Overview of Autonomic Nervous System

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The autonomic nervous system includes two types of fibers

- **Afferent fibers:**

  which carry sensations from viscera to the C.N.S.

  This system is widely distributed

- **Efferent fibers**

  which emerges from the C.N.S. to reach visceral

  organs and the smooth muscle

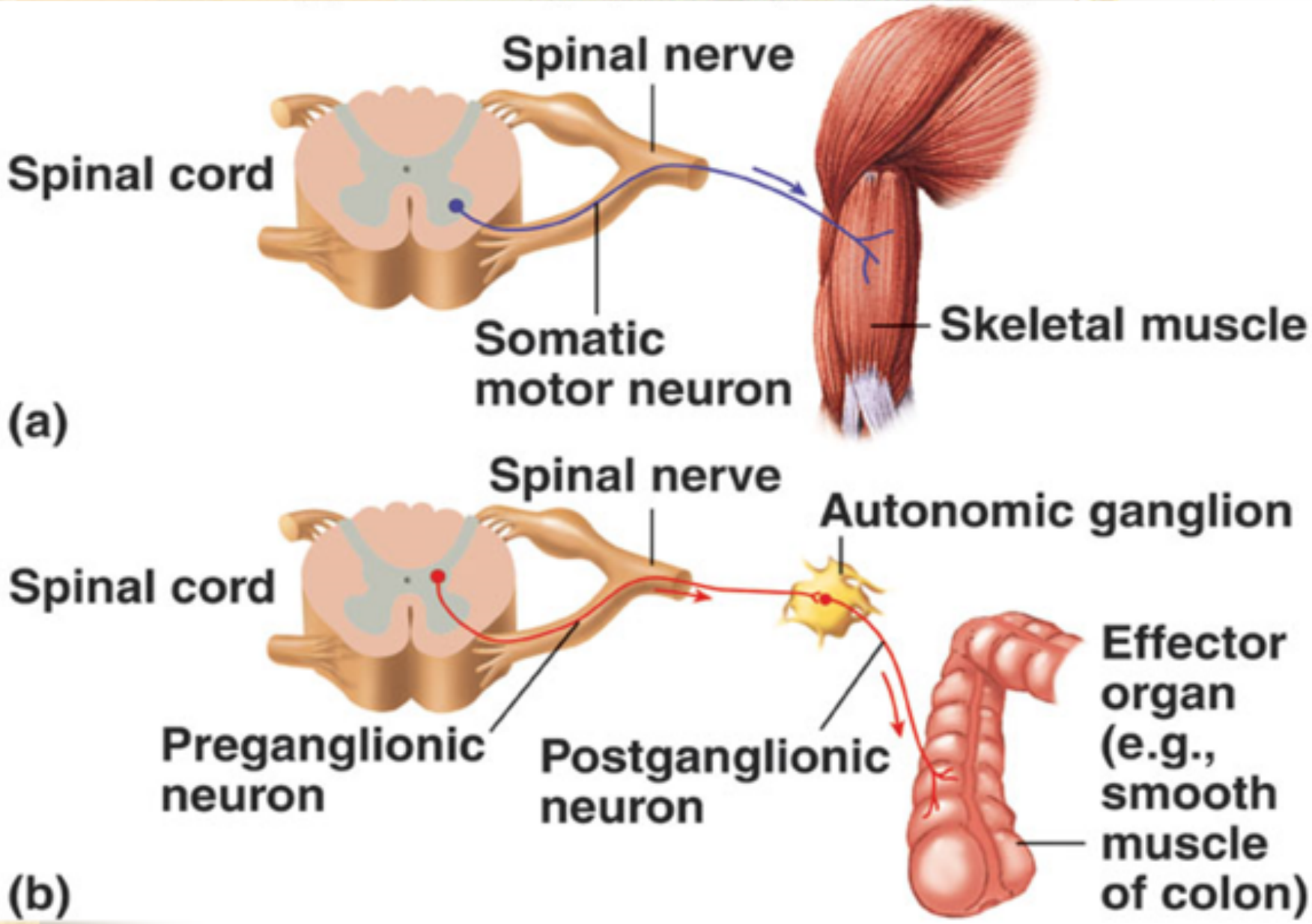
The efferent autonomic nervous system

- The A.N.S reaches its target organs via the autonomic nerve.

