



physiology

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Sheet

Slides

Number

10

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Before you start:

Important terminology:

1 – Ganglion: Nerve cell cluster, where neurons are typically linked by synapses. Also, it's the border line between preganglionic and postganglionic and where they synapse.

2 – Preganglionic = presynaptic = first neuron: the neuron which extends from Central nervous system to its synapse with second neuron.

3 – Postganglionic = postsynaptic = second neuron: the neuron that extends from the ganglion to the **effectors (usually organs)**.

4 – Miosis: constriction of the pupil of the eye.

5 – Mydriasis: dilation of the pupil of the eye.

6 – Goose pimpling: contraction of the smooth muscles that are found in the root of the hair which causes hair erection.

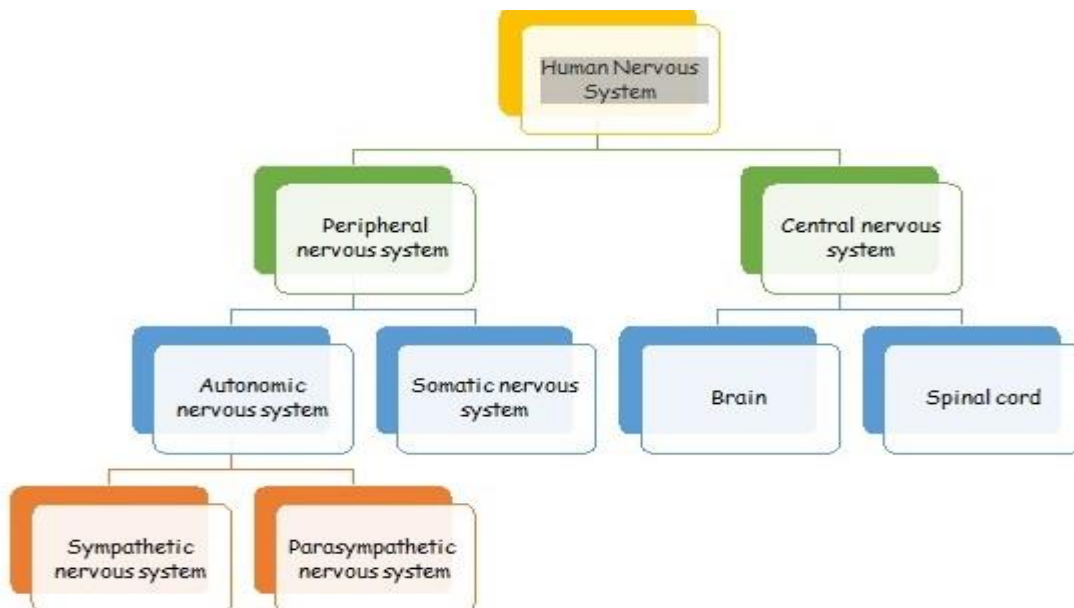
7 – Vasodilation: the widening of blood vessels, which decreases blood pressure.

8 – Vasoconstriction: narrowing of the blood vessels, which increases blood pressure.

9 – Paravertebral ganglion: ganglion that presents near the vertebral column.

10 – Prevertebral ganglion: ganglion that presents apart from the vertebral column near the **effectors (usually organs)**.

Before you start:



Autonomic nervous system (ANS) is what we are interested to deal with in this sheet.

**** NOW WE BEGIN,**

Autonomic nervous system: Portion of the nervous system that controls most of the visceral functions of the body.

***The body tries to adapt and control the changes that happen and affect the homeostasis (either internal or external) most of these changes are controlled by ANS.

EX: changes in light intensity (which is external), stress and sensation of hunger (internal changes)

All of these adaptations (deals with changes) in our body are controlled through the systems by the ANS.

The ANS is composed of two divisions:

1 – sympathetic 2 – parasympathetic

There are different origins for both divisions to provide a huge control for a lot of systems and allow the body to adapt with internal and external changes.

