



PHARMA

CHAPTER-WISE NOTES

Pharmacology

Drugs Acting on Autonomic Nervous System

DRUGS ACTING ON AUTONOMIC NERVOUS SYSTEM

GENERAL CONSIDERATION

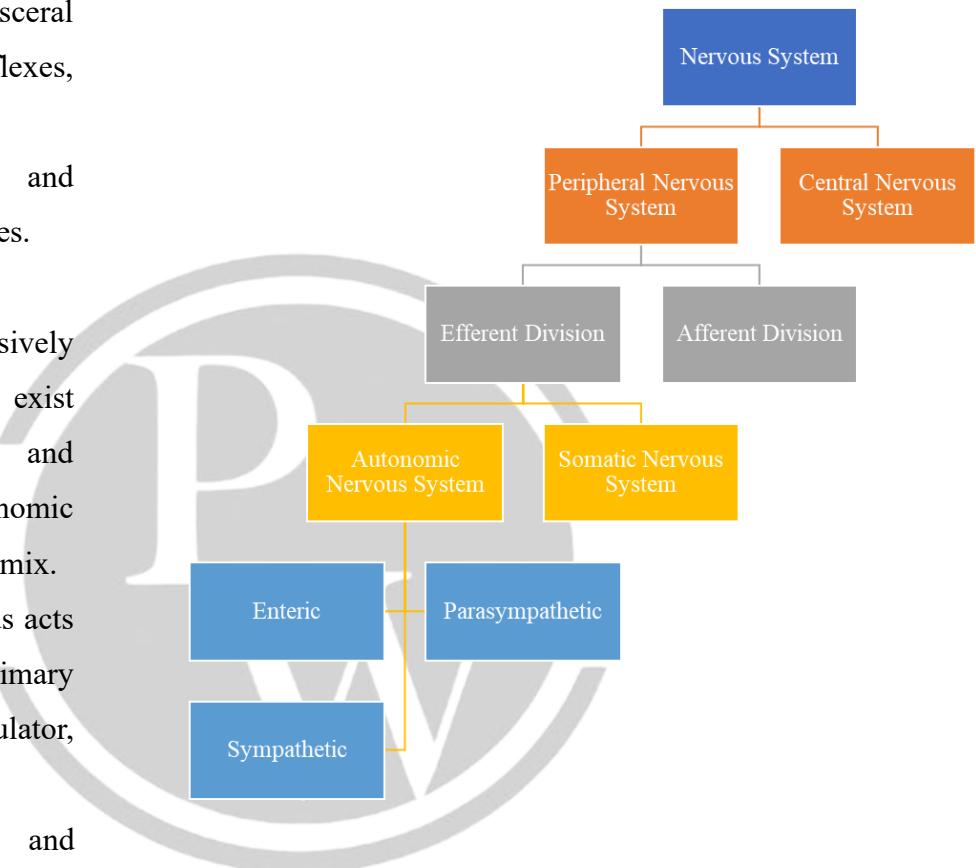
- The **autonomic nervous system (ANS)** primarily operates involuntarily, managing visceral functions. It comprises **afferents, centers, and efferents**, which differ from the somatic nervous system:

A. Afferents:

- ❖ Visceral nerves are mixed, with nonmyelinated visceral afferent fibers originating from the dorsal root ganglia of spinal nerves or sensory ganglia of cranial nerves.
- ❖ They mediate visceral pain and reflexes, including cardiovascular and respiratory reflexes.

B. Central Connections:

- ❖ No exclusively autonomic areas exist in the CNS and somatic and autonomic innervations intermix.
- ❖ The hypothalamus acts as the primary autonomic regulator, with:
 - Posterior and lateral nuclei are sympathetic.
 - The anterior and medial nuclei are parasympathetic. Additional autonomic centers in the midbrain and medulla are linked with cranial nerves.



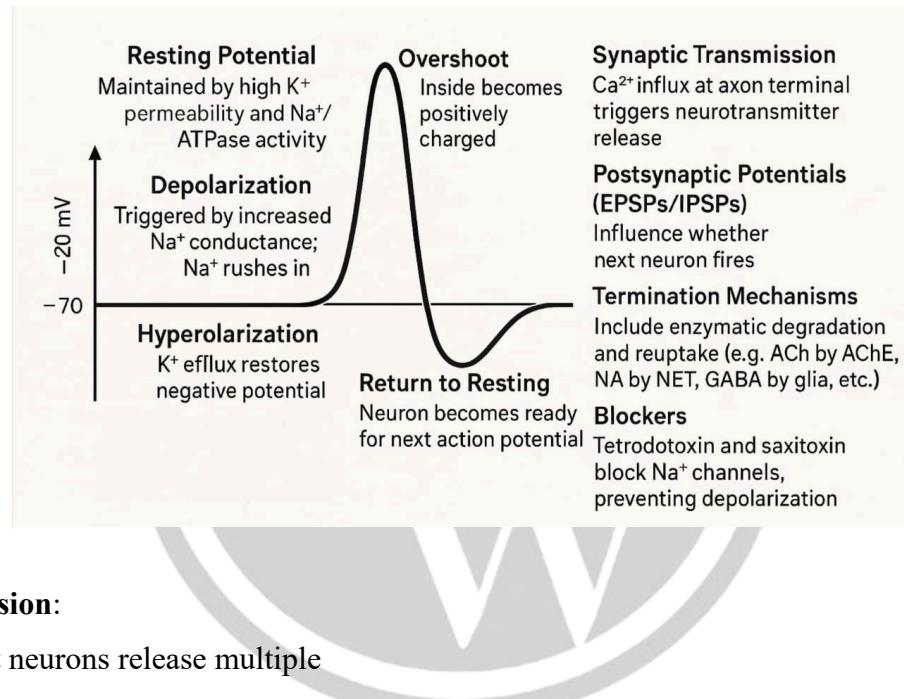
C. Efferents:

- ❖ The motor division splits into:
 - **Sympathetic division:** Handles stress responses.
 - **Parasympathetic division:** Focuses on energy conservation and routine organ functions.
- Most organs have dual sympathetic and parasympathetic innervation, which act antagonistically.
- The enteric nervous system (ENS), part of the ANS, is an independent neural network in the gut wall that regulates bowel movements and secretions but also receives input from the other ANS divisions.

Neurohumoral Transmission

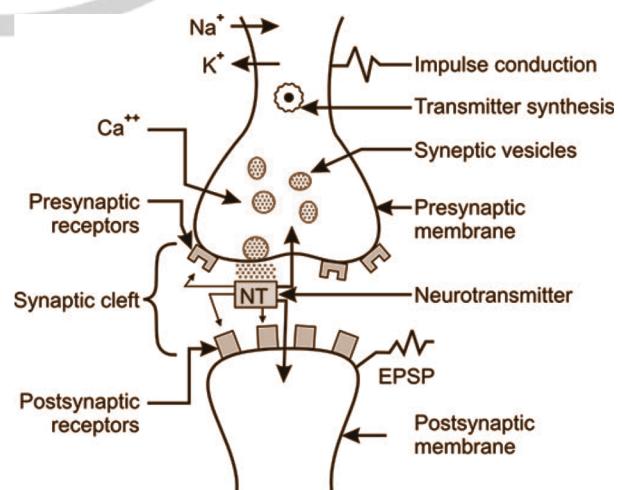
- Neurohumoral transmission involves the chemical transfer of nerve signals across synapses and neuroeffector junctions via humoral messengers (chemical substances).
- Early ideas proposed electrical transmission. However, studies by Otto Loewi demonstrated chemical transmission using acetylcholine (ACh) and noradrenaline (NA) as examples.
- **Criteria for a Neurohumoral Transmitter:**
 - ❖ Must be present in presynaptic neurons with relevant synthesizing enzymes.
 - ❖ Released in response to nerve stimulation.
 - ❖ Produces effects similar to those of nerve stimulation.
 - ❖ Its effects can be modulated by substances that alter nerve stimulation.

- **Mechanism of Transmission:**



- **Cotransmission:**

- ❖ Most neurons release multiple neurotransmitters (e.g., ACh and vasoactive intestinal peptide (VIP)).
- ❖ Cotransmitters modulate the primary neurotransmitter's effects or act independently.



CHOLINERGIC TRANSMISSIONS AND CHOLINERGIC DRUGS

- Cholinergic transmission refers to the process through which the neurotransmitter acetylcholine (ACh) facilitates communication between nerve cells.
- Acetylcholine is synthesized in cholinergic nerve endings from choline and acetyl-CoA by the enzyme choline acetyltransferase (ChAT). The rate-limiting step is choline uptake into the nerve terminal.
- ACh is stored in synaptic vesicles, and transported by a vesicular transporter (VAT). Vesamicol inhibits this transport process.
- **Release:**
 - ❖ **Mechanism:** Release occurs via exocytosis, triggered by calcium influx due to nerve action potential.
 - ❖ **Interference:** Toxins like botulinum inhibit ACh release, while the black widow spider toxin induces excessive release.
- **ACh acts on two types of receptors:**

A. Muscarinic Receptors:

Subtype	Location	Mechanism (G Protein)	Major Actions
M₁	- CNS (cortex, hippocampus, corpus striatum) - Autonomic ganglia - Enteric nervous system	Gq → ↑PLC → ↑IP ₃ /DAG → ↑Ca ²⁺	- Cognitive functions (learning, memory) - Gastric acid secretion - Intestinal secretion - Relaxation of LES
M₂	- Heart (SA/AV node) - Presynaptic cholinergic nerve terminals - Some smooth muscle	Gi → ↓AC, ↑K ⁺ conductance	- ↓Heart rate, ↓conduction velocity - Presynaptic inhibition of ACh release - Smooth muscle contraction (minor)
M₃	- Smooth muscle (viscera, bronchi, bladder, eye) - Glands - Endothelium of blood vessels	Gq → ↑PLC → ↑IP ₃ /DAG → ↑Ca ²⁺	- Smooth muscle contraction - Glandular secretion - Vasodilation via NO release
M₄	- CNS (nerve terminals)	Gi → ↓AC, ↑K ⁺ conductance	- Modulation of neurotransmitter release
M₅	- CNS (dopaminergic areas) - Cerebral blood vessels	Gq → ↑PLC → ↑Ca ²⁺	- Dopamine release - Cerebral vasodilation - Reward behavior

B. Nicotinic Receptors (N_N, N_M):

Subtype	Location	Mechanism	Major Actions
N _M	- Neuromuscular junction (skeletal muscle)	Opens Na ⁺ /K ⁺ channels → Depolarization	- Muscle contraction
N _N	- Autonomic ganglia (sympathetic & parasympathetic) - Adrenal medulla - CNS	Opens Na ⁺ /K ⁺ channels → Depolarization	- Ganglionic transmission - Catecholamine release - Modulation of CNS functions

- ACh's action is terminated by hydrolysis through acetylcholinesterase (AChE). This enzyme is strategically located to inactivate ACh rapidly at cholinergic sites.

