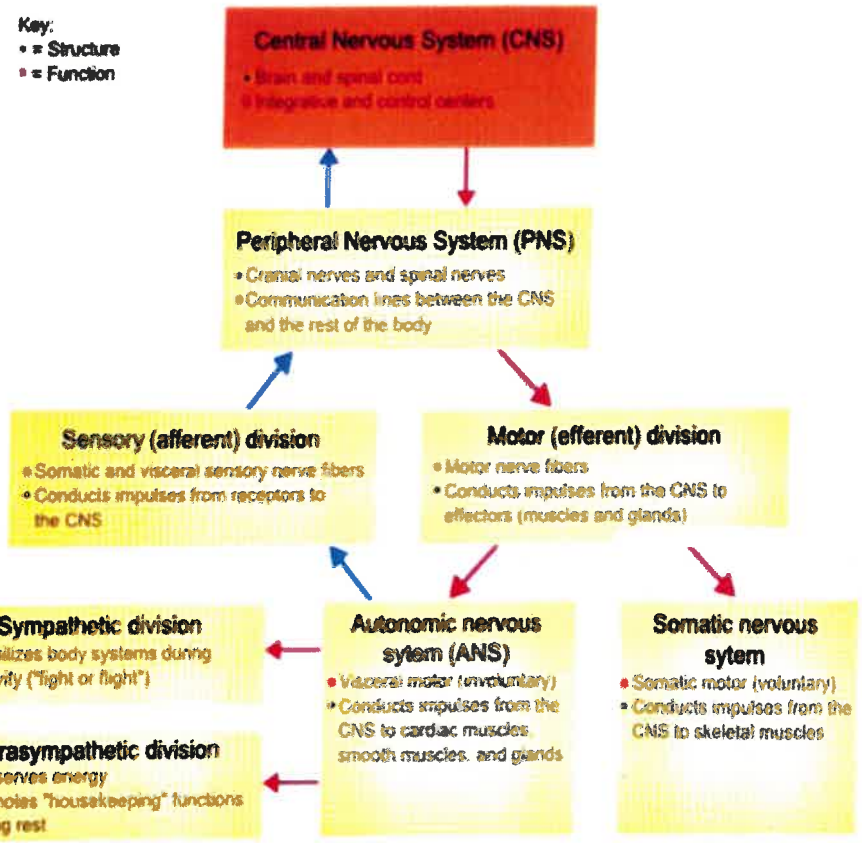
NEET SS ANAESTHESIA
GENERAL
ANAESTHESIA

CONTENT

AUTONOMIC NERVOUS SYSTEM PHYSIOLOGY & AUTONOMIC FUNCTION TESTS

Introduction

00:00:24



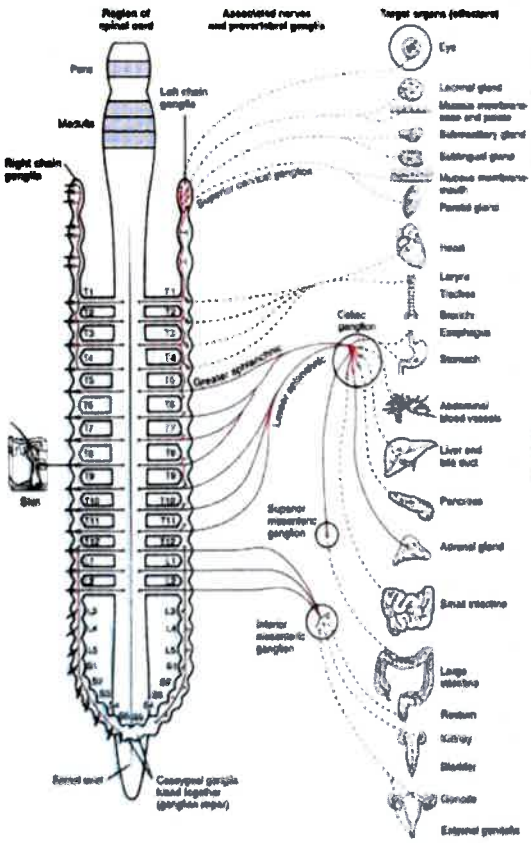
- Autonomic system (vegetative, visceral or involuntary).
- Controls the visceral activities of the body.
- Main control centre : Brain stem and hypothalamus.
- Sensory inputs are relayed to these areas and reflex responses are effected in the visceral organs.
- Dual innervation (Sympathetic and parasympathetic) to organs but one action dominates over another.

  Heart : Parasympathetic system predominates.

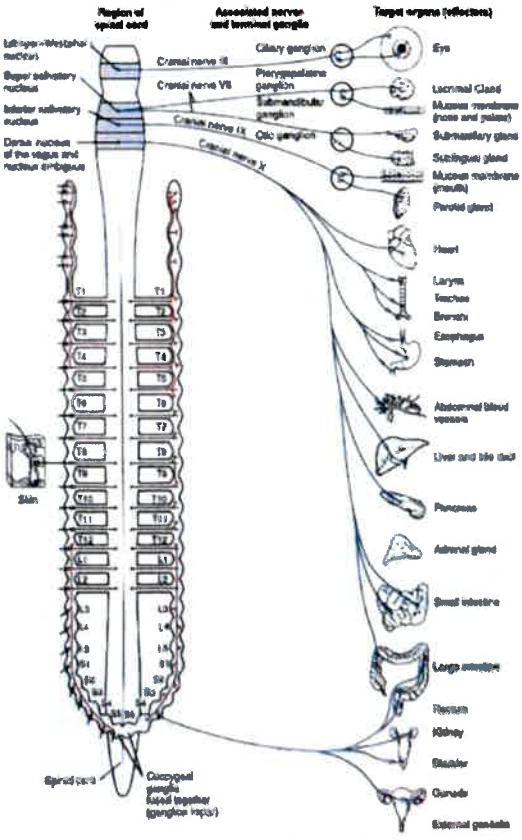
  Pupils : Parasympathetic system predominates.
- All preganglionic fibres in both sympathetic system and parasympathetic system secrete acetylcholine.
- Post ganglionic fibres in sympathetic system secrete epinephrine & norepinephrine.
- Post ganglionic fibres in sympathetic system secrete acetylcholine.