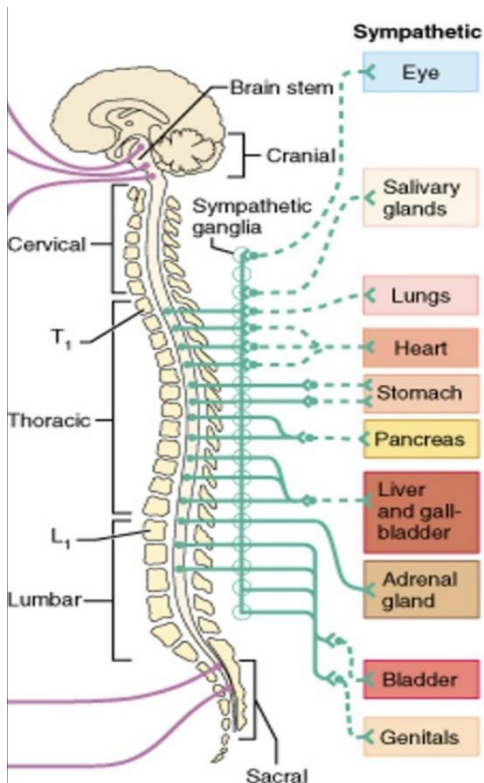
Sympathetic Autonomic Nervous system:

Originates from

1 – the thoracic part of the spinal cord 2 – the lumbar part of the spinal cord

(thoracolumbar)

SANS does the (fight or flight reactions)



Imagine that you are in a forest and you face a bear, so you have two choices: fight or run (flight).

In the previous scenario, the body is going to increase the breathing to supply the muscles (heightening the rate of CO₂ and O₂ exchange). Also speeds up metabolic reactions to generate more nutrients to supply the whole body. (carbs and other energy-rich macromolecules breakdown will increase).

Generally, “fight or flight” reactions are group of reactions that take place in body response to face the terrifying things or for getting stressed (harmful stimulus), in addition they push the body to speed up its metabolic processes, as well as the following reactions:

1 – increasing heart rate and force of contractions; to deliver more blood to cells.

2 – mydriasis, (dilation of pupils).

3 – pallor (pale of fear): paling of the face or the skin; happens as a result of decreasing the amount of blood that goes to the skin.

In “fight and flight” reactions the blood circulation is redistributed (higher amount of blood is directed to muscles and brain, lower amount is directed to skin and unnecessary tissues in the response. (vasodilation for muscles blood vessels and vasoconstriction for unnecessary tissues’ vessels).

4 – goose pimpling: contraction of the smooth muscles that are found in the root of the hair which causes hair erection.

5 – cold sweat (because of the low amount of blood in skin)

6 – dry mouth: inactivation of salivary glands.

** In the SANS all neurons come from the CNS.

So that, the first neuron extends from CNS till its synapse with second neuron in ganglion and the second neuron extends from the ganglion till **the effectors (usually organs)** which it serves.

Ganglia in SANS have two locations:

1 – paravertebral ganglia: present near the vertebral column.

2 – prevertebral ganglia: present apart from the vertebral column near the organs

Prevertebral ganglia have four sites:

a- celiac ganglion (second neuron goes to stomach and pancreas)

b- superior mesenteric ganglion (second neuron goes to ileocecal valve)

