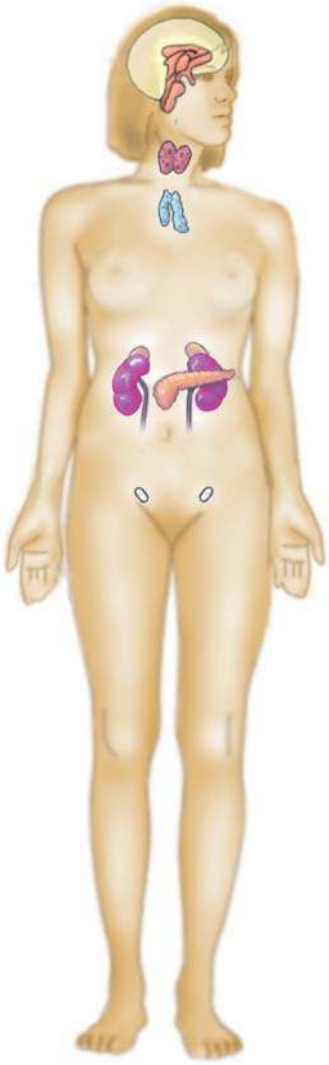
CHAPTER 15

The Endocrine System

► ENDOCRINOLOGIST



After studying this chapter, you will be able to:

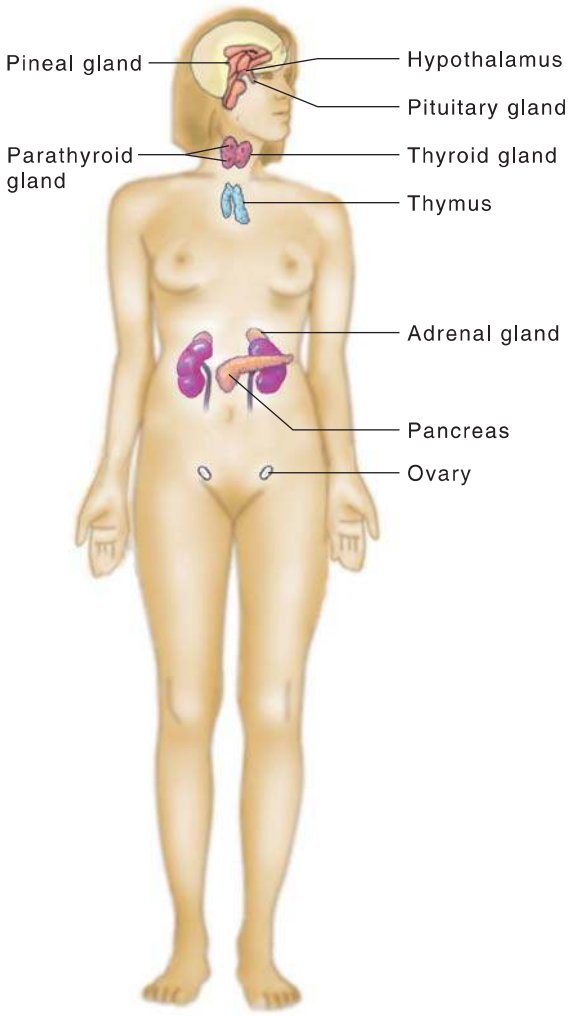
- **15.1** Name the parts of the endocrine system and discuss the function of each part
- **15.2** Define combining forms used in building words that relate to the endocrine system
- **15.3** Identify the meaning of related abbreviations
- **15.4** Name the common diagnoses, clinical procedures, and laboratory tests used in treating disorders of the endocrine system
- **15.6** List and define the major pathological conditions of the endocrine system
- **15.7** Define surgical terms related to the endocrine system
- **15.8** Recognize common pharmacological agents used in treating disorders of the endocrine system

Structure and Function

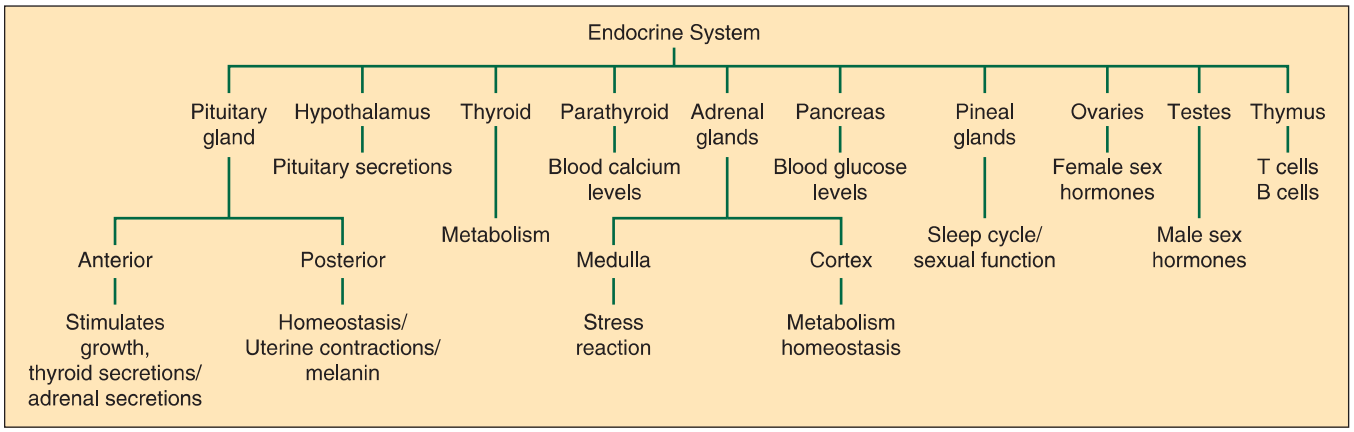
The endocrine system is a group of glands that act as the body's master regulator (Figure 15-1a). It regulates many bodily functions as diagrammed in Figure 15-1b. It helps to maintain homeostasis by regulating the production of chemicals that affect most functions of the body. It secretes substances that aid the nervous system in reacting to stress, and it is an important regulator of growth and development. The endocrine system is made up of various **glands** and other tissue that secrete **hormones,** specialized chemicals, into the bloodstream to be circulated throughout the body. The hormones are effective only in specific **target cells,** cells that have **receptors** that recognize a compatible hormone. A group of such cells forms *target tissue*. Minute amounts of hormones can initiate a strong reaction in some target cells.

Unlike **exocrine glands,** which secrete substances into ducts directed toward a specific location, **endocrine glands** secrete hormones into the bloodstream and are also known as **ductless glands.** Some endocrine glands are also exocrine glands. For example, as an endocrine gland, the pancreas secretes insulin, and as an exocrine gland, it releases digestive juices through ducts to the small intestine.

The hormones that are secreted by the endocrine glands go directly into *intercellular* spaces. From there, the hormones diffuse directly into the blood and are carried throughout the body. Each hormone may then bind to a cell that has specific receptors for that hormone, triggering a reaction in the cell. Such a cell is called a *target organ cell*. Hormones are the main regulators of



(a)



(b)

FIGURE 15-1 **(a)** The endocrine system secretes hormones that affect all parts of the body. **(b)** The bodily functions affected by the endocrine hormones.

metabolism growth and development, reproduction, and many other body activities. Hormones make the difference between normalcy and many kinds of abnormalities such as dwarfism, gigantism, and sterility. They are important not only for the healthy survival of each one of us but also for the survival of the human species. Each type of hormone is transported differently throughout the body according to its chemical properties. Hormone release is triggered

To see pictures of endocrine glands, go to a special Web site run by the University of Delaware (http://www.udel.edu/Biology/Wags/histopage/colorpage/cen/cen.htm). Note: Use uppercase letters where indicated.

by various factors including age and various diseases of the endocrine glands. Tumors or other abnormalities frequently cause a gland to secrete too much or too little hormone. Production of too much hormone by a diseased gland is called *hypersecretion*. If too little hormone is produced, the condition is called *hyposecretion*. Hormones are removed from the bloodstream by kidney functions (which is why urine can be tested for trace hormones).

Prostaglandins (PGs) or tissue hormones are important and extremely powerful substances found in a wide variety of tissues. They play an important role in communication and the control of many body functions but do not meet the definition of a typical hormone. The term *tissue hormone* is appropriate because in many instances a prostaglandin is produced in a tissue and then travels only a short distance to act on cells within that tissue. Typical hormones influence and control activities of widely separated organs; typical prostaglandins influence activities of closely neighboring cells. The prostaglandins in the body are divided into several groups, although the best known include *prostaglandin A (PGA)*, *prostaglandin E (PGE)*, and *prostaglandin F (PGF)*. They have profound effects on many body functions. They influence respiration, blood pressure, the reproductive systems, and gastrointestinal secretions.

Hypothalamus

The **hypothalamus,** located in the brain superior to the pituitary gland, is a part of the nervous system that also serves as an endocrine gland because it analyzes the body's condition and directs the release of hormones that regulate pituitary hormones. The two hormones produced by the hypothalamus are ADH (antidiuretic hormone) and oxytocin. These hormones are then released by the pituitary gland. In addition to ADH and oxytocin, the hypothalamus also produces substances called *releasing hormones* (allowing the secretion of other hormones to take place) or *inhibiting hormones* (preventing the secretion of other hormones). These substances are produced in the hypothalamus and then travel directly through a specialized blood capillary system to the anterior section of the pituitary gland, where they cause the release of anterior pituitary hormones or, in a number of instances, inhibit their production and their release into the general circulation. The combined nervous and endocrine functions of the hypothalamus allow it to play a dominant role in the regulation of many body functions related to homeostasis. Examples include the regulation of body temperature, blood pressure, heartbeat, metabolism of fats and carbohydrates, appetite, thirst, and sugar levels in the blood.

Pineal Gland

The **pineal gland** is a small, pine-cone shaped gland near the roof of the third ventricle of the brain. It produces a number of hormones in very small quantities, with **melatonin** being the most significant. Melatonin is a hormone that inhibits the hormones that affect the ovaries, and it is thought to be involved in regulating the onset of puberty and the menstrual cycle in women. Because the pineal gland receives and responds to sensory information from the optic nerves, it is sometimes called the *third eye*. The pineal gland uses information regarding changing light levels to adjust its output of melatonin; melatonin levels increase during the night and decrease during the day. This is why the pineal gland is also believed to affect sleep.

Pituitary Gland

The **pituitary gland,** is a small but mighty structure. Although no larger than a pea, it is really two endocrine glands. One is called the *anterior pituitary gland* or **adenohypophysis,** and the other is called the *posterior pituitary gland* or **neurohypophysis.** Differences between the two glands are suggested by their names—*adeno-* means "gland," and *neuro-* means "nervous." The adenohypophysis has the structure of an endocrine gland, where as the neurohypophysis has the structure of nervous tissue. The hormones secreted from these two glands serve very different functions from each other. The pituitary gland is located deep in the cranial cavity at the base of the brain in an area called the *sella turcica*. The protected location of this dual gland suggests its importance to the functioning of the human body. A stemlike structure, the *pituitary stalk*, attaches the gland to the undersurface of the brain. More specifically, the stalk attaches the pituitary body to the hypothalamus. The pituitary is considered the body's master gland regulating or aiding in the secretion of essential hormones. Table 15-1 describes the functions of all parts of the endocrine system.

Thyroid Gland

The **thyroid gland** lies in the neck just below the larynx and consists of a left lobe and a right lobe sitting on either side of the trachea. The two lobes are connected by the **isthmus,** a narrow strip of tissue on the ventral surface of the trachea. Above the thyroid gland sits the *thyroid cartilage*, a large piece of cartilage that covers the larynx and produces the protrusion on the neck known as the **Adam's apple.** The thyroid gland secretes two thyroid hormones, **thyroxine** or **T4** and **triiodothyronine** or **T3.** It also secretes the hormone calcitonin. Of the two thyroid hormones, T4 is the more abundant; however, T3 is the more potent and is considered by physiologists to be the principal thyroid hormone. Thyroid secretions control **metabolism** (the chemical changes in cells that provide energy for vital processes and activities and through which new material is assimilated) and blood calcium concentrations. Of the thyroid hormones, T_4

MORE ABOUT . . .

