



# ***The Autonomic Nervous System***

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# objects

- 1-Review the subdivisions of the nervous system.
- 2- Review the general arrangement and compare the sympathetic and parasympathetic parts.
- 3- Describe the following plans
  - Para vertebral ganglia.
  - Prevertebral ganglia.
  - Parasympathetic ganglia.
  - Splanchnic nerves.
  - Autonomic plexuses.
- 4- Map out the various plexuses in head and neck, thorax, abdomen and pelvis.
- 5- Make a list of the components of the system.
- 6- Review the basic structure of sympathetic trunk.
- 7- Describe the source of sympathetic system in the neck and make a list of target organs.
- 8-Describe the Para vertebral sympathetic ganglia in the abdomen, their locations and target organs.
- 9-Discuss the relation of this system to the adrenal medulla.
- 10-Discuss the sympathetic innervation of blood vessels.
- 11- Make a list of the components of the system.
- 12- Make a list of cranial nerves having parasympathetic activity.
- 13- Describe the parasympathetic ganglia in the head and neck, their locations and target organs.
- 14- Describe the sacral parasympathetic out flow.
- 15-Make a list of its target organs.

# *The Autonomic Nervous System*

- Concerned with the innervation and control of *visceral organs*, *smooth muscle* and *glands*.
- *Regulates* and *Coordinates* visceral functions: heart rate, blood pressure, respiration, digestion, urination & reproduction
- The majority of the activities of the autonomic system do *not impinge on consciousness*

## ■ *Sympathetic*

- Stress reaction
- Fight-or-flight
- Primes body for intense skeletal muscle activity



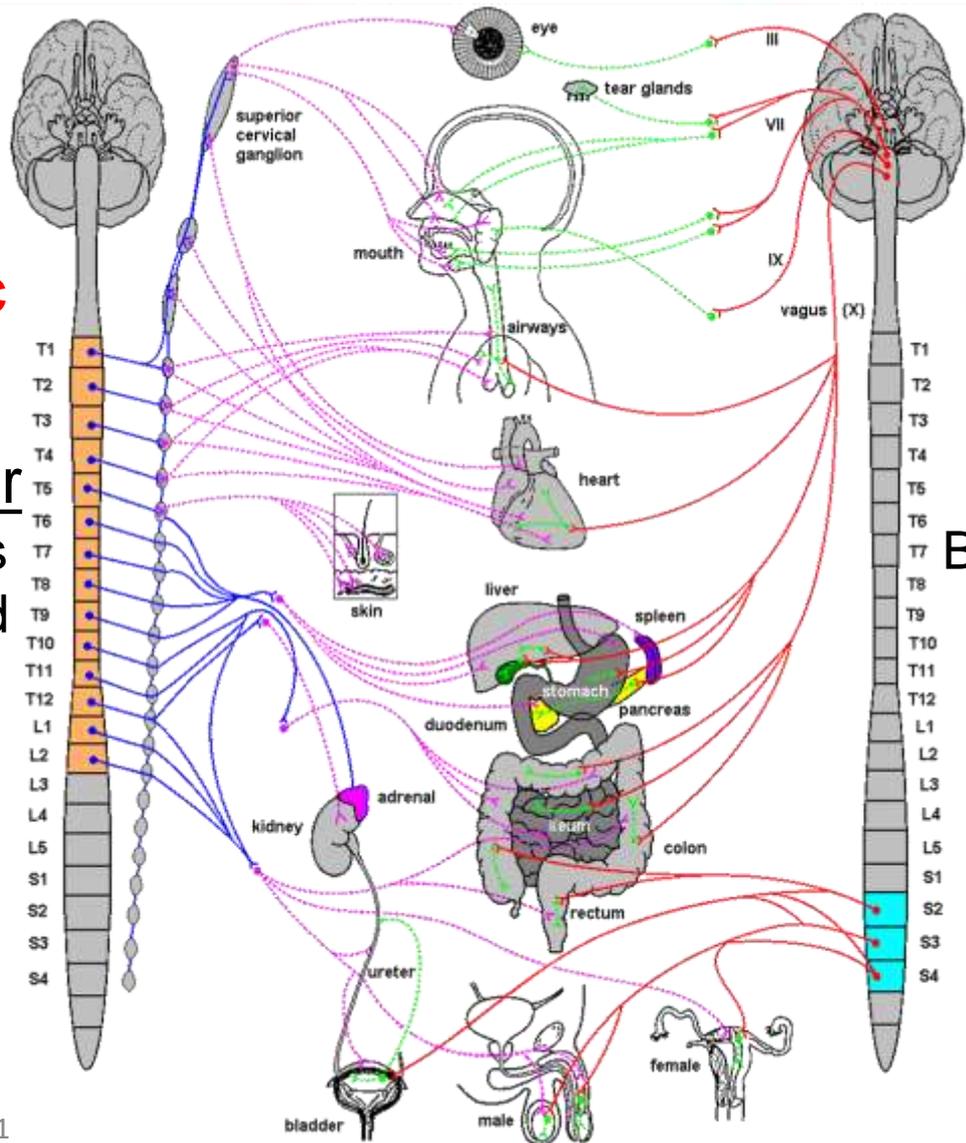
## ■ *Parasympathetic*

- Maintenance functions
- Rest-and-repair
- Counterbalances sympathetic function



# Sympathetic

# Parasympathetic



Thoracolumbar  
T1 – L2/L3 levels  
of the spinal cord

Craniosacral  
Brain: CN III, VII, IX, X  
Spinal cord: S2 – S4

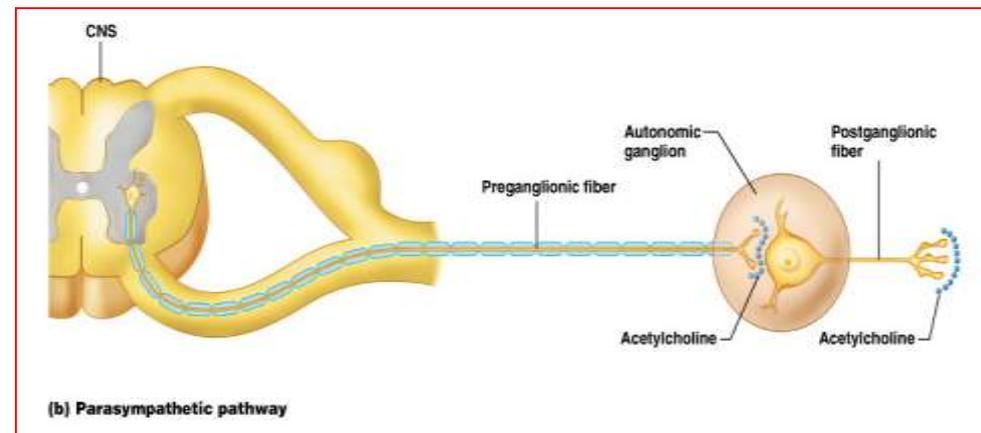
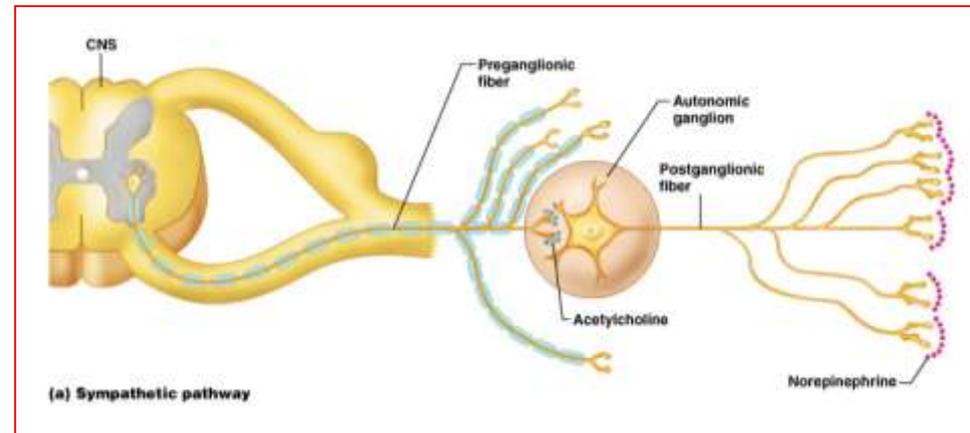
## ■ *Location, number & size of ganglia*

### ■ *Sympathetic:*

- Fewer
- Larger
- Located nearer the CNS

### ■ *Parasympathetic:*

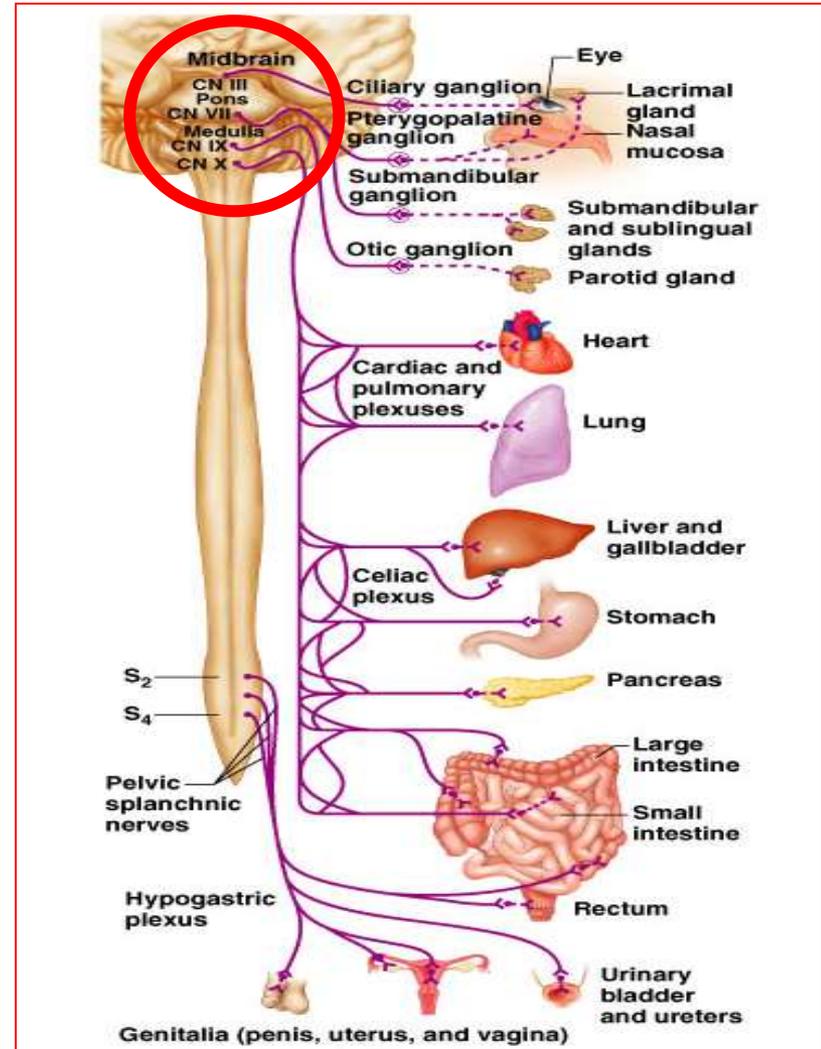
- Many
- Smaller
- Located nearer the viscera, sometimes in the wall of the viscera

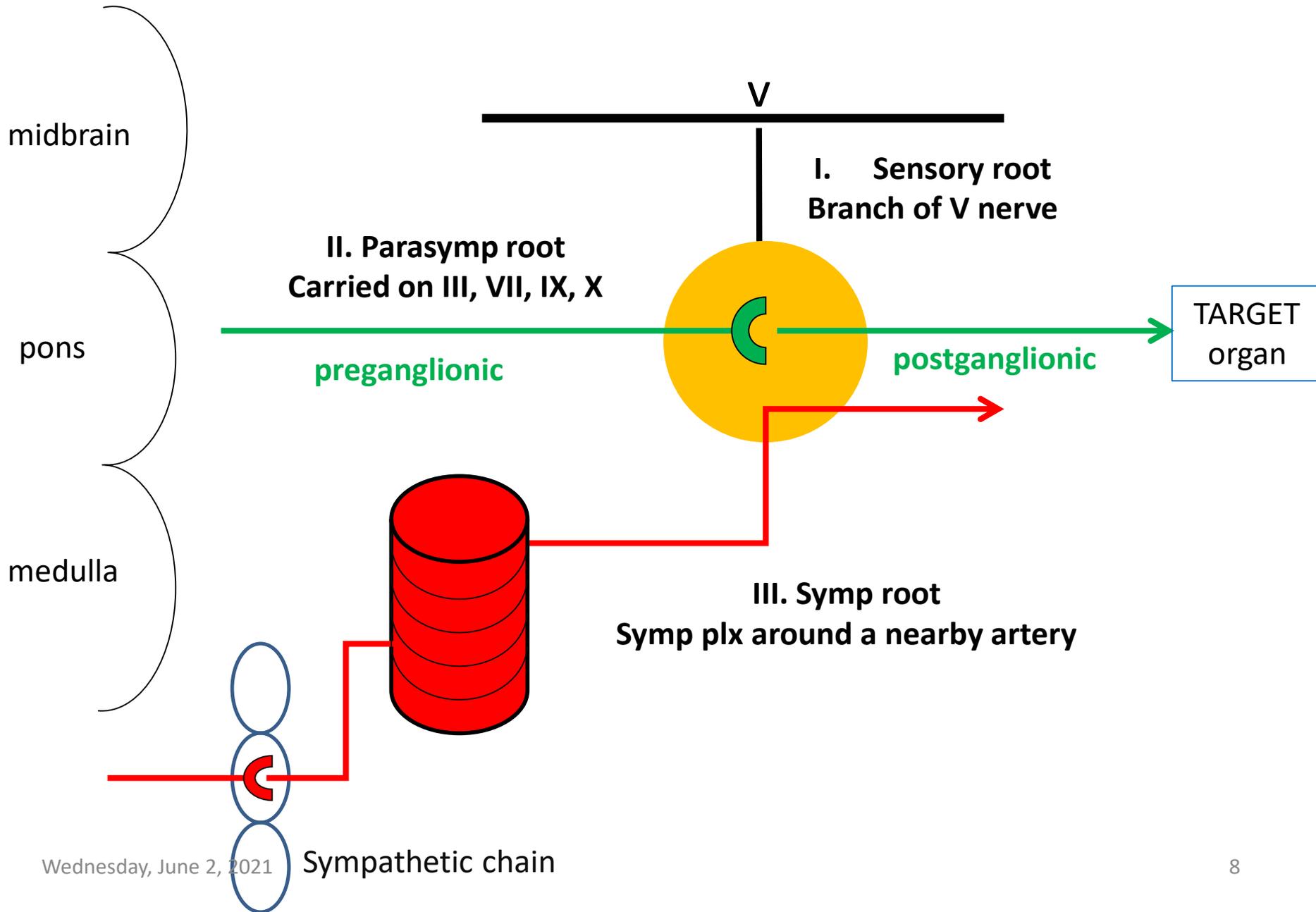


# Parasympathetic Division

## Cranial Outflow

Preganglionic fibers are carried by Oculomotor, Facial, Glossopharyngeal and Vagus nerve (3,7,9,10) and innervate organs of the head, neck, thorax, and abdomen





