
بسم الله الرحمن الرحيم

BENHA UNIVERSITY

FACULTY OF MEDICINE

1st Year Medical Students

Chemical transmission in autonomic nervous system (ACETYLCHOLINE)

BY

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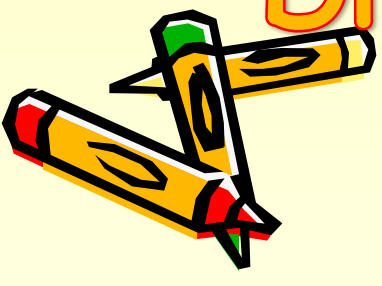
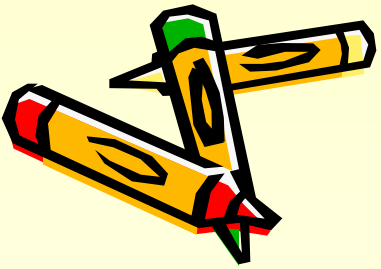


Chemical transmitter

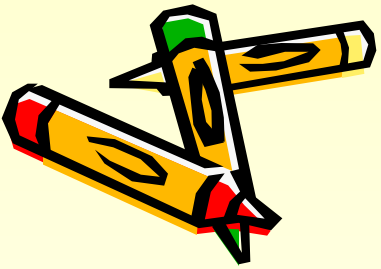
- **Definition:**

  It is the substance which transmits the activity from:

  - Neuron to another neuron (neuro-neuronal junction).



- Neuron to the effector organ;
  - From neuron to skeletal muscle (neuro-muscular junction = motor end plate).
  - From neuron to Smooth muscle.
  - From neuron to cardiac muscle.
  - From neuron to glands (neuro-epithelial junction).

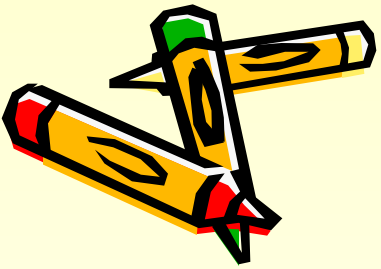


- **Storage:**

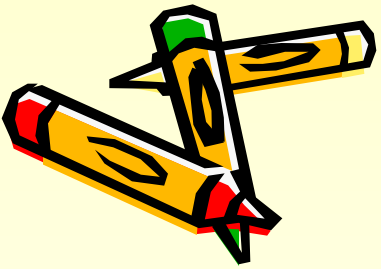
  The chemical transmitter is stored in vesicles present at the nerve endings.

