AUTONOMIC NERVOUS SYSTEM (ANS)

Foundation block - Anatomy - Lecture 4

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Objectives

At the end of the lecture, the students should be able to:

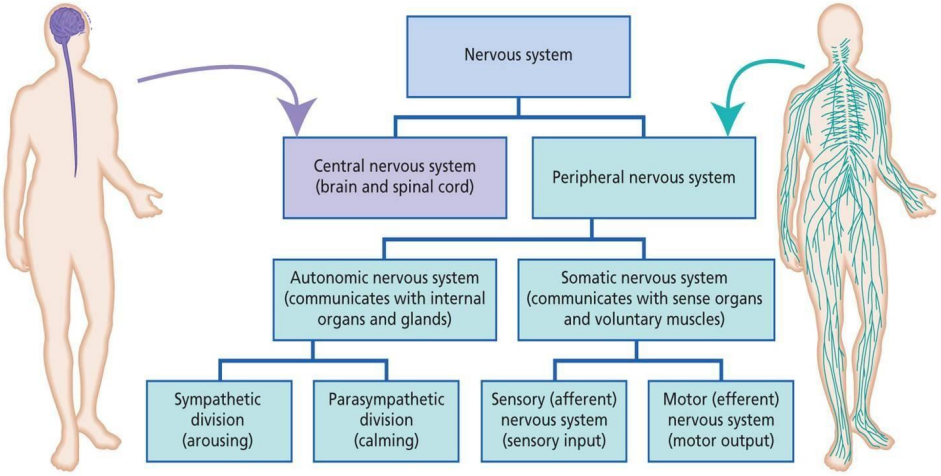
- Define the autonomic nervous system.
- Describe the structure of autonomic nervous system.
- Trace the preganglionic & postganglionic neurons in both sympathetic & parasympathetic nervous system.
- Enumerate in brief the main effects of sympathetic & parasympathetic system.

Color guide :
Only in boys slides in **Green**
Only in girls slides in **Purple**
important and doctors note in **Red**
Extra information in **Blue**

Autonomic Nervous System

Concerned with the **innervation** and control of **Involuntary structures**: visceral organs, smooth & cardiac muscles and glands.

- **Function**: maintain **homeostasis** of the internal environment along with the Endocrine system.
- **Located**: both in the **central** and **peripheral** nervous systems.
- **Regulated**: (controlled) by **Hypothalamus**.



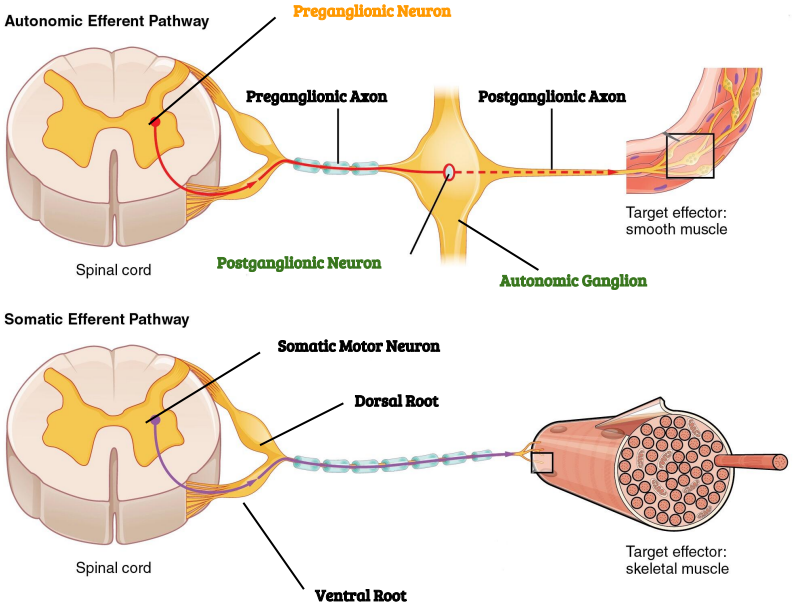
Note: Hypothalamus controls both of Autonomic system + Endocrine system.

Autonomic Nervous System

Note: slide was only found in girls slides

Unlike the somatic nervous system, the **Efferent pathway** of the autonomic nervous system is made up of **two neurons** called as **preganglionic** and **postganglionic** neurons.

The cell bodies of the **preganglionic neurons** are located in the **brain and spinal cord.** Their axons synapse with the **postganglionic neurons** whose cell bodies are located in the **autonomic ganglia.**



Note: before the fibers reach the target, it should first pass by the autonomic ganglion and synapse.