Difference between sympathetic and parasympathetic system :

Sympathetic	Parasympathetic
Thoraco-lumbar outflow.	Cranio-sacral outflow (Cranial nerves 3,7,9,10 and sacral segments S2, S3, S4).
Stress response.	Antagonise sympathetic activity.
Fight & flight response.	Rest & digestion.
Neurotransmitter : Post ganglionic fibres release epinephrine & norepinephrine (Except in sweat glands).	Neurotransmitter : Acetylcholine.
Located in the intermediolateral horn of spinal cord.	Ganglia are located close to effector organs. Hence pre-ganglionic fibres are longer.

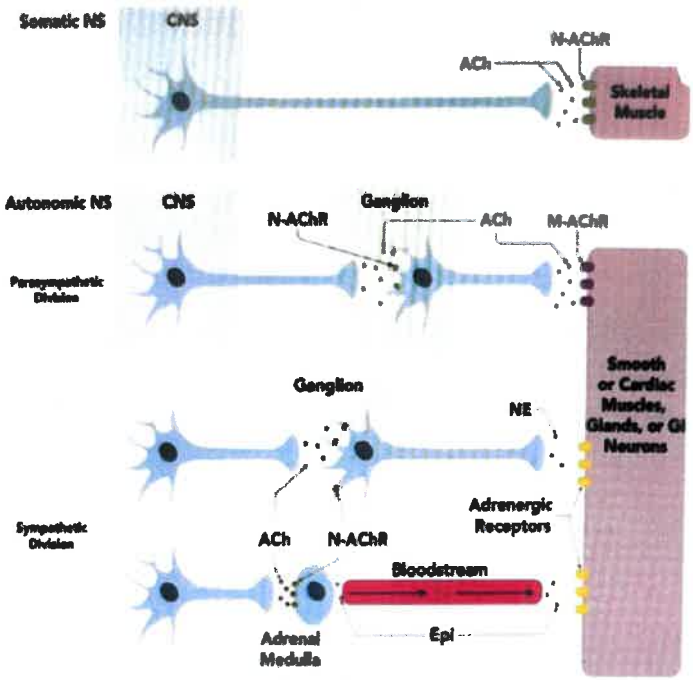


Sympathetic system.



Parasympathetic system.

Note : Adrenal medulla is innervated directly by the preganglionic fibres only, no postganglionic fibres.



Autonomic nervous system.

Sympathetic nervous system

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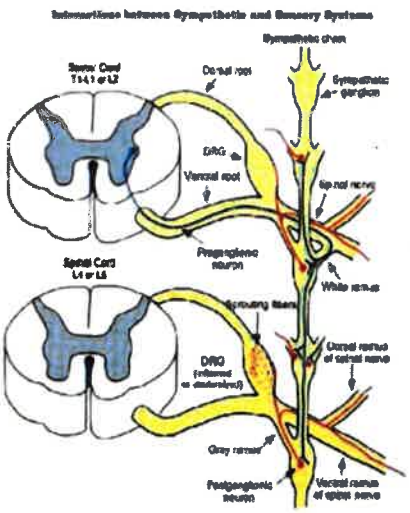
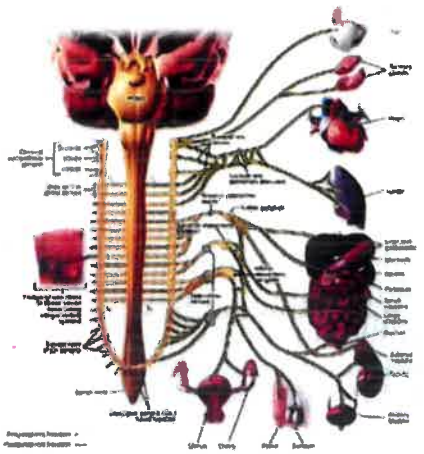
- Synapse in ganglia at the level of exit.
- Course up or down the sympathetic chain to synapse at another level.
- Exit the chain without synapsing to an outlying collateral ganglion.
- Segmental distribution of sympathetic fibres :
  - Head and neck : T1–3.
  - Upper limb : T2–7.
  - Thoracic viscera : T1–4.
  - Abdominal viscera : T4–L2.
  - Lower limb : T11–L2.
- Post ganglionic fibres from the ganglion forms plexus near the effector organs (Eg : Coeliac plexus).
- Stimulation causes "mass action" : Action on all parts of the body that it innervates.
- Short preganglionic fibres.