# PARASYMPATHETIC GANGLIA OF THE HEAD

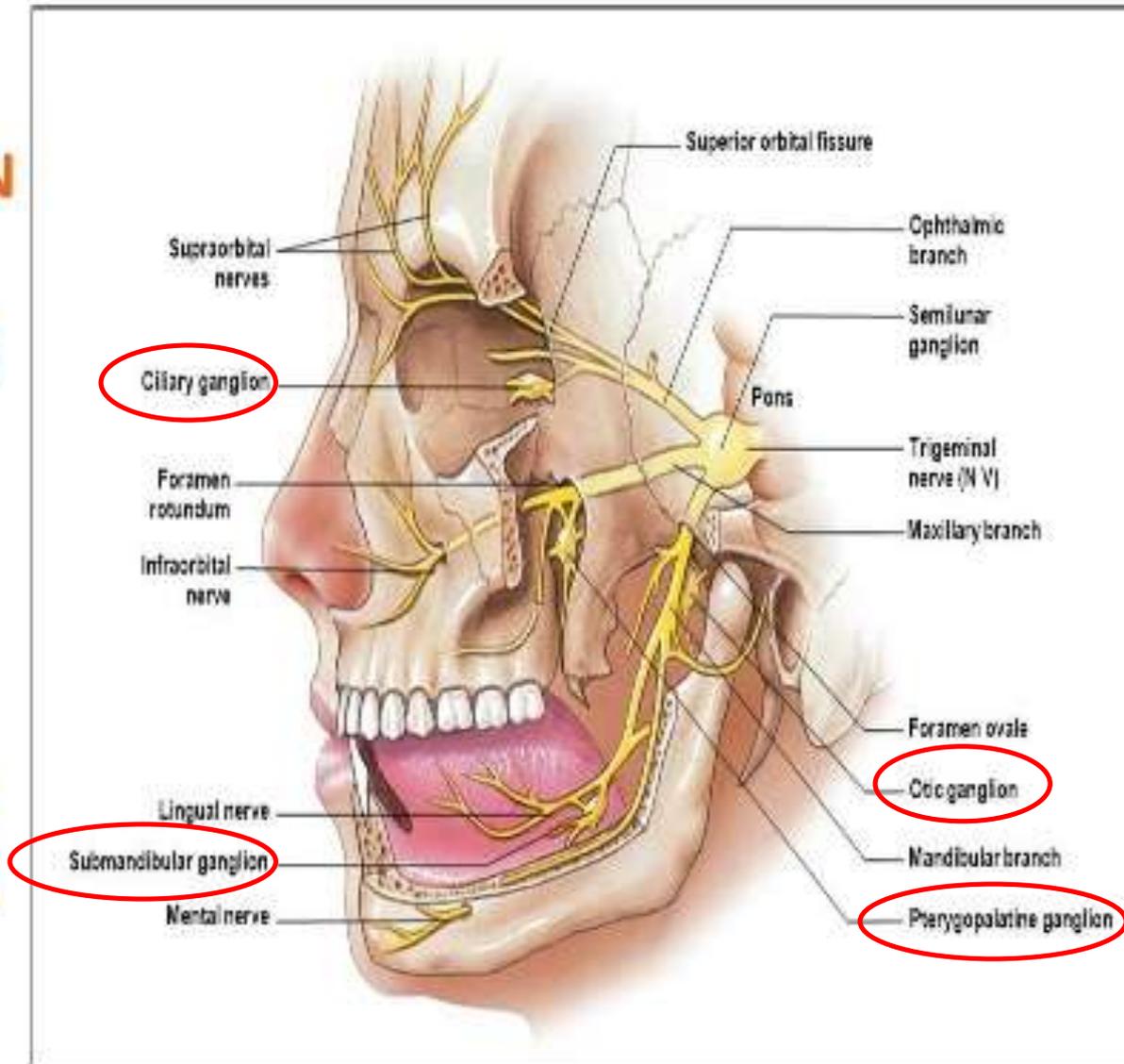
They include :

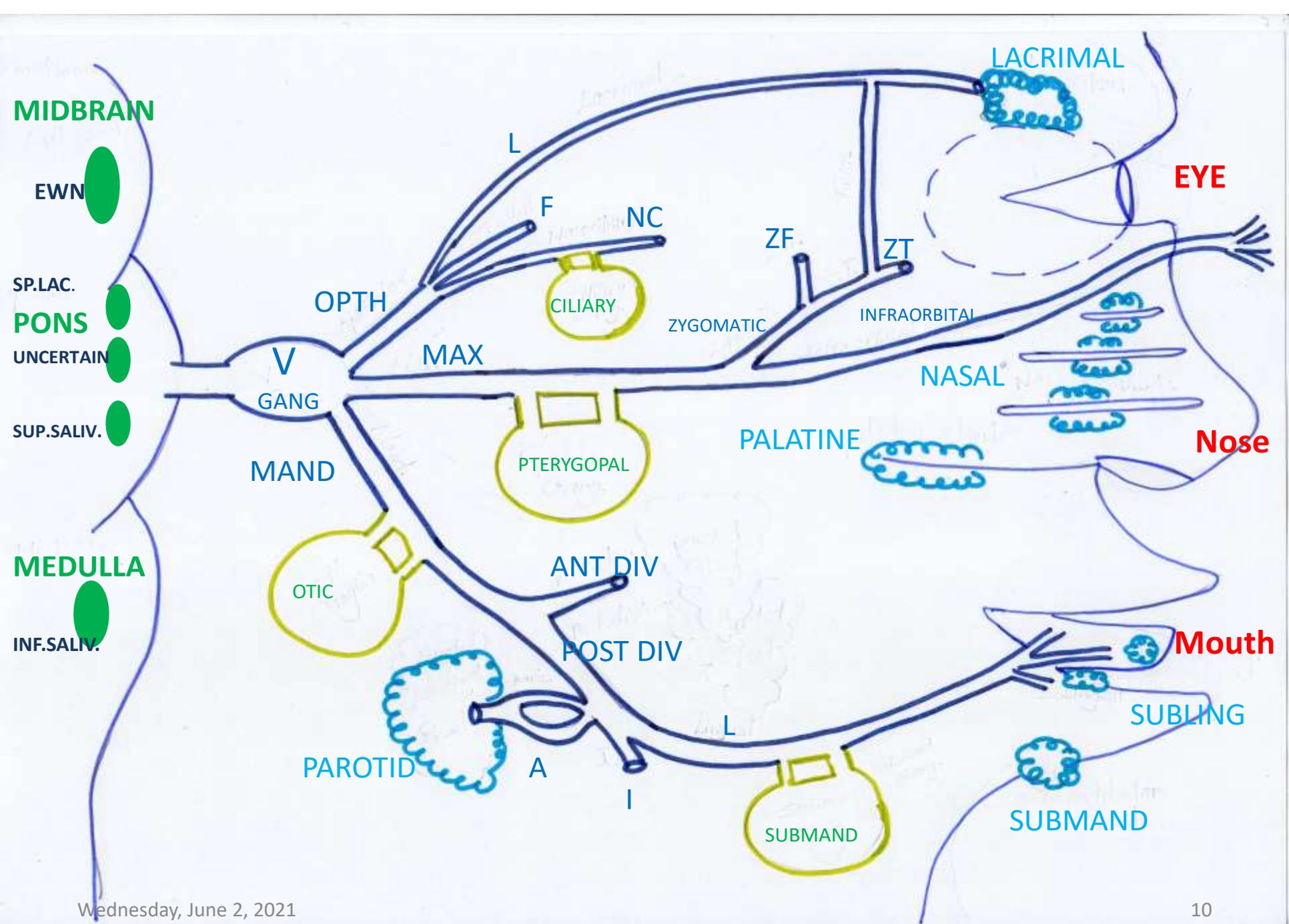
1. CILIARY GANGLION

2. SUBMANDIBULAR GANGLION

3. OTIC GANGLION

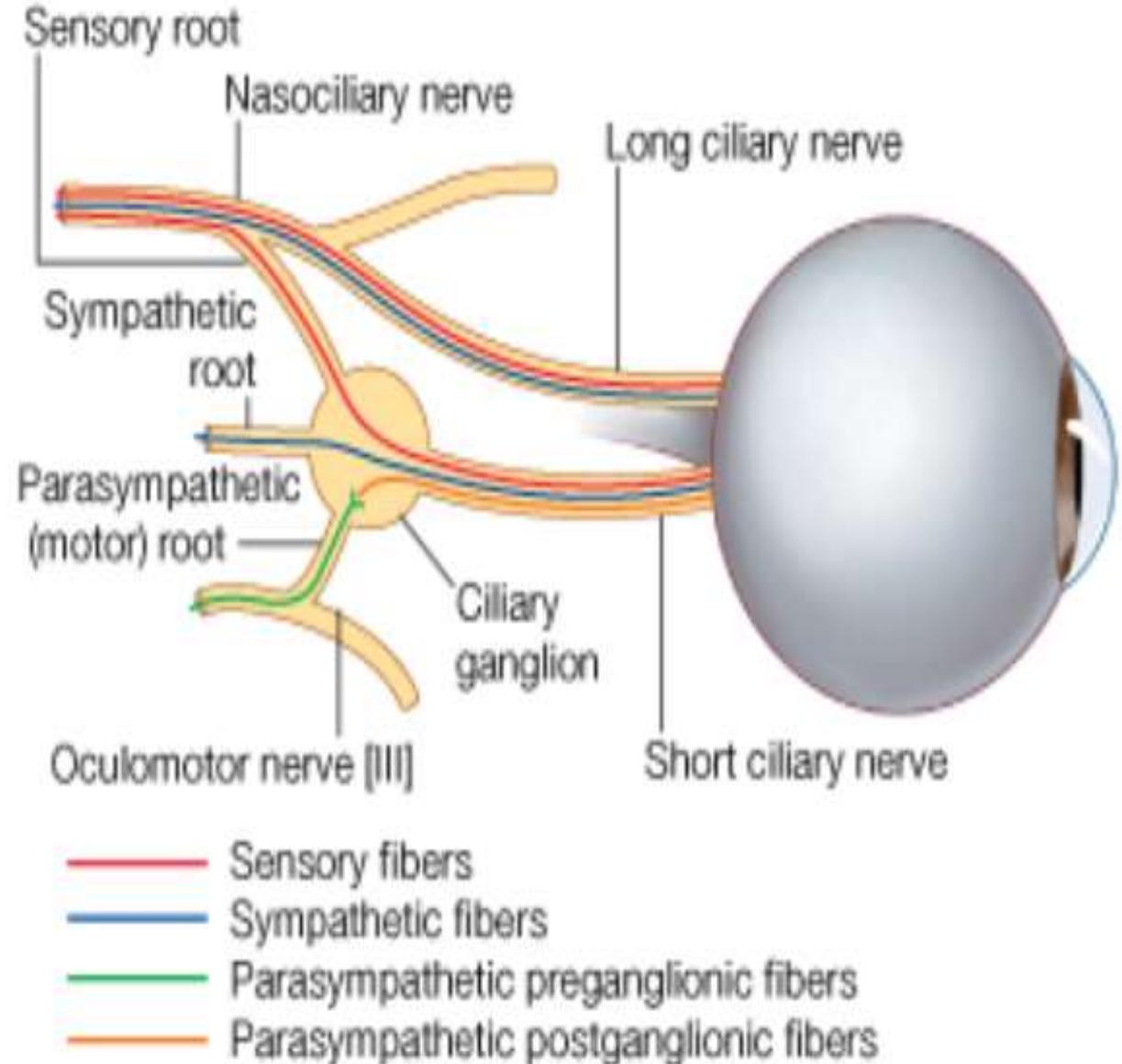
4. SPHENOPALATINE (PTERYGOPALATINE) GANGLION





# Ciliary Ganglion

- lies near the apex of the orbit
- suspended from the nasociliary nerve



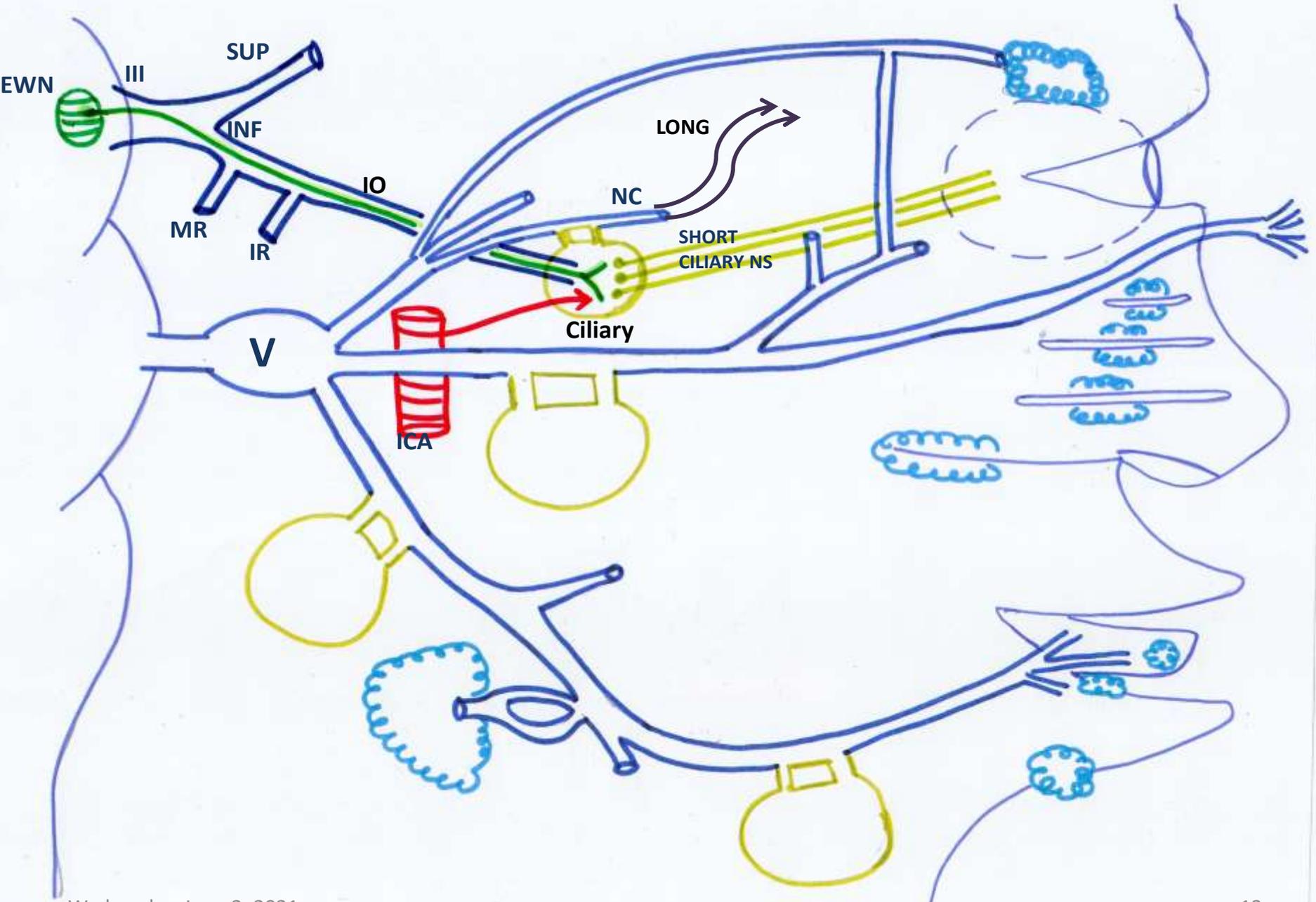
# Ciliary ganglion

➤ **Roots:** It has 3 roots:

1. **Sensory root:** Nasociliary nerve.
2. **Parasympathetic root:** **Oculomotor nerve (3<sup>rd</sup>)** through the nerve to inferior oblique.
3. **Sympathetic root:** From the sympathetic plexus around the internal carotid artery.

