The Autonomic Nervous System:

→ Contributes to homeostasis via smooth muscle, cardiac muscle glands (Visceral Glands) control.

→ Operates via Reflex arcs · regulated by hypothalamus & Brain stem
∴ Autonomic — sensory Neurons _ Sensations usually NOT perceived
" — Integrating Centres
" — Motor Neurons → It has 2 major Motor Parts sympathetic & parasympathetic.
→ Operates w/out Conscious Control.

An interoceptor a sensory receptor located in ∴ blood Vessel visceral organ, muscles & Nervous system · that monitor the internal Environ.

Somatic sensation can also affect the A.N.S activity eg pain. including that via ∴ limbic system Fear / Very threating situations.
Autonomic Motor Neurons use ∴ the Visceral organ Actively
A.N.S activity can't be voluntary controlled.

A.N.S has 2 motor Neurons
1st from ∴ CNS to ∴ Autonomic Ganglion (is myelinated
2nd from ∴ Autonomic ganglion to effector (non-myelinated

Most Organs are duo-innervated · (Impulses from both branches)

→ Sympathetic fight or Flight (Increase metabolic Activities)
→ Parasympathetic Rest & digest (conserves & restores body energy)

Mention 4 Differences btw CNS & ANS.

Anatomy of its Motor Pathways

→ 1st Neuron is Preganglionic. — type B fibre

→ 2nd " is Postganglionic.. Can synapse to more than one Preganglionic — type C fibre.

Preganglionic Neurons

- Lateral gray horn of the 12 thoracic segments & 2 lumbar segments contain sympathetic cell bodies.
- Thoracolumbar outflow = sympathetic preganglionic outflow
- The Nuclei of the CN III, VII, IX & X & lateral gray matter of 2nd to the 4th sacral segment
  Parasympathetic = Craniosacral Division

Autonomic Ganglia

① Sympathetic ganglia

types — Sympathic trunk ganglia, also Vertebral Chain ganglia
— Prevertebral Ganglia

② Para Vertebral.

→ Innervates Above diaphragm
→ Ones in the Neck are superior, middle & Inferior. Cervical ganglia.
- Its preganglions are short
- Post ganglions are long.

③ Prevertebral → Rus close to large Abdominal Arteries

innervates below the diaphragm.
→ Major ones — Celiac ganglion ganglion
— superior mesentric "
— inferior "
= Aorticopenal " ganglion

Parasympathetic Ganglia

Region of ē synapse is close or in wall of ē visceral organ.

The ones in ē Head have Names

- Ciliary ganglion
- Pterygopalatine "
- Submandibular "
- Otic "

long preganglionics & short postganglionics

Postganglionic Neurons.

Are accessed in this way:

① → Synapse in ē first one that is accessed.

② — Ascend or descend 2 the levels of synapses. this forms ē chain ē synapses in here

③ — Continues 2 prevertebral ganglions & Synapses.

④ — All through 2 ē Chromaffin cells of ē Adrenal Medulla

Sympathetic

One preganglionic has many collaterals & can synapse w more many (20) postganglionics

Autonomic Plexuses.

In ē Thorax — Cardiac
— Pulmonary.

Abdomen → Celiac plexus.
— Superior mesenteric plexus
— Inferior " "

— Hypogastric plexus
— Renal Plexus

Structure of ē Sympathetic Division

lateral Horn → Anterior Root → White Communicate
Cons

Sympathetic Trunk Ganglia Organization

- 3 - Cervical. — Superior head & heart
— middle & inferior "
- 12 - thoracic. — Hearts, lungs, bronchi & the Viscera.
- 5 — ~~Lumbar~~.
- 5 — Sacral.
- 1 — Coccygeal.

Head → sweat glands
→ smooth muscle of ē eye
→ Blood vessels of ē Face
→ Lacrimal glands / Sweat glands
→ Nasal Mucosa, salivary glands

Pathway from Sympathetic Trunk Ganglia to Visceral Effectors.

① → Enter spinal Nerves via the gray rami to all 31 spinal nerves
Innervate skin of neck / trunk & limbs (Sweat glands, Smooth muscle in blood vessels, Arrector pili muscles)
② → Form cephalic pericarterial Nerves
③ → Form sympathetic Nerves
④ → " Splanchic Nerves

The go through the trunk to ē prevertebral ganglia
Splanchic nerves 2 ē Abdominal pelvic organs

T_5 - to T_{10} → Greater splanchic Nerve.

Enters ē ē celiac ganglion of ē celiac plexus.
Follow Blood vessels to entre organs.

$T_{10} - T_{11}$ — Lesser splanchic Nerve

Through celiac plexus to ē aorticrenal ganglion & Superior mesenteric Ganglion.

T_{12} — The least/lowest splanchic Nerve to ē Renal plexus or Branch of ē lesser splanchic Nerve.

$L_1 - L_4$ — lumbar splanchic Nerve.

Ente ē inferior mesenteric plexus the inferior mesenteric ganglion
Distal colon & Rectum.