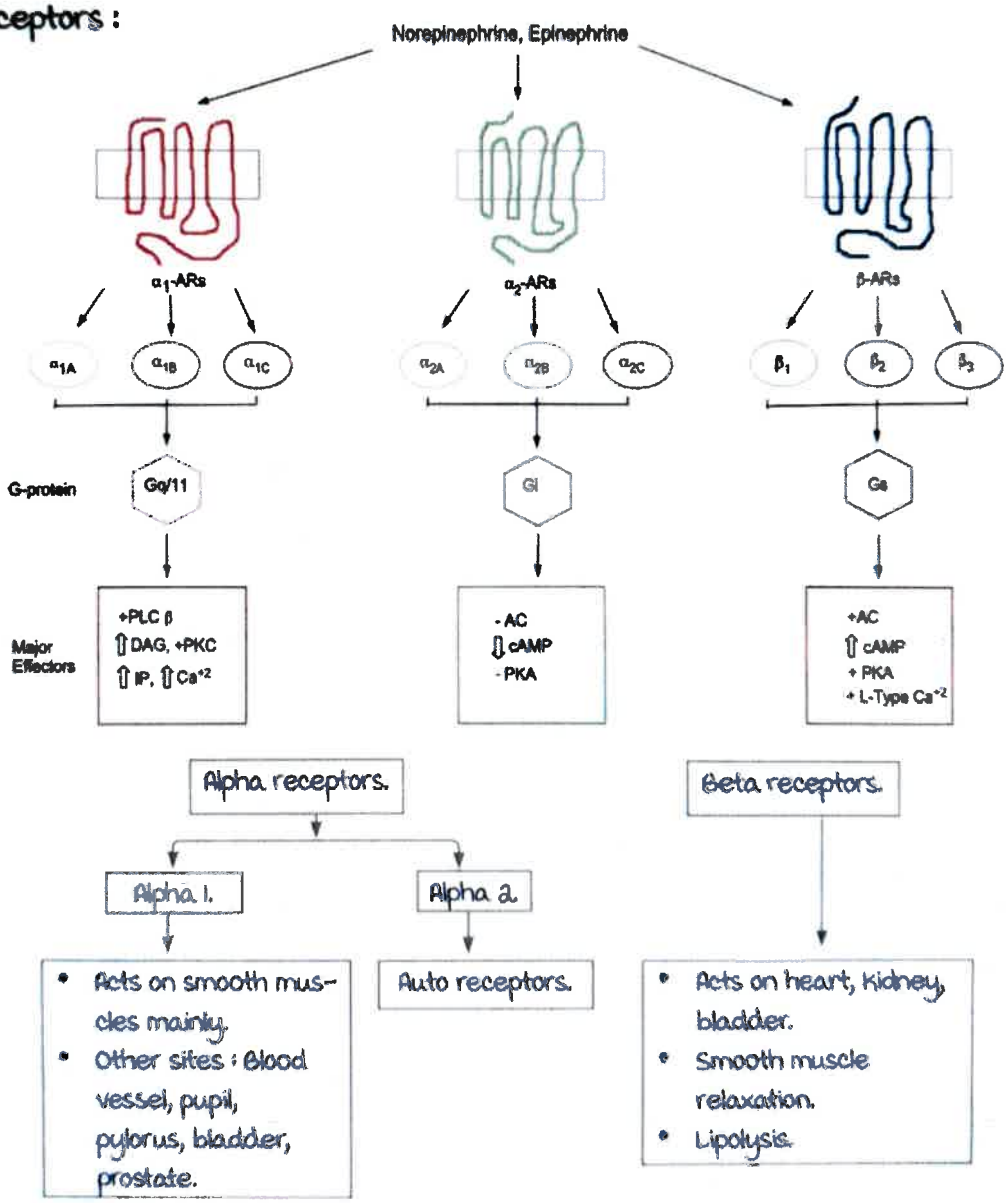


Sympathetic innervation

Effects :

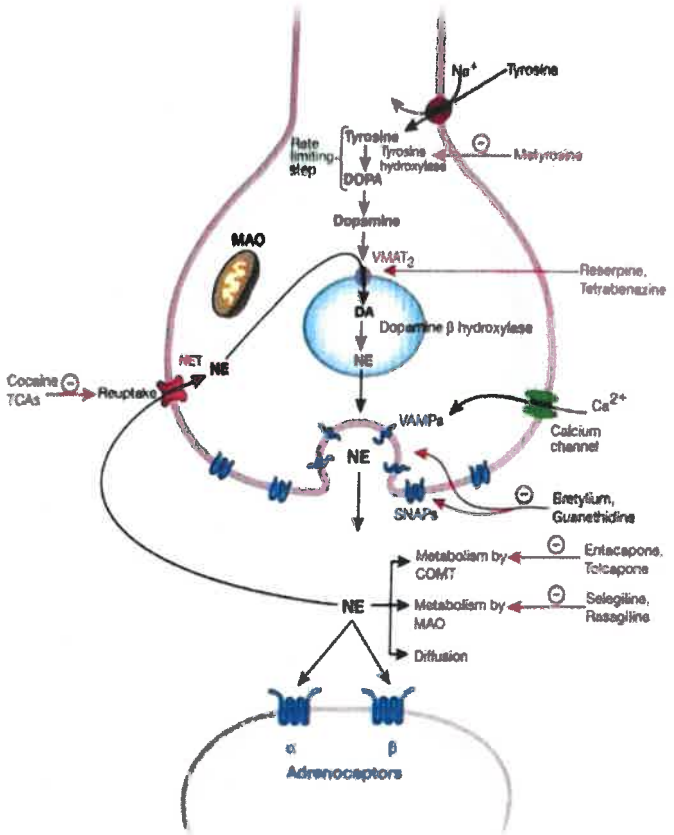
- Pupils : Dilatation.
- Respiratory system : Bronchodilatation.
- CVS : ↑HR, ↑BP.
- GIT : Decreases peristalsis, decreases acid secretion.
- Urinary bladder : Relaxation of bladder wall, constriction of bladder neck causing retention of urine.

Receptors :



- All are G-Protein coupled receptors.
- Act via adenyl cyclase except alpha 1 which acts via IP3 + DAG.

