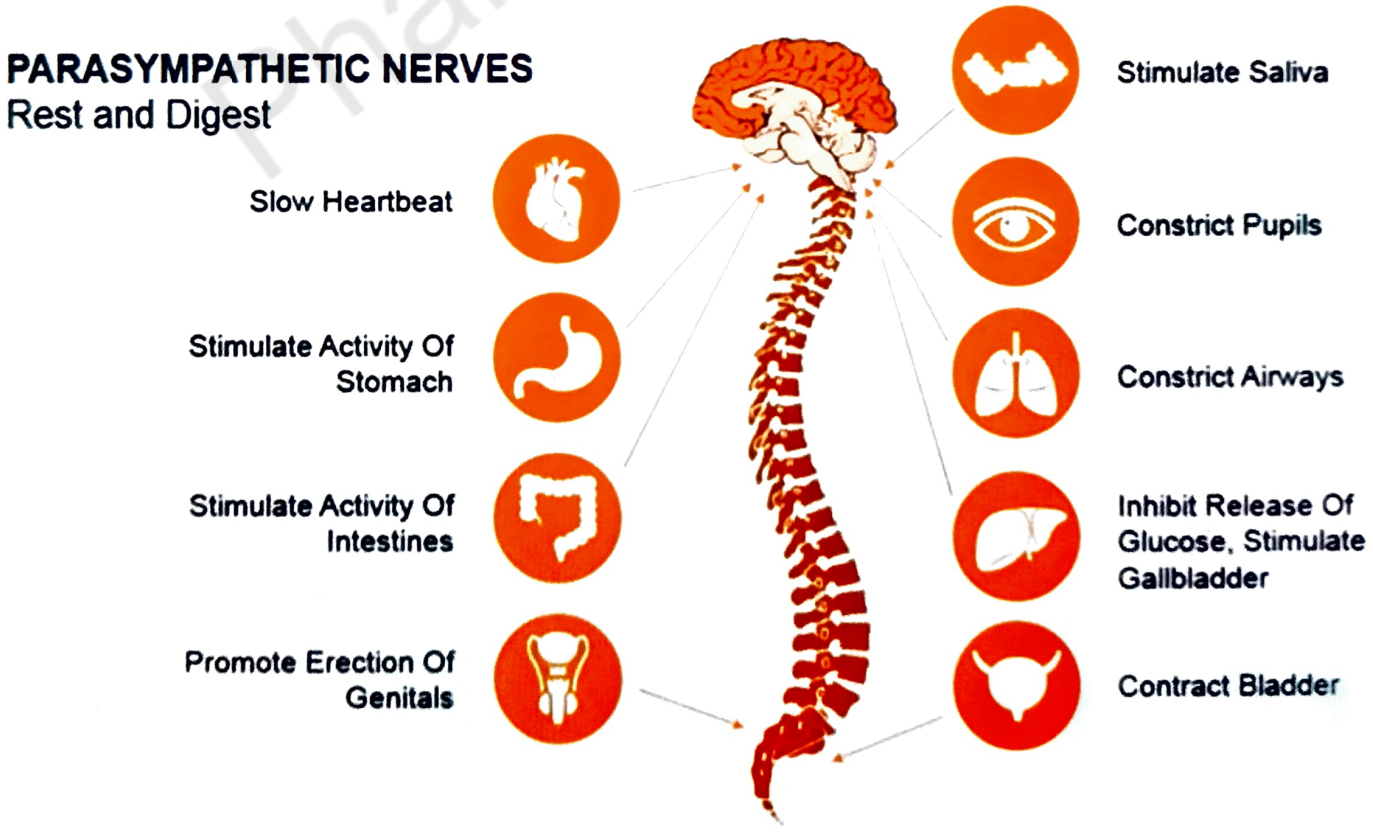
UNIT-III

Drugs acting on Autonomic nervous system

Points to be covered in this topic

- ❑ CHOLINERGIC NEUROTRANSMITTERS
- ❑ PARASYMPATHOMIMETIC AGENTS
- ❑ CHOLINESTERASE REACTIVATOR
- ❑ CHOLINERGIC BLOCKING AGENTS

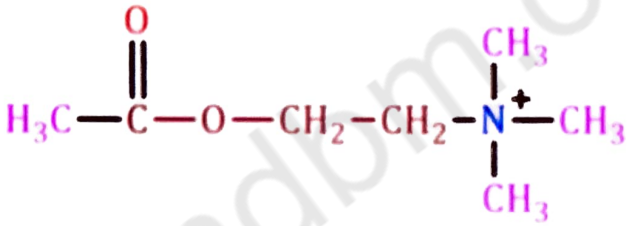


❑ CHOLINERGIC NEUROTRANSMITTERS

- **Synonyms:** Cholinomimetic, cholinergic Agonists, Cholinergic Drugs.
- The neurotransmitter acetylcholine (Ach) is the **only neurotransmitter used in the motor division of the somatic nervous system** (neuromuscular junction) **at autonomic ganglia.**

❖ Acetylcholine

- Acetylcholine (Ach) is an **ester of choline and acetic acid.**
- Acetylcholine is the **neurotransmitter in the preganglionic sympathetic** and **parasympathetic neurons.**
- Acetylcholine, at the **adrenal medulla** and **serves as a neurotransmitter** substance of **nerve impulses within the central and peripheral nervous systems.**

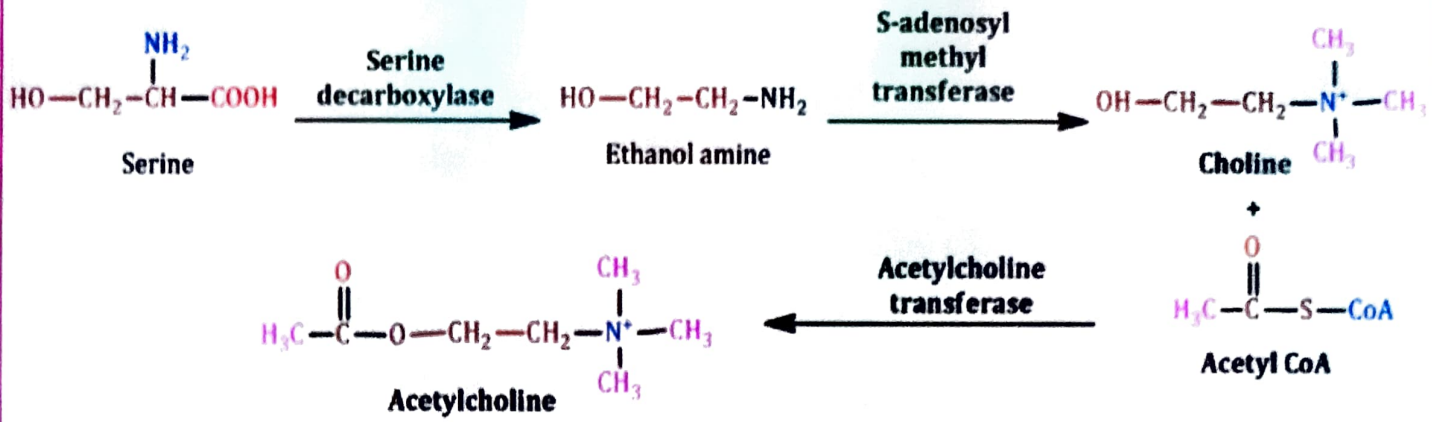


2-acetoxy-N,N,N-
trimethylethanaminium

❖ Biosynthesis, storage and release of acetylcholine

➢ **Synthesis :-** synthesis of acetylcholine (Ach) is done by cholinergic neurons.

- It was **first synthesized by Bayer in 1867 from liver** by **the reaction between the choline with active acetyl (CoA).**
- The active **acetyl CoA formed** by the **combination of acetate with Coenzyme A (CoA).**
- The **reaction between acetyl Coenzyme A and choline** is catalyzed by the **enzyme cholineacetylase**, then **transferred along the axon** to its **terminals where the acetylcholine is formed.**

