The Endocrine System

PHYSIOLOGY

☑ Sheet ☐ Slide ☐ Handout

Number:	1
Subject:	Introduction
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Price:

❖ Of all body systems, only 2 control its activities; the **nervous** system and the **endocrine** system. So let's make a little comparison between the two:

	Endocrine system	Nervous system
Mechanism of control	Hormones reach the tissues, usually, via blood	Neurotransmitters that are released from nerve endings into the postsynaptic cells
Cells affected	Almost all body's cells	Another neuron, a muscle or a gland.
Type of action that results	Changing in metabolism in the body (anabolism or catabolism)	Either action potential, contraction, or secretion of hormones and enzymes. Depending if the affected cells are neurons, muscles, or gland cells. Respectively.
Onset of action	Usually delayed (an exception is epinephrine)	Usually immediate
Duration of action	Long	Short

❖ **Types of Glands:** They are of two types:

- **Exocrine glands:**
  Secretions are released into a duct which opens either inside the body such as the intestine or outside the body such as sweat glands.
- **Endocrine glands:**
  They're of 5 types, but mainly the first one;

  1) **Classic endocrine glands: ductless** glands which secrete **classic hormones** into the blood**.**
  2) **Autocrine glands:** hormones released into the interstitial spaces, bind to specific receptor on the cell of origin**.**
  3) **Paracrine glands**: hormones released into the interstitial spaces, bind to specific receptor of nearby cells.

4) **Neuroendocrine glands:** The hormones are produced from neurons (neurohormones) and released into either:

   - The **blood,** e.g. posterior pituitary**.**
   - The **synaptic cleft** affecting the post synaptic neurons, e.g. epinephrine**.**

5) **Pheromones glands:** Pheromones are volatile hormones (evaporate rapidly), released into the environment to act on olfactory cells of another individual, produced by animals to produce physiologic changes in another animal of the same species;

   - In animals, examples include male deer and amber which is produced by whales in their intestines.
   - Also present in humans, especially females. Males and females attract each other "chemistry".

❖ Notes:

- Single endocrine glands may produce **multiple** hormones with different control mechanisms and functions.
  - The **anterior pituitary** and the **pancreas** secrete many hormones.

- Most hormones have multiple actions in their target tissues and are said to have **pleotrotropic** effects.
  - This phenomenon occurs when a single hormone regulates several functions in the same target tissue.
  - **Insulin** stimulates glucose uptake, glycolysis, glycogenesis, inhibit glycogenolysis, stimulates amino acids uptake, stimulates protein synthesis, and inhibit protein degradation.

- Some hormones are known to have different effects in certain different types of tissues, e.g. **testosterone** promotes normal sperm formation in the testes, stimulates growth of accessory sex glands such as prostate and seminal vesicles, and promotes the development of several secondary sex characteristics such as beard growth and deepening of the voice.

- Some hormones may be secreted by more than one endocrine gland, e.g. **somatostatin**, from the hypothalamus, is also produced from the pancreas.

- The same chemical can be classified as a **hormone** or a **neurotransmitter** depending on the source of secretion; a gland or a hormone and the mode of delivery of the chemical to tissues.
    - When somatostatin is secreted from the hypothalamus it's a neurotransmitter. When it's secreted form the pancreas it's a hormone.

- Some hormones' secretion is stimulated by **different** stimuli to affect the same physiological process.
    - Many hormones including insulin, glucagon, epinephrine, thyroid hormones, and adrenal glucocorticoids may regulate liver glycogen metabolism as responses to different stimuli.

- Single target cell may be influenced by more than one hormone. Some cells contain an array of receptors for responding in different ways to different types of hormones.
    - Insulin promotes the conversion of glucose into glycogen within liver cells by stimulating certain enzymes. Whereas another hormone, glucagon, enhances degradation of glycogen into glucose in liver cells by activation another enzymes.

- Some organs in the body produce just hormones. While other organs in the body perform nonendocrine functions in addition to secreting hormones, e.g. testes, ovaries, lungs, kidneys, heart..

- **Chronic** exposure of a cell to a specific hormone sometimes causes desensitization by reducing the number or the sensitivity of the receptors available to bind the same hormone (**homologous desensitization**) or another hormone (**heterologous desensitization**).
    - The reduction in number is achieved by reducing synthesis or sinking down of the receptors.

- Desensitization is **critical** to life.

- Sometimes, this exposure causes up-regulation of the receptors rather than down-regulation.

❖ Hormones Effects

1) Control **metabolic** activities.
2) Sex hormones are required to produce germ cells and **reproduce**.
3) GI hormones are essential for the **digestive** process.
4) Control **CVS** (cardiac output, blood pressure, blood volume)
5) **Transport** of substances from the blood to cells or vice versa.
6) Affect the **immune** system
7) Growth hormone and others are necessary for normal **growth**.
8) Regulate the response to a **stress**.
9) Affect individual's **behaviors**; male behave differently from females.

❖ Chemical classification of hormones

1- **Proteins** (more than 100 amino acids) or **polypeptides** (less than 100 amino acids)
Note: mainly the hormones are proteins.

2- **Amino acid** derivatives: catecholamines (epinephrine, norepinephrine, dopamine) and Thyroid hormones (T3, T4).

3- **Steroids**: adrenal cortex hormones and sex hormones.

❖ Regulation of hormone secretion

- The **stimulus – response** could be:
  a) **Hormone - hormone** (the stimulus is a hormone and the response is a hormone)
  b) **Substrate - hormone** e.g. Glucose-insulin
  c) **Mineral – hormone** e.g. Calcium - parathyroid hormone

- **This is achieved by 3 main mechanisms:**

1) Feedback control:

   a. **Positive feedback:** The response to the hormone **stimulates** additional secretion of the hormone. Both sucking of milk and uterine contractions stimulate additional oxytocin secretion.
   b. **Negative feedback:** The response to the hormone **inhibits** additional secretion of the hormone.

2) Neural control:

   - **Neurons** secrete hormones that modulate hormone secretion in **special** conditions, like pain, emotional or sexual excitement, fright, injury and stress. e.g. adrenalin, acetylcholine, dopamine, serotonin.

3) Chronotropic control:

   a. **Diurnal rhythm/ sleep-wake cycle:** the secretion of growth hormone is at its highest at 12 mid-noon and 12 mid-night.
   b. **Menstrual rhythm:** The level of estrogen, progesterone, LH and FSH vary during the 28 days of the menstrual cycle.
   c. **Developmental rhythm**: secretion of growth hormone varies according to the stages of development; childhood, puberty, adulthood, and old age.