

Autonomic Nervous System

Over view

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The Sympathetic division

it also named the **thoraco-lumbar outflow**

The Parasympathetic division

It is also named the **Cranio-sacral outflow**



distributions of the sympathetic system

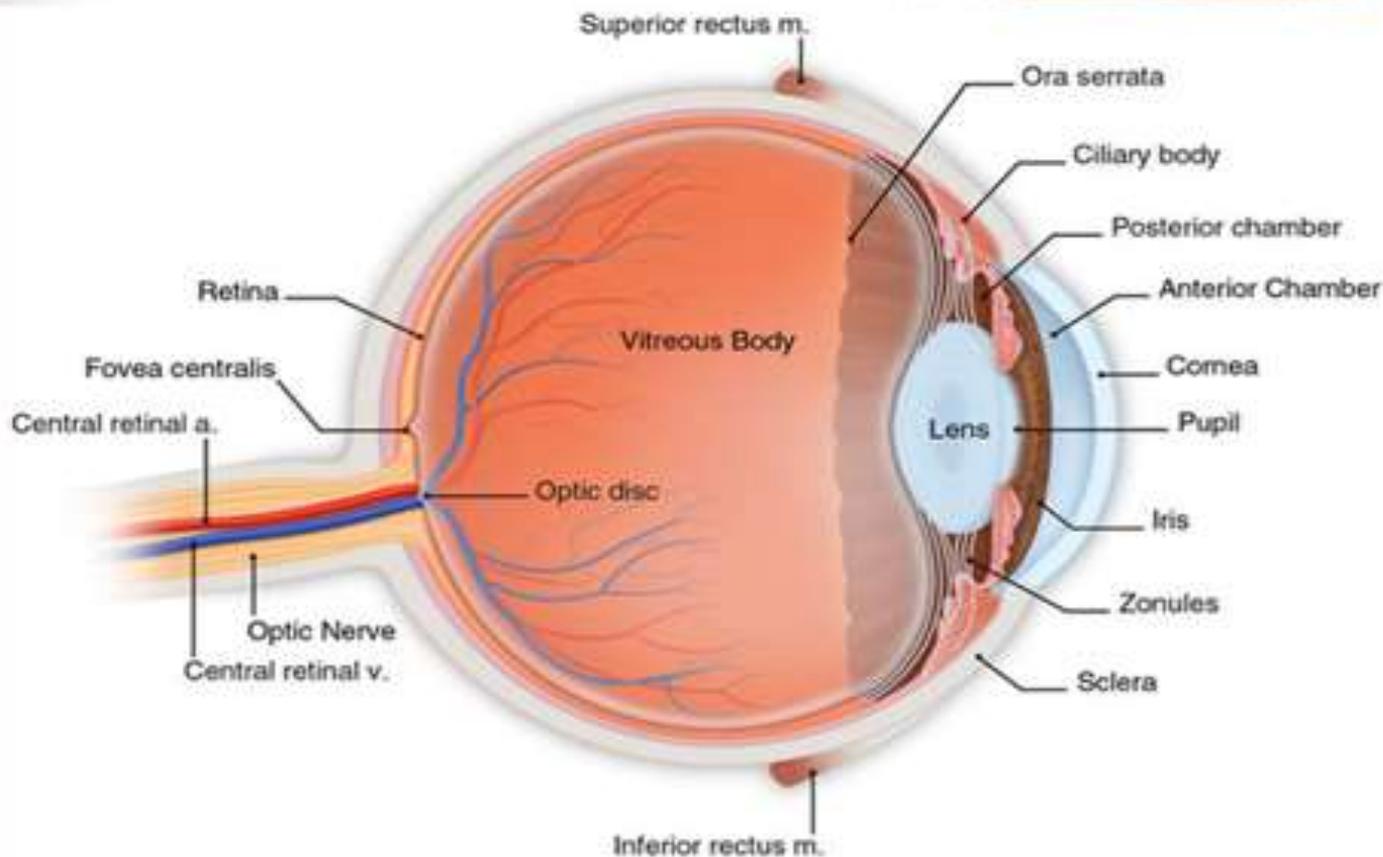
■ [A] Cervical division

which supplies structures in the head and neck

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:





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

Supply thoracic structures

1-The heart

a- They stimulate all the properties of **the cardiac muscle** (contractility, rhythmicity, conductivity and excitability) and increase its metabolism & O₂ 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

Supply abdominal and pelvic viscera

■ Abdominal division

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 splanchnic 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.