- Each autonomic nerve is an efferent axon of two nerve cells.

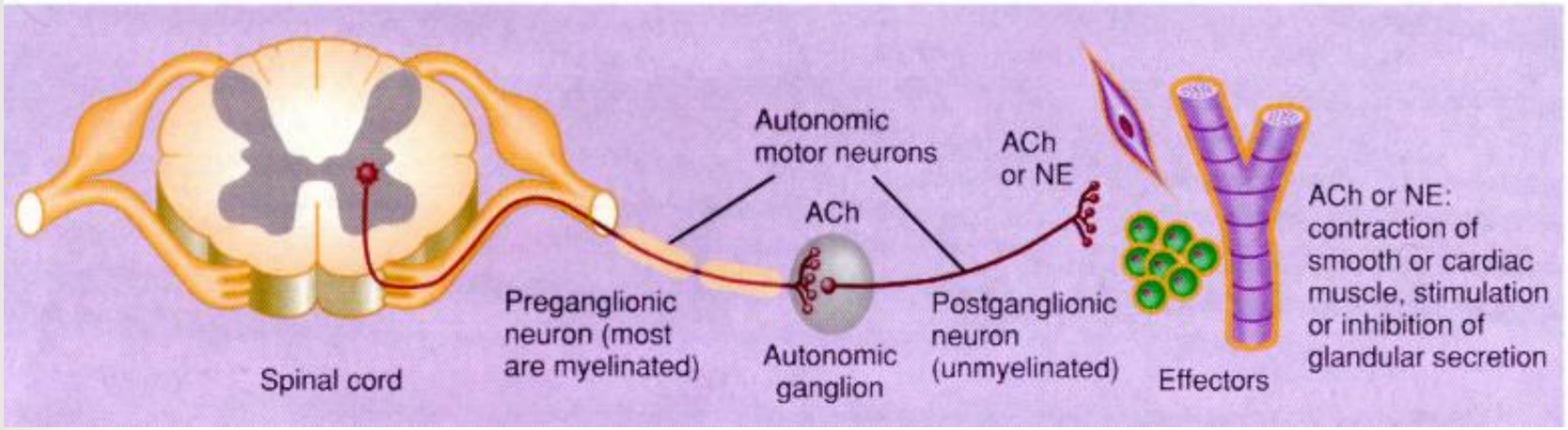
The first one lies inside either the brain or the spinal cord (C.N.S) and its axon is called the pre-ganglionic fiber.

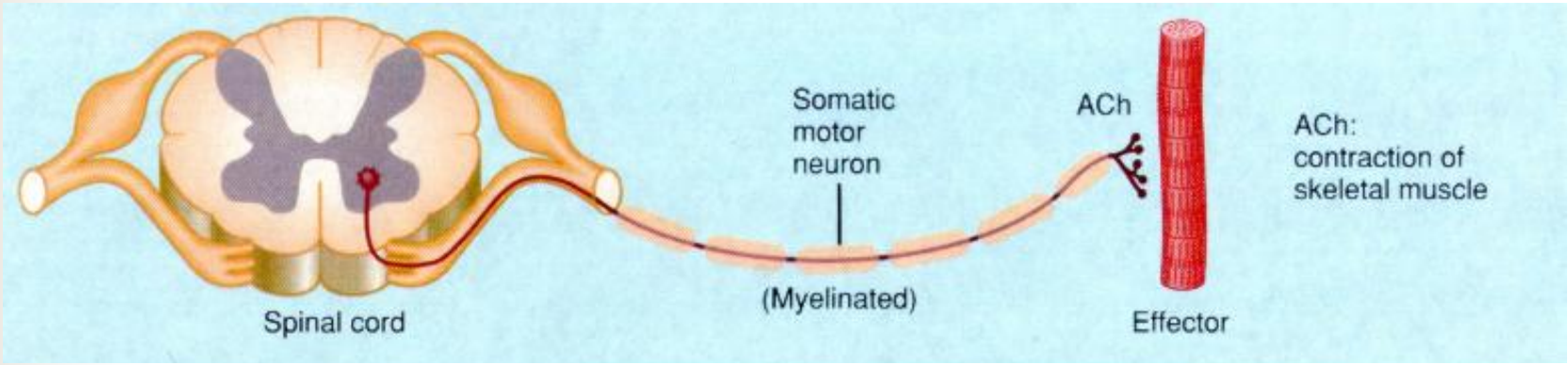
The second cell lies outside C.N.S (in what is called the autonomic ganglia) and its axon which reaches the organ is called the post-ganglionic fiber.