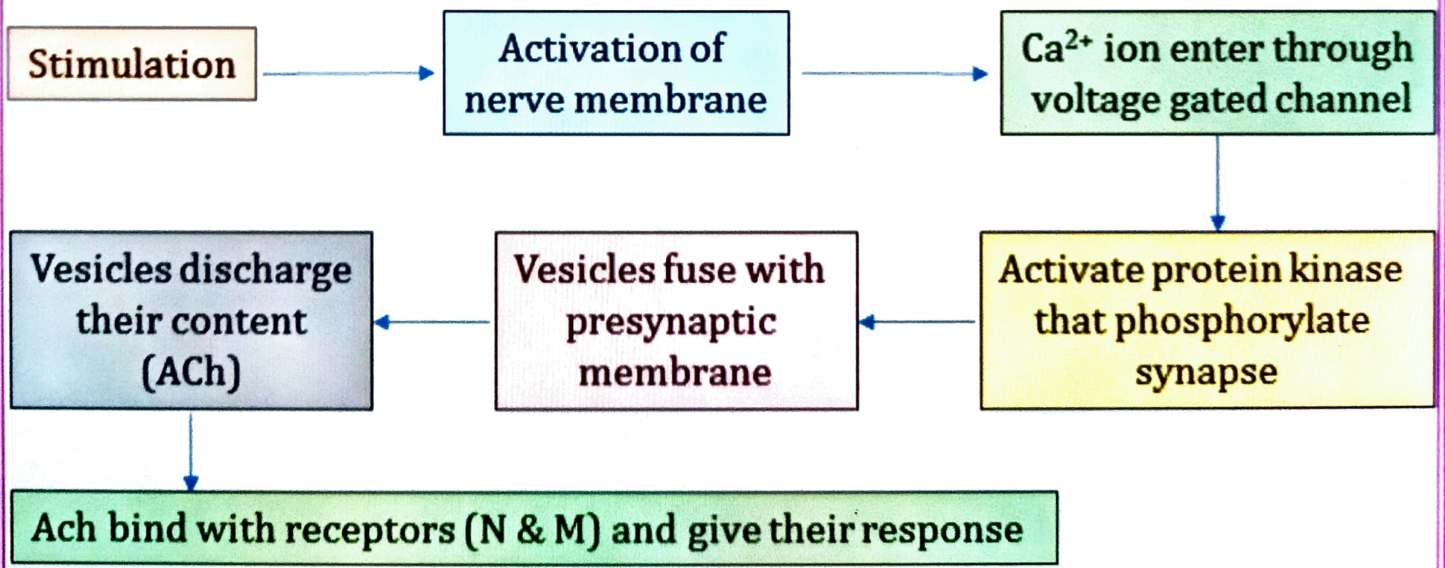


➢ Storage:-

- **ACh is stored in synaptic vesicles**, each **vesicles contains 1000-50000 molecules of acetylcholine**.
- The **mature vesicle contains** not only Ach **but also adenosine triphosphate proteoglycan.**
- The uptake of ACh into storage vesicle occurs through an **energy dependent pump that acidifies the vesicle**. The acidified vesicle then uses a vesicular ACh **transporter (VAChT) to exchange protons for ACh molecules**
- In **vesicles acetylcholine is protected from hydrolysis.**

➢ Release:-

- **Ach is released from storage granules** under the **influence of the nerve action potential and opening Ca^{2+} ion channel** (voltage gated channel).
- This **release can be stopped by botulinum toxin.**

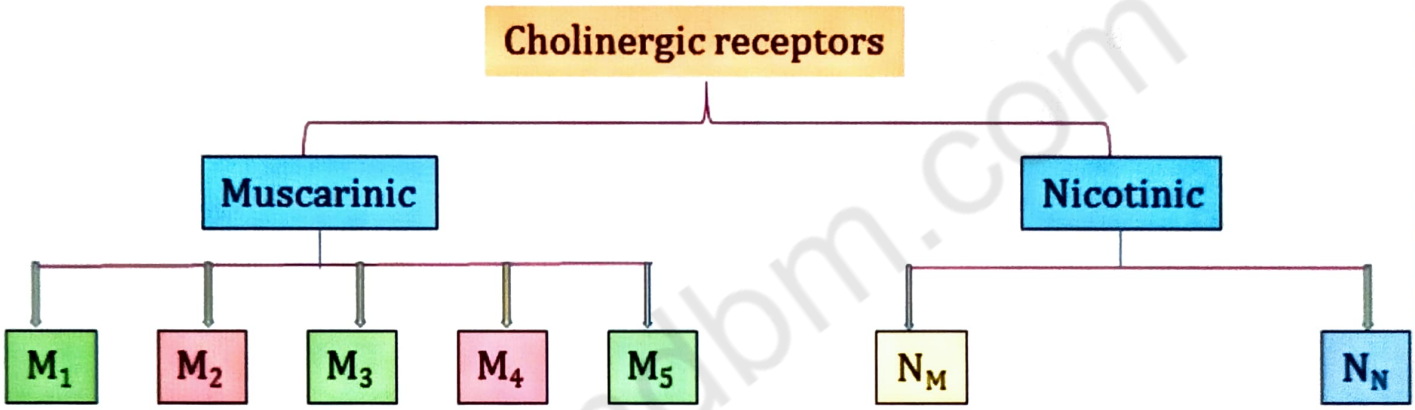


❖ Catabolism of acetylcholine :-

- After the release and action of acetylcholine, the function and effects of Ach Can be terminated with the help of enzyme hydrolysis.
- Cholinesterase enzyme also known as acetylcholine esterase (AchE) and it undergoes hydrolysis, Acetylcholine (Ach) into the inactive metabolites choline and acetic acid.

❖ Cholinergic receptors and their distribution:-

- A cholinergic receptor are those receptor in which cholinergic neurotransmitter binds directly to induce various action or responses.



➢ Muscarinic Receptors:-

- It belongs to the G-protein couple receptors family.
- The prototype agonist for these receptors is muscarinic.
- It is water soluble toxin derived from the poisonous fly agaric, Amanita muscarinic, which cause activation of parasympathetic nervous system.

❖ Receptors with their locations and functions :-

Receptor	Location	Function
M_1	CNS, gastric and salivary glands, autonomic ganglia, enteric nerves	↑ Cognitive function. ↑ Seizure activity. ↑ Secretions. ↑Autonomic ganglia depolarization. ↓ DA release and locomotion.

M_2	Autonomic nerve terminals, CNS, heart, smooth muscle	↑ Smooth muscle contraction. Neural inhibition in periphery via autoreceptors and heteroreceptor. ↓ Ganglionic transmission Neural inhibition in CNS. ↑ Tremors hypothermia & analgesia.
M_3	Salivary glands, heart	↑ Smooth muscle contraction (e.g. bladder). ↑ Salivary gland secretion. ↑ Food intake, body fat deposits Inhibits dopamine release. Synthesis of nitric oxide.
M_4	CNS and heart	Inhibition of autoreceptors and heteroreceptor mediated transmitter release in CNS, Analgesia, Cataleptic activity; Facilitates dopamine release.
M_5	CNS & Periphery nervous system	Mediates dilation of cerebral arteries. Facilitates dopamine release. Augments drug seeking behavior and reward.

➢ Nicotinic Receptors:-

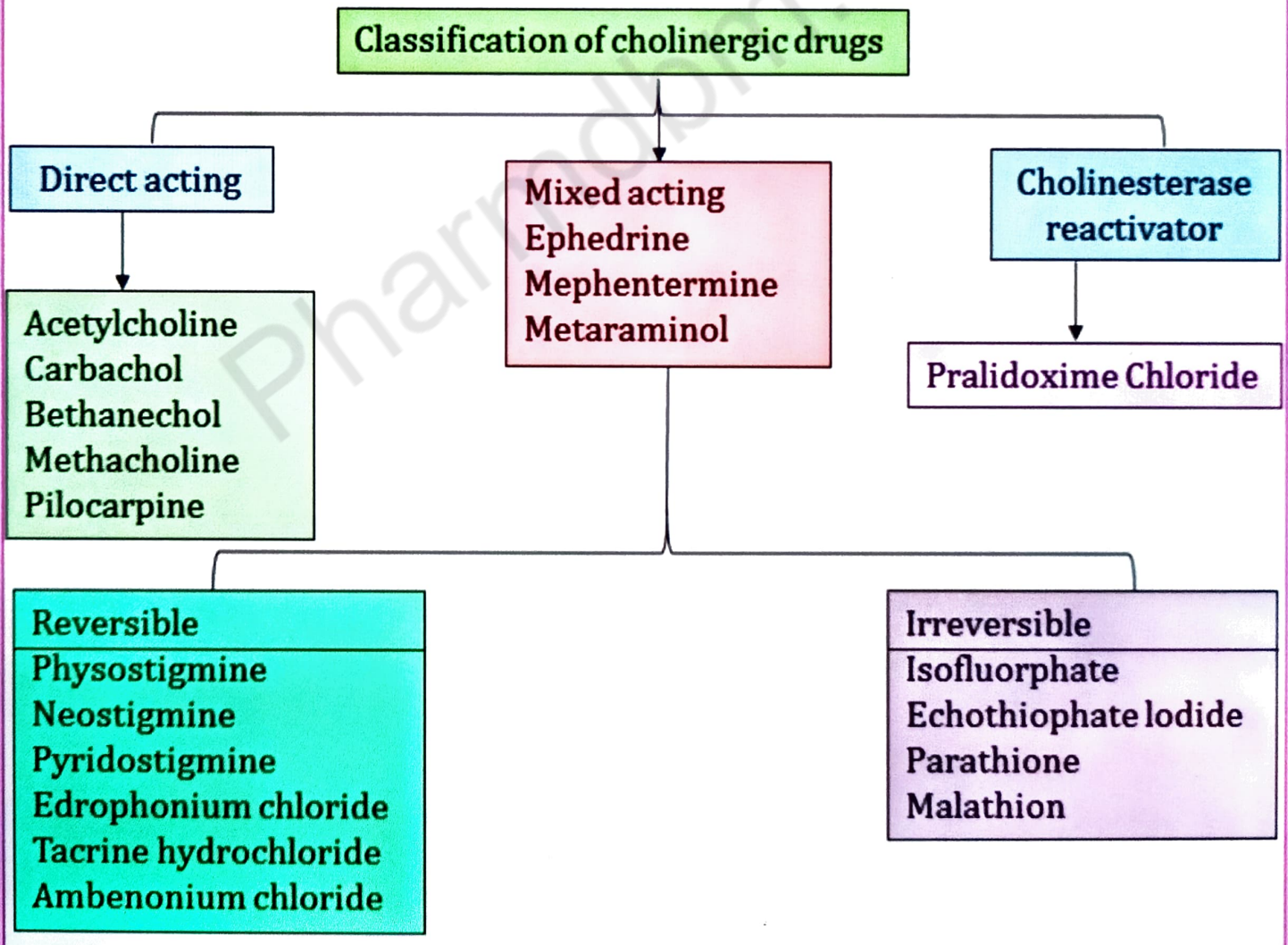
- Nicotinic receptors are directly coupled to ion channels and when activated by Ach, it shows very rapid responses.
- First neurotransmitter receptor isolated and purified in an active form.

