

Autonomic Nervous System

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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 nerves**, 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.**



The functions of the A.N.S

- **Prepare the body to face emergencies (stresses).**
- **Regulate the process of food digestion**
- **Regulation of the body temperature.**
- **Regulation of heart rate, blood pressure.**
- **Control some hormonal secretion as catecholamines.**
- **Regulation of vital excretory processes as micturition & defecation.**



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**



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 fibre 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

Each chain is formed of **23 ganglia** connected to each other by nerve fibers
i.e. **3 cervical (superior, middle and inferior)**, **12 thoracic**, **4 lumbar**
and **4 sacral ganglia**.

Sometimes, the inferior cervical ganglia fuses with the upper
thoracic one to form the "**stellate ganglion**"

Lateral ganglia are only **sympathetic**.



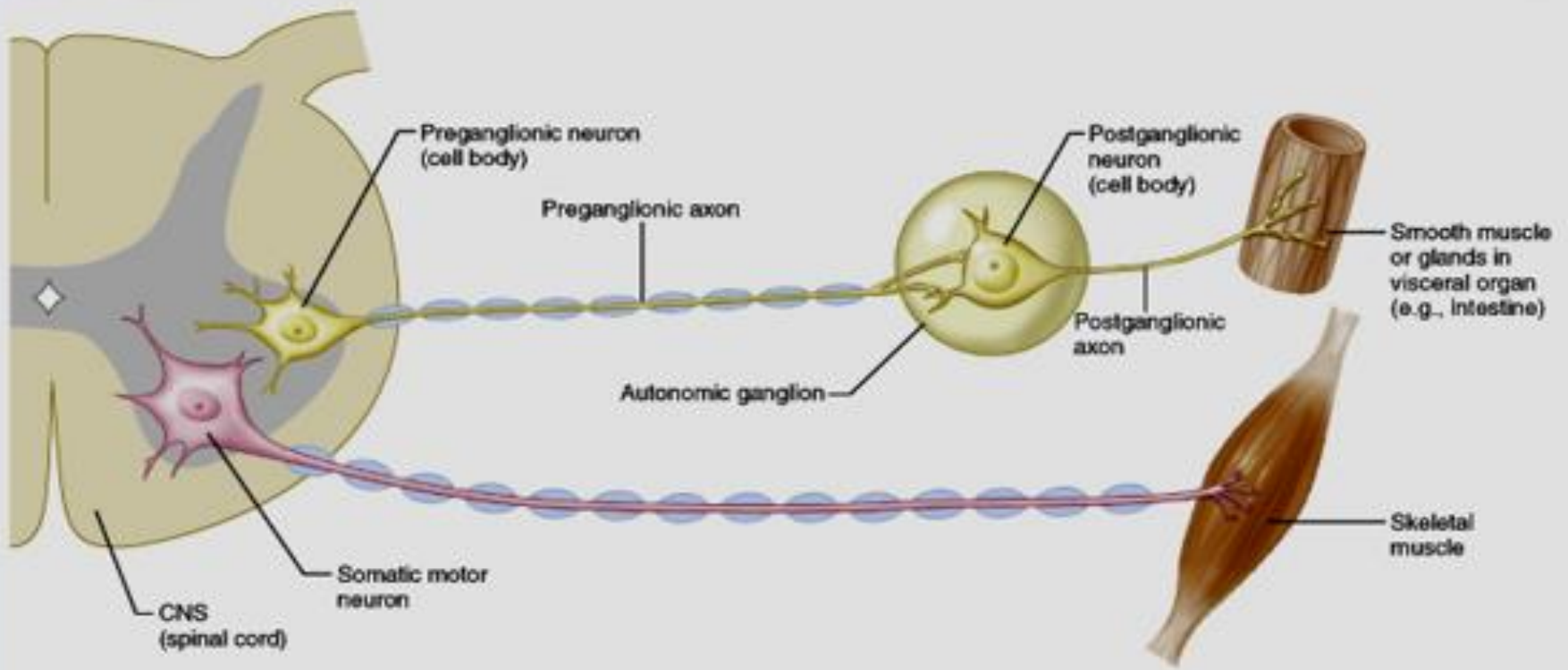
Collateral (Prevertebral)

- These are the celiac, the renal, the superior and inferior mesenteric ganglia (**sympathetic**) and otic, ciliary, sphenopalatine and submandibulare ganglia (**parasympathetic**).



