

Lecture:

Autonomic Nervous System

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الرجاء تحويل الجوال إلى وضع الصامت
مع الشكر



Anatomy of the Autonomic Nervous System (Involuntary Nervous System or Visceral Nervous System)

- **Definition:** it is the involuntary nervous system which **supplies:**
 - ✓ Unstriated (smooth) muscles of the viscera and blood vessels.
 - ✓ Cardiac muscles.
 - ✓ Glands.
- **Structures of the Autonomic Nervous System:**
 - ✓ Sympathetic nervous system (Thoraco-lumbar)
“Fight or Flight”.
 - ✓ Parasympathetic nervous system (Cranio-sacral)
“Rest and Digest”.

Parts of the Autonomic Nervous System

1. **Central part:** consists of autonomic nuclei in the brain stem, thalamus, hypothalamus, insula and intermediolateral nuclei of the spinal cord.
2. **Peripheral part:** consists of:
 - Peripheral Sympathetic nervous system (SNS).
 - Peripheral Parasympathetic nervous system (PSNS).

The Origin of the Autonomic Nervous System

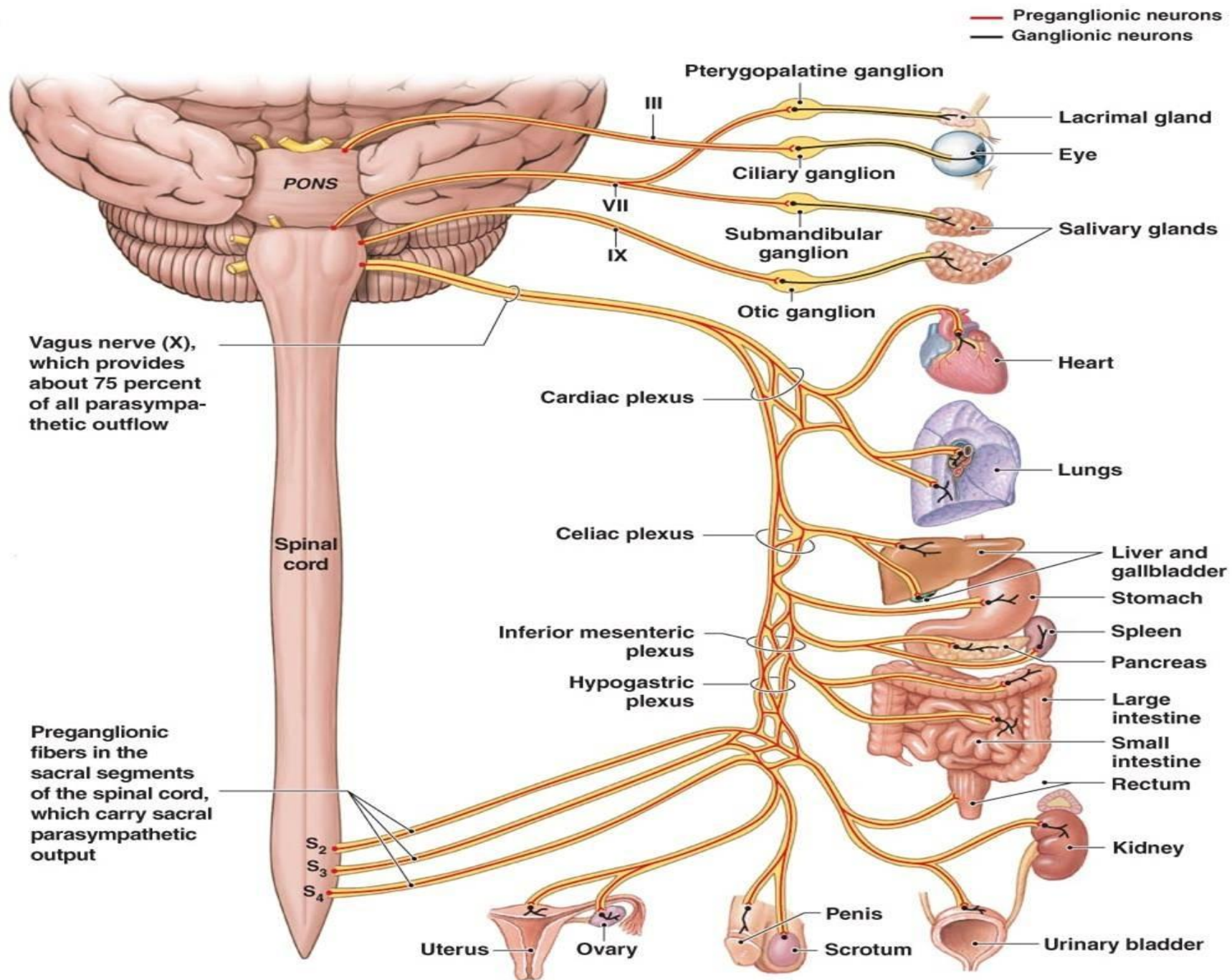
1. The origin of the sympathetic nervous system (Thoraco-lumbar nervous system):

Consists of fibers which arise from the 12 thoracic and upper 2 lumbar segments (Thoraco-lumbar part) and reach the sympathetic chain by **the white rami**.

2. The Origin of the parasympathetic nervous system (Cranio-spinal nervous system):

a. The cranial part: consists of fibers which pass in four cranial nerves (3, 7, 9 & 10 cranial nerves)=**10973**.

b. The sacral part: consists of fibers which arise from **the S2, S3, and S4** segments of the spinal cord.



The Peripheral Autonomic Nervous System

- Most of the visceral structures are supplied by two systems (receive sympathetic and parasympathetic nerves).
- **The SNS supplies:**
 1. Skin of the body (its arterioles, sweat glands).
 2. Blood vessels of the limbs (its smooth muscles).
 3. Deep viscera.
- **The PSNS supplies the deep viscera only.**
- **Each of the two systems consists of two order neurons.**

1. First Order Neurone

- **It is formed by:**
 1. The nerve cells of certain nuclei in the brain stem.
 2. Lateral horn cells (intermediolateral nuclei) of D1-L2 and AHCs of S2-S4 of the spinal cord
- The axons of these cells carry stimuli to the autonomic ganglia **(called preganglionic fibers which are white or myelinated).**

2. Second Order Neurone

- It is formed by the nerve cells in **the sympathetic and parasympathetic ganglia.**
- The axons of these cells carry stimuli to the viscera **(called postganglionic fibers which are gray or non-myelinated).**

Types of Autonomic Ganglia

They are present outside the CNS and may be:

- 1.Paravertebral ganglia (Sympathetic):** as sympathetic trunk (chain).
- 2.Collateral ganglia (Peripheral or Sympathetic):** as celiac, superior mesenteric and inferior mesenteric ganglia.
- 3.Terminal ganglia (Parasympathetic):** they are present on the walls of the viscera.

Notice that:

1. The sympathetic preganglionic fibers are **short**, while the postganglionic fibers are **long**.
2. The parasympathetic preganglionic fibers are **long**, while the postganglionic fibers are **short**.
3. The **preganglionic fibers** are white or **myelinated**.
4. The **postganglionic fibers** are gray or **non-myelinated**.

How are the Visceral Structures Supplied by Autonomic (Motor) Fibers?

The autonomic supply to the visceral structures in two points:

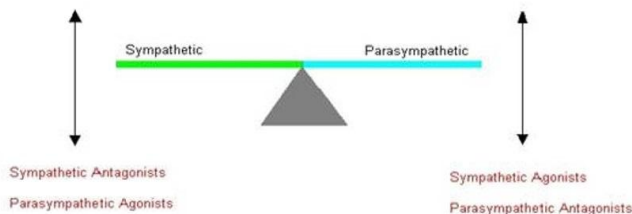
1. Most of the visceral structures have two nerve supply: **one sympathetic and one parasympathetic**. One of these nerves acts "**stimulator**" while the other acts "**inhibitor**".
2. Each of sympathetic and parasympathetic NS is formed of two neurons:

a. The body of the first neuron is found in the CNS and its axon is called **a preganglionic fiber**.

b. The body of the second neuron is found in the PNS and its axon is called **a postganglionic fiber**.

Sympathetic Agonists
Parasympathetic Antagonists

Sympathetic Antagonists
Parasympathetic Agonists



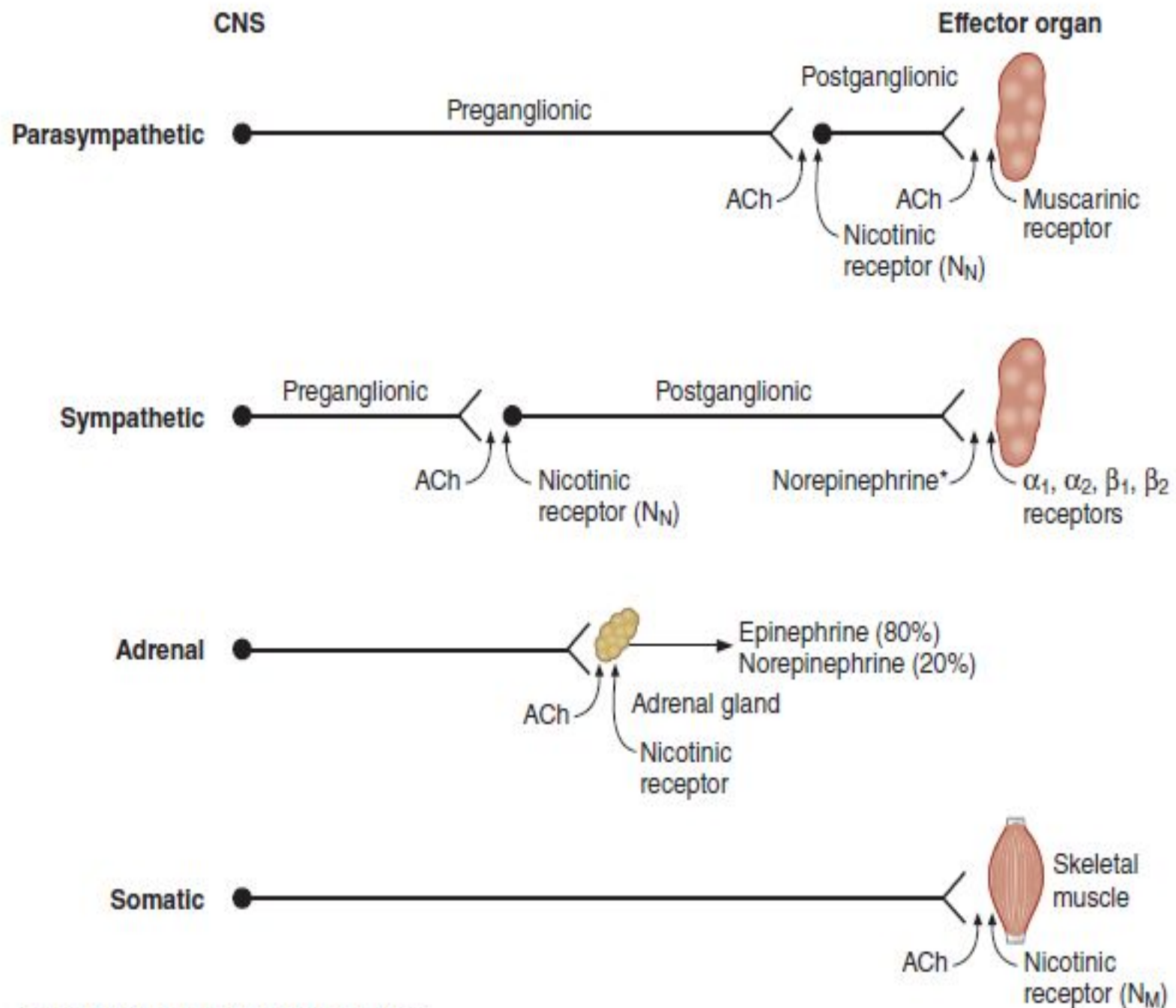
Transmitters of the Autonomic Nervous System

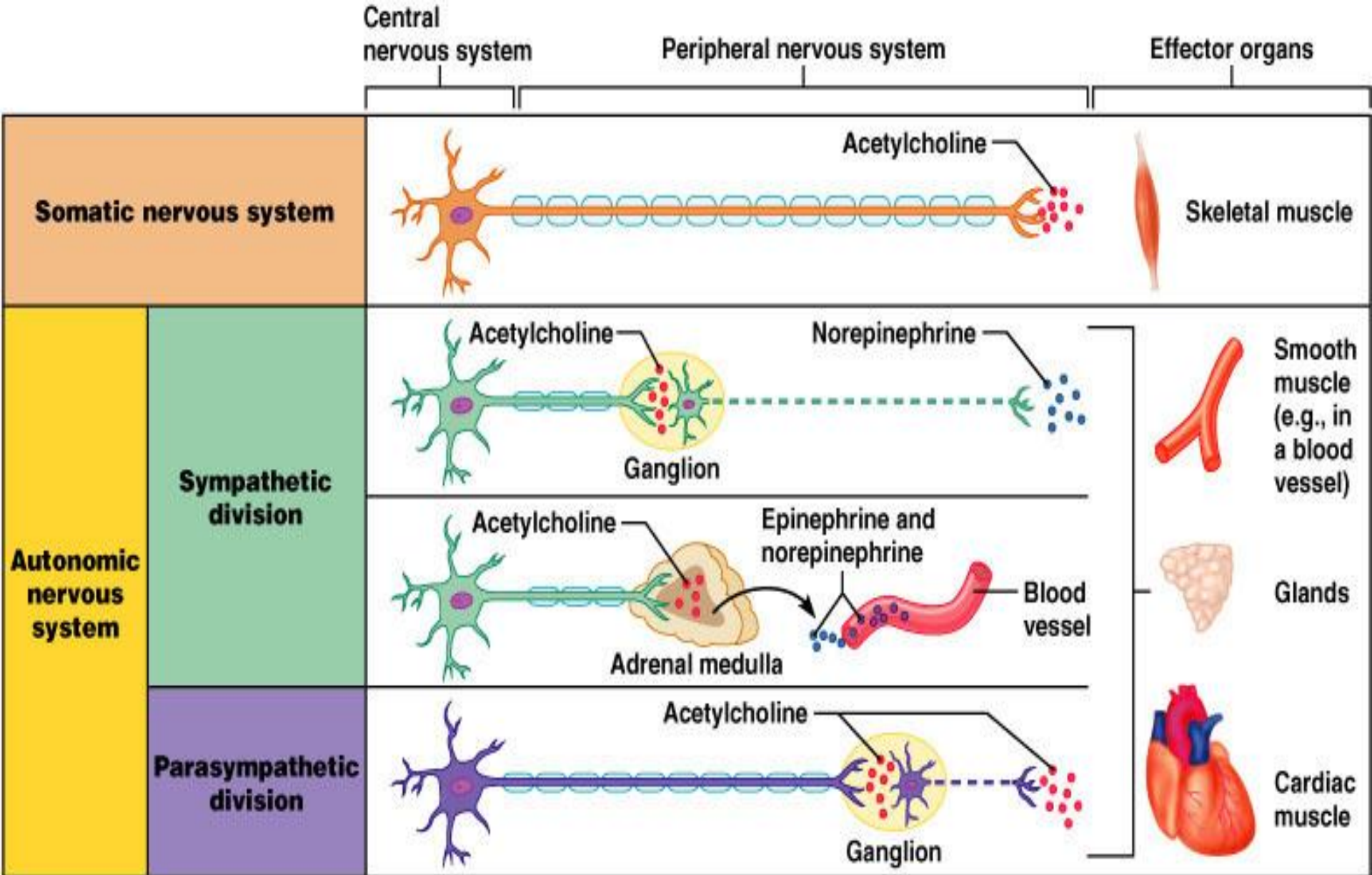
1. The preganglionic transmitter:

For sympathetic and parasympathetic preganglionic transmitter is **Acetylcholine**.

