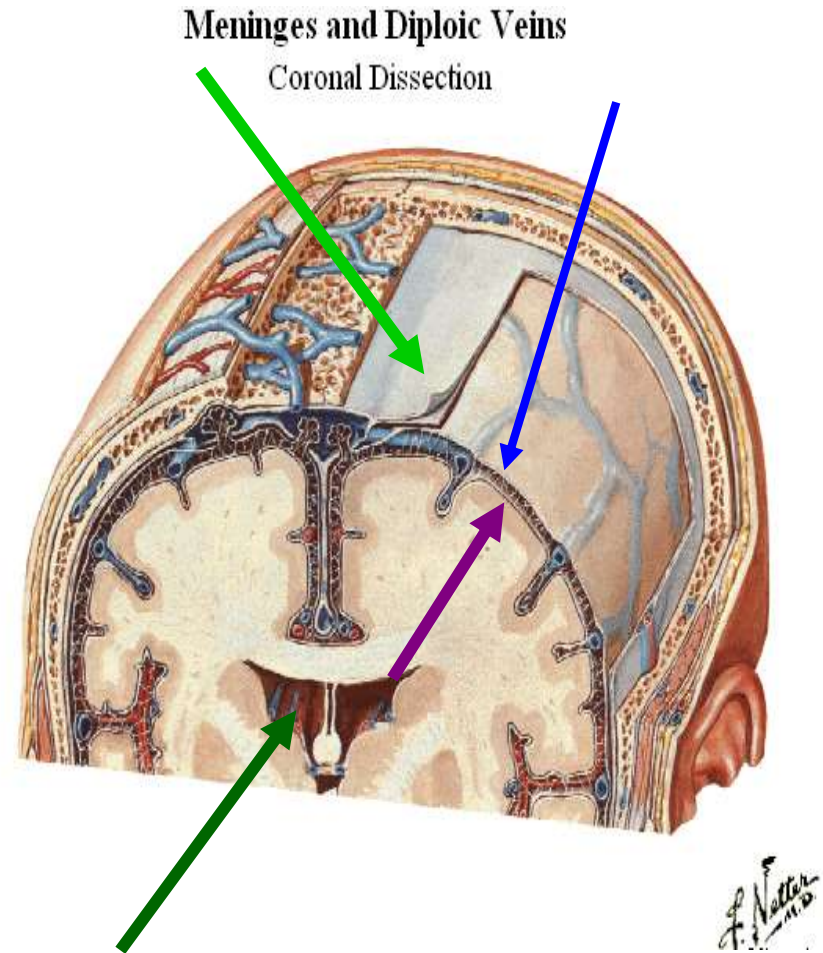
1. Grey matter (cortex): dark outer areas which contain the cell bodies.
2. White matter: light inner areas which contain nerve fibers (axons) and collections of nerve cells (nuclei).
3. Cavities: the brain contains cavities called ventricles (2 lateral, 3<sup>rd</sup> and 4<sup>th</sup>) which contain CSF.





