INTRODUCTION TO Autonomic nervous system (ANS) Objectives ● Define cholinergic transmission ● Mention types of cholinergic receptors ● Define autonomic nervous system neurotransmitter Questions 1- Acetylcholine is not a specific neurotransmitter at: a) Parasympathetic ganglia b) Sympathetic ganglia c) Sympathetic postganglionic nerve endings d) Parasympathetic postganglionic nerve endings 2- Preganglionic sympathetic and parasympathetic fibers release ____, postganglionic parasympathetic fibers release ____ (for muscarinic cholinergic receptors), and postganglionic sympathetic fibers release ____ (for adrenergic receptors). a) ACh; ACh; NE b) ACh; NE; ACh c) NE; ACh; NE d) NE; NE; Ach Introduction ●The nervous system is conventionally divided into the CNS (the brain and spinal cord) and the peripheral nervous system. ● The motor (efferent) portion of the nervous system can be divided into two major subdivisions: autonomic and somatic. ● The autonomic nervous system (ANS) is independent (autonomous) in that its activities are not under direct conscious control. It is concerned primarily with visceral functions such as cardiac output, blood flow to various organs, and digestion, which are necessary for life. Introduction ●The somatic subdivision is concerned with consciously controlled functions such as movement, and posture. ●Both systems have important afferent (sensory) inputs that provide information regarding the internal and external environments and modify motor output through reflex arcs of varying size and complexity. Figure .1 Organization of the nervous system. Anatomy of the autonomic nervous system 1- Efferent neurons: The ANS carries nerve impulses from the CNS to the effector organs by way of two types of efferent neurons (Figure .2). ●The first nerve cell is called a preganglionic neuron that emerges from the brain stem or spinal cord and make a synaptic connection in ganglia (an aggregation of nerve cell bodies located in the peripheral nervous system). ●These ganglia function as relay stations between the preganglionic neuron and a second nerve cell, the postganglionic neuron (Figure .2). Figure .2 Efferent neurons of the autonomic nervous system ● Sympathetic neurons: ● The preganglionic neurons of the sympathetic system come from thoracic and lumbar regions of the spinal cord and synapse in two cord-like chains of ganglia that run in parallel on each side of the spinal cord. Axons of the postganglionic neuron extend from these ganglia to the glands and viscera. Thus, the preganglionic fibers are short, and the postganglionic ones are long, with the ganglia far from the organ innervated. ● The adrenal medulla: ●like the sympathetic ganglia, receives preganglionic fibers from the sympathetic system. Lacking axons, the adrenal medulla, in response to stimulation by neurotransmitters, influences other organs by secreting the hormone epinephrine, also known as adrenaline (and lesser amounts of norepinephrine) into the blood. ● Parasympathetic neurons: ● The parasympathetic preganglionic fibers arise from the cranial nerves III, VII, IX and X) and from the sacral region of the spinal cord and synapse in ganglia near or on the effector organs. Thus, in contrast to the sympathetic system, the preganglionic fibers are long, and the postganglionic ones are short, with the ganglia close to or within the organ innervated. ●Neurotransmitters ● Each neuron is a distinct anatomic unit, and no structural continuity exists between most neurons. Communication between nerve cells and between nerve cells and effector organs- occurs through the release of specific chemical signals, called neurotransmitters, from the nerve terminals. This release depends on processes that are triggered by Ca2+ uptake and regulated by phosphorylation of synaptic proteins. ● The neurotransmitters rapidly diffuse across the synaptic cleft (synapse) between nerve endings and combine with specific receptors