Synthesis of catecholamines :



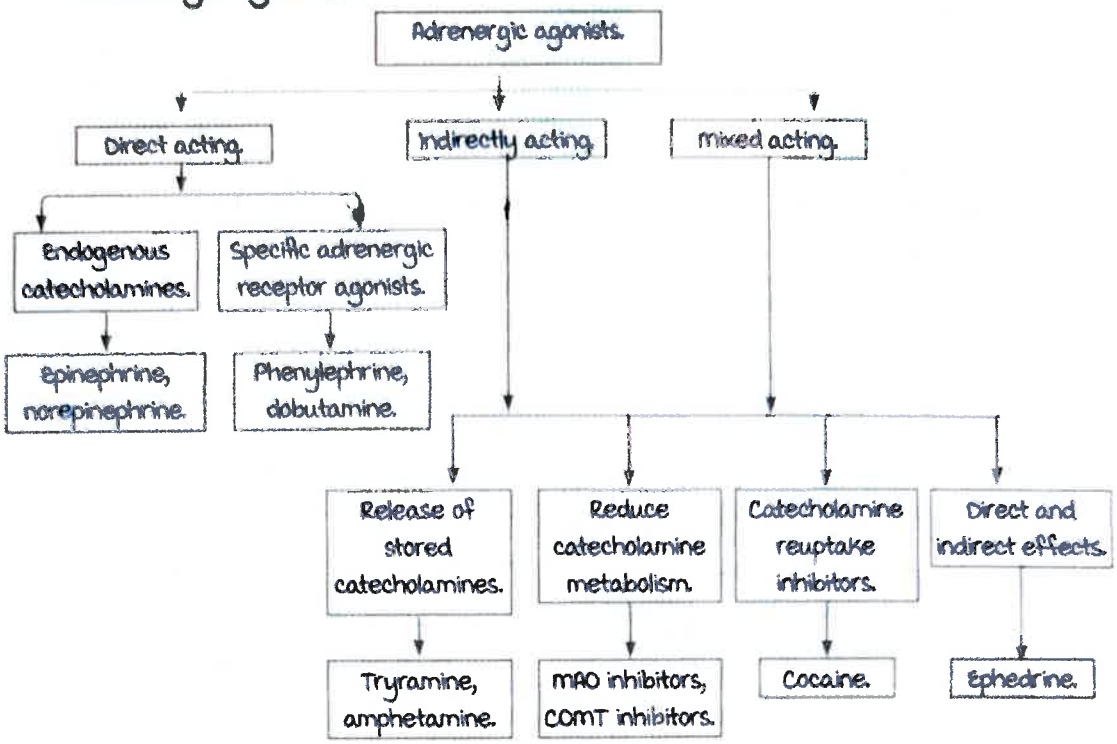
$VMAT_2$	- Vesicular Monoamine Transporter - 2
VAMPs	- Vesicle Associated Membrane Proteins
NET	- Norepinephrine Transporter
MAO	- Monoamine oxidase
COMT	- Catechol-O-methyltransferase

Catecholamine synthesis.

Adrenergic receptors :

Receptor Type	Tissue Distribution	Physiological Effects	Agonist	Antagonist
α1	Vascular Smooth Muscles, Visceral smooth Muscles	Smooth muscle contractions, Gluconeogenesis, Vasoconstriction	Norepinephrine, Phenylephrine, Methoxamine	Doxazosin, Phentolamine, Prazosin
α2	Pre-synaptic terminals, pancreas, platelets, Ciliary epithelium, Salivary Glands	Inhibits release of Neurotransmitter	Clonidine, Mivazerol	Yohimbine, Idazoxan, Tolazoline
β1	Heart, Kidney, some pre-synaptic terminals	Increase heart rate and Renin secretion	Isoproterenol, Norepinephrine, Dobutamine	Propranolol, Metoprolol, Atenolol
β2	Visceral smooth muscles, Bronchioles, Liver, Skeletal Muscles	Vasodilation, Bronchodilation, Inhibits insulin secretion	Isoproterenol, Salbutamol, Salmeterol, Albuterol, Formoterol, Terbutaline, Levalbuterol	Propranolol, ICI-118,551, Nadolol, Butoxamine
β3	Adipose Tissue	Increase lipolysis	Isoproterenol, Amibegron, Solabegron	SR59230A

Adrenergic agonists :



Parasympathetic nervous system

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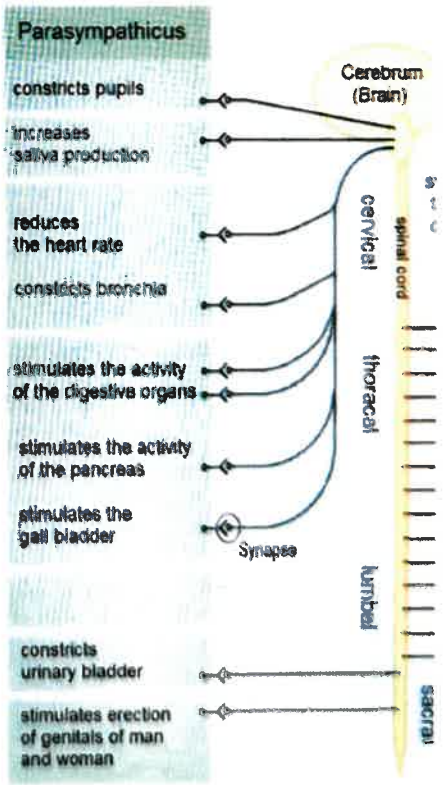
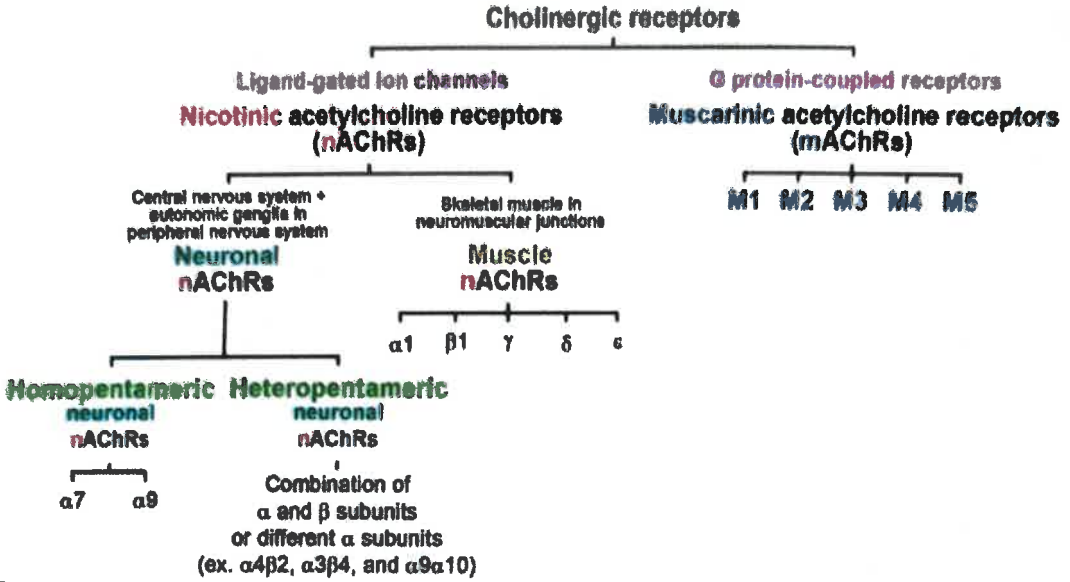
- Ganglia close to receptor organ.
- Actions are localized and targeted.
- Preganglionic fibres present in :
  - Midbrain.
  - Medulla oblongata.
  - Sacral spinal cord.
- Vagus nerve accounts for 75% of parasympathetic activity (upto proximal half of the colon).
- Rest is by the sacral segments (Constitutes of pelvic visceral nerves).