# The Brain

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





Subarachnoid space

Skull

Dura mater

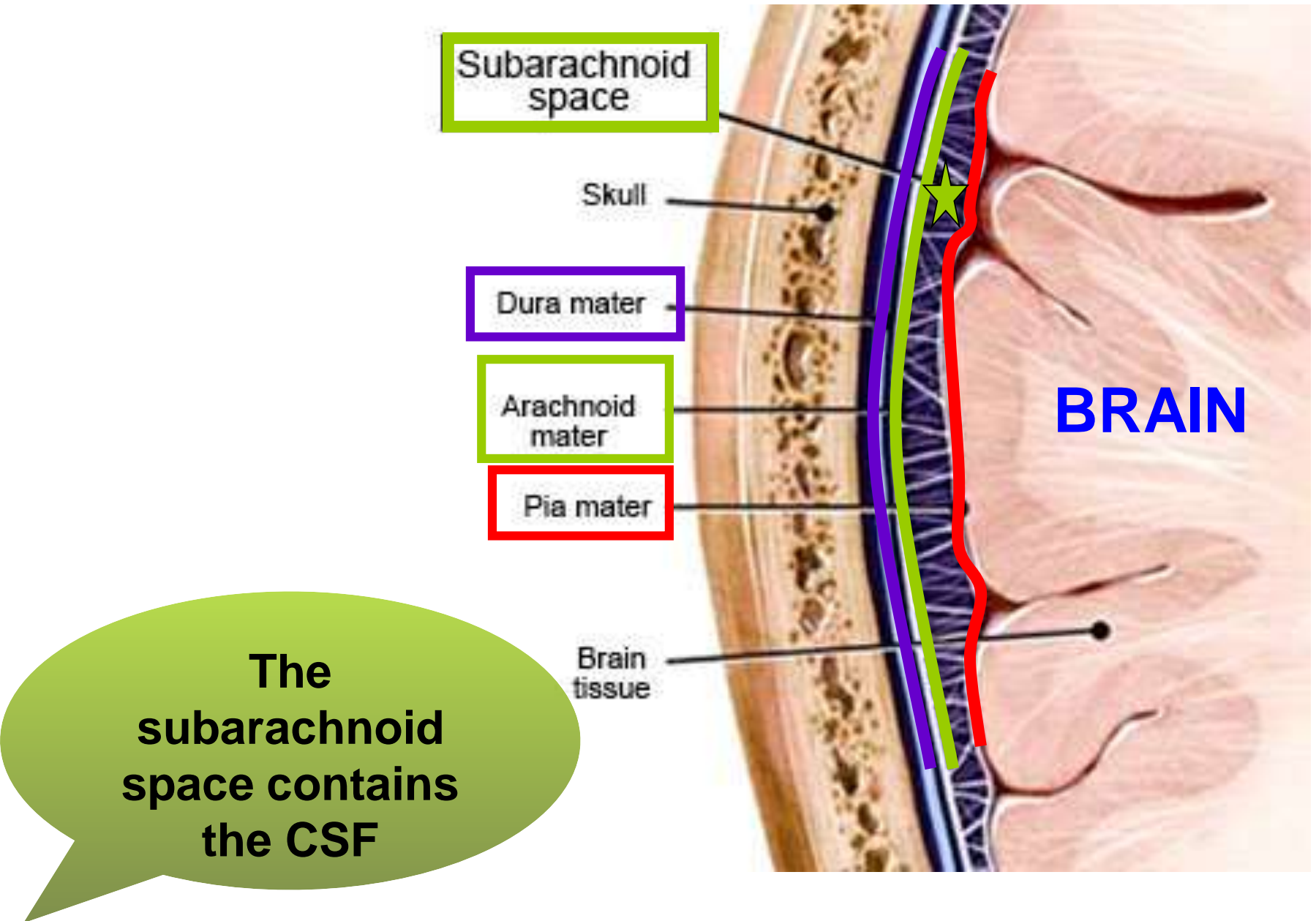
Arachnoid mater

Pia mater

Brain tissue

**BRAIN**

The  
subarachnoid  
space contains  
the CSF



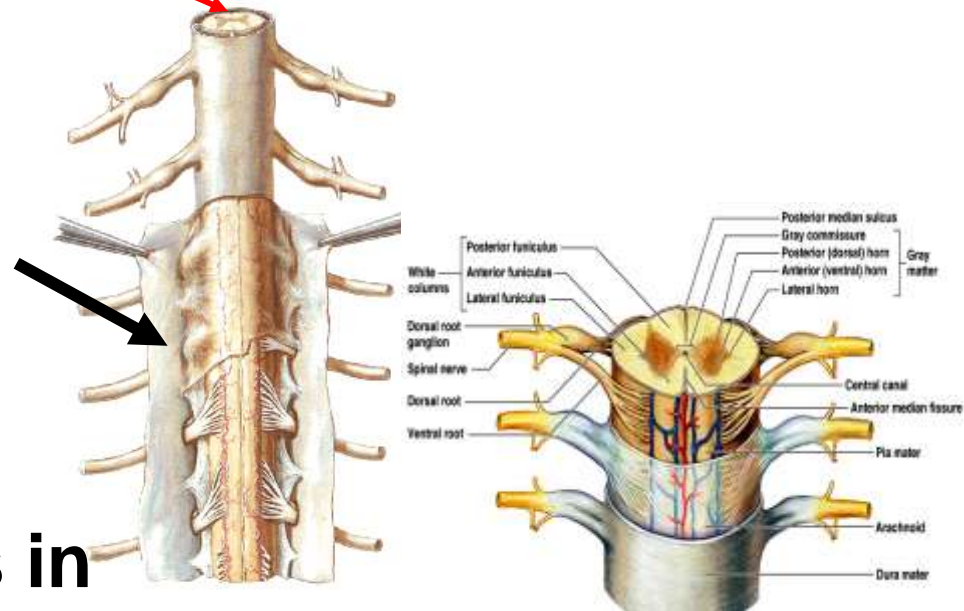
