Unit I – Problem 4 – Physiology: Autonomic Imbalance (Autonomic Nervous System)

- **What is the function of Autonomic Nervous System (ANS)?**
  - Regulating cardiovascular, respiratory and gastrointestinal systems in addition to exocrine and endocrine glands throughout the body.
  - ANS is controlled centrally by the brain and spinal cord.
- **ANS is divided into:**
  - **Sympathetic nervous system:**
    - ✓ It is usually activated during stress or emergency situations (fight-or-flight response).
    - ✓ Characteristics: Postganglionic nerve fibers are longer than preganglionic nerve fibers; the neurotransmitter is mostly norepinephrine (except sweat glands where it is acetylcholine); the receptors are mostly α or β adrenergic receptors (except sweat glands which have muscarinic receptors).
    - ✓ Adrenergic receptors and their functions:

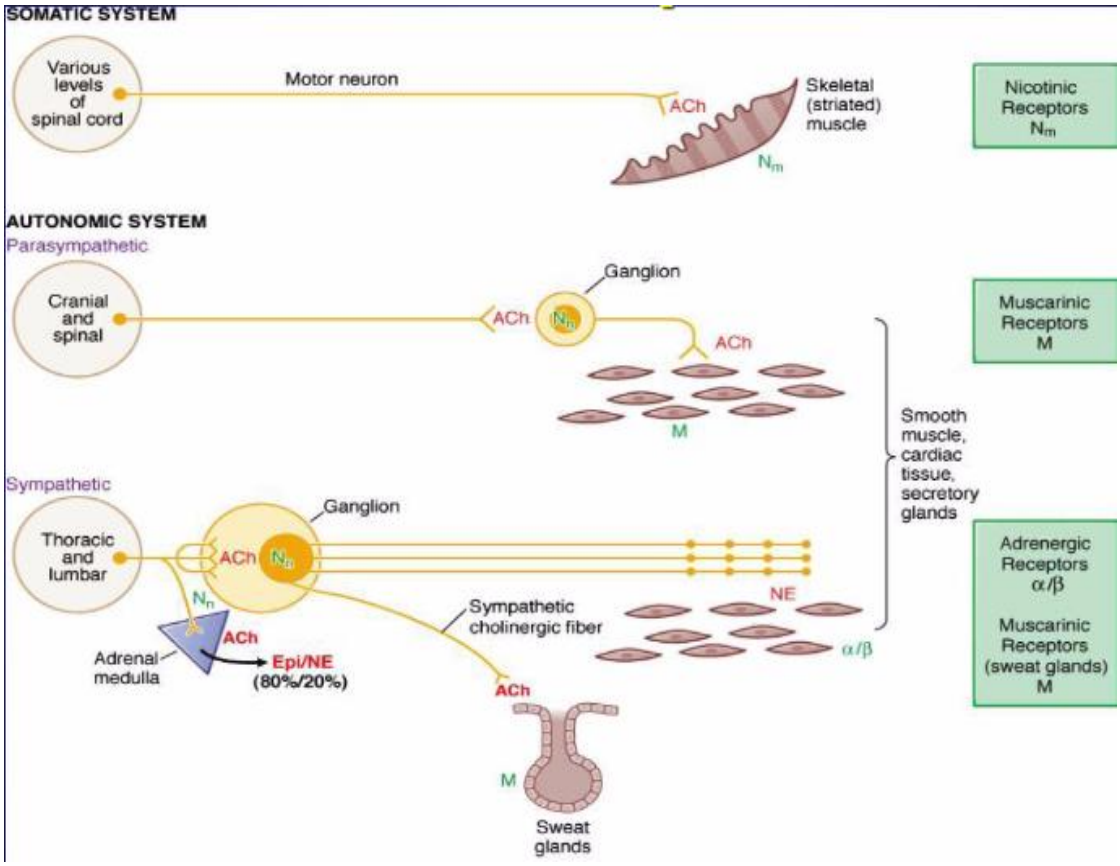
Receptor	Function
α-receptor (sensitivity: NE> E> ISO). α_1-receptors are on the effector tissue while α_2-receptors are on the presynaptic neuron	• Vasoconstriction • Iris dilation • Intestinal relaxation • Intestinal sphincter contraction • Pilomotor contraction • Bladder sphincter contraction
β_1-receptor (sensitivity in β-receptors: ISO> E> NE)	• Cardioacceleration • Increased myocardial strength
β_2-receptor	• Vasodilation • Intestinal relaxation • Uterus relaxation • Bronchodilation • Calorigenesis • Gylcogenolysis • Bladder wall relaxation

  - **Parasympathetic nervous system:**
    - ✓ It maintains energy and conserves body energy.
    - ✓ Characteristics: preganglionic nerve fibers are longer than postganglionic nerve fibers; the neurotransmitter is acetylcholine and the receptor is muscarinic receptor.