2. The postganglionic transmitter:

- A. All postganglionic fibers of the parasympathetic are **Acetylcholine**.
- B. The majority of sympathetic postganglionic fibers are **Epinephrine and/or Norepinephrine**.
- C. The few which are known to be **Acetylcholine** (for the sweat glands).



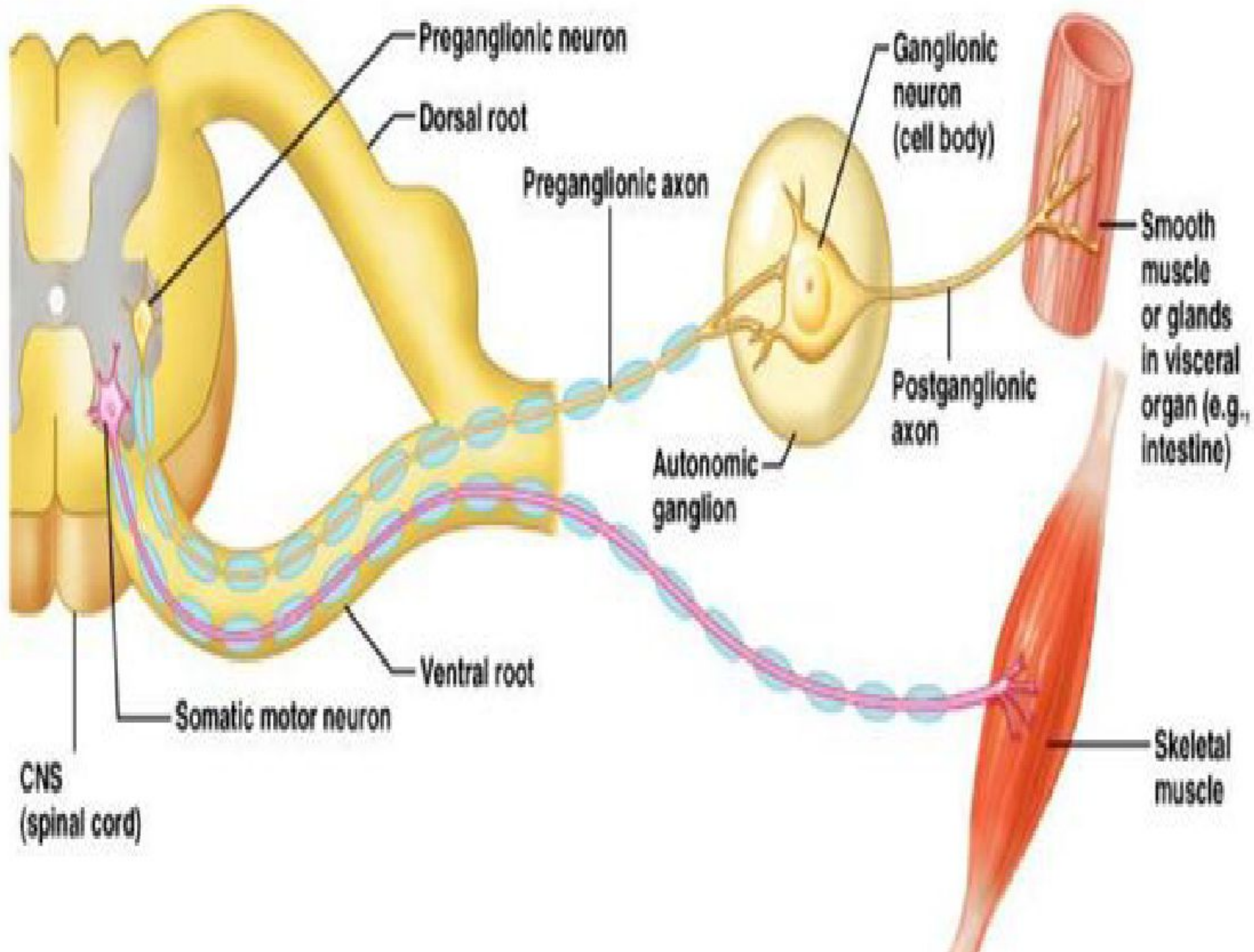


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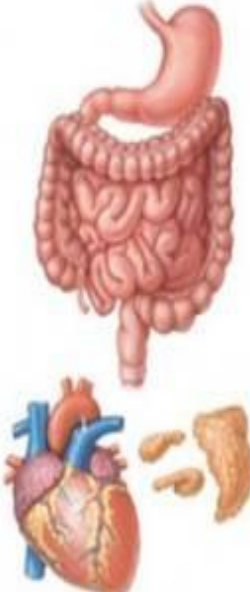
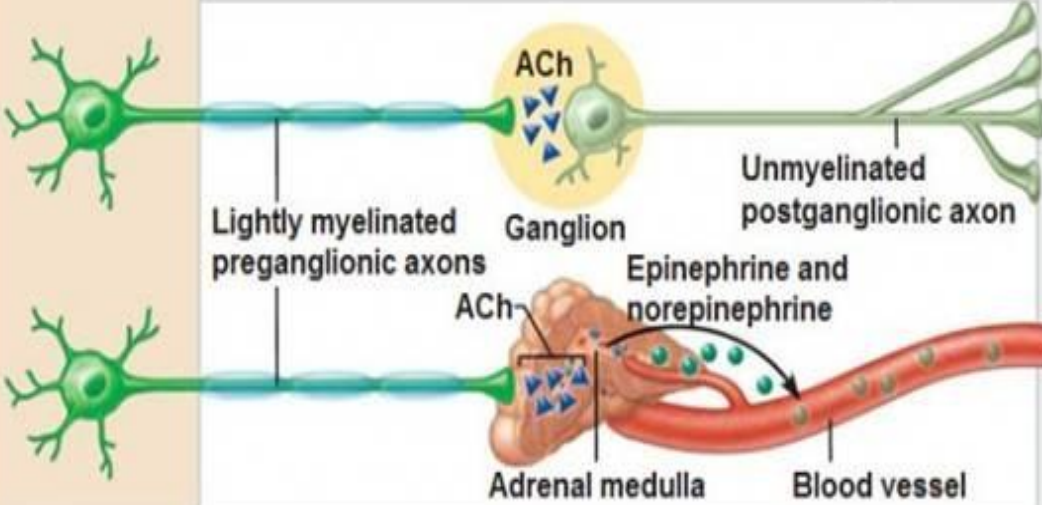
— = Preganglionic axons (sympathetic)
 - - - = Postganglionic axons (sympathetic)
 = Myelination
 — = Preganglionic axons (parasympathetic)
 - - - = Postganglionic axons (parasympathetic)

Comparison of Autonomic and Somatic Nervous System

Somatic	Autonomic
Conscious or voluntary regulation	Functions without conscious awareness (involuntary)
Fibers do not synapse after they leave the CNS (single neuron from CNS to effector organ).	Fibers synapse once at a ganglion after they leave the CNS (two-neuron chain). Motor control.
Innervates skeletal muscle fibers, always stimulatory	Innervates smooth muscle, cardiac muscle, and glands; either stimulates or inhibits



Comparison of Autonomic and Somatic Motor Systems

Cell bodies in central nervous system		Peripheral nervous system	Neurotransmitter at effector	Effector organs	Effect	
SOMATIC NERVOUS SYSTEM		Single neuron from CNS to effector organs			 Skeletal muscle	+ Stimulatory
		 Heavily myelinated axon				
AUTONOMIC NERVOUS SYSTEM		Two-neuron chain from CNS to effector organs			 Smooth muscle (e.g., in gut), glands, cardiac muscle	+ - Stimulatory or inhibitory, depending on neurotransmitter and receptors on effector organs
		 Lightly myelinated preganglionic axons Ganglion ACh Unmyelinated postganglionic axon Epinephrine and norepinephrine Adrenal medulla Blood vessel				
		 Lightly myelinated preganglionic axon Ganglion ACh Unmyelinated postganglionic axon				

Organization of the Autonomic Nervous System

Characteristic	Sympathetic	Parasympathetic	Somatic*
Origin of preganglionic nerve	Nuclei of spinal cord segments T1–T12; L1–L3 (thoracolumbar)	Nuclei of cranial nerves III, VII, IX, and X; spinal cord segments S2–S4 (craniosacral)	
Length of preganglionic nerve axon	Short	Long	
Neurotransmitter in ganglion	ACh	ACh	
Receptor type in ganglion	Nicotinic	Nicotinic	
Length of postganglionic nerve axon	Long	Short	
Effector organs	Smooth and cardiac muscle; glands	Smooth and cardiac muscle; glands	Skeletal muscle
Neurotransmitter in effector organs	Norepinephrine (except sweat glands, which use ACh)	ACh	ACh (synapse is neuromuscular junction)
Receptor types in effector organs	α_1 , α_2 , β_1 , and β_2	Muscarinic	Nicotinic

Neurotransmission at adrenergic Neurons

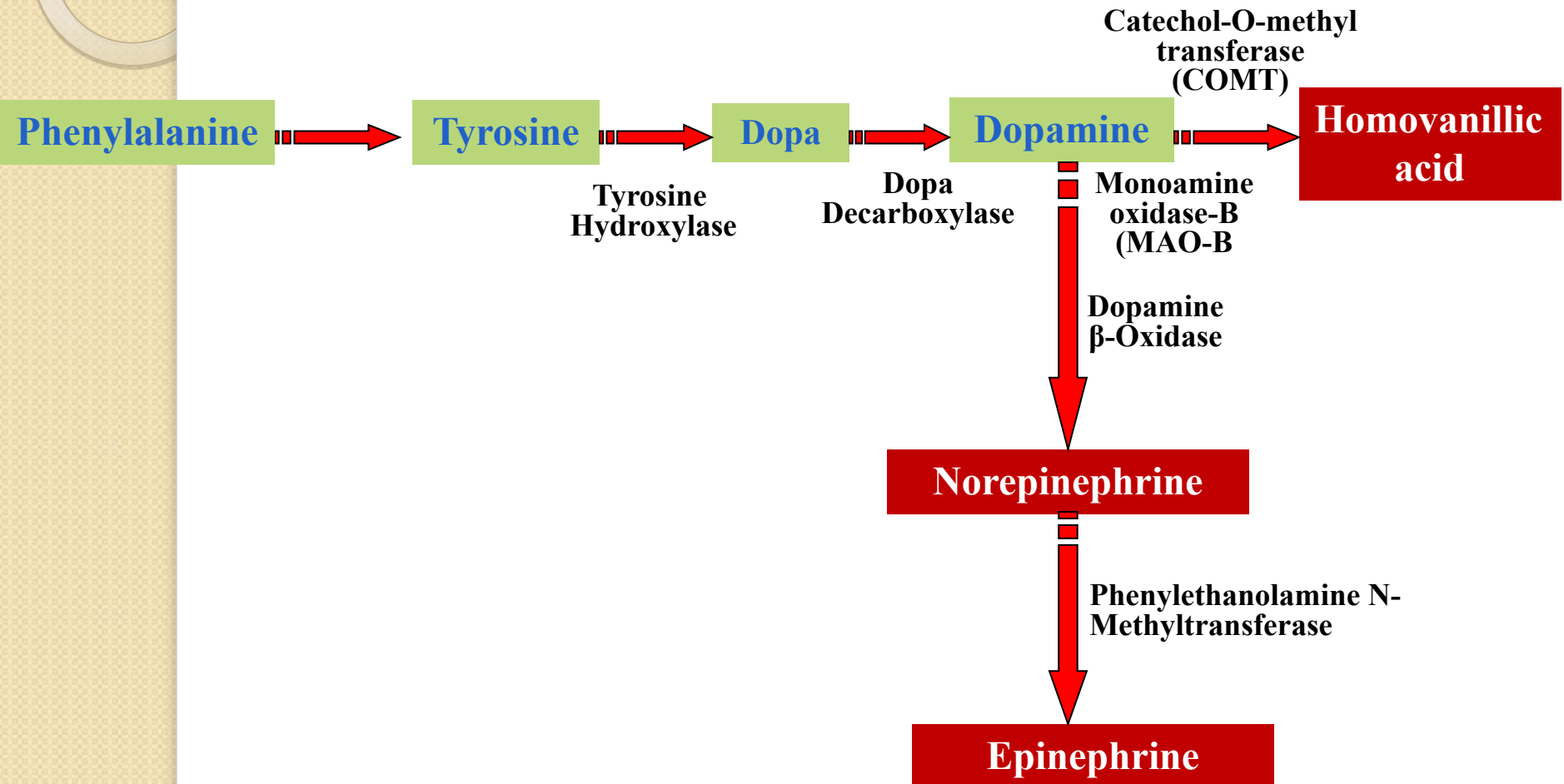
●The process involves five steps:

1. Synthesis.
2. Storage.
3. Release.
4. Receptor binding.
5. Removal of the neurotransmitter .

Pathway of Dopamine Metabolism

Synthesis

Degradation



1 SYNTHESIS OF NOREPINEPHRINE

- Hydroxylation of tyrosine is the rate-limiting step.

2 UPTAKE INTO STORAGE VESICLES

- Dopamine enters a vesicle and is converted to norepinephrine.
- Norepinephrine is protected from degradation in the vesicle.
- Transport into the vesicle is inhibited by *reserpine*.

3 RELEASE OF NEUROTRANSMITTER

- Influx of calcium causes fusion of the vesicle with the cell membrane in a process known as exocytosis.
- Release is blocked by *guanethidine* and *bretylum*.