on the postsynaptic (target) cell. ●Neurotransmitters ● Acetylcholine: ACh is the chemical transmitter across 1- All autonomic ganglia (both the sympathetic, parasympathetic) and adrenal medulla (Fig. .6). 2- Postganglionic parasympathetic nerve fibers. 3- The somatic nervous system, transmission at the neuromuscular junction. ● Norepinephrine and epinephrine: ● In the sympathetic system, norepinephrine mediates the transmission of nerve impulses from autonomic postganglionic nerves to effector organs (post ganglionic sympathetic fiber) . Figure. 6. Summary of the neurotransmitters released and the types of receptors found within the autonomic and somatic nervous systems. Autonomic nervous system ●The autonomic nervous system is a visceral, vegetative, involuntary system which is widely distributed and regulates autonomic (automatic) functions that occur without conscious control. The main processes ANS controls include: ● Heart beats and blood pressure. ● Contraction and relaxation of smooth muscles. ● All exocrine and certain endocrine secretions. ● Certain steps in intermediary metabolism. ● ANS is divided into cholinergic and adrenergic systems; both divisions supply almost all visceral involuntary organs. PARASYMPATHETICS INTRODUCTION TO PARASYMPATHETIC NERVOUS SYSTEM: I- Synthesis, storage, release and metabolism of Ach: (1) Synthesis: ● ACh is synthesized in nerve terminal by the combination of choline and acetyl COA (active acetate) using choline acetyl transferase enzyme. ● Hemicholinium inhibits the uptake of choline into the nerve terminal, so it inhibits the synthesis of ACh. 2) Storage: ● ACh is transported for storage inside vesicles (quanta). ● Vesamicol inhibits this transport, so it inhibits storage. (3) Release: ● Nerve impulse causes influx of Ca++ ions and release of ACh from the storage vesicles by exocytosis. ● Metoclopramide increases the release of Ach in GIT. Figure (1) Cholinergic transmission Figure (1) Cholinergic transmission (4) Metabolism: ● Mainly enzymatically by two types of cholinesterase enzymes: a)Acetyl cholinesterase (true cholinesterase),which is found in the neurons and neuromuscular junction. It is responsible for hydrolysis of Ach. b)Butyryl cholinesterase (pseudocholinesterase), which is found mainly in the plasma and liver. It hydrolyzes acetylcholine and succinylcholine. Figure (2): Metabolism of ACh by acetylcholinesterase enzyme 5) Sites of cholinergic transmission: ● ACh is the chemical transmitter in i)all autonomic ganglia, ii)all postganglionic parasympathetic fibers, iii)postganglionic sympathetic fibers to sweat glands iv)vasodilator fiber in muscles and v)nerve endings supplying the adrenal medulla. N.B. Norepinephrin (NEP) is the chemical transmitter to all the postganglionic sympathetic fibers except the above sites (sweat glands & vasodilator fiber in muscles). II- Types of cholinergic receptors: (a)Muscarinic receptors (blocked by atropine): M1: in the autonomic ganglia (modulate neuronal transmission), parietal cells of stomach (Increase HCl secretion) and GIT (increase motility and gastric secretions). M2: in the heart (slowing heart rate and decrease conduction velocity in AV nodes), presynaptic cholinergic nerves (autoreceptors), CNS (inhibitory functions). M3: in smooth muscles of eye (miosis, spasm of accommodation, reduce IOP), bronchi (bronchoconstriction), GIT and bladder wall (contraction), exocrine glands (increase all secretions, salivary, lacrimal, sweat) and vascular endothelium (Vasodilatation). M4 and M5 are recently discovered, found mainly in CNS. (b) Nicotinic receptors (not blocked by atropine) Nm (nicotinic muscle) receptors in the neuromuscular junction (blocked by d-(tubocurarine). Nn (nicotinic neuronal) receptors in autonomic ganglia, adrenal medulla and CNS (blocked by trimethaphan). . QUESTIONS 1-Influx of what ion causes ACh release into the synaptic cleft, prior to ACh being

terminated by acetylcholinesterase (AChE)? a) K+ b) Ca2+ c) Cl− d) Na+ 2− The correct statement about acetylcholine: a) Has a half−life of 8 to10 hours in plasma b) Is synthesized from an amino acid precursor c) It acts on both muscarinic and nicotinic receptors d) Its released from nerve terminals is stimulated by botulinum toxin 3− Which of the following statements concerning the parasympathetic nervous system is Correct? A) The parasympathetic nervous system uses epinephrine as a neurotransmitter. B) Is considered cranio−sacral. C) The preganglionic fibers of the parasympathetic division are short, compared to those of the sympathetic system. D) The postganglionic fibers of the .parasympathetic division are long, compared to those of the sympathetic system