Endocrine System

Bio 250
Human Anatomy & Physiology

Endocrine vs. Exocrine

**Endocrine glands** secrete their products called **hormones** into body fluids (the internal environment)

**Exocrine glands** secrete their products into ducts that lead to the outside of the body
The endocrine system is generally very reliable. The endocrine system controls metabolic processes that do not require rapid onset but may continue for long periods of time. When malfunctions do occur, they are often very dramatic. The particular effects may be quite different depending on whether they occur in children or adults.

Endocrine System

- Most body systems possess anatomical continuity
- Endocrine system consists of many glands scattered around the body
- Endocrine glands are only loosely connected by way of the blood stream
Neuro-Endocrine Comparison

Hormone Action

- As a group, endocrine glands regulate metabolic processes
- Endocrine glands secrete hormones that affect target cells possessing specific receptors
- Hormones are typically carried from gland to target in the bloodstream
- Hormones are extremely potent chemicals
Hormones Grouped by Function-Not Structure

Chemicals like proteins, carbohydrates and lipids are grouped by their common structure
- Proteins are composed of chains of amino acids
- Proteins may function as enzymes, structural molecules, etc
- Hormones are grouped by common function
  - Hormones may be proteins, lipids, steroids, modified amino acids, etc
  - Hormones are all chemical messengers controlling metabolic activities

Steroid Hormones

- **Steroid hormones** enter target cells and combine with receptors to form complexes
- These complexes activate specific genes
- Direct synthesis of specific proteins
- Degree of cellular response proportional to number of hormone-receptor complexes formed
Nonsteroid Hormones

- **Nonsteroid** hormones combine with receptors in the target cell membrane
- Hormone-receptor stimulates membrane proteins to induce second messenger molecules
- A second messenger activates protein kinases
- Protein kinases activate protein substrate molecules which change cell processes
- Nonsteroid response is amplified by large number of second messengers formed

Control of Hormonal Secretions

- Hormones are regulated by feedback control systems
  - **Negative feedback** systems typically maintain hormones at nearly constant levels (Common)
  - **Positive feedback** systems increases effects of hormone action. (Not very common)
- Some endocrine glands are controlled by nerve impulses
- Some glands are auto-regulated
- Some glands are controlled by releasing or inhibiting hormones from the hypothalamus
The pituitary is attached to the base of the brain by the infundibulum. It consists of an anterior lobe or adenohypophysis and a posterior lobe or neurohypophysis. Lobes have different embryological origins, different types of hormones and different controls.
Anterior Lobe

- Forms from the roof of the embryo’s mouth
- Secretes several protein hormones
- Controlled by releasing and inhibiting hormones from the hypothalamus
- Hypothalamic hormones delivered via hypophyseal portal system
Posterior Lobe

- Consists of glial cells and fibers of neurons whose cell bodies are in the hypothalamus
- Two hormones are secreted by posterior lobe but are made in the hypothalamus
  - ADH or Antidiuretic hormone causes kidneys to reduce the amount of water they excrete
  - Oxytocin stimulates the pregnant uterus to contract and causes milk let-down in the lactating breast in response to suckling

Hormones of the Anterior Lobe

- STH, GH or Growth Hormone
  - Stimulates body cells to grow and reproduce
  - GH-RH and somatostatin (GH-IH) control GH secretion
Pituitary Dwarf

Giantism

Acromegaly

Hormones of the Anterior Lobe

- **Prolactin or PRL**
  - Promotes breast development and stimulates milk production
  - PRL-IH restrains secretion
  - PRL-RH promotes secretion

- **TSH or Thyroid Stimulating Hormone**
  - Controls secretions from the thyroid gland
  - TSH is controlled by TSH-RH from the hypothalamus
**Hormones of the Anterior Lobe**

**ACTH or Adrenocorticotrophic Hormone**
- Controls secretion of certain hormones from the adrenal cortex
- ACTH is controlled by C-RH from the hypothalamus

**Hormones of the Anterior Lobe (Gonadotropins)**

**FSH or Follicle Stimulating Hormone**
- Stimulates development of follicles containing egg cells in the ovary
- Stimulates development of sperm in the seminiferous tubules of the testicle (GSH)

**LH or Luteinizing Hormone**
- Stimulates ovulation of the egg and conversion of ruptured follicle into a corpus luteum in ovary
- Stimulates Interstitial Cells to secrete testosterone in the testicle (ICSH)
Thyroid Gland