# THE SPINAL CORD

- 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.**

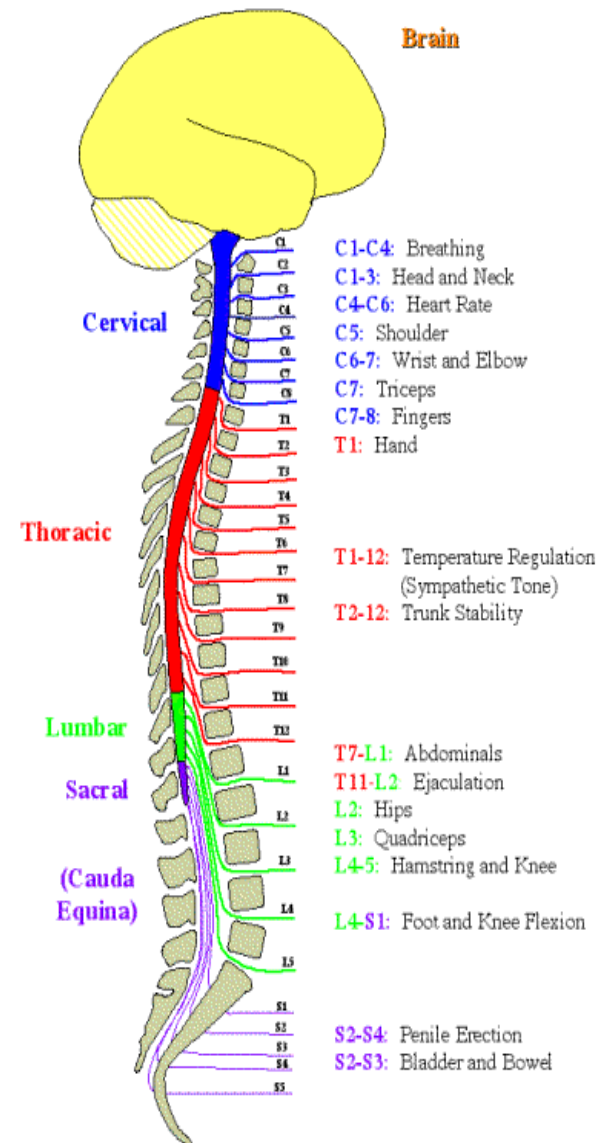
Spinal Membranes and Nerve Roots

Posterior View



# 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

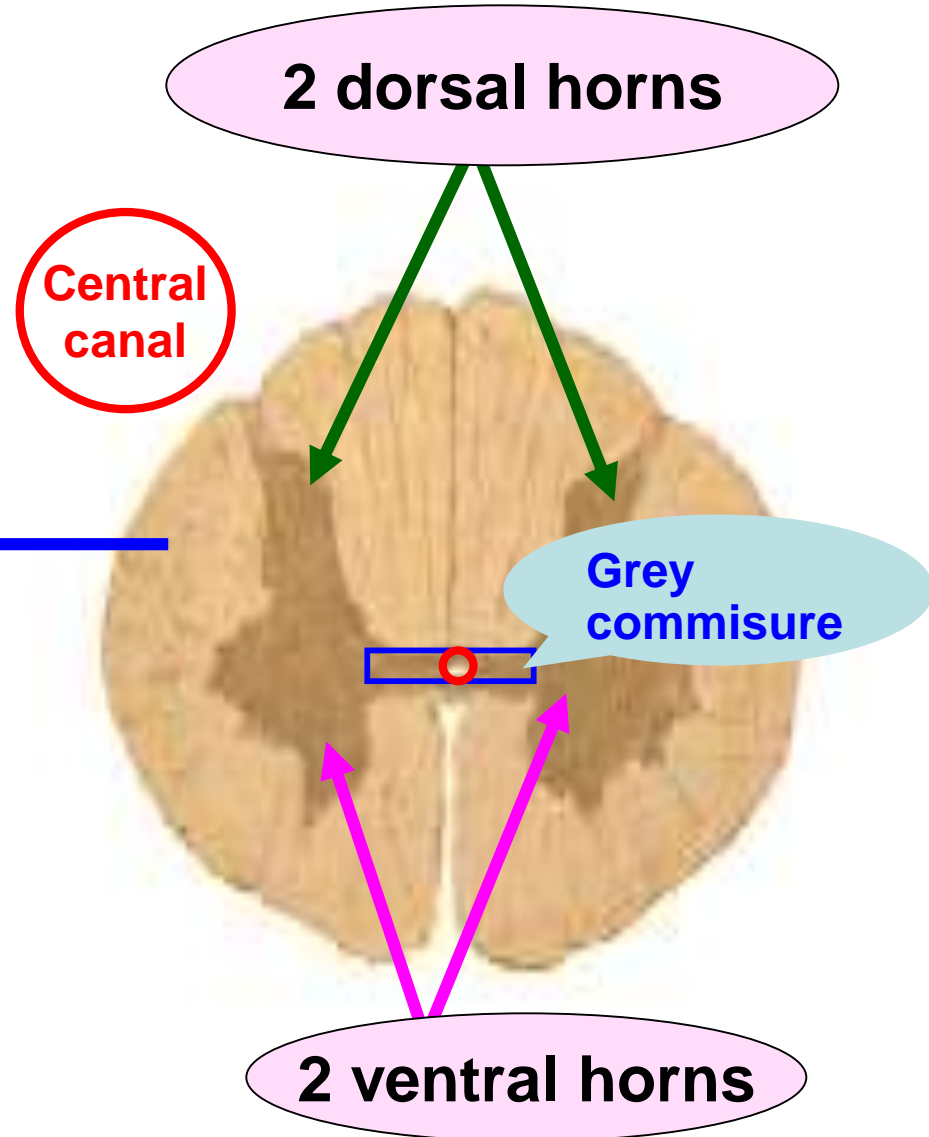
- In cross section, it shows :