8- The adrenal medulla

- **secretion of catecholamine , 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)**



- **Pelvic division**

- **The urinary bladder**

inhibitory to the wall

motor to the internal urethral sphincter → retention of urine

- **The rectum**

inhibitory to the wall

motor the internal anal sphincter

→ retention of feaces

Desire of micturition and defecation disappear



- **The sex organs**

In female

It is mainly **inhibitory** on uterus and fallopian tubes, **but** late in pregnancy it is excitatory to the uterus

In male

It is mainly **excitatory** on the smooth muscles of epididymis, vas deferens, seminal vesicles and prostate motor fibers with emission of semen during sexual intercourse leading to **ejaculation.**



[D] Somatic division

- supply skin and blood vessels of skeletal muscles

Fibers going to the skin supply

- **Sweat glands**

Eccrine copious secretion. i.e. found in skin all over the body

Apocrine thick odoriferous secretion. i.e. found in axilla and genital areas

- **Cutaneous blood vessels**

vasoconstriction

- **Erector pilea muscles**

Contraction

→ piloerection, i.e. hair erection. This is more prominent in animals like cats during fighting or cold weather.



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”**



General function of sympathetic N.S

■ I-During rest

It causes **sympathetic tone** on the **blood vessels** leading to continuous mild **vasoconstriction** to maintain the blood pressure.

Sympathetic tone to the Adrenal medulla

Maintains basal amount of **catecholamine** secretion in blood.
& this is important for regulation of blood pressure & blood glucose level.



II-In emergency conditions (The alarm or Stress response)

In cases of fight, flight, muscular excitement occurs to help the person to face the emergency with a better performance.

- Acceleration of the heart: to supply blood to active tissues.
- Vasoconstriction in inactive regions, skin and splanchnic area to divert more blood to active regions e.g. muscles, heart
- Dilatation of bronchi; facilitating pulmonary ventilation.
- Contraction of spleen: to give more RBCs to carry more oxygen to the active tissues



II-In emergency conditions (The alarm or Stress response)

- **Sweat secretion:** to get rid of the excess heat by evaporation
- **Delay muscle fatigue (Orbelli phenomenon)**
- **Glycogenolysis:** supplying glucose to the active tissues for energy production .Also, lipolysis.
- **Adrenal medulla is stimulated to secrete adrenaline and noradrenaline to aid and intensify all the above reaction. Adrenaline stimulates the brain to increase alertness and shorten response time.**
- **Increase field of vision**



II-In emergency conditions (The alarm or Stress response)

- Clotting of the blood is enhanced for more effective haemostasis
- Inhibition of gastrointestinal activities, defecation and micturition.
- All these factors lead to shift of blood from inactive areas as the skin and the gastrointestinal tract to active contracting muscles and heart to enable the body to face emergencies.

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- Parasympathetic is divided into two main types

Parasympathetic cranial outflow

- Parasympathetic fibers are found in the cranial nerves III «oculomotor», VII «facial», IX «glossopharyngeal» and X «vagus»

Parasympathetic Sacral outflow

- Parasympathetic fibers arise from LHCs of sacral 2,3 & 4 segments of the spinal cord.

Oculomotor nerve (III) (The eye)

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 in the facial nerve (VII)

- Supply the lacrimal, nasal and submaxillary salivary glands.
- The fibers which supply the salivary glands produce **True secretion** (Large in volume, less in enzymes and watery) also produce **vasodilatation**.

The glosso-pharyngeal (IX)

- Supply the parotid salivary gland

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 from **glosso-pharyngeal nerve** (to parotid gland).

-The vagus nerve (X)

The vagus nerve have the following functions

- 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.

The 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 urethral sphincter.

■ Erection

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



Parasympathetic tone

a) Vagal tone to the heart

- Decreases the rhythm of the SAN from **110** to only **70** beats / minute.
- This greatly spares excess energy & effort in the heart.

*b) Vagal tone to the **gastrointestinal tract***

- Prevents GIT distention and maintain basal amount of secretion.
- This is very important to complete the digestive process.

*c) Vagal tone to the **bronchi***

- Maintains constant distribution of air during ventilation.
- Protects the bronchial wall during cough.



***N.B.** Many structures are supplied by **one system only**:*

- ***Sympathetic***: Skin, Suprarenal medulla, Sweat glands, Skeletal muscle blood vessels, Spleen, ventricles, **dilator** pupillae muscle.
- ***Parasympathetic***: constrictor pupillae muscle.



Thanks

