

**Over view of autonomic nervous system  
(function of sympathetic)**

**BY**

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- The functions of the different body systems are regulated mainly by 2 systems:

### 1] **The nervous system:**

Rapid control system. It **is quicker** than endocrine system in its regulation.

It regulates the different functions of the body by nerve impulses that travel along the peripheral nerves.

**It is concerned with control of rapid body activities (e.g. contraction of all muscle types and secretion of glands).**

### 2] **The endocrine system:**

Slow control system.

Regulates the different functions of the body by hormones that circulate in blood to reach the target organs.

**It is concerned with control of body metabolism (i.e. slow mechanism)**

# **Anatomical classification of The Nervous System**

**I. Central Nervous System (CNS).**

**II. Peripheral Nervous System (PNS).**

# I Central Nervous System (CNS).

- It is the part of nervous system which is protected by bone cavities (the skull and vertebral column).
- It consists of the brain & spinal cord.

## ***A) Brain:***

➤ Lies inside the skull.

➤ Formed of:

Cerebrum (2 cerebral hemispheres which consists of cerebral cortex and subcortical centers e.g. thalamus, hypothalamus and basal ganglia)

Cerebellum.

Brain stem:

\* **Midbrain**

\* **Pons**

\* **Medulla oblongata**

## ***B) Spinal cord:(31 segments)***

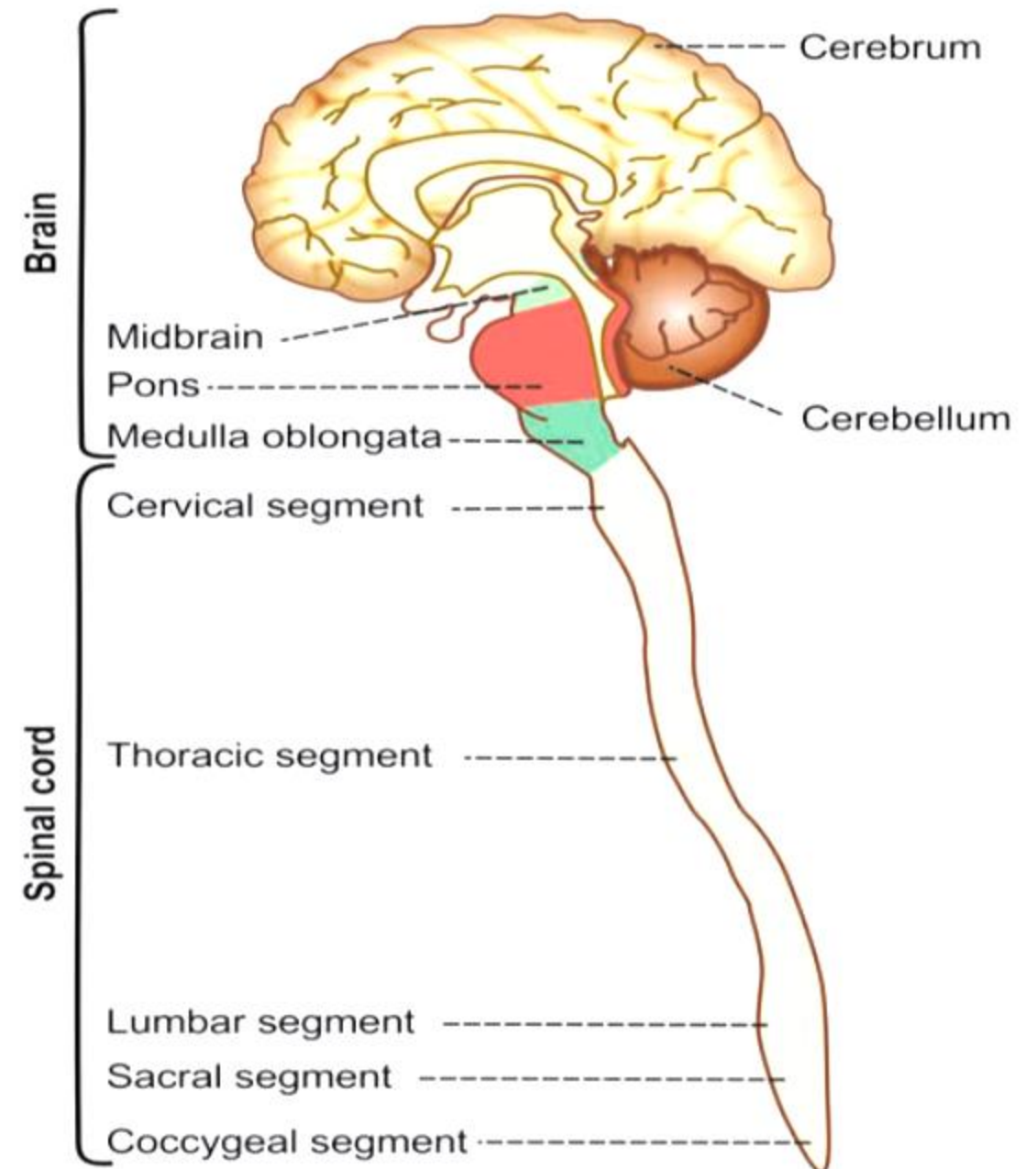
Lies inside the vertebral column.

