- Receptors in all ganglia –either in sympathetic or parasympathetic systems- are nicotinic and they utilize acetycholine. Therefore, when a nicotinic blocker is given such as pralidoxime, this is going to generate a mixed-effect on both sympathetic and parasympathetic systems.
- Postganglionic neurons in the parasympathetic system secrete acetylcholine which will bind to muscarinic receptor on the effector organs.
- Postganglionic neurons in the sympathetic system release norepinephrine (mostly) as a neurotransmitter. They might also release acetycholine in sweat glands and the adrenal medulla.
- **Synthesis and breakdown of acetylcholine:**
  - Choline + acetyl CoA → via cholinacetyl transferase → acetylcholine
  - This acetylcholine is going to be stored in vesicles and will only be released when calcium enters nerve terminals driving the vesicles to undergo exocytosis.
  - Breakdown of acetylcholine: ACh → via acetyolcholine esterase → acetate + choline (these two products are re-used).
- **Synthesis of catecholamines:**
  - Tyrosine → via hydroxylase → dopa → via decarboxylase → dopamine → via hydroxylase → norepinephrine → via methyltransferase → epinephrine
  - Notice that dopamine, norepinephrine and epinephrine are known as catecholamines.
  - When catecholamines are released:
    - ✓ 80% is epinephrine.
    - ✓ 20% is norepinephrine.
- **Fate of catecholamines after they finish their action:**
  - Norepinephrine is re-used.
  - Or degraded in the synapse by Catechol-O-Methyl Tranferase (COMT).
  - Or degraded inside the neurons by Monoamine Oxidase (MAO).

ANS receptors				
Adrenergic		Cholinergic		Dopaminergic
Alpha (α)	Beta (β)	Muscarinic	Nicotinic	
• α_1: vasoconstriction, increased blood pressure and dilation of the iris • α_2: inhibition of further release of NE (negative feedback)	• β_1: increased heart rate and lipolysis • β_2: other sympathetic actions • β_3: lipolysis	M1 – M2 – M3 – M4 – M5	• N_N: in neurons • N_M: in muscles	D1 – D2 – D3 – D4 – D5

- **The following information are based on (Aysha Khalid) notes:**
  - **Direct-acting cholinergic agonists**: they have longer duration than ACh and show little specificity in their actions (which limits their clinical usefulness).
    - ✓ Acetylcholine: it has the same parasympathetic effects and it activates both muscarinic and nicotinic receptors.
    - ✓ Carbachol: it activates both muscarinic and nicotinic receptors. It can also release epinephrine and norepinephrine from the adrenal medulla.
    - ✓ Pilocarpine: it activates muscarinic receptors. This drug can enter the brain and cause CNS disturbances.

- **Indirect-acting cholinergic agonists:**
  - ✓ Neostigmine: reversible.
  - ✓ Parathion: irreversible.
  - ✓ Pralidoxime: it is a drug which reactivates acetylcholine esterase.
- **Cholinergic antagonists-Antimuscarinic agents:**
  - ✓ Atropine: it causes reversible, non-selective blockade of muscarinic receptors (to prevent ACh from binding).
  - ✓ Tropicamide: it is considered as a short-acting atropine.
- **Cholinergic antagonists-ganglionic blockers**: these drugs block the entire output of the autonomic nervous system at nicotinic receptors
- **Cholinergic antagonists-neuromuscular blocking drugs**: these are clinically useful during surgery for producing complete muscle relaxation, orthopedic surgery and tracheal intubation.
- **Direct-acting adrenergic agonists:**
  - ✓ Epinephrine: it has a rapid onset but a brief duration of action so it is better to administer it intramuscularly.
  - ✓ Norepinephrine: it may be given intravenously to insure a rapid onset.
- **Indirect-acting adrenergic agonists:**
  - ✓ Amphitamine.
- **Mixed-actions adrenergic agonists:**
  - ✓ Ephedrine.
- **Adrenergic antagonists-β blockers:**
  - ✓ Propranolol: after oral administration, this drug is totally absorbed because it is highly lipophilic. It can cross the blood-brain barrier (BBB).

- **Effect of autonomic drugs on the eye:**