4 BINDING TO RECEPTOR

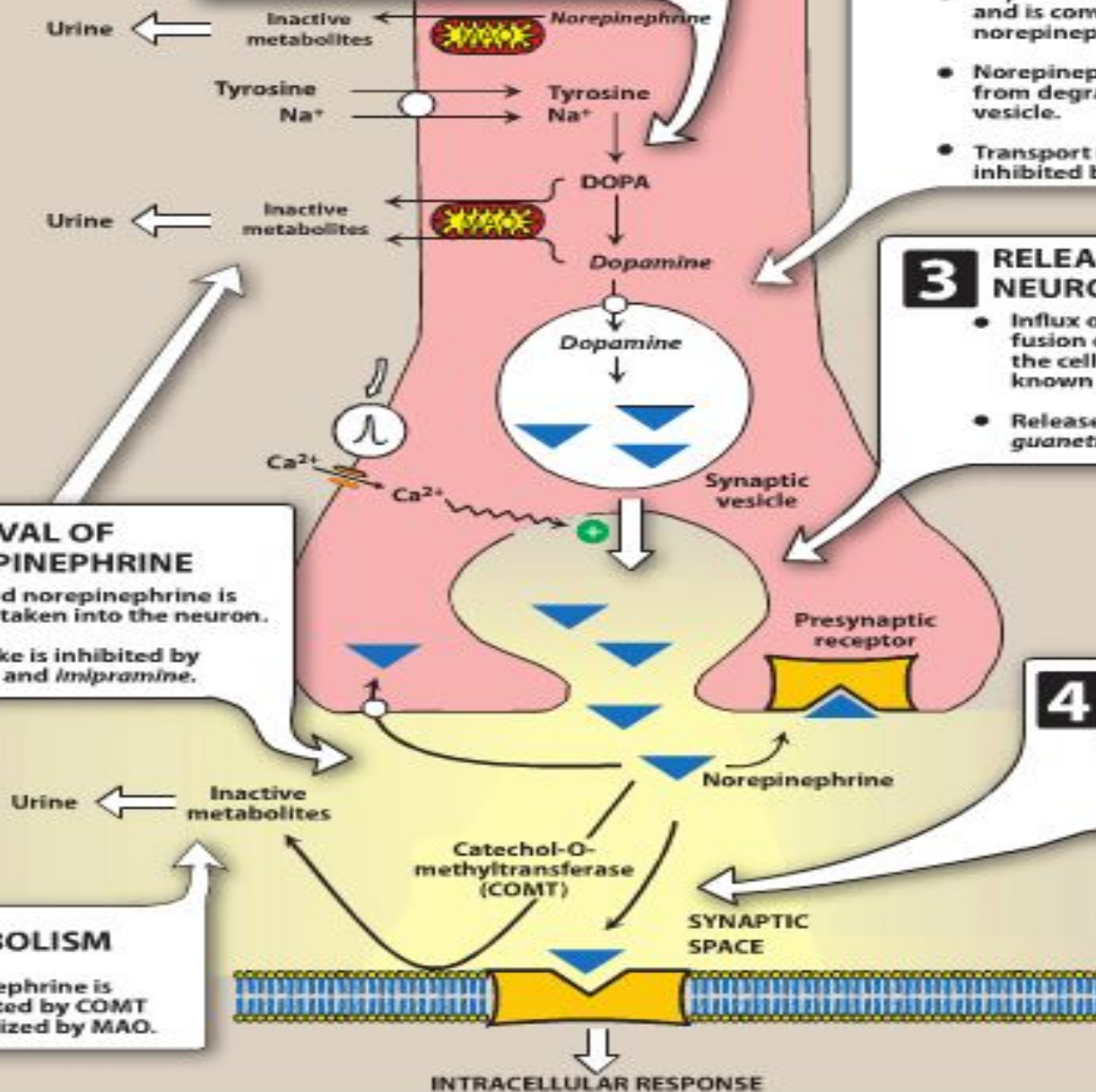
- Postsynaptic receptor is activated by the binding of neurotransmitter.

5 REMOVAL OF NOREPINEPHRINE

- Released norepinephrine is rapidly taken into the neuron.
- Reuptake is inhibited by *cocaine* and *imipramine*.

6 METABOLISM

- Norepinephrine is methylated by COMT and oxidized by MAO.



Catecholamines

- Catecholamines are sympathomimetic amines that contain the 3,4-dihydroxybenzene group such as:
 1. Epinephrine.
 2. Norepinephrine.
 3. Isoproterenol.
 4. Dopamine.

Receptor Types in the ANS

1. Adrenergic receptors (adrenoreceptors):

a. Alpha Receptors: are subdivided into two types:

- **Alpha “ α_1 ” Receptors:** are located on vascular smooth muscle of the skin, the gastrointestinal sphincters, bladder sphincters, and the radial “dilator” muscle of the iris.
✓ **Effect:** produce **excitation** (e.g., contraction or constriction).
- **Alpha “ α_2 ” Receptors:** are located on walls of GIT , and wall of bladder.
✓ **Effect:** often produce inhibition effect or relaxation.

Alpha 1 receptors



Vasoconstriction



Mydriasis



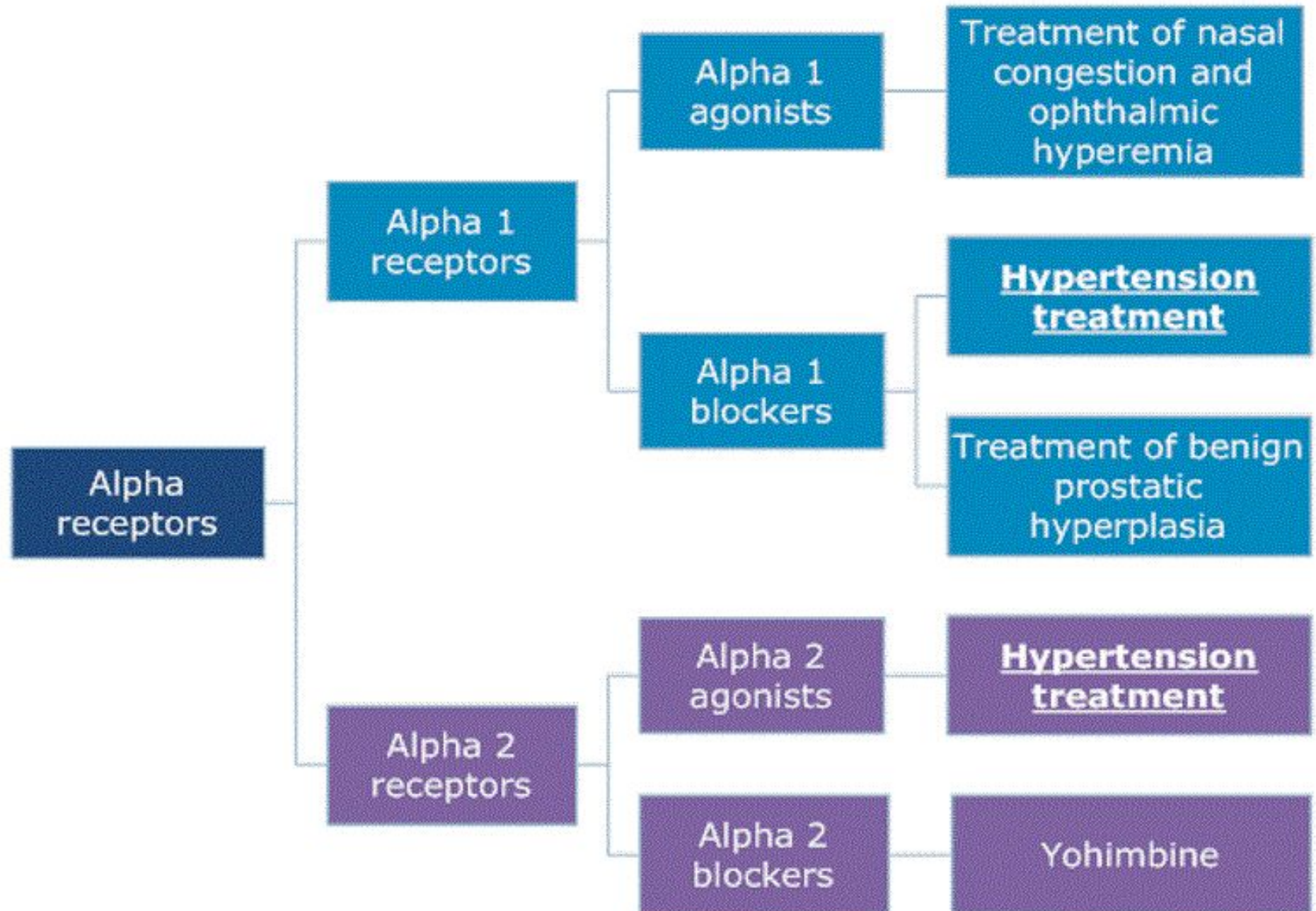
Increased closure
of internal
sphincter of the
bladder

Increased peripheral
resistance

Increased blood
pressure



Drugs Affecting Alpha Receptors



b. Beta Receptors: are subdivided into three types:

- **Beta “b₁” Receptors:** are located in the sinoatrial (SA) node, atrioventricular (AV) node, and ventricular muscle of the heart.
 - ✓ **Effect:** produce **excitation** (e.g., increased heart rate, increased conduction velocity, increased contractility).
- **Beta b₂ Receptors:** are located on vascular smooth muscle of skeletal muscle, bronchial smooth muscle, and in the walls of the GIT and bladder.
 - ✓ **Effect:** produce **relaxation** (e.g., dilation of vascular smooth muscle, dilation of bronchioles, relaxation of the bladder wall).
- **Beta b₃ Receptors:** are located in the fat cells.
 - ✓ **Effect:** Play important role with b₁ receptors in lipolysis.

β -1 receptors



Heart

Increased
chronotropy and
inotropy

Increased
AV-node
conduction
velocity



Renal juxtaglomerular
cells

Increased
renin release

β -2 receptors



Bronchial smooth
muscle

Bronchodilation



Uterine muscle

Uterine relaxation
(tocolysis)

β -2 receptors



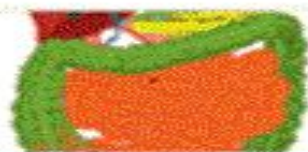
Bladder detrusor muscle

Relaxation



Eye ciliar muscle

Relaxation



GI tract

Decreased motility



Liver

Increased glucose metabolism, lipolysis



Smooth muscle

Relaxation

2. Cholinergic Receptors (cholinoreceptors)

a. Nicotinic receptors: are located in the **autonomic ganglia (NN)** of the sympathetic and parasympathetic nervous systems, at the **neuromuscular junction (NM)**.

✓ **Effect:** produce usually **excitation** postsynaptic potential.

b. Muscarinic receptors: are located in the **heart (M2)**, **smooth muscle (M3)**, and **glands (M3)**.

- a. Are **inhibitory in the heart** (e.g., decreased heart rate, decreased conduction velocity in AV node).
- b. Are **excitatory in smooth muscle and glands** (e.g., increased GI motility, increased secretion).
- c. Are activated by **ACh and muscarine**.
- d. Are blocked by **atropine**.

Adrenal Medulla

- Is a specialized ganglion of the sympathetic nervous system.
- Preganglionic fibers synapse directly on **chromaffin cells** in the adrenal medulla.
- The chromaffin cells secrete **Epinephrine (80%)** and **norepinephrine (20%)** into the circulation.
- **Pheochromocytoma:** is a tumor of the adrenal medulla that secretes excessive amounts of catecholamines.

AUTONOMIC

SOMATIC

Sympathetic innervation
of adrenal medulla

Sympathetic

Parasympathetic

Preganglionic
neuron

Ganglionic
transmitter

Acetylcholine

Acetylcholine

Acetylcholine

No ganglia

Nicotinic
receptor

Nicotinic
receptor

Nicotinic
receptor

Adrenal medulla

Postganglionic
neurons

Neuroeffector
transmitter

Epinephrine and
norepinephrine released
into the blood

Norepinephrine

Acetylcholine

Acetylcholine

Adrenergic
receptor

Adrenergic
receptor

Muscarinic
receptor

Nicotinic
receptor

Effector organs

Skeletal muscle

Autonomic Centers in the Brain Stem & Hypothalamus

1. Medulla oblongata:

- Vasomotor center.
- Respiratory center.
- Swallowing, coughing, and vomiting centers.

3. Midbrain:

- Micturition center.

4. Hypothalamus:

- Temperature regulation center.
- Thirst and hunger regulatory centers.

Effect of the Autonomic Nervous System on Organ Systems

Organ	Sympathetic Action	Sympathetic Receptor	Parasympathetic Action	Parasympathetic Receptor
Heart	$\uparrow$ heart rate $\uparrow$ contractility $\uparrow$ AV node conduction	β_1 β_1 β_1	$\downarrow$ heart rate $\downarrow$ contractility (atria) $\downarrow$ AV node conduction	M_2 M_2^2 M_2^2
Vascular smooth muscle	Constricts blood vessels in skin; splanchnic Dilates blood vessels in skeletal muscle	α_1 β_2	—	—
Gastrointestinal tract	$\downarrow$ motility Constricts sphincters	α_2, β_2 α_1	$\uparrow$ motility Relaxes sphincters	M_3 M_3
Bronchioles	Dilates bronchiolar smooth muscle	β_2	Constricts bronchiolar smooth muscle	M_3
Male sex organs	Ejaculation	α	Erection	M
Bladder	Relaxes bladder wall Constricts sphincter	β_2 α_1	Contracts bladder wall Relaxes sphincter	M_3 M_3
Sweat glands	$\uparrow$ sweating	M (sympathetic cholinergic)	—	—
Eye				
Radial muscle, iris	Dilates pupil (mydriasis)	α_1	—	—
Circular sphincter muscle, iris	—	—	Constricts pupil (miosis)	M
Ciliary muscle	Dilates (far vision)	β	Contracts (near vision)	M
Kidney	$\uparrow$ renin secretion	β_1	—	—
Fat cells	$\uparrow$ lipolysis	β_1	—	—

α_1	Reflect the "flight or fight" RX. - Vasoconstriction of blood vessels (control of B.P.). - Inhibit motility in the gut by contracting sphincter muscles and relaxing non – sphincter tissue. - Mobilize energy by breaking down liver glycogen to glucose.
α_2	- Found in presynaptic membranes. - Provide feedback control of neurotransmitter secretion (inhibit Ca^{++} influx, decrease neurotransmitter release)(autoreceptor negative feedback).
β_1	- Well known for their effects in the heart - increase heart rate and force of contraction - Induce muscle relaxation in the gut.
β_2	- Induce bronchodilation. - Induce smooth muscle relaxation in the gut. - Induce conversion of glycogen to glucose. - Stimulate secretion of insulin from pancreas.
M	- Decrease heart activity. (M2) - Increase motility in G.I. tract. (M1, M3) - Depolarization of smooth muscle fibers, (M3) - Hyperpolarization of cardiac muscle fibers. (M2)

Drugs Affecting Adrenergic and Cholinergic System

1. **Sympathomimetics Drugs:** stimulation of adrenergic receptor.
2. **Sympatholytic Drugs:** block the action of the neurotransmitters at the adrenergic receptors.
3. **Cholinergic “Anticholinesterase” Drugs:** stimulation the cholinergic receptors.
4. **Anticholinergic Drugs:** block cholinergic receptors.

