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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 N.S. has **2 Efferent** neurons:

	Pre-ganglionic fiber	Post-ganglionic fiber
Cell body	In spinal cord or brain stem.	In autonomic ganglia.
Axon	From CNS to ganglia.	From ganglia to organs.
Туре	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 postganglionic 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.

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

Functions of autonomic ganglia

- 1) Relay stations for pre-ganglionic fibers.
- 2) Distribution centers.
- As the ratio of the pre-ganglionic fibers to the postganglionic fibers is (1:8).
- In this way, pre-ganglionic impulses are expanded into several post-ganglionic neurons "and are distributed to various organs".
- 3) Site of action of autonomic **D**rugs.

Difference between autonomic & somatic nerves

	Somatic nerves	Autonomic nerves
Function	Control voluntary or skeletal muscles.	Control involuntary organs.
Cell body	1 neuron: present in anterior horn cells. (AHCs)	 2 neurons: 1st preganglionic present in lateral horn cells. (LHCs). 2nd postganglionic present in ganglion
Axon	Reach the muscle directly.	Reach the organs via ganglia.
Impulses	Always carry excitatory impulses.	Carry excitatory or inhibitory impulses.



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.



2-Glands

Lacrimal glands : little secretion of tears and vasoconstriction.

Salivary glands: trophic secretion (small in amount, viscid and concentrated) from the salivary glands.

3-Skin

Sweat glands : **Copious** secretion from eccrine sweat glands

- > Erector pilae muscles \rightarrow erection of hair.
- Bloods vessels vasoconstriction.

4-Cerebral vessels

Mild vasoconstriction. Still during sympathetic excitement, cerebral blood flow remains constant or slightly increased due to the rise in arterial blood pressure.

[B] Cardiopulmonary (thoracic) division To 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

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.

The adrenal medulla

- Preganglionic 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 urinary bladder

inhibitory to the wall and motor to the internal urethral sphincter

 \rightarrow retention of urine

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)

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 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"

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 splanchinic 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.









