What is the neurotransmitter used by preganglionic fibers terminating in the adrenal medulla, autonomic ganglia, and postganglionic fibers of the parasympathetic division?	Acetylcholine (ACh).
Which division of the nervous system uses acetylcholine for neurotransmission in the postganglionic fibers of sweat glands?	Postganglionic sympathetic division.
How many sequential steps are involved in neurotransmission in cholinergic neurons?	Six steps.
What is the first step in neurotransmission at cholinergic neurons?	Synthesis.
What is the space between the nerve endings and adjacent receptors located on nerves or effector organs called?	The synaptic cleft.
What is the rate-limiting step in acetylcholine synthesis?	The uptake of choline.
What catalyzes the reaction of choline with acetyl coenzyme A to form ACh?	Choline acetyltransferase.
What is the primary neurotransmitter stored in most synaptic vesicles?	Acetylcholine (ACh).
What other substance, along with ACh, is stored in the presynaptic vesicles?	Adenosine triphosphate (ATP) and proteoglycan.
What causes the fusion of synaptic vesicles with the cell membrane and the release of their contents into the synaptic space?	Elevated calcium levels.
What can block the release of ACh from synaptic vesicles?	Botulinum toxin.
What effect does the black widow spider venom have on the ACh stored in synaptic vesicles?	Causes all the ACh to empty into the synaptic gap.

What are the two classes of postsynaptic cholinergic receptors on the surface of the effector organs?	Muscarinic and nicotinic.
What enzyme cleaves acetylcholine in the synaptic cleft?	Acetylcholinesterase (AChE)
What are the products of the cleavage of acetylcholine by acetylcholinesterase?	Choline and acetate
How is choline recycled back into the neuron?	By a sodium-coupled, high-affinity uptake system
What are the two families of cholinoceptors?	Muscarinic and nicotinic receptors
What class do muscarinic receptors belong to?	G protein–coupled receptors (metabotropic receptors).
What is the other substance, apart from ACh, that muscarinic receptors recognize?	Muscarine.
How many subclasses of muscarinic receptors are there?	Five.
Which muscarinic receptor subtypes have been functionally characterized?	M1, M2, and M3.
Where are muscarinic receptors found in the body?	On autonomic effector organs such as the heart, smooth muscle, brain, and exocrine glands.
What is the mechanism of acetylcholine signal transduction when M1 or M3 receptors are activated?	The receptor undergoes a conformational change and interacts with a G protein, designated Gq, that in turn activates phospholipase C, leading to the production of the second messenger inositol-1,4,5-trisphosphate (IP3) and diacylglycerol (DAG).
What is pilocarpine used to treat in clinical practice?	Xerostomia and glaucoma.
What are M1 receptor agonists being investigated for?	Treatment of Alzheimer’s disease.

What are M3 receptor antagonists being investigated for?	Treatment of chronic obstructive pulmonary disease.
How many subunits is the nicotinic receptor composed of?	Five.
What type of ion channel does the nicotinic receptor function as?	Ligand-gated ion channel.
What is the result of the entry of sodium ions due to the binding of ACh molecules to the nicotinic receptor?	Depolarization of the effector cell.
Where are nicotinic receptors located in the body?	CNS, adrenal medulla, autonomic ganglia, and neuromuscular junction (NMJ) in skeletal muscles.
What are the two broad groups into which cholinergic agonists may be classified?	Endogenous choline esters and naturally occurring alkaloids.
What is the duration of action of direct-acting cholinergic drugs compared to ACh?	Longer.
What is the clinical term for pilocarpine and bethanechol?	Muscarinic agents.
What is acetylcholine's effect on heart rate and cardiac output?	It decreases heart rate and cardiac output.
How does acetylcholine affect blood pressure?	It decreases blood pressure by causing vasodilation and lowering blood pressure through an indirect mechanism of action.
What is the role of acetylcholine in the gastrointestinal (GI) tract?	It increases salivary secretion, gastric acid secretion, stimulates intestinal secretions and motility, enhances bronchiolar secretions, and causes bronchoconstriction.
What is the function of acetylcholine in the genitourinary tract?	It increases the tone of the detrusor muscle, causing urination.
What are the ocular effects of acetylcholine?	It stimulates ciliary muscle contraction for near vision and causes miosis (constriction of the pupil).

