


The Endocrine System

Key Questions

 **What are the components of the endocrine system?**

 **How do hormones affect cells?**

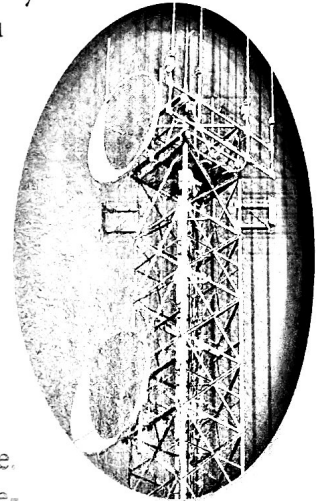
Vocabulary

hormone
target cell
exocrine gland
endocrine gland
prostaglandin


Taking Notes


Compare/Contrast Table As you read, make a table that compares and contrasts the two different types of hormones.

THINK ABOUT IT If you had to get a message to just one or two friends, what would you do? One solution would be to make a telephone call that would carry your message directly to those friends over telephone wires. But what if you wanted to send a message to thousands of people? You could broadcast your message on the radio so that everyone tuned to a particular station could hear it. Just like you, cells send messages, too. They can make a direct call or send out a broadcast.



Hormones and Glands

 **What are the components of the endocrine system?**

Your nervous system works much like a telephone. Many impulses move swiftly over a system of wire-like neurons that carry messages directly from one cell to another. But another system, the endocrine system, is more like a radio, “broadcasting” chemical messages. These chemical messengers, called **hormones**, are released in one part of the body, travel through the blood, and affect cells in other parts of the body.  **The endocrine system is made up of glands that release hormones into the blood. Hormones deliver messages throughout the body.** In the same way that a radio broadcast can reach thousands or even millions of people in a large city, hormones can affect almost every cell in the body.

Hormones Hormones act by binding to specific chemical receptors on cell membranes or within cells. Cells that have receptors for a particular hormone are called **target cells**. If a cell does not have receptors for a particular hormone, the hormone has no effect on it.

In general, the body’s responses to hormones are slower and longer lasting than its responses to nerve impulses. It may take several minutes, several hours, or even several days for a hormone to have its full effect on its target cells. A nerve impulse, on the other hand, may take only a fraction of a second to reach and affect its target cells.

Many endocrine functions depend on the effects of two opposing hormones. For example, the hormone insulin prompts the liver to convert blood glucose to glycogen and store it. The hormone glucagon prompts the liver to convert glycogen to glucose and release it in the blood. The opposing effects of insulin and glucagon maintain homeostasis by keeping blood glucose levels within a narrow range.

Glands A gland is an organ that produces and releases a substance, or secretion. **Exocrine glands** release their secretions through tube-like structures (called ducts) either out of the body or directly into the digestive system. Exocrine glands include those that release sweat, tears, and digestive enzymes. **Endocrine glands** usually release their secretions (hormones) directly into the blood, which transports the secretions throughout the body. **Figure 34-1** shows the location of the major endocrine glands. Although not usually considered as endocrine glands, other body structures such as bones, fat tissue, the heart, and the small intestine also produce and release hormones.

In Your Notebook Make a three-column table. Label the columns *Gland*, *Hormone(s)*, and *Function*. Fill in the table as you read.

MYSTERY CLUE

Fat tissue may send signals to the hypothalamus when fat reserves are low. Lisa's body fat percentage dropped from 17 percent to 9 percent. Could this have affected such signals?

Hypothalamus

The hypothalamus makes hormones that control the pituitary gland and hormones that are stored in the pituitary gland.

Pituitary Gland

The pituitary gland produces hormones that regulate many of the other endocrine glands and some organs.

Parathyroid Glands

These four glands release parathyroid hormone, which regulates the level of calcium in the blood.

Thymus

During childhood, the thymus releases thymosin, which stimulates T cell development and proper immune response.

Adrenal Glands

The adrenal glands release hormones that help the body respond to stress.

FIGURE 34-1 Major Endocrine Glands

Endocrine glands produce hormones that affect many parts of the body. *Interpret Graphics* What is the function of the pituitary gland?