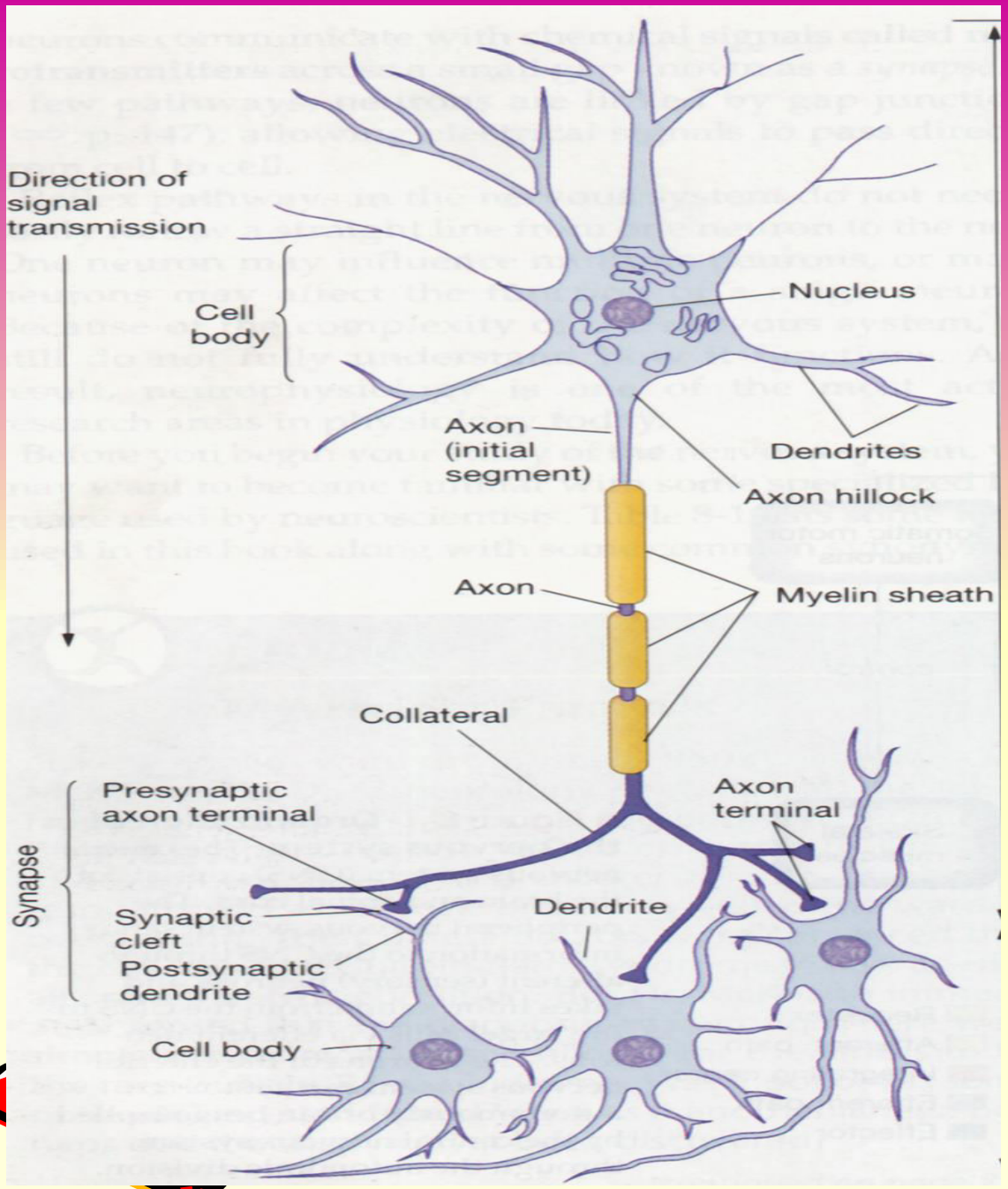
- **Release:**

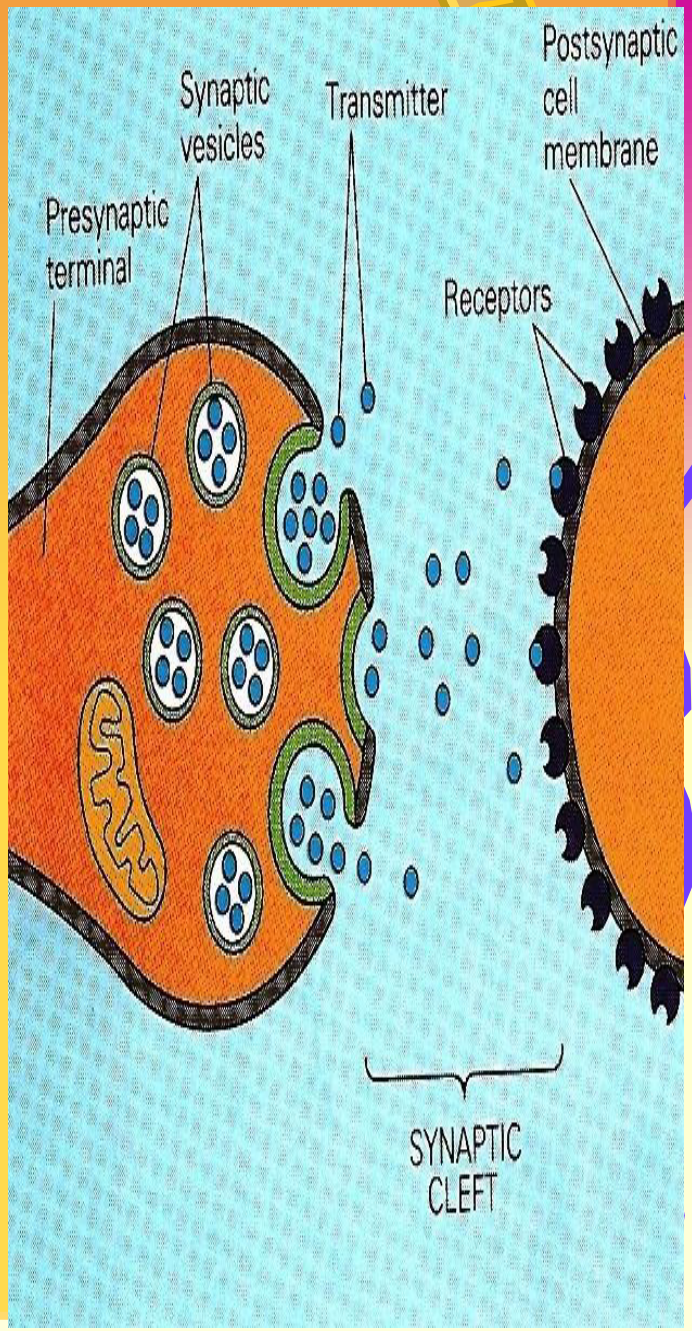
  The chemical transmitter is released on arrival of the nerve impulses to the nerve endings → Rupture of the chemical transmitter (neurotransmitter) vesicles.