➤ **Branches:** 12-15 short ciliary nerves which pierce the back of eyeball around the entrance of optic nerve. They contain the following fibers:

- a- **Parasympathetic postganglionic fibers** which supply the **ciliary and the sphincter pupillae muscles.**
- b- **Sympathetic fibers** supply the **dilator pupillae** and the blood vessels of the eyeball.
- c- **Sensory fibers:** carry the sensation from the **eyeball.**



# Otic Ganglion

Small parasympathetic ganglion lying in the infra-temporal fossa

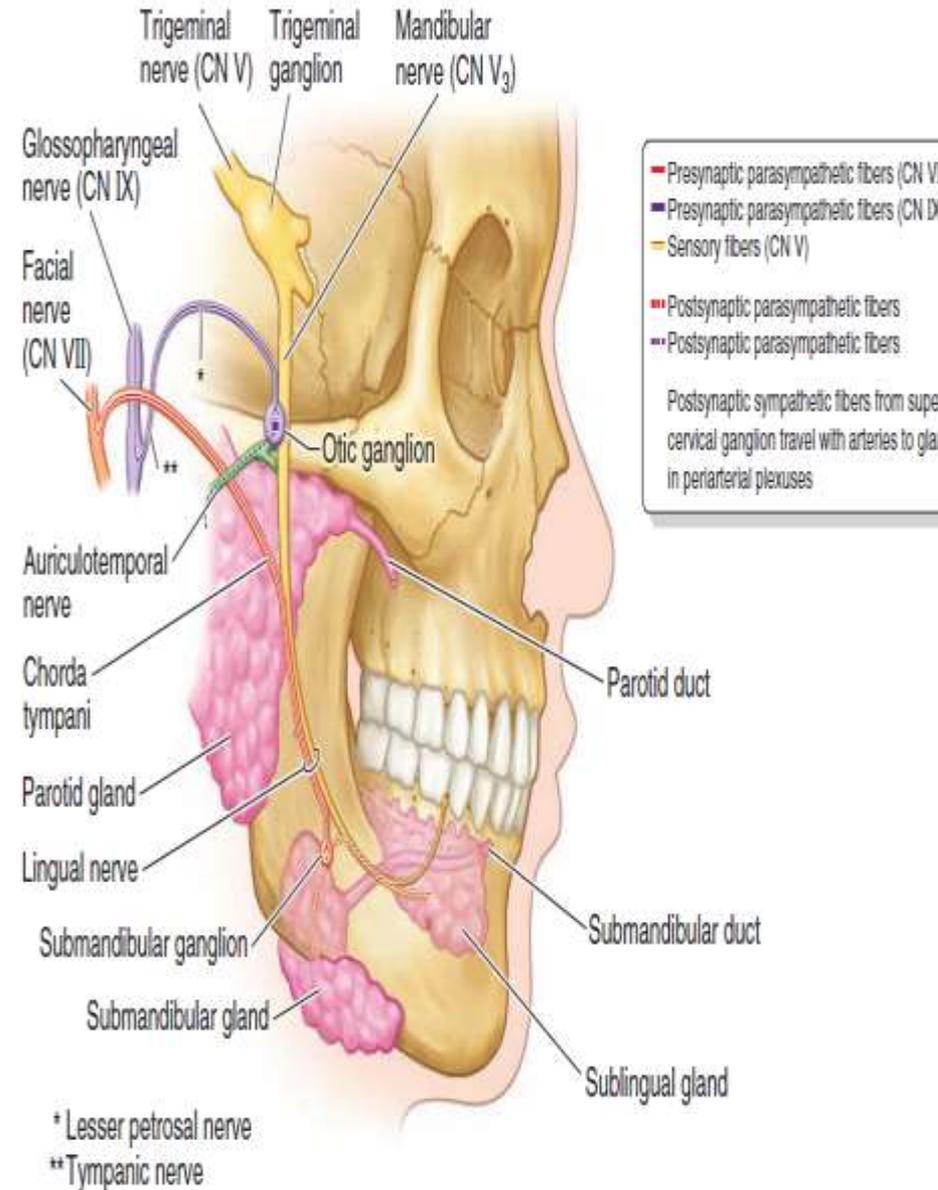
**Roots and branches of the ganglion:**

**Parasympathetic root** (Lesser petrosal nerve 9<sup>th</sup> Cr. N)

The postganglionic fibers join the auriculo-temporal nerve to reach the parotid gland.

**Sympathetic root:** It arises from sympathetic plexus around middle meningeal artery. join the auriculo-temporal nerve which supplies the parotid gland.

**Motor root:** Two fibers arise from nerve to medial pterygoid. They traverse the ganglion without relay to supply 2 muscles: tensor palati and tensor tympani.



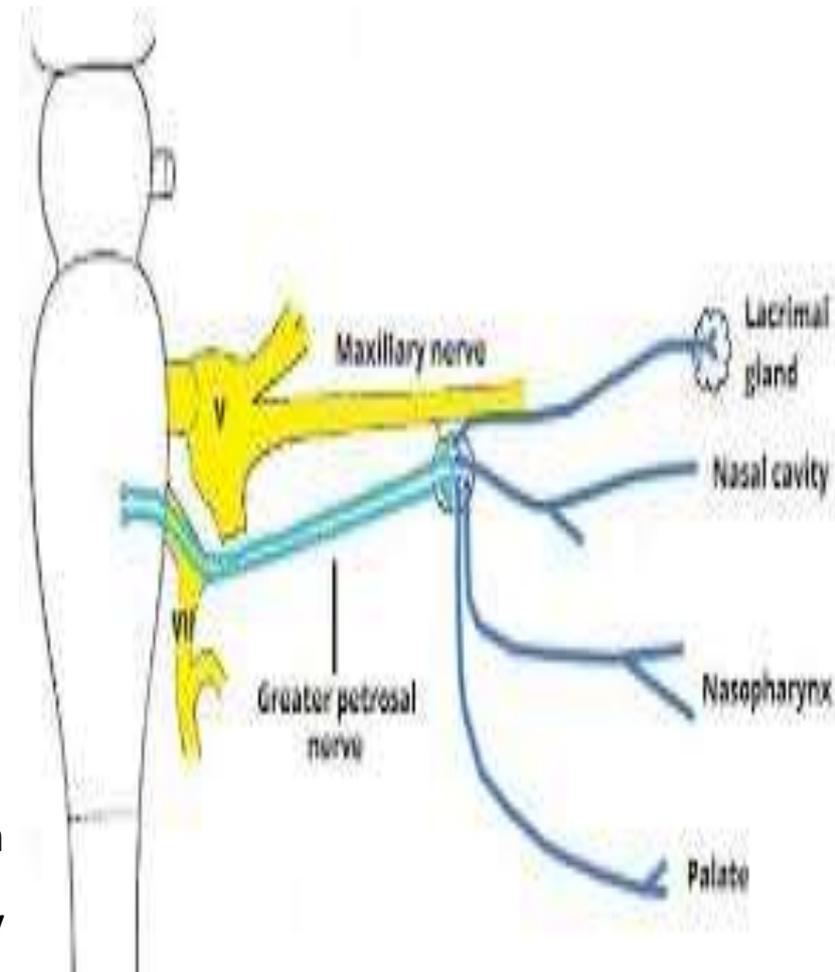
# Sphenopalatine Ganglion

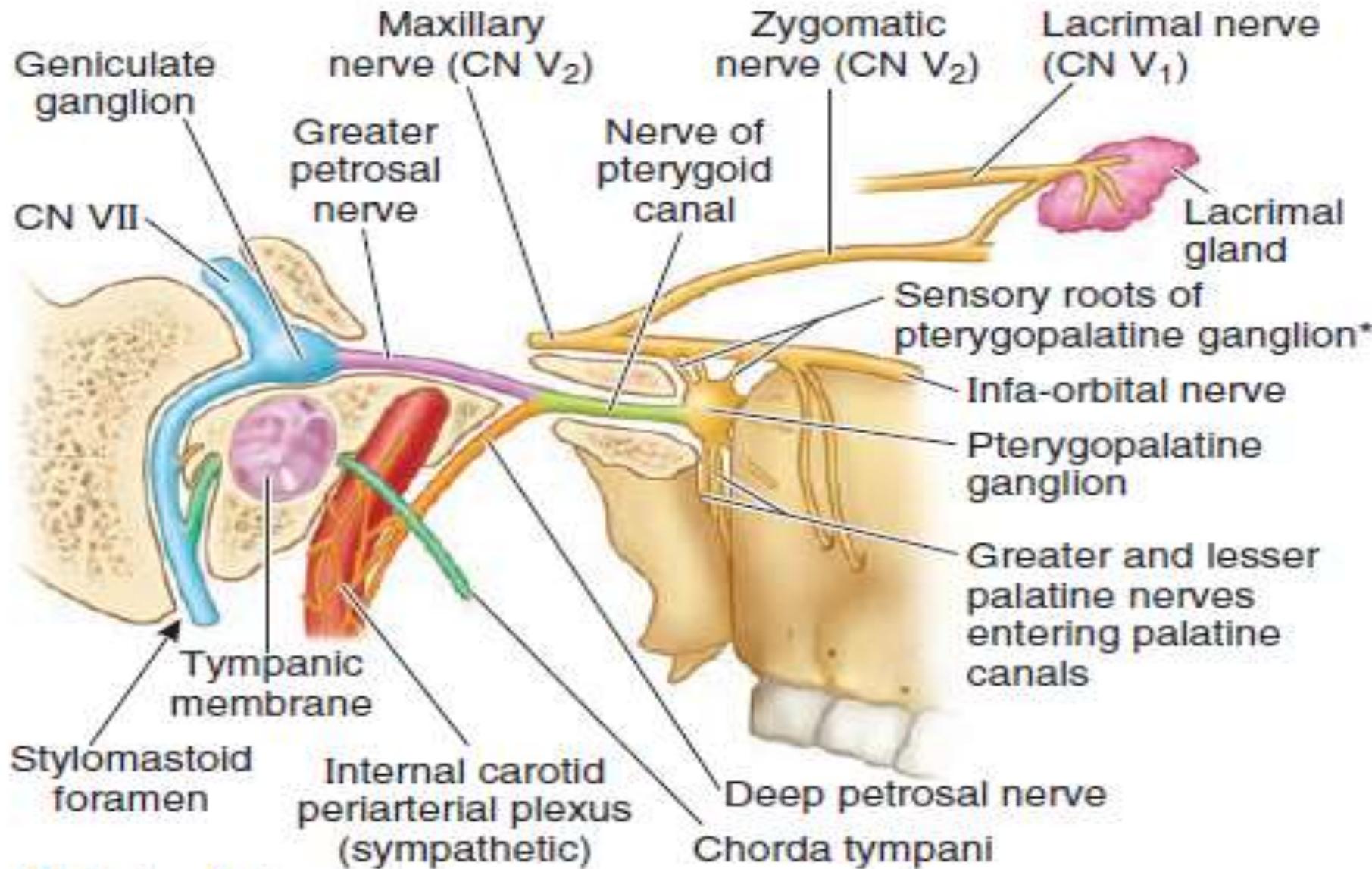
(pterygopalatine)

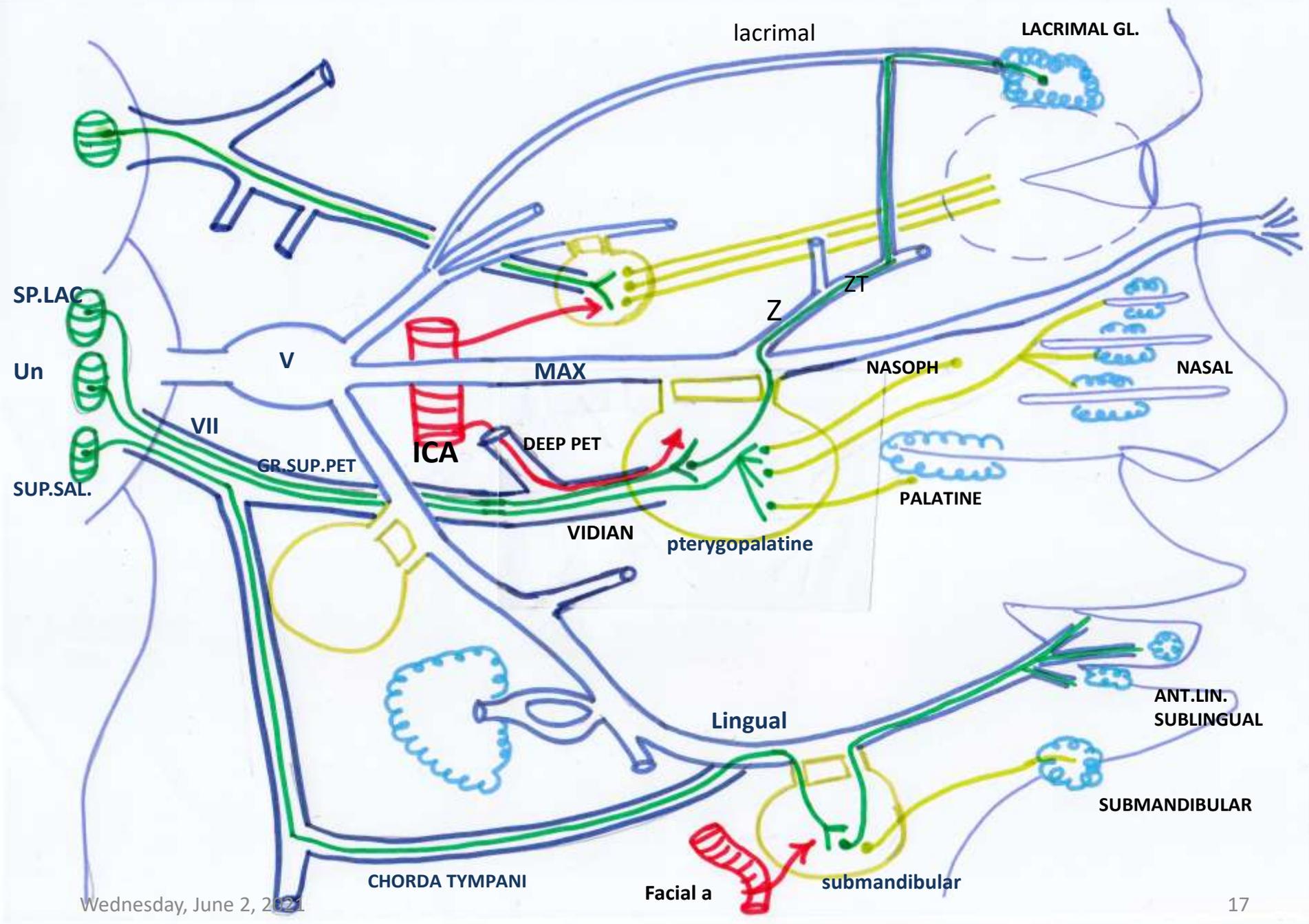
Small flattened parasympathetic ganglion that lies in the pterygopalatine fossa, suspended by 2 roots from maxillary nerve. (ganglia of hay fever)

**Roots of the ganglion:**

- ✓ **Parasympathetic root:** Greater petrosal nerve (**7<sup>th</sup> Cr. N**) relays in the ganglion.
- ✓ **Sympathetic root:** Deep petrosal nerve traverses the ganglion without relay.
- ✓ **sensory root:** Two ganglionic branches which connect the ganglion to the **maxillary nerve**. They contain sensory fibers from the **orbit, nose, palate and nasopharynx** which traverse the ganglion without relay.







# **Submandibular ganglion**

Small parasympathetic ganglion that lies in above the deep portion of the submandibular gland.