Is divided into the following regions:

- Cervical region (8 segments).
- Thoracic region (12 segments).
- Lumbar region (5 segments).
- Sacral region (5 segments).
- Coccygeal region (1 segment).

**Each spinal cord segment gives attach either side to spinal nerve (peripheral**

**There are 31 pairs of spinal nerves.**



## **II. PERIPHERAL NERVOUS SYSTEM**

**It is formed of the nerves which connect the CNS to the different organs of the body, these nerves are called peripheral nerves.**

**Anatomically they are either;**

- 1. Cranial nerves (12 pairs), arising from the brain and brain stem**
- 2. Spinal nerves (31 pairs), arising from the spinal cord.**

The peripheral nervous system is functionally divided into sensory and motor divisions, and each of these is further divided into somatic and visceral subdivisions.

### **1-The sensory (afferent) division :**

Carries sensory signals from various receptors in the body to the CNS.

- a) The somatic sensory division carries signals from receptors in the skin, muscles, bones and joints.
- b) The visceral sensory division carries signals mainly from the viscera of the thoracic and abdominal cavities, such as the heart, lungs, stomach, and urinary bladder.

### **2-The motor (efferent) division :**

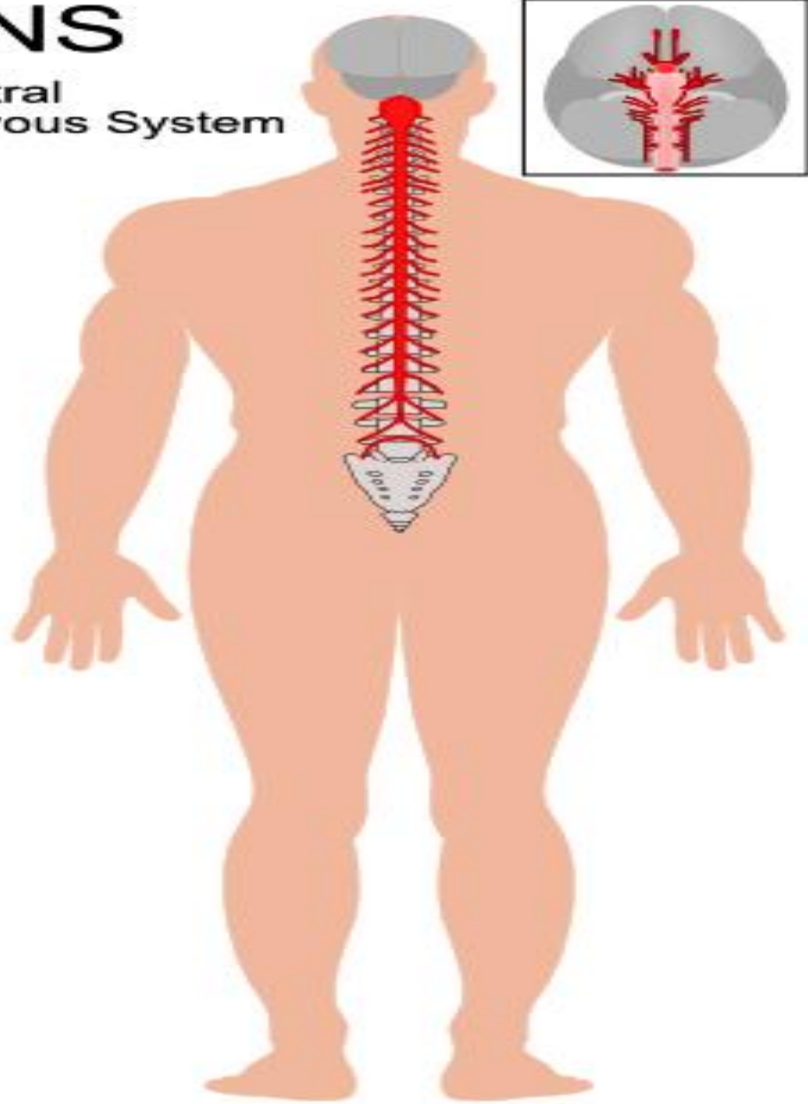
Carries signals from the CNS to gland and muscle cells that carry out the body's responses.

- a) The somatic motor division carries signals to the skeletal muscles.
- b) The visceral motor division (autonomic nervous system) carries signals to glands, cardiac muscle and smooth muscle.