Receptor	Location	Function
N_M	Skeletal neuromuscular junction	Skeletal muscle contraction, increase cation permeability

N_N	Ganglionic cells, Adrenal medulla, spinal cord, Brain	Depolarization & secretion of catecholamines

❑ Parasympathomimetic agents:-

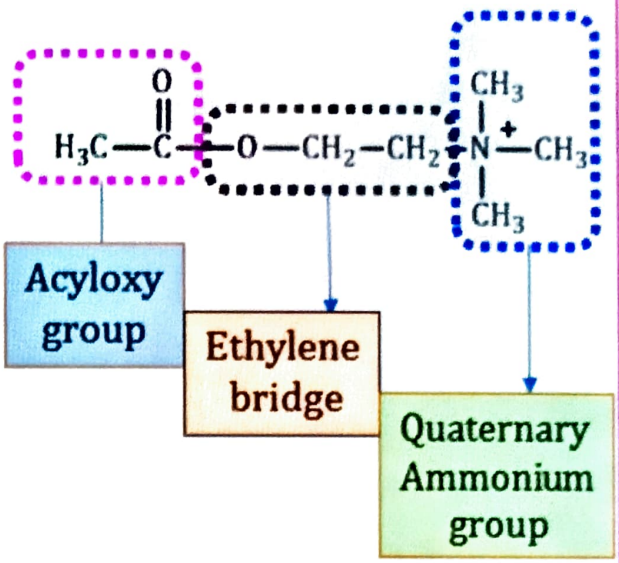
- Compounds **that mimic the action of acetylcholine** or produce the **effect of cholinergic(parasympathetic) nerve stimulation** are called as **Cholinergic or Parasympathomimetic agents.**
- Parasympathomimetic are those chemical agents **which copy the action of parasympathetic nervous system.**
- These agents or drugs **bind with cholinergic receptor (N & M) and give their action.**



❖ SAR of Parasympathomimetic agents:-

➢ Substitution on acetyl group:-

- Replacement of **acetate group** by **carbamate group**, **Increase activity** and also **more stable.**
- **Replacement of ester group by ether & ketone group** give **chemically stable and potent compound** and have **some cholinergic activity.**



➢ Substitution on ethylene bridge:-

- **Increase in the chain length** will **decrease in activity.**
- **Branching on β-substitution** leads to **reduction of nicotinic activity but increase muscarinic activity.**
- **Branching on α-substitution** leads to **increase activity for nicotinic but reduction in muscarinic activity.**

➢ Substitution on quaternary ammonium group:-

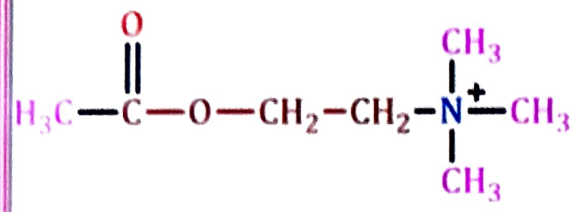
- **Placement of primary, secondary, or tertiary amines** leads to **decrease in activity.**
- **Replacement of more than one methyl group** of quaternary ammonium group leads to **complete loss of cholinergic activity.**
- **The quaternary ammonium group is essential for intrinsic activity.**

❖ Drugs acting on Parasympathomimetic agents:-

➢ Direct acting :-

- These are **those drugs or agents which directly bind with cholinergic receptor (N&M) and gives its action.**

1) Acetylcholine



2-acetoxy-N,N,N-trimethylethanaminium

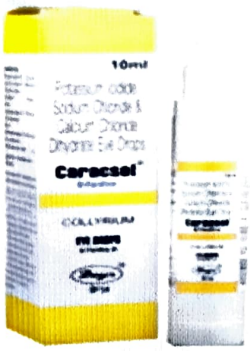
✓ Mechanism of action

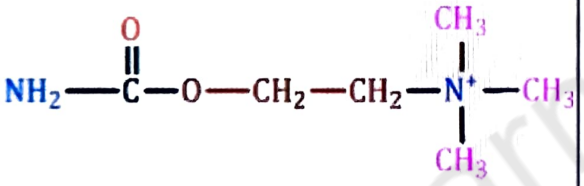
- It is direct acting cholinergic drug.
- It is powerful but its action is destructed by cholinesterase

✓ Uses

- widely used as eye drop to cause miosis during surgery & recovery.
- used as vasodilator & cardiac depressant etc.

2) Carbachol





2-(carbamoyloxy)-N,N,N-trimethylethanaminium

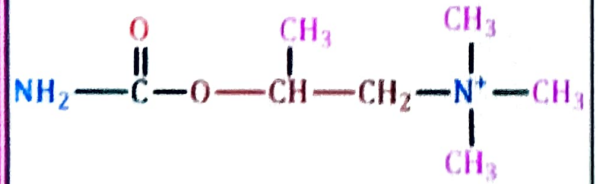
✓ Mechanism of action

- Bind with both muscarinic and nicotinic.
- It is not inactivated by cholinesterase so its action are more prolonged than acetylcholine.

✓ Uses

- Used in case of severe chronic glaucoma.
- Give intraocular to produce miosis in ocular surgery and to reduce post operative risk.

3) Bethanechol



2-(carbamoyloxy)-N,N,N-trimethylpropan-1-aminium

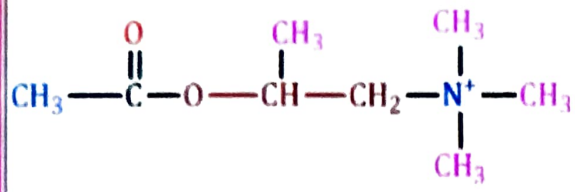
✓ Mechanism of action

- More selective on the muscarinic receptor.
- It is more stable than Carbachol due to presence of methyl group on B- Carbon.

✓ Uses

- Used to stimulate GI tract and urinary bladder after surgery.
- Prolong effect than acetylcholine.

4) Methacholine



2-acetoxy-N,N,N-trimethylpropan-1-aminium

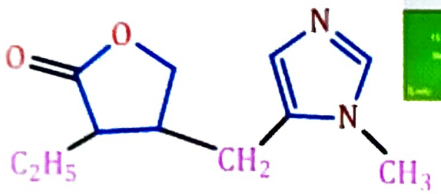
✓ Mechanism of action

- It has muscarinic actions of acetylcholine.
- Prolonged action than acetylcholine

✓ Uses

- Used in the treatment of Reynaud's syndrome and glaucoma.
- Used in case of tachycardia.

5) Pilocarpine



3-ethyl-4-((1-methyl-1H-imidazol-5-yl)methyl)dihydrofuran-2(3H)-one

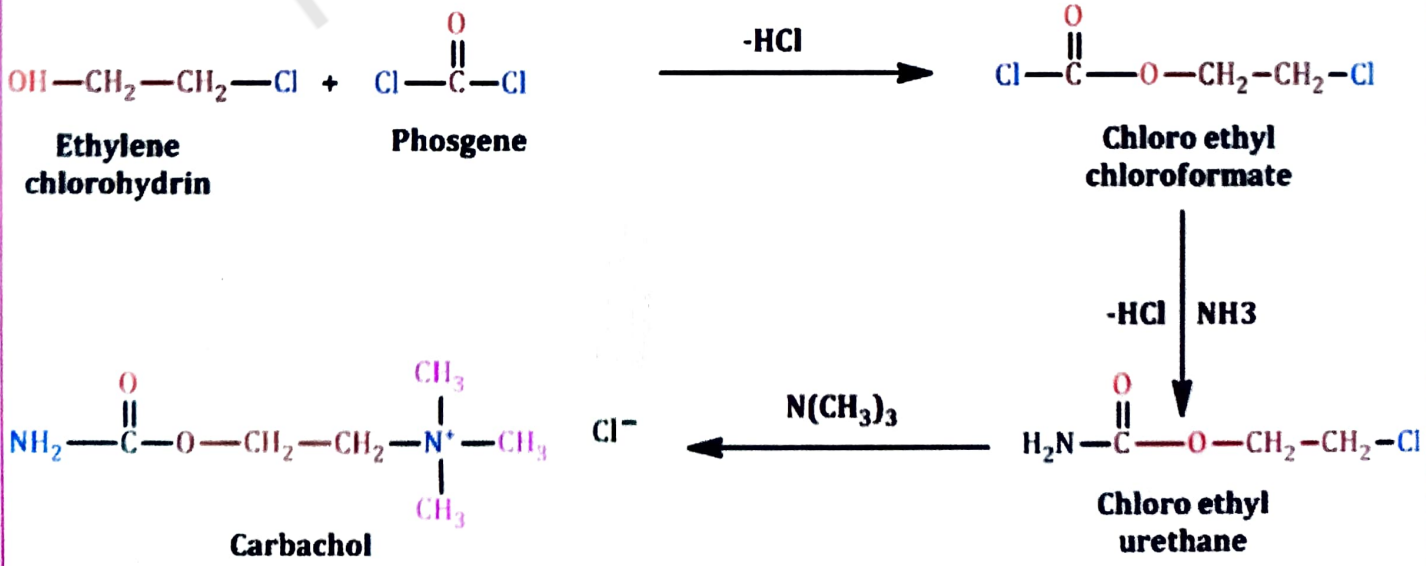
✓ Mechanism of action

- Direct acting cholinergic drug that has muscarinic effect of acetylcholine.