Biological Rhythms

All living things have biological cycles determined by nature. Humans are considered to have three basic biological rhythms or *biorhythms—ultradian, infradian,* and *circadian.* Ultradian rhythms are those cycles (heartbeat, respiration) that are shorter than 24 hours. Infradian rhythms are those cycles (menstrual, ovulation) that are longer than 24 hours. Circadian rhythms occur in the 24-hour sleep-wake periods. Most of these cycles are affected by two things—factors outside the body and factors inside the body. Factors outside the body can include almost any environmental changes, such as light and dark, weather, physical activity, stress, and so on. Factors inside the body are affected mostly by hormones released from the endocrine system. People with rhythm disorders (like insomnia) are sometimes treated with hormone supplements. In addition, some health care practitioners believe that understanding and regulating the body's biorhythms may be a key to maintaining health. There are many Internet sites that promote personal software for mapping your own biorhythms. Many of these are not based on scientific understanding of body rhythms.

TABLE 15-1 Endocrine Glands, Their Secretions, and Their Functions

Endocrine Gland or Tissue	Hormone	Function
hypothalamus	pituitary-regulating hormones	either stimulate or inhibit pituitary secretions
neurohypophysis (pituitary gland—posterior)	**antidiuretic hormone (ADH), vasopressin** **oxytocin**	increase water reabsorption
adenohypophysis (pituitary gland—anterior)	**growth hormone (GH), somatotrophic hormone (STH)** **thyroid-stimulating hormone (TSH)** **adrenocorticotropic hormone (ACTH)** **follicle-stimulating hormone (FSH), luteinizing hormone (LH)** **prolactin** **melanocyte-stimulating hormone (MSH)**	stimulate bone and muscle growth; regulate some metabolic functions, such as the rate that cells utilize carbohydrates and fats stimulates thyroid gland to secrete hormones stimulates secretion of adrenal cortex hormones stimulate development of ova and production of female hormones; stimulates maturing of ova; secretion of estrogen, triggers ovulation; stimulates the production of melanin; in males, stimulates the secretion of testosterone; in the male stimulate testes to grow and secrete sperm stimulates breast development and milk production stimulates uterine contractions and lactation stimulates the production of melanin
thyroid	thyroxine (T4); triiodothyronine (T3) calcitonin	regulates metabolism; stimulates growth lowers blood calcium as necessary to maintain homeostasis
parathyroid	**parathormone, parathyroid hormone (PTH)**	increase blood calcium as necessary to maintain homeostasis
adrenal medulla	**epinephrine (adrenaline), norepinephrine** (*noradrenaline*)	work with the sympathetic nervous system to react to stress
adrenal cortex	**glucocorticoids (cortisol, corticosteroids,** *corticosterone*), **mineralocorticoids (aldosterone)**, gonadocorticoids (androgens)	affect metabolism, growth, and aid in electrolyte and fluid balances
pancreas (in islets of Langerhans)	insulin, glucagon	maintain homeostasis in blood glucose concentration
pineal gland	melatonin	affects sexual functions and wake-sleep cycles; aids in developing skin pigment
ovaries	estrogen (estradiol, the most powerful estrogen), progesterone	promote development of female sex characteristics, menstrual cycle, reproductive functions
testes	androgen, testosterone	promote development of male sex characteristics, sperm production; also stimulate female sex drive
thymus gland	thymosin, thymic humoral factor (THF), factor thymic serum (FTS)	aid in development of T cells and some B cells; function not well understood

contains four atoms of iodine, and one molecule of T_3, as its name suggests, contains three iodine atoms. For T_4 to be produced in adequate amounts, the diet must contain sufficient iodine. Most endocrine glands do not store their hormones but secrete them directly into the blood as they are produced. The

thyroid gland is different in that it stores considerable amounts of the thyroid hormones in the form of a material that is stored in the follicles of the gland, and when the thyroid hormones are needed, they are released directly into the blood. T4 and T3 influence every one of the trillions of cells in the human body. They make the cells speed up their release of energy from foods and even normal mental and physical growth and development is dependant on normal thyroid functioning. The third thyroid hormone, **calcitonin,** is secreted from the outside surface of thyroid cells and it decreases the concentration of calcium in the blood by first acting on bone to inhibit calcium breakdown there. It is a hormone that helps maintain homeostasis of blood calcium by preventing a harmful excess of calcium in the blood from accumulating, a condition called *hypercalcemia*.

Parathyroid Glands

The **parathyroid glands** are four oval-shaped glands located on the dorsal (back) side of the thyroid gland. The parathyroids help regulate calcium and phosphate levels, two elements also necessary to maintain homeostasis. The parathyroid glands secrete **parathyroid hormone (PTH).** Parathyroid hormone increases the concentration of calcium in the blood, the opposite effect of the thyroid gland's calcitonin. This is a matter of life-and-death importance because our cells are extremely sensitive to changing amounts of blood calcium. For example, if there is too much blood calcium, brain cells and heart cells soon do not function normally; a person becomes mentally disturbed and the heart may even stop. However, with too little blood calcium, nerve cells become overactive, sometimes to such a degree that they overstimulate the production of electrical impulses to the muscles causing the muscles to go into spasms.

Thymus Gland

The **thymus gland** is considered an endocrine gland because it secretes a hormone and is ductless; however, it is also an essential part of the immune system. It is located in the mediastinum (behind the sternum and between the two lungs), and in infants it may extend up into the neck as far as the lower edge of the thyroid gland. It secretes the hormone *thymosin*, which causes the production of certain white blood cells called T lymphocytes. These T cells protect the body against foreign microorganisms, thus helping to fight infections. The thymus gland is extremely important to the development of an immune response. (Chapter 13 discusses the immune system.)

Adrenal Glands

The **adrenal glands** (or **suprarenal glands**) are a pair of glands. Each of the glands sits atop a kidney. Each gland consists of two parts—the **adrenal cortex** (the outer portion) and the **adrenal medulla** (the inner portion). The adrenal cortex makes up the bulk of the adrenal gland. Its cells are organized into three layers, each secreting and essential hormone. Hormones secreted from the adrenal cortex include *aldosterone*, which regulates sodium reabsorption and potassium excretion by the kidneys; *cortisol*, also known as *hydrocortisone*, which helps the body during stressful situations and helps maintain the proper glucose concentration in the blood between meals as well as helps reduce the inflammatory response causing swelling; and *androgens*, sex hormones which stimulate the development of male sexual characteristics and in adult women, stimulate the female sex drive.

The **adrenal medulla,** or inner portion of the adrenal gland, secretes a class of hormones called **catecholamines,** specifically *epinephrine* and *norepinephrine*. These hormones help the body resist stress. They prolong and intensify changes in body function brought about by the stimulation of the sympathetic subdivision of the autonomic nervous system. The adrenal glands are **sympathomimetic,** imitative of the sympathetic nervous system. In Chapter 8, The Nervous System, a unique reaction called the "*fight or flight*" response is discussed.

Pancreas

The **pancreas** has a dual role in that it is part of the digestive system where its cells produce digestive enzymes known as *pancreatic juice*, and it is also part of the endocrine system where its *pancreatic islets* (also known as the *islets of Langerhans*) produce the hormones **insulin** and **glucagon.** These hormones help in maintaining a proper level of blood glucose. Within the pancreas, the **islets of Langerhans,** specialized hormone-producing cells, secrete insulin to lower blood sugar when blood sugar levels are high and glucagon to raise blood sugar levels when they are low. Insulin is produced by **beta cells** in the islets of Langerhans, and glucagon is produced by **alpha cells** in the islets. When blood sugar levels get too high in the body, the beta cells release insulin into the bloodstream. Insulin allows the glucose in the blood to be transformed in the liver into *glycogen*, which is stored animal starch. The glucose is also moved into the muscle cells and adipose tissue. When blood glucose levels fall, such as between meals or during the night, the secretion of insulin decreases. If levels fall too low, alpha cells secrete glucagon which stimulates the liver to convert the stored glycogen into glucose, thus raising blood glucose levels. Figure 15-2 shows the glucagon/glucose production process.

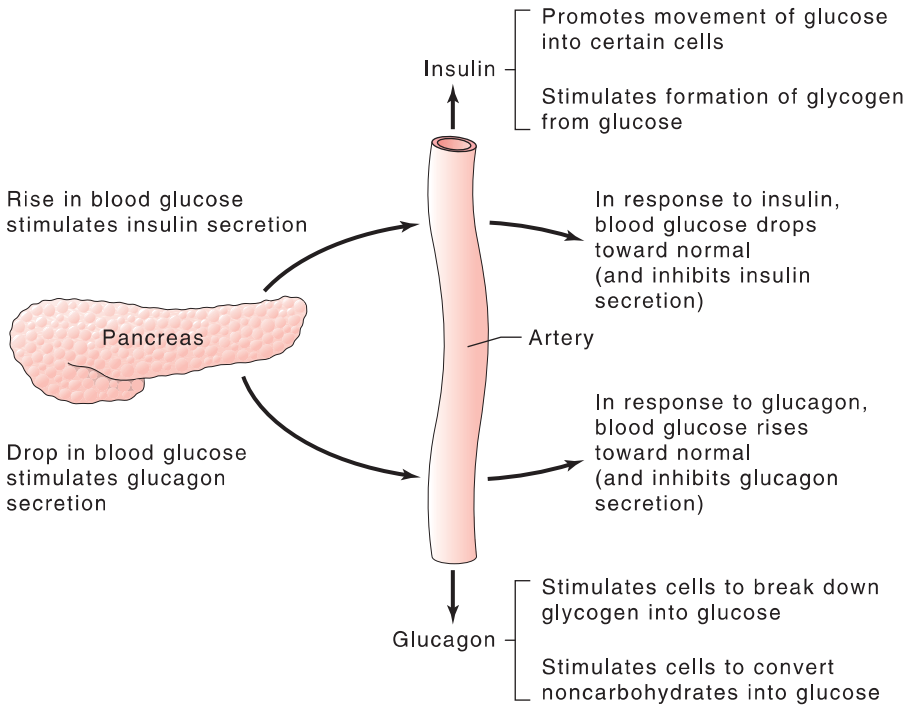


FIGURE 15-2 Glucagon and insulin help to maintain stable blood glucose levels in the body.

The pancreas is both an endocrine and an exocrine gland. The islets of Langerhans serve its endocrine functions, and the remaining cells its exocrine ones (as discussed in the digestive system in Chapter 14).

Ovaries

The **ovaries,** or female gonads, are paired glands about the size of unshelled almonds and are found in the female pelvic region, one on either side of the uterus at the top of each fallopian tube. (Chapter 10 describes the female reproductive system.) These organs produce eggs, or ova, as exocrine glands and as endocrine glands produce the female sex hormones estrogen and progesterone. Estrogen causes the development of the female reproductive structures: the fallopian tubes, uterus, and vagina. It also causes the development of the breasts, fat deposits on the hips and thighs, bone development resulting in broad hips, a higher pitched voice, and onset of the menstrual cycle.

Testes

The **testes (testicles)** or male gonads, are paired oval glands located in the scrotum, a sac on the outside of the male body. Externally, it appears as a single pouch of skin, but is actually separated into two sacs internally by a septum. Each sac contains a single testis. As an exocrine gland, the testes produce spermatozoa, which fertilize ova. As an endocrine gland, the testes produce male sex hormones called **androgens,** the most important of which is testosterone. Testosterone is the "*masculinizing hormone*" and is responsible for the development of the male reproductive structures, and at puberty, the enlargement of the testes and penis. It also promotes external male characteristics such as beard and chest hair growth, deepening of the voice, muscular development, bone growth resulting broad shoulders and narrow hips. It promotes the development of the male sexual drive and aggressiveness. (Chapter 11 describes the male reproductive system.)

Vocabulary Review

In the previous section you learned terms related to the endocrine system. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. The etymologies (word histories) are for your information only. You do not need to memorize them.

Term	Meaning
Adam's apple	Protrusion in the neck caused by a fold of thyroid cartilage.
adenohypophysis [ĂD-ĕ-nō-hī-PŎF-ĭ-sĭs] adeno-, gland + hypophysis	Anterior lobe of the pituitary gland.
adrenal cortex [ă-DRĒ-năl KŎR-tĕks]	Outer portion of the adrenal gland; helps control metabolism, inflammations, sodium and potassium retention, and effects of stress.
adrenal gland	One of two glands, each of which is situated on top of each kidney.