- **Modulators and Inhibitors:**

A. Anticholinesterases:

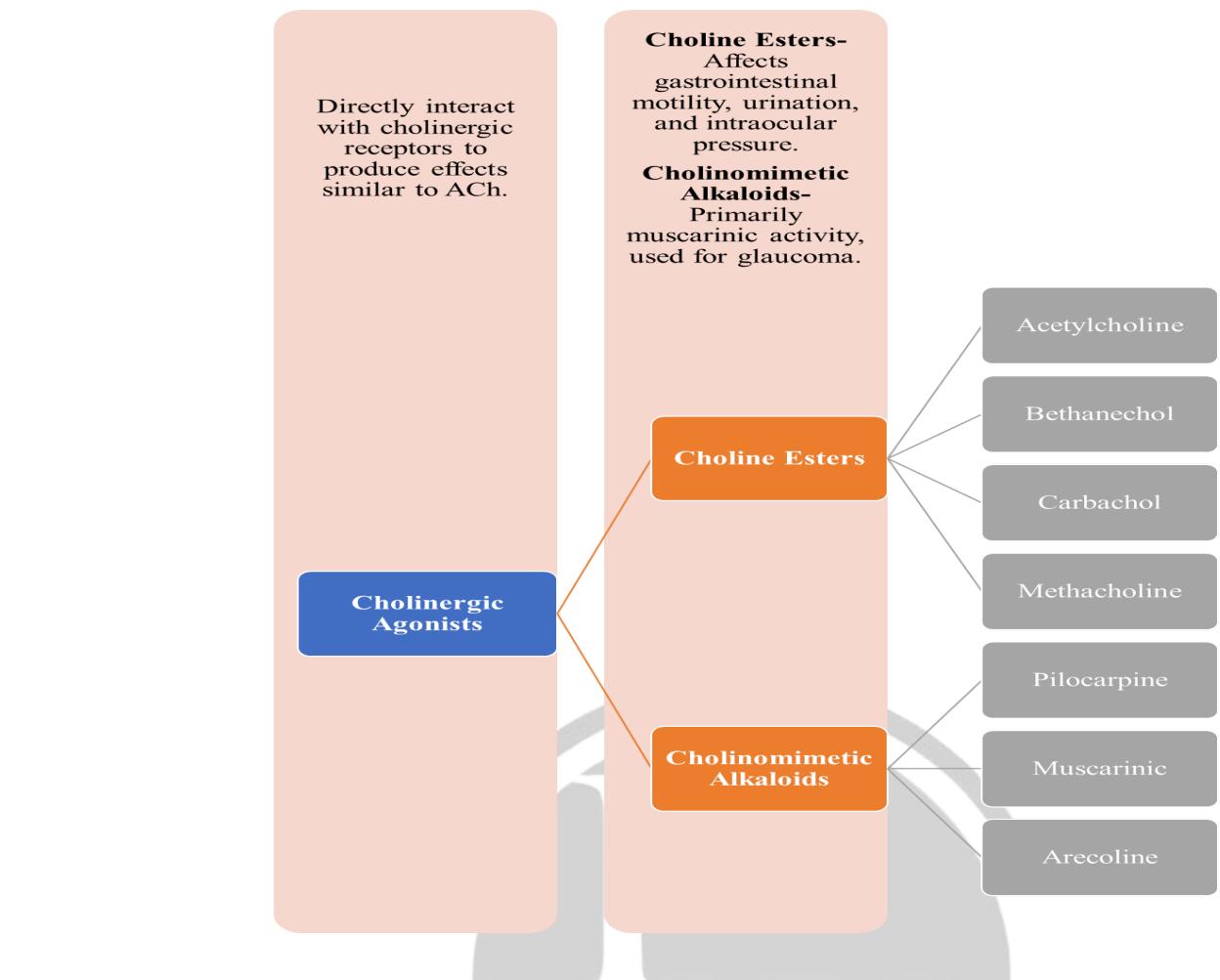
- ❖ These inhibit AChE, leading to prolonged ACh activity.
- ❖ Examples include physostigmine and neostigmine.

B. Cholinergic Blocking Agents:

- ❖ Drugs like atropine block muscarinic receptors, while agents like d-tubocurarine block nicotinic receptors.

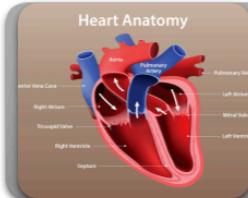
Cholinergic Agonists

- These drugs directly interact with cholinergic receptors to produce effects similar to ACh.
- These drugs mimic the actions of acetylcholine (ACh) by:
 - A. Direct receptor stimulation:** Acting as agonists on cholinergic receptors (e.g., muscarinic and nicotinic receptors).
 - B. Indirect action:** Enhancing the availability of ACh by inhibiting acetylcholinesterase (anticholinesterases).



Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Drug Interactions
Acetylcholine (ACh)	- Rapidly hydrolyzed by true & pseudocholinesterase - Not effective orally - Very short duration	- Nonselective cholinergic agonist - Stimulates muscarinic (M1–M5) and nicotinic (NM, NN) receptors	- Rarely used clinically due to short action - Occasionally used for miosis during eye surgery	- Bradycardia - Hypotension - Bronchospasm - Salivation, lacrimation	- Potentiated by anticholinesterases - Antagonized by atropine - Physiologically opposed by adrenaline
Methacholine	- Partially resistant to true cholinesterase - Resistant to pseudocholinesterase - Poor oral absorption -	- Muscarinic selective agonist - No nicotinic activity	- Formerly used in bronchial hyperreactivity testing - Rarely used now	- Hypotension - Sweating - Bronchospasm - Bradycardia	- Potentiated by anticholinesterases (less than ACh) - Blocked by atropine

	Longer duration than ACh				
Carbachol	- Resistant to both true and pseudocholinesterase - Not absorbed orally - Long duration of action	- Mixed muscarinic & nicotinic agonist - Strong ganglionic & skeletal muscle effects	- Topical for glaucoma (3% eye drops) - Induces miosis during eye surgery	- Salivation - Lacrimation - Flushing - Sweating	- Muscarinic effects not well antagonized by atropine - Potentiated by anticholinesterases
Bethanechol	- Resistant to cholinesterases - Orally active - Does not cross BBB - No nicotinic activity	- Selective muscarinic agonist (M3 >> M2) - GI & urinary smooth muscle stimulation	- Urinary retention (non-obstructive) - Neurogenic bladder - Rare use in megacolon, GERD	- Colic, cramps - Involuntary urination/defecation - Flushing, hypotension - Bronchospasm	- Potentiated by anticholinesterases - Blocked by atropine - Avoid in asthmatics



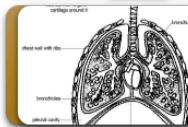
Cardiovascular System:

- Muscarinic receptors: Regulate heart contractions and blood pressure, leading to a decrease in heart rate.
- Acetylcholine can directly affect vascular tone by binding to muscarinic receptors on vascular endothelium, increasing nitric oxide production and leading to vasodilation (blood vessel relaxation).



Digestive System:

- Muscarinic receptors: Increase intestinal motility by contracting intestinal muscles and boosting stomach and intestine secretions.



Respiratory System:

- Muscarinic receptors: Induce bronchoconstriction (narrowing of airways) and increase mucus secretion.



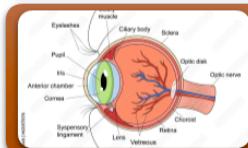
Urinary System:

- Muscarinic receptors: Control urine release and contraction of bladder muscles.



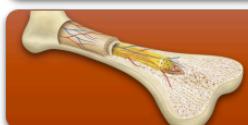
Exocrine Glands:

- Muscarinic receptors: Stimulate the secretion of all exocrine glands innervated by the parasympathetic nervous system, such as tear, salivary, and sweat glands.



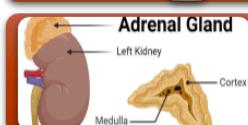
Eye:

- Muscarinic receptors: Cause pupillary constriction (miosis) and lens accommodation for near vision by contracting the sphincter muscle of the pupil and the ciliary muscle.



Skeletal Muscles:

- Nicotinic receptors: Enable skeletal muscles to contract, which is essential for voluntary movement.



Adrenal Glands:

- Nicotinic receptors: Trigger the release of adrenaline and norepinephrine.



Central Nervous System (CNS):

- In the brain, acetylcholine plays a role in memory, learning, attention, arousal, and promoting REM sleep.

Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
Pilocarpine	- Alkaloid from <i>Pilocarpus microphyllus</i> - Penetrates cornea - Topical only	- Muscarinic agonist (mainly M3) - Also stimulates ganglionic muscarinic receptors	- Open-angle glaucoma (3rd line) - Breaks/postvents posterior synechiae - Reverse mydriasis	- Ocular stinging - Spasm of accommodation - Sweating, salivation at high doses	- Antagonized by atropine - Enhanced effects with anticholinesterases

Muscarine	<ul style="list-style-type: none"> - Found in Inocybe and Amanita muscaria mushrooms - Not used clinically 	<ul style="list-style-type: none"> - Pure muscarinic agonist - No nicotinic action 	<ul style="list-style-type: none"> - None (toxicological relevance only) 	<ul style="list-style-type: none"> - Mushroom poisoning: salivation, bradycardia, diarrhea, etc. - Reversed by atropine 	<ul style="list-style-type: none"> - Antagonized by atropine - Potentiated by anticholinesterases
Arecoline	<ul style="list-style-type: none"> - Found in betel nut (Areca catechu) - Crosses BBB - Not used clinically 	<ul style="list-style-type: none"> - Muscarinic + Nicotinic agonist - Also CNS stimulant via central cholinergic pathways 	<ul style="list-style-type: none"> - None clinically - Tried (ineffectively) in dementia to enhance cognition 	<ul style="list-style-type: none"> - Nausea, vomiting, CNS stimulation - Potential for dependence or toxicity with chewing habits 	<ul style="list-style-type: none"> - May interact with anticholinesterases - Potentiated by other cholinergic agents

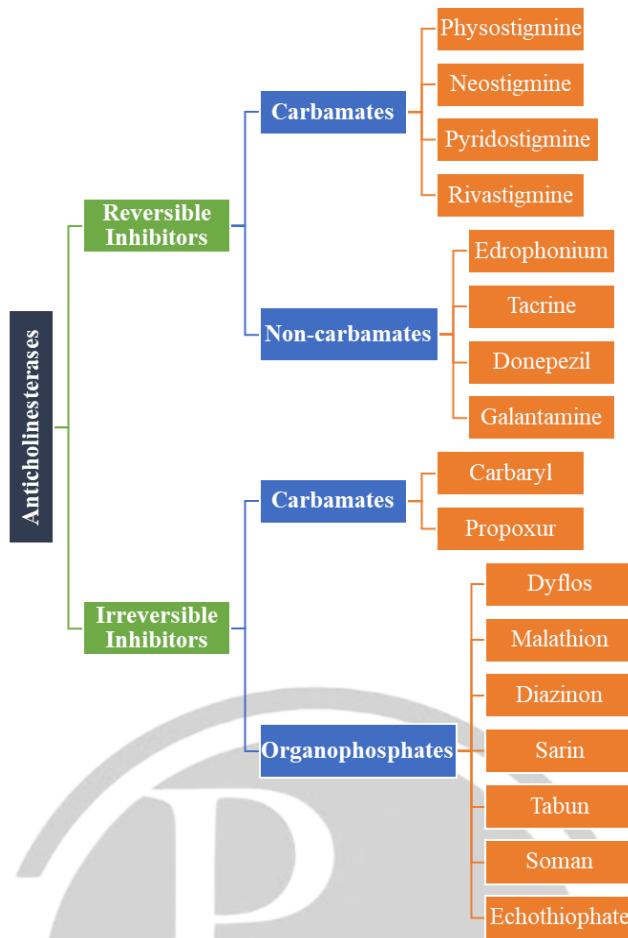
- **Cholinergic Crisis:**

❖ **SLUDGE** is an acronym used to remember the main symptoms of a **cholinergic crisis**.