**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





# 31 pairs of spinal nerves

Cervical nerves

Thoracic nerves

Lumbar nerves

Sacral/coccygeal nerves

8 cervical

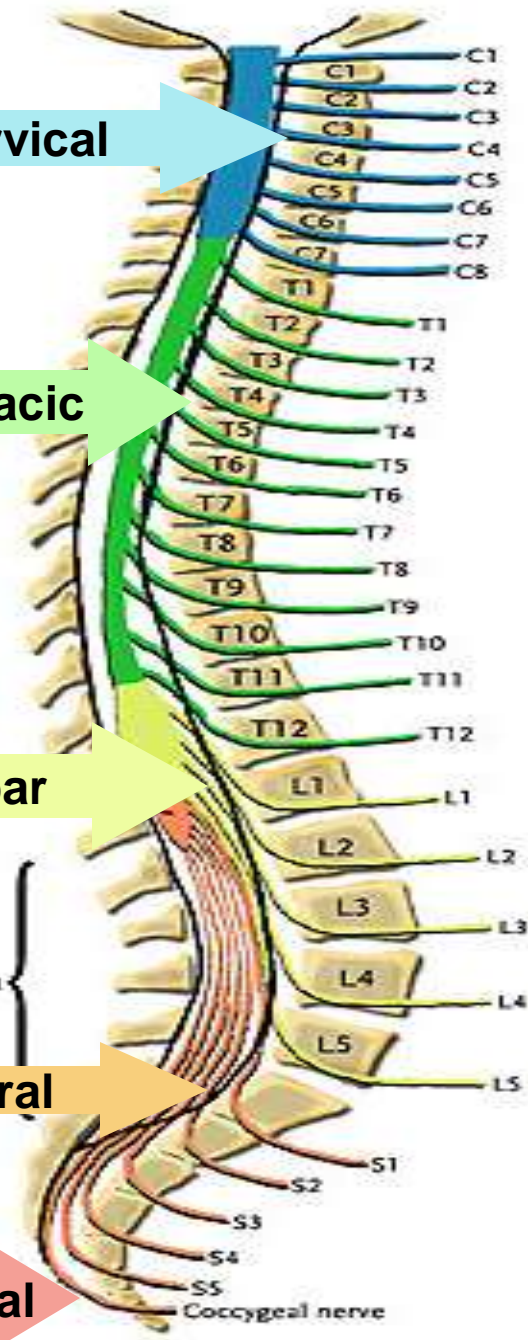
12 thoracic

5 lumbar

5 sacral