Term	Meaning
adrenaline [ă-DRĔ-nă-lĭn]	Epinephrine; secreted by adrenal medulla.
adrenal medulla [mĕ-DŪL-lă]	Inner portion of adrenal glands; releases large quantities of hormones during stress.
adrenocorticotropic [ă-DRĒ-nō-KŌR-tĭ-kō-TRŌ-pĭk] **hormone (ACTH)** adreno-, adrenal glands + cortico(steroid) + -tropic, turning	Hormone secreted by anterior pituitary; involved in the control of the adrenal cortex.
aldosterone [ăl-DŎS-tēr-ōn]	Hormone secreted by adrenal cortex; mineralocorticoid.
alpha [ĂL-fă] **cells**	Specialized cells that produce glucagon in the pancreas.
androgen [ĂN-drō-jĕn] andro-, man + -gen, producing	Any male hormone, such as testosterone.
antidiuretic [ĂN-tē-dī-yū-RĔT-ĭk] **hormone (ADH)** anti-, against + diuretic	Posterior pituitary hormone that increases water reabsorption.
beta [BĀ-tă] **cells**	Specialized cells that produce insulin in the pancreas.
calcitonin [kăl-sĕ-TŌ-nĭn] calci-, calcium + Greek *tonos*, a stretching	Hormone secreted by the thyroid gland and other endocrine glands; helps control blood calcium levels.
catecholamines [kăt-ĕ-KŌL-ă-mĕnz]	Hormones, such as epinephrine, released in response to stress.
corticosteroids [KŎR-tĭ-kō-STĒR-ŏydz]	Steroids produced by the adrenal cortex.
cortisol [KŎR-tĭ-sōl]	Hydrocortisone.
ductless gland	Endocrine gland.
electrolyte [ē-LĔK-trō-līt]	Any substance that conducts electricity and is decomposed by it.
endocrine [ĔN-dō-krĭn] **gland** endo-, within + -crine, secreting	Gland that secretes substances into the bloodstream instead of into ducts.
epinephrine [ĔP-ĭ-NĔF-rĭn] epi-, upon + nephr-, kidney + -ine, chemical compound	Hormone released by the adrenal medulla in response to stress; adrenaline.
exocrine [ĔK-sō-krĭn] **gland** exo-, external + -crine	Any gland that releases substances through ducts to a specific location.
follicle-stimulating hormone (FSH)	Hormone released by the anterior pituitary to aid in production of ova and sperm.
gland Latin *glans*, acorn	Any organized mass of tissue secreting or excreting substances.
glucagon [GLŪ-kă-gŏn]	Hormone released by the pancreas to increase blood sugar.
glucocorticoids [glū-kō-KŌR-tĭ-kŏydz] gluco- + corticoid	Hormones released by the adrenal cortex.

Term	Meaning
glycogen [GLĪ-kō-jĕn] glyco-, glycogen + -gen	Converted glucose stored in the liver for future use.
growth hormone (GH)	Hormone released by the anterior pituitary for stimulating growth.
hormone [HŌR-mōn] Greek *hormon*, rousing	Substance secreted by glands and carried in the bloodstream to various parts of the body.
hypophysis [hī-PŎF-ĭ-sĭs] Greek, undergrowth	Pituitary gland.
hypothalamus [HĪ-pō-THĂL-ă-mŭs] hypo-, beneath + thalamus	Gland in the nervous system that releases hormones to aid in regulating pituitary hormones.
inhibiting factor	Substance in a hormone that prevents the secretion of other hormones.
insulin [ĬN-sū-lĭn] Latin *insula*, island	Substance released by the pancreas to lower blood sugar.
islets of Langerhans [LĂN-gĕr-hănz] After Paul Langerhans (1847–1888), German anatomist	Specialized cells in the pancreas that release insulin and glucagon.
isthmus [ĬS-mŭs] Greek *isthmos*, narrow band	Narrow band of tissue connecting the two lobes of the thyroid gland.
luteinizing [LŪ-tē-ĭn-ĪZ-ĭng] **hormone (LH)**	Hormone released to aid in maturation of ova and ovulation in the female; and aids in the secretion of testosterone in males.
melanocyte-stimulating [mĕ-LĂN-ō-sīt, MĔL-ă-nō-sīt] **hormone (MSH)**	Hormone released by the pituitary gland; aids in development of melanin pigment of the skin.
melatonin [mĕl-ă-TŌN-ĭn] Greek *melas*, dark + *tonos*, a stretching	Hormone released by the pineal gland; affects sexual function and sleep patterns.
metabolism [mĕ-TĂB-ō-lĭzm]	The chemical changes in cells that provide energy for vital processes and activities and through which new material is assimilated.
mineralocorticoid [MĬN-ĕr-ăl-ō-KŌR-tĭ- kŏyd] mineral + corticoid, steroid secretion	Steroid secreted by adrenal cortex.
neurohypophysis [NŪR-ō-hī-PŎF-ĭ-sĭs] neuro-, nerve + hypophysis	Posterior lobe of pituitary gland.
norepinephrine [NŌR-ĕp-ĭ-NĔF-rĭn]	Hormone secreted by adrenal medulla.
ovary [Ō-văr-ē] Latin *ovum*, egg	One of two female reproductive glands that secrete hormones in the endocrine system.
oxytocin [ŏk-sĭ-TŌ-sĭn] Greek *oxytokos*, swift birth	Hormone released by the posterior pituitary gland to aid in uterine contractions and lactation.
pancreas [PĂN-krē-ăs] Greek *pankreas*, sweetbread	Gland of both the endocrine system (blood sugar control) and the digestive system (as an exocrine gland).

Term	Meaning
parathormone [păr-ă-THŌR-mōn] **(PTH)** parath(yroid) + (h)ormone	Parathyroid hormone.
parathyroid [păr-ă-THĪ-rŏyd] **gland** para-, adjacent + thyroid	One of four glands located adjacent to the thyroid gland on its dorsal surface that help maintain levels of blood calcium.
parathyroid hormone (PTH)	Hormone released by parathyroid glands to help raise blood calcium levels.
pineal [PĬN-ē-ăl] **gland** Latin *pineus*, relating to pine	Gland located above pituitary gland; secretes melatonin.
pituitary [pĭ-TŪ-ĭ-tār-ē] **gland** Latin *pituita*	Major endocrine gland; secretes hormones essential to metabolic functions.
receptor [rē-SĔP-tōr] Latin, receiver	Part of a target cell with properties compatible with a particular substance (hormone).
releasing factor	Substance in a hormone that allows secretion of other hormones.
somatotrophic [SŌ-mă-tō-TRŌF-ĭk] **hormone (STH)** somato-, sleep + -trophic, nutritional	Hormone secreted by anterior pituitary gland; important in growth and development.
suprarenal [SŪ-pră-RĒ-năl] **gland** supra-, above + renal	Adrenal gland.
sympathomimetic [SĬM-pă-thō-mĭ-MĔT-ĭk] sympath(etic) + Greek *mimikos*, imitating	Mimicking functions of the sympathetic nervous system.
target cell	Cell with receptors that are compatible with specific hormones.
testis (*pl.*, testes) [TĔS-tĭs (TĔS-tēz)], **testicle** [TĔS-tĭ-kl] Latin	One of two male organs that secrete hormones in the endocrine system.
thymus [THĪ-mŭs] **gland** Greek *thymos*, sweetbread	Gland that is part of the immune system as well as part of the endocrine system; aids in the maturation of T and B cells.
thyroid [THĪ-rŏyd] **gland** Greek *thyreos*, oblong shield	Gland with two lobes located on either side of the trachea; helps control blood calcium levels and metabolic functions.
thyroid-stimulating hormone (TSH)	Hormone secreted by anterior pituitary gland; stimulates release of thyroid hormones.
thyroxine [thī-RŎK-sēn, -sĭn] **(T_4)**	Compound found in or manufactured for thyroid gland; helps regulate metabolism.
triiodothyronine [trī-Ī-ō-dō-THĪ-rō-nēn] **(T_3)**	Thyroid hormone that stimulates growth.
vasopressin [vā-sō-PRĔS-ĭn]	Hormone secreted by pituitary gland; raises blood pressure.

CASE STUDY

Checking the Symptoms

Gail Woods is a 45-year-old woman who has noticed some disturbing symptoms, such as unusual fatigue, since her last checkup. She called her physician, Dr. Tyler, for an appointment. Dr. Tyler examined her and sent her to a lab for several tests.

Critical Thinking

1. Dr. Tyler ordered a urinalysis and blood tests. Why?
2. If Dr. Tyler is able to limit the symptoms to one body system, is he likely to send Gail to a specialist?

STRUCTURE AND FUNCTION EXERCISES

Find a Match

Match each hormone with its function by writing the name of the hormone on the appropriate line.

ADH prolactin insulin aldosterone oxytocin thyroxine testosterone thymosin melatonin epinephrine

3. may affect sleep habits: _____
4. reacts to stress: _____
5. decreases urine output: _____
6. stimulates uterine contractions and lactation: _____
7. helps transport glucose to cells and decreases blood sugar: _____
8. stimulates breast development and lactation: _____
9. affects electrolyte and fluid balances: _____
10. regulates rate of cellular metabolism: _____
11. promotes growth and maintenance of male sex characteristics and sperm production: _____
12. aids in development of the immune system: _____

Check Your Knowledge

For each of the following words, write C if the spelling is correct. If it is not, write the correct spelling.

13. adenohypophysis _____
14. adenal _____
15. hypophisis _____
16. suparenal _____
17. sympathomimetic _____
18. pituatary _____
19. lutinizing _____
20. triiodothyronine _____

CASE STUDY

Getting the Results

Gail's tests came back with abnormally high blood sugar. Her lab results are shown at right:

Critical Thinking

21. Were any other tests abnormal?

22. What body system is the likely origin of Gail's abnormal tests?

John Colter, M.D. 3 Windsor Street Nome, AK 66660 777-546-7890	Laboratory Report Grandview Diagnostics 12 Settlers Drive Nome, AK 66661 777-546-7000	
Patient: Gail Woods Date Collected: 04/27/XXXX Date Received: 04/27/XXXX	Patient ID: 099-00-1200 Time Collected: 16:05 Date Reported: 10/06/XXXX	Date of Birth: 06/10/59 Total Volume: 2000

Test	Result	Flag	Reference
Complete Blood Count			
WBC	4.0		3.9-11.1
RBC	4.11		3.80-5.20
HCT	39.7		34.0-47.0
MCV	96.5		80.0-98.0
MCH	32.9		27.1-34.0
MCHC	34.0		32.0-36.0
MPV	8.6		7.5-11.5
NEUTROPHILS %	45.6		38.0-80.0
NEUTROPHILS ABS.	1.82		1.70-8.50
LYMPHOCYTES %	36.1		15.0-49.0
LYMPHOCYTES ABS.	1.44		1.00-3.50
EOSINOPHILS %	4.5		0.0-8.0
EOSINOPHILS ABS.	0.18		0.03-0.55
BASOPHILS %	0.7		0.0-2.0
BASOPHILS ABS.	0.03		0.000-0.185
PLATELET COUNT	229		150-400
Automated Chemistries			
GLUCOSE	275		65-109
UREA NITROGEN	17		6-30
CREATININE (SERUM)	0.6		0.5-1.3
UREA NITROGEN/CREATININE	28		10-29
SODIUM	152		135-145
POTASSIUM	4.4		3.5-5.3
CHLORIDE	106		96-109
CO_2	28		20-31
ANION GAP	6		3-19
CALCIUM	9.8		8.6-10.4
PHOSPHORUS	3.6		2.2-4.6
AST (SGOT)	28		0-30
ALT (SGPT)	19		0-34
BILIRUBIN, TOTAL	0.5		0.2-1.2
PROTEIN, TOTAL	7.8		6.2-8.2
ALBUMIN	4.3		3.5-5.0
GLOBULIN	3.5		2.1-3.8
URIC ACID	2.4		2.0-7.5
CHOLESTEROL	195		120-199
TRIGLYCERIDES	68		40-199
IRON	85		30-150
HDL CHOLESTEROL	73		35-59
CHOLESTEROL/HDL RATIO	3.2		3.2-5.7
LDL, CALCULATED	126		70-129
T3, UPTAKE	32		24-37
T4, TOTAL	6.9		4.5-12.8

Combining Forms and Abbreviations

The lists below include combining forms and abbrevations that relate specifically to the endocrine system. Pronunciations are provided for the examples.