Action of parasympathetic system.

Cholinergic receptors :

A



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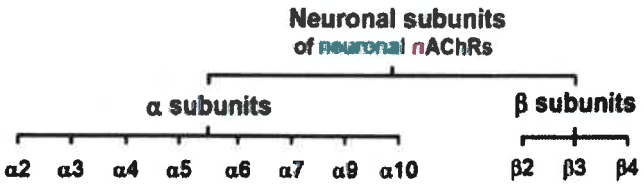
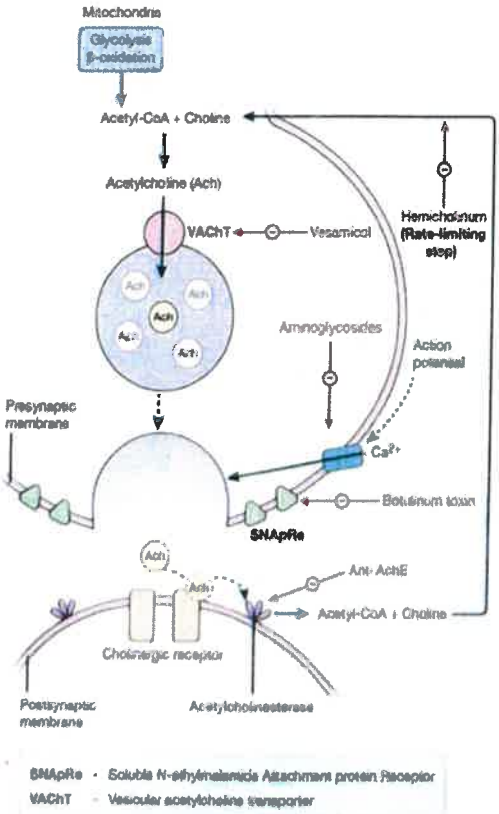
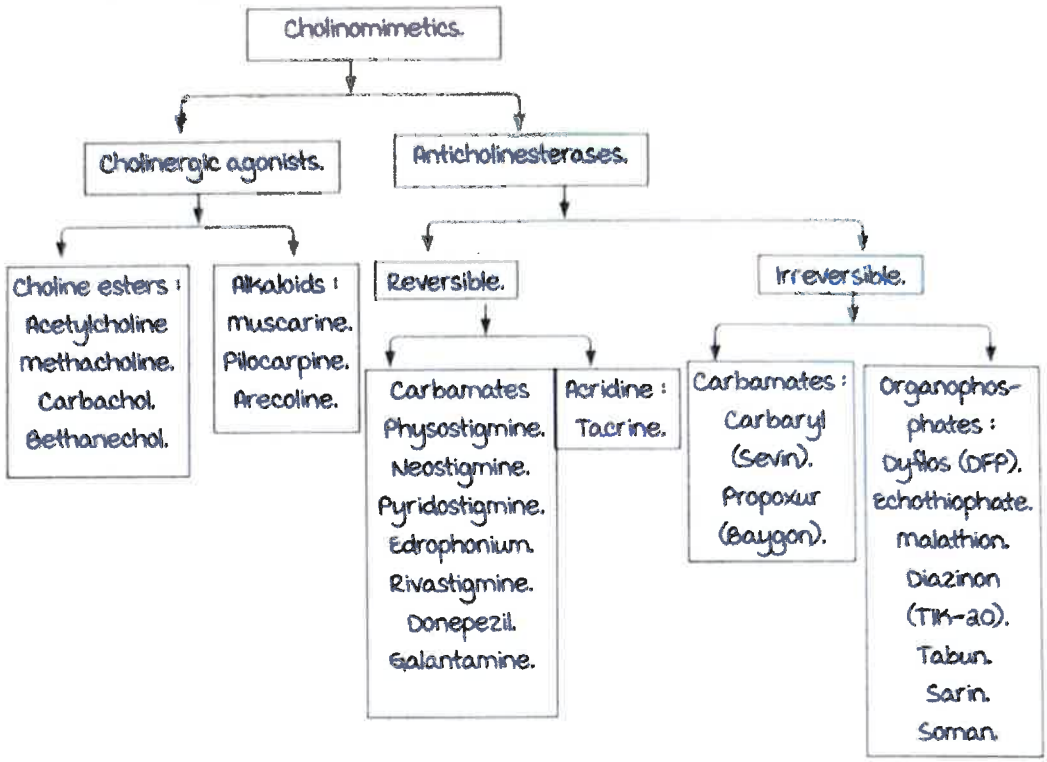


