

Autonomic Nervous System

By

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Divisions of autonomic N.S. ^{→ involuntary}

➤ Sympathetic nervous system → generalized effect

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 → localized effect

Arising from 2 distant parts

(a) From some **cranial nerves**, i.e. ³ III. ⁷ VII. ⁹ IX & ¹⁰ X

(b) From the **lateral horn cells** of the 2nd, 3rd and 4th ^S 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). *symp*
- Regulate the process of food digestion. *para*
- Regulation of the body temperature. *symp*
- Regulation of heart rate, blood pressure. *symp*
- Control some hormonal secretion as catecholamines. *symp*
- Regulation of vital excretory processes as micturition & *para* 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

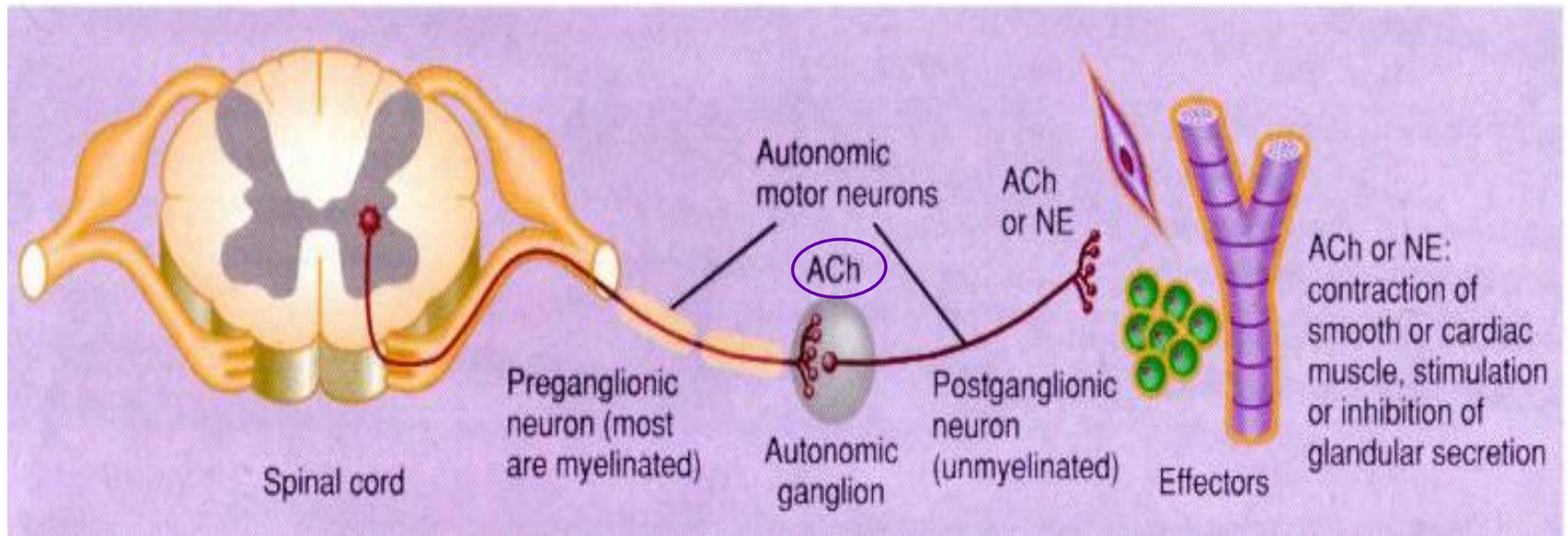
↳ no classification

■ Efferent fibers

which emerges from the C.N.S. to reach visceral organs and the smooth muscle

- Autonomic N.S. has ^{order}2 **Efferent** ^{involuntary} neurons:

	Pre-ganglionic fiber	Post-ganglionic fiber
Cell body	In spinal cord or brain stem. (CNS)	In autonomic ganglia. <i>relay station</i>
Axon	From CNS to ganglia.	From ganglia to organs.
Type	B & Myelinated & White (BMW)	C & Unmyelinated & Gray