### **3. Mixed: contain both sensory & motor fibers.**

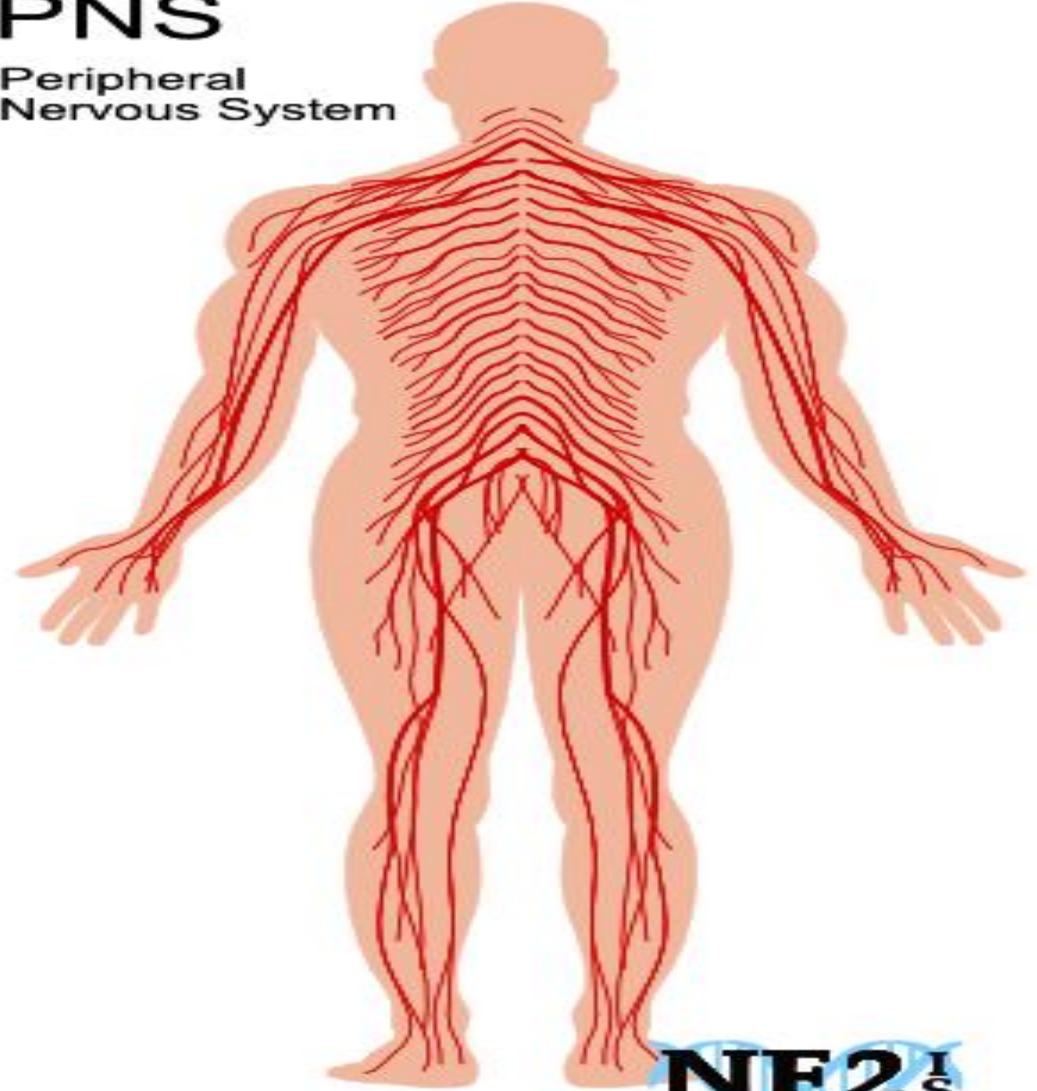
# CNS

Central  
Nervous System



# PNS

Peripheral  
Nervous System



**NE2s**

## **Motor functions of the body may be:**

A. **Voluntary**: controlled by the will.

**e.g. contraction of skeletal muscles to perform a work (controlled by somatic motor nerves).**

B. **Involuntary**: Spontaneous not controlled by the will. **e.g.**

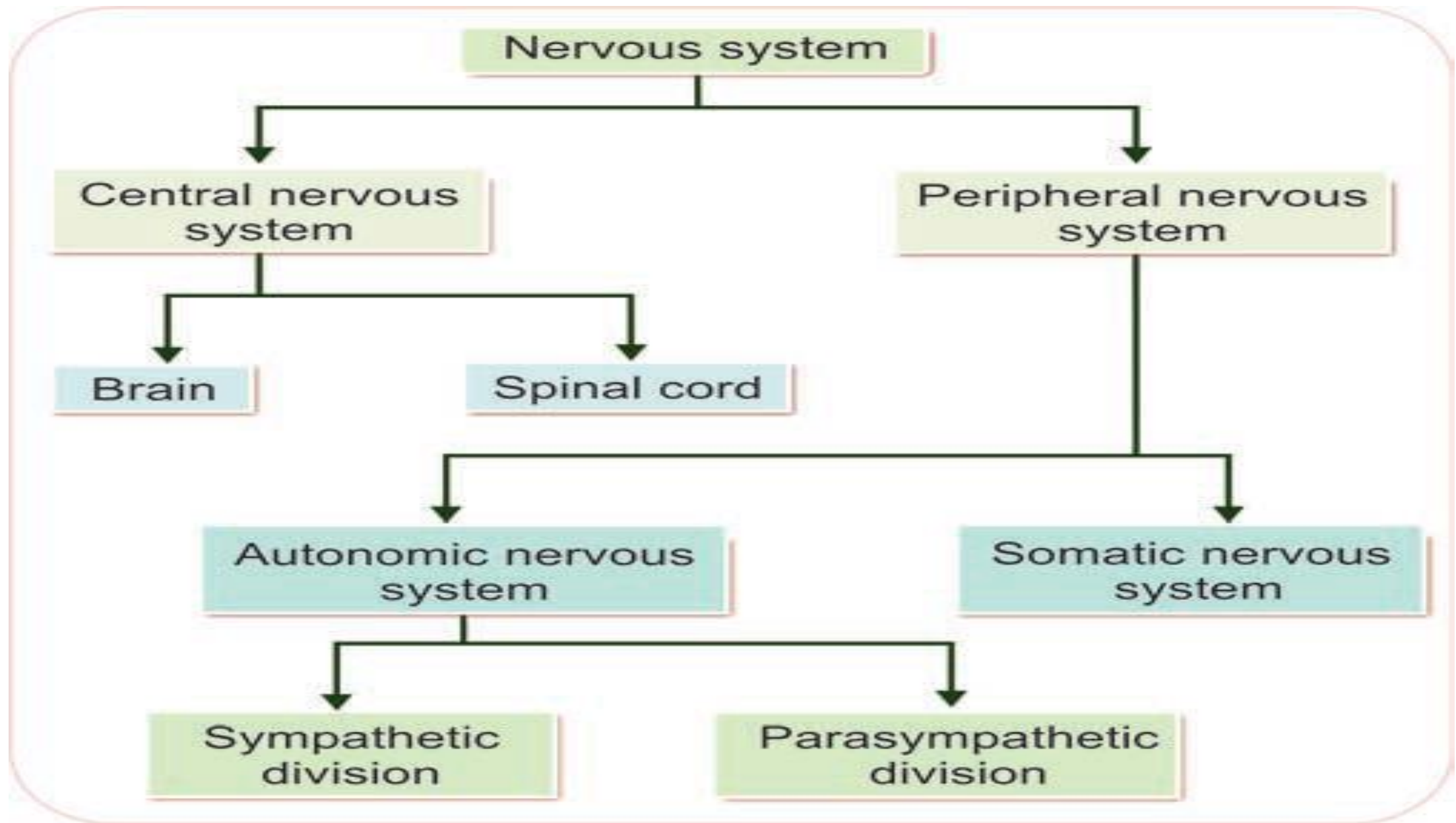
- Contraction of smooth muscles.
- Contraction of cardiac muscle.
- Secretion of glands.