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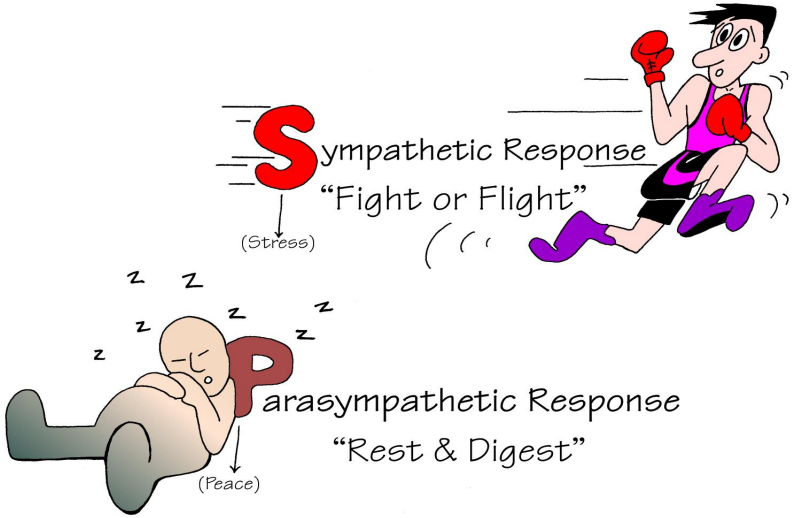
Autonomic Nervous System

Based on the **anatomical**, **physiological** and **pharmacological** characteristics, the autonomic nervous system is divided into:

- **Sympathetic**:
Activated during exercise, excitement, and emergencies.
"fight or flight".

- **Parasympathetic**:
Concerned with conserving energy.
"rest and digest"

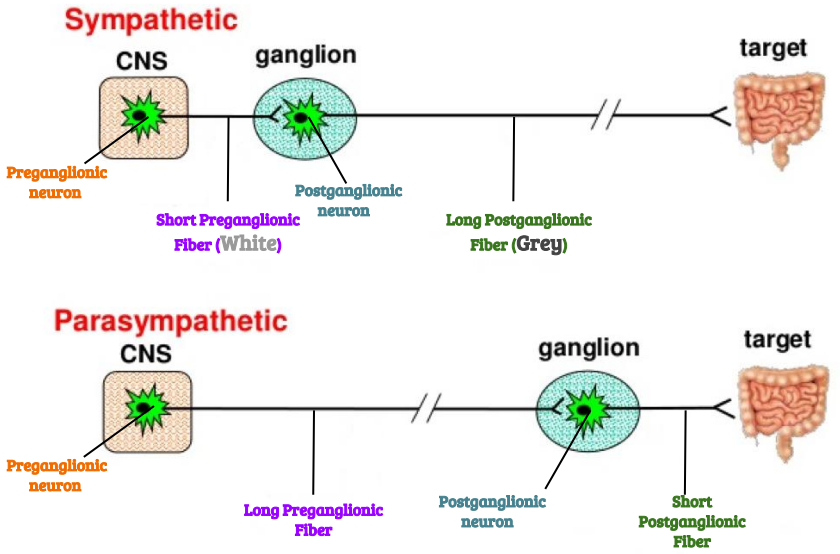


Both divisions operate in conjunction with one another (have **antagonistic** control over the viscera) to maintain a stable internal environment