Combining Form	Meaning	Example
aden(o)	gland	*adenopathy* [ă-dĕ-NŎP-ă-thē], glandular or lymph node disease
adren(o), adrenal(o)	adrenal glands	*adrenomegaly* [ă-drē-nō-MĔG-ă-lē], enlargement of the adrenal glands
gluc(o)	glucose	*glucogenesis* [glū-kō-JĔN-ĕ-sĭs], production of glucose
glyc(o)	glycogen	*glycolysis* [glī-KŎL-ĭ-sĭs], conversion of glycogen to glucose
gonad(o)	sex glands	*gonadotropin* [gō-NĂD-ō-trō-pĭn], hormone that aids in growth of gonads
pancreat(o)	pancreas	*pancreatitis* [păn-krē-ă-TĪ-tĭs], inflammation of the pancreas
parathyroid(o)	parathyroid	*parathyroidectomy* [pă-ră-thī-rŏy-DĔK-tō-mē], excision of the parathyroid glands
thyr(o), thyroid(o)	thyroid gland	*thyrotoxic* [thī-rō-TŎK-sĭk], having excessive amounts of thyroid hormones

Abbreviation	Meaning	Abbreviation	Meaning
ACTH	adrenocorticotropic hormone	IDDM	insulin-dependent diabetes mellitus
ADH	antidiuretic hormone	LH	luteinizing hormone
CRH	corticotropin-releasing hormone	MSH	melanocyte-stimulating hormone
DM	diabetes mellitus	NIDDM	noninsulin-dependent diabetes mellitus
OT	oxytoxin	PG	prostaglandins
FSH	follicle-stimulating hormone	PRL	prolactin
GH	growth hormone	PTH	parathyroid hormone, parathormone
GTT	glucose tolerance test	STH	somatotropin hormone
HCG	human chorionic gonadotropin	TSH	thyroid-stimulating hormone

Combining Forms and Abbreviations Exercises

Build Your Medical Vocabulary

Using the combining forms learned in this chapter, construct five words about the endocrine system that fit the definitions provided.

23. inflammation of a gland: _____
24. disease of the pancreas: _____
25. production of glycogen: _____
26. enlargement of the thyroid gland: _____
27. beneficial thyroid function: _____

Know the Meaning

Write the definitions for the following terms.

28. adrenalectomy: _____
29. pancreatectomy: _____
30. adenoma: _____
31. gonadotropin: _____
32. thyromegaly: _____

Diagnostic, Procedural, and Laboratory Terms

A thorough assessment can help to identify an endocrine disorder. The patient with such a disorder, or disease, commonly reports fatigue, weakness, weight changes, mental status changes, polyuria, polydipsia, and abnormalities of sexual maturity and function. A detailed family history can also help uncover a familial tendency toward endocrine disease. The only endocrine glands that can be physically examined (palpated) are the thyroid gland and testes. In many patients, the thyroid gland isn't palpable. Enlargement or atrophy of these glands can be felt. Severe enlargement can also be seen.

The results of various diagnostic tests can be used to suggest, confirm, or rule out an endocrine disease. Endocrine function can be tested by direct, indirect, and radiographic studies. Direct testing, the most common method of measuring endocrine function, involves measuring the hormone levels in blood or urine. The most often performed tests include those measuring levels of cortisol, PTH, GH, T4 and T3, FSH, LH, oral glucose tolerance testing (GTT), calcium, potassium, phosphorus, glycosolated hemoglobin, and electrolyte studies. A **fasting blood sugar** test and a **glucose tolerance test** are both started after a 10 to 12-hour period where the individual has absolutely nothing by mouth. This includes chewing gum, coffee, cigarettes, bottled water, or even toothpaste. This time of fasting is written by the physician as "**NPO**" meaning, "*non per os*"—Latin for "*nothing by mouth*." The glucose tolerance test is repeated every hour for 3 to 6 hours, according to the physician's orders, after the patient ingests a glucose solution. Results of this test analyze how efficiently the body handles sugars and carbohydrates and well it is able to balance itself after ingesting these substances. Diabetic patients often check **blood sugar** or **blood glucose** levels several times a day themselves to track fluctuations in blood sugar and/or to determine

the correct amount of insulin to take. A **postprandial blood sugar** is a test usually taken 2 hours after a meal to determine whether blood sugar levels can return to normal ranges following a meal. A urine test, also called a urinalysis, can be performed to detect the presence of ketones (proteins) and/or types of sugar in the urine, both of which may indicate diabetes. For people already diagnosed with diabetes, a **glycosylated hemoglobin** (A1c or Hemoglobin A1c) test can track the effectiveness of a patient's insulin treatment by detecting the amount of glucose present on the surface of the blood's red cells after a period of 2–3 months. The lower the levels of glycosolated red cells present, the more balanced the patient's blood sugar levels have been.

Computed tomography scanning (CT), regular x-rays, ultrasounds, or magnetic resonance imaging (MRI) may help locate tumors, lesions, cysts, gland atrophy, or abnormal increased size, bone density or frailty in diagnosing an endocrine disorder, Overall endocrine system functioning is evaluated by using the serum or plasma from human blood. Many hormones and electrolytes are present in serum. Endocrine function can be tested in the plasma by using a **radioactive immunoassay,** a test using radioactive iodine to locate various substances in the plasma such as GH (Growth Hormone). Thyroid functioning can be tested in a **thyroid function test,** a blood test for various hormones secreted by the thyroid. A complete blood count (CBC) is used to analyze the overall composition of the entire blood to include the red cells, white cells, and platelets. A basic metabolic profile/panel (BMP) would report the levels of electrolytes and other chemical compounds found in the blood. A **radioactive iodine uptake** is a measure of how quickly ingested iodine is taken into the thyroid gland. A **thyroid scan** is a test for cancer or other abnormality using radionuclide imaging. In diabetics, an ophthalmologic examination may show diabetic retinopathy, a common eye disease in insulin dependent diabetics.

Vocabulary Review

In the previous section you learned terms related to diagnosis, clinical procedures, and laboratory tests. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. The etymologies (word histories) are for your information only. You do not need to memorize them.

Term	Meaning
blood sugar, blood glucose	Test for glucose in blood.
fasting blood sugar	Test for glucose in blood following a fast of 12 hours.
glucose tolerance test (GTT)	Blood test for body's ability to metabolize carbohydrates; taken after a 10–12-hour fast, then repeated every hour for 4 to 6 hours after ingestion of a sugar solution.
glycosylated [GLĪ-ko- (comp: long o)sil (short i)-a-tĕd] **hemoglobin A1C**	Blood test for an average of glucose levels over the previous 2–3 months.
postprandial [pōst-PRĂN-dē-ăl] **blood sugar**	Test for glucose in blood, two hours after a meal.

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Term	Meaning
radioactive immunoassay (RIA)	Test for measuring hormone levels in plasma; taken after radioactive solution is ingested.
radioactive iodine uptake	Test for how quickly the thyroid gland pulls in ingested iodine.
thyroid function test or study	Test for levels of TSH, T_3, and T_4 in blood plasma to determine thyroid function.
thyroid scan	Imaging test for thyroid abnormalities.
urine sugar	Test for diabetes; determined by presence of sugar in urine.

MORE ABOUT . . .

Diabetes and Diet

For many years, doctors prescribed a high-protein, low-carbohydrate diet for diabetics. In recent years, increased understanding of how food is metabolized by the body has led to changes in diets prescribed for diabetics. Most newly diagnosed diabetics are given a varied diet by a physician or a dietitian that is tailored to their specific needs—current weight, level of diabetes (mild, moderate, severe), and lifestyle. The American Dietetic Association and the American Diabetes Association provide the dietary information on which most diets for diabetics are based. A diabetic's personalized daily diet might include four fruit exchanges, three protein exchanges, three bread exchanges, and seven vegetable exchanges. Many suppliers of processed food, particularly those foods aimed at the health-conscious consumer, now list exchanges as part of their nutrition labels as shown here.

Nutrition Facts
Serving Size 1 cup (246g)
Servings Per Container about 2

Amount Per Serving	
Calories 100	Calories from Fat 5
	% Daily Value*
Total Fat 0.5g	1%
Saturated Fat 0g	0%
Cholesterol 0mg	0%
Sodium 430mg	18%
Total Carbohydrate 23g	8%
Dietary Fiber 2g	8%
Sugars 1g	
Protein	4g
Vitamin A 30% •	Vitamin C 15%
Calcium 4% •	Iron 6%

* Percent Daily Values are based on a 2,000 calorie diet

DIETARY EXCHANGES PER SERVING:
1 Bread
1 Vegetable

Diet exchanges are based on Exchange Lists for Meal Planning, © 1989, the American Diabetes Assoc., Inc. and the American Dietetic Assoc.

CASE STUDY

Referring to a Specialist

Dr. Tyler reviewed Gail's symptoms and test results with her. She has lost 12 pounds rapidly over the last couple of months, is feeling abnormally tired, and is unusually thirsty. Dr. Tyler referred her to an endocrinologist.

Critical Thinking

33. What disease does Dr. Tyler think Gail has?
34. What test for blood glucose is taken after a meal?

Diagnostic, Procedural, and Laboratory Terms Exercises

Match the Test

Match the test with the possible diagnosis. Write D if it is a test for diabetes or T if it is a test for thyroid function.

35. fasting blood sugar _____
36. radioactive iodine uptake _____
37. radioactive immunoassay _____
38. urine sugar _____
39. glucose tolerance test _____

Pathological Terms

Body activities, homeostasis, and the response to stress are controlled by two distinct but interconnected systems: the nervous system and the endocrine system. The nervous system (discussed in Chapter 8) creates an immediate but short-lived response. The endocrine system has a slightly slower onset and a longer duration of action, and uses highly specific and powerful hormones to control the body's response chemically. Certain endocrine glands are stimulated to secrete hormones in response to other hormones and therefore keep the body in balance or homeostasis. Diseases of the endocrine system commonly involve an abnormal increase or decrease in the secretion of hormones. Symptoms of disease vary with the degree of increase or decrease in hormonal secretion and the age of the patient. The remarkable work and importance of hormones is seen in their pathology. Sometimes a minute difference in the amount of hormone can make a huge difference in the seriousness of an illness. Changes in gland size that affect the gland's production and secretion of a hormone often result from trauma to the gland such as infection, surgical procedures, inflammation, and radiation. Most endocrine illnesses are the result of **hypersecretion** (oversecretion) or **hyposecretion** (undersecretion) of one or more hormones. Hypersecretion can be caused by excessive stimulation of a gland by a bacteria, virus, other microorganism or by a tumor affecting an endocrine gland. Diagnosing endocrine disorders requires correctly matching the patient's symptoms with a specific hormone dysfunction and confirming either the overproduction or underproduction of that specific hormone or group of hormones. After the endocrine problem has been identified and diagnosed, treatment is begun to either decrease the amount of hormone being released by subjecting the patient to radiation therapy, surgical removal of the gland, or reduction of the tumor or lesion stimulating the hypersecretion. In the case of hormone deficit or hyposecretion, hormone supplements or medications may be prescribed to stimulate

a specific gland to produce and secrete more hormones or surgery may be necessary to remove the inhibiting factor causing the underproduction and secretion of the particular hormone.

Pituitary Disorders

Hyperpituitarism is a chronic, progressive disease caused by the excessive production and secretion of various pituitary hormones, such as human growth hormone (hGH). Excessive hGH produces two very distinct conditions, **acromegaly** and **gigantism. Acromegaly** (chronic hypersecretion of growth hormone (GH) beginning after puberty), causes abnormal overgrowth of the bones in the face, hands, and feet. It is often seen in patients between the ages of 30 and 40. **Gigantism** is caused by the hypersecretion of GH (somatotropin) before puberty and results in a proportional overgrowth of all body tissue. Symptoms usually appear over time and sexual and mental developments are often effected. Some patients may reach heights over 8 feet tall.

Hypopituitarism is a condition caused by a deficiency or complete absence of some, or any of the pituitary hormones, specifically those hormones produced by the anterior pituitary gland. Because the anterior pituitary gland is responsible for secretion of so many essential hormones, the condition may be very complex affecting several different areas of the body. Patients may experience stunted growth, sexual immaturity, and various metabolic problems. A decrease, or absence of pituitary hormones responsible for stimulating the production and secretion of other hormones in the endocrine system, can result in the *atrophy* or dysfunction of other endocrine glands. Hyposecretion of GH may result in a condition called **dwarfism** (Figure 15-3), which is the opposite of gigantism, and which normally occurs in children and results in the child being extremely short but with proportional body structure. The disease may be linked to mental retardation in the patient and other physical defects. Dwarfism may be congenital or the result of a cranial hemorrhage after birth. Head trauma, tumor, or infection may result in the undersecretion of the growth-hormone-releasing-hormone (GH-RH) which is produced by the hypothalamus. The age of the patient, the severity and type of deficiency, and the underlying cause of hypopituitarism will help determine the method of treatment. Treatment may include hormone supplements, including thyroxine, sex hormones, somatropin (hGH) or cortisone; and surgery to remove a tumor if this is the cause of the hormone inhibition.

FIGURE 15-3 Dwarfism is a pituitary disorder.

