

Physiology – General Concepts

Lecture #1

Human body is composed of many systems, harmony between those systems is controlled by Nervous System (immediate) and Endocrine System (delayed).

Types of Glands

1. Exocrine: Secrete into Ducts, lead to lumen (GIT; liver, stomach, testes) or body surface (sweat gland).
2. Endocrine: Produce + Secrete Hormones(chemicals). Into Bloodstream or Body Fluids, leading to Target tissue

Modes of Hormone Delivery to Target Cells

1. Classic Endocrine Delivery: Classic Hormone -> Blood -> Target
2. Autocrine Delivery: Hormone -> Affects the same (secretory) cell.
3. Paracrine Delivery: Hormone -> Interstitial Space -> Neighboring Cells
4. Neuroendocrine Delivery: Neurons produce Hormones(Neurohormones), then either to:
-> Blood -> Target
-> Synaptic Cleft -> PostSynaptic Cell (target)

Note: Neuroendocrine : Hormone synthesized in Neurons -> Extracellular Space -> Receptors at different site

Neurocrine : Hormone synthesized in Neurons -> Extracellular Space -> Receptors in nearby cells (like paracrine)

5. Pheromonal Delivery: Animals Produce + Release Pheromones (volatile hormones) -> Environment -> Olfactory Cells of other animals -> produce 3 changes: Hormonal, Physiological, Behavioral(in humans, not necessarily sexual)

Examples: Musk, Ambergris, Sex Attractants

Endocrine System Complexity

1. A Single Endocrine Gland may produce Multiple Hormones
2. Most hormones have a Pleiotropic Effect(multiple actions in a same target tissue/ single hormone regulates several functions, ex: **insulin**)
3. Some hormones have different effects in different Target Tissues
4. The Same hormone(functionally and chemically) may be secreted by 2 or more endocrine glands
5. The same chemical messenger may either be a Hormone or a Neurotransmitter (depending on source and Mode of Delivery)
6. Multiplicity of Regulation is common in endocrine system (1 metabolic pathway, many hormones)
7. A Single Target may be influenced by more than one Hormone
8. Some Organs are Exclusively Endocrine, other are Mixed(perform non endocrine in addition to hormone secretion)
9. In addition to Down Regulation(Regulate Receptor **Number**), Target cells regulate Receptor function by Desensitization(Chronic Hormone Exposure -> cells become less responsive)
(Target Cells Regulate Receptor Number(by Down Regulation) And Function(by desensitization))

Desensitization

1. Homologous Desensitization : Exposure of cells to a **Hormone** -> Decrease Receptors Response(Function) to The **Same Hormone**.
2. Heterologous Desensitization: Exposure of cells to a **Hormone** -> Decrease Receptors Response(Function) to a **Different Hormone**.

Explanation

A person steals from a supermarket => the supermarket bans this person. (**Homologous desensitization**)

In another incident a person steals from a supermarket => the supermarket bans his father. (**Heterologous desensitization**)

Person=**hormone 1**, his father=**hormone 2**, supermarket=receptor

In desensitization, the number and/or the function changes.

Physiological Effects Of Hormones

on Body Function

This is a Story to help Memorize the Points, don't memorize the story just understand it! Points are colored in **Red**.

After Food Intake, **Digestion** takes Place to break Food into smaller substrates, thus **Transporting The Substrates To Tissue** which leads to **Metabolism**, Metabolism Produces **Reproduction** Hormones, necessary for **Growth**, **Behavior** and **Stress Response**. Those Hormones are Released into the **Blood Circulation**, which is abundant with Neutrophils whose function is to mediate the body's **Defense Against Pathogens**.