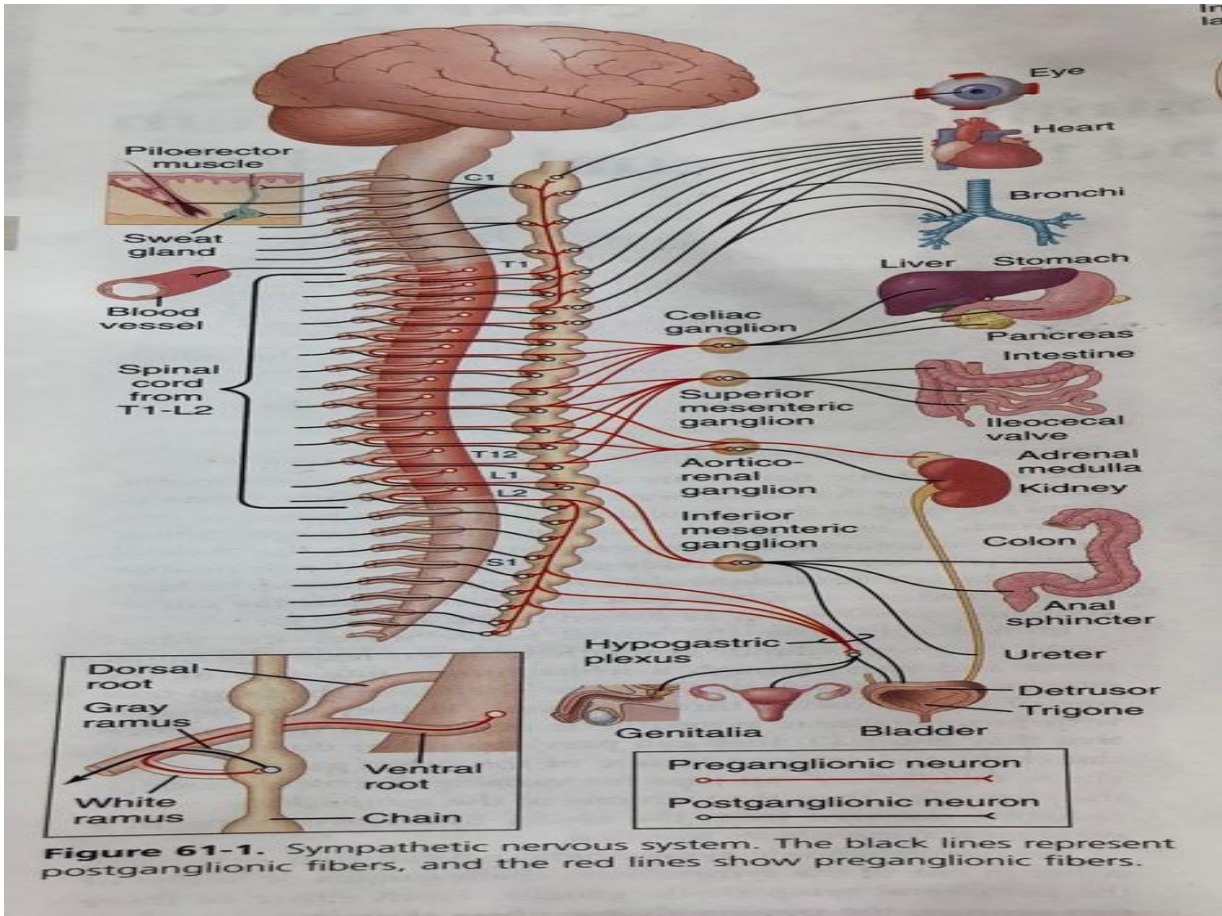
c- aortico-renal ganglion (second neuron to kidney)

d- inferior mesenteric ganglion (to colon, anal sphincter, ureter and detrusor)