**Roots of the ganglion:**

✓ **Parasympathetic root:**

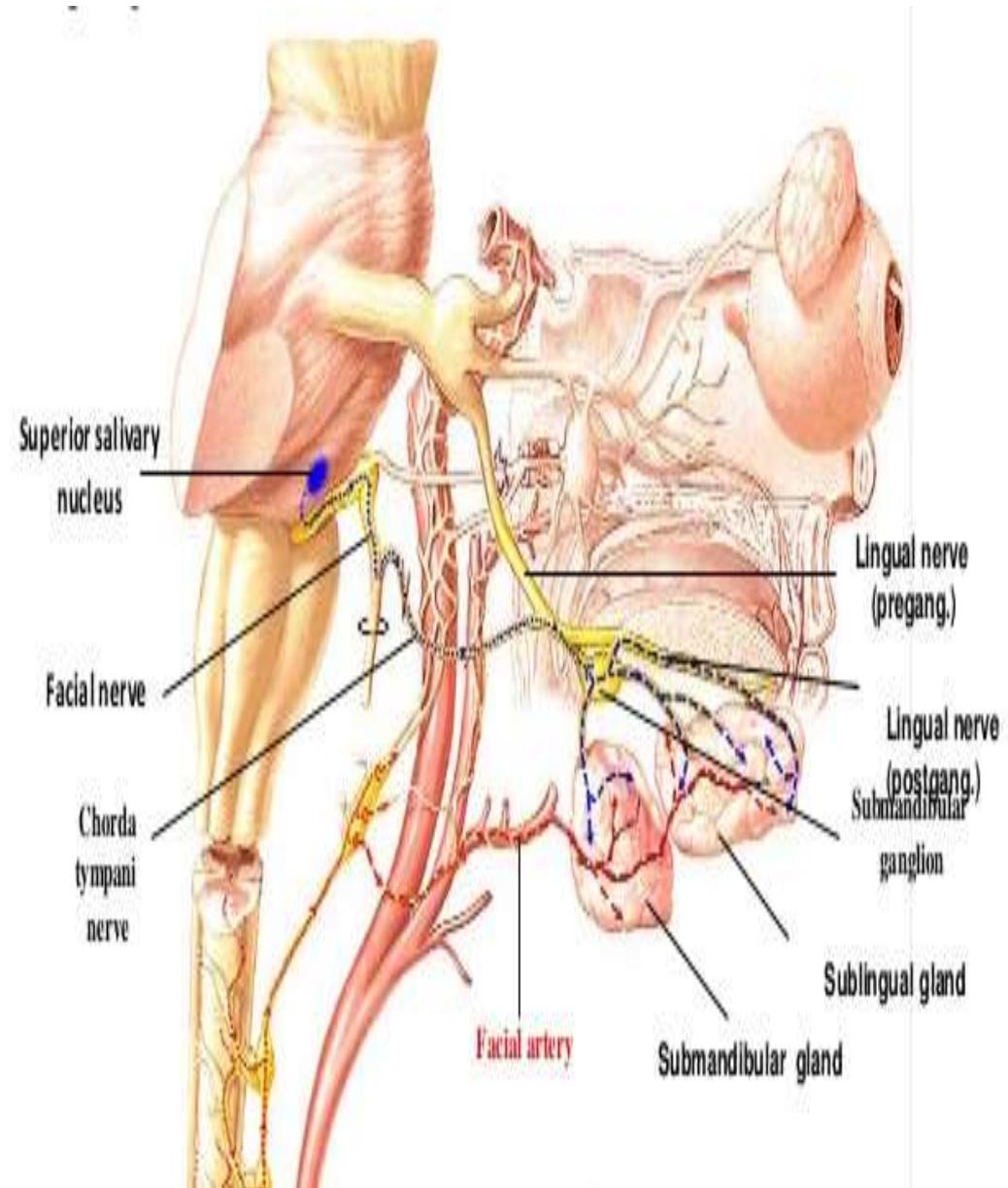
preganglionic parasympathetic fibers from the chorda tympani (from facial N) relay in submandibular ganglion & postganglionic fibers carried by the lingual nerve

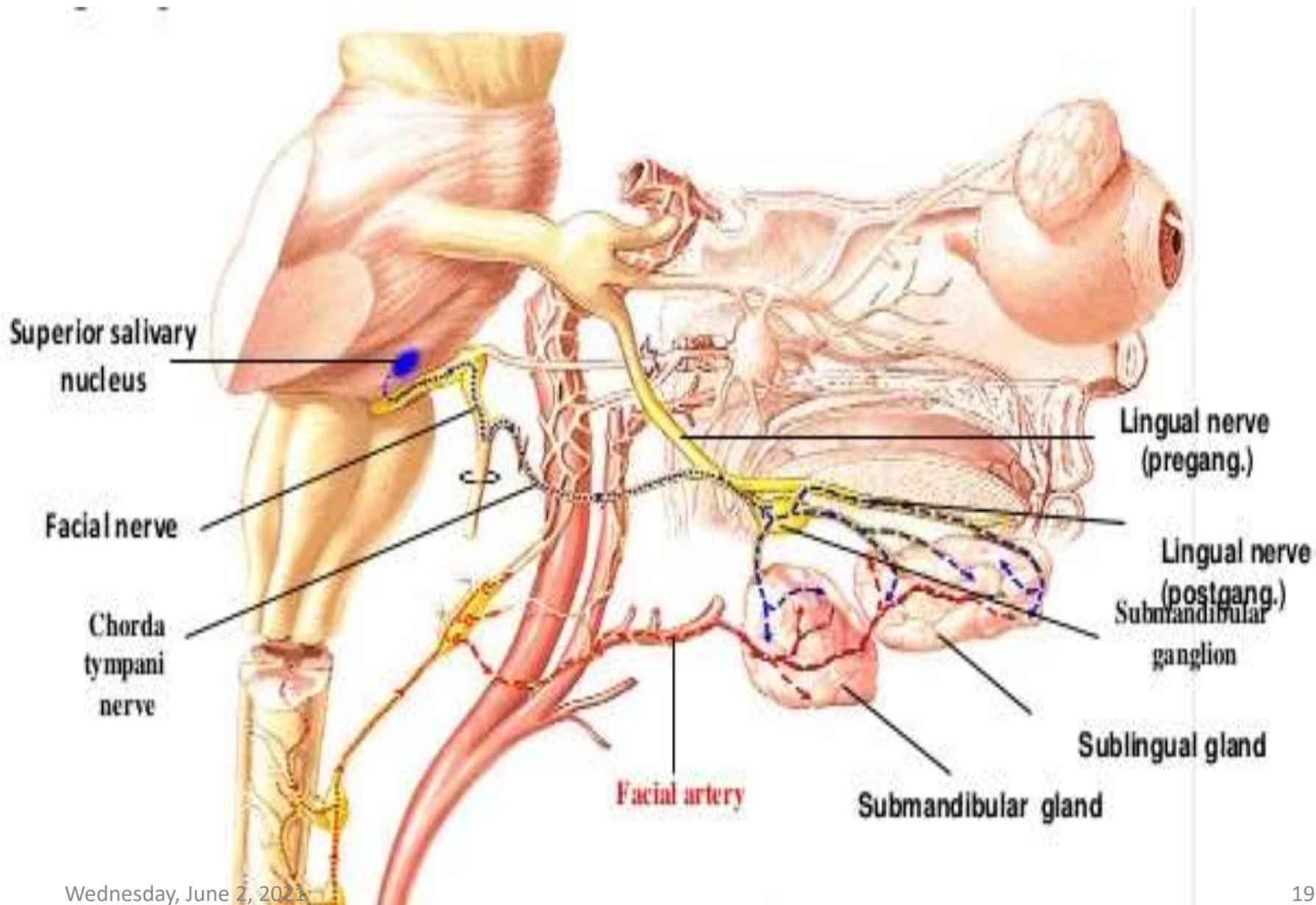
→ To submandibular salivary gland thru the brs of the ganglion itself or

→ To the sublingual via the lingual nerve.

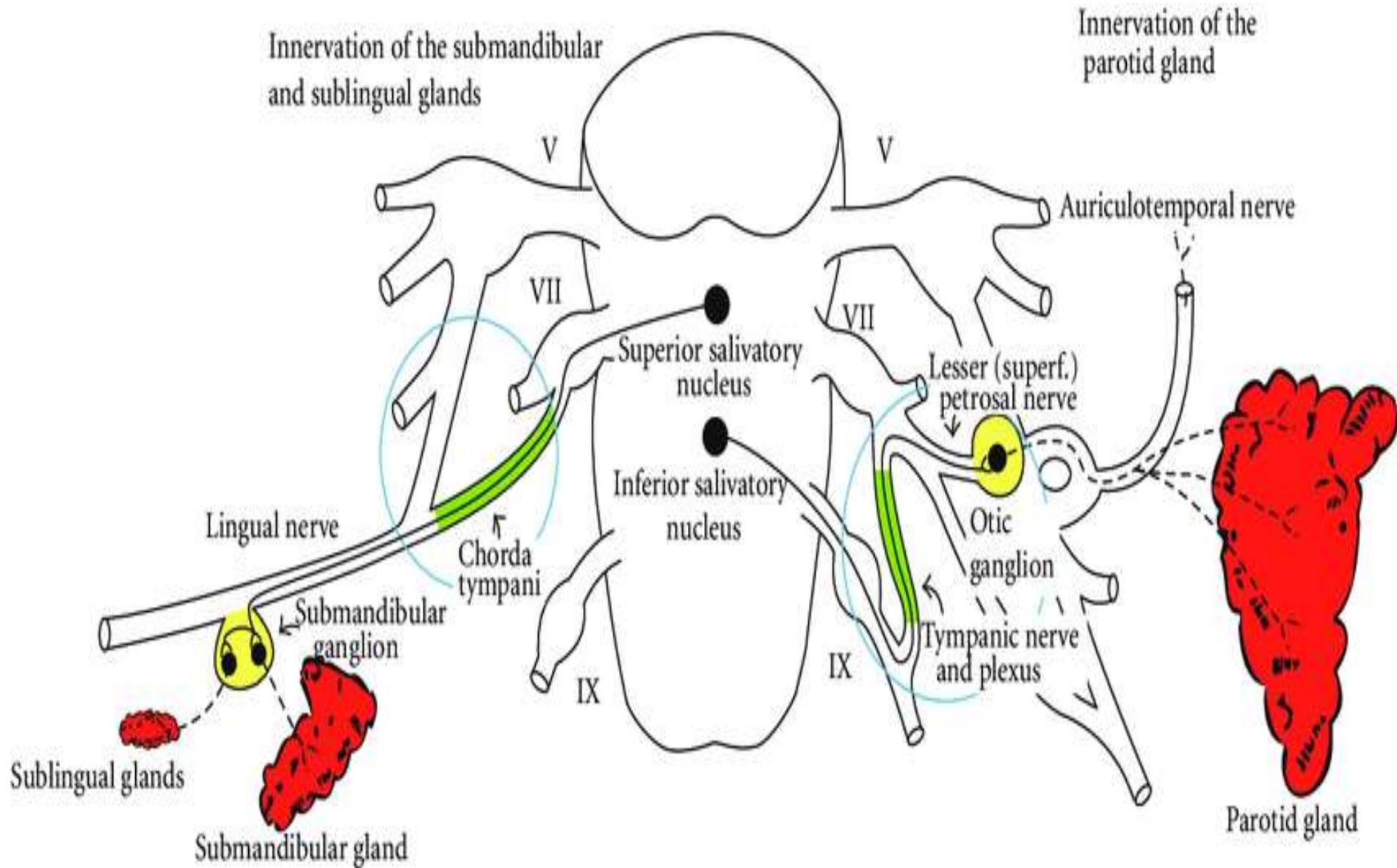
✓ **Sympathetic root:** plexuses around facial artery

✓ **sensory root:** lingual nerve



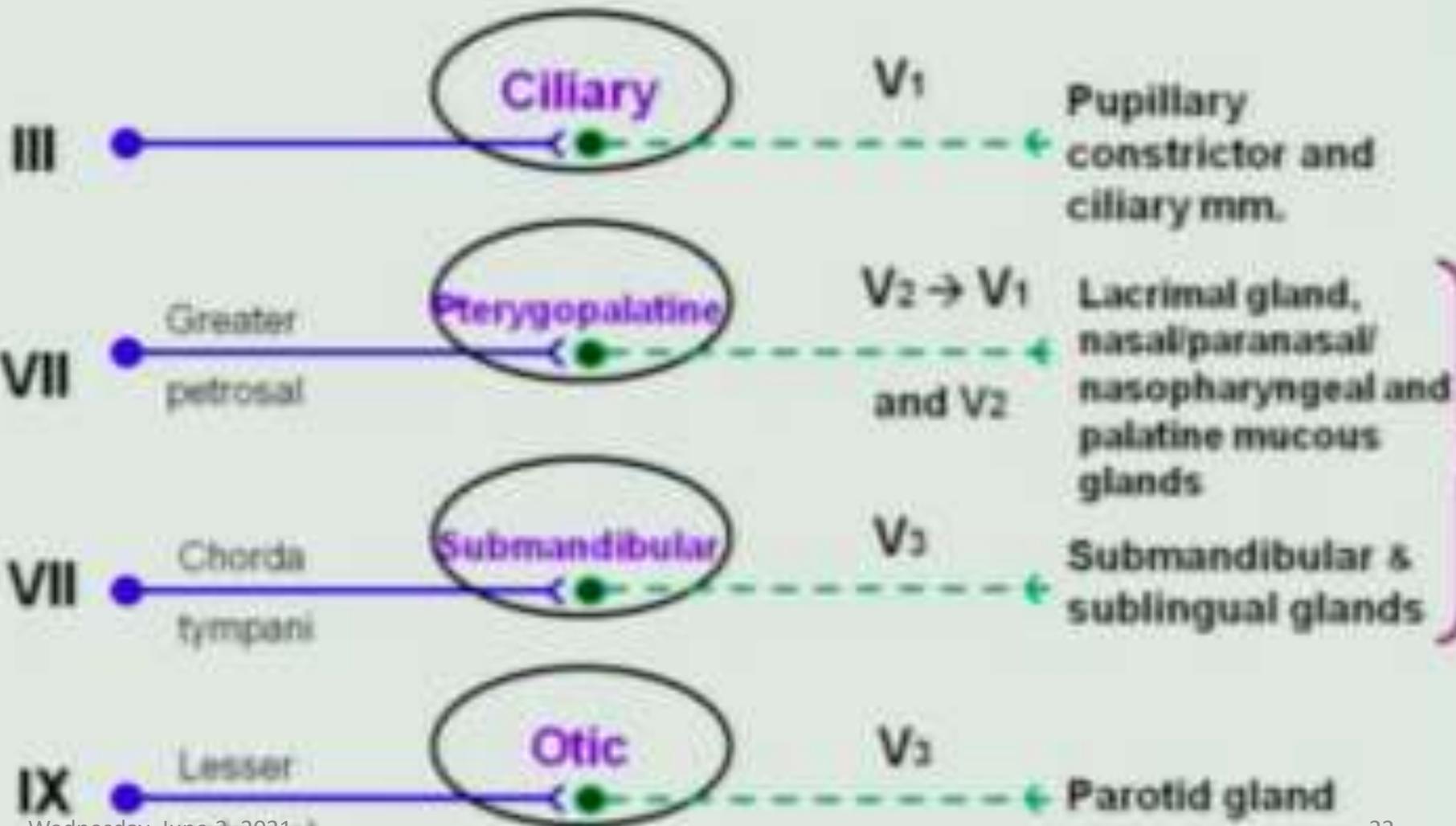


# Salivary nuclei



Nucleus	Pre-ganglionic	Ganglion	Post-ganglionic	Target organs
Edinger-Westphal (Oculomotor nerve)	Travels within the motor root of the oculomotor nerve	Ciliary ganglion	Travels via short ciliary nerves	<b>constrictor pupillae</b> Ciliary muscles
Superior salivatory nucleus (Facial nerve)	Travels within the greater petrosal nerve and nerve of pterygoid canal	Pterygopalantine ganglion	Hitchhikes on branches of the maxillary nerve	Lacrimal gland Nasopharynx Palate Nasal cavity
	Travels within the chorda tympani, a branch of the facial nerve	Submandibular ganglion	Fibres travel directly to target organs.	Sublingual and submandibular glands
Inferior salivatory nucleus (Glossopharyngeal nerve)	Travels within the lesser petrosal nerve	Otic ganglion	Hitchhikes on the auriculotemporal nerve	Parotid gland
Dorsal vagal motor nucleus (Vagus nerve)	Travels within the vagus nerve.	Many – located within the target organs	n/a	Smooth muscle of the trachea, bronchi and gastro-intestinal tract

<u>Cranial nerve</u>	<u>Ganglion</u>	<u>Branch of V</u>	<u>Target tissue</u>
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<b>C.N.</b>	<b>Ganglion</b>	<b>CN V Branch</b>	<b>Target</b>
III	Ciliary	Ophthalmic	Intrinsic eye muscles
VII	Pterygopalatine	Maxillary	Lacrimal gland, Nasal cavity, Maxillary sinus, Palate
VII	Submandibular	Mandibular	Submandibular and sublingual glands
IX	Otic	Mandibular	Parotid gland

# The sympathetic system

It is formed of:

**1. Preganglionic fibers:** they arise from the neurons of the lateral horns of grey matter of the spinal cord in the following segments:

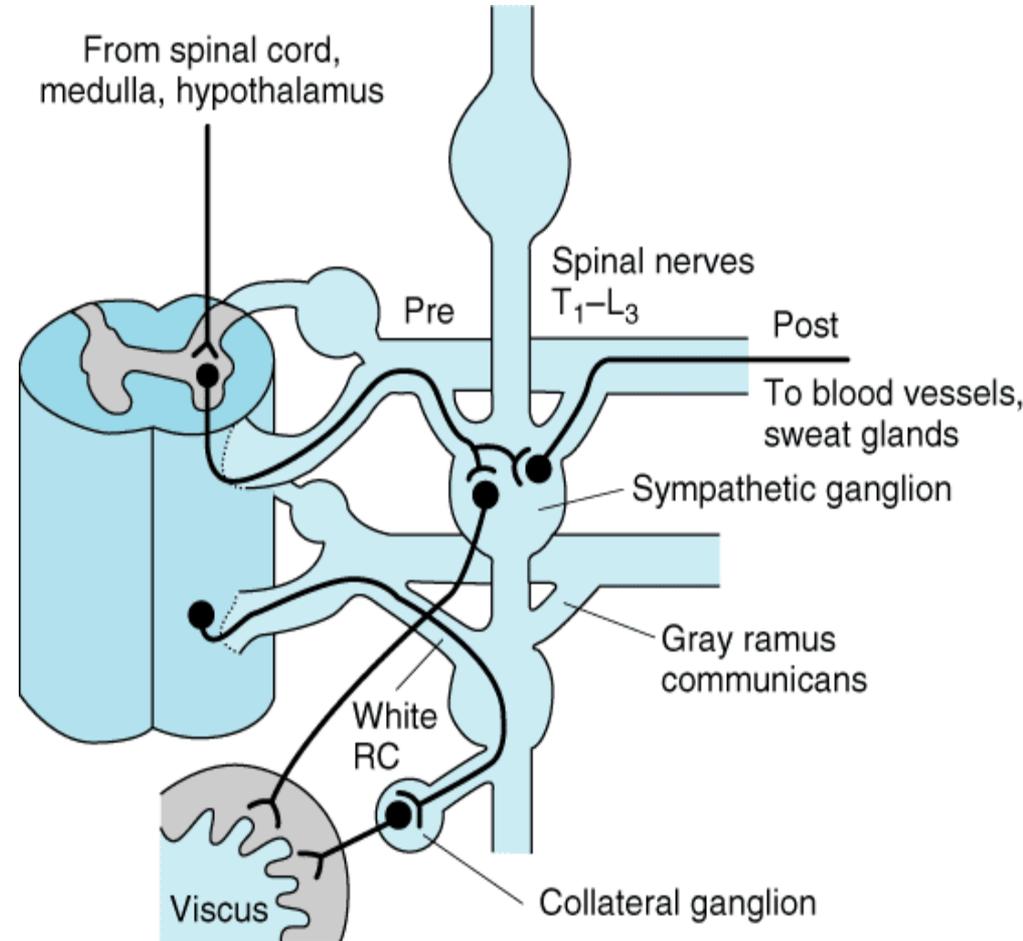
- a) all thoracic segments
- b) upper 2 lumbar segments

**(Hence called thoracolumbar outflow)**

The fibers run in the ventral root, trunk, ventral ramus of corresponding spinal nerve.

Finally they leave the ventral ramus as white ramus communicante to reach the ganglia of the sympathetic chain which extends along side of the vertebral column.

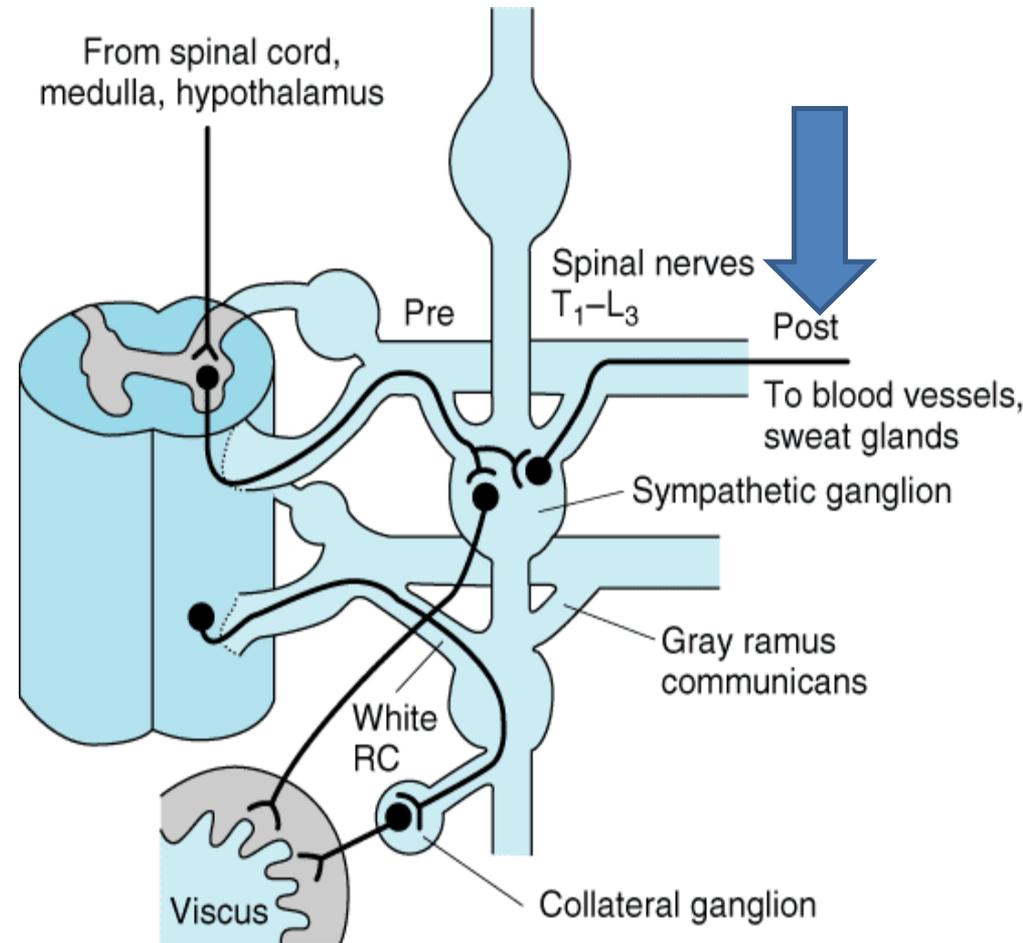
**N.B. : A ganglion** is a collection of neurons cell bodies outside the C.N.S.



**Sympathetic division**

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**2. Postganglionic fibers:** they are the axons of the cell bodies of the sympathetic ganglia. The fibers leave the ganglia as grey rami communicantes to be distributed to their target organs in close relations to the arteries.



### Sympathetic division

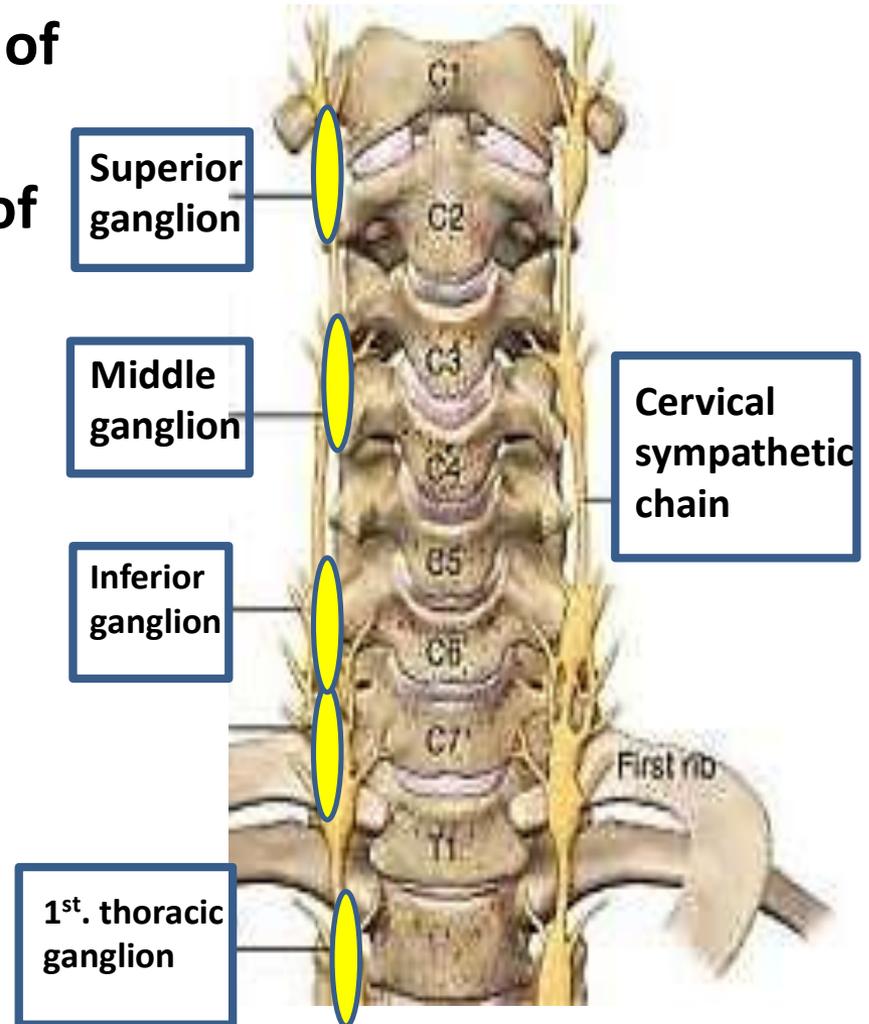
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# Cervical Sympathetic Chain

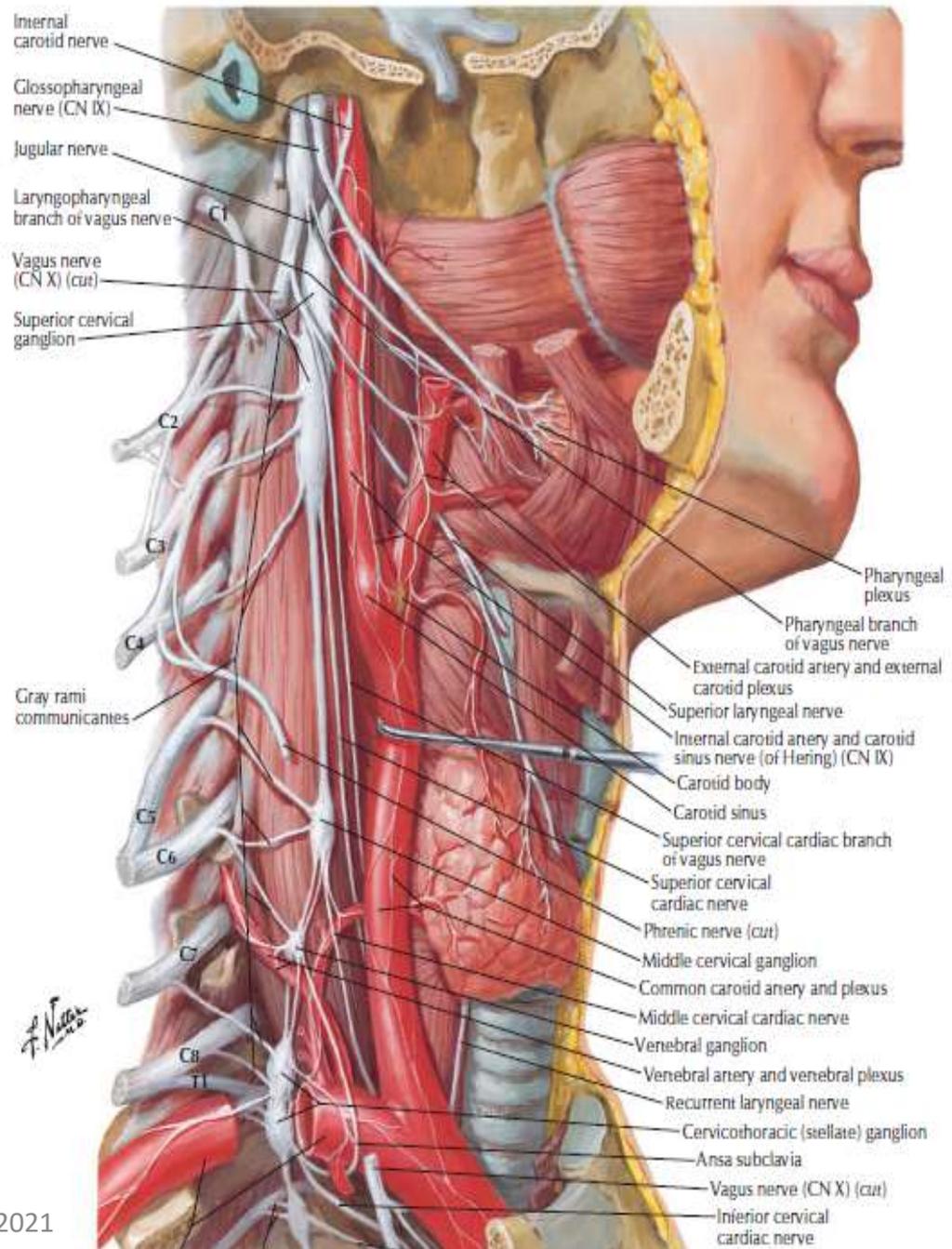
# Cervical sympathetic chain

Extends from **base of skull** to neck of the **1<sup>st</sup> rib**, where it becomes continuous with the thoracic part of the sympathetic trunk.

- It is embedded in deep fascia between the carotid sheath and the prevertebral layer of deep fascia.
- It carries three ganglion
  - 1- superior
  - 2- middle
  - 3- inferior



( in most people it is fused with 1<sup>st</sup> thoracic ganglion to form stellate ganglion in front of neck of 1<sup>st</sup> Rib.



*F. Netter M.D.*

A  
G

# Branches of Sympathetic ganglia are divided into three groups:

**1- Communicating**..... To nearest nerve.

**2- Vascular**.....around nearest artery.

**3- Visceral**.....to nearest viscera.

# Superior cervical ganglion:

## 1- Communicating

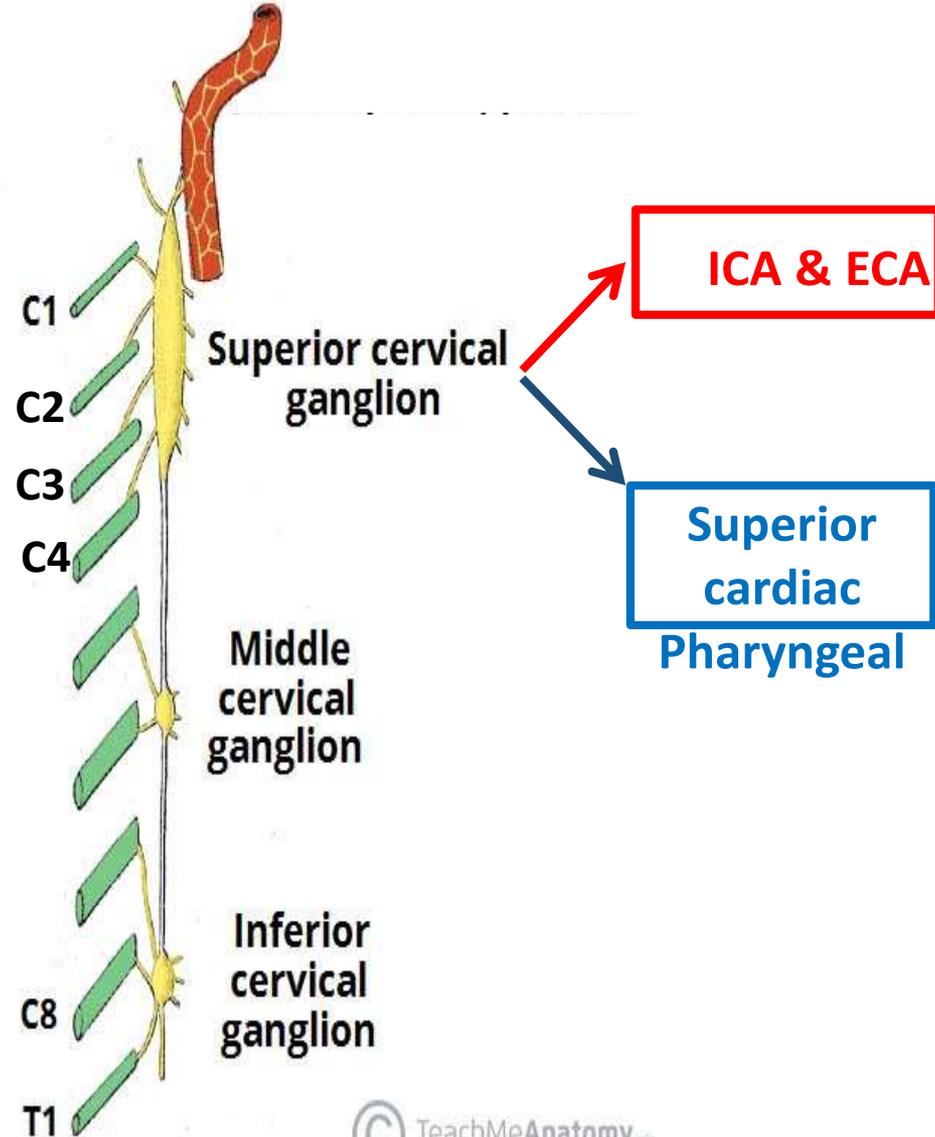
With upper 4 cervical spinal nerves  
With 9, 10 & 12 cranial nerves.