The therapeutic use of human growth hormone was first shown in 1963. Since that time the number of approved and proposed uses of human growth hormone has grown from one to more than a dozen, and the number of patients being treated with it has increased from a handful to tens of thousands worldwide. The officially approved uses of human growth hormone vary from country to country, but it is commonly used for children with growth hormone deficiency or insufficiency, poor growth due to renal failure, and children born small for gestational age with poor growth past 2 years of age. In adults the approved uses include AIDS-related wasting and growth hormone deficiency (usually due to a pituitary tumor).

In addition to the generally accepted therapeutic uses of human growth hormone, many proposed uses have not been established. Human growth hormone is a potent hormone with a wide variety of effects. The

anabolic actions of human growth hormone have made it attractive for people wishing to reverse the effects of ageing and to promote athletic abilities and muscles development. These last two potential uses have received the most attention as abuse of growth hormone. The classic form of "abuse" of human growth hormone are athletes or bodybuilders who use it as a way to gain an unfair advantage over their competitors. No good evidence or scientific research exists showing that human growth hormone actually works safely for this purpose. In addition to the lack of evidence for effectiveness of human growth hormone for these unsupported uses, it causes side effects such as diabetes, carpal tunnel syndrome, fluid retention, joint and muscle pain, and high blood pressure.

In addition to growth problems, hyposecretion of vasopressin or antidiuretic hormone (ADH) causes a condition know as **diabetes insipidus.** This is not the same as **diabetes mellitus** which is often treated with insulin injections but rather a disease caused by decreased levels of ADH by the posterior pituitary gland which results in extremely large amounts of diluted and colorless urine called **polyuria.** The patient will also experience excessive thirst known as **polydipsia** due to the dehydration caused by the polyuria. The disease may be inherited or the result of injury to the hypothalamus or pituitary gland and is more common in men than women. It can be treated with an antidiuretic medication, such as vasopressin nasal sprays, injections, or an oral medication. Hyposecretion of antidiuretic hormone also causes **syndrome of inappropriate ADH (SIADH),** which results in excessive water retention.

Thyroid Disorders

Thyroid diseases may also cause the oversecretion or undersecretion of the primary thyroid hormones, thyroxine (T4) and triiodothyronine (T3). The thyroid gland is the endocrine gland that most often produces disease and a **goiter** is often the first sign of thyroid disease. The term goiter refers to any enlargement of the thyroid gland. Most patients are asymptomatic until they notice a swollen mass appearing under the chin across the area where the thyroid gland is located. As this mass continues to grow, it may begin exerting pressure on the esophagus making the action of swallowing difficult. In extreme cases, the mass may become so large that it even presses on the trachea resulting in dyspnea or shortness of breath. Goiters can be the result of a shortage of iodine in the diet which results in the body not being able to metabolize and use T3 and T4; or inadequate levels of thyroid hormone which causes the anterior pituitary gland to increase secretion of thyrotropin (TSH). The release of TSH stimulates the thyroid gland to produce thyroid hormone but instead the thyroid gland begins to increase in size, thus creating the goiter.

Another hypothyroid condition occurs when the immune system attacks the thyroid gland in the form of an autoimmune disease called *Hashimoto's thyroiditis*. This is a chronic thyroiditis occurring in women eight times more often than men and is the leading cause of goiter and hypothyroidism. In addition to the symptoms of simple goiter, the patient may also develop weight gain, mental sluggishness, and extreme sensitivity to cold. While the true cause of Hashimoto's thyroiditis is unknown, a genetic factor is suspected and autoimmune factors have been documented through the discovery that antibodies appear to destroy thyroid tissue resulting

in chronic inflammation of the thyroid gland and the production of scar tissue which enlarges the gland. Treatment for Hashimoto's is lifelong thyroid hormone replacement therapy. When the thyroid gland becomes overactive, causing **hyperthyroidism,** a condition known as **Graves' disease** will develop. Symptoms of Graves' disease are consistent with increased T3 and T4, which cause increased metabolic rate, weight loss, insomnia, sweating, rapid heartbeat and palpitations, nervousness, and excitability. **Exophthalmos,** bulging of the eyes, is also a sign that can occur in some instances of Graves' disease. General hyperactive behavior, loss of hair, and tremors are also seen A sudden exacerbation (flare up) of symptoms may be the first sign of **thyrotoxicosis** also called "*thyroid storm*." This is the result of extremely high levels of thyroid hormone and can be a life threatening situation. Treatment is focused on reducing the amount of thyroid hormone being released and is often accomplished by antithyroid medications. In severe cases, a thyroidectomy or radioactive iodine treatments may be necessary.

Hypothyroidism is a very common condition and refers to any state in which thyroid hormone production is below normal. Some symptoms may take years to develop and be noticed. The underactivity of the thyroid gland, causes sluggishness and slow pulse, often resulting in obesity. Patients may also exhibit cold sensitivity, constipation, dry and flaky skin conditions and extreme fatigue. There are several causes for hypothyroidism with hereditary factors at the top of the list. A simple blood test evaluating levels of TSH present in the body can determine whether this condition is present. In most cases, patients will be on lifelong medication such as *Synthroid* or *Levoxyl* as replacements or supplements to the low levels of hormone. Another form of hypothyroidism disease is cretinism or congenital hypothyroidism. This disease develops during infancy or early childhood, and is a congenital condition where the thyroid gland is completely absent at birth or the thyroid gland is unable to produce hormones. The child will develop with both mental and physical retardation. A lack of developing muscle will result in the child's inability to stand and walk. They will have very distinct physical features such as wide-set eyes, puffy eyelids, a protruding abdomen, dwarf-like height, expressionless face with a wide-open mouth and thick, protruding tongue, and dry skin. Early discovery and treatment may correct most of the physical deficiences but often does not help with the mental retardation. **Myxedema** is a severe type of hypothyroidism in older children and adults, usually female, with a range of symptoms depending on the age of the patient at onset of the disease. Symptoms may include puffiness in the extremities, slow muscular response, excessively dry skin, bloated face with thickened tongue, excessive fatigue, weight gain, loss of hair, slow or slurred speech, and menorrhagia in female patients. In severe cases, myxedema can progress into coma although this is a rare life-threatening form.

Thyroid cancer occurs in the thyroid gland and often does not cause symptoms until the disease is very advanced and often irreparable damage has occurred to the gland. Some patients may complain of hoarseness or difficulty swallowing. Patients with family history of thyroid cancer are ten times more likely to also develop thyroid cancer which indicates the disease may have a strong genetic link. Women are also three times more likely to develop thyroid cancer than men. The prognosis of patients with thyroid cancer greatly depends on the patient's age at diagnosis, the advancement of the cancer at diagnosis, and the size of the primary tumor. It is a condition caused by the overactivity of one or more of the four parathyroid glands and is usually

caused by a tumor or excessive growth of one of the parathyroid glands **(adenoma).** Although some patients may have few symptoms, it may often result in such clinical symptoms as mental disturbances, fatigue, weakness, bone loss, and even in severe cases, kidney failure. **Hypoparathyroidism** (underactivity of the parathyroid glands) results from reduced levels of parathyroid hormone (PTH) and causes low blood calcium levels known as **hypocalcemia.** When levels of PTH are low, resulting in hypocalcemia, initial symptoms will include tingling of the nose, ears, fingertips or toes, followed by spasms, cramping, or twitching of the feet and hands. Severe, continual muscle contractions may then develop called **tetany.** The patient may experience emotional and mental status changes such as aggression, confusion, irritability, and memory loss. Left untreated, hypocalcemia will eventually progress into heart arrhythmias, spasms in the trachea leading to respiratory paralysis, respiratory arrest, and death. Calcium replacement therapy with vitamin D is effective in reducing hypocalcemia and this treatment is usually life-long unless the condition is discovered early enough in the patient's life to be completely ph.

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Parathyroid Disorders

The parathyroid glands help control blood calcium levels, which contribute to bone growth and muscular health. **Hyperparathyroidism** is a condition caused by the overactivity of one or more of the four parathyroid glands and is usually caused by a tumor or excessive growth of one of the parathyroid glands (adenoma). Although some patients may have few symptoms, it often results in such clinical symptoms as mental disturbances, fatigue, weakness, bone loss, and even in severe cases, kidney failure.

Hypoparathyroidism (underactivity of the parathyroid glands) results from reduced levels of parathyroid hormone (PTH) and causes low blood calcium levels known as *hypocalcemia*. When levels of PTH are low, resulting in hypocalcemia, initial symptoms will include tingling of the nose, ears, fingertips or toes, followed by spasms, cramping, or twitching of the feet and hands. Severe, continual muscle contractions called *tetany* may then develop. The patient may experience emotional and mental status changes such as aggression, confusion, irritability, and memory loss. Left untreated, hypocalcemia will eventually progress into heart arrhythmias, spasms in the trachea leading to respiratory paralysis, respiratory arrest, and death. Calcium replacement therapy with vitamin D is effective in reducing hypocalcemia and this treatment is usually life-long unless the condition is discovered early enough in the patient's life to be completely reversed.

Adrenal Disorders

Like other endocrine glands, the adrenal glands may also become overactive (**hyperadrenalism**) or underactive (**hypoadrenalism**). Hyperadrenalism can be caused by an adrenal tumor, excessive secretion of corticotrophin (ACTH) from the pituitary gland, or the abnormal production of corticotrophin in another organ (occurs in the lung cancer). **Cushing's Syndrome** is a condition where there are excessive amounts of circulating cortisol levels in the blood. The patient presents with muscular weakness, fatigue, and physical changes in body appearance. Psychiatric problems are common in this disease and patients often develop diabetes mellitus. Prolonged use or large doses of glucocorticoids (steroids) to treat other conditions may result in Cushing's

syndrome. Treatment of Cushing's depends on the cause of the hyperadrenalism and may include surgery to remove a tumor or radiation to reduce a tumor in the pituitary or adrenal gland. *Adrenogenital syndrome* results in symptoms of excessive androgens both in men and women, which, in turn, can result in **hirsutism,** abnormal hair growth. **Virilism** is also a condition caused by excessive androgen secretion. Virilism results in mature masculine features in children. Administration of steroids can keep the overactivity in balance.

Hypoadrenalism, or adrenal insufficiency, is also known as **Addison's disease** and is a partial or complete failure of adrenocortical function. It is characterized by weakness and fatigue, gastrointestinal disturbances, anorexia and weight loss, and a very distrinct bronze skin color. Reduced levels of aldosterone result in the body's inability to retain salt and water resulting in dehydration, hyperkalemia (excessive potassium blood levels), and other electrolyte imbalances. Hyperkalemia is a life-threatening condition requiring immediate emergency care. Treatment includes the replacement of natural hormones and correction of salt and potassium levels. Perhaps the most famous Addison's patient was US President John F. Kennedy.

Pancreas Disorders

Sometimes, the pancreas may become inflamed, as in **pancreatitis** effecting the production and secretion of the hormone **insulin.** *Hyperinsulinsism* is the *over*secretion of insulin and may cause **hypoglycemia,** a dangerous lowering of blood sugar levels that deprives the body of needed glucose. Hypoglycemia can be successfully controlled with dietary changes and patient awareness of physical symptoms signaling the decline in blood glucose levels. Hyposecretion of insulin can cause **diabetes mellitus,** a widespread disease that affects about 4 percent of the U.S. population.

Diabetes or Failure of the Beta Cells

Diabetes occurs either as **Type I diabetes (insulin-dependent diabetes mellitus or IDDM), Type II diabetes (noninsulin-dependent diabetes mellitus** or **NIDDM),** or **Type III diabetes (gestational diabetes or GDM).** Type I diabetes (formerly know as *juvenile onset diabetes*) usually occurs before the age of 30 and is the result of underproduction or complete absence of insulin production (hypoinsulinism) by the beta cells. A reduction in insulin deprives cells of the glucose fuel they need and they begin to metabolize proteins and fats as replacements. This activity causes metabolic waste products known as ketones to build up in the blood and spill over into the urine (ketonuria) and this leads to a very serious condition called *acidosis*. When excessive glucose accumulates in the blood and overflows into the urine a condition called **glucosuria (glycosuria)** develops. The goal of diabetes treatment is to keep blood glucose levels as near to normal as possible. Type I diabetic may be treated with controlled doses of insulin along with consistent, moderate exercise and weight management. Type II diabetics (formerly known as *adult onset diabetes)* usually do not require insulin injections but may need oral hypoglycemic medications and follow strict dietary guidelines, and exercise routines. Type II diabetes is the more common of the two diabetic forms and has a gradual onset in adults between the ages of 30 and 55. In Type II, pancreatic function of insulin production and secretion still remains but is insufficient for normal glucose metabolism. It is very common for overweight and obsess people whose responsiveness

to insulin is abnormally low to develop Type II diabetes. This response is called *insulin resistance*.