Autonomic Nervous System

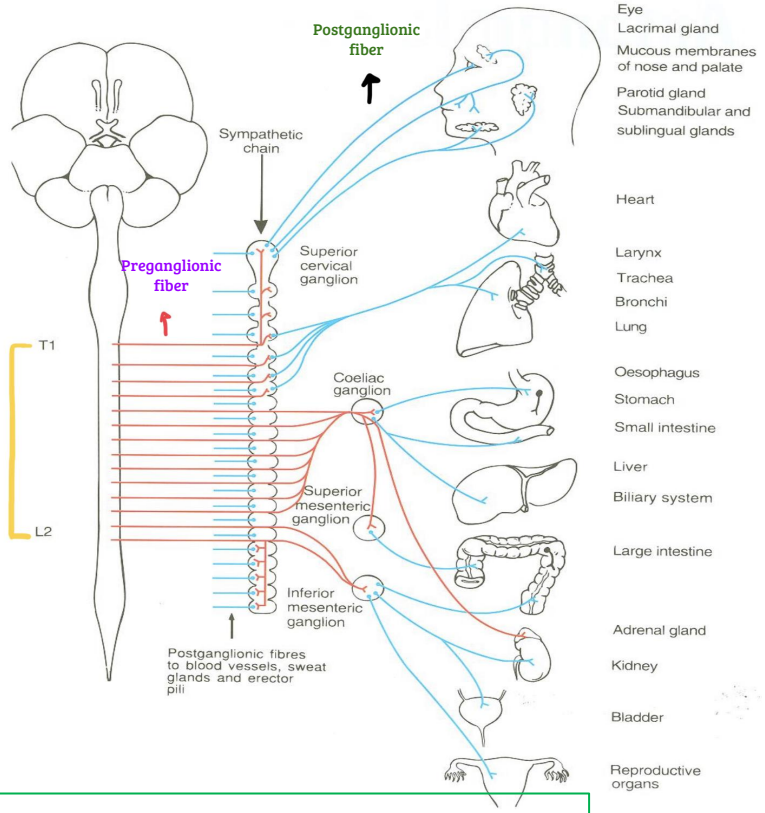
Note: slide was only found in girls slides

Sympathetic	Parasympathetic
-Preganglionic neuron is in the CNS. -The Preganglionic fiber(axon) is shorter. -The Postganglionic neuron is in the PNS. and far from the target. -The Postganglionic fiber (axon) is longer.	-Preganglionic neuron is in the CNS. -The Preganglionic fiber(axon) is longer. -The Postganglionic neuron is in the PNS and close to the target -The Postganglionic fiber(axon) is shorter.



Note: The cause of preganglionic (White) and postganglionic (Grey) fibers having different colors is the Myelin sheath that the preganglionic fibers (white) are sheeted with.
Myelin helps isolate preganglionic fibers for **faster** transportation. (تخليه معزول اكثر ويوصل اسرع)

Sympathetic Nervous System

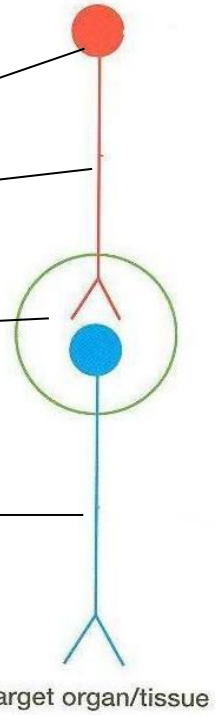


Preganglionic neuron :Cells of lateral horn of spinal cord (T1 – L2)

Preganglionic fiber(axon):Short axon

Postganglionic neuron :
located in :
1-Cells of sympathetic chain
2-Cells of plexuses surrounding abdominal (Coeliac, superior & inferior mesenteric)

Postganglionic fiber (axon): Long axon



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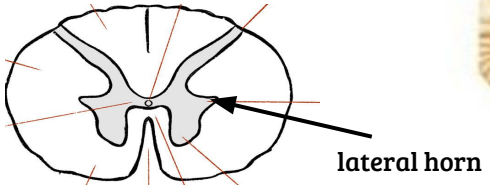
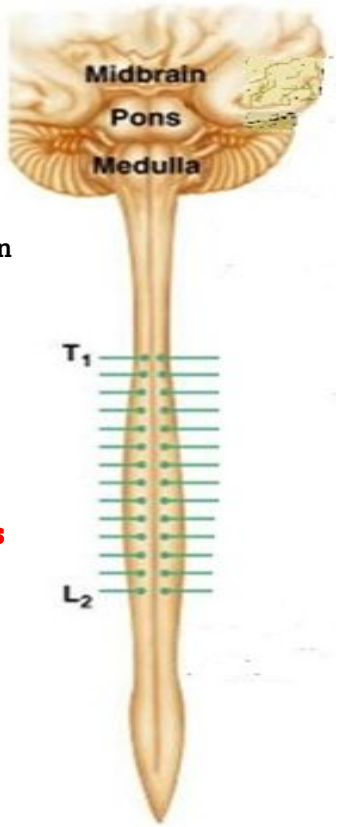
Sympathetic Division:

1)Preganglionic neurons:

located in the lateral gray horn of T1-L2 segments of spinal cord (ThoracoLumbar outflow)

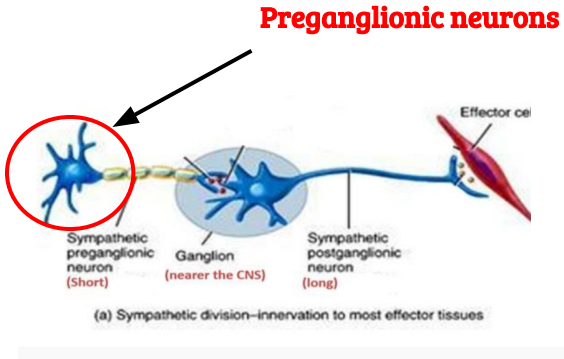




Important Note: Sympathetic neurons only found in spinal cord

Note: as their preganglionic neurons are short, their ganglia (POSTGANGLIONIC NEURONS) are located near to the CNS (spinal cord).