✓ Uses

- Used in treatment of glaucoma and in treatment of dry eye or dry mouth.
- Used before surgery as part of emergency treatment of acute attacks of angle-closure glaucoma.

❖ Synthesis of carbachol:- From: Ethylene chlorohydrin



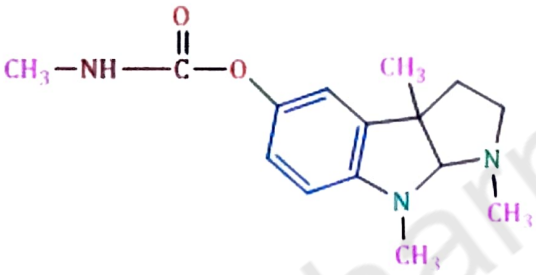
➢ Indirect acting :-

- Also known as **anticholinesterases**.
- These are those drug **which does not directly act on receptor but inhibit the hydrolysis of acetylcholine by acetyl cholinesterase** and hence **increase the life of acetylcholine so acetylcholine give their action**.
- They are of two types:-

I. Reversible:-

- These are **those drugs which binds reversibly to the acetyl cholinesterase enzyme.**
- They are **capable of combining with the anionic and esteratic sites of cholinesterase** as well as with Ach receptor.

1) Physostigmine



1,3a,8-trimethyl-1,2,3,3a,8,8a-hexahydropyrrolo[2,3-b]indol-5-yl methylcarbamate

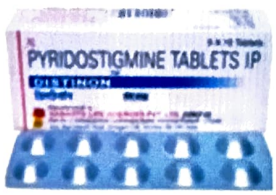
✓ Mechanism of action

- Reversible cholinesterase Inhibitor.
- It indirectly stimulate both muscarinic and Nicotinic receptor.

✓ Uses

- Used as **a miotic.**
- Used to **decrease intraocular pressure in glaucoma.**

3) Pyridostigmine



3-((dimethyl carbamoyl)oxy)-1-methylpyridin-1-ium

✓ Mechanism of action

- **Block acetyl cholinesterase enzyme** and **inhibit the destruction of released acetylcholine.**

✓ Uses

- Used in the **treatment of myasthenia gravis.**
- Also **helpful in nerve gas poisoning.**

2) Neostigmine

3-((dimethylcarbamoyl)oxy)-N,N,N-trimethylbenzenaminium

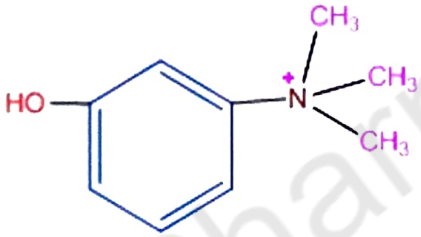
✓ Mechanism of action

- It **indirectly Stimulates both muscarinic and nicotinic receptors.**
- It **bind to the anionic and esteratic site of cholinesterase** and **block the activity of anticholinesterase.**

✓ Uses

- Used in the **treatment of myasthenia gravis.**
- Also used in **glaucoma (lower intraocular pressure).**

4) Edrophonium chloride



3-hydroxy-N,N,N-trimethylbenzenaminium

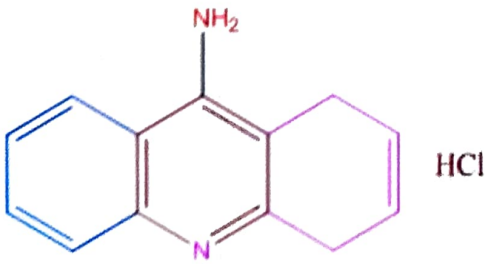
✓ Mechanism of action

- **Reversible cholinergic inhibitor**
- **short duration of action than neostigmine and pyridostigmine**

✓ Uses

- Useful for **the treatment of myasthenia gravis (not for regular).**
- Used in **the treatment snake bite.**

5) Tacrine hydrochloride



1,4-dihydroacridin-9-amine hydrochloride

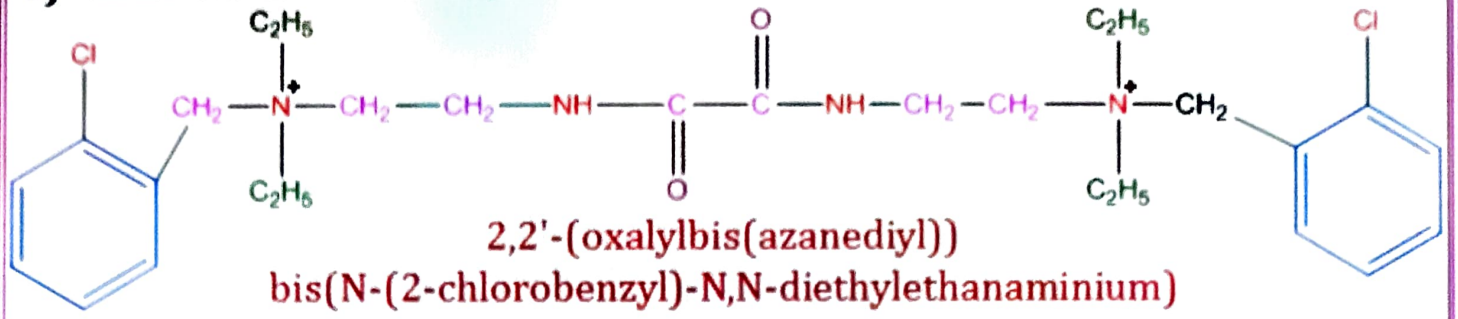
✓ Mechanism of action

- **Centrally acting anticholinesterases.**

✓ Uses

- Used for **the treatment of Alzheimer's disease.**

6) Ambenonium Chloride



2,2'-(oxalylbis(azanediyl))
bis(N-(2-chlorobenzyl)-N,N-diethylethanaminium)

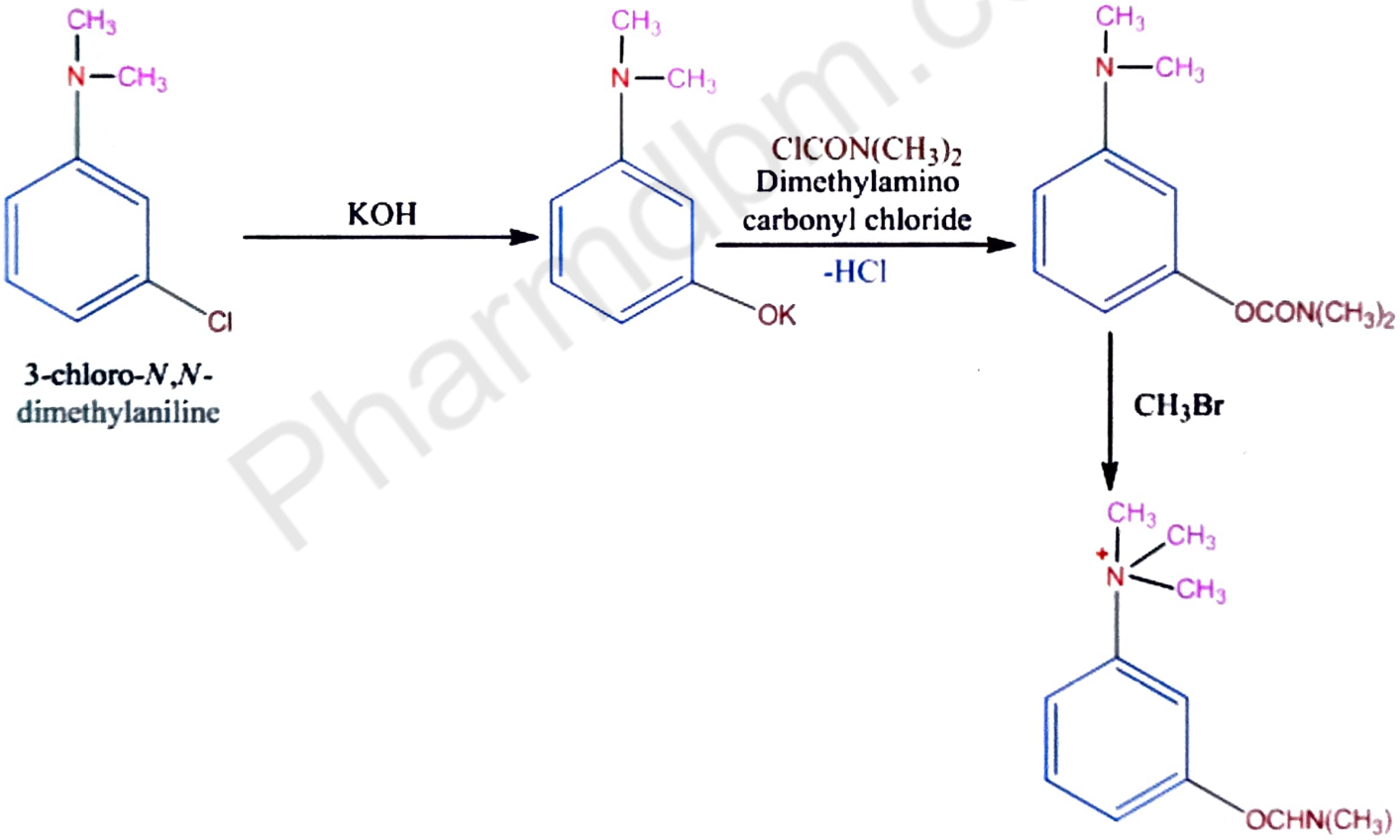
✓ Mechanism of action

- Reversibly inhibit acetyl cholinesterase enzyme.