**Peripheral motor nerves that control involuntary motor functions of the body are called Autonomic Nerves (i.e. ANS)**

• The autonomic nervous system has two further divisions:

i. The sympathetic division tends to arouse the body for action, for example, by accelerating the heartbeat and increasing respiratory airflow but it inhibits digestion.

ii. The parasympathetic division tends to have a calming effect, slowing down the heartbeat, for example but stimulating digestion.



# Autonomic ganglion

## Definition:

• Collection of nerve cells outside the CNS where the preganglionic fibers relay with the postganglionic autonomic efferent fibers.

Types: According to their situation, the ganglia are classified into:

### [1] Lateral (paravertebral) ganglia:

• This consists of 23-25 ganglia on both sides of the vertebral column which form a sympathetic chain.

- 3 Cervical (superior, middle & inferior), 10 –12 thoracic, 5 lumbar, 5 sacral & 1 coccygeal
- The inferior cervical ganglion may join with the first one or two thoracic ganglia to form the stellate ganglion.
- They are for relay of sympathetic fibers only.

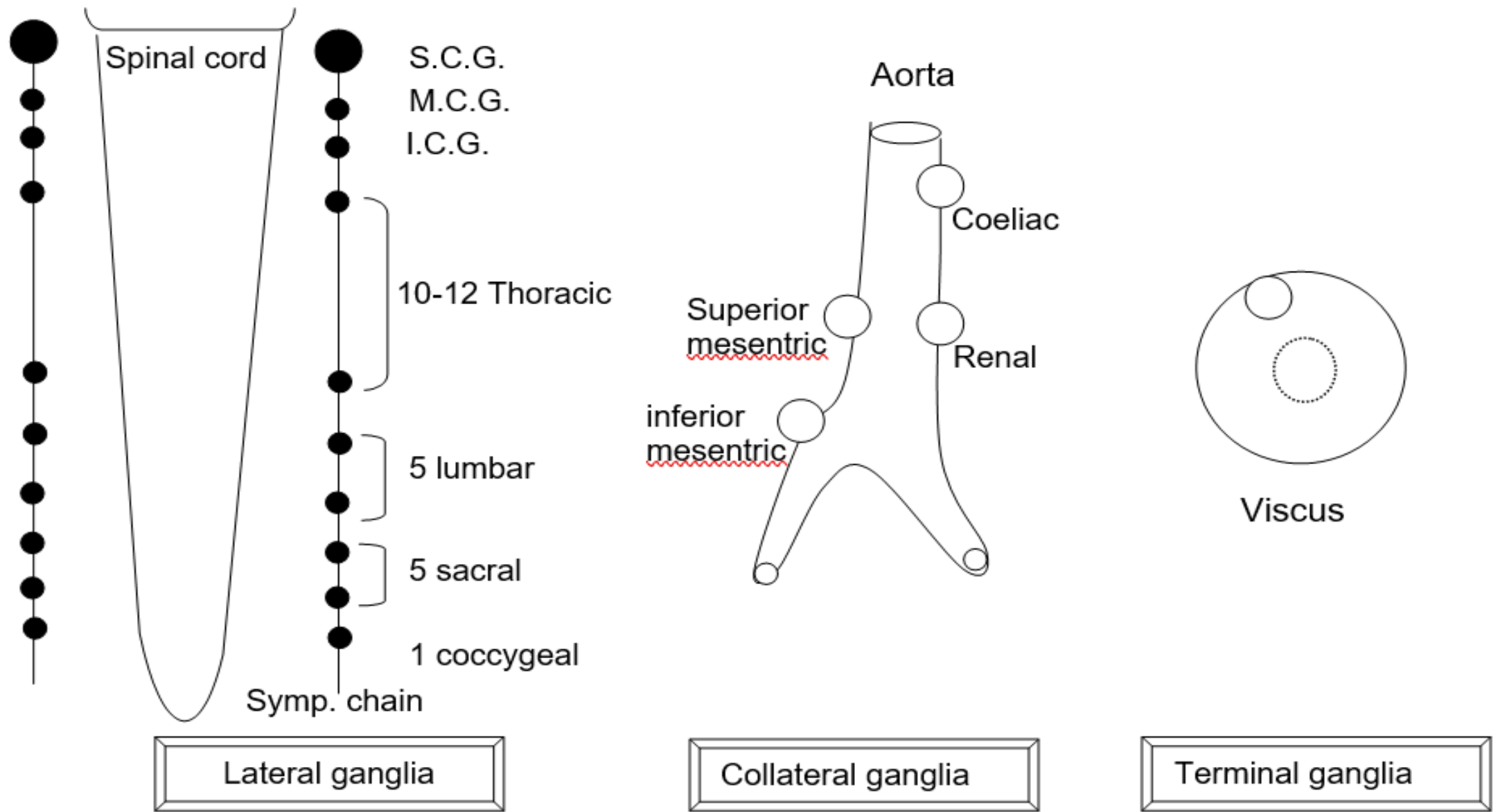
### [2] Collateral ganglia:

• Present in the abdomen near the abdominal aorta at the region of big arterial branches of aorta & named after them:

- Coeliac, superior mesenteric, renal & hypogastric ganglia.
- Collateral ganglia exist also in head & neck e.g. otic & ciliary ganglia.
- They are for relay of symp. & parasymp. fibers.

### [3] Terminal ganglia:

• These are present near or in the wall of the effector organs specially in the walls of the pelvic viscera & the heart. They are for relay of parasymp. fibres only.

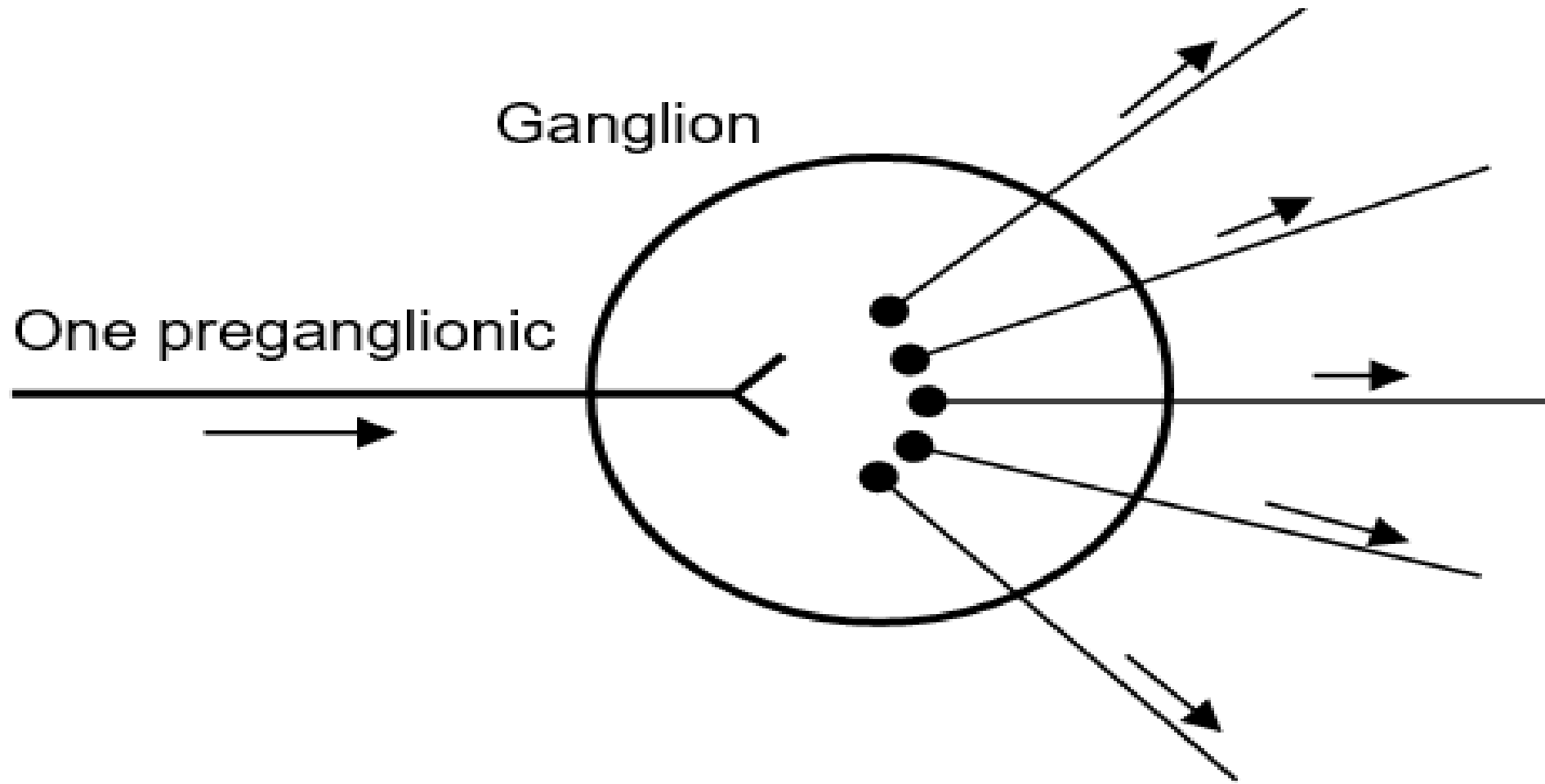


**Types of autonomic ganglia**

- **Functions & properties of autonomic ganglia:**

- 1) **Distributing centers:**

- The pregang. fibers are few in numbers & arise from limited regions in CNS.
  - Through divergence of the preganglionic fibers in the ganglia, so that, one preganglionic fiber gives several postganglionic fibers that distribute the autonomic impulses to many organs.
  - The ratio of preganglionic fibers to postganglionic fibers:
    - **Symp**  $\Rightarrow$  1 : 32. (in superior cervical ganglion)
    - **Parasymp.**  $\Rightarrow$  1 : 2. (in ciliary ganglion)
- i.e. parasymp. activity is much limited than the symp.



**Function of autonomic ganglia**

# Origin & Distribution of Autonomic Nerves

## **(I) Sympathetic system:**

It arises from the L.H.C. of all thoracic & upper 4 lumbar segments of the spinal cord (thoraco-lumbar outflow).

## **(II) Parasympathetic system:**

It arises from the L.H.C. of 2, 3, 4 sacral segments & form the nuclei of the 3<sup>rd</sup>, 7<sup>th</sup>, 9<sup>th</sup> & 10<sup>th</sup> cranial nerves (cranio-sacral outflow).