Pineal Gland

The pineal gland releases melatonin, which is involved in rhythmic activities, such as daily sleep-wake cycles.

Thyroid

The thyroid produces thyroxine, which regulates metabolism throughout the body.

Pancreas

The pancreas produces insulin and glucagon, which regulate the level of glucose in the blood.

Ovaries

Ovaries produce estrogens and progesterone. Estrogens are required for the development of female secondary sex characteristics and for the development of eggs. Progesterone prepares the uterus for a fertilized egg.

Testes

The testes produce testosterone, which is responsible for sperm production and the development of male secondary sex characteristics.

BUILD Vocabulary

WORD ORIGINS **Prostaglandins** get their name from a gland in the male reproductive system, the prostate, in which they were first discovered.

Prostaglandins The glands of the endocrine system were once thought to be the only organs that produced hormones. However, nearly all cells have been shown to produce small amounts of hormonelike substances called **prostaglandins** (prahs tuh GLAN dinz). Prostaglandins are modified fatty acids that are produced by a wide range of cells. They generally affect only nearby cells and tissues, and thus are sometimes known as “local hormones.”

Some prostaglandins cause smooth muscles, such as those in the uterus, bronchioles, and blood vessels, to contract. One group of prostaglandins causes the sensation of pain during most headaches. Aspirin helps to stop the pain of a headache because it inhibits the synthesis of these prostaglandins.

Hormone Action

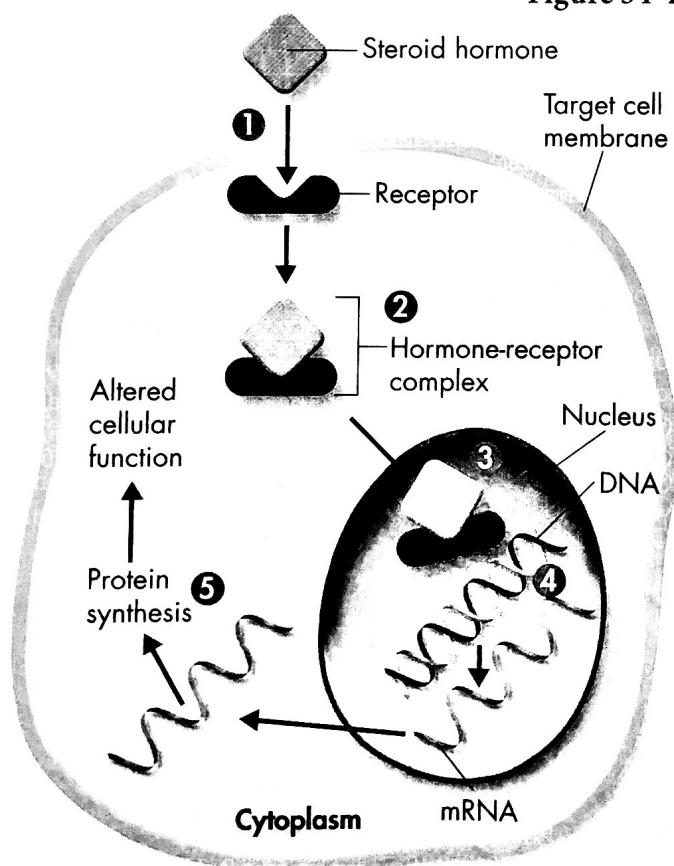
🚗 How do hormones affect cells?

Hormones fall into two general groups—steroid hormones and nonsteroid hormones. Steroid hormones are produced from a lipid called cholesterol. Nonsteroid hormones include proteins, small peptides, and modified amino acids. Each type of hormone acts on a target cell in a different way.

Steroid Hormones Because steroid hormones are lipids, they can easily cross cell membranes. 🚗 **Once in the cell, steroid hormones can enter the nucleus and change the pattern of gene expression in a target cell.** The ability to alter gene expression makes the effects of many steroid hormones especially powerful and long lasting. **Figure 34–2** shows the action of steroid hormones in cells.

FIGURE 34–2 Steroid Hormones

Steroid hormones act by entering the nucleus of a cell and changing the pattern of gene expression.