✓ Uses

- Used in the treatment and management of myasthenia gravis.

❖ Synthesis of Neostigmine:- From –m-chloro-N,N-dimethyl amino benzene

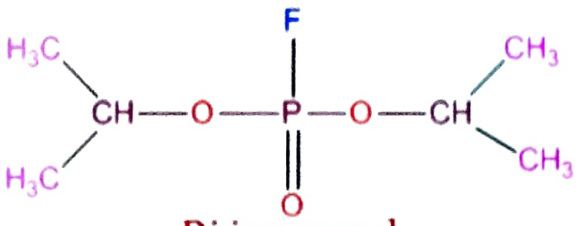


3-chloro-*N*,*N*-dimethylaniline

II. Irreversible:-

- These are those drug which produces Irreversible inactivation of acetylcholinesterase enzyme.
- Bind to cholinesterase and form a permanent covalent bond.
- The body must make new cholinesterase to break these bonds.

1) Isoflurophate



Di isopropyl phosphorofluoridate

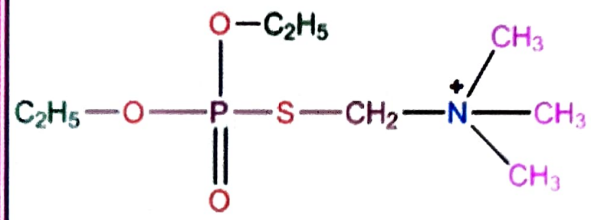
✓ Mechanism of action

- **Irreversible Inactivation of the acetyl cholinesterase.**

✓ Uses

- **Used as miotic agent in treatment of glaucoma.**

2) Ecothiophate Iodide



1-((diethoxy phosphoryl)thio)-N,N,N-trimethylmethanaminium

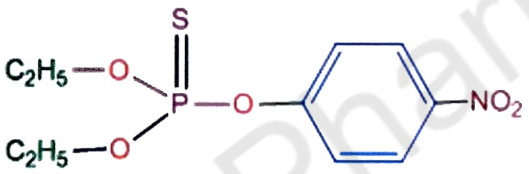
✓ Mechanism of action

- **Irreversible acetyl cholinesterase inhibitor.**
- **Permanently inactive the enzyme.**

✓ Uses

- **Used as Chronic an Ocular antihypertensive in the treatment of glaucoma.**

3) Parathione



O,O-diethyl O-(4-nitrophenyl) phosphorothioate

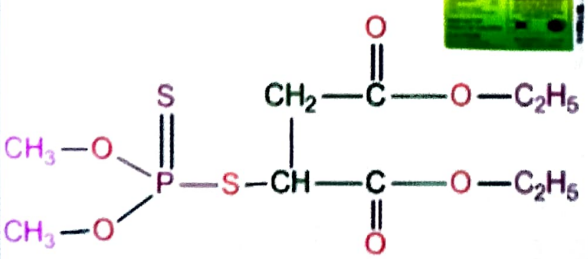
✓ Mechanism of action

- **Indirectly inhibitor.**

✓ Uses

- **Used as insecticide in agriculture.**

3) Malathion



diethyl 2-((dimethoxyphosphorothioyl)thio)succinate

✓ Mechanism of action

- **Binding serine residue on cholinesterase enzyme & inactive it irreversibly.**

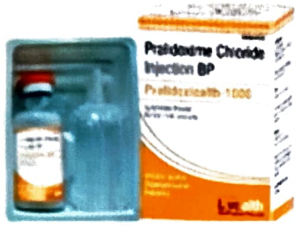
✓ Uses

- **Used for treatment of scabies.**
- **Used as insecticide.**

❑ Cholinesterase reactivator:-

- Drugs used to reverse the inactivation of cholinesterase caused by organophosphates or sulfonates.
- They are an important component of therapy in agricultural, industrial, and military poisonings by organophosphates and sulfonates.

1) Pralidoxime chloride



2-((hydroxyamino)methyl)-1-methylpyridin-1-ium chloride

✓ Mechanism of action

- It reactivate the enzyme by binding to the anionic site of enzyme.
- And displaces the phosphate from the serine residue.

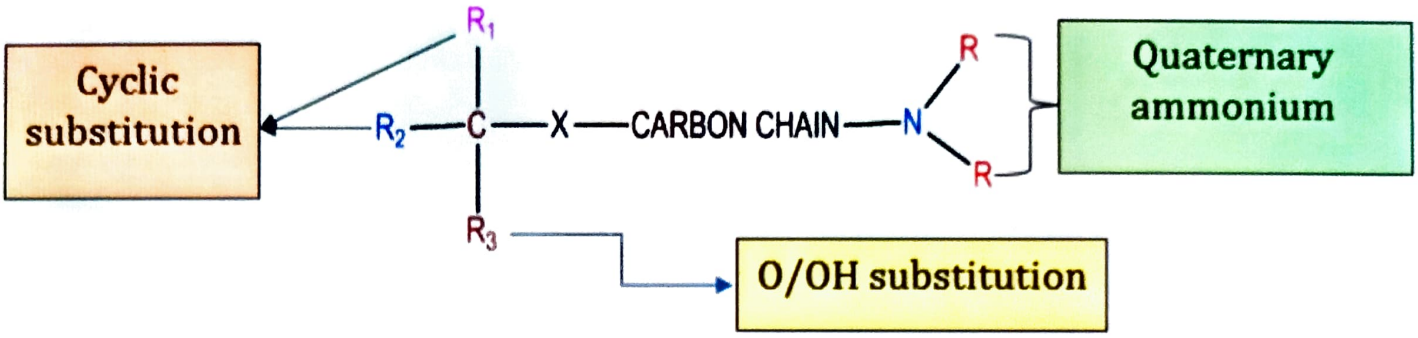
✓ Uses

- Used for the treatment of poisoning organophosphorus Compounds.

❑ CHOLINERGIC BLOCKING AGENTS:-

- **Synonyms:- Cholinergic blocking agents, Cholinolytic agents, Anticholinergic agents/drugs, Cholinergic antagonist, Parasympatholytic agents, antimuscarinic agents.**
- These are those agents or drugs which inhibit the effect of acetylcholine or parasympathomimetic agents. by blocking the cholinergic receptors.
- These drugs are highly specific reversible competitive antagonists for muscarinic ACh receptors.
- They are rapidly absorbed from the gastrointestinal tract, slowly absorbed when applied locally on eye or skin.

❖ SAR OF CHOLINERGIC BLOCKING AGENTS:-



➢ Substitution on Quaternary ammonium groups:-

- Quaternary ammonium compounds **possess most potent anticholinergic activity.**
- Replacement of quaternary to the **tertiary, secondary or primary Cause decreases in activity.**

$1° < 2° < 3° < 4°$

➢ Substitution in carbon chain:-

- The Substitution **may be ester, ether, alcohol amine.**
- But, **Ester group provides the most potent anticholinergic activity. E.g.-Atropine.**
- **The nature of the group X effects only the duration of action, the physicochemical properties and the side effects of the drug molecule but not its ability to bind with the receptor.**
- **The distance between the ring-substituted carbon and the amine nitrogen apparently is not critical; the length of the alkyl chain connecting these can be from two to four carbons.**
- **The most potent anticholinergic agents have two methylene units in this chain.**

➢ Substitution in carbon chain:-

- Substituent R_1&R_2 should be carbocyclic or heterocyclic ring for maximal antagonist activity.
- Replacement of heterocyclic rings to aromatic decrease activity.
- The rings could be identical but the more potent compounds are found to have different ring Substitution.

➢ Substitution on R_3 group:-

- Substituent R_3 should be a hydrogen atom, hydroxy group, hydroxymethyl group, or methyl group.
- H or OH attached antagonist are more potent (activity increase).
- In H or OH,

  OH → Action (activity increase), duration of action will decrease.

  H → Action (Activity decrease), duration of action will increase.