- Salivation: increased salivation
- Lacrimation: increased tearing
- Urination: frequent urination
- Diarrhea
- Gastrointestinal cramps
- Emesis (vomiting)

Anticholinesterases

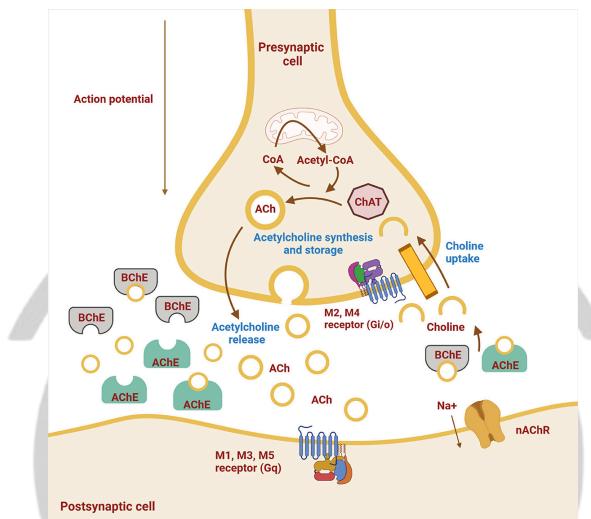
- Anticholinesterases (anti-ChEs) are agents that inhibit cholinesterase, protecting acetylcholine (ACh) from hydrolysis and amplifying its effects at cholinergic synapses.
- They are classified as reversible or irreversible inhibitors based on their interaction with the enzyme.



Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
Physostigmine	Lipid-soluble; crosses BBB; absorbed orally & ocularly; metabolized by ChE	Reversible AChE inhibitor; carbamylates esteratic site	- Glaucoma (rarely used) - Belladonna poisoning - Anticholinergic overdose (TCA, antihistamines)	- Hypotension - CNS effects (confusion, seizures) - Bradycardia, bronchospasm	- Potentiated by β-blockers, anticholinesterases - May counteract anticholinergics
Neostigmine	Poor oral absorption; does not cross BBB; excreted unchanged and partially hydrolyzed	Reversible AChE inhibitor; also has direct action on NM receptors	- Myasthenia gravis - Postoperative urinary retention/ileus - Reversal of non-depolarizing NM blockers - Cobra bite (with atropine)	- Salivation, nausea, bradycardia - Muscle cramps, cholinergic crisis in overdose	- Additive with depolarizing blockers - Antagonized by atropine

Pyridostigmine	Similar to neostigmine; longer-acting; slower onset; less potent	Same as neostigmine	- First-line in Myasthenia gravis - Requires less frequent dosing	- Similar to neostigmine, but milder	- Similar to neostigmine
Ambenonium	Long-acting; similar to pyridostigmine	Same as other reversible AChE inhibitors	- Myasthenia gravis (alternative)	- Cholinergic effects at high doses	- Similar interactions as other reversible AChE inhibitors
Edrophonium	Short-acting (10–30 min); rapid onset; IV use	Binds reversibly to anionic site only (non-covalent); AChE inhibition	- Diagnostic test for myasthenia gravis (Tensilon test) - Differentiate myasthenic vs. cholinergic crisis	- Bradycardia, hypotension, muscle twitching	- Potentiated by cholinomimetic drugs
Tacrine	Lipophilic; crosses BBB; longer duration; hepatotoxic	Reversible non-covalent AChE inhibition; increases CNS ACh	- Alzheimer's disease (withdrawn due to hepatotoxicity)	- Hepatotoxicity - GI upset - CNS disturbances	- Caution with hepatotoxic drugs
Rivastigmine	Lipophilic; crosses BBB; relatively cerebroselective	Reversible AChE & BuChE inhibitor	- Alzheimer's disease	- GI disturbances - Dizziness - Weight loss	- Additive with other CNS cholinomimetic agents
Donepezil	Centrally acting; long-acting; once daily dosing	Reversible, selective CNS AChE inhibitor	- Alzheimer's disease	- Nausea, insomnia, bradycardia	- Potentiated by anticholinesterase agents - May interact with antipsychotics
Galantamine	Natural alkaloid; lipophilic; CNS penetration	Reversible AChE inhibitor + weak nicotinic agonist	- Alzheimer's disease	- Similar to donepezil	- May interact with other nicotinic or cholinergic agents

Dyflos (DFP)	Organophosphate; lipid-soluble; irreversible; obsolete	Irreversible AChE inhibitor (phosphorylates esteratic site); long-lasting	- Previously used as miotic (now obsolete)	- Cholinergic excess - Risk of poisoning	- Reactivated with pralidoxime - Antagonized by atropine
Echothiophate	Organophosphate; water-soluble; long-acting; does not cross BBB	Irreversible AChE inhibitor	- Long-acting miotic for glaucoma (historical use)	- Miosis - Systemic cholinergic symptoms possible	- Inhibits plasma cholinesterase — prolongs action of suxamethonium and ester anesthetics



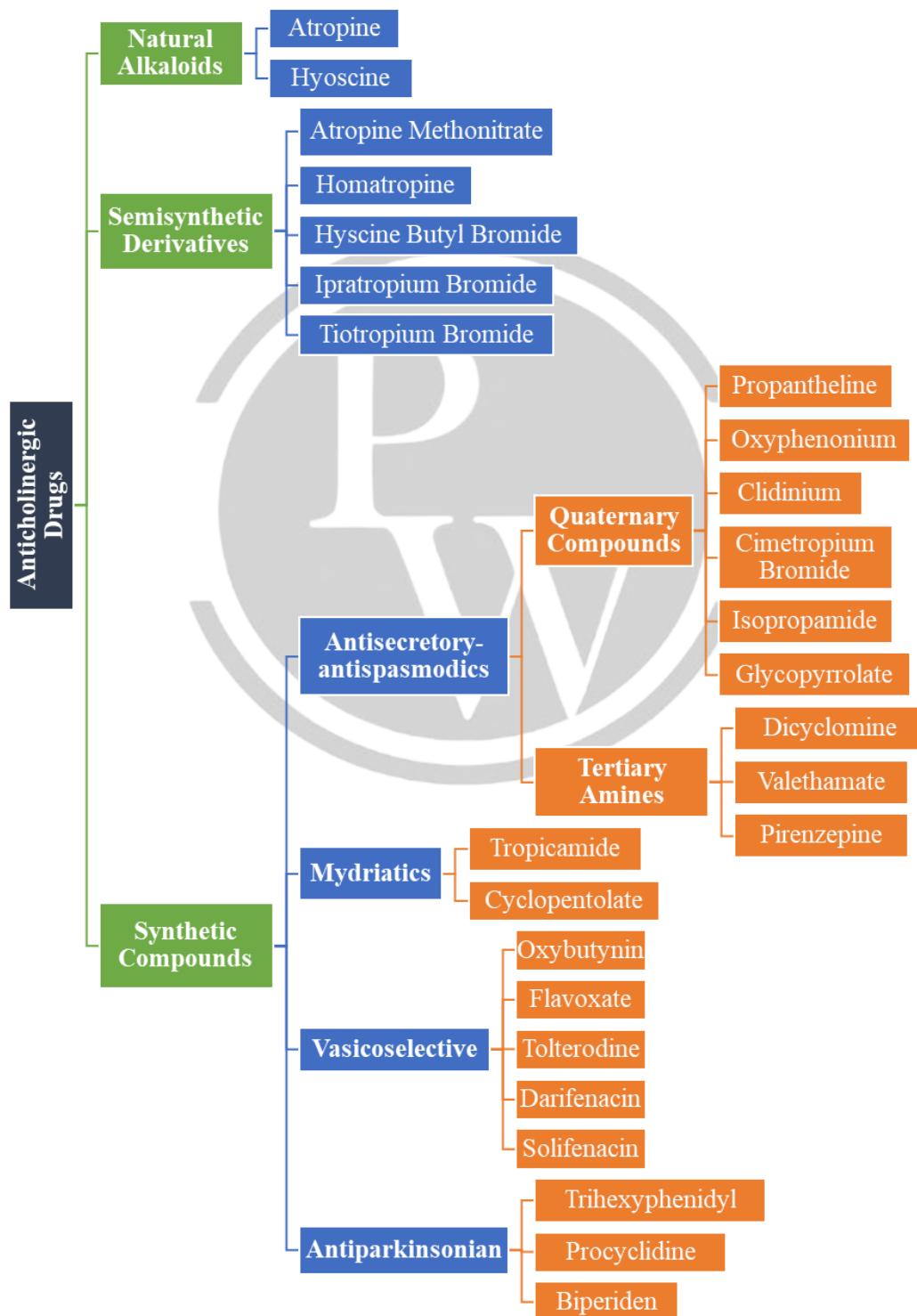
- **Toxicity and Poisoning:**

Agent	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
Organophosphate (e.g., DFP, Malathion, Parathion)	Lipid-soluble; absorbed via skin, lungs, GI; long duration	Irreversible inhibition of AChE by phosphorylation of esteratic site → accumulation of ACh	None (Toxic exposure only: insecticides, warfare)	- SLUDGE symptoms: salivation, lacrimation, urination, defecation, GI upset, emesis - CNS depression - Respiratory failure	Additive toxicity with other ChE inhibitors or parasympathomimetics

Carbamates (e.g., Physostigmine, Neostigmine)	Variable absorption; shorter action; reversible inhibition	Reversible inhibition of AChE by carbamylation of esteratic site	Therapeutic (myasthenia, glaucoma), but also causes toxicity in overdose	Similar to OPs but milder CNS effects	Pralidoxime is contraindicated (ineffective + may worsen symptoms)
Atropine	Well absorbed parenterally; crosses BBB; short-to-moderate duration	Competitive antagonist at muscarinic receptors → blocks parasympathetic effects	First-line antidote in both organophosphate and carbamate poisoning	- Dry mouth - Blurred vision - Tachycardia - CNS delirium at high doses	May interact with other anticholinergics or drugs with anticholinergic side effects
Pralidoxime (2-PAM)	Quaternary compound; IV use; does not cross BBB; not effective in aged enzyme or CNS	Reactivates phosphorylated AChE (before aging) by attaching to anionic site and removing organophosphate	Adjunct to atropine in organophosphate poisoning (not useful in carbamate poisoning)	- Dizziness - Hypertension - Muscle weakness at high doses	Ineffective with carbamates Delayed use reduces efficacy due to enzyme aging
Obidoxime	More potent oxime than pralidoxime; poor CNS penetration	Same as pralidoxime	Organophosphate poisoning (not widely available everywhere)	Similar to 2-PAM	Same as pralidoxime
DAM (Diacetylmonoxime)	Lipophilic oxime; crosses BBB	Reactivates CNS and peripheral AChE (more experimental use)	Experimental use in CNS organophosphate poisoning	CNS toxicity at high doses	Not widely approved or used clinically

ANTICHOLINERGIC DRUGS AND DRUGS ACTING ON AUTONOMIC GANGLIA

- Anticholinergic drugs act by blocking the action of acetylcholine (ACh) on muscarinic and, in some cases, nicotinic receptors.
- These drugs are used for a variety of therapeutic purposes based on their ability to inhibit parasympathetic activity.



Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Drug Interactions
Atropine	Rapid GI absorption; $t_{1/2}$: 3–4h; partial CNS penetration; 50% hepatic metabolism	Non-selective muscarinic antagonist	Preanaesthetic, bradycardia, antispasmodic, antidote for anti-ChE poison	Dry mouth, tachycardia, urinary retention, CNS excitation	Additive with TCAs, antihistamines; ↓ levodopa absorption
Hyoscine	Good CNS penetration; more completely metabolized	Central and peripheral muscarinic antagonist	Motion sickness, GI spasm, preanaesthetic	Sedation, dry mouth	Additive CNS depression with alcohol/sedatives
Ipratropium	Inhaled; poor systemic absorption; 4–6 h action	M1/M3 muscarinic receptor blocker in bronchi	COPD, asthma, rhinorrhoea	Dry mouth, throat irritation	Additive with β_2 agonists
Tiotropium	Inhaled; long-acting ($t_{1/2}$ ~24h); poor systemic absorption	Long-acting M1/M3 antagonist	Maintenance therapy in COPD	Dry mouth	None significant
Dicyclomine	Rapid GI absorption; weak M1 selective	Weak M1 antagonist + direct smooth muscle relaxant	IBS, dysmenorrhea, GI spasms	Anticholinergic toxicity in infants	Caution with other anticholinergics
Oxybutynin	Well absorbed; metabolized by CYP3A4	M3/M1 selective antagonist + smooth muscle relaxant	Urinary incontinence, neurogenic bladder	Dry mouth, constipation, blurred vision	↑ levels with CYP3A4 inhibitors
Tolterodine	Oral; metabolized by CYP3A4	Relatively M3 selective	Overactive bladder	Dry mouth, dyspepsia	↑ levels with CYP3A4 inhibitors

Flavoxate	Oral; bladder selectivity	Antimuscarinic + muscle relaxant	Urinary urgency, dysuria (esp. in UTIs)	Dry mouth, GI upset	None significant
Glycopyrrolate	Parenteral; does not cross BBB	Peripheral muscarinic antagonist	Preanaesthetic use, COPD (inhaled form)	Dry mouth	Additive with other anticholinergics
Cyclopentolate	Topical; rapid onset (30–60 min), lasts ~24 h	Muscarinic antagonist (ocular)	Cycloplegic refraction, iritis	CNS effects in children	None significant

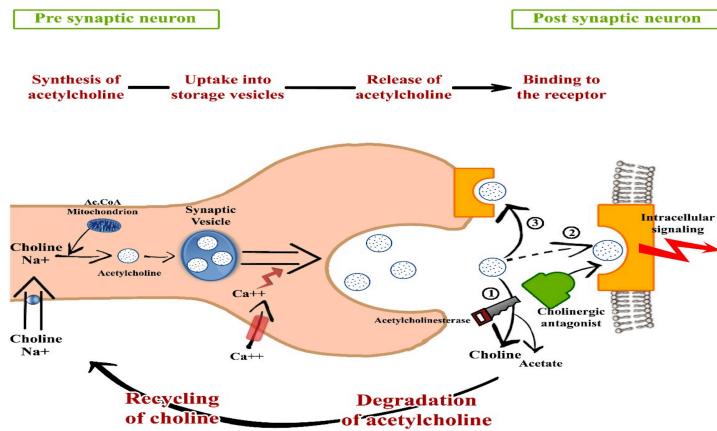


Figure: Cholinergic synapse. Mechanisms of action of cholinergic antagonists. 1. Acetylcholinesterase hydrolyzes ACh to inactive choline and acetate. 2. Cholinergic antagonists compete with Ach for binding to post-synaptic receptors. Non-competitive antagonism: the cholinergic agonist and antagonist can bind simultaneously, but the binding of the cholinergic antagonist reduces or inhibits the action of the agonist. Competitive antagonism: binding of the antagonist to the receptor prevents the binding of the agonist to that same receptor. 3. Presynaptic muscarinic autoreceptor performing a negative feedback loop in signal transduction.

- **Adverse Effects:**

❖ The adverse effects can be remembered as, **"Hot as a Hare, Blind as a Bat, Dry as a Bone, Red as a Beet, Mad as a Hatter"**

- **Hot as a Hare:** Fever (due to decreased sweating)
- **Blind as a Bat:** Dilated pupils (mydriasis)
- **Dry as a Bone:** Dry mouth, skin, and mucous membranes
- **Red as a Beet:** Flushed skin
- **Mad as a Hatter:** Confusion, delirium, hallucinations

DRUGS ACTING ON AUTONOMIC GANGLIA

- Drugs acting on autonomic ganglia include those that influence ganglionic transmission by targeting cholinergic receptors.

- **Primary Mechanism:**

- ❖ Acetylcholine (ACh) serves as the primary excitatory neurotransmitter in both sympathetic and parasympathetic ganglia.
- ❖ Drugs that inhibit ACh synthesis (e.g., hemicholinium) or release (e.g., botulinum toxin, procaine) can affect ganglionic transmission.

- **Ganglionic Stimulants:**

- ❖ **Selective Nicotinic Agonist:**

- Nicotinic (N_N) receptors mediate rapid depolarization and primary ganglionic response.

- ❖ **Muscarinic Agonists:**

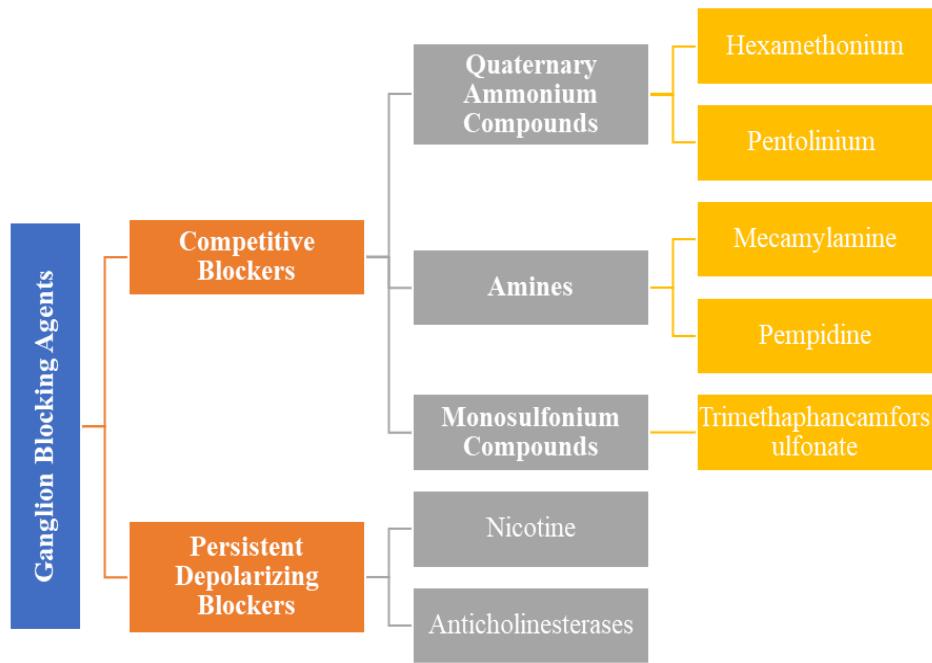
- Muscarinic (M_1, M_2), adrenergic, dopaminergic, amino acid, and peptidergic receptors provide modulatory effects, causing secondary and longer-lasting changes in excitability.



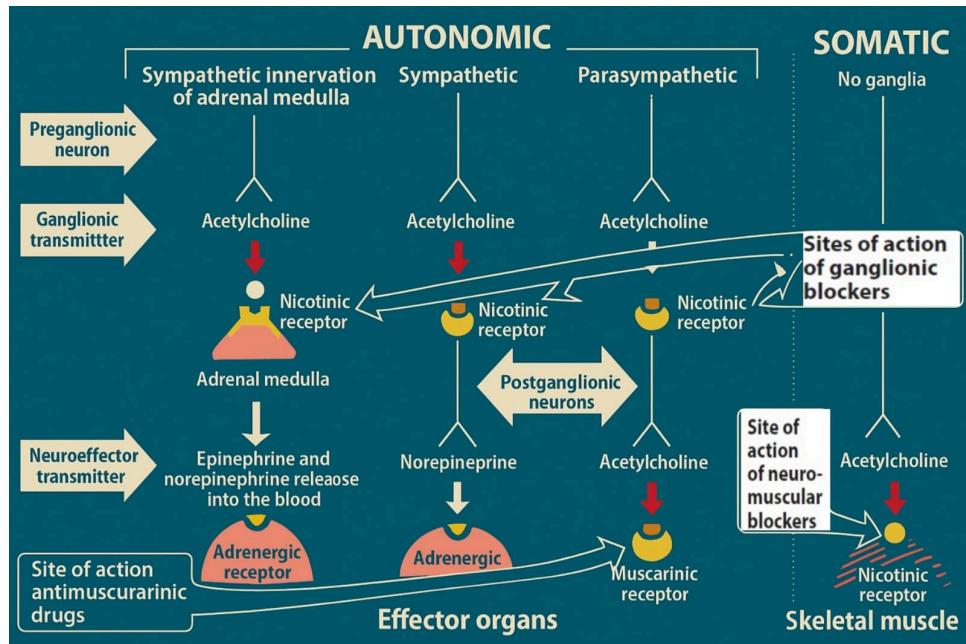
Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
Nicotine	Absorbed via patch/gum/nasal; peak levels vary by route; $t_{1/2} \sim 2$ hrs	Agonist at NN & NM nicotinic receptors; stimulates ganglia; high doses block	Smoking cessation (replacement therapy)	Headache, insomnia, dyspepsia, cramps, local irritation; contraindicated in IHD	Additive sympathomimetic effects; avoid in cardiac disease
Nicotine patch	Transdermal; slow onset; steady plasma levels; 7–21 mg/24 hr	Provides constant low-level nicotine to reduce withdrawal	Smoking cessation	Irritation at site, insomnia, dyspepsia	May worsen angina or arrhythmias
Nicotine gum	Buccal absorption; onset quicker than patch; 1–4 mg per gum piece	Provides variable nicotine; chewed on demand	Smoking cessation	GI upset, sore throat, hiccups	Less predictable blood levels; avoid excessive use
Varenicline	Oral; good absorption; $t_{1/2} \sim 24$ hrs; renally excreted	Partial agonist at $\alpha 4\beta 2$ neuronal nicotinic receptors; DA modulation	Smoking cessation	Sleep disturbances, agitation, suicidal thoughts, mood changes	Additive neuropsychiatric effects; caution with psychiatric illness
Bupropion	Oral; metabolized by liver (CYP2B6); $t_{1/2} \sim 14$ hrs; SR form used	Inhibits DA and NA reuptake; antidepressant and craving suppressant	Smoking cessation, depression	Dry mouth, insomnia, risk of seizures in predisposed individuals	Contraindicated with MAOIs; caution with CYP2B6 inhibitors