The Parasympathetic Ganglia in the Head and Neck

There are four parasympathetic ganglia in the head and neck:

1. Ciliary ganglion.
2. Submandibular ganglion.
3. Sphenopalatine (pterygopalatine) ganglion.
4. Otic ganglion.

Ciliary Ganglion

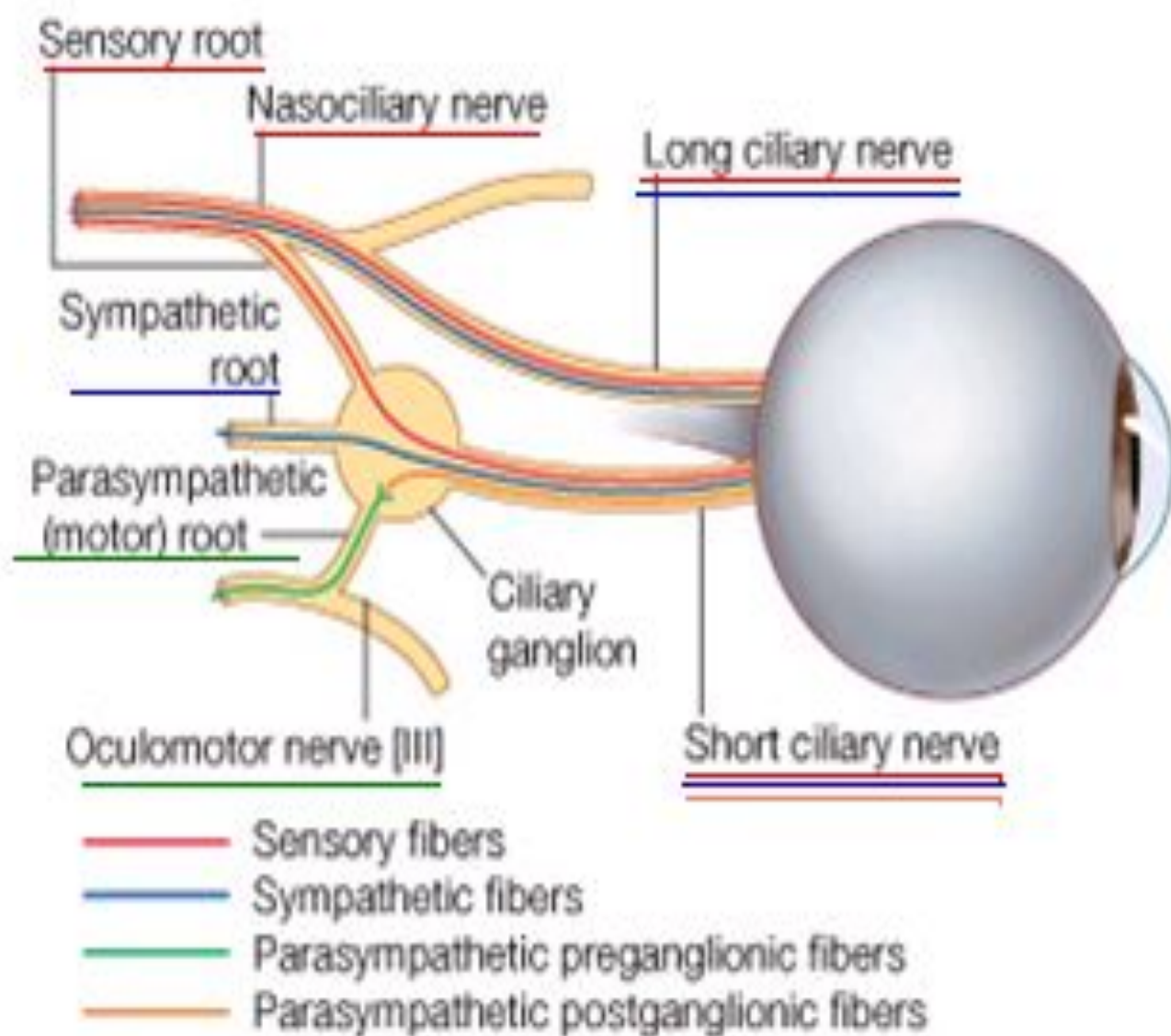
- **Type:** it is a small parasympathetic ganglion (1-2 mm in diameter).
- **Site:** in the posterior part of the orbit.
- **Roots Entering the Ciliary Ganglion:**
 1. **Sensory root:** branch from nasociliary nerve (branch of ophthalmic nerve).
 2. **Sympathetic root:** from the sympathetic plexus around the ICA.
 3. **Parasympathetic root:** from nerve to inferior oblique muscle (branch of oculomotor nerve).

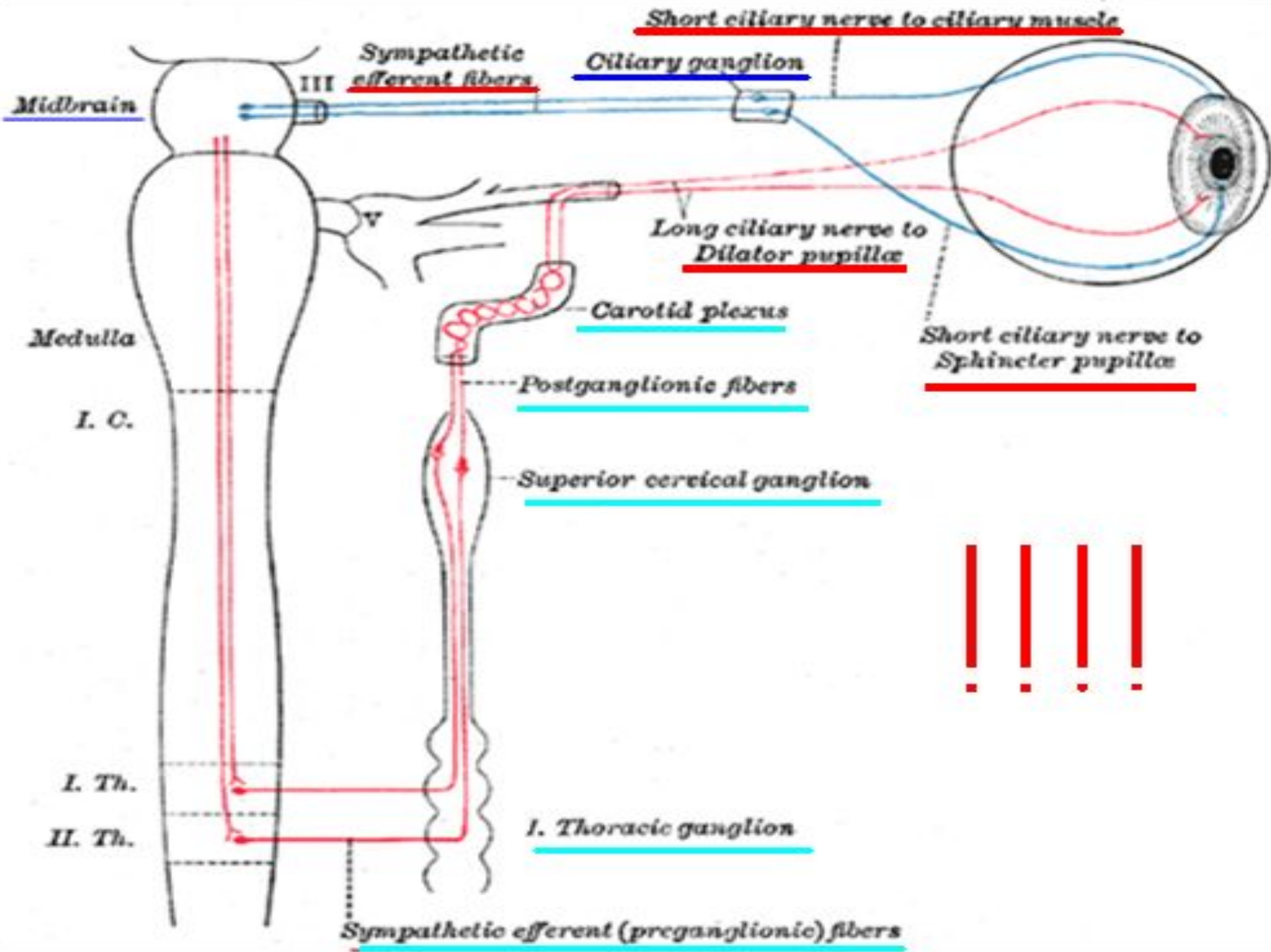
Branches of the Ciliary Ganglion

The ciliary ganglion has **8-10 short ciliary nerves** which pierce the sclera around optic nerve.

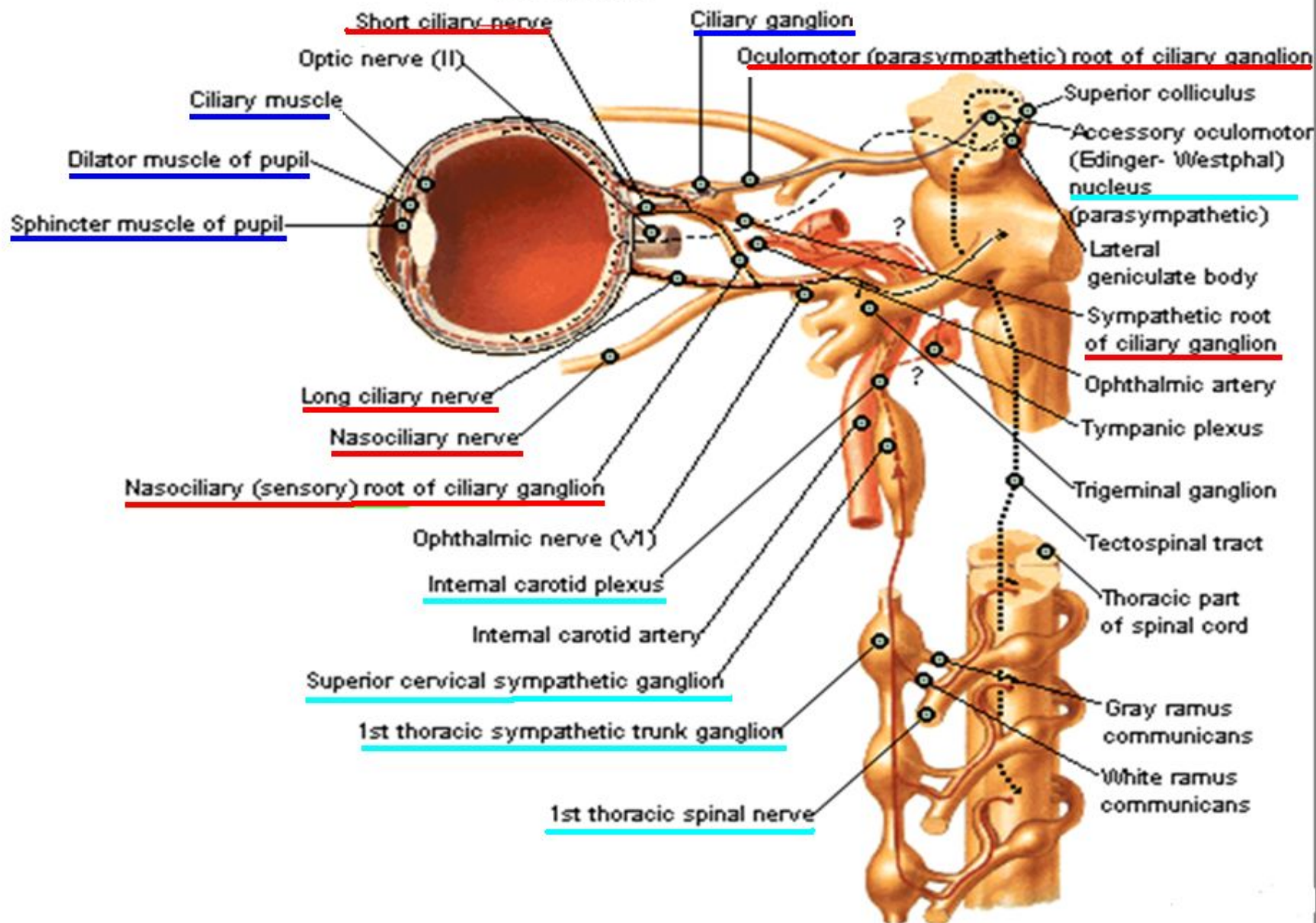
They contain:

- 1. Sympathetic fibers:** to the blood vessels of the eye.
- 2. Sensory fibers:** to the cornea and iris.
- 3. Parasympathetic fibers:** to the supply the sphincter pupillae (for light reflex) and ciliary muscle (for accommodation).





Ciliary Ganglion Schema



Submandibular Ganglion

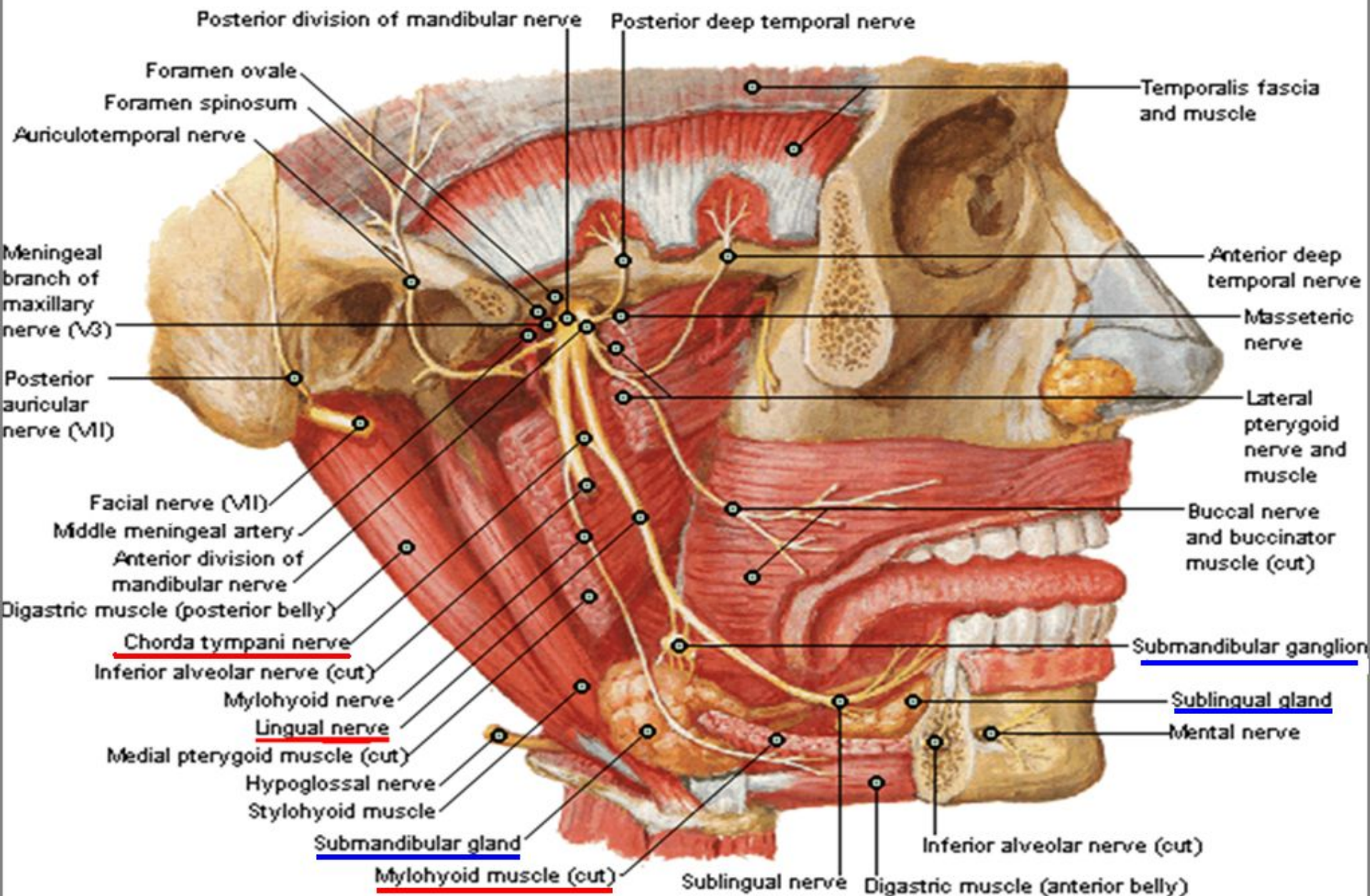
- **Type:** it is a small parasympathetic ganglion (2-3 mm in diameter).
- **Site:** it lies in the submandibular region on the upper part of hyoglossus muscle.
- **Roots Entering the Submandibular Ganglion:**
 1. **Parasympathetic root:** arising from the chorda tympani nerve (Branch of facial nerve).
 2. **Sympathetic root:** arising from the sympathetic plexus around facial artery.
 3. **Sensory root:** from lingual nerve (branch of mandibular nerve).