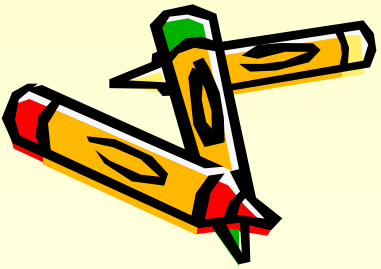
- **The autonomic nerves are classified according to the chemical transmitter released from its endings into:**
  - **Cholinergic fibers:** Fibers which secrete acetylcholine (A.Ch).
  - **Adrenergic fibers:** Fibers which secrete noradrenaline (NA).




Direction of signal transmission
Cell body
Nucleus
Axon (initial segment)
Dendrites
Axon hillock
Axon
Myelin sheath
Collateral
Presynaptic axon terminal
Axon terminal
Synapse
Synaptic cleft
Dendrite
Postsynaptic dendrite
Cell body


Synaptic vesicles
Transmitter
Postsynaptic cell membrane
Presynaptic terminal
Receptors
SYNAPTIC CLEFT

I- Acetylcholine (A.Ch.)



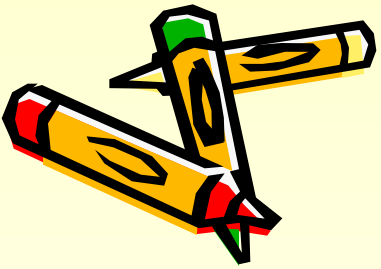
- **Formation (Synthesis):**
  - Acetic acid + Coenzyme A (Co A) → Acetyl-Co A.
  - Acetyl-CoA + Choline Choline acetylase enzyme Acetylcholine + Co A.

- **Storage:**

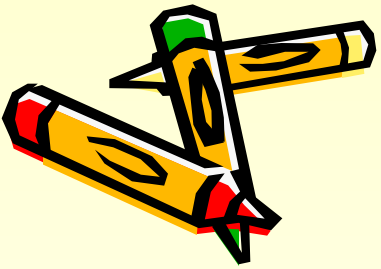
  It is stored in clear vesicles in the cholinergic nerve terminal.

- **Release:**

  It is released by exocytosis in presence of Ca++.