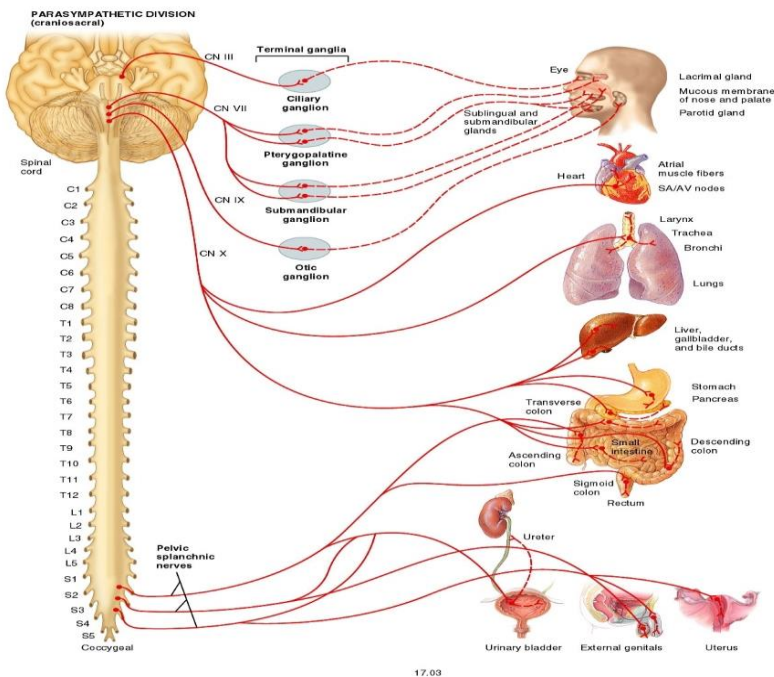
****## we are not supposed to know where the postganglionic fibers go to ##****

** in aortico-renal ganglion first neuron completes to reach adrenal medulla)

Adrenal medulla=adrenal gland=suprarenal gland: mainly secretes **epinephrine (adrenaline)**. And **norepinephrine (noradrenaline)** **one neuron passes to the effector without any synapse**



Parasympathetic autonomic nervous system:



Originates from cranial nerves and the sacral part of the spinal cord, so it's named "craniosacral". Like the SANS, the preganglionic neuron of PANS extends from CNS till its synapse with preganglionic neuron in ganglion, but the preganglionic neuron here is very long so the synapse is usually on the wall of organs. (rest and digest reactions)

ANS anatomical and physiological characteristics:

For both divisions (SANS and PANS) there are two neurons from the cord of each which in turn control the effector structure.

In SANS the axon of the first neuron is short and the one of second neuron is long. Conversely IN PANS the first is long and the second is short.

****Somatic nervous system: portion of nervous system controls voluntary responses.**

Somatic nervous system has one neuron not like ANS. And divides into sensories and motors**

**** In the axon of neurons you could find some fibers belong to SNS and some belong to ANS, (sensory and motor neurons are SNS's)**

Convergence and divergence in sympathetic:

In convergence: the cell body of the postganglionic neuron can receive signals from more than one preganglionic neuron.

In divergence the preganglionic neuron can synapse with more than one postganglionic neuron.

The question is why we want to have one preganglionic synapses with more than one postganglionic, and vice versa?

Because in "fight or flight" reactions the body wants to accelerate the reactions of the targeted effectors, and they give a push to these reactions .

In parasympathetic preganglionic and post ganglionic are 1:1 or maximum

2:1 because each change in PANS is localized and specified to a targeted organ, not like SANS.

EX: when you eat your dinner the stomach activities will increase while the heat activities won't be affected.

**** In our body, some parts have a diffused effect as : (sweat glands and blood vessels)**

Those parts are assisted by the SANS and PANS.

Physiological characteristics for ANS:

1 – Rapid initiations like: (heightening the heart rate)

2 – Tonic activity: Increasing or decreasing generation of action potential

Tonic= generation of action potential.

There are specific tonic activities for SANS and PANS.

3 – automatic nature.

Effects of SANS stimulation:

1 – blood pressure: by widening or narrowing the diameter of blood vessels

2 – body temperature: appears as a result of vasodilation and vasoconstriction.

Dilation—losing temperature—sweating (cold sweat)

Constriction—fixing temperature—no sweating

3 – Cardiovascular system

4 – heart: has two parts:

a – conductive tissue: when SANS is stimulated the velocity of blood movement will increase with the same heart rate

b – cardiac muscle: force of contraction (beats) will increase.

5 – respiratory system: relaxation of smooth muscles in the bronchial (bronchodilation); it's important to facilitate the rate of oxygenation.

6- digestive system: inhibition of motility and secretion.

7 – metabolism: a- mobilization of glucose

b- increased lipolysis c- increased metabolic rate

Effects of PANS stimulation:

Gastrointestinal system: increases motility and secretory activity.