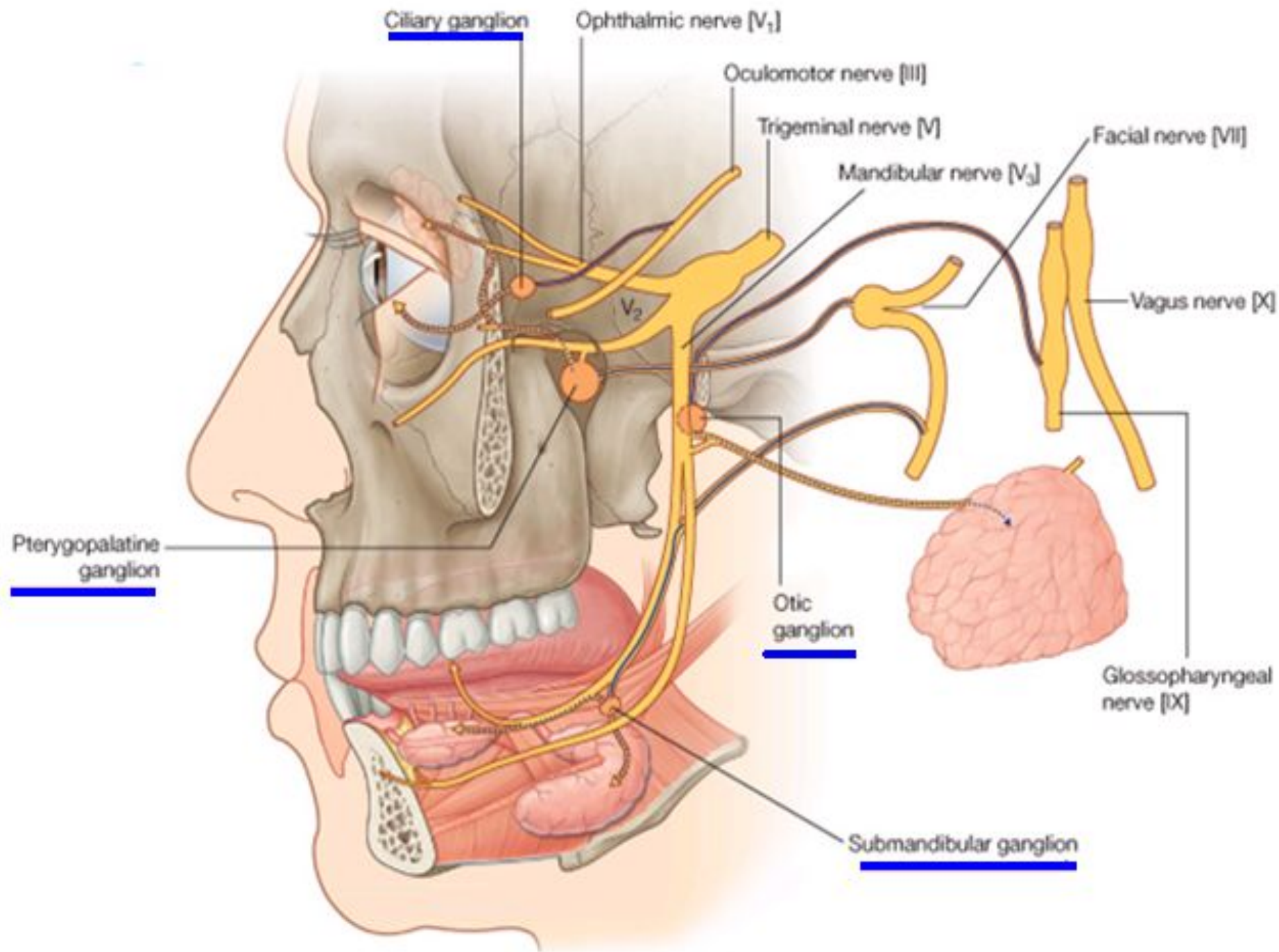
Branches of the Submandibular Ganglion

1. **Several small branches (mixed: parasympathetic + sympathetic + sensory fibers)** pass directly from the ganglion to supply **the submandibular salivary gland.**
2. **Similar branches** join the lingual nerve to reach **the sublingual salivary gland.**

Mandibular Nerve [V3]

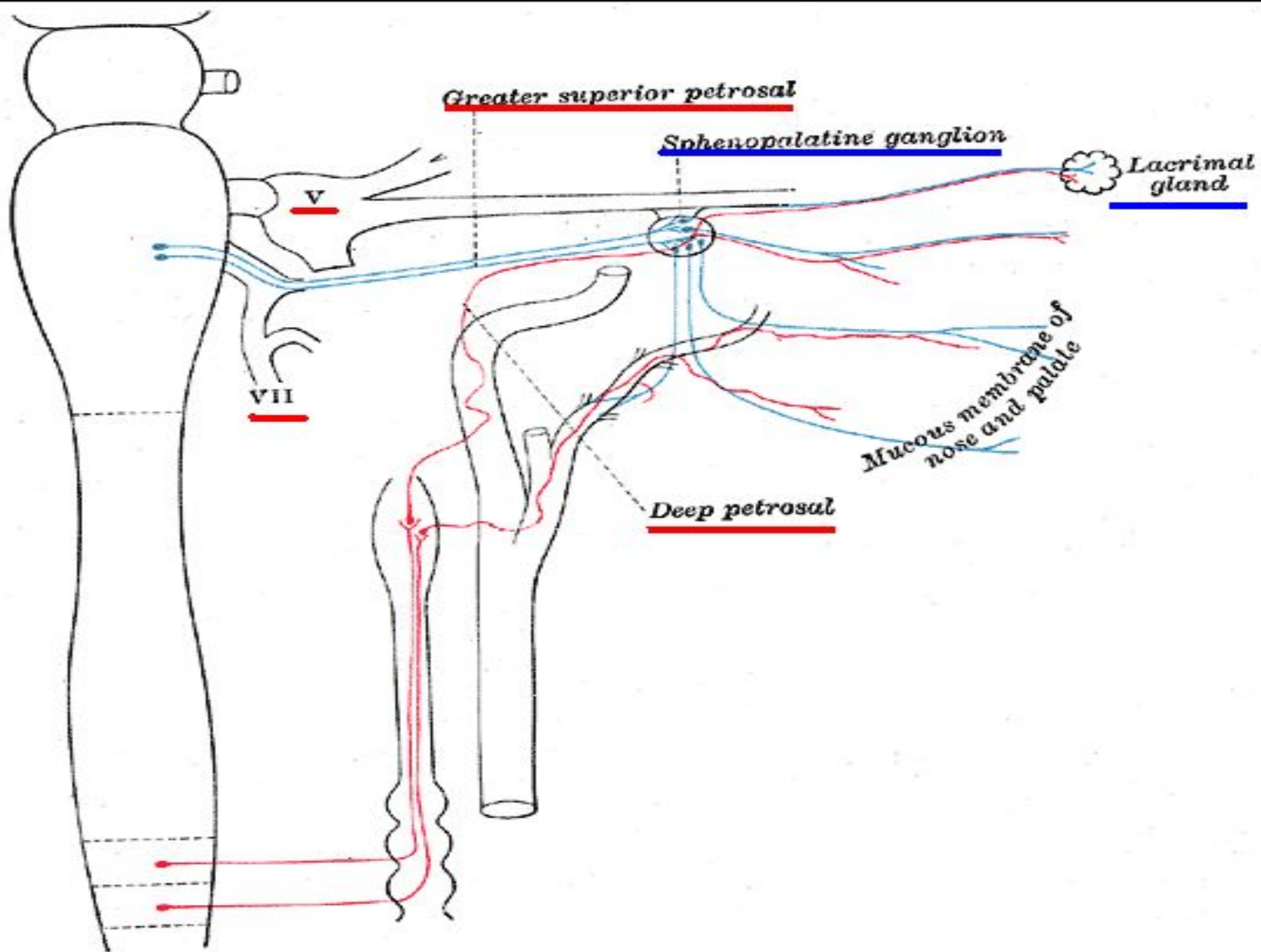
Lateral View





Sphenopalatine (Pterygopalatine) Ganglion

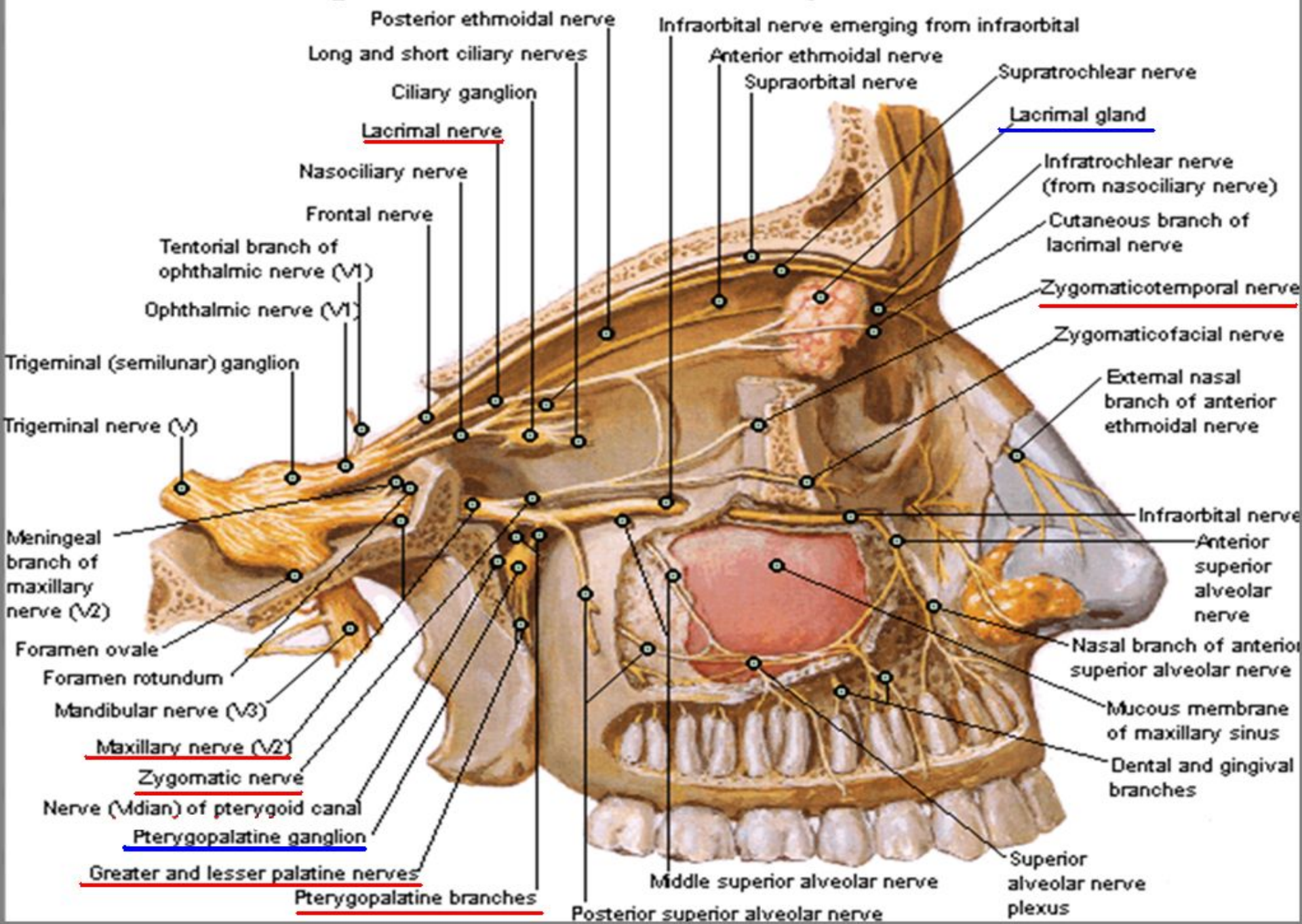
- **Type:** it is the largest parasympathetic ganglion (4-5 mm in diameter).
- **Site:** it lies in the pterygopalatine fossa.
- **Roots Entering the Sphenopalatine Ganglion:**
 1. **Sensory root:** two sensory branches arising from the maxillary nerve.
 2. **Sympathetic root:** the deep petrosal nerve from sympathetic plexus around the ICA.
 3. **Parasympathetic root:** the greater petrosal nerve (branch of facial nerve).



Branches of the Sphenopalatine Ganglion

1. **Orbital branches:** enter the orbit through the inferior orbital fissure. They supply the orbital periosteum and the mucous membrane of the sphenoid air sinus. Another fibers pass with the **zygomaticotemporal nerve** to the orbit, where they branch off to join the lacrimal nerve to supplies **lacrimal gland**.
2. **Pharyngeal branch:** to supply the mucous membrane of the nasopharynx.
3. **Greater palatine nerve:** to supply the mucous membrane of the hard palate and part of the nose.
4. **Lesser palatine nerve:** to supply the mucous membrane of the soft palate and the palatine tonsil.
5. **Short sphenopalatine nerve:** to supply the mucous membrane of the upper part of the lateral wall of the nose and nasal septum.
6. **Long sphenopalatine nerve:** to supply the mucous membrane of the anterior part of the hard palate.