Thru ē hypogastric plexus. Rectum, Urinary Bladder & genital organs.

Splanchic Nerves 2 ē Adrenal Medulla.

Structure of ē parasympathetic Division

4 pairs of Cranial ganglia

1. Ciliary ganglia → lateral to CN II & portion 2 orbit fibres make w CN III to smooth muscles of ē eyeball
2. Pterygopalatine → Receive fro ē VII Send to nasal mucosa, palate, pharynx & lacrimal gland
3. Submandibular → Receives fro ē VII found near ē submandibular gland Send 2 ē submandibular & Sublingual Salivary gland
4. Otic → just infra 2 ē foramen Ovale.

Receives axons from ē IX
Sends " to ē parotid Salivary gland

CN X carys 85% of ē parasympathetics.
Axons terminate in many terminal ganglia in ē thorax & Abdomen - (heart, lungs, G.I organs).

Sacral parasympathetic outflow.
axons of S_2–S_4.
the axons branch off to form pelvic splanchnic nerves.
Their terminal ganglia r in walls of ē Visceral.

Innervate ē Colon, Ureters, Urinary Bladder & Reproductive organs

A.N.S Neurotransmitters & Receptors

→ Cholinergic.
→ Adrenergic.

Cholinergic

1. Sympathetic & parasympathetic preganglionic neurons.
2. All parasympathetic postganglionic neurons.
3. sympathetic postganglionic neuros innervating sweat glands.

Types of Cholinergic Receptors.

→ **Nicotinic**

in ē plasma membrane of dendrites & cell bodies of both **Sympathetic & parasympathetic postganglionic Neurons.**

‡ – Chromaffin cells plasma Membrane.

→ **Muscarinic.**

In ē plasma Membrane of All effectors of parasympathetic axons

Also most sweat glands as ey are innervated by cholinergic sympathetic neurons.

Activation of Muscarinic receptors by Ach.

cause → excitation.
→ Inhibition. → Depends on ē effector

Ach is inactivated by acetylcholinesterase.

Adrenergic Neurons & Receptors.

- Bind both Epinephrine & Norepinephrine.

Major Receptors

α & β.

α_1 α_2 β_1, β_2 & β_3 ~~heat Generation~~.

α_1 & β_1 → excite α_2 & β_2 → activation.

COMT – Catechol-O-methyltransferase
– MAO – Monoamine oxidase.

Adrenergic effects linger for a longer time

Receptor Agonists & Antagonists

Phenylephrine.

Atropine Blocks Muscarinic Ach.
Propanol Non selective Betablocker
Selective – β_1
– β_2.

Physiology of ē A.N.S.

Autonomic Tone

Is the balance btn Sympathetic & parasympathetic.

The hypothalamus turns up symp
turns down parasymp.

Structures that only receive sympathetic innervation
- Sweat glands.
- Arrector pilli muscles.
- The kidneys.
- Spleen.
- Most Blood vessels
- & Adrenal Medullae.

} Depend of Activation & deactivation.

E E E E (exercise, emergency, excitement, Embarrassment)

Sympathetic Responses

- During physical or emotional stress

- Favours energy release & Not energy storage
- Fight or flight response.

Response Include → Pupil dilation
→ Heart Rate ↑ Force of heart contraction ↑ & BP ↑se.

→ Airway Dilatation.
→ Constriction of ē blood Vessels of ē Kidney & G.I.T.
→ Dilatation of ē " " of ē Skeletal, Cardiac, liver & Adipose

→ liver Glycogenolysis & Adipose lipolysis
→ G.I motility & secretions reduce.
→ Blood Glucose ↑ses.

3 Reasons as to Why sympathetic effect lasts longer.

Parasympathetic Responses.

Conserves & Restores Body Energy

Salivation Lacrimation Urination Digestion Defecation

Control of Autonomic Reflexes.

Components – Receptor Mostly Interoceptors

- Sensory Neuron
- Integrating centre Mainly hypothalamus & Brainstem. Also spinal cord.
- Motor Neuron.
- Effector.

The hypothalamus Receives Information About
→ Olfaction → Temp → Visceral Functions
→ Taste → Osmolarity → Emotional input.
– Anterior & medial → Control para.
– Posterior & lateral → Control Sympathetic.

Hypothalamic Nucleus – Via axons to parasympathetic & Sympathetic Nuclei in the Brainstem & Spinal cord.

Through relays in the reticular formation.

Raynaud's Phenomenon.

Result from excess sympathetic stimulation → Vasoconstriction in digits

→ Pts have low BP.
→ Use no. of α adrenergic Receptors
→ Typical in young women in cold climates
→ Avoid cold.
→ Smoking & Alcohol exacerbate symptoms
→ Drugs → Nifedipine – Ca++ blocker.
→ Prazosin – α receptor blocker Effects in Vasculature

Autonomic Dysreflexia.

Exaggerated response of the sympathetic Division post Spinal cord injury. At or Above T6.
Due to No interruption from higher centres.
Pressure & Blood Flow in Affected Areas