- **Ganglion Blocking Agents:**

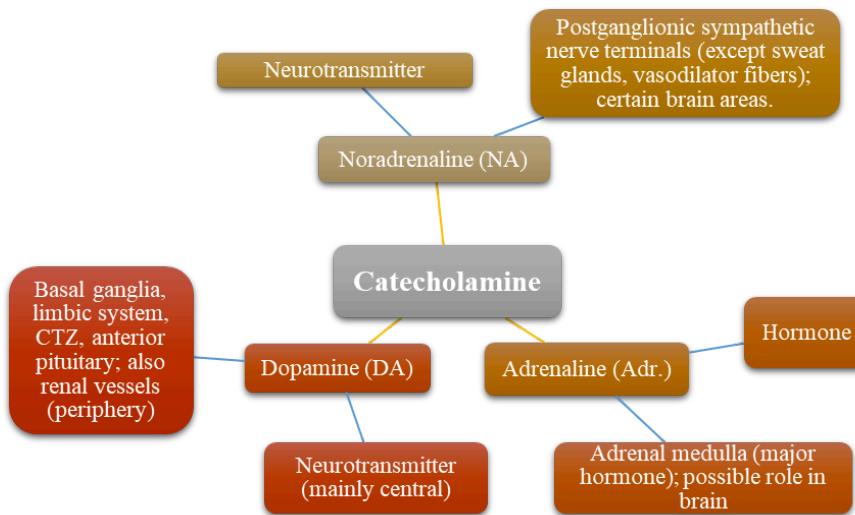
- ❖ Historically used for hypertension and peptic ulcers but are now obsolete due to intolerable side effects such as postural hypotension, syncope, and dry mouth.
- ❖ These are mainly of two types:



Organ/System	Dominant Tone	Effect of Ganglionic Blockade (Side Effect)
Heart	Parasympathetic	Tachycardia (palpitation)
Blood Vessels	Sympathetic	Vasodilatation, abolition of reflexes (postural and exercise hypotension, syncope)
Iris	Parasympathetic	Mydriasis (photophobia)
Ciliary Muscle	Parasympathetic	Cycloplegia (blurring of near vision)
Intestines	Parasympathetic	Decreased motility (distension, constipation)
Bladder	Parasympathetic	Decreased tone (difficulty in micturition)
Male Sexual Function	Parasympathetic & Sympathetic	Inhibition of erection & ejaculation
Salivary Glands	Parasympathetic	Inhibition of salivation (dry mouth, difficulty in swallowing and talking)
Sweat Glands	Sympathetic (cholinergic)	Inhibition of sweating (anhidrosis)



ADRENERGIC TRANSMISSION AND ADRENERGIC DRUGS



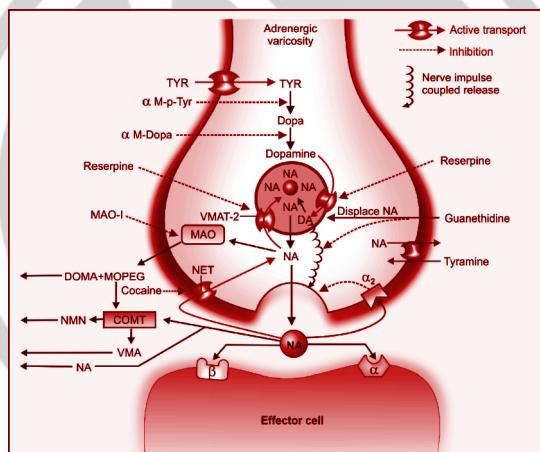
Step	Key Details
1. Synthesis	Starts from phenylalanine → tyrosine → DOPA → DA → NA → Adr (in adrenal medulla). - Rate-limiting enzyme: <i>Tyrosine hydroxylase</i> . - Inhibited by: α -methyl-p-tyrosine (metyrosine). - Adr synthesis needs glucocorticoids.
2. Storage	NA stored in vesicles with ATP (4:1) and chromogranin . - Final NA synthesis (via <i>dopamine β-hydroxylase</i>) occurs inside vesicles . - In adrenal medulla, NA → Adr in cytoplasm → re-stored in separate granules. - MAO keeps cytoplasmic CA low.
3. Release	Via exocytosis , triggered by nerve impulse and Ca^{2+} . - Contents: NA/Adr, ATP, chromogranin, dopamine β -hydroxylase, peptides (NPY, enkephalin). - Inhibited by: α_2 , Y ₂ , P ₁ , dopaminergic, muscarinic, 5-HT, PGE ₂ receptors. - Enhanced by: β_2 , AT ₁ , nicotinic receptors. - Indirect sympathomimetics (e.g., amphetamine, tyramine) release NA via displacement , not exocytosis.
4. Reuptake	A. Axonal (Uptake-1): - NET (Na^+ -dependent); major mechanism (75–90%). - Inhibited by cocaine, desipramine . B. Vesicular (VMAT-2): - Transports DA/NA into vesicles (H^+ antiport). - Inhibited by reserpine . C. Extraneuronal (Uptake-2): - ENT (OCT3), OCT1/2 ; Adr > NA; inhibited by corticosterone .

5. Metabolism	Enzymes involved: → MAO (cytoplasm, mitochondria), → COMT (liver, tissues), → AR, AD, ADH (intermediate steps). - End products: VMA, 3-Methoxy-4-hydroxyphenylglycol, metanephrines, DOMA. - Mostly conjugated with glucuronic acid/sulfate before excretion. - Free CA excretion: ~25–50 µg NA, 2–5 µg Adr in 24h. - Metabolism is not the major mechanism for termination of action.
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- **Adrenergic Receptors:**

System/Organ	α -Receptor Actions	β -Receptor Actions
Blood vessels	Constriction → ↑ BP ($\alpha_1 + \alpha_2$)	Dilation → ↓ BP (β_2)
Heart	Little action	Cardiac stimulation: ↑ rate, force, conduction velocity (β_1)
Bronchi	—	Bronchodilation (β_2)
Eye	Radial muscle contraction → mydriasis (α_1), ↓ aqueous secretion	No effect on iris, slight ciliary relaxation, ↑ aqueous secretion
Intestine	Relaxation, sphincter contraction	Relaxation (β_2)
Bladder & Prostate	Trigone & prostate contraction (α_1)	Detrusor relaxation (β_2, β_3)
Uterus	Contraction (α_1)	Relaxation (β_2)
Spleen	Capsule contraction (α_1)	Relaxation (slight) (β_2)
Neuromuscular junction	Facilitates ACh release	Prolonged activity in fast muscles, shortened in slow; tremors (β_2)
Pancreas (Insulin)	Inhibits insulin secretion (α_2 , dominant)	Mild augmentation of insulin & glucagon secretion (β_2)

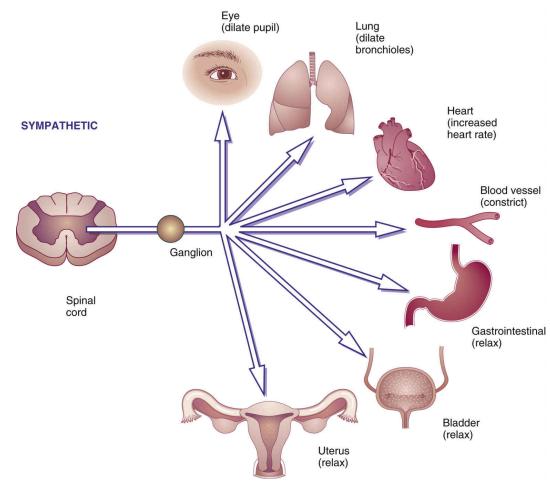
Metabolism	—	Liver: glycogenolysis → hyperglycemia (β_2) Muscle: glycogenolysis → lactate ↑ (β_2) Fat: lipolysis → ↑ FFA, ↑ heat ($\beta_1 + \beta_2 + \beta_3$)
Kidney	—	Renin release (β_1)
Male sex organs	Ejaculation (α_1)	—
Salivary glands	K^+ and water secretion (α_1)	Ptyalin secretion
Posterior pituitary	—	ADH (vasopressin) secretion (β_1)
Adrenergic nerve terminals	Inhibits noradrenaline release	Mild facilitation of noradrenaline release



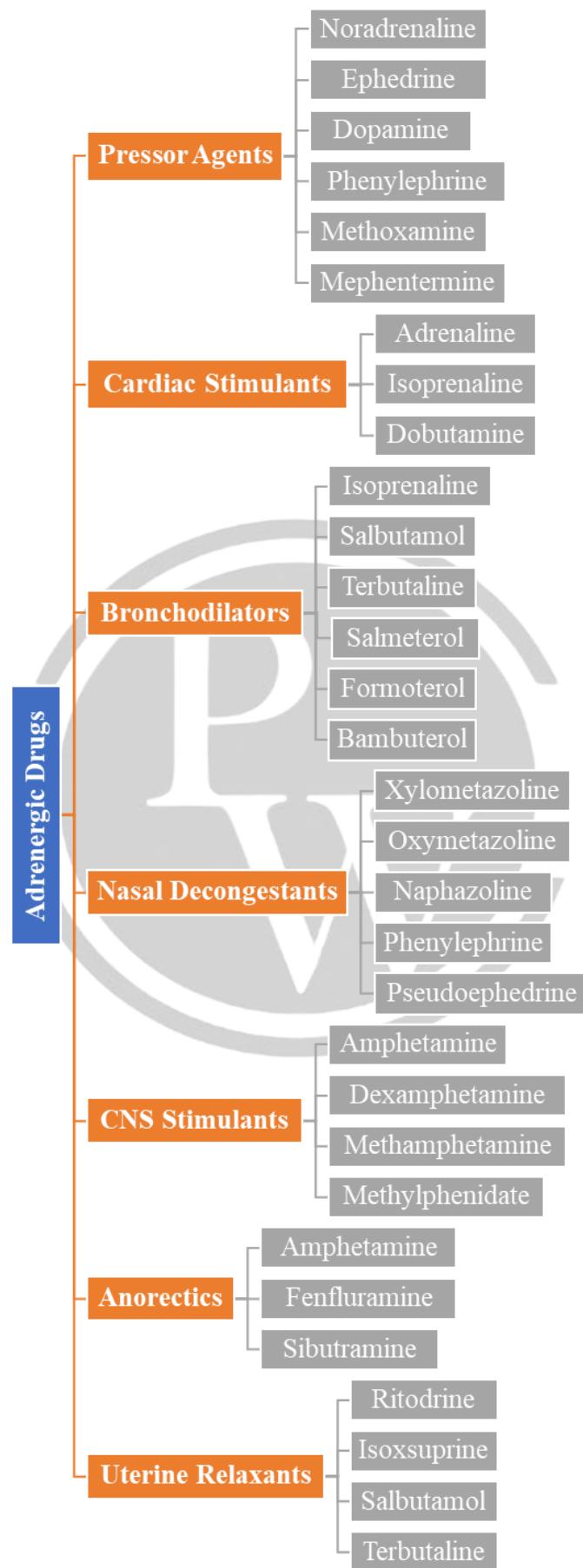
ADRENERGIC DRUGS

- **Effects of Adrenergic Drugs:**

- ❖ The effects of the adrenergic drugs can be remembered by the mnemonic "SHAPED"
 - Stimulation of the heart (increased heart rate and force of contraction)
 - Hyperglycemia (increased blood sugar levels)
 - Alertness and arousal
 - Pupil dilation (mydriasis)
 - Epinephrine release