Ophthalmic and Maxillary Nerves

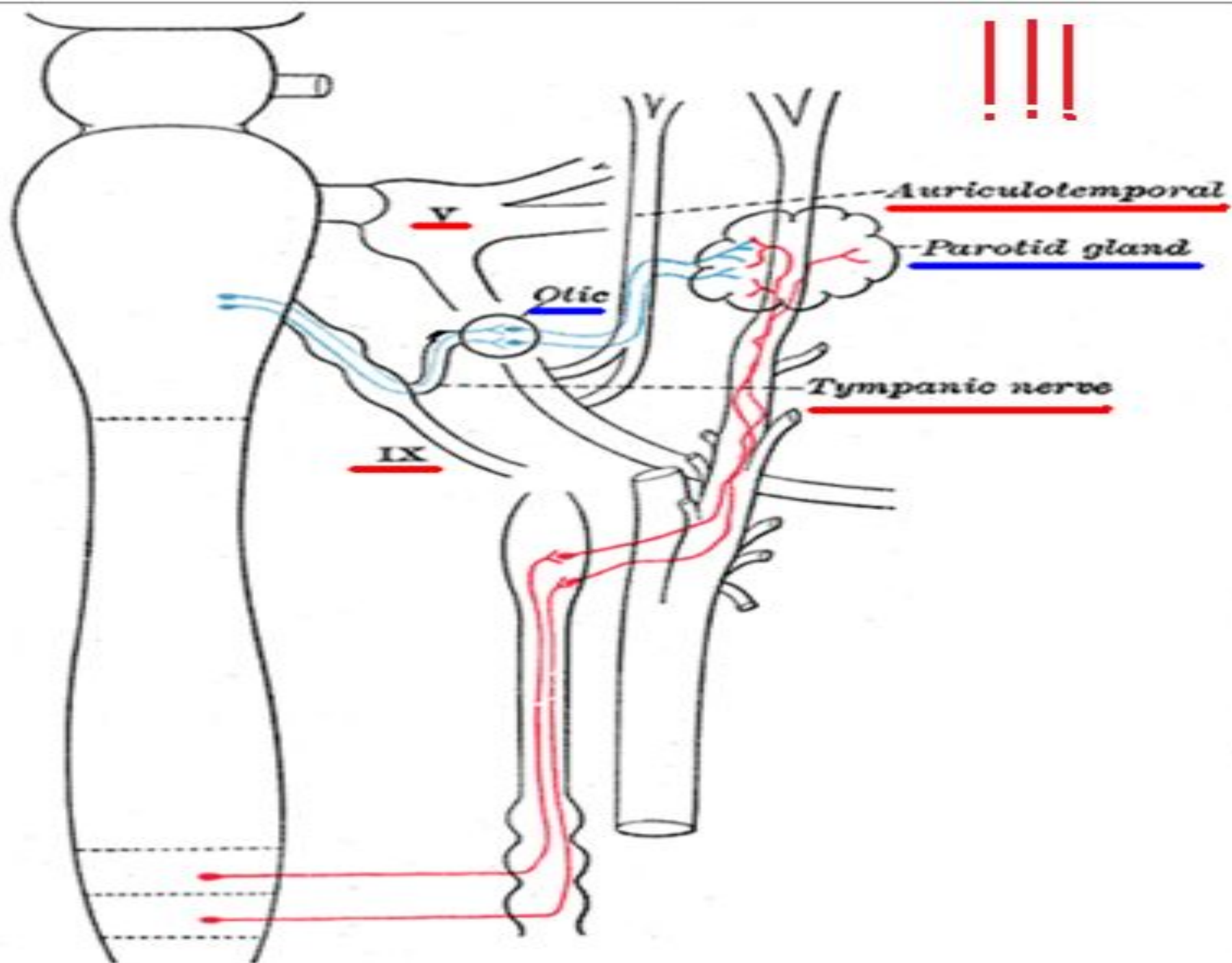


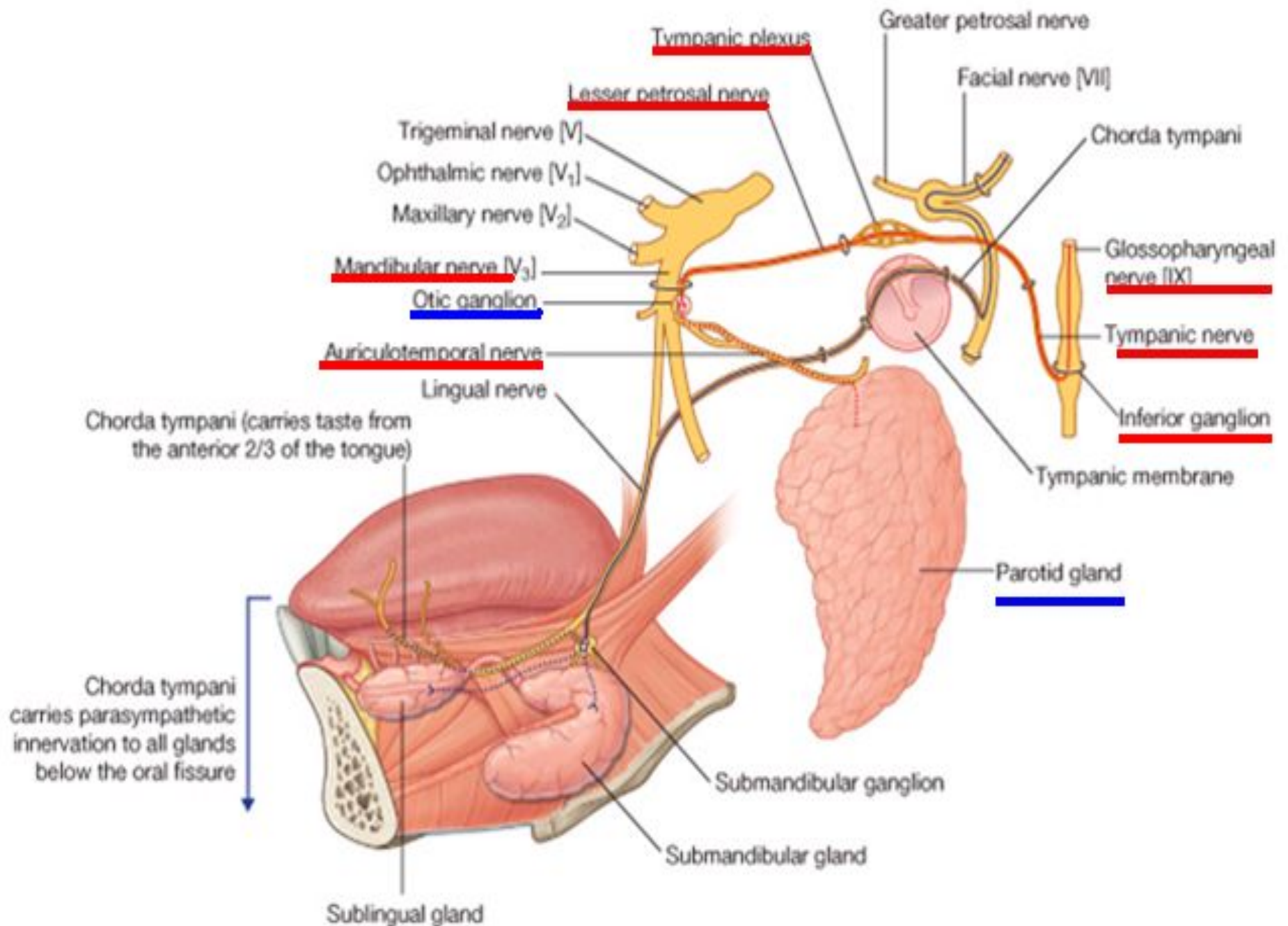
Otic Ganglion

- **Type:** it is a small parasympathetic ganglion.
- **Site:** in the infratemporal fossa just below foramen ovale.
- **Roots Entering the Otic Ganglion:**
 1. **Motor root:** arising from nerve to medial pterygoid muscle (branch of the main trunk of mandibular nerve).
 2. **Parasympathetic root:** formed by lesser superficial petrosal nerve (branch of glossopharyngeal nerve).
 3. **Sympathetic root:** from the plexus around middle meningeal artery (from the plexus around ECA).

Branches of the Otic Ganglion

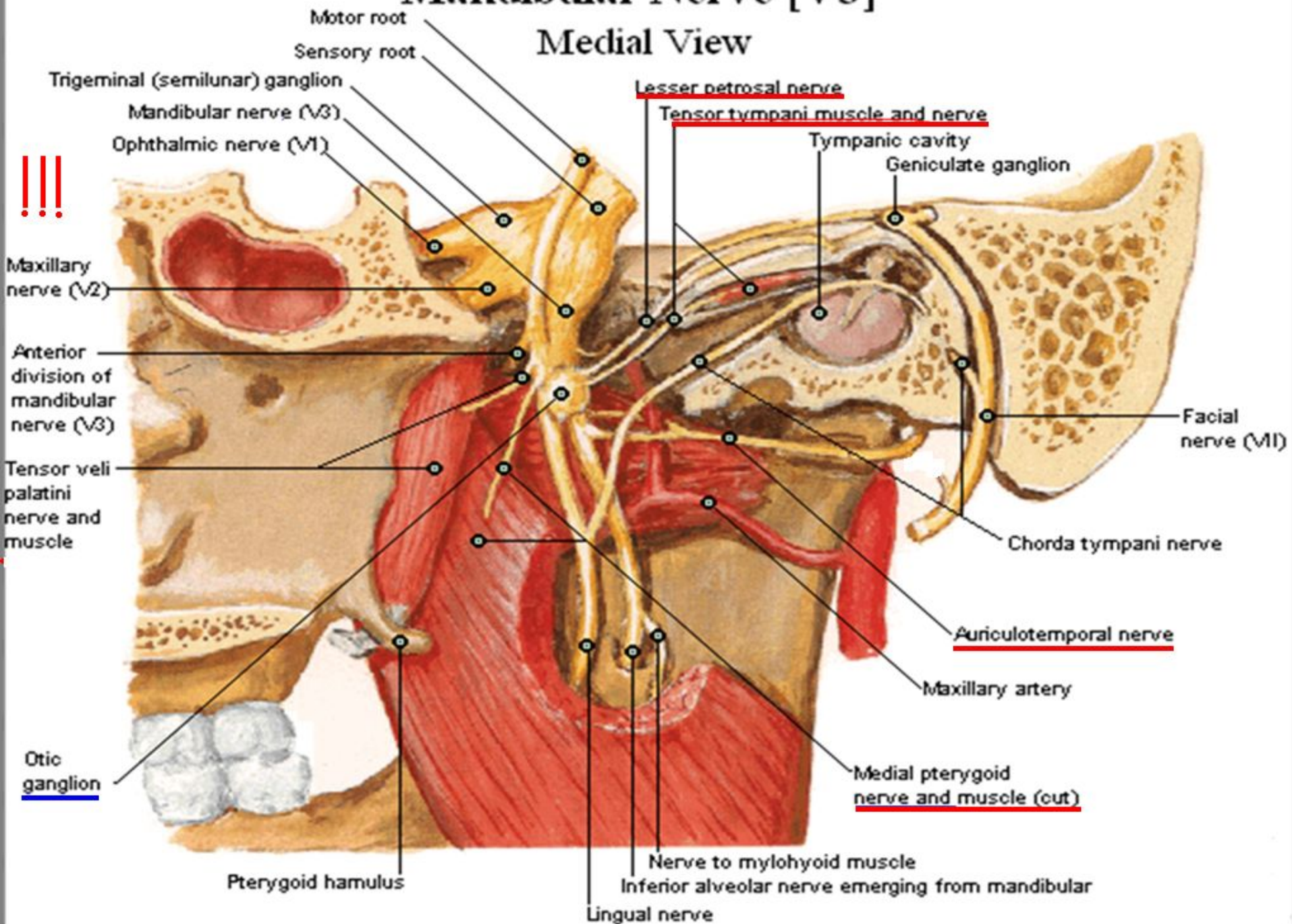
1. **Motor branch:** to tensor palati muscle and another branch to tensor tympani muscle.
2. **A communicating branch:** to **auriculotemporal nerve**, this branch is formed of:
 - a. **Sympathetic fibers:** to supply the blood vessels of parotid gland.
 - b. **Parasympathetic fibers:** secretomotor to parotid gland.





Mandibular Nerve [V3]

Medial View



The Parasympathetic Ganglia in the Head and Neck

Ganglion	Nucleus	Parasympathetic root	Sensory or motor root	Sympathetic root	Organs supplied
Ciliary	Edinger-Westphal	Oculomotor nerve	Nasociliary	Nasociliary nerve from internal carotid plexus	Sphincter pupillae and ciliary muscles
Sphenopalatine	Superior salivary	Greater superficial petrosal nerve from VII nerve	Maxillary	Deep petrosal nerve from internal carotid plexus	Lacrimal glands; glands of nose, palate, mouth and pharynx
Submandibular	Superior salivary	Chorda tympani nerve from VII nerve	Lingual	Plexus around facial artery	Submandibular and sublingual glands
Otic	Inferior salivary	Lesser superficial petrosal nerve from IX nerve	Mandibular "Motor"	Plexus around middle meningeal artery	Parotid gland
Many ganglion in the different organs	Dorsal motor nucleus of vagus	Vagus nerve	Many nerves	Many plexus	Heart, Respiratory system, Abd. viscera

Oculomotor

Edinger Westphal nucleus

3

oculomotor

inferior division of 3 nerve

nerve to inferior oblique M.

ciliary g.

s.c.n.

ciliary muscle

sphincter pupillae

Facial

superior salivary nucleus

7

facial

greater superficial petrosal n.

spheno-palatine g.

lacrimal gland

glands of nose & palate

chorda tympani n.

joins lingual n.

sub-mandib. g.

sub-lingual gland

sub-mandib. gland

Glossopharyngeal

inferior salivary nucleus

9

glosso-pharyngeal

tympanic branch

tympanic plexus in middle ear

lesser superficial petrosal n.

otic g.

auriculo-temporal n.

parotid gland

The Sympathetic Nervous System

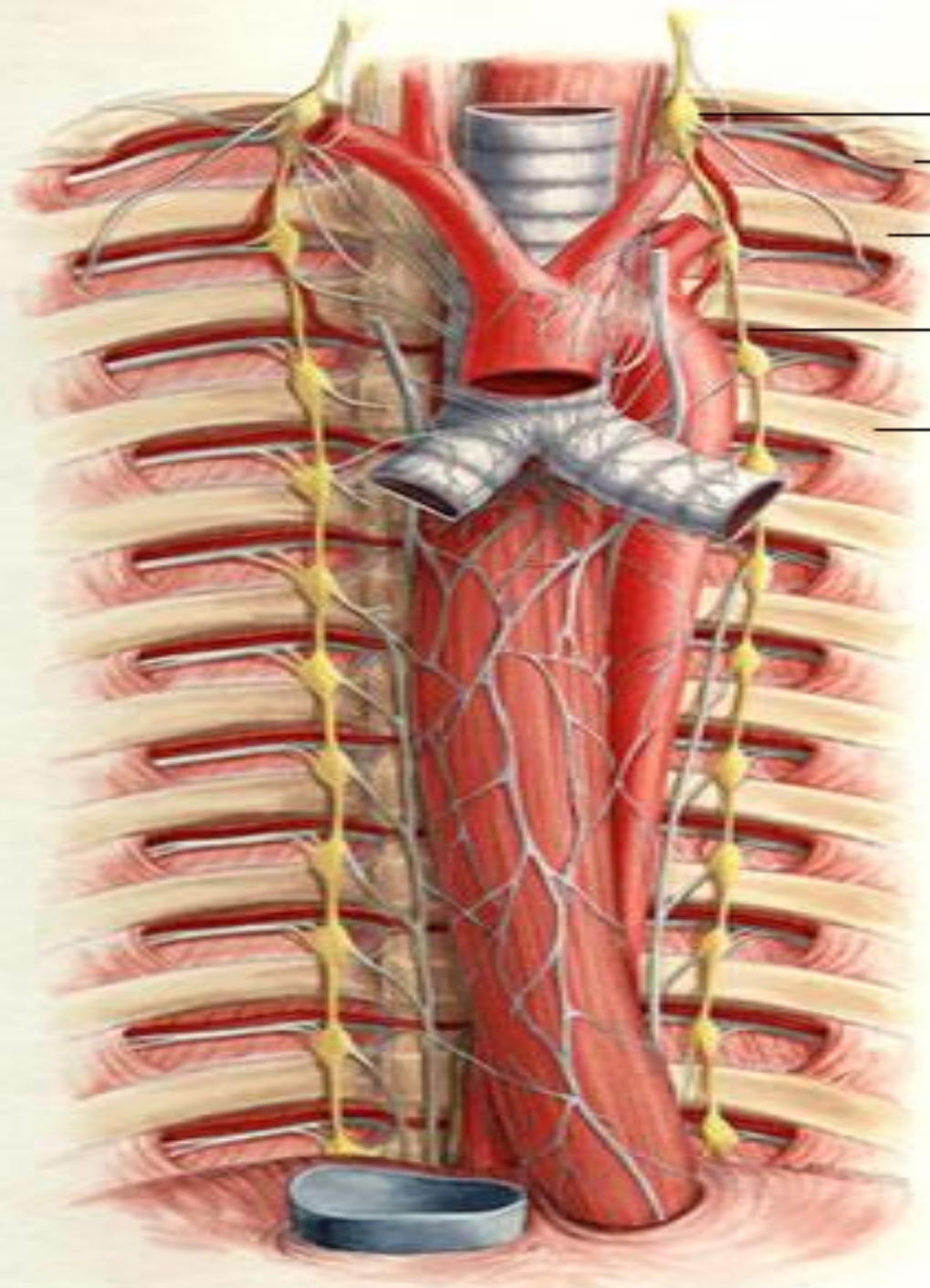
- ❖ **Cells of Origin:** The sympathetic NS formed by the cells of the intermediolateral nuclei of the lateral horn of **T1-L2** segments of the spinal cord (**Thoraco-lumbar part**) and reach the sympathetic chain by the white rami (right and left).
- ❖ Sympathetic cells may also be found in **C8 segments of the spinal cord.**

The Sympathetic Ganglia

1. **Paravertebral Ganglia:** which formed the sympathetic chain or trunk.
 - ❖ There are two sympathetic chains (right and left) on each side of the vertebral column.
 - ❖ Each chain extends from the level of the **first cervical vertebra** (above) to front of **the coccyx** (below) where two chains unite to form a single coccygeal ganglion (**impar ganglion**).
 - ❖ It formed of 22-23 ganglia on each side.
2. **Collateral or Peripheral Ganglia:** these are ganglia that surround some large arteries: **celiac, superior and inferior mesenteric ganglia**.