Note: Estrogen is called the blessing hormone because it's against everything

(blood pressure, lipids, cholesterol, osteoporosis, tension, etc..). سبحانه الله! الموضوع يدع و عجيب

Chemical Classes Of Hormones

	Examples	Size	Solubility Water/Lipid Soluble	Membrane Penetration Of Cell + Nuclear Membrane
Proteins	Many Examples	Large Peptide Hormone: <20 AA Protein Hormone: >20 AA	Water – soluble	Can't Penetrate
A A. Derivatives	Catecholamines Epinephrine, Norepinephrine, Dopamine Thyroid Hormones T4 (aka thyroxine), T3	Small 1-2 AA	Lipid – soluble Except catecholamines = Water Soluble	Can Penetrate Except catecholamine
Steroids	AdrenalCortex H. Cortisol, Aldosterone Sex H. Testosterone, Progesterone, Estrogen Vitamin D	-	Lipid – Soluble	Can Penetrate

(Just memorize Examples from: A A Derivates + Steroid and all other hormones are Proteins).

-AA = Amino Acid

-H. = Hormone/s

-The Ability To Penetrate the Cell/Nuclear Membrane is affected by the lipid solubility of the Hormone, An Increase in the **Lipid** solubility will increase the ability of the Hormone to Penetrate, while an Increase in the **Water** Solubility will Decrease the Ability to Penetrate.

-Catecholamines are transported via ATP-dependent carrier transport.

Hormone Secretion Regulation

Hormones require **Constant** Regulation, so we need Multiple Mechanisms

1. Neural Control:
2. Chronotropic Control: related to time(hormone levels are affected by different times of season or day-). Chronotropic has many Rhythms:
 - Diurnal Rhythm During Day and Night ex: Growth Hormone(GH) **secretion**
 - Sleep-Wake Cycle during Sleep and Wake
 - Menstrual Rhythm during the Menstrual Cycle
 - Seasonal Rhythm ex: Increase in sex Hormones during Breeding Season
 - Developmental Rhythm during different Developmental Stages ex: (GH) **level**

Note: Hormones are released either in a regular manner, increasing and decreasing (Oscillating) or in pulses (Pulsatile).

3. Feedback Control: Is The relationship between the response and stimulus. Two types:
 - Positive Feedback Control Response -> Increases Stimulus -> Increase Hormone
 - Negative Feedback Control Response -> Decrease Stimulus -> Decrease Hormone

Feedback Control May Occur on a

- Hormone – hormone level: a hormone(H.) affects the release/inhibition of another H.
Ex: increase in Thyroxin -> inhibits Thyroxin Releasing H.
- Substrate- hormone level : Hyperglycemia -> Insulin release
Hypoglycemia -> Glucagon release
- Mineral – Hormone level : Hypocalcemia -> Parathyroid H. Release
Hypercalcemia -> Calcitonin Release

Note: Regulation may occur in gene transcription and translation of the hormone, or in the processing and release of the hormone.

Negative Feedback

Usually occurs in loops, ex: hypothalamus-pituitary-peripheral gland axis.

1. Ultra Short loops Regulation by an **Autocrine** manner
2. Short loop Regulation by Hormones produces by an **Intermediate Product**
3. Long loop Regulation by the Hormone Produces by **end Product**

Positive Feedback

Examples

1. Neural hormonal positive feedback loop
2. Uterine Contraction

Regulation of Receptor Number

By regulating the Number or Activity(Function) of receptors

1. Down Regulation: Hormone -> decrease number + affinity of receptor for itself or another H.
2. Up Regulation: Hormone -> increase number + affinity of receptor for itself or another H

Note: Down-regulation of receptors found on the cell membrane is done by endocytosis of these receptors to the inside of the cell followed by their destruction by lysosomes.

Interactions Between Hormones

Hormones function together, not separately

1. **Permissive effect**(Permissiveness): ($0+1=2$) (the first hormone **Permits** the second hormone to function efficiently)
2. **Synergistic effect**(Synergism) : ($1+1>2$) (each hormone functions in different degrees, but when all of them function simultaneously a better response can be achieved.)
3. **Antagonist effect**(Antagonism) : Effect of a Hormone on a target cell is **Opposed** by another Hormone

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