1 coccygeal

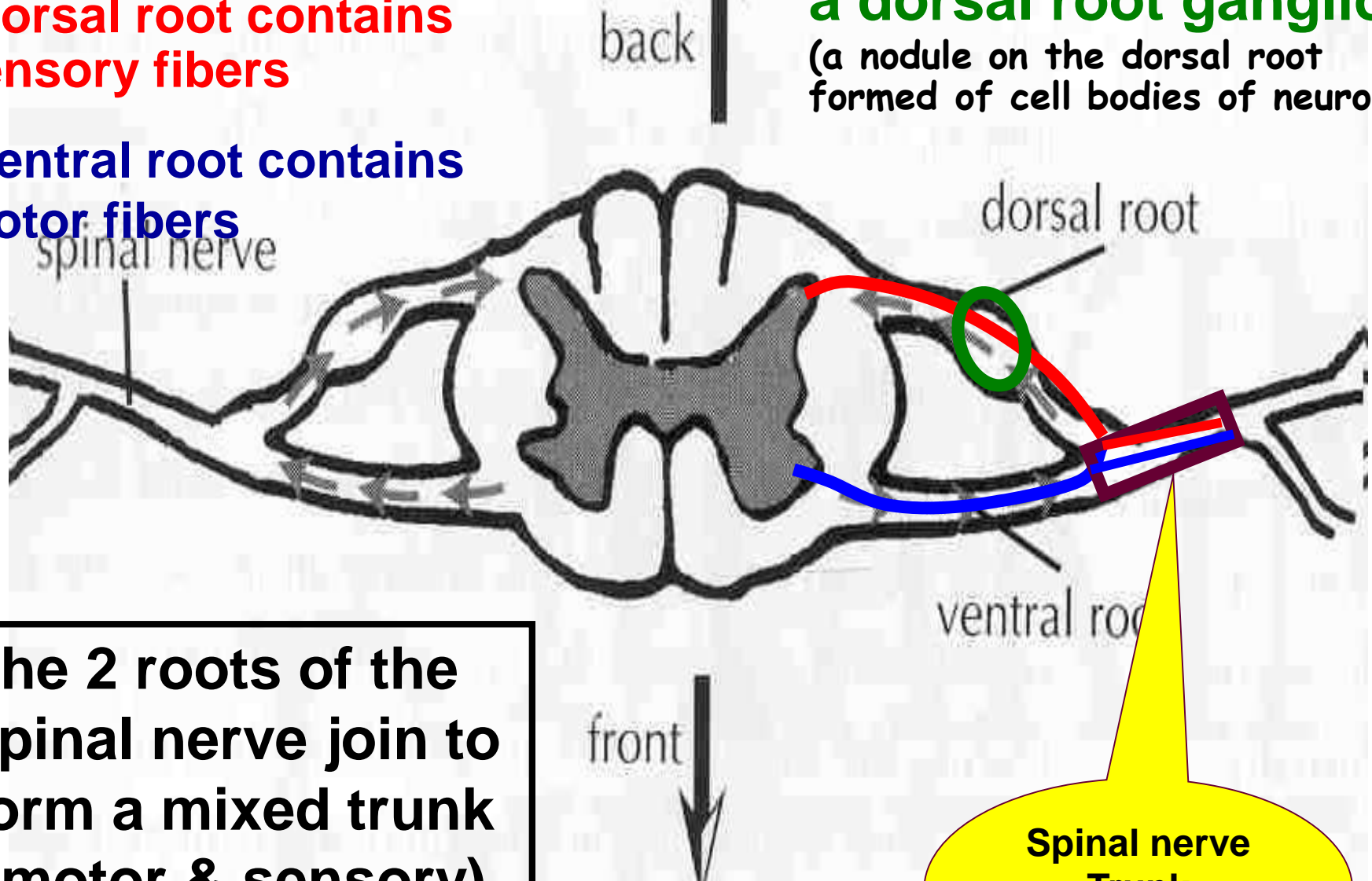
Cauda equina



# 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)



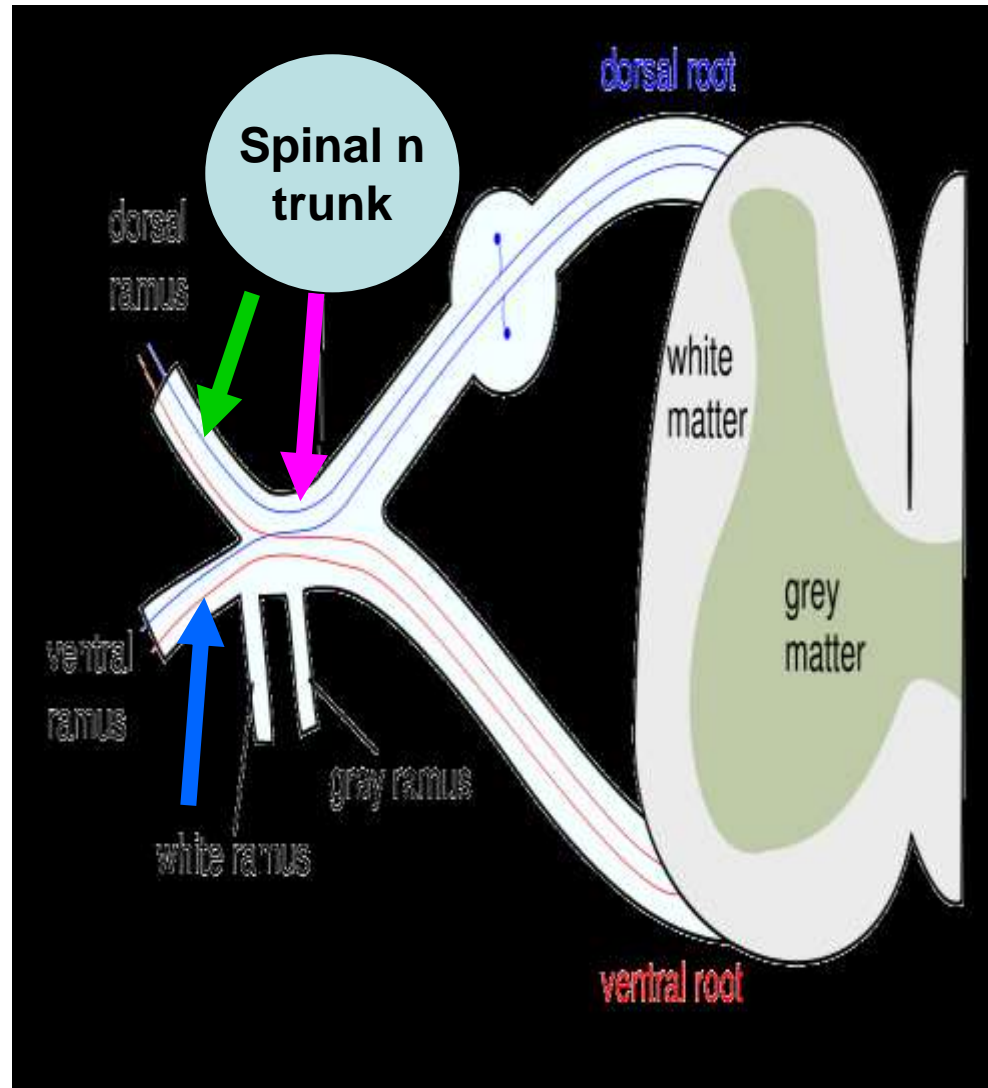
The 2 roots of the spinal nerve join to form a mixed trunk ( motor & sensory)