## 2- Vascular

Around ICA & ECA

## 3- Visceral

- Superior cardiac
- Pharyngeal branches



# Middle cervical ganglion:

## 1- Communicating

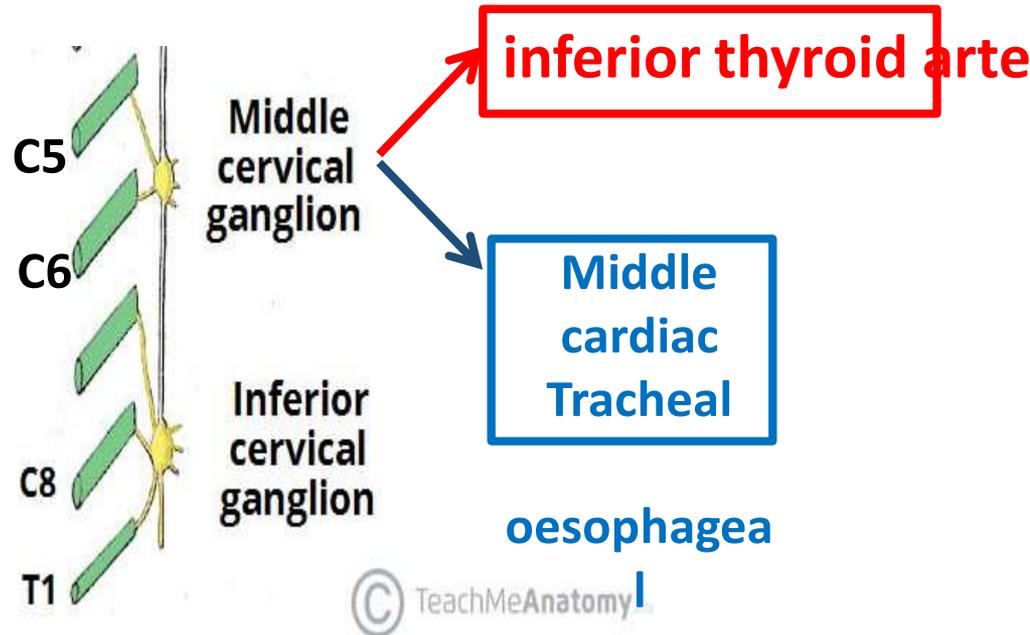
With C5,6 spinal nerves.

## 2- Vascular

Around inferior thyroid artery

## 3- Visceral

- Middle cardiac branches
- Tracheal & oesophageal branches



# Inferior cervical ganglion:

## 1- Communicating

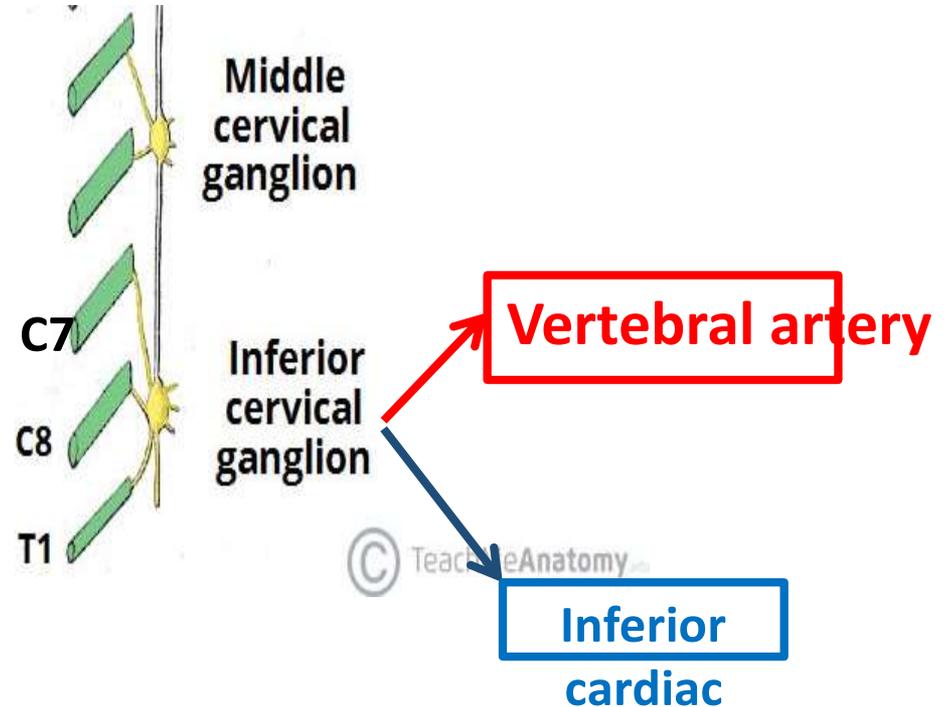
With C7,8 spinal nerves.

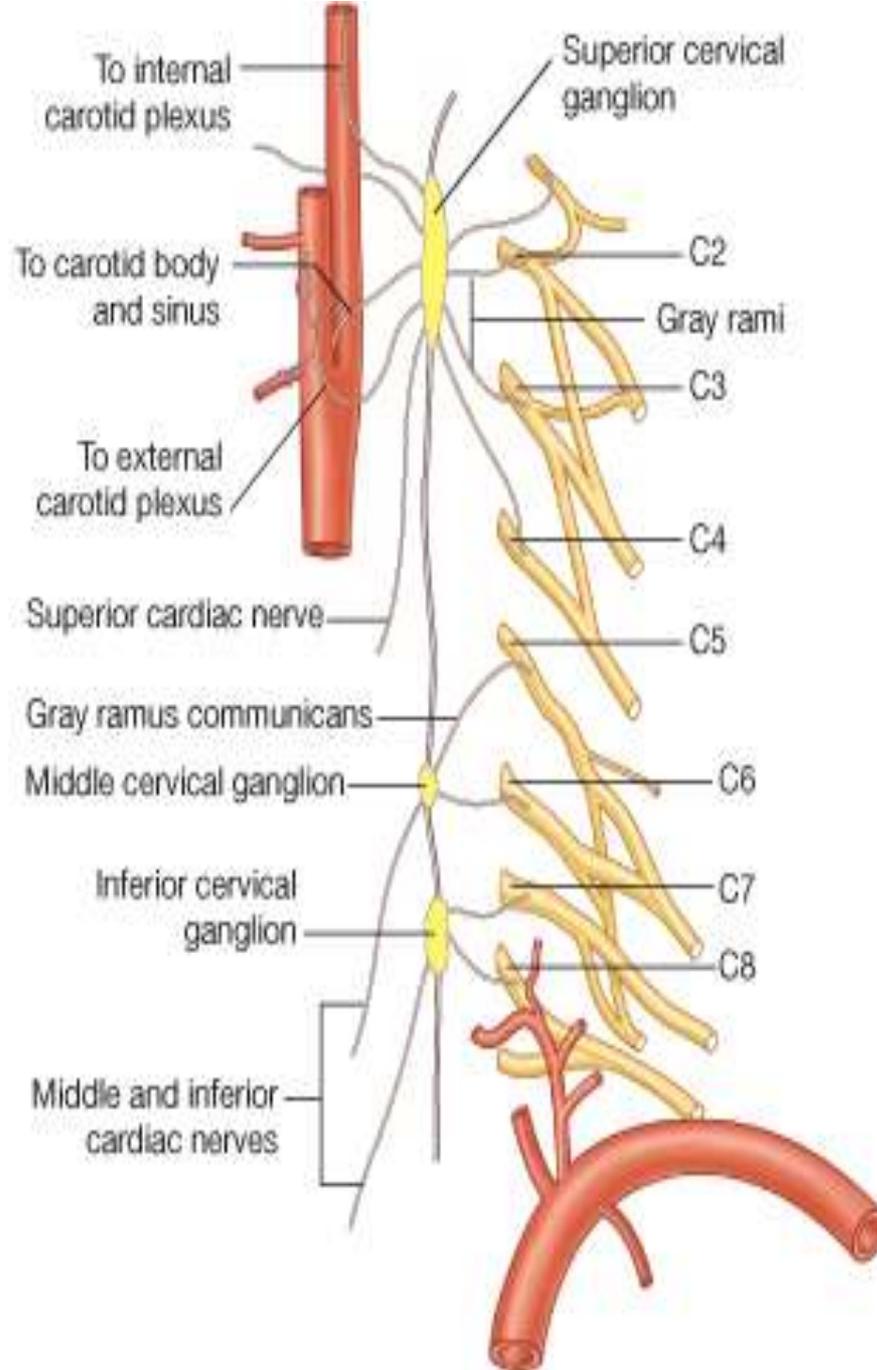
## 2- Vascular

Around vertebral artery

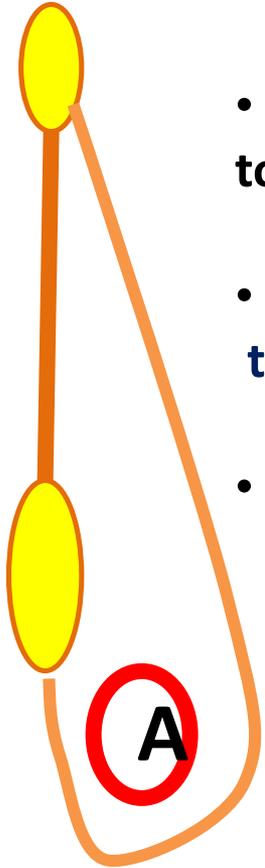
## 3- Visceral

- Inferior cardiac branches



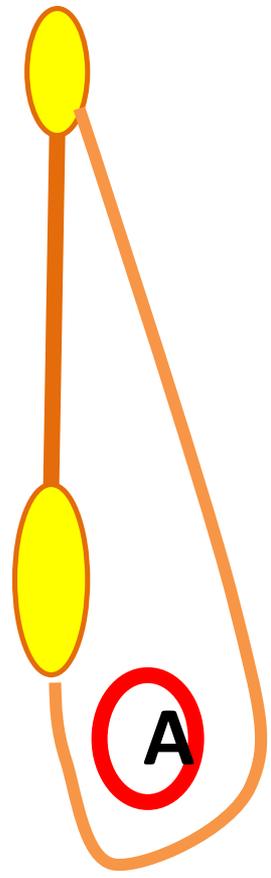


# Ansa subclavia



- The part of the sympathetic trunk connecting middle cervical ganglion to inferior or stellate ganglion is represented by 2 more bundles.
- The most anterior bundle crosses **infront of subclavian artery** and then turns upward behind it.
- This anterior bundle is referred to as ansa subclavia.

# Ansa subclavia



inferior ganglion

middle ganglion

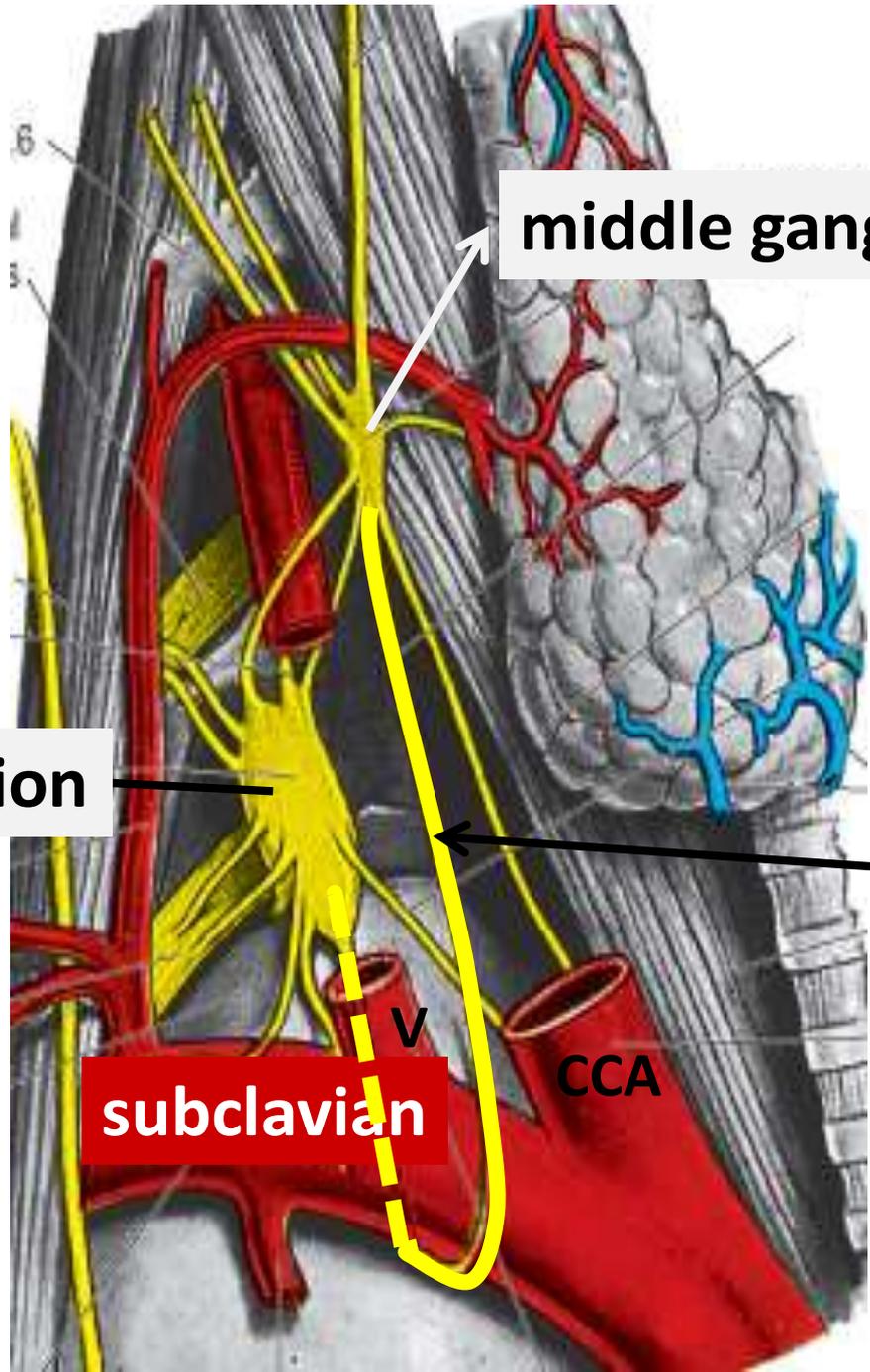
Ansa subclavia

subclavian

CCA

V

Ansa subclavia around subclavian artery



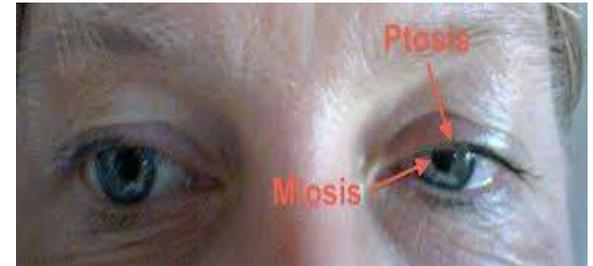
**Pancoast syndrome, this apical lung tumor may spread to involve the sympathetic trunk, affect the lower portion of the brachial plexus (C8, T1, and T2),**