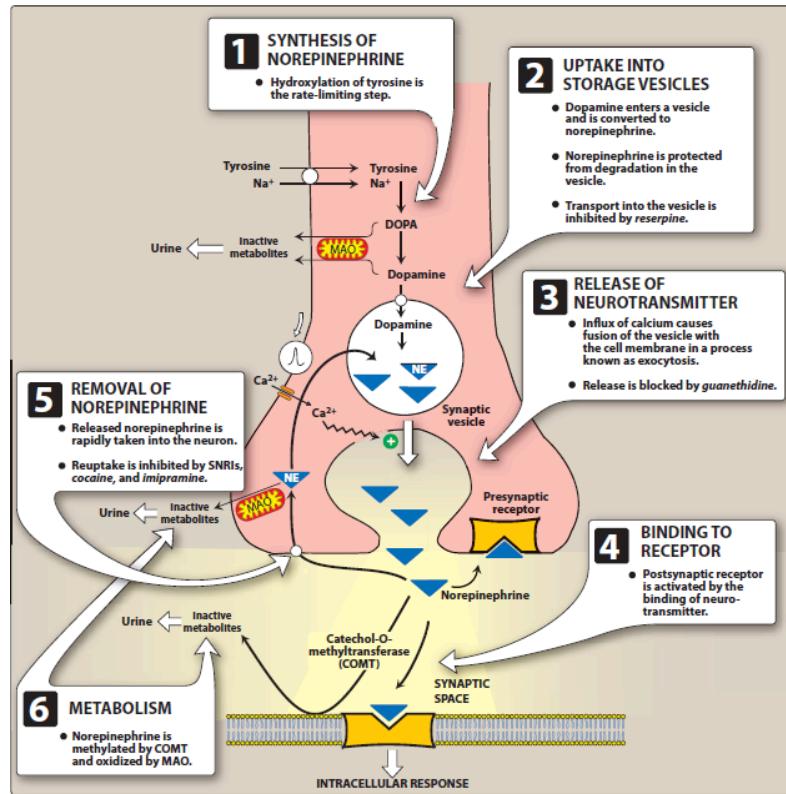


➤ Dilation of bronchioles



Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
Adrenaline	SC/IM: 0.2–0.5 mg, duration 0.5–2 hrs; local use with LA	Non-selective α and β agonist	Anaphylaxis, cardiac arrest, asthma, local vasoconstrictor	Headache, tremor, anxiety, arrhythmias, hypertension	β -blockers, halothane, MAOIs, TCAs
Noradrenaline	IV infusion (2–4 μ g/min); short duration	Mainly α_1 , $\alpha_2 > \beta_1$ agonist	Acute hypotension, shock	Reflex bradycardia, tissue necrosis	NaHCO ₃ (incompatibility), MAOIs, TCAs
Isoprenaline	Sublingual, IM, IV; duration 1–3 hrs	Pure β agonist ($\beta_1 = \beta_2$)	Bradycardia, AV block	Palpitations, tachycardia, flushing	β -blockers, other sympathomimetics
Dopamine	IV infusion (0.2–1 mg/min); does not cross BBB	D1, D2, β_1 agonist; indirect NA release	Cardiogenic/septic shock, acute HF	Nausea, tachycardia at high dose	MAOIs, halogenated anaesthetics
Dobutamine	IV infusion (2–8 μ g/kg/min)	Selective β_1 agonist, weak α agonist	Acute HF, cardiogenic shock, cardiac stress test	Arrhythmias, tolerance	β -blockers, sympathomimetics
Ephedrine	Oral; long duration (4–6 hrs); crosses BBB	Mixed: direct α/β agonist + indirect NA release	Hypotension, mild asthma, nasal decongestant	Tachycardia, insomnia, CNS excitation	MAOIs, TCAs, β -blockers
Amphetamines	Oral; long-acting (4–6 hrs), potent CNS stimulant	Indirectly \uparrow NA/DA/5-HT release, inhibits reuptake	ADHD, narcolepsy, obesity (previously)	Insomnia, agitation, psychosis, dependence	MAOIs, TCAs, CNS stimulants
Phenylephrine	Oral, IV, nasal, topical; long duration	Selective α_1 agonist	Nasal decongestant,	Reflex bradycardia,	MAOIs, TCAs, α -blockers

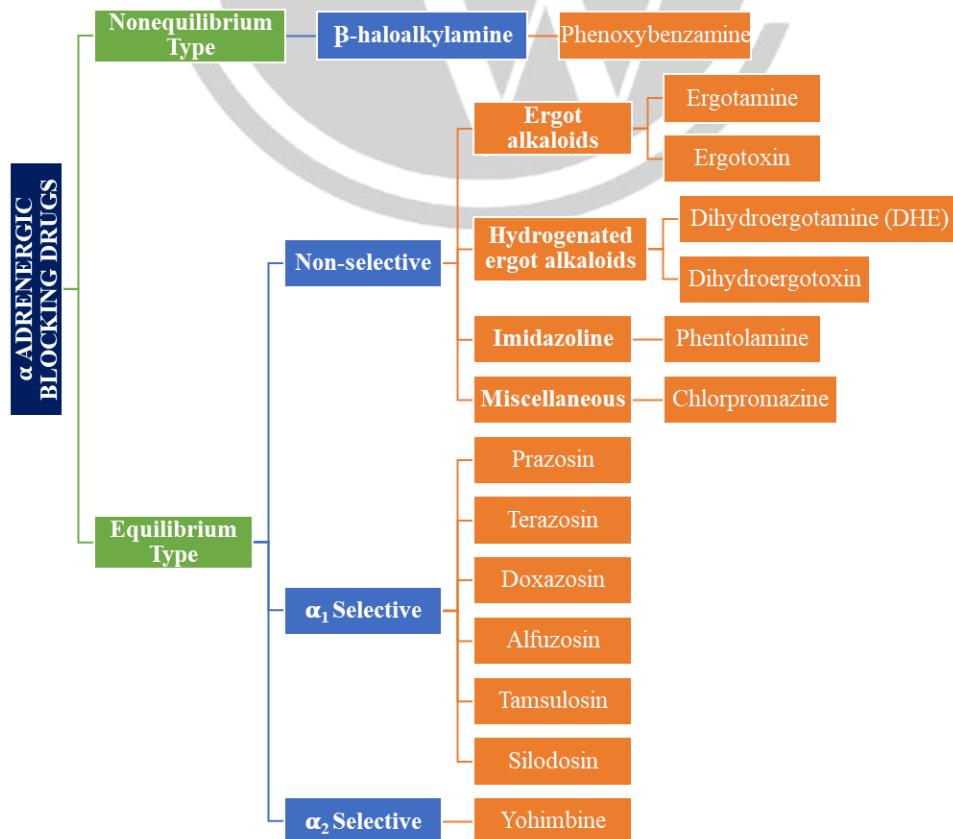
			mydriasis, hypotension	rebound congestion	
Methoxamine	IM/IV; longer-acting	Selective α_1 agonist	Hypotension during anaesthesia	Bradycardia, hypertension	MAOIs, TCAs
Mephentermine	Oral/IM/IV; duration 2–6 hrs	Mixed: $\alpha + \beta$ agonist + indirect NA release	Spinal anaesthesia hypotension, MI shock	Palpitations, restlessness	MAOIs, TCAs, β -blockers
Salbutamol	Inhaled/oral; short-acting	Selective β_2 agonist	Asthma, COPD, hyperkalaemia	Tremors, tachycardia	β -blockers, digoxin
Isoxsuprine	Oral/IM; long-acting	β agonist + smooth muscle relaxant	Threatened abortion, dysmenorrhoea, PWD	Nausea, flushing, hypotension	β -blockers, hypotensives
Xylometazoline	Topical nasal; action \leq 12 hrs	Selective α_2 agonist	Nasal decongestant	Rebound congestion, hypertension	MAOIs, TCAs
Oxymetazoline	Topical nasal; long-acting	Selective α_2 agonist	Nasal decongestant	CNS depression (infants), rebound effects	MAOIs, hypertensives
Naphazoline	Topical nasal; rapid onset	Selective α_2 agonist	Nasal decongestant	Irritation, CNS effects	MAOIs, sedatives
Pseudophedrine	Oral; fewer CNS/heart effects	Indirect sympathomimetic	Nasal congestion, allergic rhinitis	Mild CNS stimulation	Restricted due to abuse potential
Ritodrine	IV infusion	Selective β_2 agonist	Preterm labour	Pulmonary oedema, tachycardia	β -blockers, CCBs



ANTIADRENERGIC DRUGS AND DRUGS FOR GLAUCOMA

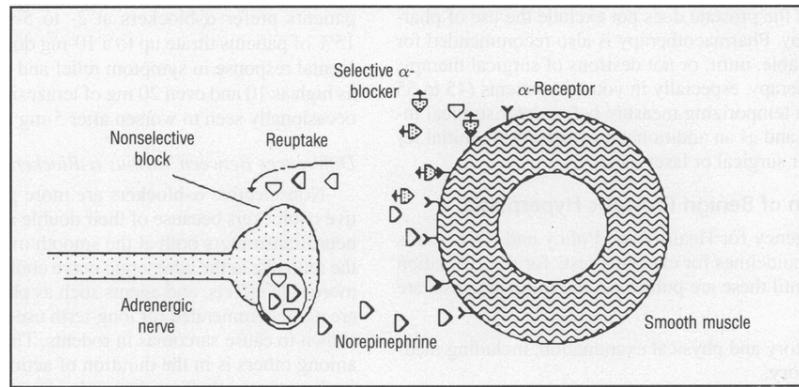
Feature	Antiadrenergic Drugs	Adrenergic Neurone Blocking Drugs
Locus of Action	Adrenergic receptors on effector cells or neurones	Adrenergic neuronal membrane or contents
Effect of Adrenergic Nerve Stimulation	Blocked (less completely)	Blocked (more completely)
Effect of Injected Adrenaline (Adr)	Blocked	Not blocked (may be potentiated)
Type of Effects Blocked by a Single Drug	Either α or β (except labetalol and its congeners)	Sympathetic function decreased irrespective of receptor type
Examples	α -blockers: Phentolamine β -blockers: Propranolol	Reserpine, Guanethidine, Bretylium, α -methyl-p-tyrosine