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

→ relay and amplifying of response

■ 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]**

8 Collateral (Prevertebral)

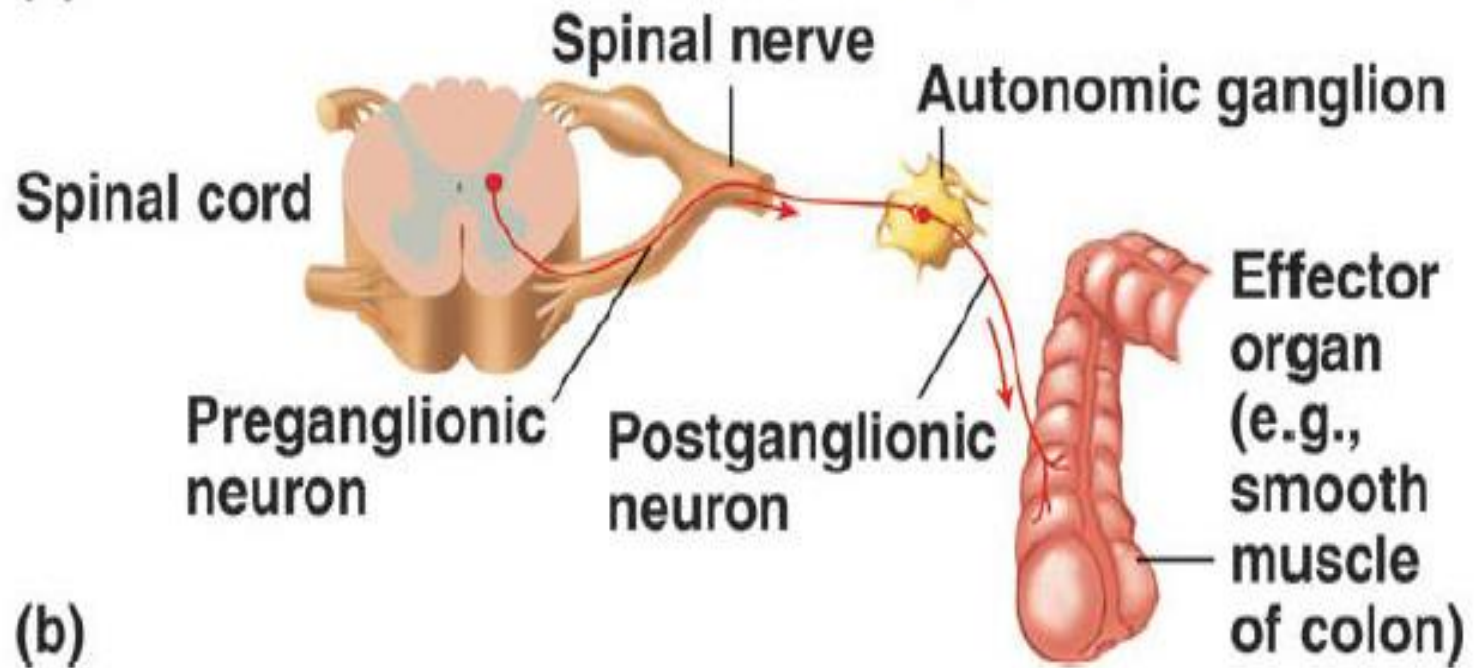
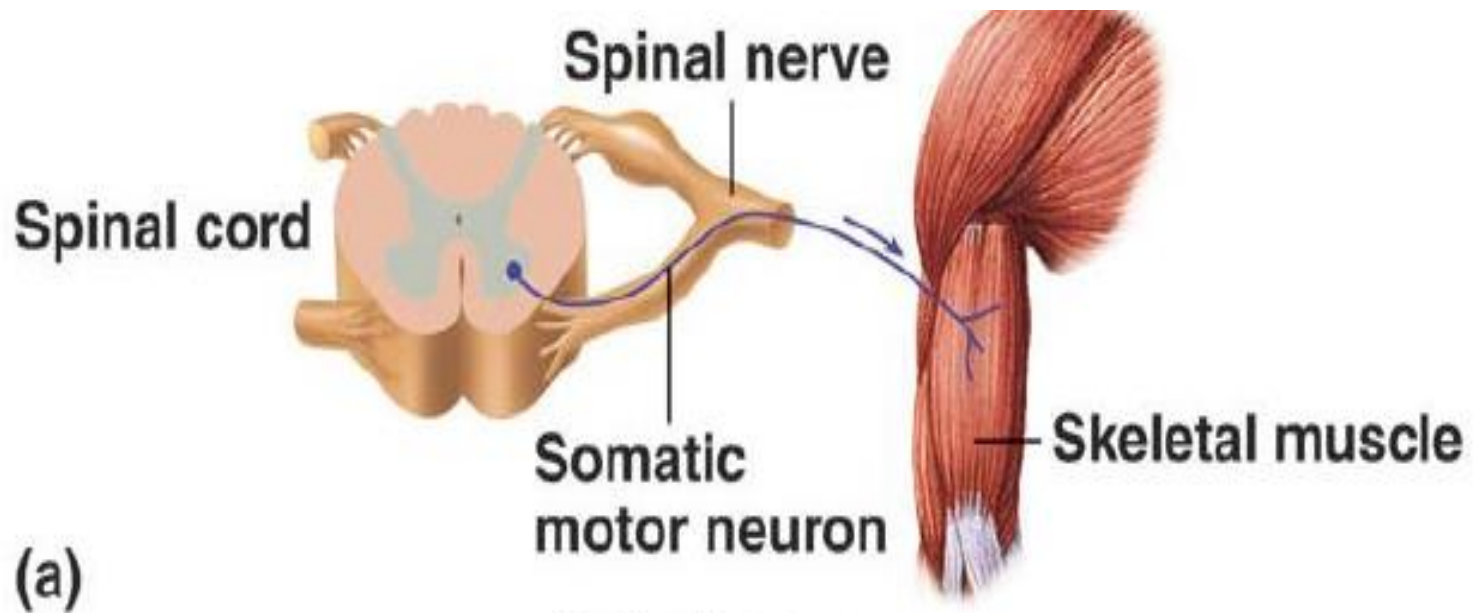
- These are the celiac, the renal, the superior and inferior mesenteric ganglia (**sympathetic**) and otic, ciliary, sphenopalatine and submandibular ganglia (**parasympathetic**).