**This may lead to Horner's syndrome on the affected side:**

- Miosis: constricted pupil
- Ptosis: minor drooping of the upper eyelid
- Anhidrosis: lack of sweating
- **Flushing: subcutaneous vasodilation**

**Traumatic injury to cervical sympathetic chain at root of neck**

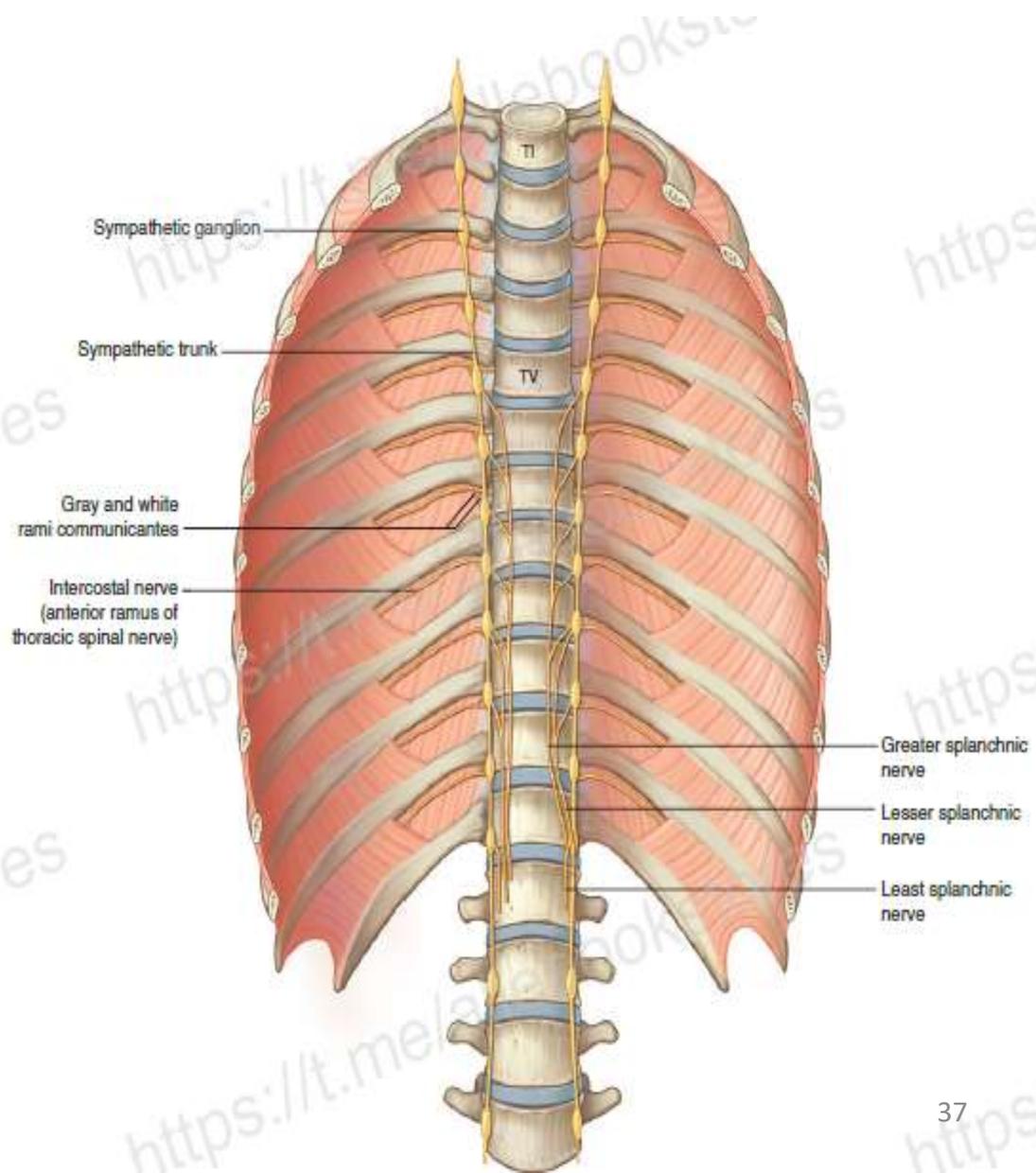
**causes Horner syndrome????????**



# Thoracic Sympathetic Chain

- In the posterior mediastinum
- 12 thoracic ganglia
- Connected to the adjacent thoracic spinal nerve by white rami communicantes

The upper 5 ganglia give **postganglionic fibers** to the thoracic viscera



# Thoracic Sympathetic Chain

The lower **7** ganglia give **preganglionic fibers** to various abdominal and pelvic viscera through 3 nerves

## Greater splanchnic

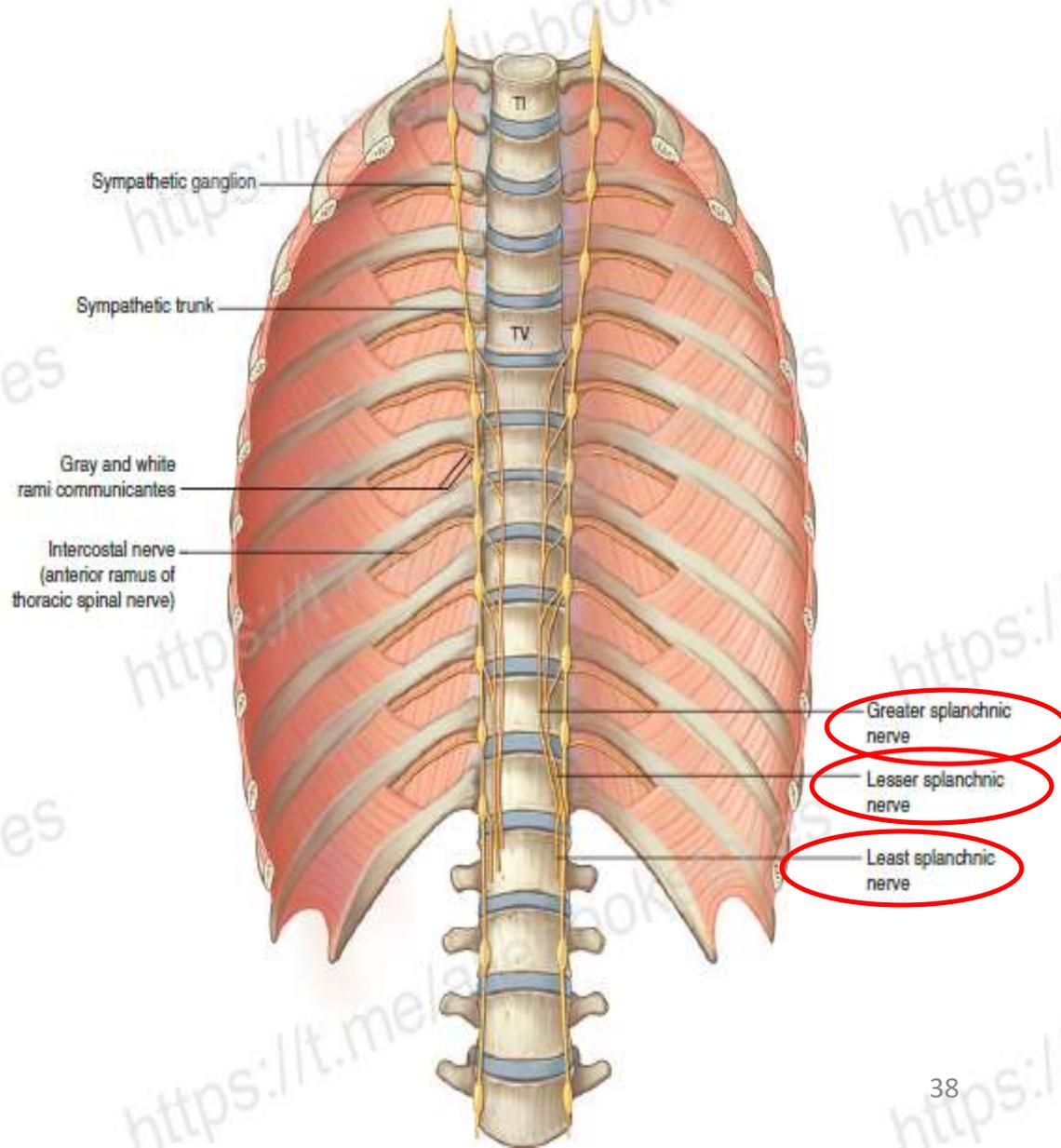
From the 5<sup>th</sup> to 9<sup>th</sup> ganglia  
To the celiac ganglion

## Lesser splanchnic

10<sup>th</sup> 11<sup>th</sup> to aortico renal ganglia

## Least splanchnic

12<sup>th</sup> to renal plexus



# The lumbar part of the sympathetic chain

continuous above with the thoracic part of the sympathetic trunk and pass into the abdomen behind the **medial arcuate ligament** to descend along the **medial margin** of the psoas major.

# The lumbar part of the sympathetic chain

Each trunk has **4 lumbar ganglia**.

**\*Branches:**

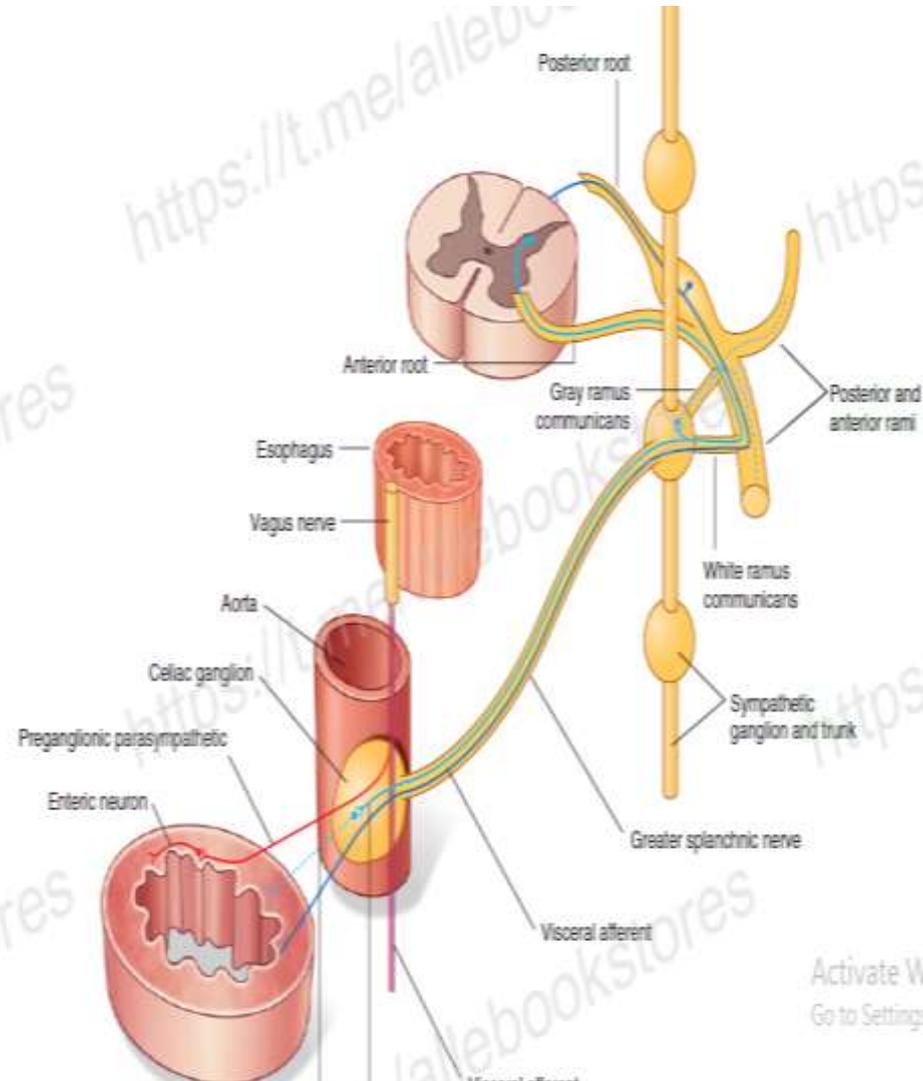
## **1. Lumbar splanchnic nerves:**

These are 4 nerves, one from each ganglion.

They join the abdominal autonomic plexuses (Coeliac, aortic, inferior mesenteric and superior hypogastric).

## **2. Rami communicans:**

Each of the 4 ganglia gives a grey ramus communicans (postganglionic) to the corresponding lumbar spinal nerve.



# Autonomic plexuses on the posterior abdominal wall

## 1) *Coeliac plexus: (mixed Sympathetic and parasympathetic)*

**\*Site:** This plexus of nerves lies on the front of the abdominal aorta, around the coeliac trunk and the root of superior mesenteric artery .

It is connected with the *coeliac ganglia*.

**\*The coeliac ganglia:** →

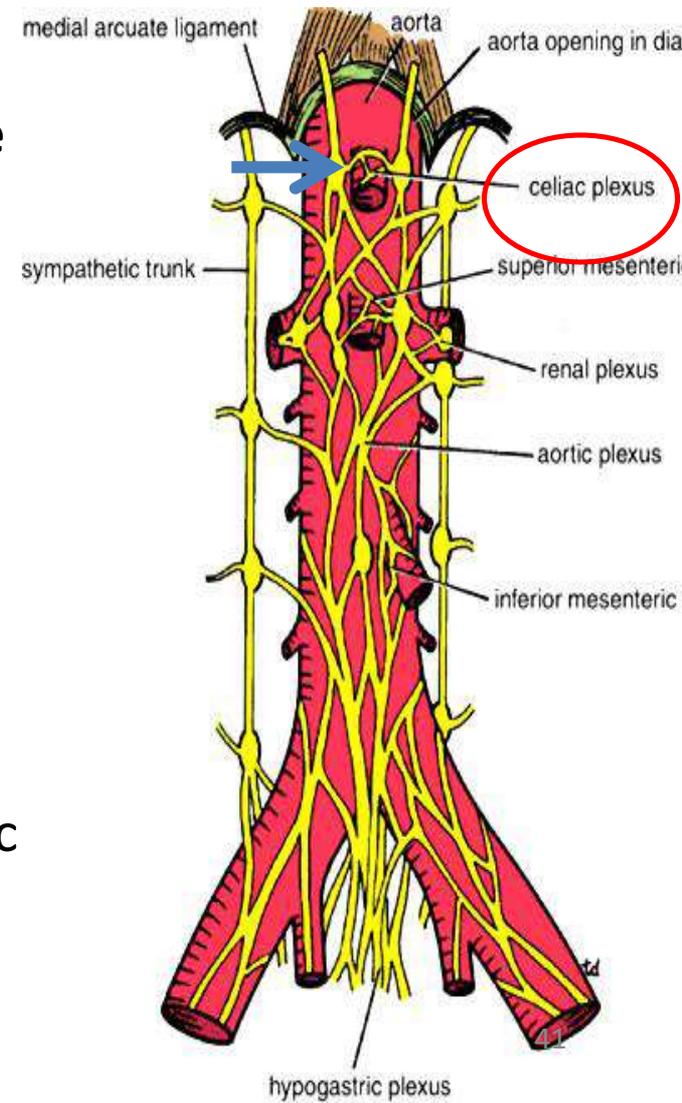
- Each ganglion lies on a crus of the diaphragm between the coeliac trunk and the suprarenal gland.