Spinal nerve
Spinal cord
Somatic
motor neuron
Skeletal muscle
(a)
Spinal nerve
Autonomic ganglion
Spinal cord
Preganglionic
neuron
Postganglionic
neuron
Effector
organ
(e.g.,
smooth
muscle
of colon)
(b)

Somatic nerve

- - Unlike the autonomic nerve, the **somatic nerve** which moves the voluntary or skeletal muscles is a group of axons of many neurons in the C.N.S that lie in the **anterior horn.**
- reach the muscle **directly** without passing through any ganglia.
- somatic nerve always carries an **excitatory** impulses to the skeletal muscles.
- while the autonomic nerve may carry excitatory or inhibitory impulses.


Autonomic motor neurons
ACh
ACh or NE
Preganglionic neuron (most are myelinated)
Autonomic ganglion
Postganglionic neuron (unmyelinated)
Spinal cord
Effectors
ACh or NE: contraction of smooth or cardiac muscle, stimulation or inhibition of glandular secretion


Somatic motor neuron
ACh
(Myelinated)
Spinal cord
Effector
ACh: contraction of skeletal muscle

Autonomic ganglia

- **Definition**

A ganglion is a collection of nerve cells outside the C.N.S surrounded by connective tissue capsule. It contains the nerve fiber of the pre-ganglionic neurons and cells of the post-ganglionic neurons

Types of autonomic ganglia

- **Lateral (Paravertebral)**

form the sympathetic chains lying on both sides of the vertebral column

Lateral ganglia are only sympathetic.

- **Collateral (Prevertebral) :**

Some of them are sympathetic and others are parasympathetic.

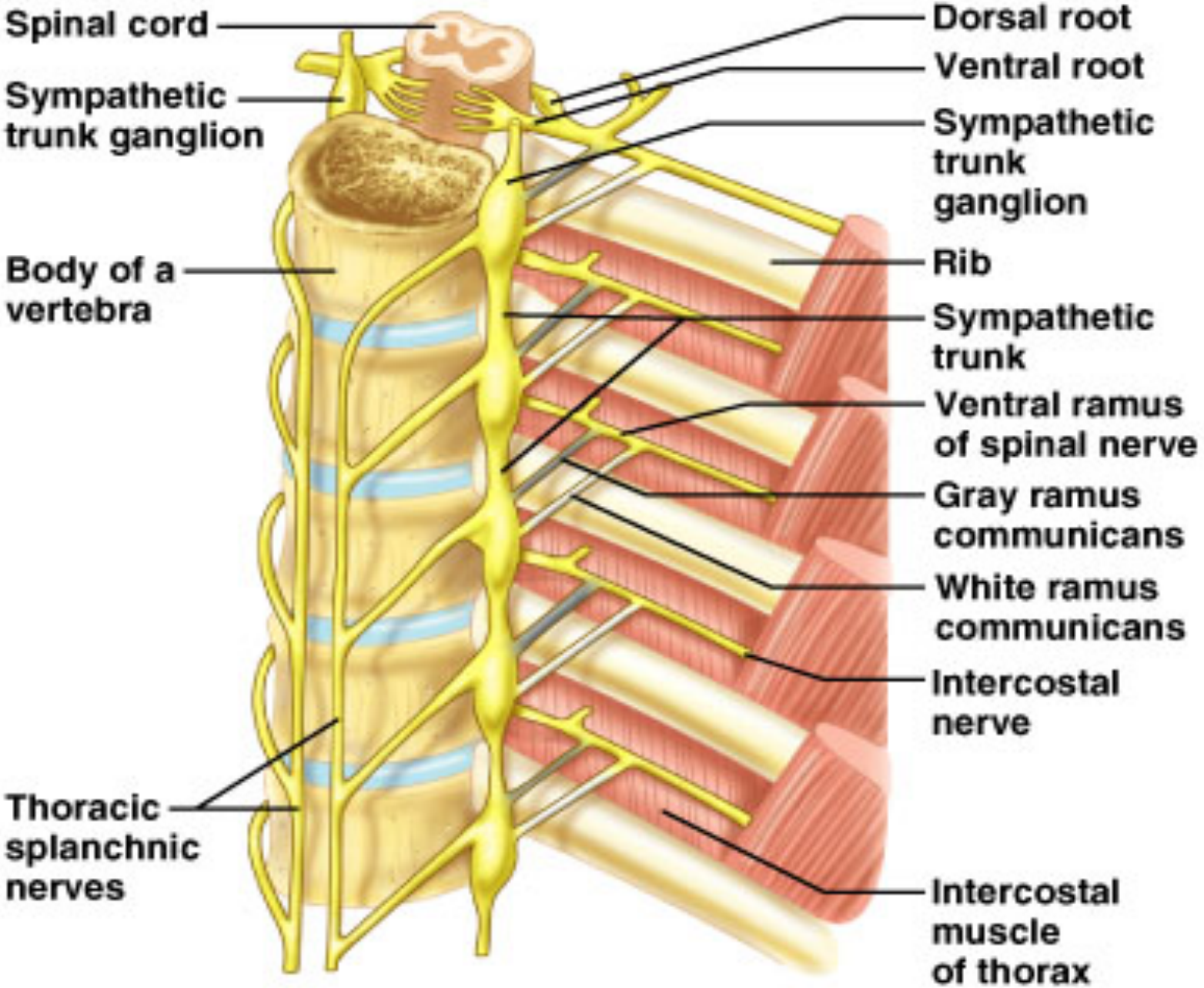
They are related to blood vessels.

