Chapter 16: The Endocrine System

I. OVERVIEW

Communication with hormones slower and more prolonged than with NS. Effects determined by receptors on target cells. Ductless glands release hormones into blood. Many hormones produced by non-endocrine organs. Local chemical messengers: autocrines (effect same cell), paracrines (nearby cells).

II. HORMONES

(A) Chemistry
Most are amino acid based. A few are steroids, produced from cholesterol.

Eicosanoids, autocrine and paracrine, are lipids.
   e.g. leukotrienes, prostaglandins.

(B) Mechanics
Alter target cell activity, e.g. membrane characteristics, protein synthesis, enzyme activity, secretion, mitosis.

Membrane receptors for amino acid hormones, intracellular receptors for steroids and thyroid hormones.

Second messengers include cAMP and PIP2-Calcium. Bind to plasma membrane. Sequential activities before hormone has an effect.

Intracellular receptors associated with gene activation.

(C) Target Cell Specificity
Regulation via up- and down-regulation, changes in number of receptors. May be influenced by other hormones.

(D) Half-Life, Onset & Duration of Hormone Activity
Half life shorter for water soluble hormones. Delayed onset with steroids. Duration varies with hormone, ten seconds to several hours.
(E) **Hormone Interaction at Target Cells**

Permissiveness, e.g. thyroid Hs for reproductive Hs.
Synergism, e.g. glucagon and epinephrine.
Antagonism, e.g. PTH and calcitonin.

(F) **Control of Hormone Release**

Negative feedback.
Stimuli may be humoral (ions & nutrients); neural; hormonal.
Nervous System modulation.

III. **PITUITARY & HYPOTHALAMUS**

Pituitary = hypophysis, attached via infundibulum to hypothalamus.

(A) **Relationship**

Hypothalamus connects to posterior pituitary with hypothalamic-hypophyseal tract. Carries two hormones.

Hypothalamus connects to anterior pituitary with hypophyseal portal system, carries releasing and inhibiting hormones, RHs & IHs

(B) **Anterior Pituitary = Adenohypophysis**

Four of the six are tropic Hs (*), influence other endocrine tissues.
Most use cAMP.

-1- **Growth Hormone = GH = somatotropin**
Increases metabolism, growth. Especially bone and muscle. Anabolic.
Control with GHRH & GHIH from hypothalamus.
Hypersecretion \(\rightarrow\) gigantism during development, acromegaly (adults); hyposecretion \(\rightarrow\) dwarfism during development.

-2- **Thymid Stimulating Hormone = TSH** Hypothalamic TRH.

-3- **Adrenocorticotropic Hormone = ACTH** Hypothalamic CRH.

-4- & -5- **Gonadotropins = LH & FSH**. GnRH.

-6- **Prolactin** for milk production. PIH = Dopamine.
(B) **Posterior Pituitary = Neurohypophysis**

Stores and releases hormones made by hypothalamus.

- **Oxytocin**  For labor contractions and milk let-down.

- **Anti-diuretic Hormone = ADH.**
  Inhibited by alcohol.
  At high levels can cause vasoconstriction (other H name = vasopressin).
  Deficiency causes **diabetes insipidus**.

**IV. THYROID GLAND**

(A) **Anatomy**  Butterfly-shaped. Inferior to larynx.

Lobes connected by isthmus.
Follicles produce colloid which becomes thyroid Hs.
Parafollicular cells produce **calcitonin**.

(B) "**Thyroid Hormones**"  T3 = Thyroxine;  T4 = Triiodothyronine.

T4 becomes T3.
Effects most body cells.
Increases metabolism.
Calorigenic effect.
Requires iodine and tyrosine.
Carried by transport proteins in blood.

Hyosecretion causes **myxedema** in adults, **cretinism** in children.
One form of hypersecretion is Grave’s disease (autoimmune).

(C) **Calcitonin**  Decreases blood calcium.

**V. PARATHYROID GLANDS**

Usually four, posterior to thyroid.

**Parathyroid Hormone = PTH.**  Increases blood calcium.
VI. ADRENAL = SUPRARENAL GLANDS

(A) **Cortex**  Its hormones are **corticosteroids**.  Three layers/ zones.

-1-  **Mineralocorticoids**  regulate Na+ and K+.

Most influential is **aldosterone**.
Increases Na+ in body, increases BP.
Influenced by other hormones, e.g. renin-angiotensin, ANP.

-2-  **Glucocorticoids**  influence energy metabolism, reaction to stress.

Most influential is **cortisol**.
Release triggered by ACTH.
Promotes gluconeogenesis.
Also with anti-inflammatory, anti-immune effects.

Excess is **Cushing’s Syndrome**;
Deficiency is **Addison’s Disease**.

-3-  **Gonadocorticoids**  Most are androgens.  Some estrogens.

Hypersecretion causes **adrenogenital syndrome** (masculinization).

(B) **Medulla**  is neuroendocrine.  Sympathetic axons release hormones.

**Eprinephrine** (80%)  and **Norepinephrine**.

VII. PINEAL GLAND

Produces **melatonin**, daily pattern.

VIII. OTHER ENDOCRINE TISSUES

(A) **Pancreas**  Consists mostly of acinar cells for digestive secretions.
Endocrine portions = **Islets of Langerhans**.
-1- **Glucagon** from alpha cells, increases blood glucose.
-2- **Insulin** from beta cells, decreases blood glucose.

**Diabetes Mellitus** a lack of functional insulin.
Three types:
Type I (autoimmune destruction of beta cells, juvenile),
Type II (loss of insulin receptors), and
Gestational (inactive receptors during pregnancy).

Short term consequences = **hyperglycemia, glycosuria, polyuria, polydipsia,**
sometimes **polyphagia,** itchy skin, blurred vision……  Worst is **ketoacidosis.**

Long term consequences due to vascular damage: cardiovascular disease,
blindness, poor wound healing (leg amputations), kidney damage….

(B) **GONADS, PLACENTA**

(C) **OTHER ORGANS**

-1- **Heart**  Atrial Natriuretic Peptide = **ANP.**  Lowers BP.
-2- **GIT**  many hormones.
-3- **Kidneys**  **Erythropoietin** = EPO, increases RBC production,
   **Renin**  elevates BP.
-4- **Skin**  **Vitamin D,** for calcium absorption.
-5- **Fat**  **Leptin,** reduces hunger.
-6- **Skeleton**  **Osteocalcin:**  enhances insulin.
-7- **Thymus**  **Thymosin** develops early immune system.

**X. DEVELOPMENT**

Endocrine system not effected much by aging (without pathology).  Pineal
becomes less active- melatonin deficiency disrupts sleep.