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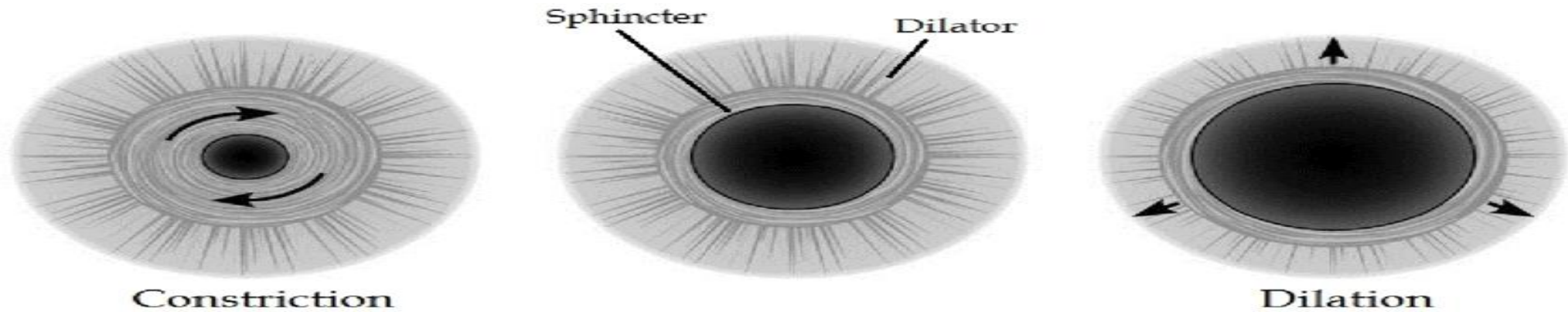
# General characters of autonomic nervous system:

Sympathetic nervous system	Parasympathetic nervous system
Catabolic.	Anabolic.
Increases energy expenditure of the body.	Preserve energy in the body (i.e. save energy in the heart and offer it in the intestine).
Prepares the body for activity, increasing the capacity to perform severe muscular effort (fight and flight) in response to stress (emergency situation).	Predominates during sleep where there are continuous digestion, slow heart rate and constricted pupil.
Sympathetic <u>mass stimulation</u> is useful.	Parasympathetic <u>mass stimulation</u> is fatal.

# Sympathetic outflow to head & neck:

## On the Eye:

1. Motor to the dilator pupillae muscle → **Mydriasis** (i.e. dilatation of the pupil to increase light entering the retina)
2. Motor to superior tarsal muscles → **Retraction** of the upper eye lid → widening of palpebral fissure to increase visual field.
3. Motor to retro-ocular (Muller's Muscle) → **Exophthalmos** (i.e. protrusion of eye ball).



## 2) Skin:

Vasoconstriction (V.C.) of skin blood vessels.

Secretory to the sweat glands  $\Rightarrow$   $\uparrow$  sweating.

Cont. of erector pillae muscle  $\Rightarrow$  hair erection in animals.

## (3) Salivary glands:

Trophic secretion of saliva ( $\downarrow$  amounts, viscid,  $\uparrow$  enzymes).

Contraction of myoepithelial cells surrounding salivary acini  $\Rightarrow$  squeezing of saliva.