- **Terminal (Peripheral)**

They are present near or in the wall of the autonomic organ.

e.g., the urinary bladder

Terminal ganglia are only parasympathetic


Spinal cord
Sympathetic trunk ganglion
Body of a vertebra
Thoracic splanchnic nerves
Dorsal root
Ventral root
Sympathetic trunk ganglion
Rib
Sympathetic trunk
Ventral ramus of spinal nerve
Gray ramus communicans
White ramus communicans
Intercostal nerve
Intercostal muscle of thorax

Divisions of autonomic N.S.

- **Sympathetic nervous system**

  Arising from the lateral horn cells of all the thoracic segments and the upper two lumbar segments. So it is called the thoraco-lumbar outflow

- **Parasympathetic nervous system**

  Arising from 2 distant parts

  (a) From some cranial nervous, i.e. III.VII.IX&X.

  (b) From the lateral horn cells of the 2nd , 3rd and 4th sacral segments of the spinal cord. So, it is called the cranio-sacral outflow.

Functions of sympathetic nervous system

[A] Cervical division

1-Eye:

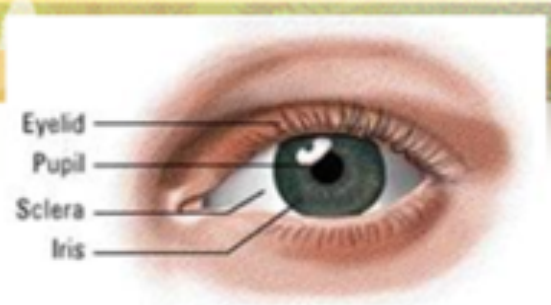
-Motor to dilator pupillae muscle → mydriasis (dilatation of the pupil)