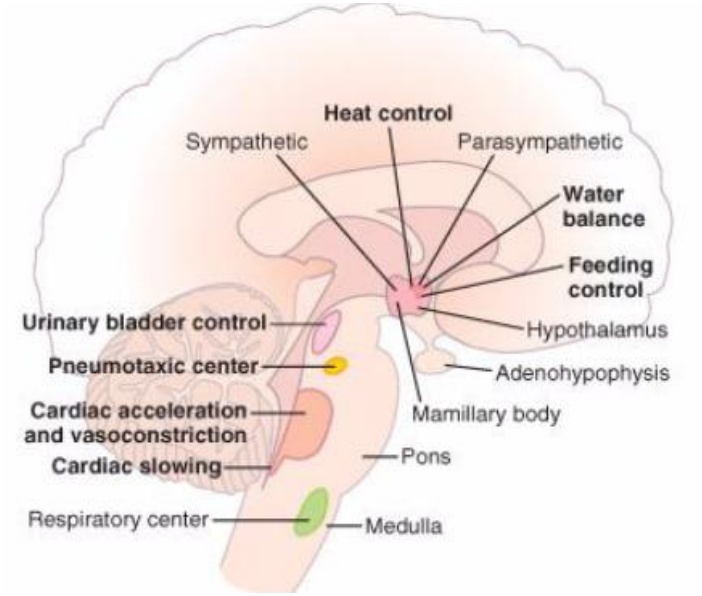
Notice that preganglionic nerve fibers always release acetylcholine in sympathetic and parasympathetic nervous systems.

- **Effects of ANS on the organs:**

Organ	Sympathetic effect	Parasympathetic effect
Eye	Papillary dilation	Papillary constriction and accommodation reflex (ability of the lens to focus on near or far objects)
Glands of the body	Stimulation of sweat glands	Stimulation of nasal, lacrimal, salivary and GI glands
GI tract	Very little effect	Stimulation of overall activity including GI smooth muscle
Heart	Increasing the rate and contractility	Decreasing heart rate
Blood vessels	Vasoconstriction	Vasodilation



- **Functions of the adrenal medulla:**
  - It is a large sympathetic ganglion which releases epinephrine (80%) and norepinephrine (20%) into the blood.
  - Therefore, cardiovascular function and metabolic rate will be stimulated.
- **Sympathetic and parasympathetic tone:**
  - **This tone refers to the basal rate of activity of each system and this allows for an increase or decrease in activity by a single system.**
    - ✓ Sympathetic tone: causes 50% vasoconstriction.
    - ✓ Parasympathetic tone: provides background GIT activity.
- **Stress response/ fight-or-flight response (in life-threatening situations):**
  - **Increased activity of sympathetic nervous system which leads to increase in:**
    - ✓ Arterial pressure.
    - ✓ Heart rate and contractility.
    - ✓ Blood flow to muscles and muscle strength.
    - ✓ Blood glucose.
    - ✓ Metabolic rate.
    - ✓ Mental activity.
    - ✓ Blood coagulation.
    - ✓ Dilation of bronchioles for easier breathing.
    - ✓ Inhibition of digestive functions
- **Cooperative effects of ANS (best seen in control of external genitalia):**
  - **Parasympathetic system**: erection of clitoris and penis.
  - **Sympathetic system**: ejaculation (in males); reflex perstalisis (in females).
- **Autonomic control areas in the brainstem and hypothalamus:**
  - **Hypothalamus**: Heat control, water balance and feeding control.
  - **Midbrain**: urinary bladder control.
  - **Pons**: pneumotaxic center; cardiac acceleration and vasoconstriction; cardiac slowing.
  - **Medulla**: respiratory center.
    Notice that midbrain, pons and medulla compose the brainstem.



- **Biochemical events at cholinergic endings:**
  - Acetyl-CoA + choline will form acetylcholine (ACh).
  - ACh will be released from the nerve ending –via influx of calcium- to bind to its receptors which are present on the postsynaptic tissue.
  - ACh will be degraded by acetycholine esterase into choline which is recycled to re-synthesized acetylcholine.
- **Biochemical events at noradrenergic endings:**
  - Tyrosine (tyrosine hydroxylase) → dopa (amino acid decarboxylase) → dopamine (dopamine-β-hydroxylase) → NE (norepinephrine)
  - NE will be released from the nerve ending –via influx of calcium- to bind to its receptors which are present on the postsynaptic tissues.
  - NE will be degraded by MAO or COMT.