Terminal (Peripheral) *mural*

- 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**]

Difference between autonomic & somatic nerves

	Somatic nerves	Autonomic nerves
Function	Control <u>voluntary</u> or skeletal muscles.	Control <u>involuntary</u> organs.
Cell body	<u>1 neuron</u> : present in anterior horn cells. (AHCs)	<u>2 neurons</u> : 1 st <u>preganglionic</u> present in lateral horn cells. (LHCs). 2 nd <u>postganglionic</u> present in ganglion
Axon	Reach the <u>muscle directly</u> . → without relay	Reach the <u>organs via ganglia</u> .
Impulses	<u>Always</u> carry <u>excitatory</u> impulses.	Carry <u>excitatory</u> or <u>inhibitory</u> impulses.



Distributions of the sympathetic system

- **[A] Cervical division** → not arising from cervical but take from thoraco-lumbar 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

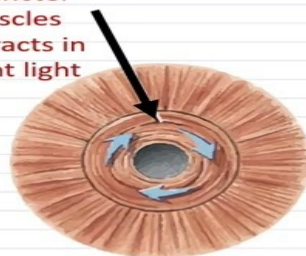
follow the course of carotid arteries to:

1-Eye

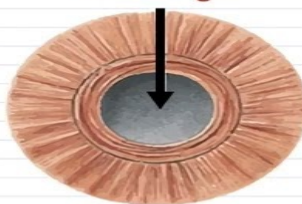
- **Motor** to dilator pupillae muscle → radial fibers → mydriasis (dilatation of the pupil)
- **Motor** to the superior and inferior tarsal muscles → **widening of the palpebral fissure**. Thus widening the field of vision.
- **Motor** to Muller's muscle (in animals) → present behind the eye → **exophthalmos** (forward protrusion of the eye ball)
- **Relaxation** of the ciliary muscle, decreasing the power of the lens to prepare the eye for far vision.