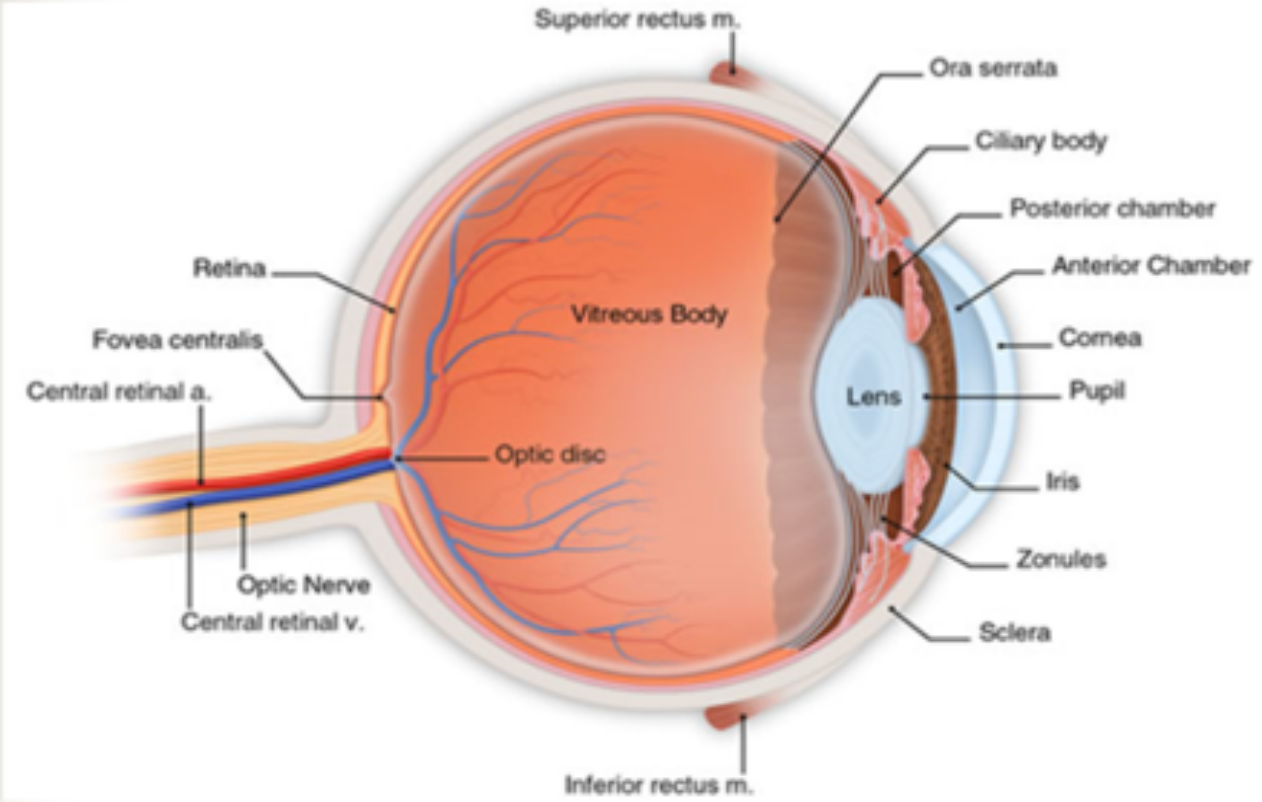
-Motor to the superior and inferior tarsal muscles → widening of the palpebral fissure. Thus widening the field of vision.

-Motor to Muller's muscle (in animals) → exophthalmos (forward protrusion of the eye ball)

-Relaxation of the ciliary muscle, decreasing the power of the lens to prepare the eye for far vision.

1-Eye:


Eyelid
Pupil
Sclera
Iris


Superior rectus m.
Ora serrata
Ciliary body
Posterior chamber
Anterior Chamber
Cornea
Pupil
Iris
Zonules
Sclera
Inferior rectus m.
Retina
Fovea centralis
Central retinal a.
Optic disc
Optic Nerve
Central retinal v.
Vitreous Body
Lens

2-Glands:

- -Lacrimal glands : little secretion of tears and vasoconstriction.

- -Salivary glands: **trophic** secretion (small in amount, viscid and concentrated) from the submaxillary gland.

3-Skin

- -Sweat glands : copious secretion eccrine glands
- -Erector pilae muscles→ erection of hair .
- -Bloods vessels vasoconstriction.

4-Cerebral vessels:

- -Mild vasoconstriction. Still during sympathetic excitement, cerebral blood flow increase due to the rise in arterial blood pressure.

[B] Cardiopulmonary (thoracic) division

1-The heart

a- They stimulate all the properties of the cardiac muscle (contractility, rhythmicity, conductivity and excitability) and increase its metabolism & O_2 consumption .

b- Coronary vessels: Direct effect is vasoconstriction, but coronary vessels dilate due to increased metabolism of the heart that decrease O2 concentration (indirect effect). The metabolites itself cause direct dilatation

2-The Lung

- **a-Bronchi**

  Bronchodilation and inhibition of bronchial secretions.

