chapter **22**

Physiology of the Endocrine System

Objectives

AFTER STUDYING THIS CHAPTER, THE STUDENT WILL BE ABLE TO:

1. Discuss the relationship between the endocrine system and the central nervous system.
2. Describe general characteristics and functions of hormones.
3. Differentiate steroid and protein hormones in relation to site of action and pharmacokinetics.
4. Discuss hormonal action at the cellular level.
5. Describe the second messenger roles of cyclic adenosine monophosphate and calcium within body cells.
6. Differentiate between physiologic and pharmacologic doses of hormonal drugs.

OVERVIEW

The endocrine system participates in the regulation of essentially all body activities, including metabolism of nutrients and water, reproduction, growth and development, and adapting to changes in internal and external environments. The major organs of the endocrine system are the hypothalamus, pituitary, thyroid, parathyroids, pancreas, adrenals, ovaries, and testes. These tissues function through *hormones*, substances that are synthesized and secreted into body fluids by one group of cells and have physiologic effects on other body cells. Hormones act as chemical messengers to transmit information between body cells and organs. Most hormones from the traditional endocrine glands are secreted into the bloodstream and act on distant organs.

In addition to the major endocrine organs, other tissues also produce hormones. These endocrine-like cells intermingle with nonendocrine cells in various organs. Their hormones are secreted into tissue fluids and act locally on nearby cells, as in the following examples:

- Gastrointestinal mucosa produces hormones that are important in the digestive process (eg, gastrin, enterogastrone, secretin, and cholecystokinin).
- The kidneys produce erythropoietin, a hormone that stimulates the bone marrow to produce red blood cells.
- White blood cells produce cytokines that function as messengers among leukocytes in inflammatory and immune processes.
- Many body tissues produce prostaglandins and leukotrienes, which have a variety of physiologic effects.

Neoplasms also may produce hormones. In endocrine tissues, neoplasms may be an added source of the hormone normally produced by the organ. In nonendocrine tissues, various hormones may be produced. For example, lung tumors may produce corticotropin (adrenocorticotropic hormone [ACTH]), antidiuretic hormone, or parathyroid hormone; kidney tumors may produce parathyroid hormone. The usual effects are those of excess hormone secretion.

This chapter focuses on the traditional endocrine organs and their hormones. Specific organs are discussed in the following chapters; general characteristics of the endocrine system and hormones are described in the following sections and in Box 22–1.

ENDOCRINE SYSTEM–NERVOUS SYSTEM INTERACTIONS

The endocrine and nervous systems are closely connected, anatomically and physiologically, and work in harmony to integrate and regulate body functions. In general, the nervous system regulates rapid muscular and sensory activities by secreting substances that act as neurotransmitters, circulating hormones, and local hormones (eg, norepinephrine, epinephrine). The endocrine system regulates slow metabolic activities by secreting hormones that control cellular metabolism, transport of substances across cell membranes, and other functions (eg, reproduction, growth and development, secretion).

The main connecting link between the nervous system and the endocrine system is the hypothalamus, which responds to nervous system stimulation by producing hormones. Thus, secretion of almost all hormones from the pituitary gland is controlled by the hypothalamus. Special nerve fibers originating in the hypothalamus and ending in the posterior pituitary gland control secretions of the posterior pituitary. The hypothalamus secretes hormones called *releasing* and *in-*