The Endocrine System

Overview and Function

- Second control system of the body (besides nervous)
- Uses chemical messengers (hormones) that are released into the blood
- Hormones control several major processes
  - Reproduction
  - Growth and development
  - Mobilization of body defenses
  - Maintenance of much of homeostasis
  - Regulation of metabolism

Hormone Overview

- Hormones are produced by specialized cells
- Cells secrete hormones into extracellular fluids
- Blood transfers hormones to target sites
- These hormones regulate the activity of other cells

The Chemistry of Hormones

- Hormones are classified chemically as
  - Amino acid-based, which includes
    - Proteins
    - Peptides
    - Amines
  - Steroids—made from cholesterol
  - Prostaglandins—made from highly active lipids

Mechanisms of Hormone Action

- Hormones affect only certain tissues or organs (target cells or target organs)
- Target cells must have specific protein receptors
- Hormone-binding alters cellular activity
Effects Caused by Hormones

- Changes in plasma membrane permeability or electrical state
- Synthesis of proteins, such as enzymes
- Activation or inactivation of enzymes
- Stimulation of mitosis
- Promotion of secretory activity

The Chemistry of Hormones

- Two mechanisms in which hormones act
  - Direct gene activation
  - Second-messenger system

Direct Gene Activation (Steroid Hormone Action)

- Diffuse through the plasma membrane of target cells
- Enter the nucleus
- Bind to a specific protein within the nucleus
- Bind to specific sites on the cell’s DNA
- Activate genes that result in synthesis of new proteins

Second-Messenger System (Nonsteroid Hormone Action)

- Hormone binds to a membrane receptor
- Hormone does not enter the cell
- Sets off a series of reactions that activates an enzyme
- Catalyzes a reaction that produces a second-messenger molecule
- Oversees additional intracellular changes to promote a specific response
Nonsteroid hormone (first messenger)

Enzyme

Second messenger

Effect on cellular function, such as glycogen breakdown

Plasma membrane of target cell

ATP

cAMP

Figure 9.1b, step 1

Figure 9.1b, step 2

Figure 9.1b, step 3

Figure 9.1b, step 4
Control of Hormone Release

- Hormone levels in the blood are mostly maintained by negative feedback
- A stimulus or low hormone levels in the blood triggers the release of more hormone
- Hormone release stops once an appropriate level in the blood is reached
Hormonal Stimuli of Endocrine Glands

- Most common stimuli
- Endocrine glands are activated by other hormones
  - **Examples:**
    - Anterior pituitary hormones

Humoral Stimuli of Endocrine Glands

- Changing blood levels of certain ions stimulate hormone release
- **Humoral** indicates various body fluids such as blood and bile
  - **Examples:**
    - Parathyroid hormone
    - Calcitonin
    - Insulin

Neural Stimuli of Endocrine Glands

- Nerve impulses stimulate hormone release
- Most are under the control of the sympathetic nervous system
- **Examples include the release of**
  - norepinephrine
  - epinephrine by the adrenal medulla
Major Endocrine Organs

- Pituitary gland
- Thyroid gland
- Parathyroid glands
- Adrenal glands
- Pineal gland
- Thymus gland
- Pancreas
- Gonads (Ovaries and Testes)
- Hypothalamus

Location of Major Endocrine Organs