- 1 A steroid hormone enters a cell by passing directly across the cell membrane.
- 2 Once inside, the hormone binds to a receptor (found only in the hormone's target cells) and forms a hormone-receptor complex.
- 3 The hormone-receptor complex enters the nucleus of the cell, where it binds to regions of DNA that control gene expression.
- 4 This binding initiates the transcription of specific genes to messenger RNA (mRNA).
- 5 The mRNA moves into the cytoplasm and directs protein synthesis.

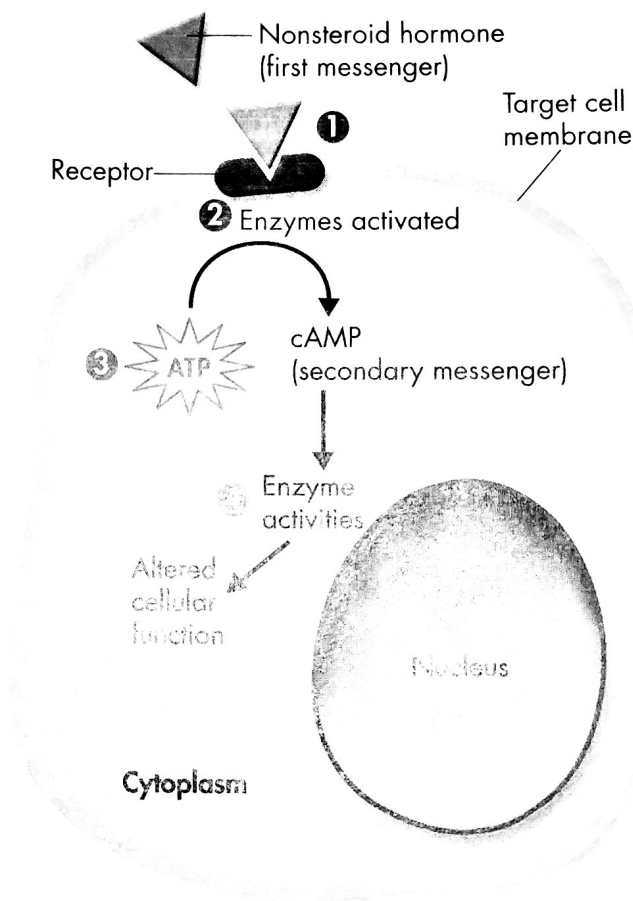
Hormone-receptor complexes work as regulators of gene expression—they can turn on or turn off whole sets of genes. Because steroid hormones affect gene expression directly, they can produce dramatic changes in the activity of a cell or organism.

Nonsteroid Hormones Nonsteroid hormones generally cannot pass through the cell membrane of their target cells. **Nonsteroid hormones bind to receptors on cell membranes and cause the release of secondary messengers that affect cell activities.** Figure 34-3 shows the action of nonsteroid hormones in cells.

- 1 A nonsteroid hormone binds to receptors on the cell membrane.
- 2 The binding of the hormone activates enzymes on the inner surface of the cell membrane.
- 3 These enzymes release secondary messengers such as calcium ions, nucleotides, and even fatty acids to relay the hormone's message within the cell. One common secondary messenger is cAMP (cyclic AMP), which is produced from ATP.
- 4 These secondary messengers can activate or inhibit a wide range of cell activities.

Steroid and nonsteroid hormones can have powerful effects on their target cells. It is therefore especially important to understand the ways in which the endocrine system regulates their production and release into the blood.

FIGURE 34-3 Nonsteroid Hormones
Nonsteroid hormones bind to receptors on a target cell membrane and cause the release of secondary messengers that affect cell activities.



34.1 Assessment

Review Key Concepts

1. **a. Review** What are the two components of the endocrine system?
b. Explain Explain the difference between endocrine and exocrine glands.
c. Compare and Contrast How are hormones and prostaglandins similar? How are they different?
2. **a. Review** Explain how steroid hormones act on a cell.
b. Explain Explain how nonsteroid hormones act on a cell.
c. Apply Concepts Use what you learned in Chapter 7 about how materials cross cell membranes to explain the actions of steroid hormones and nonsteroid hormones.

Apply the Big idea

Homeostasis

3. What are the advantages of having both a nervous system and an endocrine system?