Classification of cholinergic blockers

Solanaceous alkaloids

- Atropine sulphate
- Hyoscyamine sulphate
- Scopolamine hydrobromide
- Homatropine hydrobromide
- Ipratropium bromide

Synthetic cholinergic blockers

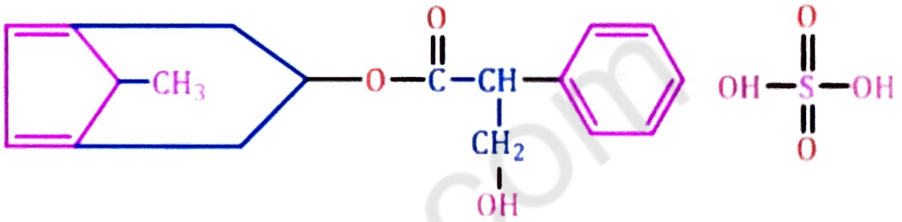
- Tropicamide
- Cyclopentolate hydrochloride
- Clidinium bromide
- Dicyclomine hydrochloride
- Glycopyrrolate
- Methantheline bromide
- Propantheline bromide
- Benztropine mesylate
- Orphenadrine citrate
- Biperidine hydrochloride
- Procyclidine hydrochloride
- Tridihexethyl chloride
- Isopropamide iodide
- Ethopropazine hydrochloride

❖ Drugs acting on cholinergic blocking agents:-

➢ Solanaceous alkaloids and analogues:-

- Solanaceous alkaloids are **ester of the tropine, these alkaloids** are **obtained from plants these such as atropa belladonna, Hyoscyamus niger, Datura stramonium etc.**
- It is an **optically active compound and levoform is potent.**
- **(-) scopolamine is slightly water miscible viscous liquid.**
- Scopolamine occurs as Scopolamine hydrobromide salt, **which is colorless, odorless, water soluble powder.**

1) Atropine sulphate



[(1S,5R)-8-methyl-8-azabicyclo[3.2.1]octan-3-yl]3-hydroxy-2-phenylpropanoate;sulfuric acid

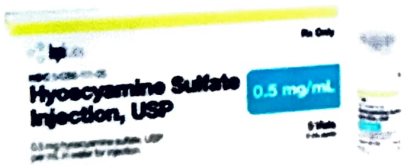
✓ Mechanism of action

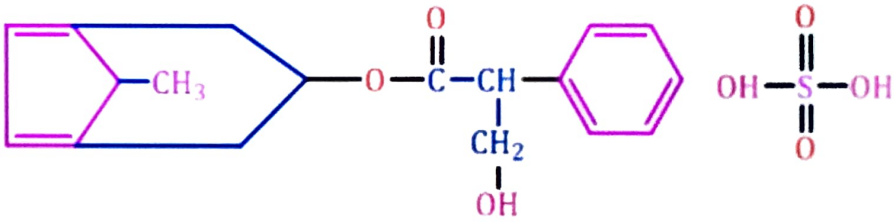
- It **has both central and peripheral action.**
- It **first stimulates and then depresses the CNS.**

✓ Uses

- used in **the treatment of gastric and duodenal ulcers.**
- used in the **treatment of smooth muscle spasm.**

2) Hyoscyamine sulphate





8-methyl-8-aza-bicyclo[3.2.1]octan-3-yl 3-hydroxy-2-phenylpropanoate;sulfuric acid

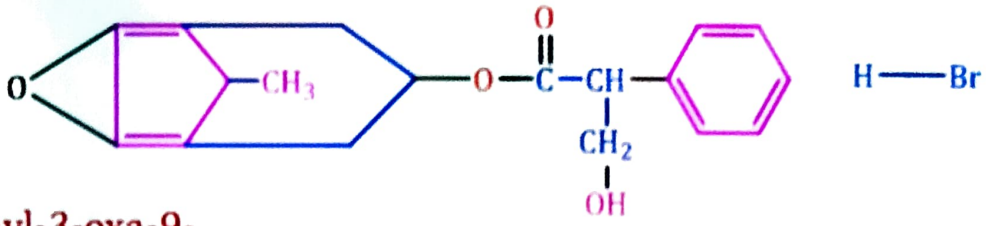
✓ Uses

- **Treatment of gastric and duodenal ulcer.**
- Also **used In treatment of parkinsonism.**
- **Prevent motion sickness.**

✓ mechanism of action

- **Similar to atropine.**
- More **potent than atropine.**

3) Scopolamine hydrobromide



[(1R,2R,4S,5S)-9-methyl-3-oxa-9-azatricyclo[3.3.1.02,4]nonan-7-yl] (2S)-3-hydroxy-2-phenylpropanoate;hydrobromide

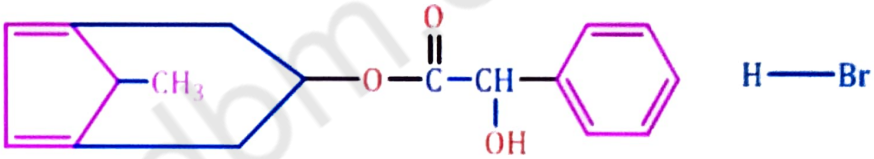
✓ Uses

- Used in the **treatment of motion sickness.**
- Sometimes **used before surgery to decrease saliva**

✓ Mechanism of action

- It has **more rapid onset but shorter duration of action than atropine.**
- **More potent than atropine.**
- **More toxic**

4) Homatropine hydrobromide



8-methylbicyclo[3.2.1]octa-1(7),5-dien-3-yl2-hydroxy-2-phenylacetate;hydrobromide

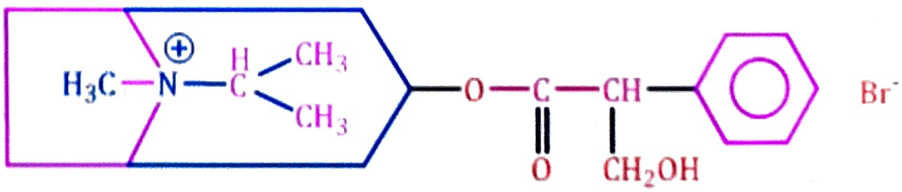
✓ Mechanism of action

- It **is a competitive inhibitor of acetylcholine at the muscarinic receptor,** blocks parasympathetic stimulation.

✓ Uses

- It is **used to dilate or enlarge pupils in eyes.**

5) Ipratropium bromide



(8-methyl-8-propan-2-yl-8-azoniabicyclo[3.2.1] octan-3-yl)3-hydroxy-2-phenylpropanoate ; bromide

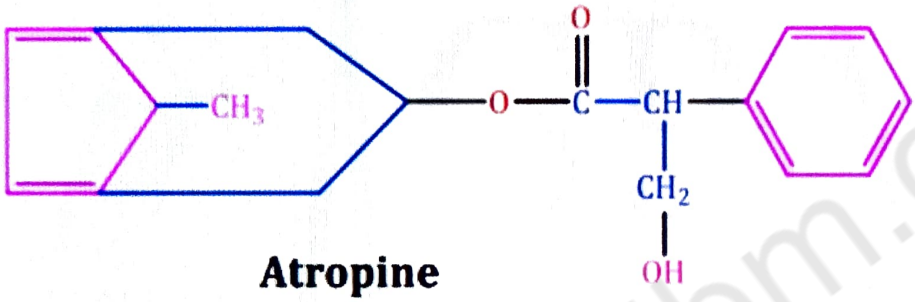
✓ Mechanism of action

- It is quaternary ammonium compound which blocks muscarinic acetylcholine receptors.
- It is non-selective Muscarinic antagonist.

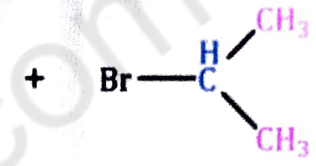
✓ Uses

- Used in the treatment of Asthma.
- treatment of chronic obstructive pulmonary disease (COPD).

❖ Synthesis of Ipratropium bromide:-

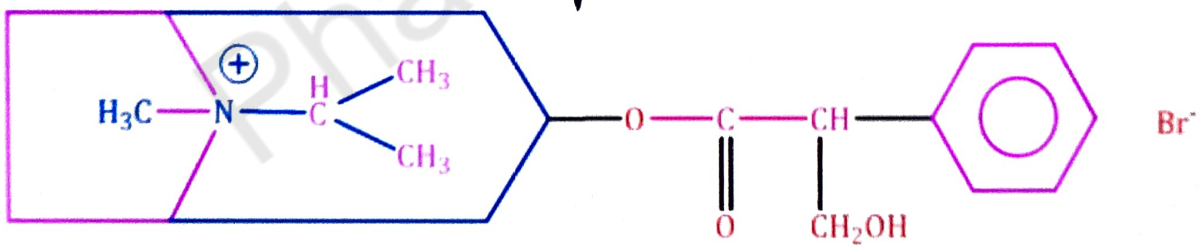


Atropine



Isopropyl bromide

HBr

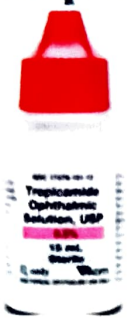


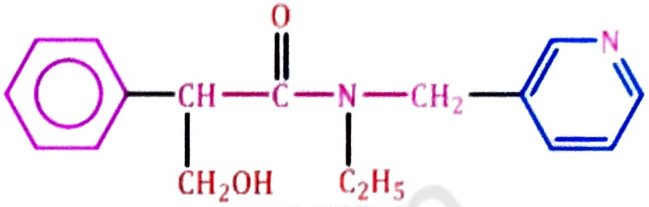
Ipratropium bromide

➢ Drugs acting on synthetic cholinergic blocking agents:-

- Solanaceous alkaloids have lack selectivity and also have Some Side effects, this lead to the development of synthetic anticholinergic agents.
- Various modification have been made in the structure of atropine to give various cholinergic antagonist.