Both Type I and Type II diabetes can lead to *insulin reaction* and/or *diabetic coma*. Insulin reaction or insulin shock, is a condition where excessive levels of insulin causes a rapid onset of symptoms such as tremors, tachycardia, hunger, dizziness, irritability, confusion, seizures, and loss of consciouness. Diabetic coma results from abnormally low levels of insulin, such as occurs when an insulin dose is skipped or excessive amounts of carbohydrates have been consumed by the patient. Diabetic coma has a slow onset and presents with such symptoms as excessive thirst, increased urination, nausea and vomiting, abdominal pain, flushed and dry skin, "fruity" breath odor, heavy respirations, dilated and fixed pupils, hyperglycemia, loss of consciousness, and coma. Left untreated, the patient could die.

Type III, or gestational, diabetes (GDM) is a condition where a female's body loses the ability to process carbohydrates and sugars during pregnancy. Affecting approximately four percent of pregnant women today, its onset usually occurs between weeks 24 to 28 of the pregnancy and may have most of the typical symptoms of the other forms of diabetes. During the pregnancy, the treatment of GDM is similar to the treatment of any diabetes, watching the mother and the fetus very closely due to the increased risk for complications. This condition usually disappears right after delivery of the baby with 30–40 percent of women with GDM developing Type II diabetes within 5 to 10 years after GDM.

Complications of diabetes cover a wide range of ailments from circulatory problems to infections to organ failure. **Diabetic nephropathy** is a kidney disease resulting from diabetes mellitus. Also called *glomerulosclerosis*, this condition can be expected to eventually develop in all Type I diabetic patients. Insufficient control of blood glucose levels and blood pressure by the diabetic patient will accelerate the destruction of the renal function. **Diabetic neuropathy** is loss of sensation in the extremities. This condition is compounded by hyperglycemia which delays healing and substantially reduces the diabetic's resistance to infection. Diabetics require close observation for the development of foot wounds and infections that may occur from circulatory difficulties common in diabetes, especially in the lower extremities. **Diabetic retinopathy** is a disease of the retinal blood vessels causing gradual visual loss leading to blindness. Diabetic retinopathy is a major cause of blindness and results from hemorrhages, abnormal dilation of retinal veins, the formation of abnormal new vessels, and damaging microaneurysms in the eyes. The body uses stored proteins and fats to replace glucose for energy, thereby causing **acidosis, ketoacidosis,** and **ketosis,** all of which are marked by the abnormal presence of ketone bodies in the blood and urine.

Before the discovery of insulin as a compound that affects blood sugar levels, people with diabetes usually died of some of the many complications of the disease. Although diabetes is still not curable, technology has given new solutions to diabetes care. Quick-acting and long-acting insulins provide more options for managing insulin-dependent diabetes. A wider range of oral drugs are available to treat Type II diabetes. New monitors make it easier and more comfortable for people to test and track their blood glucose. External insulin pumps can replace the discomfort of daily injections. Laser surgery can treat diabetic eye disease and prevent blindness. Successful kidney and pancreas transplantation procedures bring hope to people with organ failure. In addition, much has been learned about how to manage diabetes and

MORE ABOUT . . .

Misleading Common Terms

In certain parts of the country, both types of diabetes are simply called *sugar,* as in the phrase, "he has sugar." Sometimes common terms for diseases seem to misrepresent what the disease is. Diabetes is in fact an underproduction of or resistance to *insulin,* although in the past, many people thought it was caused by sugar alone.

prevent complications through weight reduction, blood glucose control, and exercise and there are more successful methods of managing diabetes during pregnancy today. Researchers have also identified lifestyle changes that can help prevent diabetes.

Cancers of the Endocrine System

The American Diabetes Association (www.diabetes.org) provides information for people with diabetes or those who wish to prevent it.

Cancers occur commonly in the endocrine system. Many, such as thyroid cancer, can be treated with removal of the affected gland and supplementation with a synthetic version of the necessary hormones that are then missing from the body. In other endocrine cancers, such as pancreatic cancer, the prognosis is poor even after aggressive treatment. Cancer of the pancreas is the fourth-leading cause of cancer-related death in the United States. Surgical removal of the affected area of the pancreas is currently the only potential cure, however only 15–20 percent of diagnosed patients are candidates for surgery.

Vocabulary Review

In the previous section you learned terms related to pathology. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. The etymologies (word histories) are for your information only. You do not need to memorize them.

Term	Meaning
acidosis [ăs-ĭ-DŌ-sĭs] acid + -osis, condition	Abnormal accumulation of ketones in the body.
acromegaly [ăk-rō-MĔG-ă-lē] acro-, extreme + -megaly, enlargement	Abnormally enlarged features resulting from a pituitary tumor and hypersecretion of growth hormone.
Addison's [ĂD-ĭ-sŏnz] **disease** After Thomas Addison (1793–1860), English physician	Underactivity of the adrenal glands.
Cushing's [KŪSH-ĭngs] **syndrome** After Harvey Cushing (1869–1939), U.S. neurosurgeon	Group of symptoms caused by overactivity of the adrenal glands.
diabetes [dī-ă-BĒ-tēz] Greek, a siphon	*See* Type I diabetes, Type II diabetes, Type III diabetes.
diabetes insipidus [ĭn-SĬP-ĭ-dŭs]	Condition caused by hyposecretion of antidiuretic hormone (ADH).

Term	Meaning
diabetes mellitus [MĔL-ī-tŭs, mĕ-LĪ-tŭs]	*See* Type I diabetes, Type II diabetes.
diabetic nephropathy [dī-ă-BĔT-ĭk nĕ-FRŎP- ă-thē]	Kidney disease due to diabetes.
diabetic neuropathy [nū-RŎP-ă-thē]	Loss of sensation in the extremities due to diabetes.
diabetic retinopathy [rĕt-ĭ-NŎP-ă-thē]	Gradual loss of vision due to diabetes.
dwarfism [DWŌRF-ĭzm] dwarf + -ism, state	Abnormally stunted growth caused by hyposecretion of growth hormone, congenital lack of a thyroid gland, or a genetic defect.
exophthalmos [ĕk-sŏf-THĂL-mŏs] ex-, out of + Greek *ophthalmos*, eye	Abnormal protrusion of the eyes typical of Graves' disease.
gigantism [JĪ-găn-tĭzm] Greek *gigas*, giant + -ism	Abnormally fast and large growth caused by hypersecretion of growth hormone.
glucosuria [glū-kō-SŪ-rē-ă] gluco-, glucose + -uria, urine	Glucose in the urine.
glycosuria [glī-kō-SŪ-rē-ă] glyco-, glycogen + -uria	Glucose in the urine.
goiter [GŎY-tĕr] Latin *guttur*, throat	Abnormal enlargement of the thyroid gland.
Graves' [grāvz] **disease** After Robert Graves (1796–1853), Irish physician	Overactivity of the thyroid gland.
hirsutism [HĔR-sū-tĭzm] hirsut(e), hairy + -ism	Abnormal hair growth due to an excess of androgens.
hyperadrenalism [HĪ-pĕr-ă-DRĒN-ă-lĭzm] hyper-, excessive + adrenal + -ism	Overactivity of the adrenal glands.
hyperparathyroidism [HĪ-pĕr-pă-ră-THĪ-rŏyd-ĭzm] hyper- + parathyroid + -ism	Overactivity of the parathyroid glands.
hypersecretion [HĪ-pĕr-sĕ-KRĒ-shŭn] hyper- + secretion	Abnormally high secretion, as from a gland.
hyperthyroidism [hī-pĕr-THĪ-rŏyd-ĭzm] hyper- + thyroid + -ism	Overactivity of the thyroid gland.
hypoadrenalism [HĪ-pō-ă-DRĒN-ă-lĭzm] hypo-, below normal + adrenal + -ism	Underactivity of the adrenal glands.
hypoglycemia [HĪ-pō-glī-SĒ-mē-ă] hypo- + glyc- + -emia	Abnormally low level of glucose in the blood.
hypoparathyroidism [HĪ-pō-pă-ră-THĪ-rŏyd-ĭzm] hypo- + parathyroid + -ism	Underactivity of the parathyroid glands.
hyposecretion [HĪ-pō-sĕ-KRĒ-shŭn] hypo- + secretion	Abnormally low secretion, as from a gland.
hypothyroidism [HĪ-pō-THĪ-rŏyd-ĭzm] hypo- + thyroid + -ism	Underactivity of the thyroid gland.

Term	Meaning
insulin-dependent diabetes mellitus (IDDM)	*See* Type I diabetes.
ketoacidosis [KĒ-tō-ă-sĭ̆-DŌ-sĭ̆s] keto(ne) + acidosis	Condition of high acid levels caused by the abnormal accumulation of ketones in the body.
ketosis [kē-TŌ-sĭ̆s] ket(one) + -osis, condition	Condition caused by the abnormal release of ketones in the body.
myxedema [mĭ̆k-sĕ-DĒ-mă] Greek *myxa*, mucus + edema	Advanced adult hypothyroidism.
noninsulin-dependent diabetes mellitus (NIDDM)	*See* Type II diabetes.
pancreatitis [PĂN-krē-ă-TĪ-tĭ̆s] pancreat-, pancreas + -itis, inflammation	Inflammation of the pancreas.
polydipsia [pŏl-ē-DĬP-sē-ă] poly-, much + Greek *dipsa*, thirst	Excessive thirst.
polyuria [pŏl-ē-YŪ-rē-ă] poly- + -uria	Excessive excretion of urine, resulting in frequent urination.
syndrome of inappropriate ADH (SIADH)	Excessive secretion of antidiuretic hormone.
tetany [TĔT-ă-nē] Greek *tetanos*, convulsive tension	Neurological syndrome, usually due to decreased serum levels of calcium in the blood.
thyrotoxicosis [THĪ-rō-tŏk-sĭ̆-KŌ-sĭ̆s] thyro-, thyroid + toxic + -osis	State of dangerously high levels of thyroid hormone.
Type I diabetes	Endocrine disorder with abnormally low or completely absent levels of insulin; also known as insulin-dependent diabetes mellitus (IDDM).
Type II diabetes	Disease caused by failure of the body to recognize insulin that is present or by an abnormally low level of insulin; also known as noninsulin-dependent diabetes mellitus (NIDDM); usually adult onset.
virilism [VĬR-ĭ̆-lĭ̆zm] Latin *virilis*, masculine	Condition with excessive androgen production, often resulting in the appearance of mature male characteristics in young.

CASE STUDY

Getting a Diagnosis

Gail decides to wait until after the holidays to make her appointment with the endocrinologist. She thinks that she will watch what she eats and then go to the doctor when she is less busy. For a few days, she moderates her eating and feels a little better. However, on the big holiday weekend, Gail goes to several parties, drinks, and overeats. When she wakes up in the morning, she feels dizzy, is in a cold sweat, and feels very hungry. Right away, she realizes that something is terribly wrong. Since it is a holiday weekend, she has a friend take her to the emergency room. Once there, her symptoms worsen. The emergency room doctor tests her blood sugar and finds it is very low. After she has eaten something, he tests it again. Because Gail is overweight, the doctor suspects that her body is not sensitive to insulin. Gail is sent to Dr. Malpas, an endocrinologist, the very next day.

Critical Thinking

40. What type of diabetes does Gail appear to have?

41. What might some recommendations be for Gail's diet?

Pathological Terms Exercises

Write A for adrenal, PA for pancreas, PI for pituitary, and T for thyroid to indicate the gland from which each of the following diseases arises.

42. acromegaly: _____
43. diabetes mellitus: _____
44. exophthalmos: _____
45. gigantism: _____
46. goiter: _____
47. myxedema: _____
48. Cushing's syndrome: _____
49. Graves' disease: _____
50. Addison's disease: _____
51. dwarfism: _____
52. cretinism: _____

Surgical Terms

Certain endocrine glands that become diseased can be surgically removed and then synthetic versions of the hormones they formerly produced are given to the patients to help their bodies continue performing the necessary endocrine functions.

An **adenectomy** is the removal of any gland. An **adrenalectomy** is the removal of an adrenal gland. Adrenalectomy may be performed in two methods—an open procedure or a laparoscopic procedure. Open operations may be performed through the back (sometimes requiring partial removal of a rib), the flank, or the abdomen. Laparoscopic procedures use small telescopes and long instruments to remove the adrenal gland through a series of small incisions. Typically, patients having laparoscopic procedures have less pain and a rapid recovery.