## (4) Blood vessels:

V.C. to all blood vessels with weak V.C. to cerebral blood vessels.

# Horner syndrome

## Cause:

- 1) Injury to cervical symp. nerve fibers in superior cervical ganglion (S.C.G).
- 2) Injury to upper 2 thoracic segments.

## Manifestations: (on the same side of lesion)

- 1) **Miosis**: Constriction of eye pupil due to paralysis of dilator pupillae muscles.
- 2) **Ptosis**: Drooping of upper eye lid due to paralysis of superior tarsal muscles.
- 3) **Enophthalmos**: Backward retraction of the eye in the orbit due to paralysis of Muller's muscle in the orbit.
- 4) **Anhydrosis**: Loss of sweating due to paralysis of symp. nerve supplying sweat glands.
- 5) **Vasodilatation ( V.D.) of skin vessels**: Skin becomes warm & red.



# II Sympathetic to the thoracic viscera

## Functions:

### (1) Heart:

- Stimulation of all cardiac properties  $\Rightarrow$   $\uparrow$  contractility, rhythmicity, excitability & conductivity.
- V.D. of coronary blood vessels  $\Rightarrow$   $\uparrow$  blood supply to cardiac muscle.
- $\uparrow$  O<sub>2</sub> Consumption of cardiac muscle.

### (2) Lung:

- Inhibitory to the plain muscles of bronchi  $\Rightarrow$  bronchodilatation.
- Inhibits mucous secretion.
- V.C. of pulmonary blood vessels.

# III Sympathetic to the abdominal viscera

## Functions:

### (1) Gastrointestinal tract (GIT):

- Inhibitory to plain muscles of stomach, small intestine & proximal half of large intestine but motor to their sphincters  $\Rightarrow$   $\downarrow$  evacuation of stomach & intestine.

### (2) Liver:

- Stimulation of glycogenolysis  $\Rightarrow$   $\uparrow$  blood glucose level.
- Relaxation of the wall of gall bladder & motor to its sphincter  $\Rightarrow$   $\downarrow$  evacuation of bile.

(3) Spleen: Contraction of the splenic capsule  $\Rightarrow$  ejection of its stored blood  $\Rightarrow$

$\uparrow$  blood volume.

#### 4) Kidneys:

- Stimulation of juxtaglomerular cells leading to **increased renin** secretion.
- Decrease renal blood flow.

#### (5) Adrenal medulla:

- Secretion of two hormones (adrenaline 80% & noradrenaline 20%).
- These hormones have the same effects as direct symp. stimulation except:  
Their effects are more prolonged (**10 times**) than direct symp. stimulation because catecholamines are removed from the blood slowly.

**Adrenaline has powerful metabolic effect.**

#### (6) Blood vessels:

- V.C. & V.D. to the blood vessels of the abdominal viscera as stomach, small intestine & proximal part of large intestine, kidney, pancreas & liver.
- **V.C. is more powerful than V.D.**  $\Rightarrow$  V.C. is the net effect.

# **[IV] Sympathetic to the pelvic viscera**

## **Functions:**

### **(1) G.I.T.:**

- Inhibitory to plain muscle of distal part of large intestine & the wall of the rectum but motor to internal anal sphincter ⇒ retention of faeces.

### **(2) Urinary bladder(U.B.):**

- Inhibitory to the wall of U.B. but motor to internal urethral sphincter ⇒ retention of urine.

### **(3) Blood vessels:**

- V.C. of blood vessels of pelvic viscera ⇒ shrinkage of penis & clitoris.

### **(4) Genital system:**

**Male:** Contraction of vas deferens, seminal vessels & prostatic plain ms ⇒ ejaculation of semen.

# [V] Sympathetic to the limbs, thoracic & abdominal walls

## Functions:

- V.C. of skin blood vessels.
- V.D. of skeletal blood vessels.
- Motor to the erector pilae muscle  $\Rightarrow$  hair erection.
- Secretory to the sweat glands.
- **Orbelli phenomenon**
  - It is better contraction, delayed fatigue & early recovery of skeletal muscles after fatigue.
  - It occurs when the symp. nerves to the skeletal muscles are stimulated or when adrenaline is injected.

# Effects of generalized sympathetic effect

- In many instances, almost all portions of the sympathetic nervous system discharge simultaneously as a complete unit, a phenomenon called **mass discharge**. This frequently occurs in fright or fear or severe pain. The result is a widespread reaction throughout the body called the **alarm or stress response**. (**fight-or-flight response**)

- 1. Increased oxygenation of the blood to ↑ oxygen supply to active organs through bronchodilatation, increasing blood by enhancing pumping action of heart and splenic contraction.**
- 2. Shift of blood from less active areas e.g. the splanchnic circulation and skin to areas of maximum activity e.g. skeletal muscles.**

### 3. C.V.S.:

a) **Heart:** Stimulation all properties of the heart, ↑ excitability, ↑ contractility, ↑ rhythmicity & ↑ conductivity.

### b) B. Vs.:

- V.C. of skin & mucous membrane blood vessels.
- V.D. of coronary & Skeletal blood vessels.