Synthesis of acetylcholine :

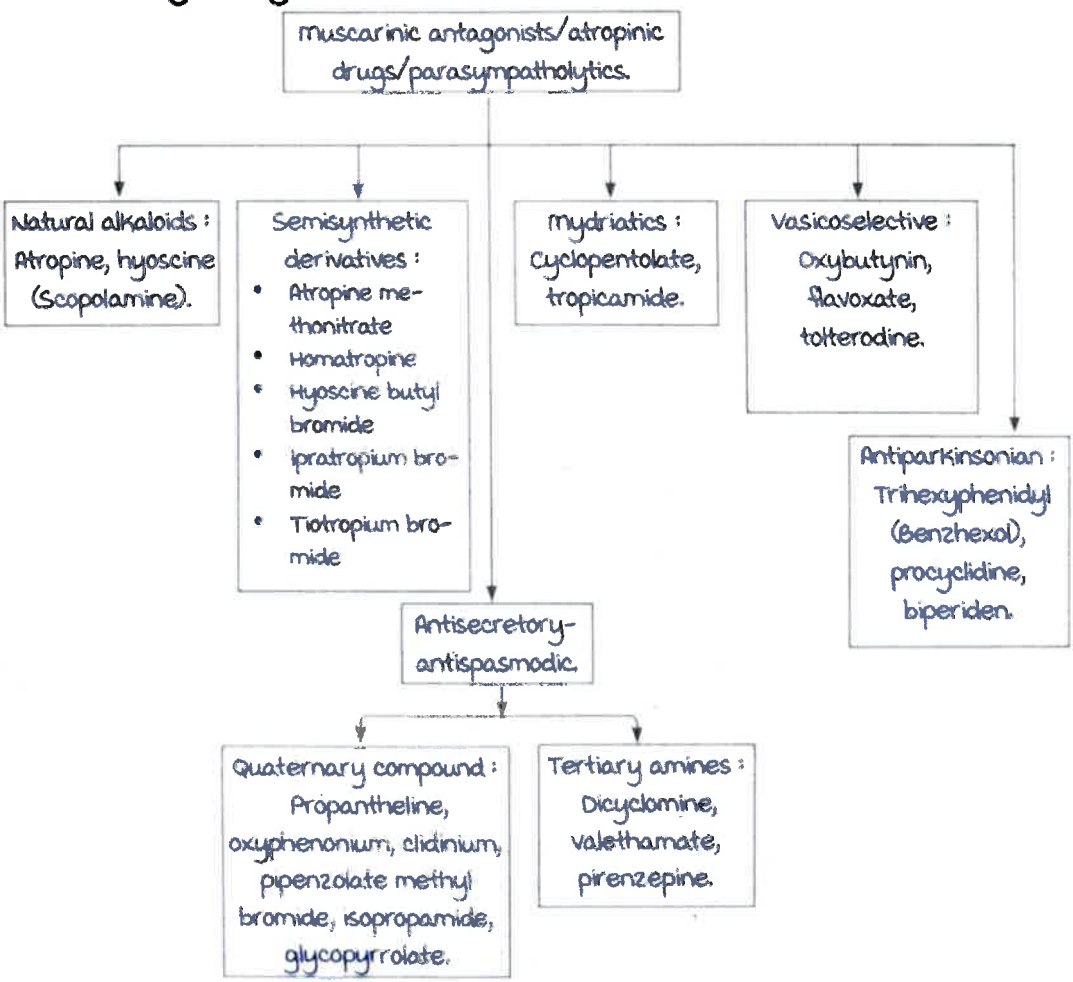


Acetylcholine synthesis.

Cholinergic drugs :



Anticholinergic drugs :

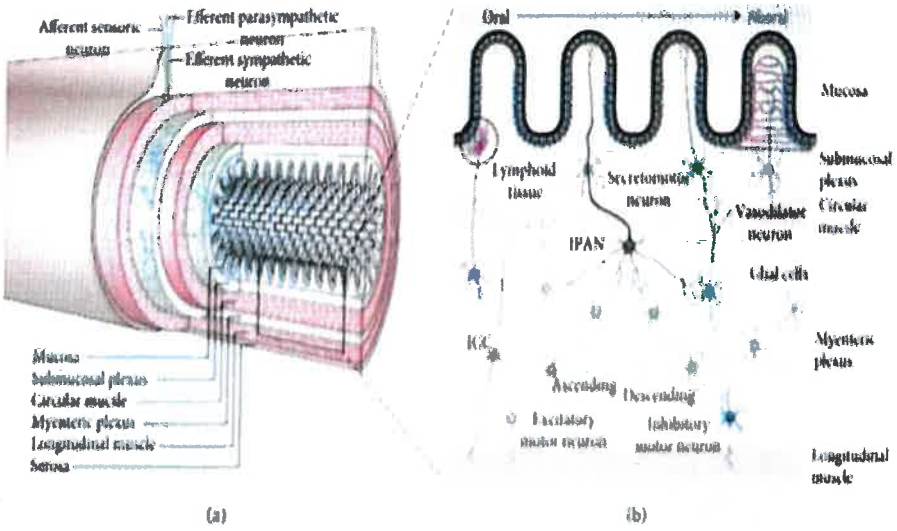


Autonomic innervation :

Site.	Predominant tone.
Arterioles.	Sympathetic (Adrenergic).
Veins.	Sympathetic (Adrenergic).
Heart.	Parasympathetic (Cholinergic).
Iris.	Parasympathetic (Cholinergic).
Ciliary muscle.	Parasympathetic (Cholinergic).
Gastrointestinal tract.	Parasympathetic (Cholinergic).
Urinary bladder.	Parasympathetic (Cholinergic).
Salivary glands.	Parasympathetic (Cholinergic).
Sweat glands.	Sympathetic (Adrenergic).
Genital tract.	Sympathetic and parasympathetic.