Spinal nerve  
Trunk  
(mixed)



# 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** → 1ry **dorsal ramus** & 1ry **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	Glosso-pharyngeal
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**

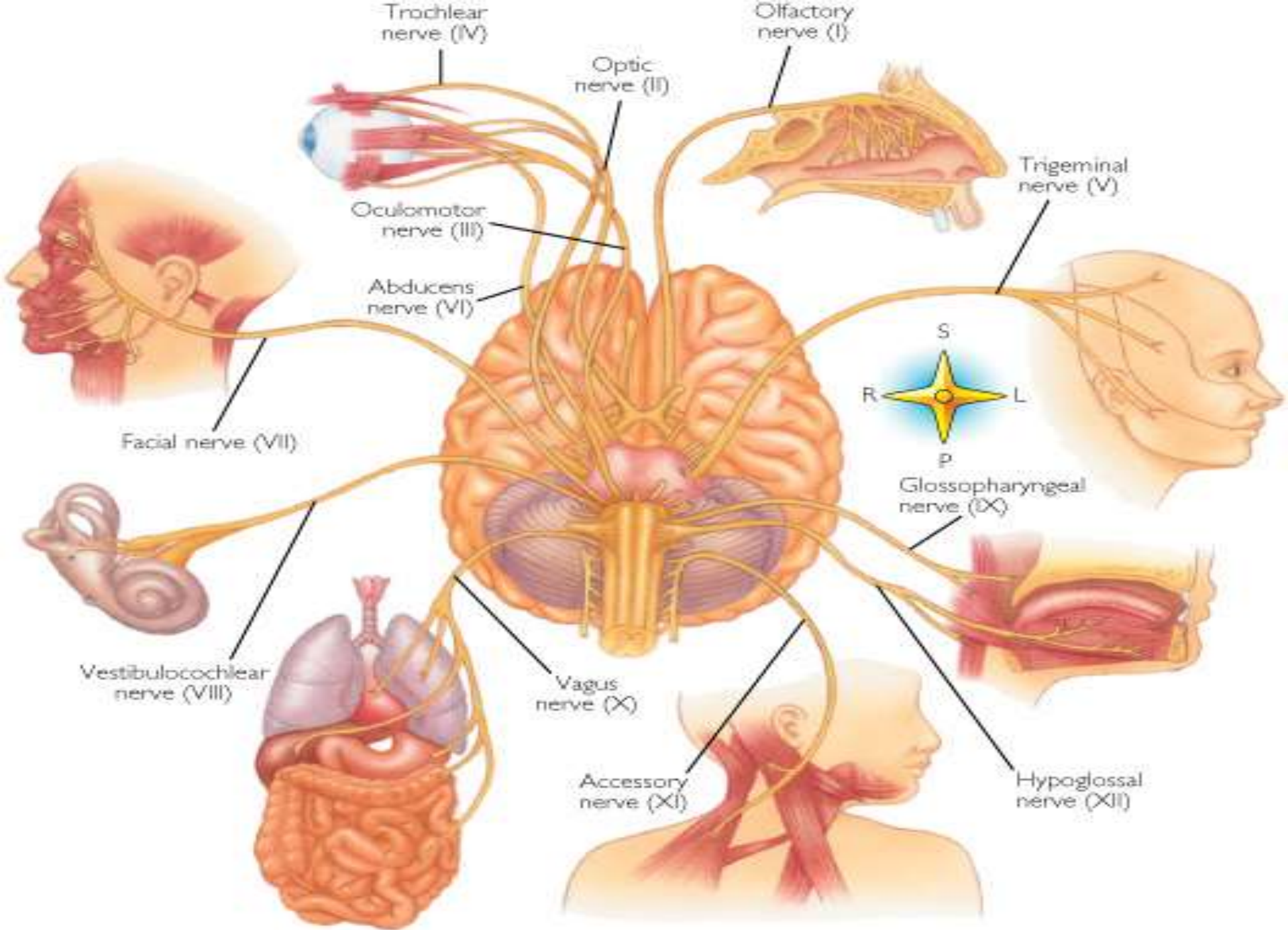
- It is a **mixed nerve** controls the heart, respiratory tract, digestive tube regarding their autonomic functions.