- **b- Pulmonary vessels**

  vasoconstriction (VC)

  This widens the air passages lead to better ventilation

[C] Splanchnic division to abdominal and pelvic viscera

1-Gastrointestinal tract (GIT):

relaxation of the wall, but constriction of the sphincters. Leading to delayed evacuation of food.

2-GIT secretions : inhibition

3-The splanchinic vessels

- vasoconstrictor and vasodilator the effect is mainly vasoconstriction)

4-The spleen

- motor to smooth muscle fibers of the capsule and trabeculae → 250 mL of stored blood is poured into the circulation. This action is more prominent in animals

5-The liver

- to stimulate metabolism ,glycogenolysis with increase blood glucose level , lipolysis with elevation of the blood lipid level and dilatation to its vessels.

6-The endocrine pancreas

- usually inhibition of insulin secretion.

7- The Kidney

- Vasoconstriction of renal blood vessels, decreased renal blood flow, decreased urinary output and stimulation of renin secretion.

The adrenal medulla

- preganglionic cholinergic fibers
- secretion of catecholamines, adrenaline (80%) and noradrenaline (20%) hormones
- The released adrenaline stimulates lipolysis, thermogenesis and enhances blood clotting by releasing blood clotting factors from the liver. It stimulates the reticular formation of the brainstem → increased alertness with lack of sleep (insomnia)
- **Modified sympathetic ganglia**

{D}Pelvic division

1-The urinary bladder

inhibitory to the wall & motor to the internal urethral sphincter → retention of urine

2- The rectum

inhibitory to the wall & motor to the internal anal sphincter → retention of feaces

Fibers going to the skeletal muscles supply:

- **1-Blood vessels of skeletal muscles causing vasodilatation**
- **2-This vasodilatation increases the blood flow and stimulates metabolic processes needed for energy production leading to increase power of contraction, delay of fatigue and early recovery after exhaustion**
- **This effect is known as "Orbelli phenomenon"**

Functions of parasympathetic nervous system

- **Oculomotor nerve** (III)

a) Contraction of the constrictor pupillae

→ narrowing of the pupil. (miosis).

b) Contraction of the ciliary muscle:

→ relaxation of suspensory ligaments, causing increased power of the lens which is very useful in near vision accommodation.

The parasympathetic fibers to the lacrimal, nasal and salivary glands are secretomotor and vasodilator

So, nerve supply to salivary glands arise from facial nerve (to submaxillary and sublingual glands) and from glosso-pharyngeal nerve (to parotid gland).

These fibers supply the salivary glands and produce True secretion (Large in volume, less in enzymes and watery) also produce vasodilatation.

The vagus nerve (X)

1-Inhibition of all properties of atrial cardiac muscle.

2- Decrease of the coronary blood flow and O2 consumption of the heart (indirect v.c in coronary to increased O2 conc.).

- **Constriction** of the bronchi and bronchioles **(Bronchoconstriction)**
- **Increased secretion** from bronchial glands.
- **VD** of pulmonary blood vessel. This leads to **narrowing of air passages**.

- **Motor** to **GIT wall** (contraction).

oesophagus, stomach, small intestine and proximal part of large intestine.

but inhibitory (↓) to sphincters

- (↑) Secretory to **digestive glands** of stomach, pancreas and liver enhancing (↑) **insulin** hormone release.
- **Motor (↑)to gall bladder and inhibitory to sphincter of Oddi .**

- **Vasodilatation** to the **splanchnic** vessels.

Parasympathetic sacral outflow

- The **sacral** parasympathetic fibers supply :
- The rest of the digestive tract that is **the descending colon, the rectum the anal canal.**
- The urinary bladder
- the **blood vessels** of the external genitals.

This Sacral flow have the following functions:-

- **Defecation**

  contraction of the wall of the rectum and relaxation of internal rectal sphincter.

- **Micturition**

  contraction of the wall of the bladder and relaxation of the internal uretheral sphincter.

- **Erection**

  vasodilatation of the blood vessels of the erectile tissue of the penis in the male and clitoris in the female.


Thanks