Terminal (Peripheral)

- They are present **near or in the wall** of the autonomic organ, e.g. the eye, the heart, the stomach and the urinary bladder.
- Terminal ganglia are only **parasympathetic**



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**distributions of the
sympathetic system**



distributions of the sympathetic system

- **[A] Cervical division**

which supplies structures in the head and neck

Preganglionic fibers

arise from the upper 2 thoracic segments and relay in the superior cervical sympathetic ganglion.

Postganglionic fibers

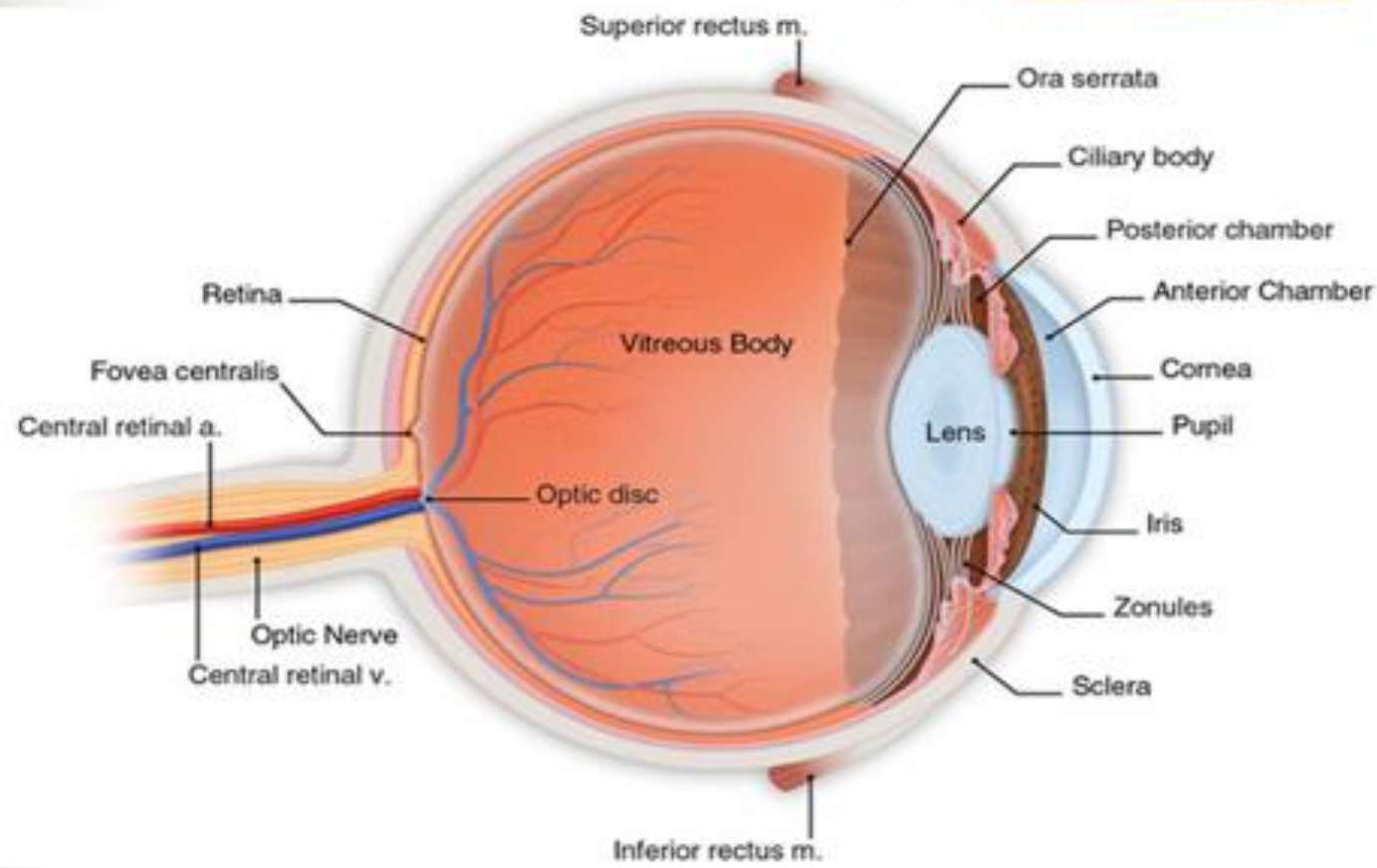
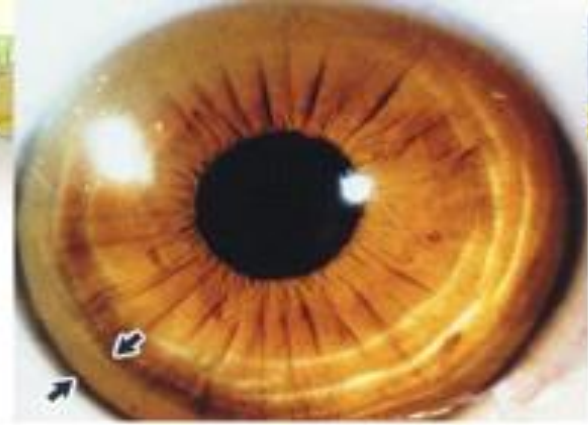
follow the course of carotid arteries to:



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.

Horner's Syndrome

- This occurs due to damage of the superior cervical sympathetic ganglion either experimentally or by disease. This leads to
- **1-Ptosis**
drop of upper eye lid, due to paralysis of superior tarsal muscle.
- **2-Miosis**
pupillo-constriction, due to paralysis of the dilator pupillae muscle. The constrictor pupillae muscle acts unantagonized





■ **3-Enophthalmos**

inward sinking of the eyeball in the orbit due to paralysis of Muller's muscle (in animals).

■ **4-Anhydrosis**

dryness of the skin due to absence of sweat secretion on the affected side

■ **5-Vasodilatation**

in the affected side, so appearing more red than the normal side. This is due to the absence of the sympathetic vasoconstrictor tone to the skin vessels.



[B] Cardiopulmonary (thoracic) division

to thoracic structures

- **Preganglionic fibers**

arise from the upper 4 thoracic segments. They relay in the cervical and upper 4 thoracic ganglia

- **Postganglionic fiber**

form the superficial and deep cardiopulmonary plexuses which supply:



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

to abdominal and pelvic viscera

■ Abdominal division

■ Preganglionic fibers:

arise from the **lower 8 thoracic segments** and pass without relay in sympathetic chain to form

The **greater splanchnic nerves**

relay in celiac, renal and superior mesenteric ganglia

■ The postganglionic fibers supply

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.



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**



- Pelvic division

- **The preganglionic fibers**

fibers arise from upper 2 lumbar segments and pass without relay to form

lesser splanchnic nerves

The lesser splanchnic nerves on both sides unit to form the **presacral nerve** which **relay** in the **inferior mesenteric ganglion**.

- **The postganglionic fibers supply**

- **The urinary bladder**

inhibitory to the wall motor 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

- sympathetic supply to skin and blood vessels of skeletal muscles
- **-To the upper limbs**

Preganglionic fibers arise from **the 4th to 8th thoracic segments**, relay in the lower cervical and upper 4 thoracic ganglia. Postganglionic fibers join the brachial plexus.