Enteric nervous system :

- The third branch of the ANS.
- Extraordinary degree of local autonomy (Ach, NO, substance P, VIP).
- Within the walls of the GIT.
- Derived from neuroblasts.
- 2 types :
  - Myenteric plexus : Auerbach plexus.
  - The submucous plexus : Meissner plexus.



Enteric nervous system.

Autonomic dysfunction

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Affects small, lightly myelinated and unmyelinated autonomic nerve fibers.
most common cause is long standing diabetes mellitus :

- 24% in type 1 DM.
- 35% in type 2 DM.

Anaesthetic importance : Alteration in the doses of anesthetic agents to produce the same effect as that in a normal individual.
Parasympathetic affected earlier.

Causes :

- Diabetes.
- Amyloidosis.
- Acute and subacute autonomic neuropathies.
- Immune mediated & paraneoplastic neuropathies.
- Hereditary autonomic neuropathies.
- Autonomic neuropathies due to infectious diseases.
- Toxic neuropathies.

Mnemonic (NEUROPATHY) :
N : Nutritional deficiency.
E : Endocrine.
U : Unknown.
R : Renal failure.
O : Others.
P : Paraneoplastic syndrome.
A : Autoimmune.
A : Abnormal proteins.
T: Toxins and drugs.
H : Human imunodeficiency virus .
Y : Y Chromosome defect (Congenital).

Autonomic features involve :

- Cardiovascular system.
- Gastrointestinal system.
- Urogenital system.
- Sudomotor system, pupilomotor system.
- metabolic system.

Clinical manifestations :

- Resting tachycardia/fixed heart rate.
- Orthostatic hypotension.
- Exercise intolerance.
- Peri-operative cardiovascular instability : Profound hypotension/tachycardia on inducing patient with IV anaesthetics.
- myocardial ischaemia and infarction.
- Left ventricular dysfunction.
- Increased risk of renal diseases.
- Chronic renal failure.
- Syncope.
- Stroke.
- Sudden cardiac death.
- Gastroparesis : Diarrhea & constipation.
- Sudomotor effects :
  - Anhidrosis.
  - Hyperhidrosis.
  - Heat intolerance.
  - Gustatory sweating.
  - Dry skin.
  - Difficulty with food intake due to decreased salivation.
  - Eye irritation due to decreased lacrimation.
- Pupillomotor function impairment :
  - Decreased diameter of dark adapted pupil.
  - Pseudo Argyll-Robertson pupil.
- Genitourinary impairment :
  - Impotence.
  - Erectile dysfunction.
  - Retrograde ejaculation.
  - Defective vaginal lubrication.
  - Bladder dysfunction : Atonic bladder, automatic reflex bladder, autonomous bladder.

Autonomic function testing

00:36:07

Devised by Ewing and Clark.

Cardiac parasympathetic function checked by :

- Heart rate response to Valsalva maneuver.
- Heart rate variation during deep breathing.
- Immediate heart rate response to standing.

Cardiac sympathetic function measured by :

- Blood pressure response to standing.
- Blood pressure response to sustained handgrip.

Pre-requisites :

- Discontinue following medications for 8-24 hrs before the test :
  - Cardiovascular medications.
  - Anxiolytics.
  - Antidepressants.
  - Caffeine.
  - Decongestants.
- Test performed :
  - In the morning.
  - Under fasting condition.
  - Capillary blood glucose should be < 180 mg%.
- Normal values depend on age.

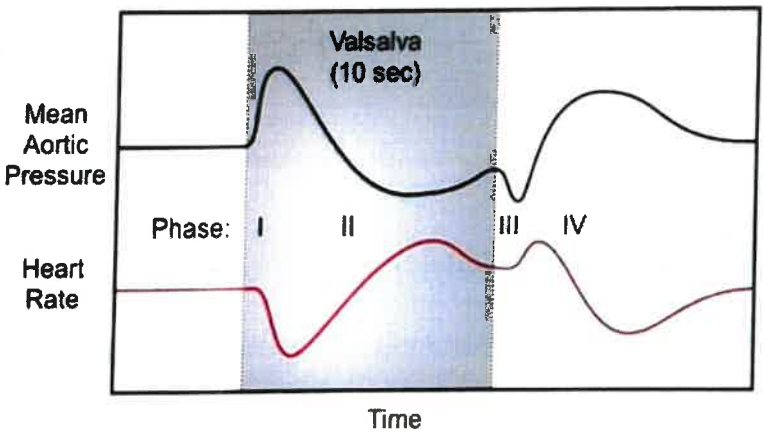
Cardiac parasympathetic function tests :

Heart rate response to Valsalva maneuver :

- The seated subject blows into a mouthpiece (while maintaining a pressure of 40 mm Hg) for 15 seconds.
- Valsalva ratio : Ratio of the longest R-R interval (which comes shortly after release) to the shortest R-R interval (which occurs during the manoeuvre).
- Normal value : Ratio of > 1.21.