Note: Outflow means the passage of impulses outwardly from the central nervous system.



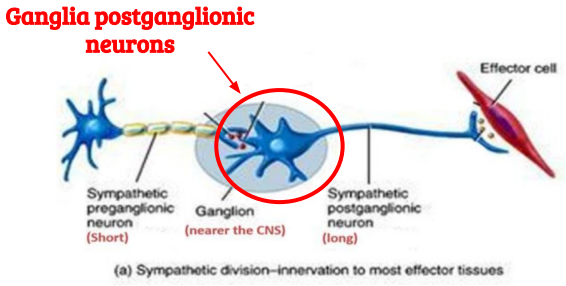
Sympathetic Division

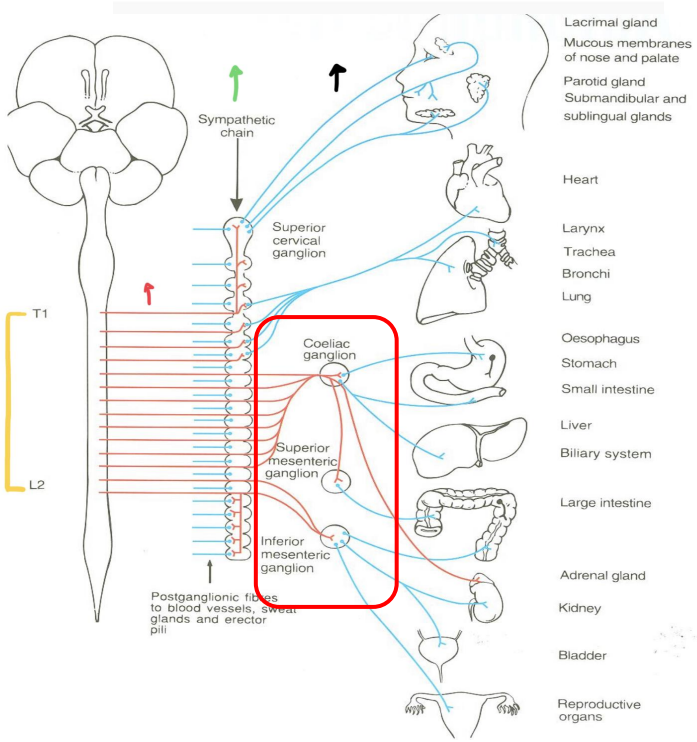
2)Ganglia (postganglionic neurons)

(Located nearer the central nervous system) depending on their location with respect to the vertebral column they are divided into :

1- Prevertebral ganglia (pre means in front of)
2- Paravertebral ganglia (para means next to)

Prevertebral ganglia
coeliac & (superior & inferior) mesenteric ganglia (In front of the vertebrae on the abdominal aorta, named after the coeliac and mesenteric arteries where they locate) ***Postganglionic fibers of Pre**vertebral ganglia **supply:*** 1) abdominal 2) pelvic viscera





Sympathetic Division

2)Ganglia (postganglionic neurons)