α ADRENERGIC BLOCKING DRUGS

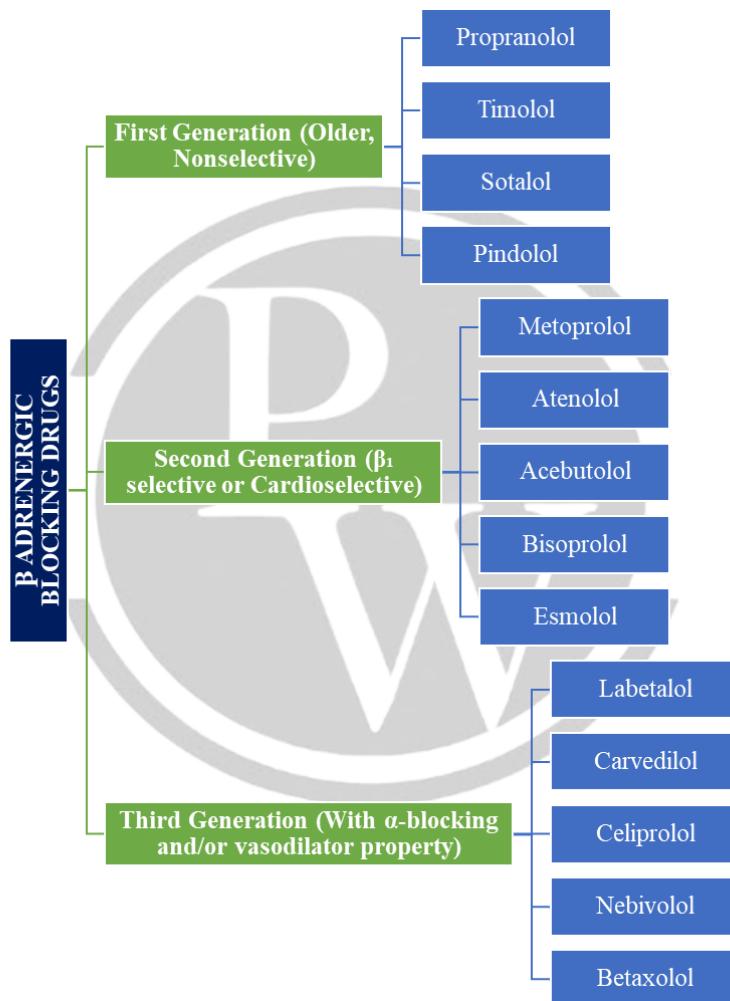


Drug	Pharmacokinetic (PK) Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
Phenoxybenzamine	Oral absorption erratic; i.v. excretion in urine; irreversible binding; $t_{1/2} = \text{days}$	Irreversible α -blocker (non-selective); covalent binding via ethyleniminium ion	Pheochromocytoma, peripheral vascular disease	Postural hypotension, CNS stimulation, lethargy, miosis, inhibition of ejaculation	CNS effects with rapid i.v. use; accumulates with chronic use
Phentolamine	Rapid onset, short-acting, given i.v.	Non-selective $\alpha 1/\alpha 2$ blocker; increases NA release	Pheochromocytoma diagnosis, clonidine withdrawal HTN, cheese reaction, local infiltration of vasoconstrictors	Tachycardia, postural hypotension	Enhances NA effects due to $\alpha 2$ blockade
Prazosin	Oral, ~60% bioavailability; $t_{1/2}$ 2–3 hrs; duration 6–8 hrs	Selective $\alpha 1$ -blocker (all subtypes); inhibits PDE; increases cAMP	Hypertension, Raynaud's, BPH	First-dose hypotension, dizziness, mild tachycardia, nasal stuffiness, inhibition of ejaculation	Additive with other antihypertensives
Terazosin	Oral bioavailability ~90%, $t_{1/2} \sim 12$ hrs	Selective $\alpha 1$ -blocker; may promote prostatic apoptosis	Hypertension, BPH	Dizziness, postural hypotension	Additive hypotension with other vasodilators
Doxazosin	Oral, long-acting; $t_{1/2} \sim 18$ hrs	Selective $\alpha 1$ -blocker; may promote prostatic apoptosis	Hypertension, BPH	Dizziness, retrograde ejaculation	Additive BP lowering with CYP inhibitors

Alfuzosin	Oral t _{1/2} 3–5 hrs; ER form available	Nonselective α 1 blocker (all subtypes); not used for HTN	BPH	Postural hypotension, dizziness	Metabolism inhibited by CYP3A4 inhibitors (e.g., ketoconazole, erythromycin)
Tamsulosin	Oral t _{1/2} 6–9 hrs; modified release dosing once daily	Selective α 1A/ α 1D blocker; uroselective	BPH	Retrograde ejaculation, floppy iris syndrome, low incidence of hypotension	Lower risk of systemic effects; caution in cataract surgery
Silodosin	Oral bioavailability ~30%, t _{1/2} ~13 hrs	Highly selective α 1A blocker	BPH	Ejaculation failure, low postural hypotension	Metabolism by glucuronidation; excreted in urine/feces
Yohimbine	Short-acting	Selective α 2 blocker; also blocks 5-HT receptors; increases central sympathetic outflow	Psychogenic impotence (no valid clinical indication)	Increased HR and BP, genital congestion	Not recommended for clinical use
Ergot Alkaloids	Long-lasting; ergotoxine = better α -blocker than ergotamine	Partial agonist/antagonist at α , 5-HT, dopamine receptors; ergotamine = vasoconstrictor	Migraine (ergotamine), cognition enhancer (dihydroergotoxine)	Vasoconstriction, gangrene (ergotism)	Avoid in peripheral vascular disease
Chlorpromazine	Lipid soluble neuroleptic	Central D2 blockade; also blocks peripheral α receptors	Psychosis; side effect: α blockade	Hypotension, nasal stuffiness, inhibition of ejaculation	Enhanced hypotensive effect with other vasodilators



B ADRENERGIC BLOCKING DRUGS

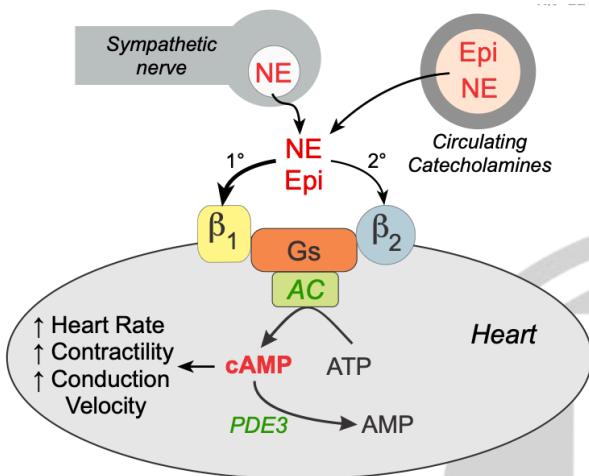


Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
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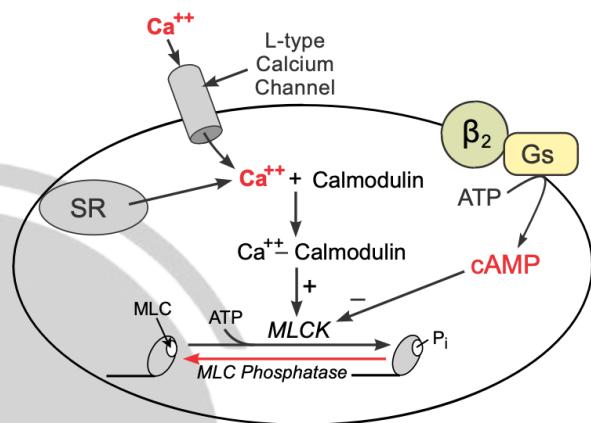
Propranolol	High first-pass metabolism, lipophilic, variable oral bioavailability, t _½ ~3–6h. Metabolized in liver.	Non-selective β1 & β2 blocker; membrane-stabilizing; no ISA.	Hypertension, angina, arrhythmias, post-MI prophylaxis, migraine, essential tremor, anxiety, thyrotoxicosis, glaucoma (ocular)	Bradycardia, bronchospasm, CHF worsening, fatigue, cold extremities, depression, hypoglycemia masking, lipid profile changes, rebound hypertension	Additive AV block with verapamil/digitalis, NSAIDs reduce efficacy, masks hypoglycemia, interacts with lidocaine metabolism
Metoprolol	Moderate first-pass metabolism, lipophilic, t _½ ~3–7h. Metabolized by CYP2D6.	β1 selective blocker, weak inverse agonist.	Hypertension, angina, CHF, arrhythmias, post-MI prophylaxis	Less CNS effects than propranolol, safer in asthma/diabetes (but not entirely), fatigue, bradycardia	Similar to propranolol; caution with CYP2D6 inhibitors
Atenolol	Hydrophilic, low lipid solubility, incompletely absorbed, long duration (t _½ 6–20h), renally excreted unchanged	β1 selective blocker	Hypertension, angina	Less CNS effects, less bronchospasm, less metabolic disturbance, fatigue, bradycardia	Fewer CNS interactions; safer in diabetic and asthmatic patients
Bisoprolol	Low lipid solubility, long t _½ (10–12h), oral, once daily dosing	Highly β1 selective blocker	Hypertension, CHF, angina	Fewer side effects, less bradycardia, good tolerability	Low potential for CNS side effects
Nebivolol	High β1 selectivity, enhances NO release, oral t _½ ~10h	β1 selective blocker + stimulates NO-mediated vasodilation	Hypertension, CHF	Improves insulin sensitivity, minimal metabolic effect, less fatigue, good exercise tolerance	Few interactions, possibly CYP2D6 inhibitors

Acebutolol	Metabolized to active diacetolol, $t_{1/2} \sim 8-12\text{h}$	β_1 selective blocker + ISA + membrane stabilizing	Hypertension, arrhythmias	Less bradycardia, mild CNS effects, fatigue	Reduced withdrawal effects
Pindolol	Moderate lipid solubility, oral	Non-selective β blocker with ISA	Hypertension	Less bradycardia, fatigue, may worsen angina; lipid profile not worsened	Lower risk of rebound hypertension
Sotalol	Non-lipophilic, renally excreted, long $t_{1/2}$	Non-selective β blocker + Class III antiarrhythmic (K ⁺ channel block)	Ventricular arrhythmias, supraventricular arrhythmias	Proarrhythmic (QT prolongation), fatigue	Additive risk with other QT-prolonging drugs
Timolol	Lipophilic, no LA activity	Non-selective β blocker	Topical for glaucoma, oral: hypertension, angina	Minimal local irritation; systemic: bradycardia, bronchospasm	Systemic effects possible even with topical use
Esmolol	Ultra-short acting, $t_{1/2} < 10\text{ min}$, inactivated by plasma esterases	β_1 selective, no ISA	Supraventricular tachycardia, perioperative arrhythmia, hypertensive emergencies	Rapid dose control, short-term use only	IV agents with caution; additive AV blockade
Celiprolol	Long acting, oral	β_1 selective blocker + partial β_2 agonist + NO release	Hypertension (esp. with airway disease)	Low risk of bronchospasm, good lipid & metabolic profile	Few; safer in patients with asthma
Labetalol	Oral & IV; first pass metabolism	Mixed $\alpha_1 + \beta_1 + \beta_2$ blocker; weak β_2 agonist	Hypertension, pheochromocytoma, preeclampsia, postural hypotension, sexual dysfunction, liver	Postural hypotension, sexual dysfunction, liver	Additive hypotensive effect with other antihypertensives

			hypertensive emergency	damage, bronchospasm	
Carvedilol	Oral bioavailability ~30%, $t_{1/2} \sim 6-8\text{h}$, metabolized by CYP2D6	$\beta_1 + \beta_2 + \alpha_1$ blocker + calcium channel blocking; antioxidant action	CHF (cardioprotective), hypertension, post-MI	Orthostatic hypotension, dizziness, fatigue, hepatic effects	Interactions with CYP2D6 inhibitors (e.g., fluoxetine, quinidine)



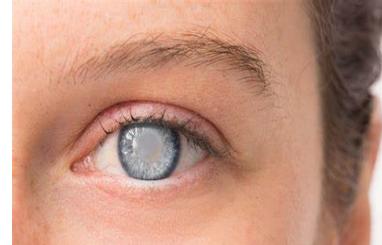
Abbreviations: NE, norepinephrine; Epi, epinephrine; Gs, Gs-protein; AC, adenylyl cyclase; PDE3, cAMP-dependent phosphodiesterase (type 3)