Phases of valsalva maneuver :

Phase	maneuver	BP	HR
1	Expiration against a closed glottis.	Increased due to increase in intrathoracic pressure added to pressure in aorta.	Decreased.
2	Continued expiration.	Decreased due to decreased venous return.	Increased.
3	End of expiration.	Decreased due to decrease in venous return and decreased baroreceptor discharge or, decreased due to increased capacitance of pulmonary bed.	Increased further.
4	Recovery.	Increased due to increased venous return and cardiac output.	Decreased.



Phases of Valsalva maneuver.

HR response to deep breathing :

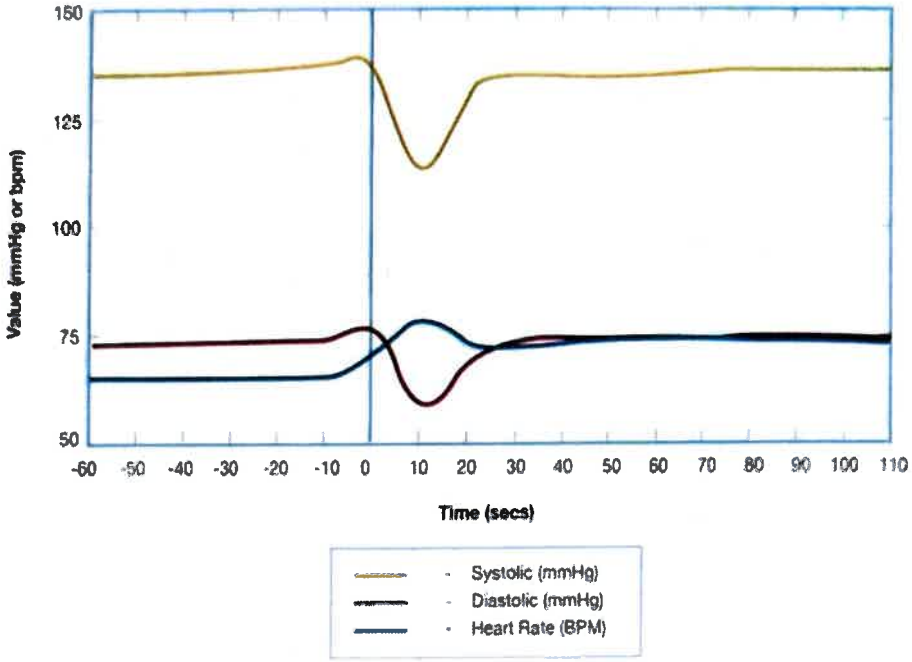
- Patient takes six deep breaths in 1 minute.
- The maximum and minimum heart rates during each cycle are measured.
- Mean of the differences (maximum HR - minimum HR) during three successive breathing cycles is taken.
- Normal value : >15 beats/min.

HR response to standing :

- HR is measured as the patient moves from supine to standing.
- HR response to standing is expressed as a 30:15 ratio.
- Ratio of the longest R-R interval (30th beat) to the shortest R-R

interval (15th beat).

- Normal value : Ratio of >1.04.



HR and BP response to standing.

Cardiac sympathetic function tests :

BP response to standing :

- The subject moves from supine to standing and change in SBP is measured.
- Normal value : Difference of <10 mm Hg.

BP response to sustained handgrip :

- Sustained handgrip is a rise in BP secondary to an increased HR with unchanged peripheral vascular resistance.
- The subject maintains a handgrip of 30% of the maximum handgrip squeeze, for up to 5 minutes → DBP is measured every minute → The initial DBP is subtracted from the DBP just before release.
- Normal value : >16 mm Hg.

Other tests :

- Pupillary abnormalities.
- Hypoglycemia unawareness.
- Neurovascular dysfunction.
- Sweating disturbances :
  - Quantitative sudomotor axon reflex test (QSART).
  - Thermoregulatory sweat test (TST).

Pharmacologic tests :

- measurement of plasma norepinephrine (NE) :
  First supine and then after standing for at least 5 minutes.
  In cases of autonomic dysfunction, supine values are reduced.
- Administration of tyramine : Reduced release of NE.
- Administration of phenylephrine : Excessive response to subthreshold doses.
- Ganglionic blockade with trimethaphan : Greater fall in BP.
- Arginine vasopressin : To evaluate afferent central pathways.

Anaesthetic implications and management 00:46:54

Anaesthetic implications in a patient with autonomic dysfunction :

- Accentuated fall in BP.
- High incidence of dysrthymias and cardiac arrest due to :
  - Reduced appreciation of ischemic pain.
  - ↓ HR response to chronotropic agents.
  - Prolonged QT interval.
- High risk of aspiration due to presence of gastroparesis.
- Blood loss : No compensatory vasoconstriction.
- Change in position is poorly tolerated.
- Hypoglycemic unawareness.
- Reduced hypoxic-induced ventilatory drive.
- Susceptible to CNS depressant drugs.
- Impaired temperature control can lead to severe hypothermia.

Management :

i. Detailed history and autonomic nervous system testing.
ii. Check for gastroparesis : Longer fasting time is advised.
iii. Rapid sequence intubation after good preoxygenation.
iv. Titrated doses of anaesthetic agents.
v. Invasive monitoring of haemodynamics.
vi. Vasopressors and inotropes should be kept ready.
vii. Careful during positioning.
viii. Temperature and blood sugar monitoring.
ix. Assess blood loss.
x. Extubate only when fully conscious and adequate reversal.

Autonomic hyperreflexia :

Seen in patients who sustain spinal cord injury.

Clinical features :

- Initial spinal shock : Reduced sympathetic outflow.
- Spastic paralysis.
- Any stimulus causes hypertension and bradycardia (Risk is higher if injury above the level of T6).
- Profuse sweating.
- Ventricular dysrhythmias.
- Flushing (vasodilation) above the lesion and blanching (vasoconstriction) below the lesion.
- Non specific : Severe headache, difficulty breathing, nausea, shivering, blurred vision.