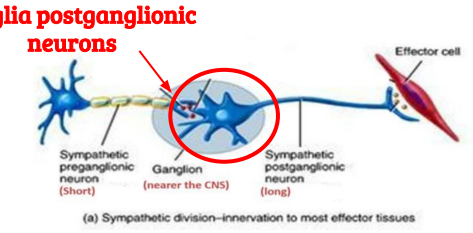
Paravertebral ganglia

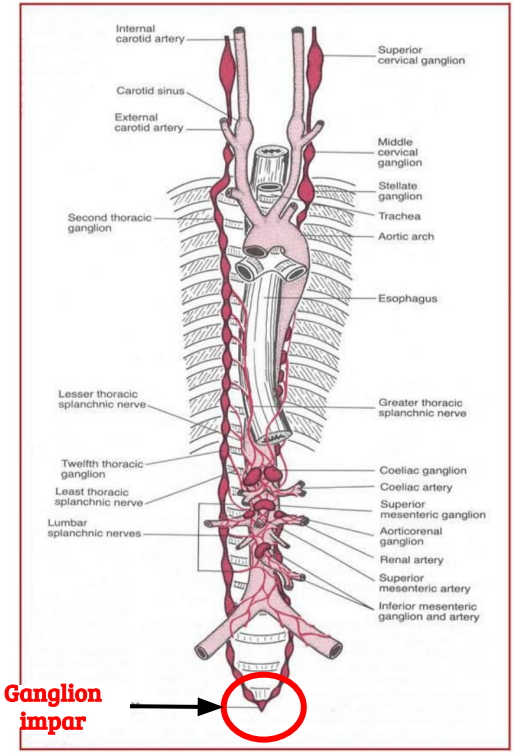
Sympathetic chain ganglia (Two interconnected chains, one on each side of vertebral column)

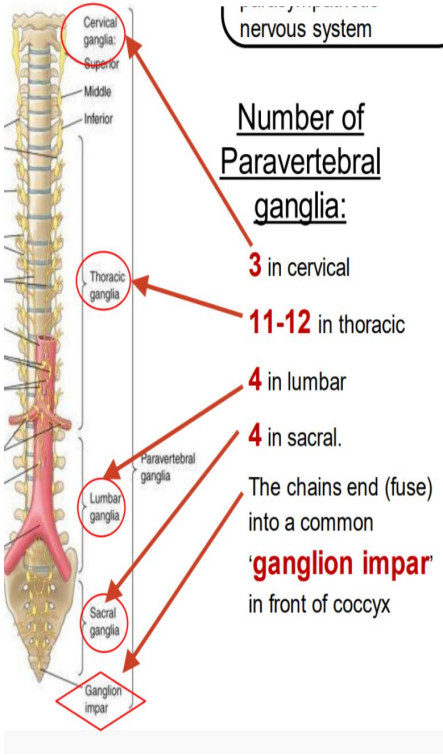
Number of ganglia:
3 in the cervical part of the chain
11 to 12 in thoracic part
4 in lumbar & sacral parts each.

the chains end into a common **"ganglion impar"** in front of coccyx.

Postganglionic fibers of Paravertebral ganglia supply:
1) structures in head & thorax
2) blood vessels
3) sweat glands







Sympathetic Division

3) Fibers:

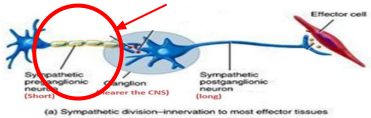
Preganglionic fibers (axon)

Run in the ventral roots of the spinal nerve.

Travel through the spinal nerve, and then join the sympathetic chain via the White Rami Communicantes (WRC).

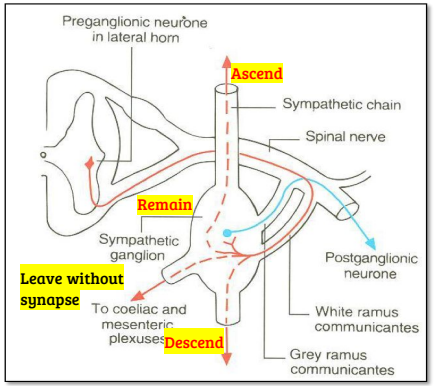
Note: White ramus Preganglionic fibers (before rely)

Preganglionic fibers surrounded by Myelin sheath

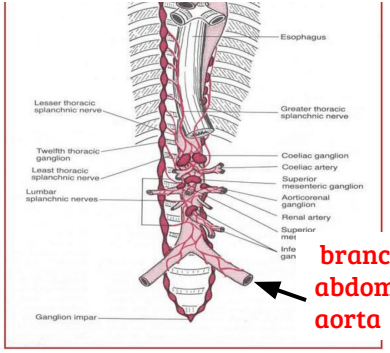


Within the sympathetic chain, these fibers may:

1- **ascend** : to move upward.
2- **descend** : to move downward.
3- **remain** at the same level to **synapse** with neurons (postganglionic) of paravertebral ganglia located in sympathetic chain.



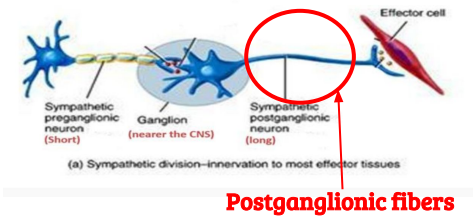
4- **leave the sympathetic chain (without synapse)** to reach coeliac & mesenteric ganglia (around branches of abdominal aorta) to synapse with their neurons (postganglionic).