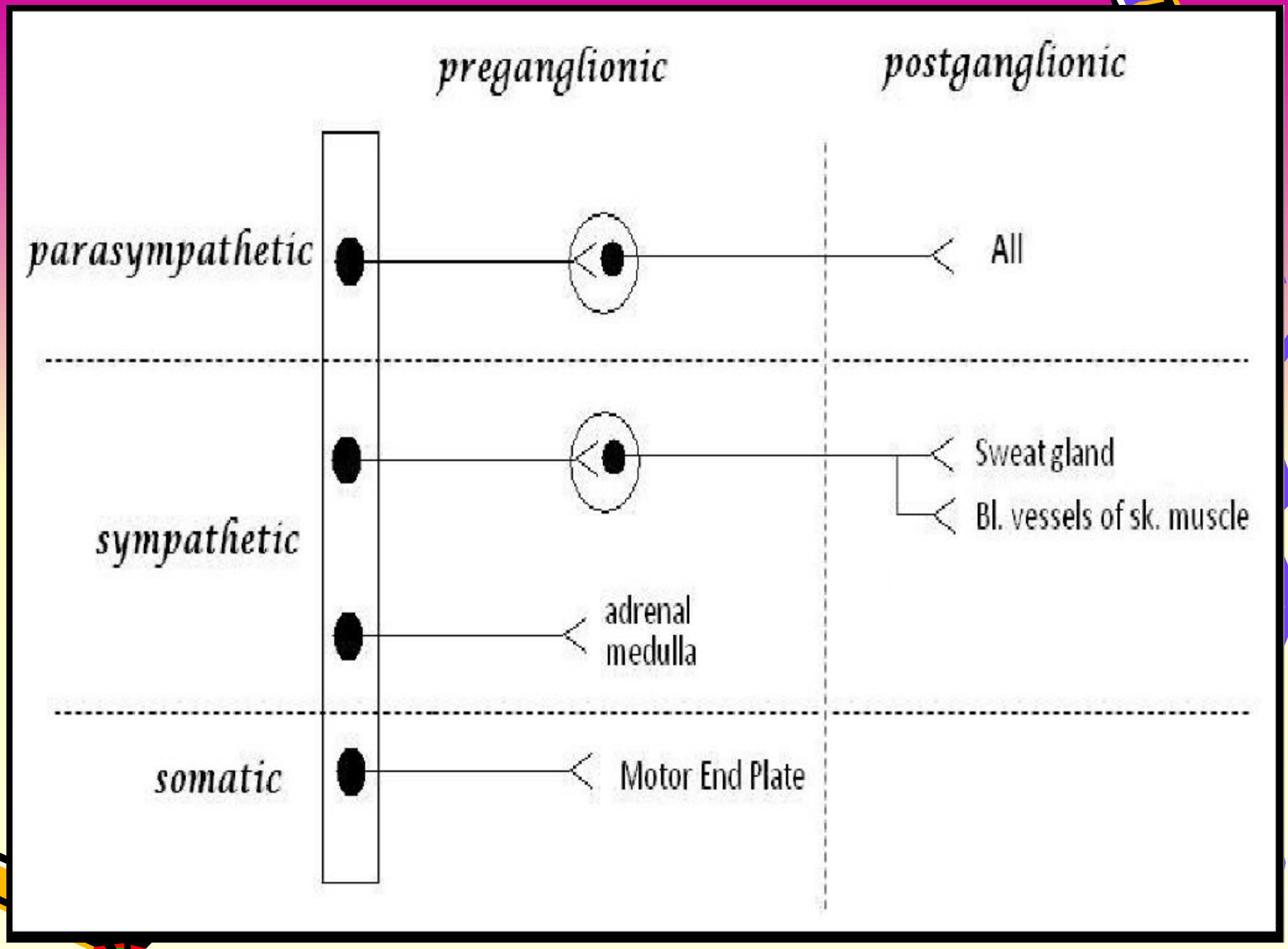


- **Sites of formation and release of acetylcholine:**
  - Central cholinergic fibers.
  - Peripheral cholinergic fibers.
  - Neurotransmitter in CNS.



✹Types of cholinergic fibers:

	Central Cholinergic Fibers	Peripheral Cholinergic Fibers
Origin	They arise from CNS	They arise from autonomic ganglia.
Includes	❖ Autonomic fibers: All preganglionic fibers that arise from LHC to autonomic ganglia whether sympathetic or parasympathetic. ❖ Somatic fibers: Fibers arise from AHC to skeletal muscle i.e. at motor end plate	❖ All postganglionic parasympathetic fibers. ❖ Postganglionic sympathetic fibers to sweat glands and skeletal muscles' blood vessels.

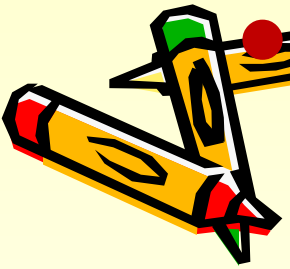

preganglionic
postganglionic
parasympathetic
All
sympathetic
Sweat gland
Bl. vessels of sk. muscle
adrenal
medulla
somatic
Motor End Plate

Removal of A.Ch.:

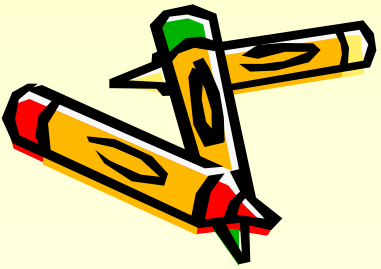
- Mainly by enzymatic destruction to prevents generalized harmful effects of A.Ch.

Acetylcholine —Choline esterase enzyme→ Acetic acid + Choline.

- True (specific) choline esterase enzyme: Present in nervous tissue and RBCs.
- Pseudo (non-specific) choline esterase enzyme: Present in liver and spleen.



- Small amounts are removed by active reuptake by nerve terminal.
- Small amounts are removed by diffusion into surrounding tissues.

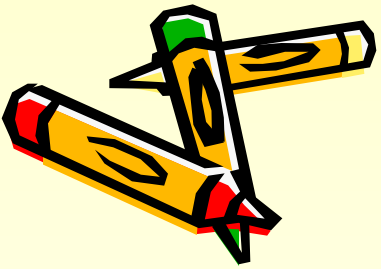


Cholinergic receptors:

A.Ch bind with its specific receptor at the target organ named cholinergic receptors.

There are 2 types of cholinergic receptors;

- Central cholinergic receptors (Nicotinic receptors).
- Peripheral cholinergic receptors (Muscarinic receptors).