How Many Sympathetic Ganglia are Found in the Sympathetic Chains?

1. **Cervical ganglia:** 3 pairs.
2. **Thoracic ganglia:** 10-12 pairs.
3. **Lumbar ganglia:** 4-5 pairs.
4. **Sacral ganglia:** 4-5 pairs.
1. **Coccygeal ganglion:** one fused together (impar ganglion).



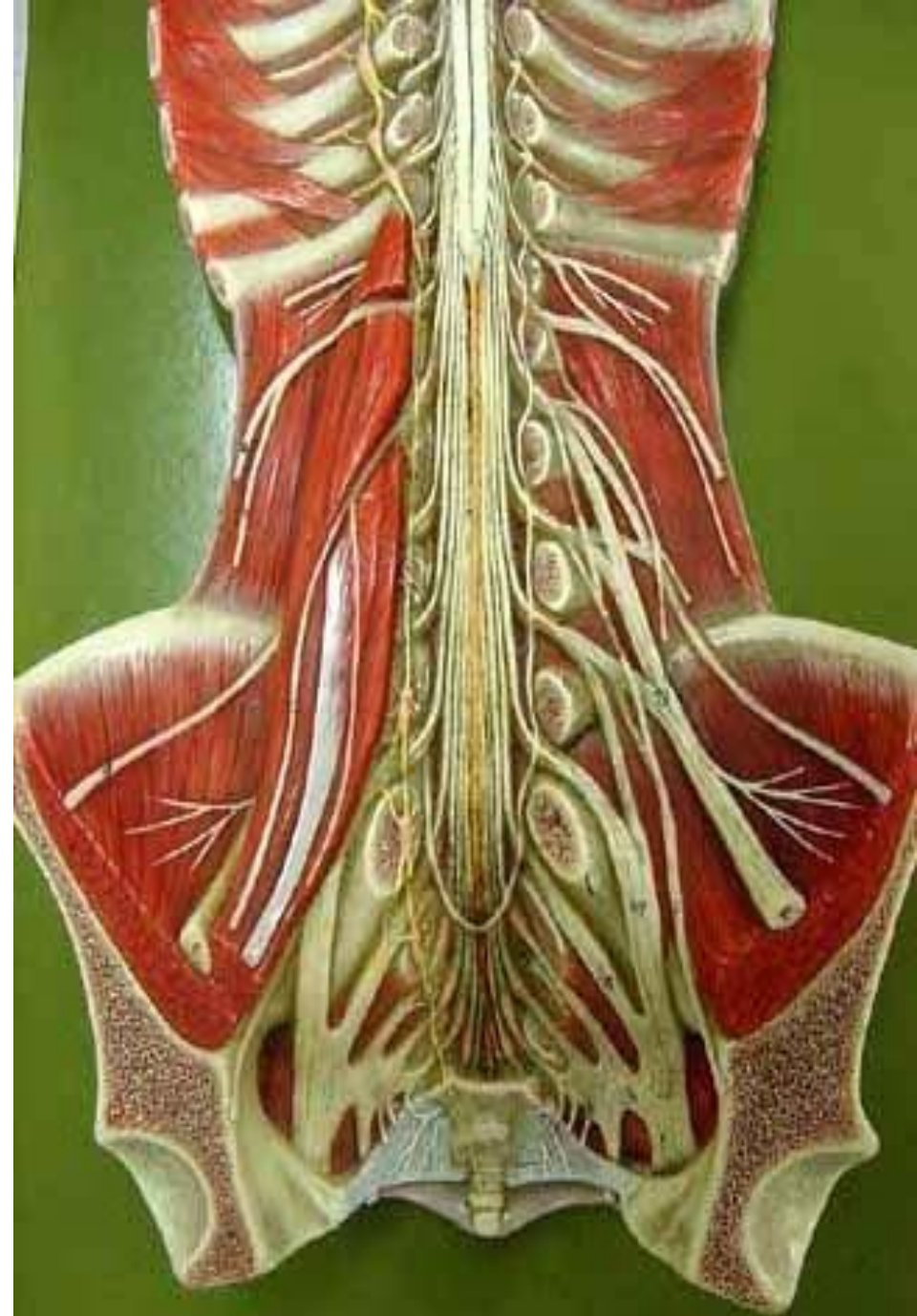
sympathetic ganglion

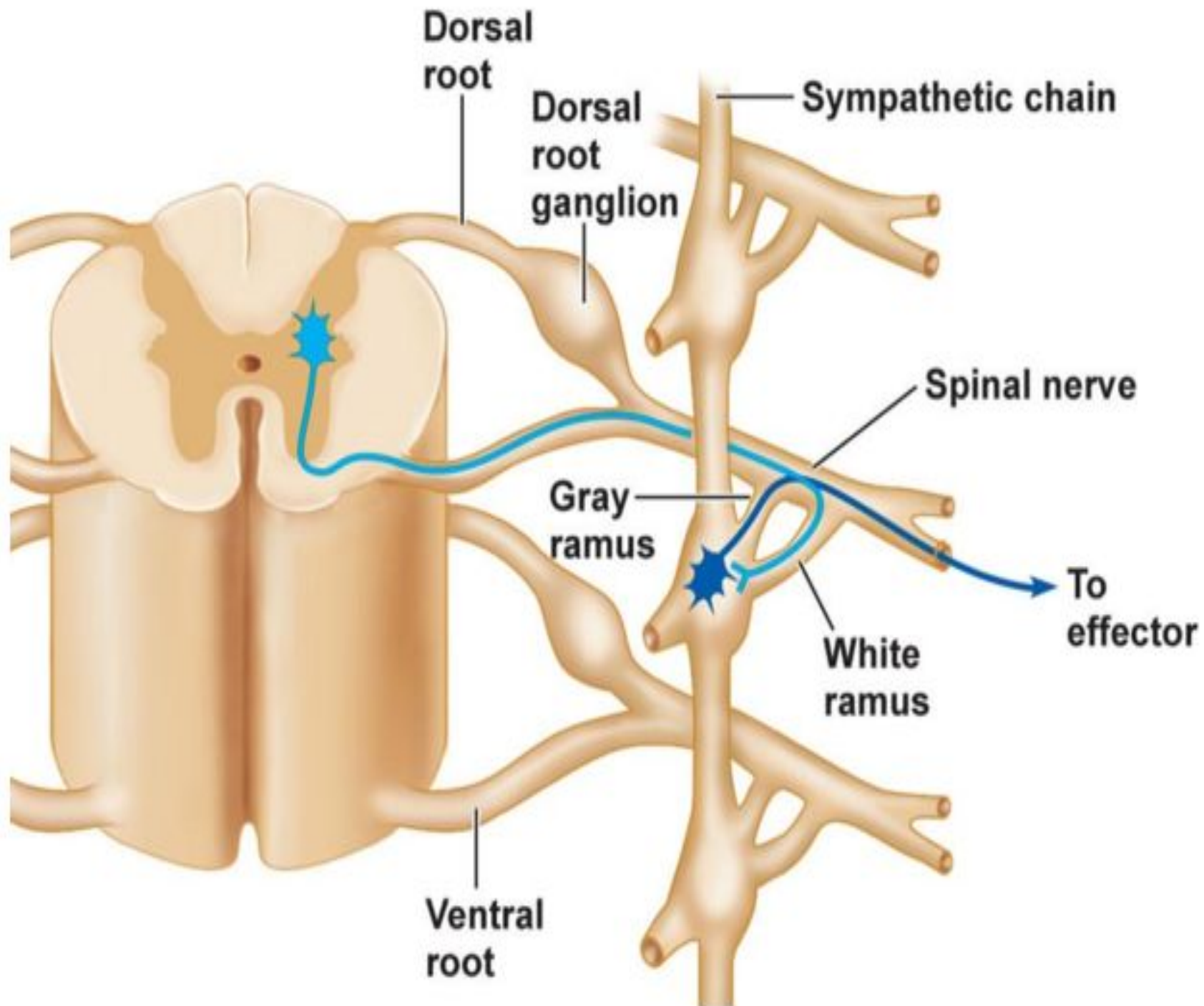
first rib

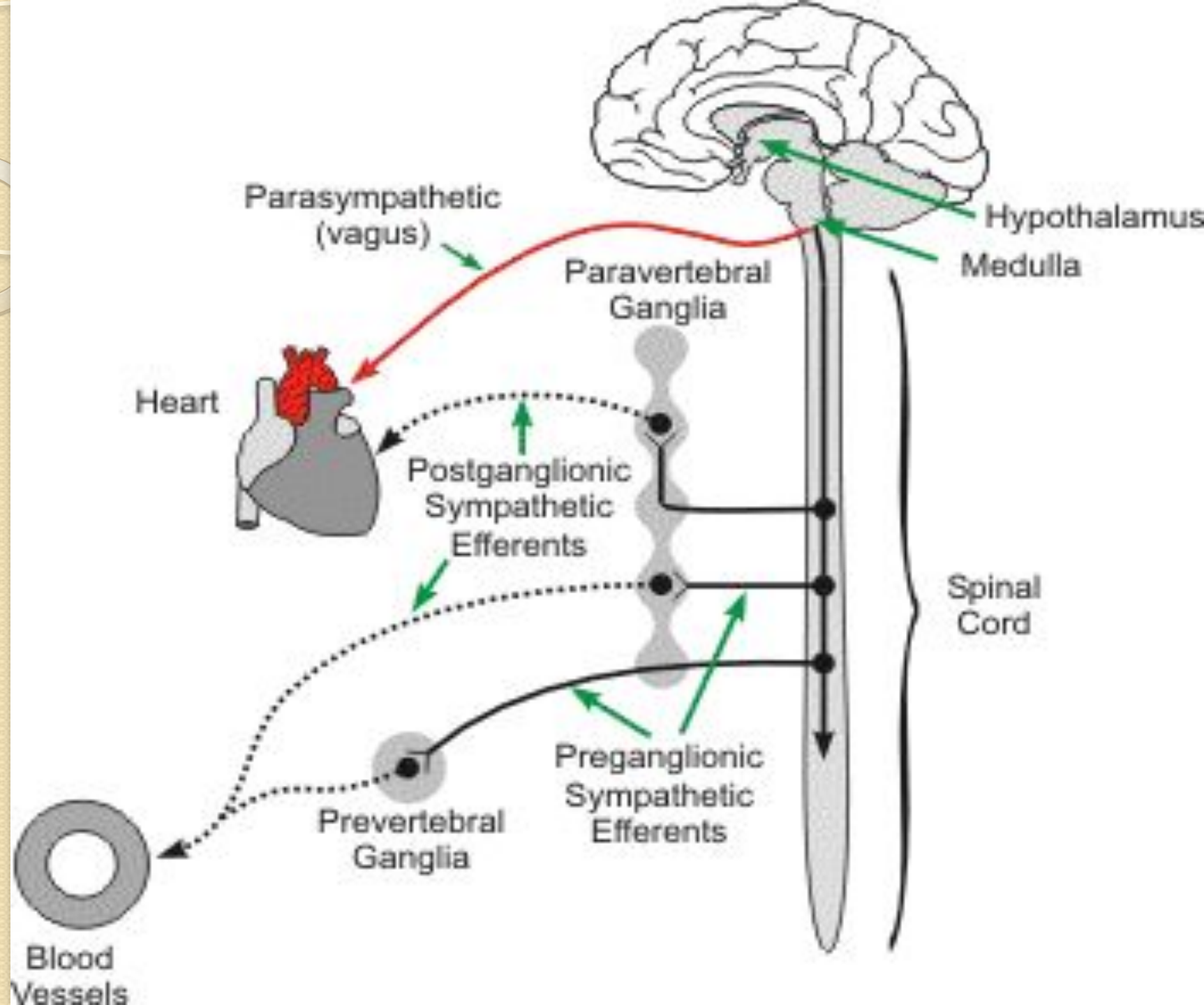
second rib

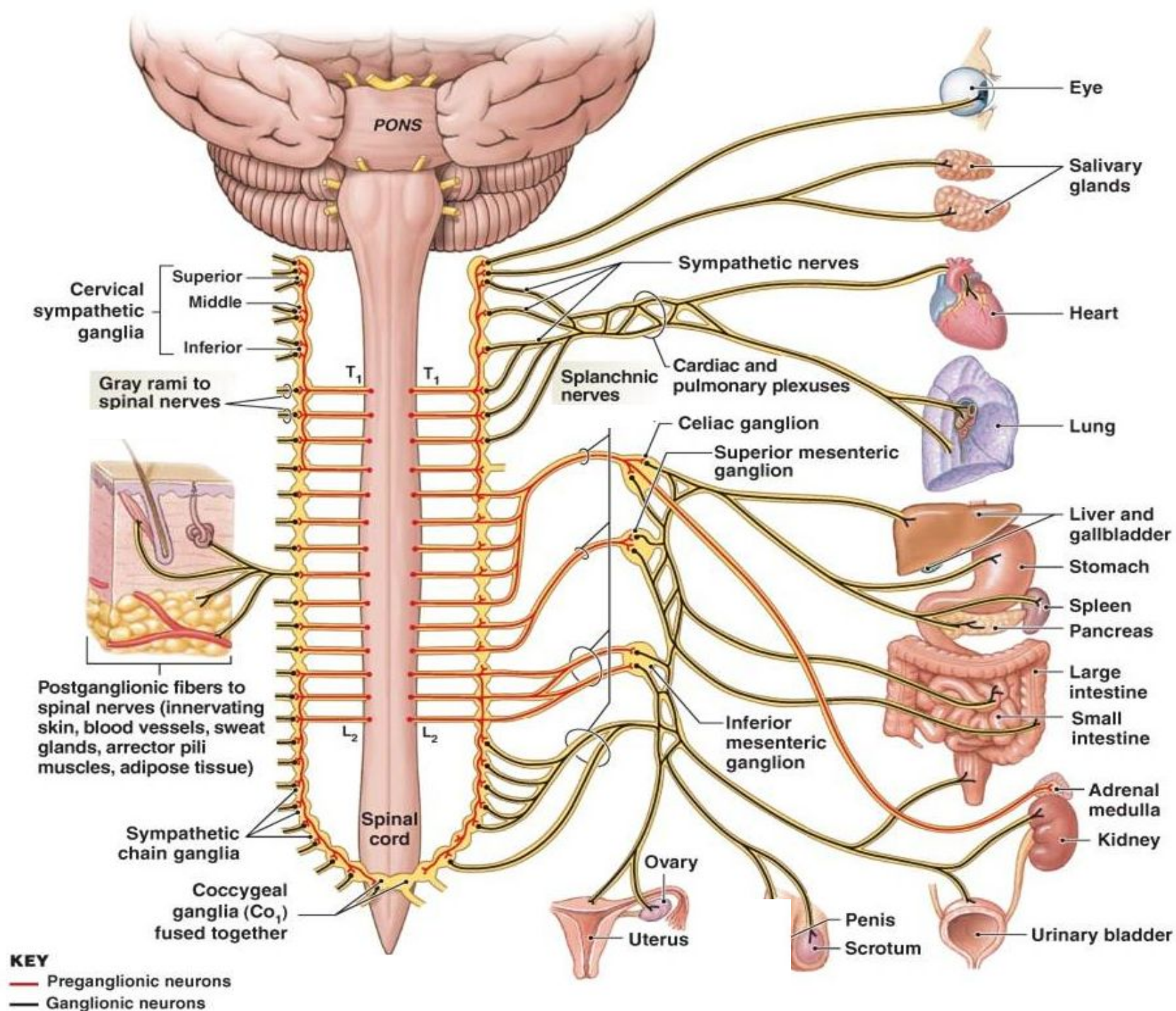
sympathetic chain

fourth rib









The Cervical Part of the Sympathetic Chain

Site: It lies behind the common, external, and internal carotid arteries, outside carotid sheath and medial to the vagus nerve.