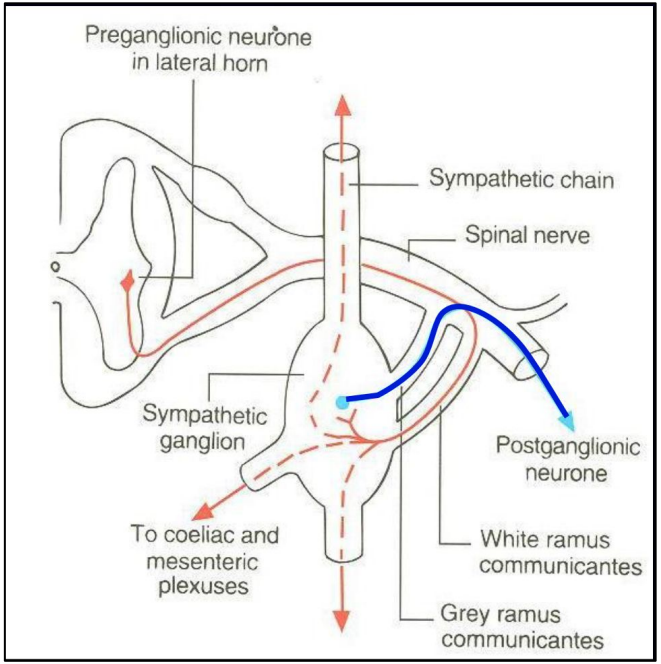
branches of abdominal aorta

Sympathetic Division

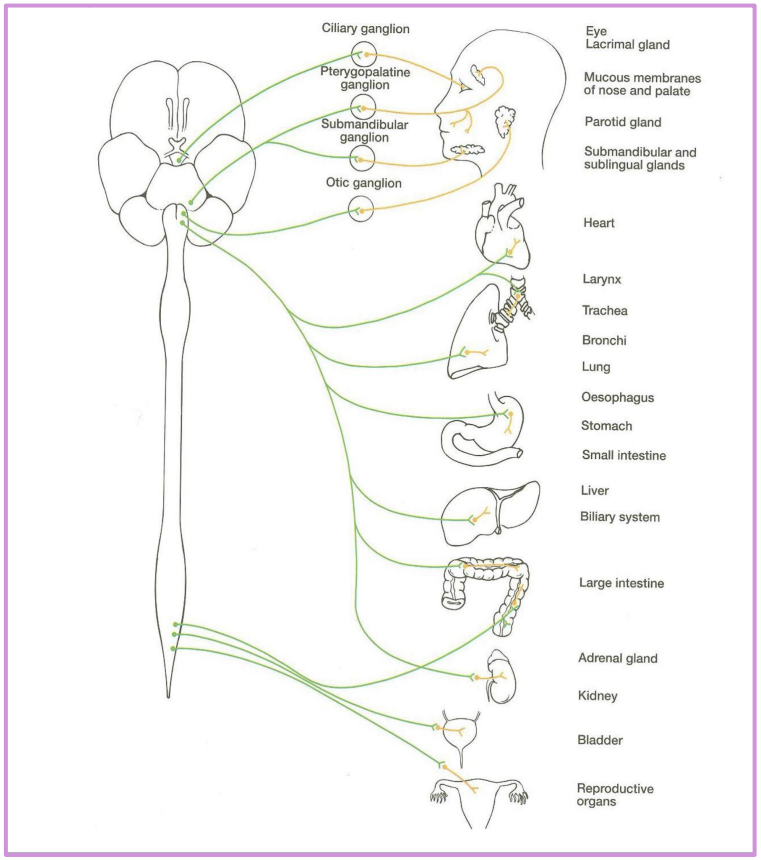
3) Fibers:



Postganglionic fibers
1- **From the sympathetic chain** ganglia enter again into the spinal nerve, to supply structure in head & thorax + blood vessels & sweat glands.
Enter into the spinal nerve through Grey Rami Communicantes (GRC). note: Grey ramus Postganglionic fibers **(after rely).**
2- From the cells of (Coeliac, superior & inferior mesenteric) ganglia supply abdominal & pelvic viscera.