What is the structural relation between Bethanechol and ACh?	Bethanechol is structurally related to ACh.
Why is Bethanechol not hydrolyzed by AChE?	Due to the esterification of carbamic acid.
What are the major actions of Bethanechol?	Stimulating muscarinic receptors, increasing intestinal motility and tone, and stimulating the detrusor muscle of the bladder.
In which medical condition is Bethanechol used in urologic treatment?	To stimulate the atonic bladder, particularly in postpartum or postoperative, non-obstructive urinary retention.
What adverse effects can be caused by Bethanechol?	Sweating, salivation, flushing, decreased blood pressure, nausea, abdominal pain, diarrhea, and bronchospasm.
What are the actions of Carbachol on the cardiovascular and GI systems?	Profound effects due to ganglion-stimulating activity.
How does Carbachol affect the eye when locally instilled?	It mimics the effects of ACh, causing miosis and a spasm of accommodation.
Where is Carbachol rarely used therapeutically?	Except in the eye for treating glaucoma.
What are the therapeutic uses of Carbachol in the eye?	As a miotic agent to treat glaucoma by causing pupillary contraction and a decrease in intraocular pressure.
Why do little or no side effects occur at ophthalmological doses of Carbachol?	Due to lack of systemic penetration (quaternary amine).
What is the primary therapeutic use of pilocarpine?	To treat glaucoma.
How does pilocarpine lower intraocular pressure in glaucoma?	By opening the trabecular meshwork around the Schlemm canal.
What is the immediate effect of pilocarpine in lowering intraocular pressure?	An immediate drop in intraocular pressure.
What adverse effects can pilocarpine cause?	Blurred vision, night blindness, and brow ache.

What is the miotic action of pilocarpine useful for?	Reversing mydriasis due to atropine.
What is the function of anticholinesterase agents?	To prevent the degradation of ACh.
Where is AChE located in the nerve terminal?	Both pre- and postsynaptically.
What is the prototype short-acting AChE inhibitor?	Edrophonium.
How does edrophonium work in the body?	It binds reversibly to the active center of AChE, preventing hydrolysis of ACh.
What is the duration of action of edrophonium?	10 to 20 minutes.
What is the use of edrophonium in the diagnosis of myasthenia gravis?	To assess the degree of muscle weakness.
What is the therapeutic use of physostigmine?	Treatment of overdoses of drugs with anticholinergic actions, such as atropine, and to reverse the effects of NMBs.
What are the adverse effects of high doses of physostigmine?	Convulsions, bradycardia, and a fall in cardiac output.
How does physostigmine act on the muscarinic and nicotinic sites of the ANS?	It stimulates them.
What is the duration of action of physostigmine?	About 30 minutes to 2 hours.
What is the main therapeutic use of neostigmine?	To reverse the effects of NMBs.
What is the main difference between neostigmine and physostigmine in terms of chemical structure?	Neostigmine has a quaternary nitrogen.
What are the therapeutic uses of neostigmine?	Stimulating the bladder and GI tract, antidote for competitive neuromuscular-blocking agents, managing symptoms of myasthenia gravis.
What are the adverse effects of neostigmine?	Salivation, flushing, decreased blood pressure, nausea, abdominal pain, diarrhea, bronchospasm.
What is the duration of action for neostigmine?	30 minutes to 2 hours.

What is the duration of action for pyridostigmine?	3 to 6 hours.
What is the primary adverse effect of anticholinesterases used in the management of Alzheimer's disease?	Gastrointestinal distress.
What is the mechanism of action of echothiophate?	It covalently binds via its phosphate group at the active site of AChE.
What is the result of echothiophate binding to AChE?	Permanently inactivates the enzyme, requiring synthesis of new enzyme molecules for restoration of AChE activity.
What is the term for the loss of an alkyl group from the phosphorylated enzyme?	Aging.
What are the actions of echothiophate?	Generalized cholinergic stimulation, paralysis of motor function, convulsions, and intense miosis.
How does echothiophate affect intraocular pressure?	It facilitates the outflow of aqueous humor, leading to a fall in intraocular pressure.
What is the therapeutic use of echothiophate?	Treatment of open-angle glaucoma.
Why is echothiophate rarely used?	Due to its side effect profile, including the risk of cataracts.
What are organophosphate compounds commonly used as?	Agricultural insecticides.
What are the manifestations of toxicity with organophosphate nerve gases such as sarin?	Nicotinic and muscarinic signs and symptoms (cholinergic crisis).
What can reactivate inhibited AChE?	Pralidoxime (2-PAM).
Why is pralidoxime unable to treat the CNS effects of organophosphates?	It is unable to penetrate into the CNS.
What is administered to prevent muscarinic side effects of organophosphate agents?	Atropine.

What is administered to reduce the persistent convulsion caused by organophosphate agents?	Diazepam.