### **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.

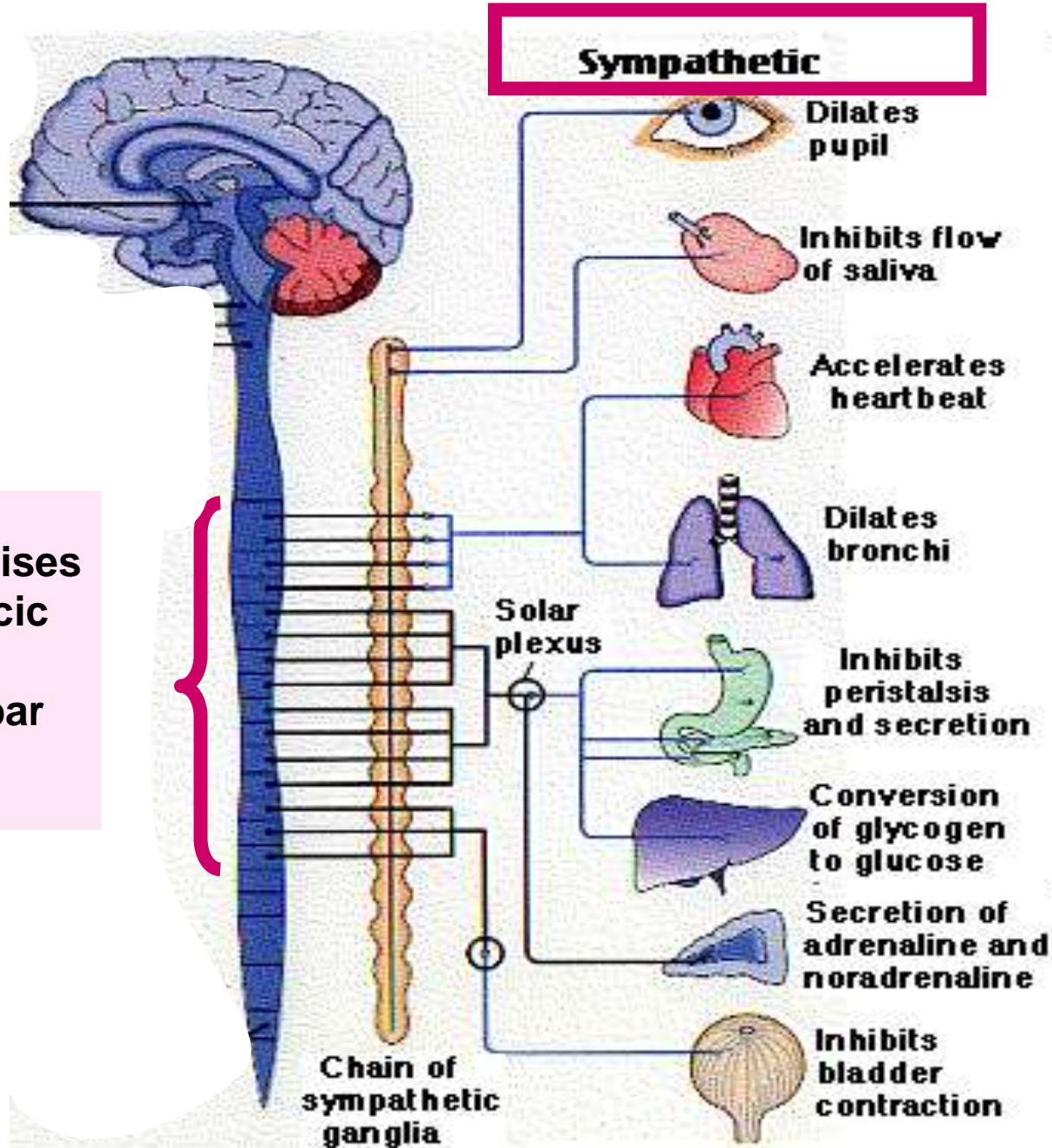


# Autonomic nervous system

**Sympathetic nervous system:** present in the lateral horn cells of **all thoracic and upper two lumbar segments** of the spinal cord (thoracolumbar 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 **3<sup>rd</sup>, 7<sup>th</sup>, 9<sup>th</sup> and 10<sup>th</sup>** 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**:

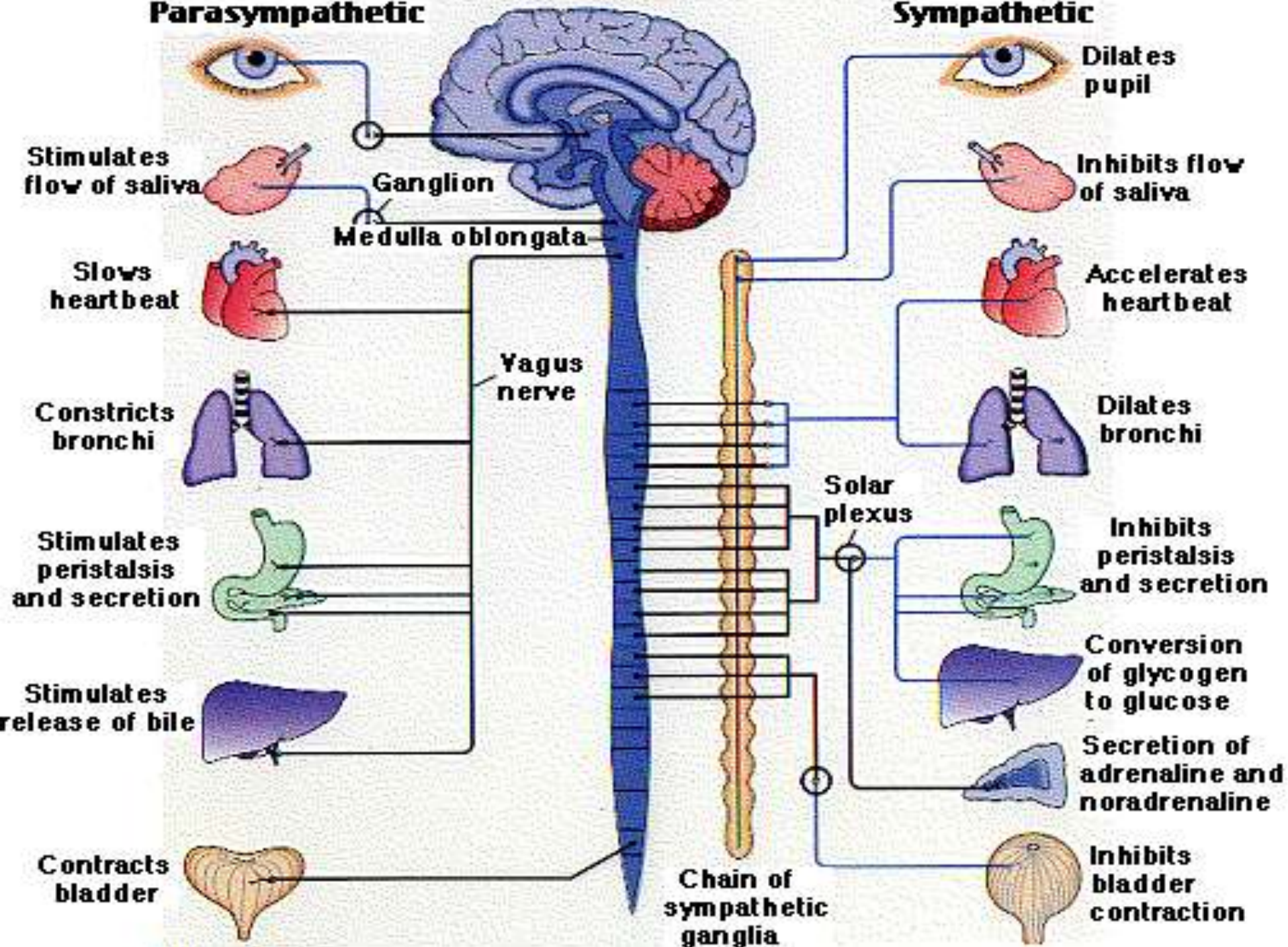
- The parasympathetic nervous system aims to restore energy.
- It slows the heart rate, increase peristalsis and opens the sphincters and increases the glandular activity.

	Sympathetic (Thoracolumbar)	Parasympathetic (Craniosacral)
<b>Origin:</b>	<ul style="list-style-type: none"> <li>- Lateral horn cells of (T1 to L3) spinal cord segments.</li> </ul>	<ul style="list-style-type: none"> <li>- Cranial Outflow: from the brainstem.</li> <li>- Sacral Outflow: from spinal cord segments S2, 3, 4.</li> </ul>
<b>Ganglia:</b>	<ul style="list-style-type: none"> <li>- Lateral: on both sides of vertebral column.</li> <li>- Collateral: between the spinal cord and the organs.</li> </ul>	<ul style="list-style-type: none"> <li>- Terminal: located near or at the organs.</li> <li>- Collateral: between the spinal cord and the organs.</li> </ul>
<b>Function:</b>	<ul style="list-style-type: none"> <li>- <i>Fight and flight.</i></li> <li>- Inhibitory to everything except the heart.</li> <li>- Decrease glandular secretion &amp; peristalsis of the gut.</li> <li>- Contraction of the sphincters.</li> <li>- Bronchodilatation.</li> </ul>	<ul style="list-style-type: none"> <li>- <i>Rest and digest.</i></li> <li>- Excitatory to everything except the heart</li> <li>- Increases glandular secretion &amp; peristalsis of the gut.</li> <li>- Relaxation of the sphincters.</li> <li>- Bronchoconstriction.</li> </ul>



## Parasympathetic

## Sympathetic



THANK YOU