- Located in the neck and has two lobes
- Thyroid gland consists of fluid filled secretory parts called follicles
- Follicles store the hormones the follicle cells secrete
- Thyroid Hormones called **Thyroxine** (T₄) (80%) and **triiodothyronine** (T₃) (20%)
  - T₃ is about 3x more active than T₄
  - Stimulate rate of metabolism
  - Enhance protein synthesis & lipid breakdown
  - Needed for normal growth, development and maturation of the nervous system
Thyroid Gland–Calcitonin

- **Calcitonin** lowers blood calcium and phosphate ion concentrations
- Prevents prolonged elevation of calcium ion after a meal
- Stimulates osteoblast activity in bones to store excess calcium and phosphate in bone tissue
Parathyroid Glands

- Located on the posterior surface of thyroid
- Typically 2 pair of small glands
- Secrete Parathyroid hormone (PTH)
- Increases blood calcium ion concentration
  - Causes osteoclasts to resorb bone calcium ions
  - Inhibits osteoblasts from storing calcium ions
  - Causes kidneys to conserve calcium ion
  - Stimulates increased absorption from GI tract
- Autoregulated by negative feedback control
Adrenal Glands

- Glands sit on top kidneys (suprarenal)
- Gland consists of cortex and medulla
- Remember, adrenal medulla is part of the sympathetic function secreting epinephrine or nor-epinephrine
- Adrenal medulla consists of post-ganglionic fibers of the sympathetic nervous system
Adrenal Glands

- Gland consists of cortex and medulla
- Adrenal cortex secretes several steroids:
  - Mineralocorticoids
  - Glucocorticoids
  - Sex Hormones
Adrenal Cortex

**Mineralocorticoids** (e.g. aldosterone)
- Causes kidney to conserve sodium ions and water and excrete potassium ions
- Secretion autoregulated in response to low blood sodium ions, increased blood potassium ions or presence of angiotensin II
- Helps to maintain normal blood volume and normal blood pressure
- Produced by the zona glomerulosa
**Adrenal Cortex**

- **Glucocorticoids (e.g., cortisol)**
  - Inhibits protein synthesis, releases stored fatty acids and stimulates **gluconeogenesis**
  - Anti-inflammatory properties
  - Anti-allergic properties
  - Aids in body's reaction to stress
  - Controlled by negative feedback loop involving the hypothalamus, anterior pituitary and adrenal cortex (C-RH ---->ACTH --->glucocorticoids)

- Produced by the zona fasciculata

**Cortisol and Aldosterone. Figure 13.30**

**Aldosterone**

**Cortisol**

**Stimulatory**

**Inhibitory**

Adrenal Cortex

**Adrenal sex hormones**
- These hormones are primarily male type in both sexes but can be converted into female hormones
- They supplement sex hormones made by the gonads
- Hypersecretion in fetus can cause adrenogenital syndrome: can masculinize female fetus.
Pancreas

- Exocrine gland producing digestive enzymes and endocrine gland producing hormones
- Endocrine portion called **islets of Langerhans** which secretes **insulin**, glucagon (2-8%)
- Insulin moves glucose through cell membranes, stimulates its storage, promotes protein synthesis and stimulates fat storage
- Nerve cells lack insulin receptors and are depend on diffusion for glucose supply
Pancreas

- Endocrine portion called **Islets of Langerhans** which secretes insulin, glucagon
- Glucagon stimulates liver to produce glucose, increasing blood glucose level

Pineal Gland

- Attached to the thalamus above the third ventricle
- Secretes melatonin which inhibits secretion of gonadotropins (FSH & LH) from anterior pituitary
- May help regulate circadian rhythms (daily or 24 hour rhythms)
- May help regulate onset of puberty
- May help regulate female reproductive cycle
- Seasonal Affective Disorder (SAD)
Thymus Gland

- Lies posterior to sternum and between lungs (i.e. in the mediastinum)
- Size and activity varies with age (reaches maximum size just before puberty, then regresses)
- Secretes thymosin which affects production of certain lymphocytes (T-cells) and helps provide immunity

Reproductive Glands

- Ovaries secrete estrogens (female hormones) and progesterone
- Placenta secretes estrogens, progesterone, a growth hormone and a gonadotropin
- Testes (testicles) secrete androgens (male hormones) e.g. testosterone
Other Hormones Producers

- Digestive glands secrete several hormones that help regulate digestion, e.g., gastrin.
- Heart and kidneys produce hormones, e.g., renin, erythropoietin.
- Most of the cells in the body secrete some kind of chemical messenger, but most only affect the cells nearby.