

I. Endocrine system

A. Functions

1. Coordinates body activities, i.e. gamete production and release.
2. Helps maintain homeostasis.
3. Controls growth and development.
4. Regulates metabolic processes.
5. Helps body respond to trauma or stress.
6. Works with the autonomic nervous system
 - a. The nervous system can control the release of hormones.
 - b. Hormones are able to stimulate or inhibit the production of nerve impulses.
 - c. The endocrine system has an effect that is slower but longer lasting than the nervous system.

B. General background

1. The endocrine system consists of **ductless glands** and some **diffuse tissues** (cells within organs and tissues that secrete hormones).
2. The tissues involved produce **hormones**.
 - a. Hormones are released into the circulatory system.
 - b. A hormone will travel throughout the body, but can only stimulate **target cells** with a complementary **receptor** for that hormone.

C. Chemistry of hormones

1. Lipid-soluble hormones
 - a. Diffuse through the cell membrane to bind with a receptor found within the cytoplasm or the nucleus of the cell.
 - i. The hormone-receptor complex binds to a DNA segment and activates or inactivates specific genes.
 - b. Steroid hormones**
 - i. Derived from cholesterol.
 - ii. Produced by the cortex of the adrenal gland, the ovary and the testis.
 - c. Thyroid hormones**
 - i. Produced by the thyroid gland.
 - ii. Derived from the amino acid tyrosine.
 - iii. **Note:** although made of an amino acid, the thyroid hormones act like steroid hormones and bind to receptors inside the cell.
2. Water-soluble hormones
 - a. These hormones will bind to a receptor embedded within the plasma membrane of the target cell.
 - i. This binding activates a **second messenger** system inside the cell.
 - ii. Causes **ATP** to be converted into **cyclic AMP** (the second messenger).
 - iii. The cyclic AMP activates enzymes within the cell.
 - iv. These enzymes cause reactions inside the cell such as
 - (a) altering the permeability of the cell
 - (b) promoting protein synthesis
 - (c) stimulating mitosis
 - (d) stimulating the release of hormones
 - b. Amino acid based hormones**
 - i. The most common type of hormone.

- ii. Include hormones such as epinephrine, norepinephrine, insulin and human growth hormone.
 - 3. Hormone-like chemicals
 - a. **Prostaglandins and leukotrienes**
 - i. Derived from fatty acids associated with cell membranes, except red blood cells.
 - ii. Released in response to chemical or mechanical stimulation.
 - iii. Act locally.
 - iv. Rapidly inactivated.
 - v. Produce a wide variety of effects including smooth muscle contraction blood flow, inflammation and respiration.
- D. Control of hormone secretions
1. **Humoral control**
 - a. Occurs when a chemical in the blood (i.e. sugar or calcium) directly interacts with endocrine tissue stimulating or inhibiting the release of a hormone.
 2. **Neural control**
 - a. Occurs when nerve impulses stimulate a gland to release a hormone.
 - b. Includes the release of hormones stored in the **posterior pituitary gland**.
 - i. The **hypothalamus** has **neurosecretory cells** whose axons extend into the posterior pituitary gland.
 - ii. These neurosecretory cells produce 2 hormones within the cell bodies (located in the hypothalamus) which are transported to and stored within the terminal knobs of the axons.
 - iii. In order to release a hormone an impulse must be generated by the neurosecretory cells.
 - c. The release of **epinephrine (adrenaline)** from the **adrenal gland** requires impulses.
 - d. The inhibition of **melatonin** from the **pineal gland** requires impulses.
 3. **Hormonal control**
 - a. Occurs when a hormone directly stimulates or inhibits the release of a hormone from a gland.
 - b. Includes the release of hormones from the **anterior pituitary gland**.
 - i. The anterior pituitary gland produces 7 different hormones.
 - ii. In order to stimulate or inhibit the release of these hormones the neurosecretory cells of the **hypothalamus** produce **releasing hormones**.
 - iii. These releasing hormones are secreted into a network of capillaries that deliver them to the anterior pituitary gland causing the gland to release or stop releasing a specific hormone.
 - iv. Many hormones of the anterior pituitary gland are **tropic** (hormones that stimulate another gland to produce another hormone).
- E. Regulation of secretion
1. The amount of hormone released is controlled by a feedback mechanism.
 - a. **Negative feedback**
 - i. Generates a response that is opposite of the original stimulus.
 - ii. For example, if blood sugar is too high (stimulus) the pancreas releases insulin which lowers blood sugar (response).

- iii. Intended to **stabilize** conditions.
- iv. Most hormones are controlled by negative feedback.

b. Positive feedback

- i. Generates a response that stimulates more of that same condition.
- ii. For example, a baby suckling stimulates the production of more milk, which allows for more suckling and more milk production, etc.
- iii. Tends to produce **unstable** conditions.

F. Elimination of hormones

1. Hormones have a half-life of up to 30 minutes.
2. Lipid-based hormones that bind to intracellular receptors are generally metabolized by the target cell.
3. After releasing from receptors at the surface of a cell, amino acid based hormones are inactivated by the kidney and the liver and are excreted into the urine or into bile.
4. **Note:** diseases involving the liver and kidney may result in increased hormone levels.