Parasympathetic Nervous System

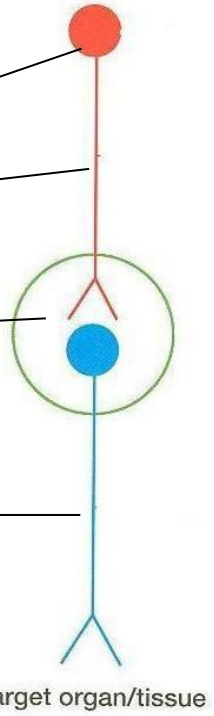


Preganglionic neuron
1- Cranial: cells in brain stem: nuclei of 3rd, 7th 9th & 10th
2- Sacral: cells in S2 – S4 segments of spinal cord

Preganglionic fiber(axon): long axon

Postganglionic neuron :
located in :
1- Cranial: cells of ciliary, pterygopalatine, submandibular, otic & peripheral ganglia
2- Sacral: cells of peripheral ganglia

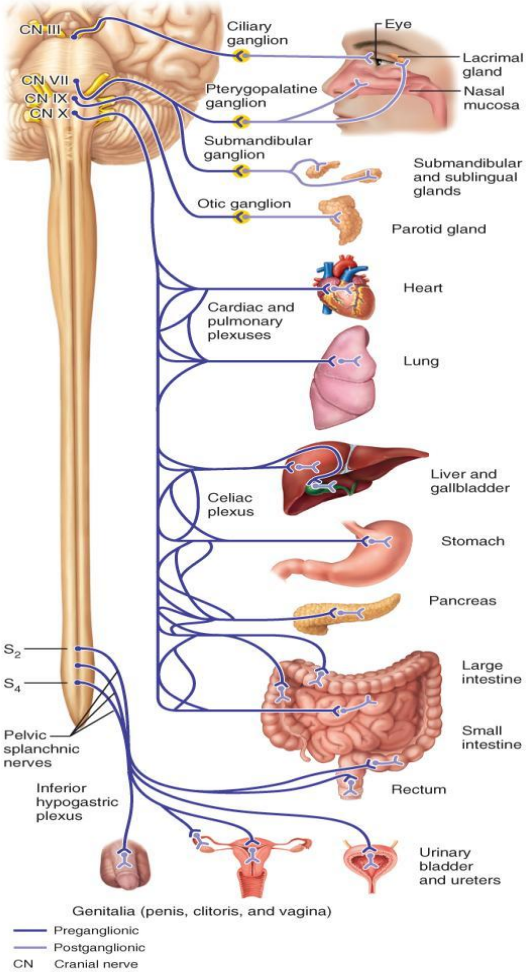
Postganglionic fiber (axon): short axon



Note: slide was only found in boys slides

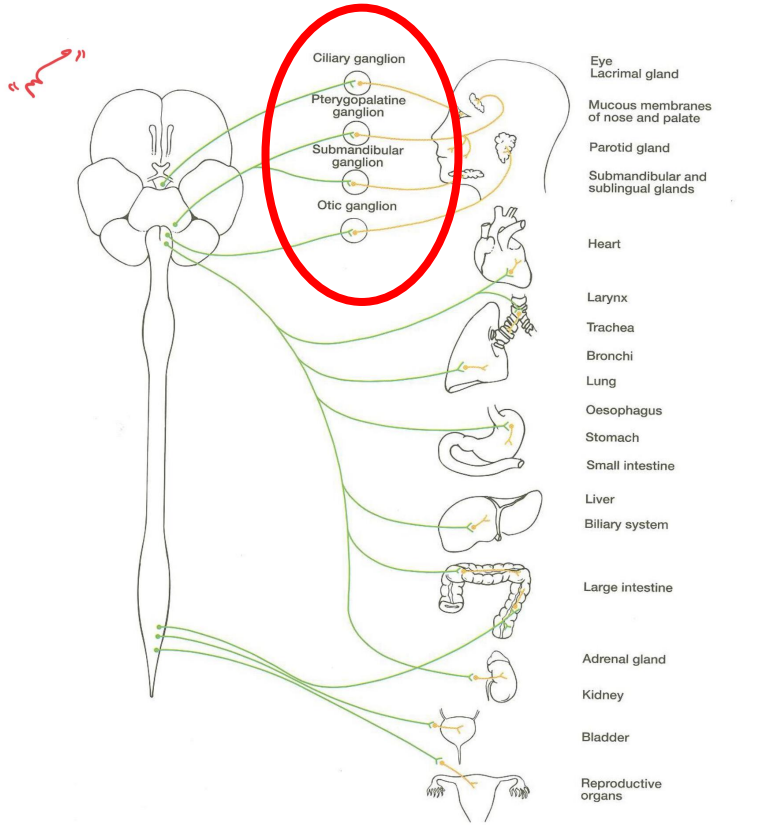
Parasympathetic division

	Cranial outflow	Sacral outflow
Preganglionic neuron	Nuclei of the **3rd, 7th, 9th & 10th** cranial nerves, in the brain stem (Cranial outflow)	The lateral gray horn of **S2-S4** segments of spinal cord (Sacral outflow)
Preganglionic fiber (axon)	Preganglionic axon leave the brain stem **Carried by:** 3rd, 7th, 9th & 10th cranial nerve Terminate in: ⬇	Preganglionic axons leave the spinal cord **carried by:** pelvic splanchnic nerves (girls slide) leave the spinal cord, join corresponding sacral spinal nerves to reach peripheral ganglia in pelvis where they synapse (boys slide) Terminate in: ⬇
Postganglionic neuron	ciliary pterygopalatine, submandibular, otic & peripheral ganglia	peripheral ganglia in pelvis
Postganglionic fiber(axon)	Postganglionic axons **Innervate (supply) organs of the:** head, neck, thorax, and abdomen	Postganglionic axon **Innervate (supply) organs of the:** pelvis and lower abdomen



helpful video https://youtu.be/PiM_pLLrVto

Parasympathetic division



From boys Doctors

You have to memorise:

1- Nerves number

2- Name of ganglia

3- Affecting organ

3rd→ciliary ganglion → **eye**

7th→pterygopalatine ganglion→ **lacrimal gland (الغدة الدمعية) and mucous membrane (nose and palate)**

7th→submandibular ganglia→ **Submandibular and sublingual glands** الغدد التي تحت اللسان

9th→otic ganglion→ **mucous membrane (mouth) and parotid gland (لإنتاج اللعاب)(الغدة النكفية)**

Autonomic Nervous System

Structure	Sympathetic effect	Parasympathetic effect
Iris of the eye(pupils)	**Dilates** pupil	**Constricts** pupil
Ciliary muscle of the eye	**Relaxes**	**Contracts**