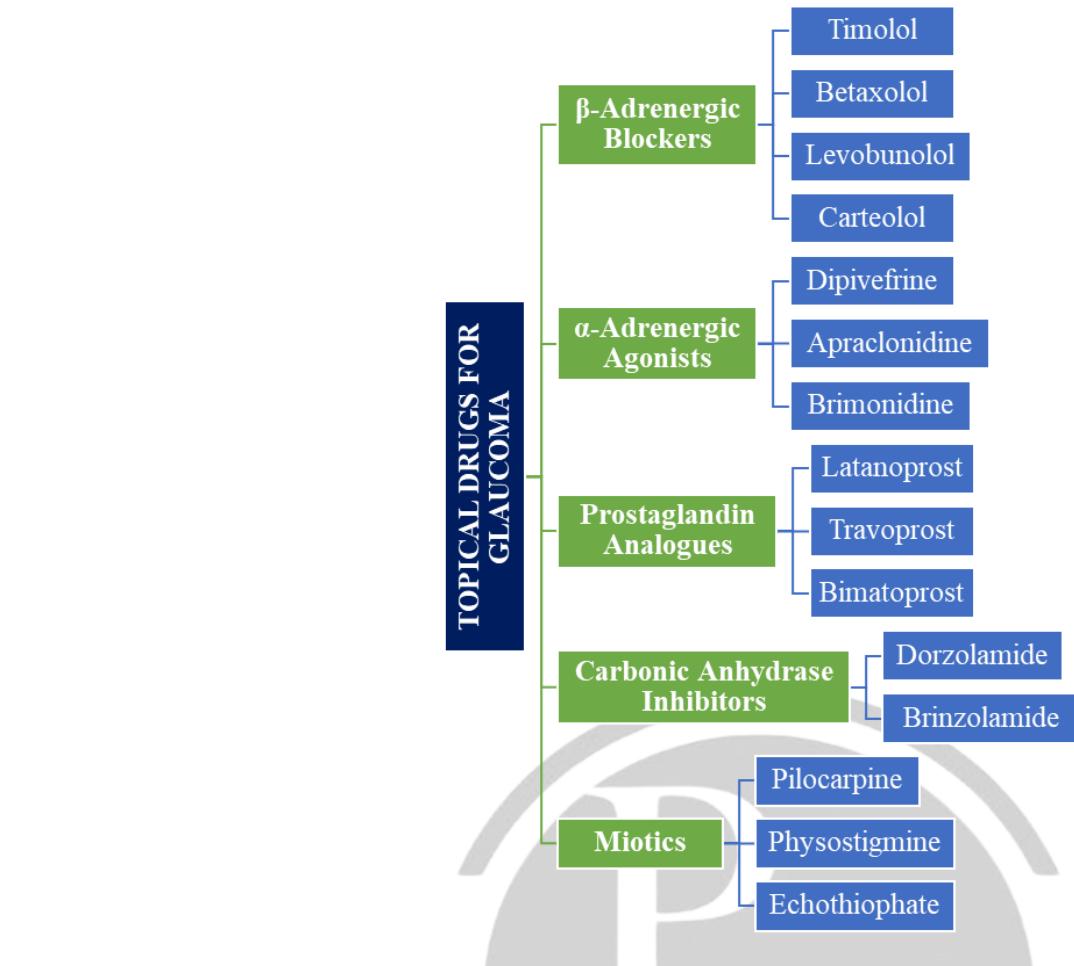


Abbreviations: SR, sarcoplasmic reticulum; Gs, Gs-protein; MLC, myosin light chain; MLCK, myosin light chain kinase; Pi, myosin phosphorylation

DRUGS FOR GLAUCOMA

- **Glaucoma** is a group of diseases involving **optic nerve damage**, typically associated with raised **intraocular tension (IOT)**.
- The goal of therapy is to lower IOT by reducing aqueous humor production or increasing its drainage.





Drug	PK Properties	Mechanism of Action	Therapeutic Uses	Side Effects	Potential Drug Interactions
Timolol	Nonselective $\beta_1+\beta_2$ blocker; effective for 12 hrs; some residual effect post-discontinuation	Decreases aqueous humor formation by blocking β_2 in ciliary epithelium	Open angle glaucoma (chronic); 1st line previously	Ocular: stinging, dry eye, allergic blepharoconjunctivitis; Systemic: bronchospasm, bradycardia, heart block, CHF	Other systemic β blockers; enhanced bradycardia with CCBs
Betaxolol	β_1 selective; 0.5% drops; safer in respiratory/ CV disease	Reduces aqueous production; protective against retinal neuron injury	Open angle glaucoma; preferred initial choice	Transient stinging/burning; less systemic risk	Additive effect with other hypotensive drugs

Levobunolol	Similar to timolol; longer acting; OD dosing	Reduces aqueous production via β blockade	Open angle glaucoma	Similar to timolol	Same as timolol
Dipivefrine	Prodrug of adrenaline; better corneal penetration	Increases uveoscleral outflow; β_2 -mediated trabecular effects + reduces aqueous	Add-on therapy in glaucoma	Burning, hyperemia	Additive adrenergic effects
Apraclonidine	$\alpha_2 > \alpha_1$ agonist; limited CNS effects	Reduces aqueous production via α_2 action	Short-term post-laser IOP spike control	Itching, dermatitis, dry mouth, eyelid retraction	Additive CNS depressants
Brimonidine	Lipophilic α_2 selective; crosses BBB	Reduces aqueous + increases uveoscleral flow	Long and short term in glaucoma; add-on therapy	Dry mouth, sedation, allergic conjunctivitis	CNS depressants; antihypertensives
Latanoprost	PGF2 α analogue; once daily dosing; refrigerated	Increases uveoscleral outflow	1st line in open angle glaucoma	Blurred vision, iris pigmentation, eyelash growth, macular edema	Additive with other IOP-lowering drugs
Travoprost	PGF2 α analogue; effect starts in 2 hrs; no refrigeration	Increases uveoscleral outflow; mild trabecular effect	Alternative to latanoprost in open angle glaucoma	Blurred vision, iris pigmentation, eyelash growth, macular edema	Additive ocular hypotensives
Bimatoprost	Prostamide derivative; OD dosing; no refrigeration	Increases uveoscleral outflow	Effective alternative in glaucoma	Similar to PG analogs	As above
Acetazolamide	Oral CAI; t _{1/2} ~6–12 hr; crosses BBB	Inhibits carbonic anhydrase → reduces aqueous formation	Acute angle closure glaucoma; pre/post-op IOP	Systemic: paresthesia, hypokalemia, malaise, acidosis	Diuretics, digoxin, corticosteroids (hypoK risk)

			control		
Dorzolamide	Topical CAI; 2% drops; TDS	Reduces aqueous formation via CA inhibition	Add-on in glaucoma, esp. when PG/β-blockers contraindicated	Ocular stinging, corneal edema, bitter taste	Other sulfonamides; systemic CAIs
Brinzolamide	Similar to dorzolamide ; topical	Carbonic anhydrase inhibition	Same as dorzolamide	Similar ocular side effects	Same class risk
Pilocarpine	Topical miotic; 1–4% solution; QID	Contracts ciliary muscle → improves trabecular outflow	Open angle (rare use), angle closure glaucoma	Headache, blurred vision, brow ache, poor night vision	Synergistic with other IOP reducers
Mannitol (20%) / Glycerol (10%)	IV mannitol; oral/rectal glycerol	Osmotic agents reducing vitreous volume	Acute angle closure glaucoma (emergency)	Headache, nausea, dehydration	Diuretics, nephrotoxic agents
Apraclonidine (1%) / Latanoprost	Topical; rapid onset	Lower IOP acutely via dual mechanism	Acute angle closure attacks	Headache, nausea, dehydration	Additive with systemic hypotensives

Mnemonics to Remember

Adrenergic system: Tiger aya, bhago....

Cholinergic system: Bhag gaya, aram karo....

Organ	Adrenergic Effect (Fight)	Mnemonic	Cholinergic Effect (Feast)	Mnemonic
Eye	Pupil dilation (mydriasis)	"दूर देखो, खतरा आया!"	Pupil constriction (miosis)	"बारीक अक्षर पढ़ो, मेन्यू देखो!"
Heart	↑ HR, ↑ force (β_1)	"भागने के लिए दिल दौड़े!"	↓ HR (M2)	"आराम से खाओ, दिल को सुकून!"
Bronchi	Bronchodilation (β_2)	"ज्यादा सांस लो, दौड़ना है!"	Bronchoconstriction	"आराम से, गहरी सांस लो"
GI Tract	↓ Motility, ↓ secretion	"टॉयलेट का टाइम नहीं!"	↑ Motility, ↑ secretion	"पकवान पचाओ, आराम करो!"
Bladder	Detrusor relax, sphincter contract	"अभी वॉशरूम नहीं जाना!"	Detrusor contract, sphincter relax	"शांति से शौचालय जाओ!"
Saliva	Thick, scanty (α_1)	"डर के मारे मुँह सूखा!"	Watery, copious (M3)	"खाने की खुशबू से मुँह में पानी!"
Liver	Glycogenolysis, ↑ glucose (β_2)	"भागने के लिए शुगर!"	Mildly ↓ glucose production	"आराम करो, ऊर्जा बचाओ!"
Blood vessels	Constrict (α_1) or dilate in skeletal muscles (β_2)	"पैरों में ताक़त भेजो!"	Minimal effect	-
Sweat glands	Generalized sweating (symp. cholinergic - M3)	"तनाव में पसीना!"	No effect	-

Feature	Adrenergic Drugs (Sympathomimetics)	Antidiadrenergic Drugs (Sympatholytics)
Mnemonic (Function)	“FIGHT”(↑SNS stimulation)	“BLOCK”(↓SNS activity)

Full Mnemonic Expansion	F - Flight/fight response I - Increases HR & BP G - Glucose ↑ H - Hypotension treated T - Treats asthma, shock, etc.	B - Block β or α receptors L - Lowers BP & HR O - Orthostatic hypotension risk C - CNS depression (some) K - Kills adrenergic tone
Receptors Targeted	α_1 , α_2 , β_1 , β_2	α_1 , α_2 , β_1 , β_2 (blockade) or pre-synaptic inhibition
Mechanism of Action	Stimulate adrenergic receptors directly (e.g., adrenaline) or indirectly (e.g., amphetamine)	Block adrenergic receptors (e.g., propranolol) or deplete NE (e.g., reserpine)
Effects	\uparrow HR, \uparrow BP, bronchodilation, mydriasis, \uparrow glucose	\downarrow HR, \downarrow BP, bronchoconstriction, miosis
Example Drugs	Adrenaline, Noradrenaline, Salbutamol, Dopamine, Dobutamine	Propranolol, Prazosin, Reserpine, Clonidine, Phenoxybenzamine
Clinical Use Mnemonic	"ADDS" : Asthma, Dobutamine (CHF), Dopamine (shock), Septic shock	"CHiPP" : Clonidine (HTN), Hypertension, Prazosin (BPH), Phenoxybenzamine (PCC)
Side Effects Mnemonic	"HOT BRAIN" : Hypertension, Overstimulation, Tremors, BP ↑, Restlessness, Arrhythmia, Insomnia, Nausea	"BLOWS" : Bradycardia, Lethargy, Orthostatic hypotension, Weakness, Sexual dysfunction
Main Subtypes	- Direct (e.g. NE, Epi)- Indirect (e.g. amphetamines)	- α -blockers (e.g., prazosin)- β -blockers (e.g., atenolol)- Centrally acting (e.g., clonidine)- Neuron blockers (e.g., reserpine)
Useful Phrase to Recall	"Adrenergic ACTIVATE the SNS"	"Antiadrenergics BLOCK the SNS"