### c) A.B.P.:

- ↑ A.B.P. due to ↑ cardiac output & ↑ heart rate

4. Increase visual field (mydriasis, elevation of upper eye lid, exophthalmos).

5. G.I.T.: ↓ functions of the digestive tract

## **6. Blood:**

- ↑ blood volume due to cont. of splenic capsule  $\Rightarrow$  ejection of its stored blood.
- ↑ blood volume by ↑ pumping action of heart through stimulation all properties of the heart.

## **7. Metabolism:**

↑ Cellular metabolism all over the body.

↑ circulatory catecholamines.

↑ blood glucose level due to ↑ liver glycogenolysis.

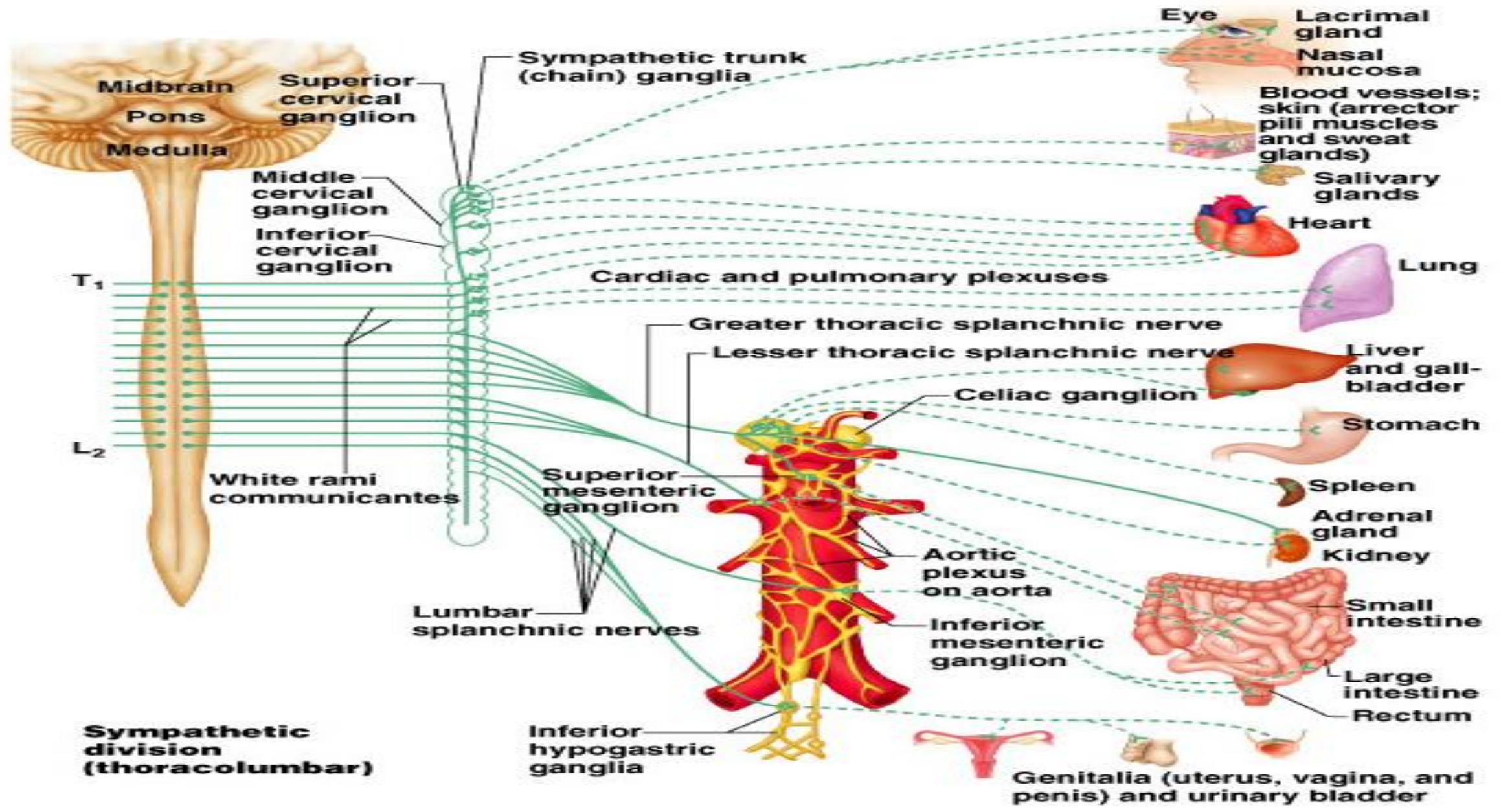
↑ sweating  $\Rightarrow$  protection against excess elevation of body temperature resulting from the increased metabolism.

## **8. Orbelli phenomenon:**

- Better cont., delayed fatigue & early recovery of sk. ms. after fatigue.

## **9. Mental activity:**

- Increased alert & mental activity.



THANK YOU

The image features the words "THANK YOU" in a highly stylized, 3D font. The word "THANK" is positioned on the top line, and "YOU" is on the bottom line. Each letter is a different color and has unique decorative elements: 'T' is blue with white dots; 'H' is orange with white dots; 'A' is yellow with white dots; 'N' is green with white dots; 'K' is teal with white dots; 'Y' is light blue with a white dot; 'O' is orange with a white dashed border; and 'U' is pink with a white dot. The background is white and filled with various colorful abstract shapes, including circles, teardrops, and a gingerbread man figure, creating a festive and celebratory atmosphere.