

TOPIC 9: THE ENDOCRINE SYSTEM

I. Purpose of Topic 9 and Topic 10

- A. In these discussions of the endocrine system, we will focus on some general principles and on a few select systems. Throughout the remainder of the course, as we discuss the different body systems, we will refer to the general principles you learn in these two topics to provide an understanding of how each of the body systems is controlled by hormones.

II. General Principles

- A. Endocrine system composed of ductless endocrine glands (Fig 6.1)
1. endocrine glands
 - a) are invaginations of epithelial cells
 - b) release product (i.e., hormone) to inside of body; blood transports the product
 2. Although endocrine glands not connected anatomically, constitute a functional system
 3. Only specific target cells respond to a particular hormone; ***response is based on presence of specific receptors for that hormone!***
- B. Two general types of hormones
1. Tropic: act on another endocrine gland to produce its hormone
 2. Non-tropic: act on target cell to produce an event
- C. General Features of Endocrine System
1. single endocrine gland may produce more than one hormone (e.g., anterior pituitary produces 6 hormones).
 2. single hormone may be produced by more than one endocrine gland (e.g., somatostatin produced by pancreas and hypothalamus).
 3. single hormone may have more than one type of target cell (e.g., vasopressin acts on kidneys and blood vessels)
 4. single target cell can be influenced by more than one hormone (e.g., liver target of both insulin and glucagon)
 5. a single chemical can be both a hormone and a neurotransmitter (e.g., norepinephrine is released as a neurotransmitter by postganglionic cells in the sympathetic nervous system & is also released as a hormone by the adrenal medulla)
 6. some organs only produce hormones (e.g., thyroid glands); others produce hormones and perform other functions too (e.g., kidneys)
- D. Two control systems of the Body: Nervous System vs Endocrine System
1. Nervous system coordinates rapid, precise responses and is especially important in interactions with external environment
 2. Endocrine system tends to control activities that require duration, not speed.

III. Major Classification of Hormones

- A. General
1. Small difference in chemical structure makes a big differences in function (e.g., testosterone vs. estradiol = masculinizing vs. feminizing)
 2. Chemistry of hormone determine how they are synthesized, stored, secreted, transported, and how they function.
- B. Peptides
1. Are small proteins (short chains of amino acids)
 2. Produced by: pineal gland, pancreas, GI tract, kidney, liver, thymus, heart
 3. *hydrophilic and lipophobic* (dissolve in water, not fat)
 4. Transport in Blood: dissolved in plasma

5. Example: Melatonin (see below)

C. Amines

1. Derived from amino acid tyrosine
2. Two different types of amines
 - a) Thyroid amines
 - (1) T3 and T4
 - (2) *lipophilic and hydrophobic* (dissolve in fat, not water)
 - (3) Transport in blood: bound to protein in blood
 - b) Adrenal medulla
 - (1) catecholamines (epinephrine and norepinephrine)
 - (2) *hydrophilic and lipophobic* (dissolve in water, not fat)
 - (3) Transport in blood: dissolved in plasma

D. Steroids

1. Derived from cholesterol
2. Produced by: adrenal cortex, gonads, placenta during pregnancy
3. *lipophilic and hydrophobic* (dissolve in fat, not water)
4. Transport in Blood: bound to protein in blood
5. Example: testosterone

IV. General Function

A. Hydrophilic hormones (peptides and catecholamines)

1. Can not pass through lipid bilayer of membrane
2. Instead, bind to receptor on membrane
3. Opens/closes ion channels which changes membrane permeability/potential (Fig 5.15) or
4. Triggers second messenger systems; second messenger systems drastically amplify the signal received by the membrane receptor which thereby alters the activity of pre-existing proteins (usually enzymes) Fig 5.18

B. Lipophilic hormones (steroids and thyroid hormones) Fig 5.11

1. Are able to pass through lipid bilayer of membrane of target cell
2. Interact with DNA in nucleus of target cell
3. Alter transcription of DNA
4. Causes the formation of *new* proteins (usually enzymes)

V. Non-Tropic Endocrine Systems

A. Pineal Gland (Fig 6.2)

1. Located in brain
2. Responds to amount of light? Wavelength of light?
3. Produces melatonin
 - a) Primary function: regulates body's biological clock
 - b) Promoted as a "wonder drug" for jet lag, sleep disorders, etc.

B. Pancreas (Fig 6.10)

1. Responds to blood glucose levels
2. Releases insulin which promotes uptake of glucose by cells from blood
3. Releases glucagon which promotes increase in blood glucose levels

VI. Tropic Endocrine Systems

A. Hypothalamus and Pituitary (Fig 6.2 & 6.3)

1. Pituitary located at base of hypothalamus
2. Hypothalamus and Anterior Pituitary

- a) Anterior pituitary makes and secretes 6 hormones; all but prolactin are tropic hormones
- (1) growth hormone (regulates overall body growth)
 - (2) thyroid stimulating hormone (TSH)
 - (3) adrenocorticotrophic hormone (ACTH)
 - (4) follicle stimulating hormone (FSH; called a gonadotropin)
 - (5) lutenizing hormone (LH; called a gonadotropin)
 - (6) prolactin (enhances breast development and milk production in females; function uncertain in males)
- b) Hypothalamus produces and releases 7 hormones which stimulate or inhibit the release of the anterior pituitary hormones. We will discuss some of these in future topics.
- c) Regulation via negative feedback (Fig 6.6)

Hypothalamus	Anterior Pituitary	Endocrine Gland	Hormone	Response
TRH	TSH	Thyroid Gland	T3 and T4	Metabolism & more
CRH	ACTH	Adrenal Cortex	Cortisol	Stress Response & more
GnRH	LH & FSH	Gonads	Androgens & Estrogens	Reproductive Cycle and More
PRH + PIH -	Prolactin	N/A	N/A	Breasts/lactation
GHRH + GHIH -	Growth Hormone Growth Hormone	Liver N/A	Somatomedins N/A	Growth Growth