The Endocrine System

ESSENTIALS OF HUMAN ANATOMY & PHYSIOLOGY
EIGHTH EDITION

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The Endocrine System

- Second messenger system of the body
- Uses chemical messages (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

- Amino acid-based hormones
  - 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 organs)
- Target cells must have specific protein receptors
- Hormone binding influences the working of the cells
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
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
Steroid Hormone Action

(a) Steroid hormone action

1. Steroid hormone enters the cell.
2. Steroid-hormone receptor complex forms in the cytoplasm.
3. Steroid-receptor complex binds to DNA in the nucleus.
4. Hormone-receptor complex activates transcription of mRNA.
5. mRNA synthesis.

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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 Action

(b) Nonsteroid hormone action
Control of Hormone Release

- Hormone levels in the blood are 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

- Endocrine glands are activated by other hormones

Figure 9.2a
Humoral Stimuli of Endocrine Glands

- Changing blood levels of certain ions stimulate hormone release

Figure 9.2b
Neural Stimuli of Endocrine Glands

- Nerve impulses stimulate hormone release
- Most are under control of the sympathetic nervous system
Pituitary Gland

- Size of a grape
- Hangs by a stalk from the hypothalamus
- Protected by the sphenoid bone
- Has two functional lobes
  - Anterior pituitary – glandular tissue
  - Posterior pituitary – nervous tissue
Chemicals which are secreted into extracellular fluid travel through the blood stream and regulate metabolic function of target cells are known as:

a. hormones.

b. antibodies.

c. enzymes.

d. antibiotics.
Location of Major Endocrine Organs

- Pineal gland
- Hypothalamus
- Pituitary gland
- Thyroid gland
- Parathyroid glands (on dorsal aspect of thyroid gland)
- Thymus gland
- Adrenal glands
- Pancreas
- Ovary (female)
- Testis (male)

Figure 9.3
Hormones of the Anterior Pituitary

- Six anterior pituitary hormones
  - Two affect non-endocrine targets
  - Four stimulate other endocrine glands (tropic hormones)

- Characteristics of all anterior pituitary hormones
  - Proteins (or peptides)
  - Act through second-messenger systems
  - Regulated by hormonal stimuli, mostly negative feedback
The anterior pituitary stimulates other endocrine organs by secreting a group of hormones called ____________.

a. releasing factors
b. tropic hormones
c. relay proteins
d. target hormones
Which area of the brain regulates the endocrine system?

a. Cerebral cortex

b. Thalamus

c. Hypothalamus

d. Neurohypophysis
Hormones of the Anterior Pituitary

Figure 9.4

- Hypothalamus
  - Releasing hormones in portal circulation
  - Anterior pituitary
  - Posterior pituitary

- Growth hormone (GH)
  - Bones and muscles

- Prolactin (PRL)
  - Mammary glands

- Follicle-stimulating hormone (FSH)
  - and luteinizing hormone (LH)
  - Testes or ovaries

- Thyrotropic hormone (TSH)
  - Thyroid

- Adrenocorticotropic hormone (ACTH)
  - Adrenal cortex
Growth Hormone (GH)

- General metabolic hormone
- Major effects are directed to growth of skeletal muscles and long bones
- Causes amino acids to be built into proteins
- Causes fats to be broken down for a source of energy
Functions of Other Anterior Pituitary Hormones

- Prolactin (PRL)
  - Stimulates and maintains milk production following childbirth
  - Function in males is unknown

- Adrenocorticotropic hormone (ACTH)
  - Regulates endocrine activity of the adrenal cortex

- Thyroid-stimulating hormone (TSH)
  - Influences growth and activity of the thyroid
Functions of Other Anterior Pituitary Hormones

- Gonadotropin hormones
  - Regulate hormonal activity of the gonads
    - Follicle-stimulating hormone (FSH)
      - Stimulates follicle development in ovaries
      - Stimulates sperm development in testes
Functions of Other Anterior Pituitary Hormones

- Gonadotropin hormones (continued)
  - Luteinizing hormone (LH)
    - Triggers ovulation
    - Causes ruptured follicle to become the corpus luteum
    - Stimulates testosterone production in males
      - Referred to as interstitial cell-stimulating hormone (ICSH)
The epiphyseal plate is the target organ of this hormone.

a. GH
b. ACTH
c. Parathormone
d. Glucagon
Pituitary - Hypothalamus Relationship

- Release of hormones from pituitary is controlled by releasing and inhibiting hormones produced by the hypothalamus

- Hypothalamus produces two hormones that are transported to neurosecretory cells of the posterior pituitary

- The posterior pituitary is not strictly an endocrine gland (doesn’t make hormones), but does store and release hormones
Hormones of the Posterior Pituitary

- Oxytocin
  - Stimulates contractions of the uterus during labor
  - Causes milk ejection

- Antidiuretic hormone (ADH)
  - Can inhibit urine production
  - In large amounts, causes vasoconstriction leading to increased blood pressure (vasopressin)
Hormones of the Posterior Pituitary

Figure 9.5

Optic chiasma
Hypothalamic neurosecretory cells
Hypothalamus
Axon terminals
Arterial blood supply
Posterior lobe
Capillary bed
Venous drainage
Anterior lobe of the pituitary

ADH
Oxytocin

Kidney tubules
Mammary glands
Uterine muscles
Oxytocin is produced here.

a. Anterior pituitary gland
b. Posterior pituitary gland
c. Hypothalamus
d. Ovary