The Iris and Pupil

Sphincter muscles contracts in bright light



Both muscles relatively relaxed in normal light

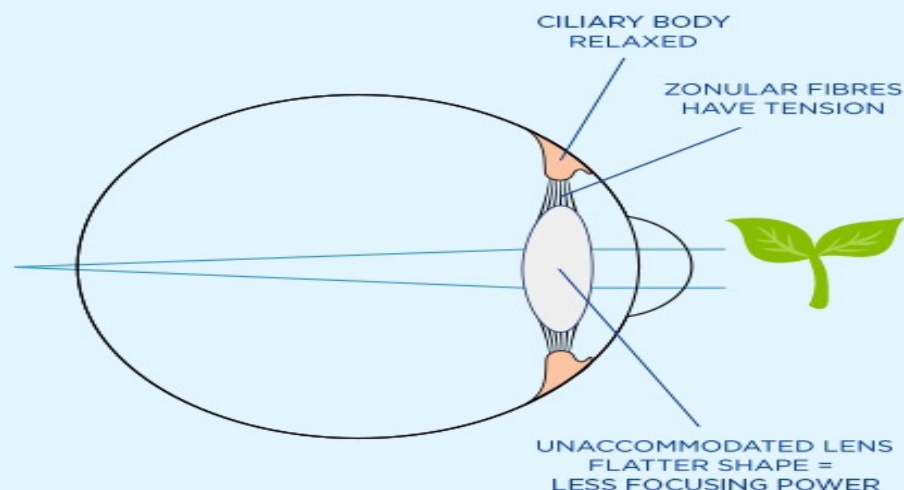
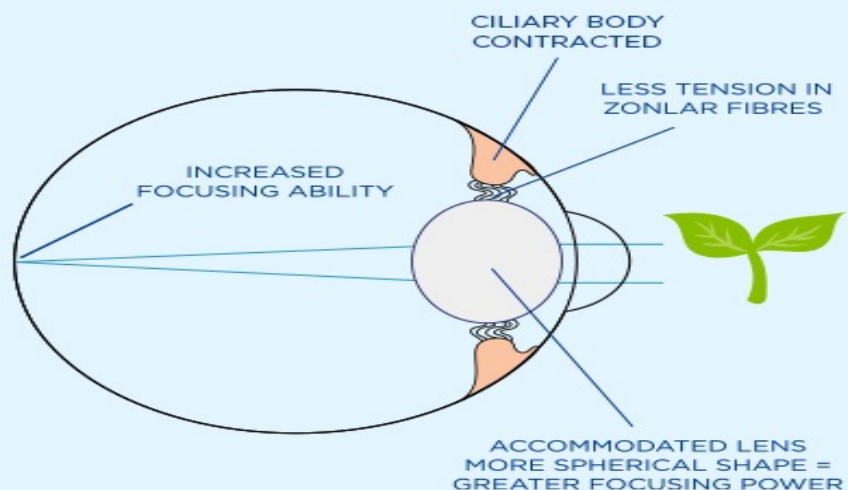


Dilator muscles contracts in dim light



- The pupil is constricted by the Sphincter pupillae and dilated by the dilator pupillae muscles.
- Constriction and dilation of the pupil is more accurately called the Pupillary reflex.
- Normal pupil size ranges from 2 to 4 mm in the light, and 4 to 9 mm in the dark.

CONTRACTED CILIARY BODY



2-Glands

اللب ما يشتغلش ما ياكلش

➤ 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 → *sub-cutaneous* → *more in animals*
- Bloods vessels vasoconstriction.

4-Cerebral vessels

- Mild vasoconstriction. Still during sympathetic excitement, cerebral blood flow ~~increase~~ due to the rise in arterial blood pressure. → *maintained constant*
↳ *autoregulation*

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] ^{heart}Cardiopulmonary ^{lung}(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

↳ prominent

2-The Lung

a-Bronchi

β_2
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: (5-12)

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

The **greater splanchnic nerves** → preganglionic fibers
[relay in celiac, renal and superior mesenteric ganglia] → collateral

■ The postganglionic fibers supply

1-Gastrointestinal tract (GIT):

^{storage B₂}
Relaxation of the wall, but ^{a1} constriction of the sphincters. Leading to delayed evacuation of food.
_{no digestion}

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 ^{يُضَب}

→ reach in RBCs

5-The liver → exception

- To stimulate metabolism, glycogenolysis with increase blood glucose level, lipolysis with elevation of the blood lipid level and dilatation to its vessels. → β_2

6-The endocrine pancreas

- Usually inhibition of insulin secretion.

7- The Kidney → to ↓ fluid loss

- Vasoconstriction of renal blood vessels, decreased renal blood flow, decreased urinary output and stimulation of [renin secretion].
 β_1

The adrenal medulla

-
- ⊗ **Preganglionic fibers** ⊗
- release ACh
- ↓ help in release of
- secretion of catecholamines, adrenaline (80%) and noradrenaline (20%) hormones → Adrenergic nerve عصب الادريناليني
 - 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** (⊗) → relay in its secretory 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 and ^{→ constriction} motor to the internal urethral sphincter

→ retention of urine

↳ external :- somatic (voluntary)

- **The rectum**

inhibitory to the wall and Motor to 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**

Ecocrine 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**

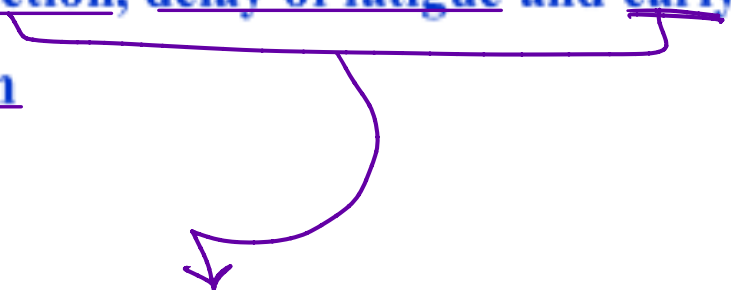
vasoconstriction

❑ **Erector pilea muscles**

Contraction

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

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”
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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 hemostasis
- 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