Salivary glands	**Reduces** secretion	**Increases** secretion
Lacrimal gland	**Reduces** secretion	**Increases** secretion
Heart	**Increases** rate and force of contraction	**Decreases** rate and force of contraction
Bronchi (الشعب الهوائية)	**Dilates**	**Constricts**
Gastrointestinal tract	**Decreases** motility	**Increases** motility
Sweat glands	**Increases** secretion	———
Erector pili muscles (attached to hair follicles)	**Contracts**	———

Note: Don't memorize the functions! just know that the Sympathetic and Parasympathetic have a counter effect.

Note: the Sweat Gland & Erector pili muscles are only under the sympathetic effect.

MCQs

Question 1: The cell bodies of Preganglionic neuron (Autonomic Nervous System) are located in:

A. Autonomic Ganglia
B. Brain and Spinal Cord
C. Blood Vessels
D. Lower Abdomen

Question 2: The Parasympathetic division is activated during:

A. Exercise
B. Fear
C. Conserving energy
D. Excitement

Question 3: which of the following is not a sympathetic effect:

A. Increase secretion of sweat glands
B. Increase secretion of salivary glands
C. Relaxes of the ciliary muscle of the eye
D. Contracts of the erector pili muscles

Question 4: Autonomic nervous system is regulated by:

A. Hypothalamus
B. Pineal gland
C. Diencephalon
D. Thymus gland

Question 5: Preganglionic fibers from cranial outflow are carried by:

A. 3rd,5th,11th,8th cranial nerves
B. 2nd,4th,7th,9th cranial nerves
C. 3rd,5th,8th,10th cranial nerves
D. 3rd,7th,9th,10th cranial nerves

Question 6: Sympathetic Preganglionic fibers join the sympathetic chain (Autonomic Ganglia) via:

A. Ventral rami
B. White communicants rami
C. Dorsal rami
D. Grey communicants rami

Question 7: preganglionic fibers of the Sacral outflow are carried by:

A. Ciliary ganglion
B. Submandibular ganglion
C. Pelvic splanchnic nerves
D. Peripheral ganglion

Question 8: which of the following is a Parasympathetic effect:

A. Decreased secretion of lacrimal gland
B. Constriction of the ciliary muscle of the eye
C. Dilated iris of the eye
D. Dilated bronchi

Answers: 1.B - 2.C - 3.B - 4.A-5.D-6.B- 7.C-8.B

A special thanks to the 436 anatomy team, who inspired our work.

Good luck to you all

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