- **Glands**: increases secretory activity (but remember sweat glands are under sympathetic control).

- **Heart**: decrease rate of contraction (bradycardia), by lowering the rate of depolarization (lowering the leakage of Na⁺ inside the conductive tissue membrane)

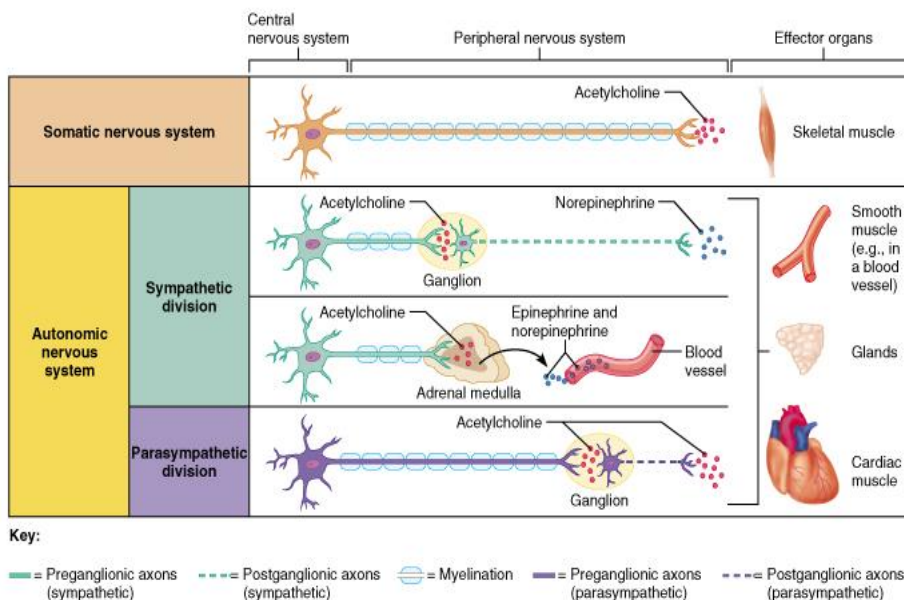
****NOTE: heart rate decreasing: PANS, increasing: SANS.**

- **Pupil**: control pupil diameter by papillary light reflex (miosis) → (regulates the amount of light falling on retina).

- Accommodation of the **lens** for near vision.

- Voiding the **urinary bladder** (micturition).

MOLECULAR BASIS OF PHYSIOLOGICAL ACTIONS OF THE ANS:



Acetylcholine is secreted from preganglionic neurons of both SANS and PANS and the postganglionic neurons of PANS.

Norepinephrine is secreted from postganglionic neurons of SANS.

EXCEPTION: the postganglionic neuron of SANS that goes to sweat glands and some blood vessels secretes acetylcholine .

Receptors and Signal transduction mechanisms:

At ganglia: sympathetic and parasympathetic neurons have **nicotinic** receptors at the post synaptic membrane which receive acetylcholine from preganglionic neuron. These receptors activate sodium channels when activated.

IN ADDITION: They could be activated by nicotine.

on effector cells: Muscarinic receptors: receive acetylcholine released from postganglionic neurons.

Why they are named muscarinic: because they could be stimulated by muscarine.

** muscarine is the toxic molecule that is found in poisonous fungi (mushroom).

(muscarine isn't existed in the body).

So when the muscarine binds to the muscarinic and activates it the following happens:

- Stimulation of secretory activity: salivation, tearing, sweating, nasal and bronchial secretion.
- Increase gastrointestinal tract motility → vomiting and diarrhea.
- Contraction of urinary bladder → urination.
- Slowing of the heart → Bradycardia.

**** Also, the adrenergic receptors receive the norepinephrine that is secreted from the postganglionic neuron which extends from the SANS .**

**NOTE: the fibers (neurons) that secrete norepinephrine are called adrenergic, and the ones that secrete acetylcholine are named cholinergic.