	Central Cholinergic Receptors	Peripheral Cholinergic Receptors
Name	They are called nicotinic receptors because they are stimulated by small dose of nicotine.	They are called muscarinic receptors because they are stimulated by muscarine.
Site	• All autonomic ganglia whether sympathetic or parasympathetic. • Adrenal medulla which is considered as modified sympathetic ganglia. • Motor end plate of skeletal muscle.	• Effector organs supplied by postganglionic parasympathetic fibers. • Sweat glands. • Blood vessels of skeletal muscle.

Drugs acting on cholinergic receptors:

- Stimulant drugs (Drugs which ↑↑ Parasympathetic activity) named Parasympathomimetics or acetylcholine agonist.
- Inhibitor drugs (Drugs which ↓↓ Parasympathetic activity) named Parasympatholytics or acetylcholine antagonists.

I-Stimulant drugs (Parasympathomimetics or acetylcholine agonist).

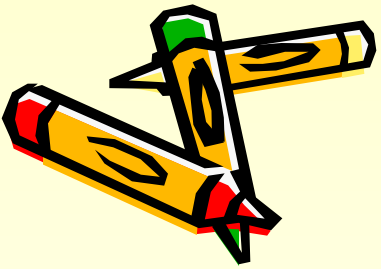
- **Definition:** They are drugs that produce effects in the body similar to the effects of Parasympathic stimulation.
- **Mechanism of action:** They act either by:
  - Direct action on cholinergic receptors: They have structure similar to acetylcholine.
  - Indirect action: They act by inhibition of acetylcholine esterase enzyme (Anti choline esterases) → Accumulation of acetylcholine.

Stimulants (Parasympathomimetic):

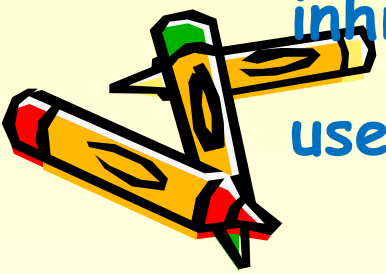
	Nicotinic Receptors	Muscarinic Receptors
Direct action	• Acetylcholine. • Nicotine in small dose.	• Pilocarpine. • Muscarine.
Indirect action	• Reversible anticholine esterase: They cause temporary inhibition of choline esterase enzyme e.g. neostigmine (prostigmine) and physostigmine (eserine). • Irreversible anticholine esterase: They cause permnant inhibition of choline esterase enzyme e.g. organophosphorus compounds as di-isopropyl flurophosphate (DFP = biological war poison) and parathion (insecticidal).	

II-Inhibitor drugs (Parasympatholytics or acetylcholine antagonist).

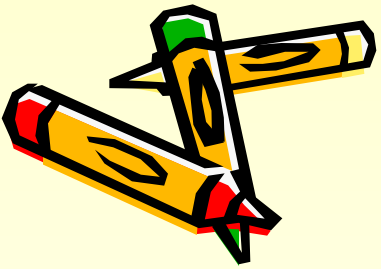
- **Definition:** They are drugs that antagonize the action of acetylcholine.
- **Classification:** They are classified according to the site of action into:
  - Drugs acting on nicotinic receptors (Nicotinic receptor blocker): They include ganglion blockers or neuromuscular blockers.



- Ganglion blockers: They inhibit nicotinic receptors at autonomic ganglia or adrenal medulla. They may be competitive ganglion blocker or depolarizing ganglion blocker.
  - **Competitive ganglion blockers:** They compete with A.Ch for the receptor site preventing it from its binding with the receptors e.g. Hexamethonium.
  - **Depolarizing ganglion blockers:** They cause initial stimulation (prolonged depolarization) followed by inhibition e.g. Nicotine large dose but its not used clinically because it is very toxic.



- Neuromuscular blockers: They inhibit nicotinic receptors at motor end plate (neuromuscular junction). They may be:
  - Competitive neuromuscular blockers e.g. Curare.
  - Depolarizing ganglion blockers e.g. Succinylcholine.
- Drugs acting on muscarinic receptors (Muscarinic receptor blocker): They act by competitive inhibition e.g. Atropine and Homatropine.



Inhibitors (Parasympatholytics):

Nicotinic Receptors	Muscarinic Receptors
Ganglionic blockers: • Competitive inhibition e.g. Hexamethonium. • Depolarizing inhibition e.g. Nicotine in large dose. **Neuromuscular blockers:** • Competitive e.g. Curare. • Depolarizing e.g. Succinylcholine.	• Competitive inhibition e.g. Atropine and Homatropine.