**\*Each ganglion receives:**

**a) Sympathetic preganglionic fibres** from the greater and lesser splanchnic nerves relay in the coeliac ganglion.

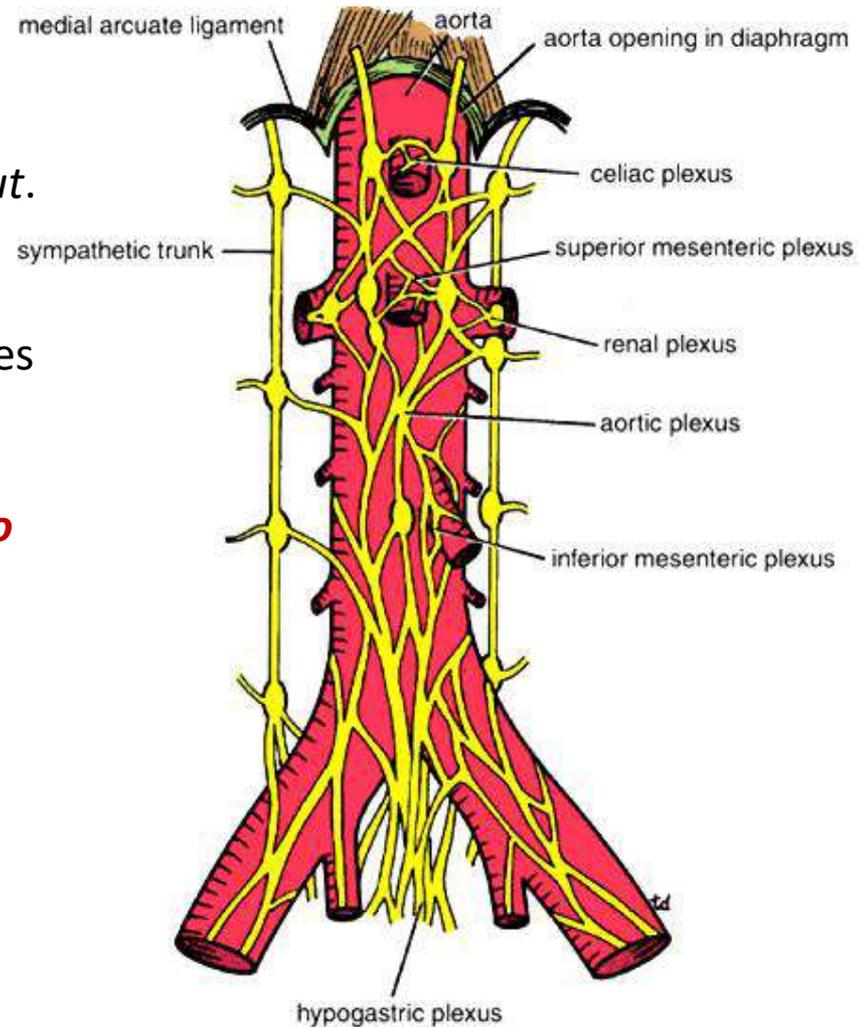
**b) Parasympathetic fibres** from the posterior gastric nerve (contains fibres from **both vagi, mostly the right vagus**).

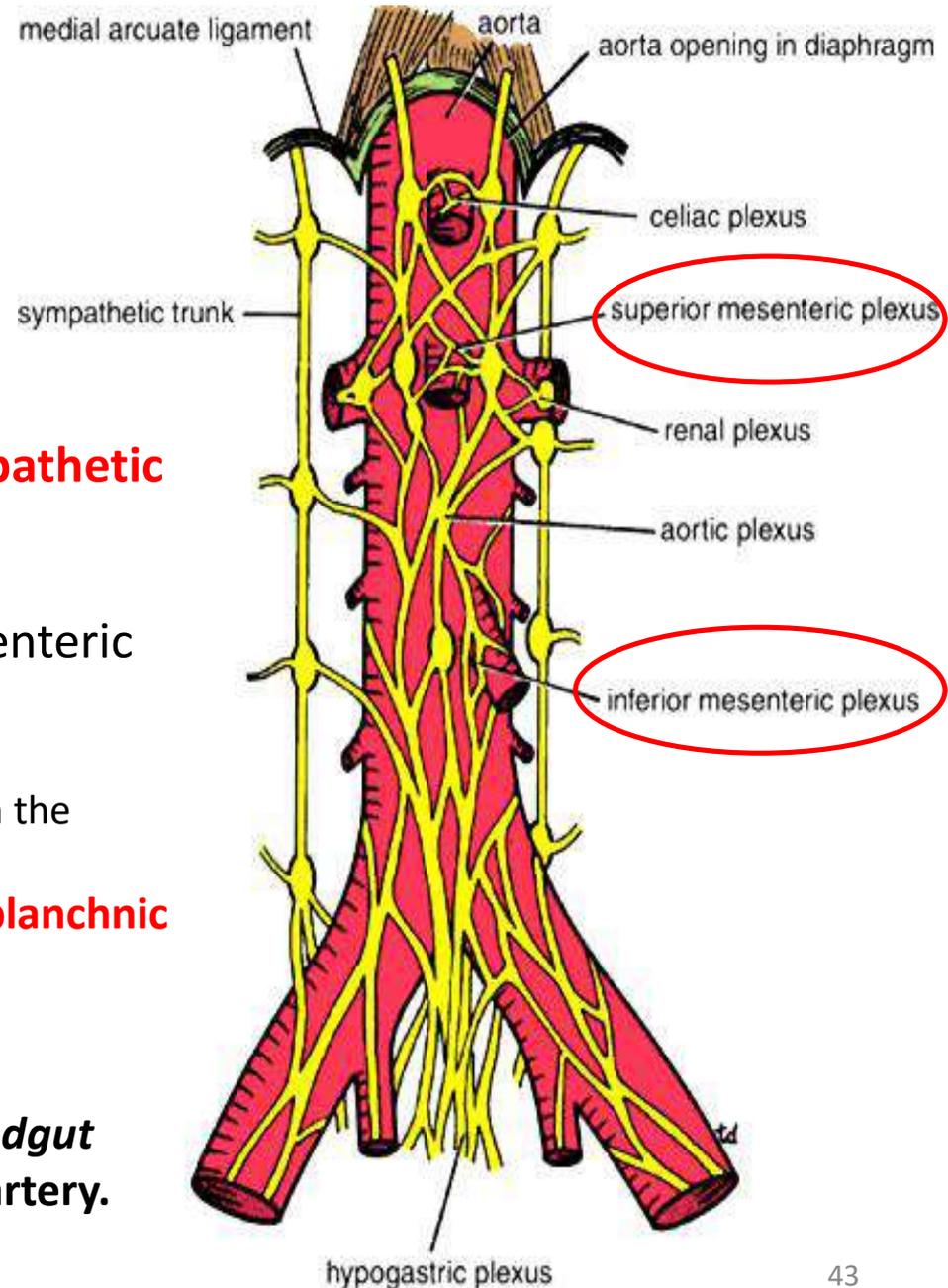
**c) Sensory fibres**, from the right phrenic nerve (distributed to biliary system through **hepatic plexus**).



**Distribution:** Mostly through branches along the blood vessels to:

- Along branches of the coeliac trunk to *foregut*.
- Along branches of the superior mesenteric artery to *midgut*.
- Along the gonadal arteries to *gonades* (testes or ovaries)
- **Suprarenal glands (direct preganglionic sympathetic fibres from splanchnic nerves to the medulla of the gland).**
- Kidneys which receive also the lowest splanchnic nerve (T12).





## 2) Superior mesenteric plexus

### 3) Aortic (intermesenteric) plexus:

**\*Site:** on front and sides of the abdominal aorta between the origin of the superior and inferior mesenteric arteries.

### 4) Inferior mesenteric plexus: (mixed sympathetic and parasympathetic)

**\*Site:** Around the origin of the inferior mesenteric artery from the abdominal aorta.

**-It contains:**

a) Sympathetic fibres from the aortic plexus and from the lumbar splanchnic nerves (L2,3).

b) Parasympathetic fibres from sacral (pelvic) splanchnic nerves (S2,3,4)

**\*Distribution:** Postganglionic sympathetic and preganglionic parasympathetic fibres to the *hindgut* along the branches of the **inferior mesenteric artery**.

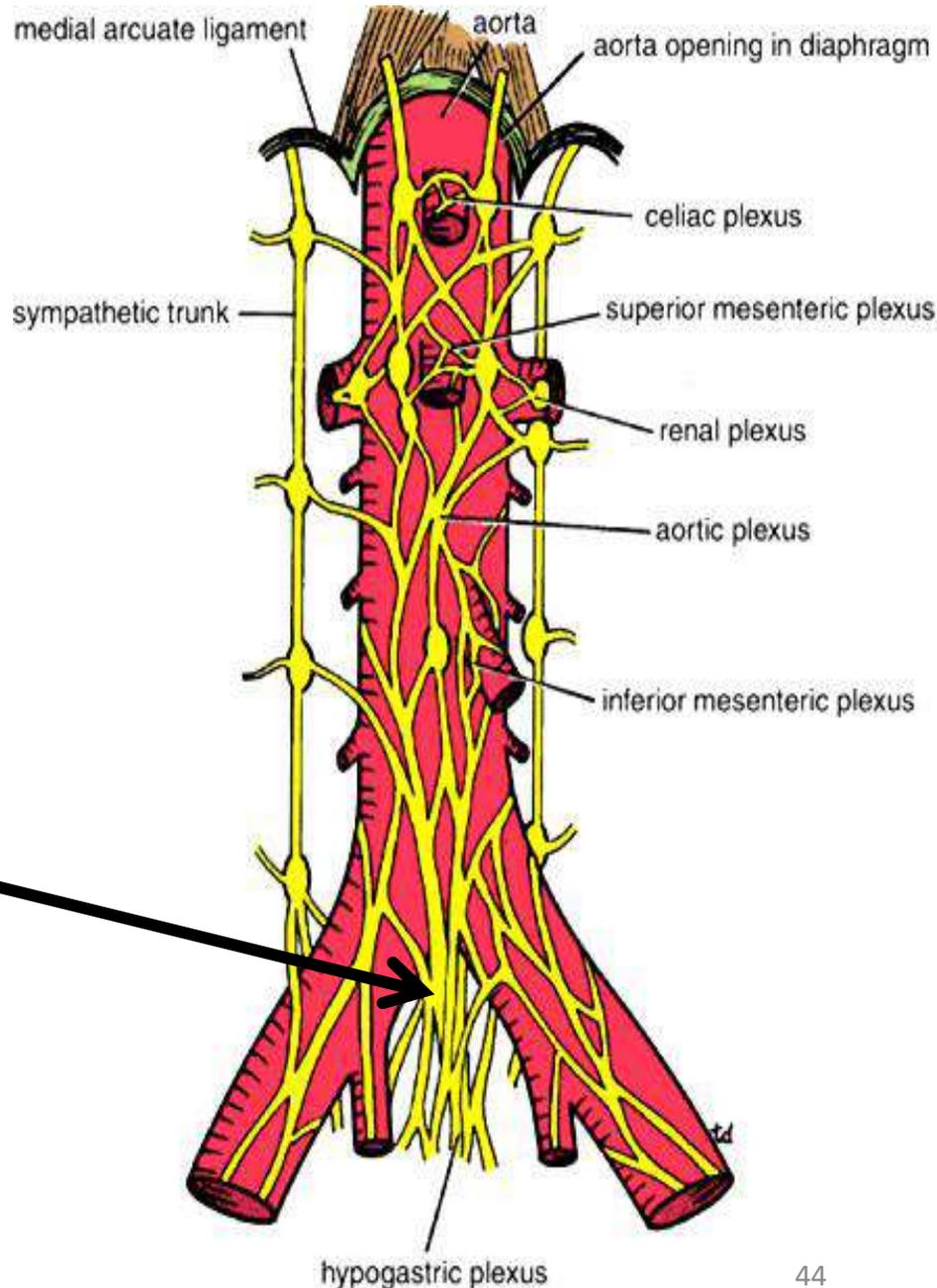
**5) Superior hypogastric plexus (presacral nerves): (sympathetic)**

**\*Site:** It lies below the bifurcation of the abdominal aorta in front of the L5 vertebra .

**It receives fibres from:** sympathetic fibres from the aortic plexus and branches from the lumbar splanchnic nerves (L3,4).

**It supplies** branches to ureteric, testicular, ovarian and common iliac plexuses.

**Continuation:** The plexus divides below into right and left hypogastric nerves which are formed mostly of **sympathetic fibres only** and descend into the pelvis to become the 2 **inferior hypogastric plexuses**



**Inferior hypogastric plexus: (sympathetic)**

**Formation:**

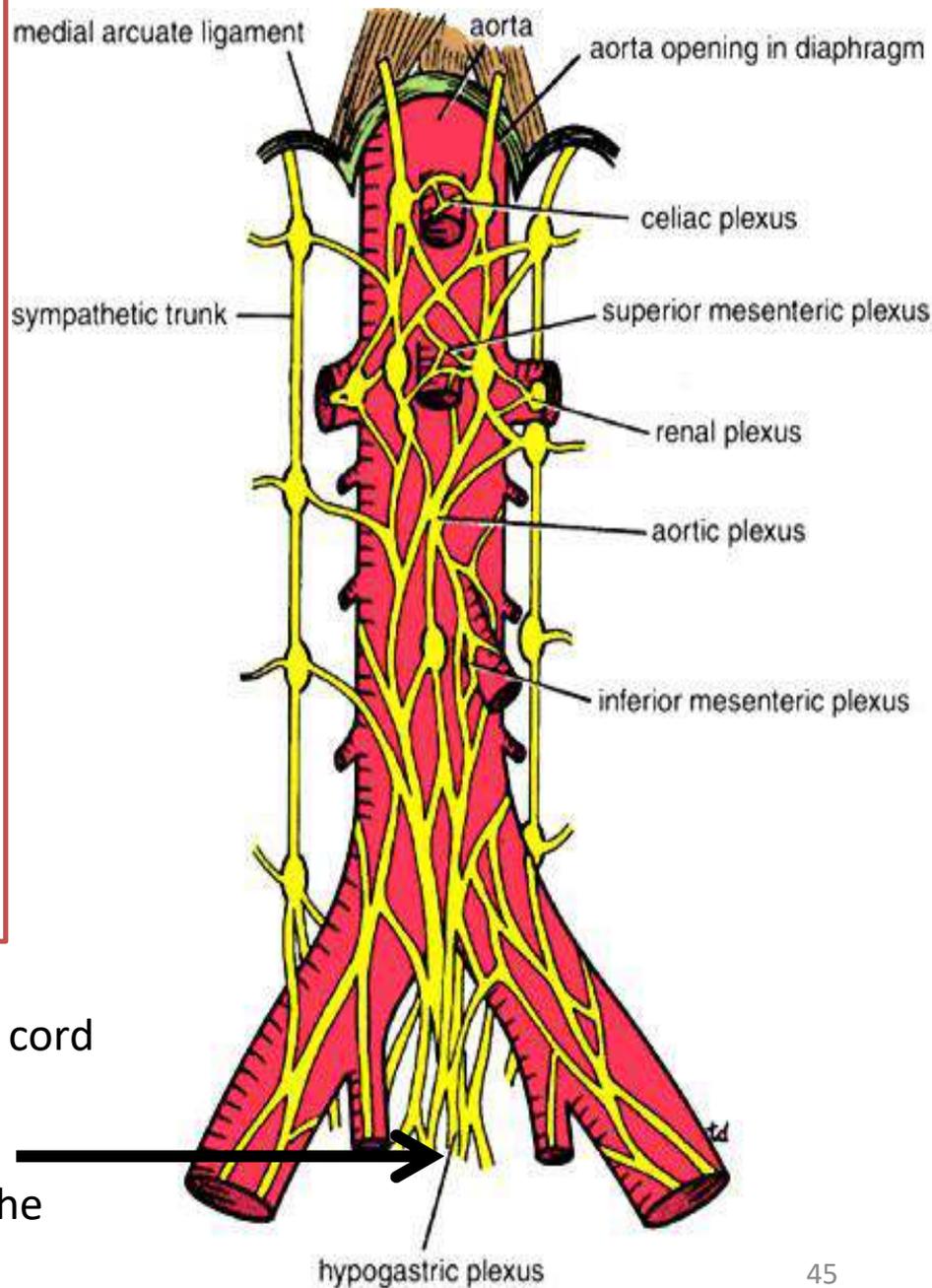
- 1. Inferior hypogastric nerve which is derived from the superior hypogastric plexus (purely sympathetic).
- 2. Sympathetic fibres from the sacral sympathetic trunk.

**Distribution:** The plexus divides into secondary plexuses which accompany the branches of the internal iliac artery to pelvic viscera and perineal organs.

**Visceral afferent fibers travel with the autonomic nerve fibers.**

**Visceral afferent fibers** convey pelvic sensory information (largely pain) via both the **Sympathetic fibers** (to the upper lumbar spinal cord [L1-L2] or lower thoracic levels [T11-T12])

**parasympathetic fibers** (to the S2-S4 levels of the spinal cord).





**Thank you**