1) Tropicamide





N-ethyl-3-hydroxy-2-phenyl-N-(pyridin-3-ylmethyl)propanamide

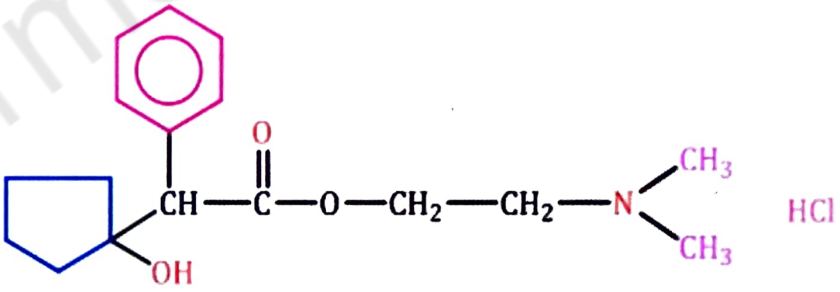
✓ Mechanism of action

- Act as a competitive antagonist for Ach.

✓ Uses

- Used for dilation of pupil (before & after eye surgery).

2) Cyclopentolate hydrochloride



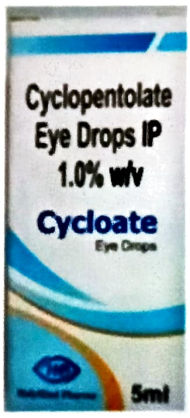
2-(dimethylamino)ethyl-2-(1-hydroxyl cyclopentyl)-2-phenylacetate;hydrochloride

✓ Uses

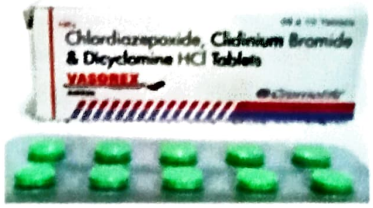
- Used in a eye drop for mydriasis (dilation of pupil).

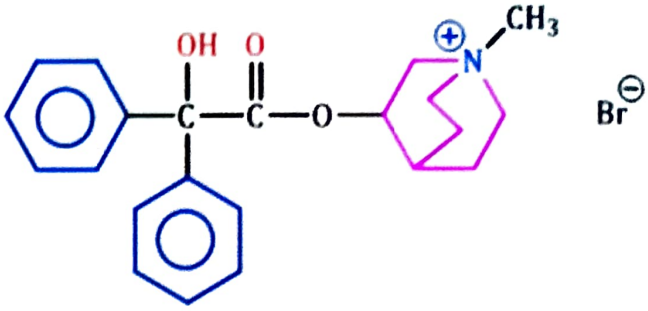
✓ Mechanism of action

- Act as a competitive antagonist for Ach.
- Act more quickly than atropine



3) Clidinium bromide





(1-methyl-1-azoniabicyclo[2.2.2] octan-3-yl) 2-hydroxy-2,2-diphenyl acetate; bromide

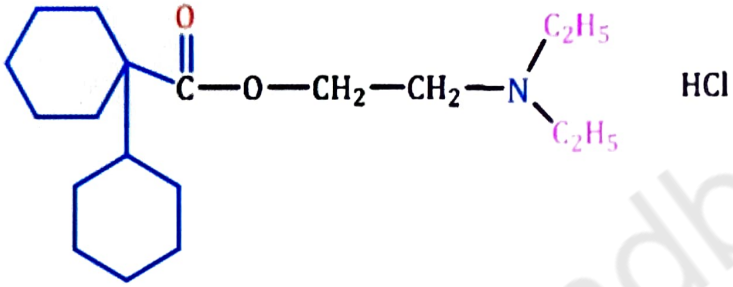
✓ Mechanism of action

- Bind with **muscarinic receptor on smooth muscles and secretory gland & Inhibit the receptor.**

✓ Uses

- it **relaxes smooth muscles and decrease biliary tract secretion.**
- **Used in treatment of irritable bowel syndrome.**

4) Dicyclomine hydrochloride



2-(diethylamino)ethyl1-(cyclohexyl methyl)Cyclohexanecarboxylate hydrochloride

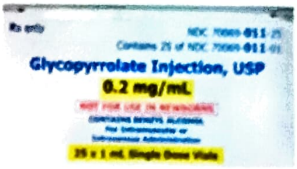
✓ Mechanism of action

- Acts as **non selective smooth. muscle relaxant.**
- It has **specific anticholinergic effect at muscarinic receptor and has direct effect on smooth muscles.**

✓ Uses

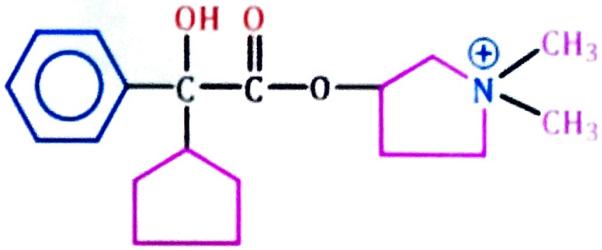
- used in **the treatment of irritable bowel syndrome.**
- Also used in **the treatment of gastric and duodenal ulcer.**

5) Glycopyrrolate



✓ Mechanism of action

- Blocks muscarinic receptor thus inhibiting cholinergic transmission.



(1,1-dimethylpyrrolidin-1-ium-3-yl) 2-cyclopentyl-2-hydroxy-2-phenylbromide

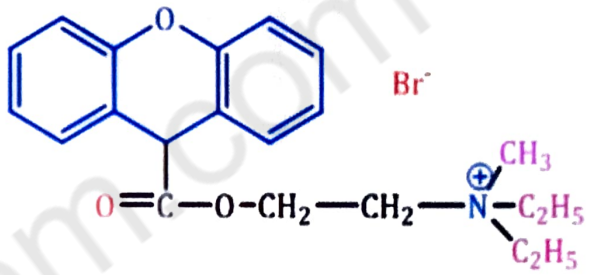
✓ Uses

- Used to treat gastric ulcer by reducing acidic secretion.
- Used before surgery to reduce salivary, bronchial and gastric secretion.

6) Methantheline bromide

✓ Mechanism of action

- Bind muscarinic receptor & blocks the action of Ach.



2-(9H-xanthene-9-carbonyloxy)-N,N-diethyl-N-methyl ethanaminium bromide

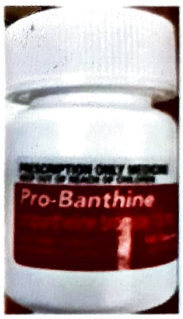
✓ Uses

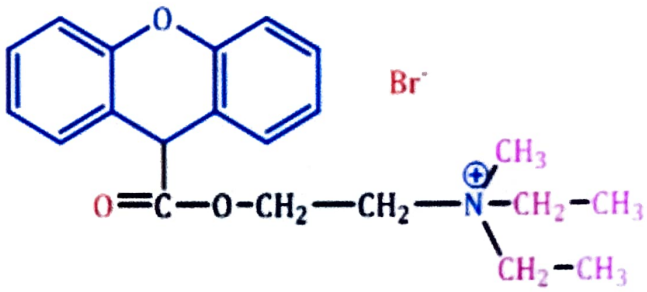
- Uses It is given in the combination of antacid to treat peptic ulcer.

7) Propantheline bromide

✓ Mechanism of action

- It blocks the action of acetylcholine by binding to Muscarinic receptor present in various smooth muscle like gut bladder and eye.



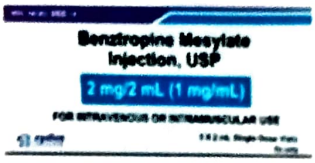


diethyl-methyl-[2-(9H-xanthene-9-carbonyloxy)ethyl]azaium; bromide

✓ Uses

- treatment of spasm of the stomach, intestine & bladder.
- used in the treatment of excessive sweating.

8) Benztropine mesylate

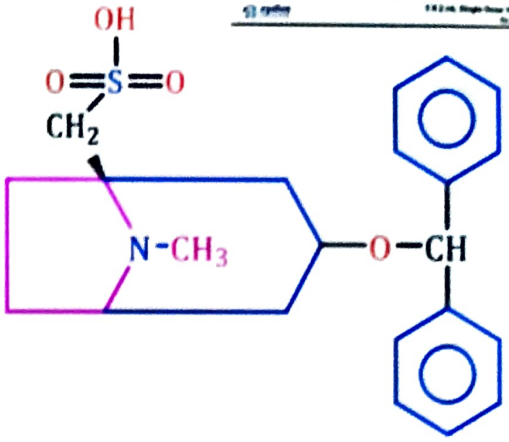


✓ Mechanism of action

- centrally acting anticholinergic & antihistamine agent. It is selective M_1 Muscarinic antagonist.

✓ Uses

- Used in treatment of Parkinson's disease.
- Anticholinergic, antihistaminic and local anesthetic activity.