- **-To the lower limbs**

Preganglionic fibers arise from **10th thoracic to 2nd lumbar** segment, relay in the lumbar and sacral ganglia. Postganglionic fibers join the lumbar plexus



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**

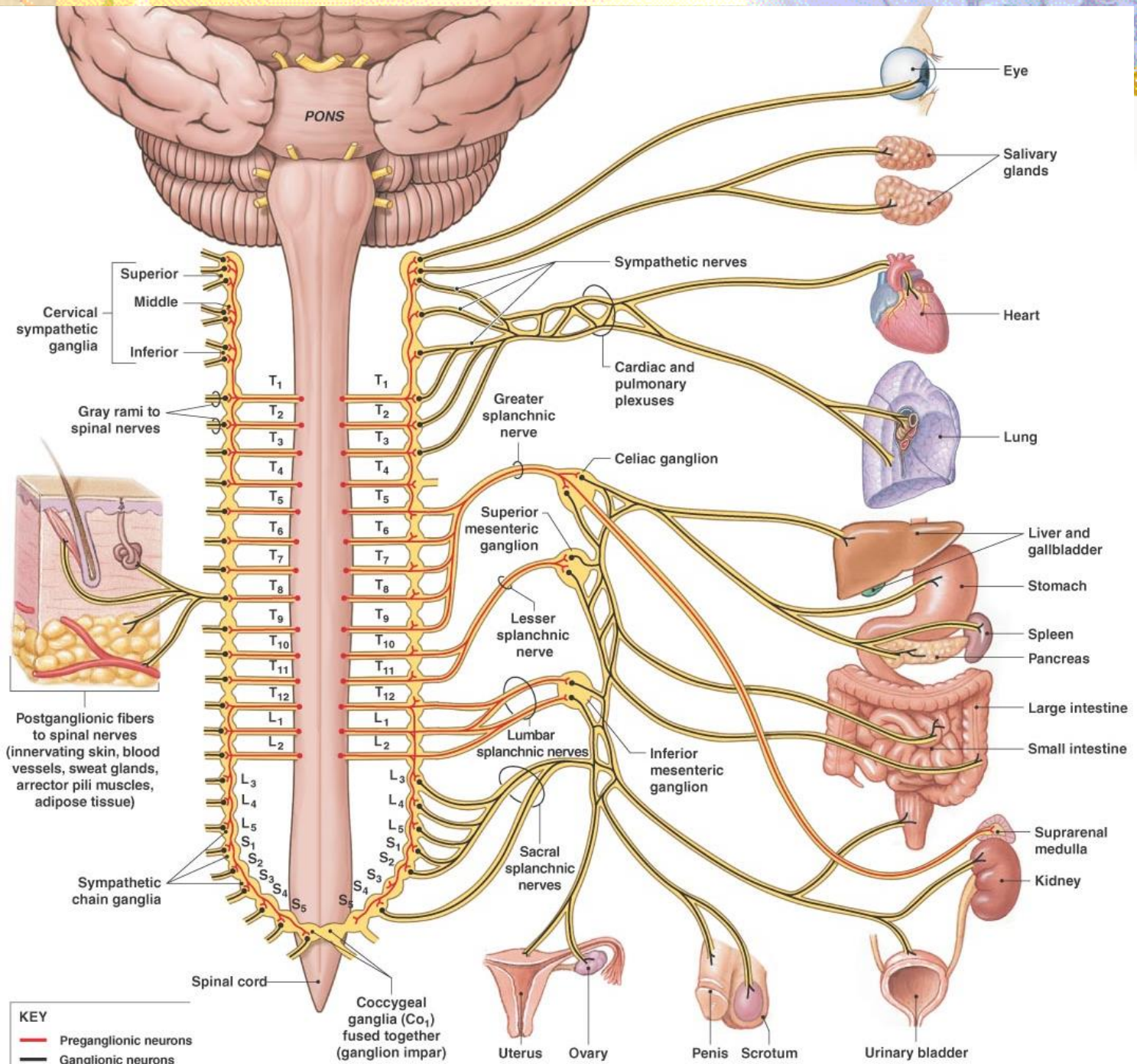
Contraction

→ 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 and brain.
- 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.

Thanks