Removal of the pituitary gland (also called hypophysis) is a **hypophysectomy.** It is most commonly performed to treat tumors and sometimes is used to treat Cushing's syndrome due to pituitary adenoma.

The pancreas is removed in a **pancreatectomy.** Operations on the pancreas typically require an abdominal incision with some dissection of the stomach and intestines to expose the pancreas located deep within the abdomen. Many tumors may be dissected out of the substance of the pancreas, but in some cases may require partial removal of the pancreas. Removal of the parathyroid gland is performed in a **parathyroidectomy.** An incision is made along the collar line. The surgeon will move the thyroid gland to one side, then the other, to allow inspection of the parathyroid glands, which are located behind or to the side of the thyroid, deep within the neck. The surgeon will remove one or more of the parathyroids, depending on the specific disorder. The muscles are then repaired and the skin incision is closed with sutures that will either absorb or be removed soon after the operation. Recently, there has been discussion of the acceptability of a minimally invasive, or "keyhole," surgery for this problem. This is sometimes feasible and is being investigated here in the United States very carefully. Although it is being performed in some areas of the world, there are concerns about the possibility of more complications and a lower success rate with this type of procedure. Therefore, it is not yet widely accepted as a standard operation. A **thymectomy** is an operation to remove the thymus gland, leading to remission. However, this remission may not be permanent. A thymectomy is mainly carried out in an adult. This is because the thymus loses most of its functional capacity after adolescence, but

does retain a small portion of its function during adulthood. This is shown in the decreasing size of the thymus with increasing age after adolescence. A **thyroidectomy** is the removal of the entire thyroid gland. Surgery to remove only a portion of the thyroid is termed a partial, sub-total, or hemi-thyroidectomy. The metabolic functions of the thyroid are easily replaced with a well-tolerated oral medicine if surgery makes this necessary.

Some of these operations mentioned above may only require the removal of only the diseased part of a gland, leaving the remaining portion to continue its endocrine function. Other procedures that surgically remove the entire gland may require life-long hormone replacement or supplement therapy to replace the hormones once produced and secreted by the removed gland.

Vocabulary Review

In the previous section you learned terms related to surgery. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. The etymologies (word histories) are for your information only. You do not need to memorize them.

Term	Meaning
adenectomy [ă-dĕ-NĔK-tō-mē] aden-, gland + -ectomy, removal	Removal of a gland.
adrenalectomy [ă-drē-năl-ĔK-tō-mē] adrenal + -ectomy	Removal of an adrenal gland.
hypophysectomy [hī-pŏf-ĭ-SĔK-tō-mē] hypophys(is) + -ectomy	Removal of the pituitary gland. Also called hypophysis.
pancreatectomy [PĂN-krē-ă-TĔK-tō-mē] pancreat-, pancreas + -ectomy	Removal of the pancreas.
parathyroidectomy [PĂ-ră-thī-rŏy-DĔK-tō-mē] parathyroid + -ectomy	Removal of one or more of the parathyroid glands.
thymectomy [thī-MĔK-tō-mē] thym(us) + -ectomy	Removal of the thymus gland.
thyroidectomy [thī-rŏy-DĔK-tō-mē] thyroid + -ectomy	Removal of the thyroid.

CASE STUDY

Controlling the Disease

After the emergency room incident, Gail goes to her appointment with the endocrinologist, where she is given medication to make her body more sensitive to insulin, and told to diet sensibly and exercise. When she returns three months later, Dr. Malpas is pleased to see that Gail is controlling her diabetes, losing weight slowly, and exercising regularly. Her outlook is favorable. Dr. Malpas has another patient, Will Burns, who has had an overactive thyroid since he was a child. Lately, Will's hyperthyroidism has increased. Dr. Malpas biopsies Will's thyroid and tells Will it would be best to remove the thyroid.

Critical Thinking

53. What did Dr. Malpas probably find that necessitated thyroid removal?

54. What medications could Will be given after the operation?

Surgical Terms Exercises

Build Your Medical Vocabulary

Supply the missing part of the term:

55. removal of a gland: _____ectomy
56. removal of the pituitary gland: _____ectomy
57. removal of an adrenal gland: _____ectomy
58. removal of the thymus gland: _____ectomy
59. removal of part of the pancreas: _____ectomy
60. removal of the thyroid gland: _____ectomy
61. removal of one or more of the parathyroid glands: _____ectomy

After completing the terms in items 55 through 61, use them to define the following treatments:

62. Treatment for Graves' disease: _____
63. Treatment for severe virilism: _____
64. Treatment for a cancerous gland: _____
65. Treatment for hyperparathyroidism: _____
66. Treatment for acromegaly: _____

Pharmacological Terms

Hormonal deficiencies are sometimes treated by **hormone replacement therapy (HRT)**. Common types of hormone therapy include synthetic thyroid, estrogen, and testosterone. Other medications include those that regulate levels of substances in the body, such as glucose levels in diabetics. An **antihypoglycemic** raises blood sugar. An **antihyperglycemic** or **hypoglycemic** lowers blood sugar. Instead of or in addition to using drugs to regulate blood sugar, many diabetics are now treated with medications that increase sensitivity to their own insulin. **Human growth hormone** (somatotropin) occurs naturally in the body. In some cases of dwarfism, a synthetic version of HGH is given to promote growth. **Steroids** are used in controlling various symptoms and treating many diseases within and outside the endocrine system. Steroids can also be abused for muscle growth as discussed in Chapter 5. Table 15-2 lists common pharmacological agents used in treating the endocrine system.

There are several new endocrine therapy drugs available for the replacement or supplemental treatment of hormone absence or deficiency. Tamoxifen is an orally estrogen which is used in the treatment of breast cancer and is currently the world's largest selling drug for that purpose. Anastrozole (trade name: Arimidex) is a drug indicated in the treatment of breast cancer in post-menopausal women. It is used both following surgery and in metastatic breast cancer. It has the effect of decreasing the amount of estrogens that the body makes. While officially indicated for women, this

TABLE 15-2 Agents Used in Treating the Endocrine System

Drug Class	Purpose	Generic	Trade Name
antihyperglycemic	to lower blood sugar or increase sensitivity to insulin	insulin glyburide rosiglitazone pioglitazone chlorpropamide	Humulin, Novolin Diabeta, Micronase Avandia Actos Diabinese
antihypoglycemic	to prevent or relieve severe hypoglycemia or insulin reaction	glucagon	Glucagon Diagnostic Kit
human growth hormone	to increase height in cases of abnormal lack of growth	somatotropin	Humatrope, Nutropin
steroid	to increase growth; to relieve symptoms of various diseases	methylprednisolone prednisone desamethasone	Medrol Cortan, Deltasone Decadron, Cortastat

drug has proven effective in also reducing estrogens (in particular and more importantly, estradiol) in men. Excess estradiol in men can cause benign prostatic hyperplasia, gynecomastia, and symptoms of hypogonadism. Some athletes and body builders will also use anastrozole as a part of their steroid cycle to reduce and prevent symptoms of excess estrogens; in particular, gynecomastia and water retention. This drug is frequently used in the treatment of growth disorder affected children to stop or slow the onset of puberty. At the onset of puberty the bone growth plates begin to close. This can occur in children as young as 5 years old so for children severely behind in growth, the opportunity for increased growth is diminished. Arimidex is shown to slow or stop this process.

Carbimazole is used to treat hyperthyroidism by reducing the production of the thyroid hormones T3 and T4 thyroxine). Treatment is usually given for 12–18 months followed by a gradual withdrawal. Letrozole is approved by the United States Food and Drug Administration (FDA) for the treatment of local or metastatic breast cancer that is hormone receptor positive or has an unknown receptor status in postmenopausal women. Side effects include signs and symptoms of hypoestrogenism. Levothyroxine, a thyroid hormone, is used to treat hypothyroidism. When taken correctly, levothyroxine reverses the symptoms experienced with hypothyroidism. It is also used to treat congenital hypothyroidism (cretinism) and goiter (enlarged thyroid gland).

In 2002, studies on the effects of Hormone Replacement Therapy (HRT) for the treatment of menopause in women proclaimed HRT as a danger to women. The U.S. federal government halted the hormone trial of the Women's Health Initiative (WHI) early, a study Levothyroxine, a thyroid hormone, is used to treat hypothyroidism. When taken correctly, levothyroxine reverses the symptoms experienced with hypothyroidism. It is also used to treat congenital hypothyroidism (cretinism) and goiter (enlarged thyroid gland). But fast-forward to 2008 and the picture of hormone replacement therapy changed yet again. Because the 2002 WHI

study included women from ages 50 to 79, the initial results were a combined tabulation of all age groups together. But when data was re-analyzed to focus on the youngest members alone, an entirely different risk-to-benefit ratio of HRT began to emerge. While the impact of HRT on the heart may seem less ominous today than in 2002, links to breast cancer are less clear—and some say less encouraging. Many experts say that in the years following the WHI announcement, women stopped taking hormones en masse and the incidence of breast cancer subsequently declined. While studies are still ongoing, and reanalysis of the original data continues to shape medical opinions, experts say there are a few lessons learned thus far that are not likely to change. Among them: That hormone replacement therapy is not a panacea for disease prevention, even in situations where it was found to be helpful, such as reduction in hip fractures. Moreover, if hormone replacement therapy must be used to control menopause symptoms, the lowest possible dose for the shortest possible duration is recommended. Today the emphasis rests on the importance of treating every woman individually, with decisions about hormone use made strictly on a case-by-case basis.

Vocabulary Review

In the previous section you learned terms related to pharmacology. Before going on to the exercises, review the terms below and refer to the previous section if you have any questions. Pronunciations are provided for certain terms. Sometimes information about where the word came from is included after the term. The etymologies (word histories) are for your information only. You do not need to memorize them.

Term	Meaning
antihyperglycemic [ĂN-tē-HĪ-pĕr-glī-SĒ-mĭk] anti-, against + hyperglycem(ia) + -ic, pertaining to	Agent that lowers blood glucose.
antihypoglycemic [ĂN-tē-HĪ-pō-glī-SĒ-mĭk] anti- + hyporglycem(ia) + -ic	Agent that raises blood glucose.
hormone replacement therapy (HRT)	Ingestion of hormones to replace missing (or increase low levels of needed) hormones.
human growth hormone	Naturally occurring substance in the body that promotes growth; synthesized substance that serves the same function.
hypoglycemic [HĪ-pō-glī-SĒ-mĭk] hypoglycem(ia) + -ic	Agent that lowers blood glucose.
radioactive iodine therapy	Use of radioactive iodine to eliminate thyroid tumors.
steroid [STĔR-ŏyd, STĒR-ŏyd] ster(ol), alcohol compound + -oid, like	A hormone or chemical substance released by several endocrine glands or manufactured in various medications.

CASE STUDY

Learning the Outcome

At the same time that Gail's diabetes is diagnosed, she is beginning to feel symptoms of menopause. Women in their late forties and throughout their fifties represent a large concentration of newly diagnosed diabetics. Will has had his thyroid removed. Both Gail and Will probably get hormone replacement therapy.

Critical Thinking

67. What hormones could be prescribed for Gail?
68. What hormones could be prescribed for Will?

PHARMACOLOGICAL TERMS EXERCISES

Build Your Medical Vocabulary

In the space provided, write the name of the gland from which a hormone is needed to relieve symptoms of the disease.

69. Addison's disease: _____
70. hyperglycemia: _____
71. diabetes insipidus: _____
72. myxedema: _____
73. panhypopituitarism: _____

CHALLENGE SECTION

The laboratory report shown here is for a woman on hormone replacement therapy who also takes thyroid medications.

Pathologist's Laboratory
West Lake Road
West Lake, CT 00008
555-678-8900

Patient Name: Sally Benedict **Age/Sex:** 50/F **Patient Number:** 41983

Requesting Physician: Jane Merdin, MD **D.O.B.:** 10/28/50

Source: 09/30/XXXX **Collected:** 03-27-XXXX 0826 **Reported:** 03-28-XXXX 1649

Comments: Fasting 12 hrs.
Thyroid & Hormone Meds.