((1R)-3-(benzhydryloxy)-8-methyl-8-aza-bicyclo[3.2.1]octan-1-yl)methane sulfonic acid

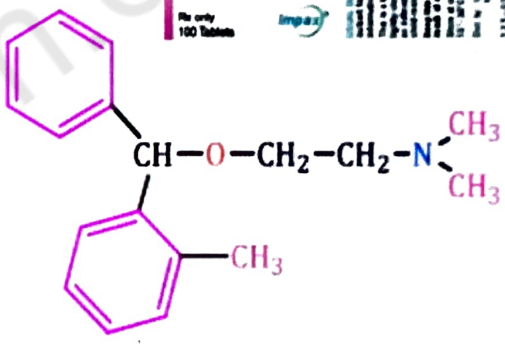
9) Orphenadrine citrate

✓ Mechanism of action

- It is well known non selective acetylcholine receptor antagonist and also antihistamine.

✓ Uses

- It is used in skeletal muscles relaxant.
- Also used in treatment of Parkinson's disease.



N,N-dimethyl-2-(phenyl(o-tolyl) methoxy) ethanamine

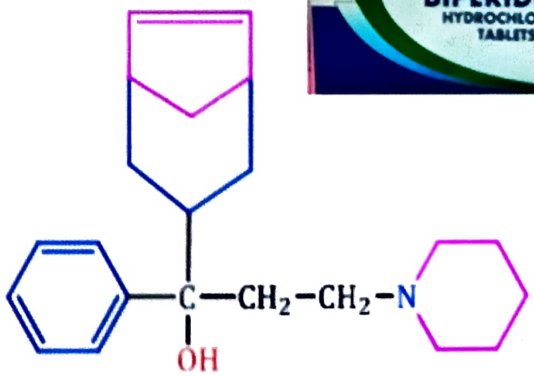
10) Biperidine Hydrochloride

✓ Mechanism of action

- Acts as a centrally blocking agent and block M_1.

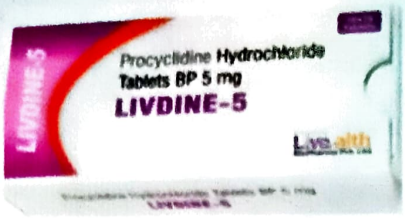
✓ Uses

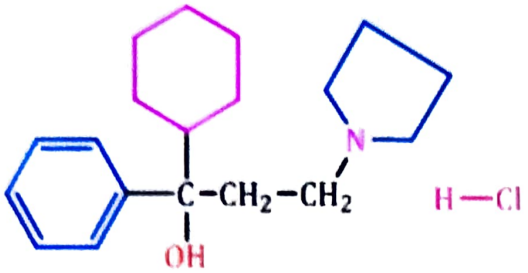
- It have strong musculotropic action.
- Used in all type of Parkinson's disease.



(1S)-1-(bicyclo[3.2.1]oct-6-en-3-yl)-1-phenyl-3-(piperidin-1-yl) propan-1-ol

11) Procyclidine Hydrochloride





1-cyclohexyl-1-phenyl-3-pyrrolidin-1-ylpropan-1-ol; hydrochloride

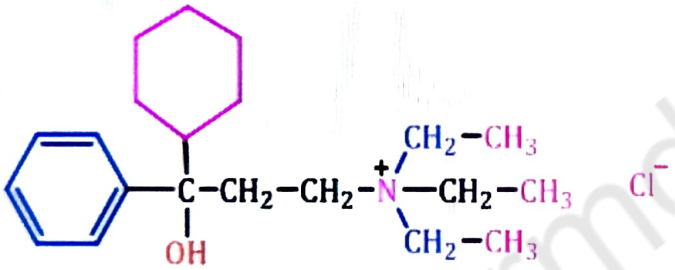
✓ Mechanism of action

- Acts on central cholinergic receptors, and thus balancing cholinergic and dopaminergic activity in the basal ganglia.

✓ Uses

- used in treatment of Parkinson's disease.
- Involuntary movements due to the side effects of certain antipsychotic drugs.

12) Tridihexethyl chloride



(S)-3-cyclohexyl-N,N,N-triethyl-3-hydroxy-3-phenylpropan-1-aminium chloride

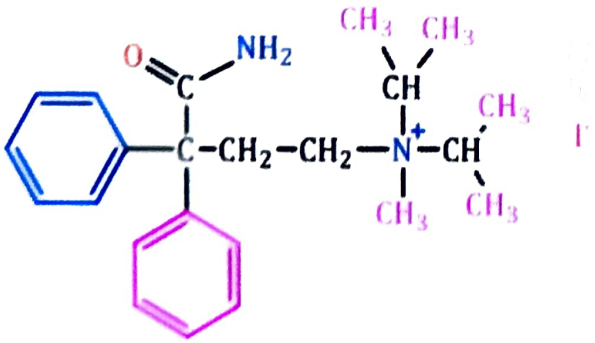
✓ Mechanism of action

- It blocks all three muscarinic receptors i.e. M_1, M_2 & M_3.

✓ Uses

- Used as antispasmodic and anti Parkinson's agents.

13) Isopropamide iodide



(4-amino-4-oxo-3,3-diphenylbutyl)-methyl-di(propan-2-yl)azanium; iodide

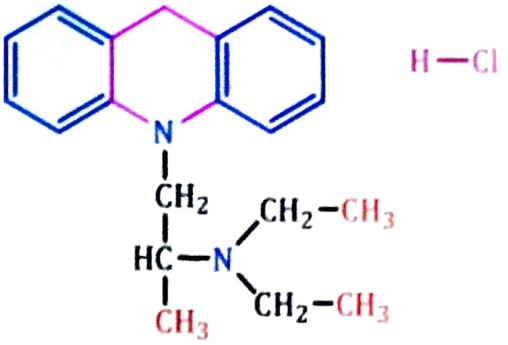
✓ Mechanism of action

- inhibit parasympathetic nerve impulses by blocking acetylcholine.

Uses

- Used in the treatment of peptic ulcer.
- Potent anticholinergic, antispasmodic and antisecretory effects.

14) Ethopropazine hydrochloride



N,N-diethyl-1-phenothiazin-10-ylpropan-2-amine;hydrochloride

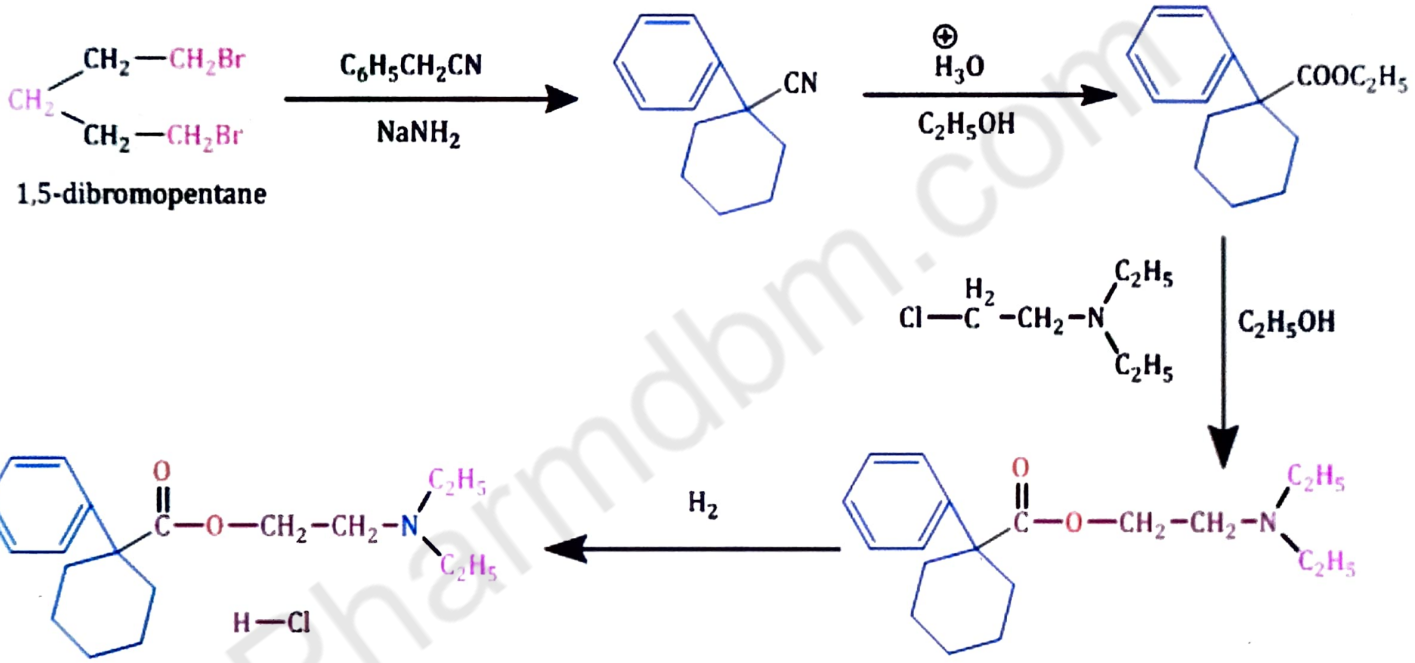
✓ Mechanism of action

- Act on An antimuscarinic receptors.

✓ Uses

- Used as adrenergic antagonist, Histamine antagonist and antiparkinson drugs.

❖ Synthesis of Dicyclomine hydrochloride:-



Dicyclomine hydrochloride

❖ Synthesis of Procyclidine hydrochloride:-