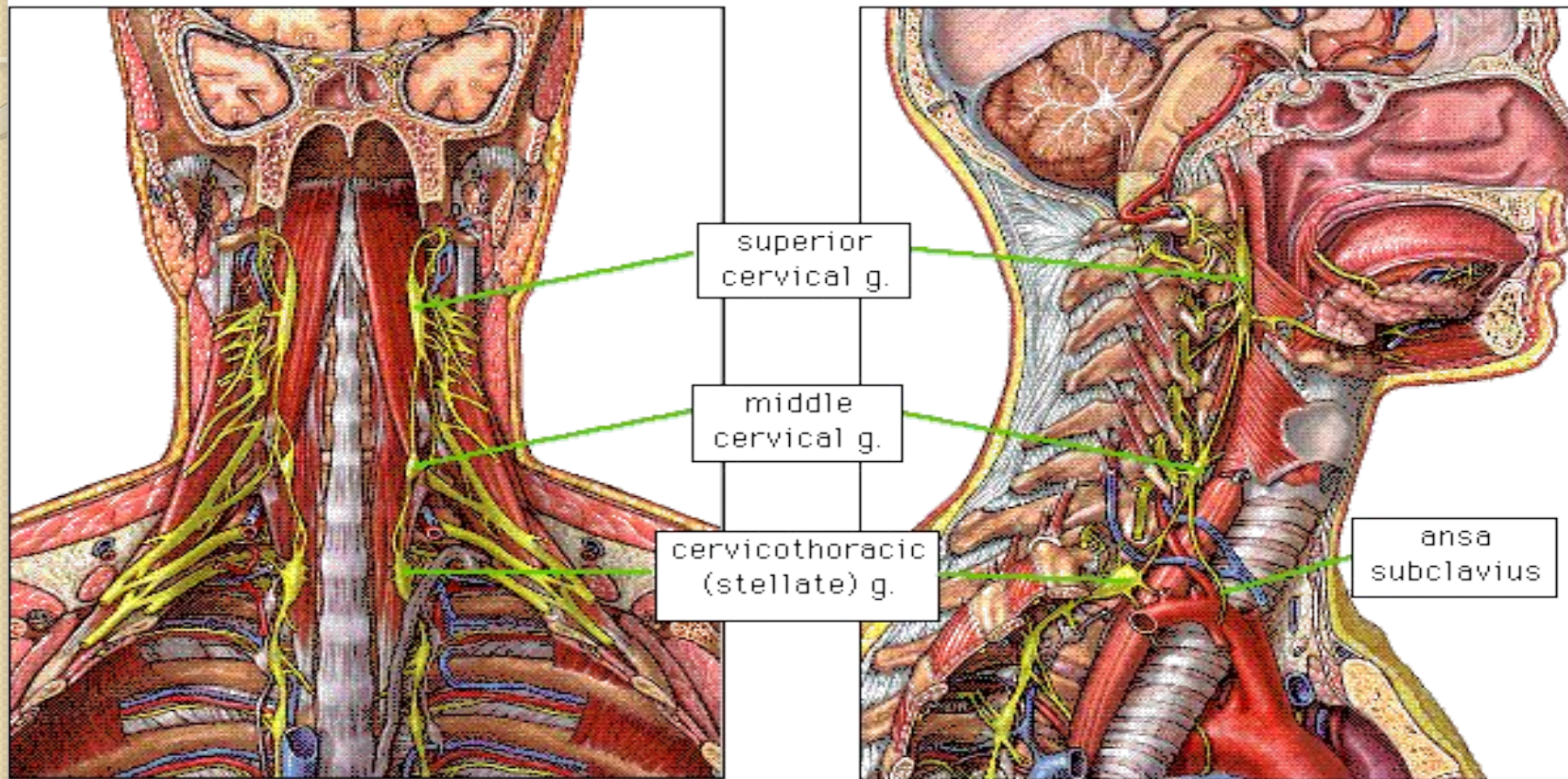
It has:

- 1. Preganglionic fibers:** from upper thoracic segments (T1-T4) until the three cervical ganglion.
- 2. Postganglionic fibers:** leave these ganglia, to the cervical nerves, cranial nerves and large vessels.

The Cervical Sympathetic Ganglion

There are three cervical sympathetic ganglion:

1. Superior cervical sympathetic ganglion.
2. Middle cervical sympathetic ganglion.
3. Inferior cervical sympathetic ganglion.



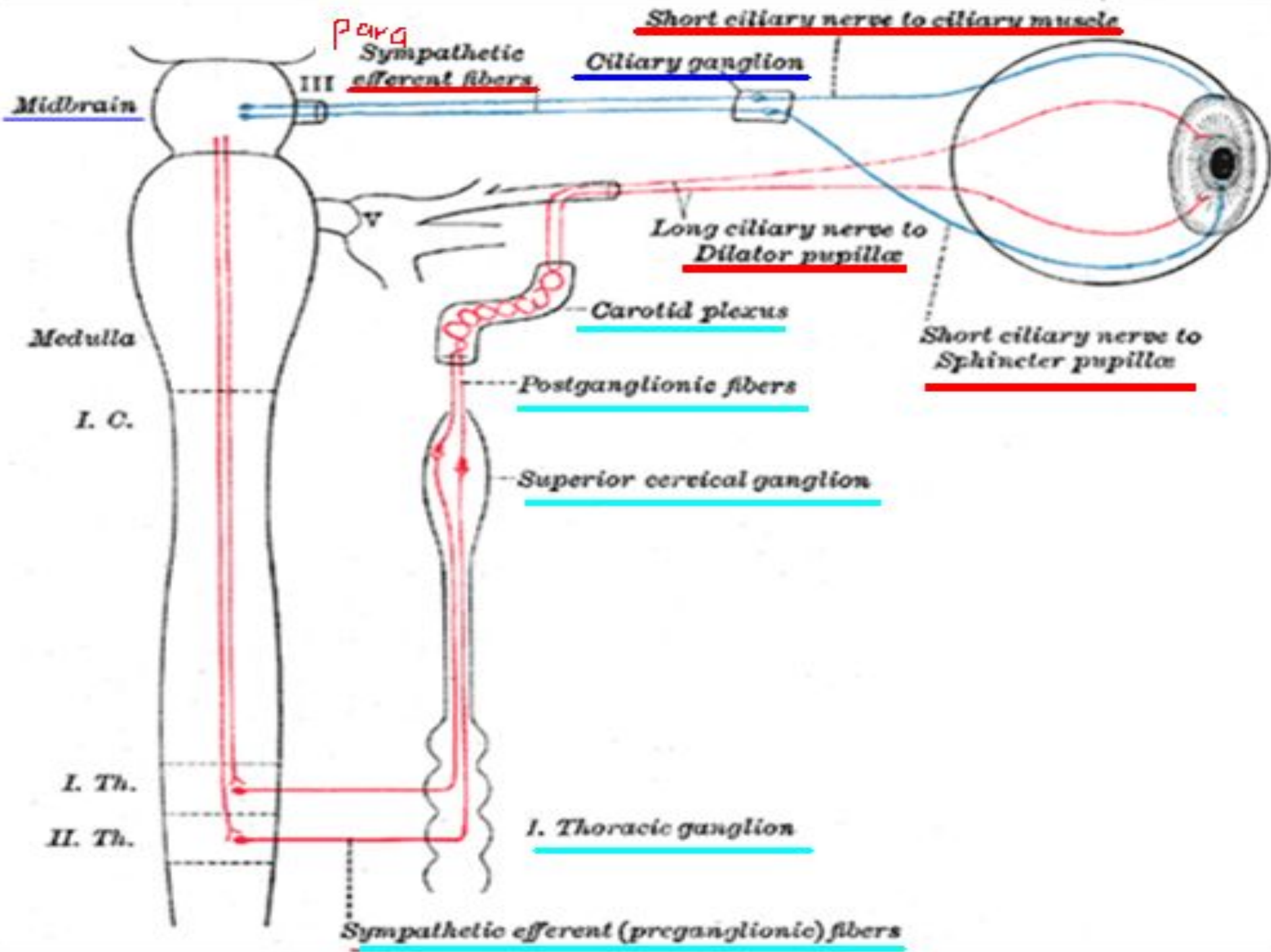
Destruction of the Superior Cervical Sympathetic Ganglion

- ❖ This removes all the sympathetic fibers that reach face and neck and produces **Horner's syndrome**:
 1. Myosis.
 2. Partial ptosis.
 3. Anhydrosis.
 4. Enophthalmus.



Sympathetic Supply of the Pupil

Pathway: Fibers start from hypothalamus, descends through the brain stem and cervical part of the spinal cord to the lateral horn cells of **C8 – T2 segment** → preganglionic fibers → sympathetic chain → relay in the superior cervical sympathetic ganglion. The postganglionic fibers pass with carotid plexus (around ICA) → long ciliary nerve → **dilator pupillae muscle.**



Innervation of the Urinary Bladder and Rectum

They receive 3 types of nerves:

1. **Somatic innervation (Pudendal nerve):** supplies the striated muscles of the external sphincter of the urethra and rectum.
2. **Sympathetic nerves:** branches from the pelvic plexuses. They supply the blood vessels of the urinary bladder and rectum.
3. **Parasympathetic nerves:** branches from S2, S3 & S4 segments of the spinal cord → pass in S2, S3 & S4 → pelvic plexuses. **They supply:**
 - The muscles of the walls of urinary bladder and rectum **(contraction)**.
 - Inhibitory fibers to the internal sphincter of the urinary bladder and rectum **(relaxation)**.

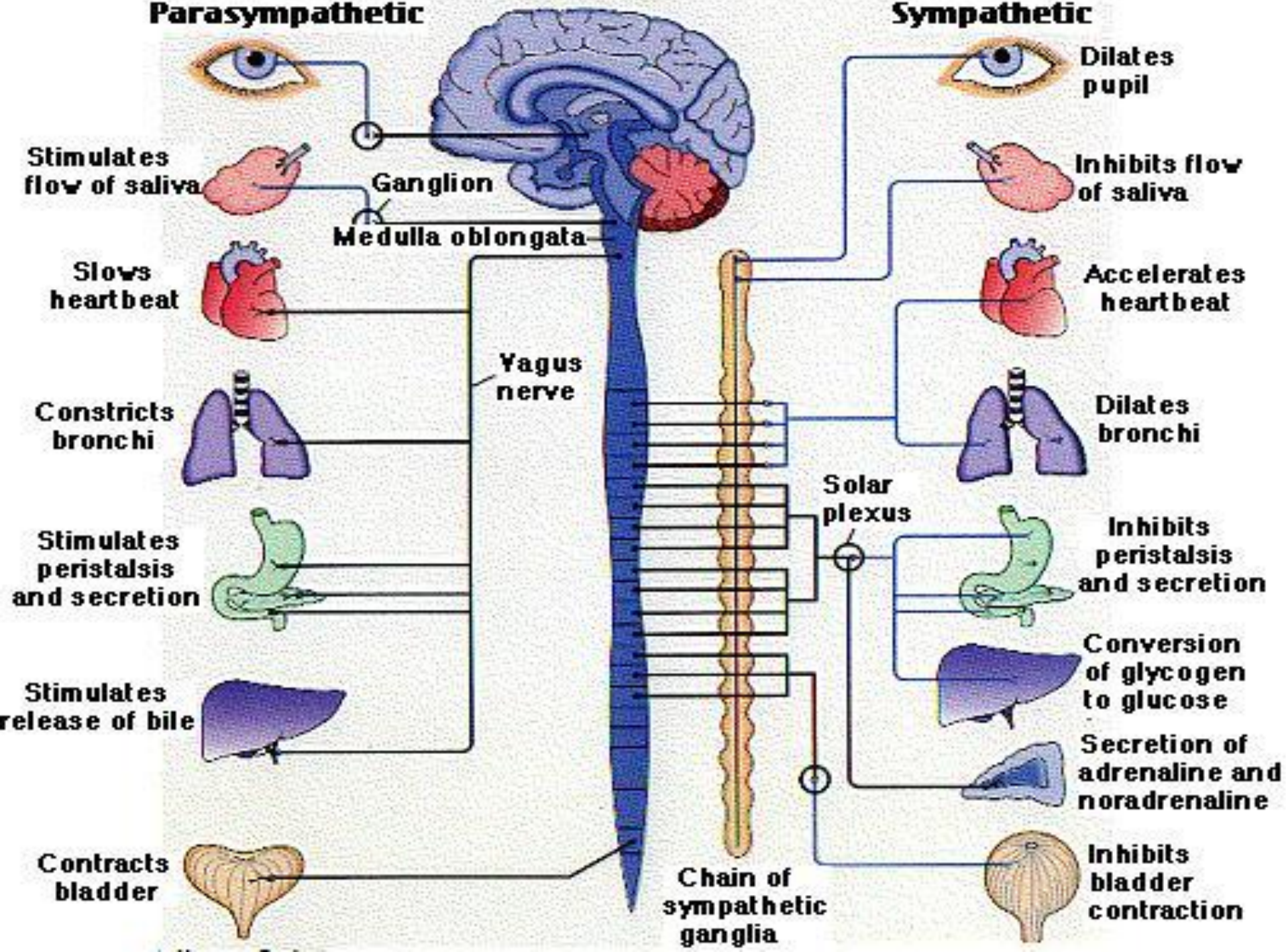
Effects of Autonomic Nervous System on Organs and Body

Organ	Sympathetic action	Parasympathetic action
Eye: •Pupil •Ciliary muscle	- Dilates - Relaxes	- Constricts - Contracts
Glands: •Lacrimal & nasopharyngeal glands •Salivary glands	- Reduces secretion - Vasoconstriction	- Increase secretion - Increase secretion
Heart	- Heart rate & muscle contraction increased	- Heart rate & muscle contraction decreased
Lung: •Bronchial muscle •Bronchial arteries	- Dilates bronchi - Constricts	- Constricts bronchi - Dilates
GIT: •Muscle in walls •Muscle in sphincters •Glands	- Decreases peristalsis - Contracts - Reduce secretion	- Increases peristalsis - Relaxes - Increases secretion
Kidney	- Decreased urine secretion	- Increased urine secretion
Urinary bladder: •Bladder wall •Sphincter	- Relaxes - Contracts	- Contracts - Relaxes

Organ	Sympathetic action	Parasympathetic action
• Gall bladder	- Relaxation	- Contraction
• Liver	- Increased conversion of glycogen to glucose	- Stimulate release of bile
• Pancreas	- Inhibition of insulin and glucagon secretion	- Stimulation of insulin and glucagon secretion
• Male sex organs	- Ejaculation	- Erection
Pineal gland	- Increase melatonin synthesis and secretion	-
Skin:		
• Sweat glands	- Increases secretion	-
• Pilomotor muscle	- Contraction	-
• Platelet	Increase aggregation	-
• Lipolysis	- Increase	-
• Renin secretion	- Increase	-
• Mast cells: histamine	- Decrease	-

Parasympathetic

Sympathetic



Thank You