Operator: _____
Reviewed by: _____

Test	Results	Normal Range	
		FEMALE (Adjusted For Age)	
CPK	66	24-170	IU/L
LDH	122	122-220	IU/L
SGOT (AST)	21	0-31	IU/L
SGPT (ALT)	28	0-31	IU/L
ALK PHOSPHATASE	54	39-117	IU/L
GGTP	21	7-33	IU/L
TOTAL BILIRUBIN	0.3	.0-1.0	MG/DL
URIC ACID	3.5	2.4-5.7	MG/DL
TRIGLYCERIDE	105	0-200	MG/DL
CHOLESTEROL	229	0-240	MG/DL

TRIG/CHOL RATIO	0.5		
GLUCOSE	103	70-105	MG/DL
BUN	14	5-23	MG/DL
CREATININE	1.0	.6-1.1	MG/DL
BUN/CREAT RATIO	14.0		
PHOSPHORUS	3.2	2.7-4.5	MG/DL
CALCIUM	8.1	8.7-10.4	MG/DL
TOTAL PROTEIN	6.7	6.5-8.0	GM/DL
ALBUMIN	4.2	3.5-5.5	GM/DL
GLOBULIN	2.5	2.2-4.2	GM/DL
A/G RATIO	1.7	1.2-2.2	
SODIUM	140	135-148	MEQ/L
POTASSIUM	4.0	3.5-5.3	MEQ/L
CHLORIDE	106	100-112	MEQ/L
IRON	79	40-145	UG/DL
**THYROID			
T UPTAKE	29.5	27.8-40.8	%
THYROXINE	7.5	4.5-13.0	UG/DL
F.T.I. (T7)	2.2	1.8-4.4	

Critical Thinking

From the results of the lab report, do you think the patient's thyroid medication is putting her thyroid in the normal range? Explain your answer.

Terminology in Action

Below is a lab report for a 55-year-old patient.

Claudia Dinavo, M.D.
20 Ridge Road
Tuscaloosa, AL 99999
555-111-4444

Laboratory Report
Lab Services
University Square
Tuscaloosa, AL 99999
555-111-2222

Patient: Sam Oscar	Patient ID: 099-00-1200	Date of Birth: 4/3/XXXX
Date Collected: 03/28/XXXX	Time Collected: 09:10	Total Volume: 2000
Date Received: 03/28/XXXX	Date Reported: 3/31/XXXX	

Test	Result	Flag	Reference
Complete Blood Count			
WBC	5.2		3.9-11.1
RBC	4.11		3.80-5.20
HCT	39.7		34.0-47.0
MCV	96.5		80.0-98.0
MCH	32.9		27.1-34.0
MCHC	34.0		32.0-36.0
MPV	8.6		7.5-11.5
NEUTROPHILS %	45.6		38.0-80.0
NEUTROPHILS ABS.	3.4		1.70-8.50
LYMPHOCYTES %	36.1		15.0-49.0
LYMPHOCYTES ABS.	1.44		1.00-3.50
EOSINOPHILS %	4.5		0.0-8.0
EOSINOPHILS ABS.	0.18		0.03-0.55
BASOPHILS %	0.7		0.0-2.0
BASOPHILS ABS.	0.03		0.000-0.185
PLATELET COUNT	325		150-400
Automated Chemistries			
GLUCOSE	405	*	65-109

(continued)

Test	Result	Flag	Reference
UREA NITROGEN/CREATININE	28		10-29
SODIUM	152	*	135-145
POTASSIUM	4.4		3.5-5.3
CHLORIDE	106		96-109
CO_2	28		20-31
ANION GAP	6		3-19
CALCIUM	9.8		8.6-10.4
PHOSPHORUS	3.6		2.2-4.6
AST (SGOT)	28		0-30
ALT (SGPT)	19		0-34
BILIRUBIN, TOTAL	0.5		0.2-1.2
PROTEIN, TOTAL	7.8		6.2-8.2
ALBUMIN	4.3		3.5-5.0
GLOBULIN	3.5		2.1-3.8
URIC ACID	2.4		2.0-7.5
CHOLESTEROL	195		120-199
TRIGLYCERIDES	68		40-199
IRON	85		30-150
HDL CHOLESTEROL	73		35-59
CHOLESTEROL/HDL RATIO	3.2		3.2-5.7
LDL, CALCULATED	126		70-129
T3, UPTAKE	42	*	24-37
T4, TOTAL	13.6	*	4.5-12.8

Which items indicate abnormalities in the endocrine system?

Using the Internet

Go to the site of The Endocrine Society (http://www.endo-society.org), click the news and fact section, then click the fact sheet, and click on an article about an endocrinological disease. Write a brief summary of the information you collect.

CHAPTER REVIEW

The material that follows is to help you review this chapter.

Match the Meaning

Match the following combining forms with the correct meanings. Some answers may be used more than once or not at all.

74. ____ dips(o)
75. ____ aden(o)
76. ____ thyr(o), thyroid(o)
77. ____ glyc(o)
78. ____ pancreat(o)
79. ____ acr(o)
80. ____ kal(i)
81. ____ calci(o)
82. ____ gluc(o)
83. ____ gonad(o)
84. ____ vag(o)
85. ____ cortic(o)
86. ____ endocrin(o)
87. ____ parathyroid(o)
88. ____ macr(o)
89. ____ oophor(o)
90. ____ orch(o), orchi(o), orchid(o)
91. ____ pachy(o)
92. ____ somat(o)
93. ____ thym(o)

a. large, long
b. gonads, sex glands
c. ovary
d. thymus gland
e. calcium
f. gland
g. extreme, extremity
h. thyroid gland
i. potassium
j. sugar, glyogen
k. body
l. vagus nerve
m. testis, testicle
n. uric acid
o. pancreas
p. glucose
q. cortex, outer layer of organs
r. endrocrine gland
s. parathyroid gland
t. thirst

Mix and Match

Match the following abbreviations with their correct meaning.

94. ____ ACTH
95. ____ HCG
96. ____ DM
97. ____ GH
98. ____ ADH
99. ____ GTT
100. ____ CRH
101. ____ FSH

a. somatotrophic hormone
b. glucose tolerance test
c. potassium
d. hormone Replacement Therapy
e. human chorionic gonadotropin
f. fasting blood sugar
g. insulin-dependant diabetes mellitus
h. thyroxine

102. ____ T3	i. triiodothyronine
103. ____ IDDM	j. rheumatoid arthritis
104. ____ HRT	k. parathyroid hormone, parathormone
105. ____ AODM	l. melanocyte-stimulating hormone
106. ____ T4	m. radioactive iodine uptake
107. ____ NIDDM	n. growth hormone
108. ____ PTH	o. corticotropin-releasing hormone
109. ____ STH	p. luteinizing hormone
110. ____ DI	q. antidiuretic hormone
111. ____ ERT	r. diabetes insipidus
112. ____ FBS	s. adult-onset diabetes mellitus
113. ____ K	t. adrenocorticotropic hormone
114. ____ RA	u. diabetes mellitus
115. ____ RAIU	v. non–insulin-dependant diabetes mellitus
116. ____ MSH	w. follicle-stimulating hormone
117. ____ LH	x. estrogen replacement therapy

Match the Suffix

Match the following suffixes commonly used with endocrine system terms with their correct meaning.

118. ____ -logy	a. study of
119. ____ -megaly	b. inflammation
120. ____ -emia	c. tumor, mass
121. ____ -ism	d. disease
122. ____ -oma	e. in the blood
123. ____ -ectomy	f. condition
124. ____ -itis	g. incision
125. ____ -osis	h. enlargement
126. ____ -otomy	i. state
127. ____ -pathy	j. excision

Match the Prefix

Match the following prefixes commonly used with endocrine system terms with their correct meaning.

128. ____ hypo-	a. excessive
129. ____ para-	b. deficient
130. ____ syn-	c. against, opposing
131. ____ poly-	d. all, entire
132. ____ pan-	e. good, well, normal
133. ____ hyper-	f. together, with, joined

134. ____ eu-
135. ____ anti-

g. alongside of, near
h. many, more than one

Word Building

Using word parts you have learned in this chapter, build the correct medical terms for the following definitions.

136. study of the endocrine system _____
137. not enough sugar in the blood _____
138. excessive potassium in the blood _____
139. disease of the adrenal glands _____
140. state of inadequate pituitary gland activity throughout _____
141. inflammation of the adrenal glands _____
142. excision of the thyroid gland _____
143. resembling the cortex _____
144. physician who studies endocrine disease _____
145. enlargement of the extremities _____
146. deficient calcium in the blood _____
147. excessive development of the adrenal cortex _____
148. inflammation of a gland _____
149. disease of the endocrine system _____

Definitions

Define and pronounce the following terms. The words in the curly blue brackets refer to the Spanish glossary available online at www.mhhe.com/medterm3e.

Word

150. acidosis [ăs-ĭ-DŌ-sĭs] {acidosis}
151. acromegaly [ăk-rō-MĔG-ă-lē] {acromegalia}
152. Adam's apple
153. Addison's [ĂD-ĭ-sŏnz] disease
154. aden(o)
155. adenectomy [ă-dĕ-NĔK-tō-mē]
156. adenohypophysis [ĂD-ĕ-nō-hī-PŎF-ĭ-sĭs]
157. adren(o), adrenal(o)
158. adrenal cortex [ă-DRĒ-năl KŌR-tĕks]
159. adrenalectomy [ă-drē-năl-ĔK-tō-mē] {adrenalectomía}
160. adrenal {adrenal} gland
161. adrenaline [ă-DRĔ-nă-lĭn] {adrenalina}
162. adrenal medulla [mĕ-DŪL-lă]
163. adrenocorticotropic [ă-DRĒ-nō-KŌR-tĭ-kō-TRŌ-pĭk] hormone (ACTH)
164. aldosterone [ăl-DŎS-tēr-ōn] {aldosterina}
165. alpha [ĂL-fă] cells
166. androgen [ĂN-drō-jĕn] {andrógeno}
167. antidiuretic [ĂN-tē-dī-yū-RĔT-ĭk] hormone (ADH)
168. antihyperglycemic [ĂN-tē-HĪ-pĕr-glī-SĒ-mĭk]
169. antihypoglycemic [ĂN-tē-HĪ-pō-glī-SĒ-mĭk]
170. beta [BĀ-tă] cells
171. blood sugar, blood glucose
172. calcitonin [kăl-sĕ-TŌ-nĭn] {calcitonia}
173. catecholamines [kăt-ĕ-KŌL-ă-mēnz] {catecolaminas}

Word

174. corticosteroids [KŎR-tĭ-kō-STĒR-ŏydz] {corticosteroides}
175. cortisol [KŎR-tĭ-sōl] {cortisol}
176. Cushing's [KŪSH-ĭngs] syndrome
177. diabetes [dī-ă-BĒ-tēz] {diabetes}
178. diabetes insipidus [ĭn-SĬP-ĭ-dŭs]
179. diabetes mellitus [MĚL-ī-tŭs, mĕ-LĪ-tŭs]
180. diabetic nephropathy [dī-ă-BĚT-ĭk nĕ-FRŎP-ă-thē]
181. diabetic neuropathy [nū-RŎP-ă-thē]
182. diabetic retinopathy [rĕt-ĭ-NŎP-ă-thē]
183. ductless gland
184. dwarfism [DWŌRF-ĭzm] {enanismo}
185. electrolyte [ē-LĚK-trō-līt] {electrólito}
186. endocrine [ĔN-dō-krĭn] gland {glándula endocrina}
187. epinephrine [ĔP-ĭ-NĔF-rĭn] {epinefrina}
188. exocrine [ĔK-sō-krĭn] gland {glándula exocrina}
189. exophthalmos [ĕk-sŏf-THĂL-mŏs] {exoftalmía}
190. fasting blood sugar
191. follicle-stimulating hormone (FSH)
192. gigantism [JĪ-găn-tĭzm] {gigantismo}
193. gland {glándula}
194. gluc(o)
195. glucagon [GLŪ-kă-gŏn] {glucagon}
196. glucocorticoids [glū-kō-KŌR-tĭ-kŏydz]
197. glucose tolerance test (GTT)
198. glucosuria [glū-kō-SŪ-rē-ă]
199. glyc(o)
200. glycogen [GLĪ-kō-jĕn] {glucógeno} glycated [GLĪ-kā-tĕd] hemoglobin
201. glycosuria [glī-kō-SŪ-rē-ă]
202. goiter [GŎY-tĕr] {bocio}
203. gonad(o)
204. Graves' [grāvz] disease
205. growth hormone (GH)
206. hirsutism [HĔR-sū-tĭzm] {hirsutismo}
207. hormone [HŌR-mōn] {hormona}
208. hormone replacement therapy (HRT)
209. human growth hormone
210. hyperadrenalism [HĪ-pĕr-ă-DRĒN-ă-lĭzm]
211. hyperparathyroidism [HĪ-pĕr-pă-ră-THĪ-rŏyd-ĭzm] {hiperparatiroidismo}
212. hypersecretion [HĪ-pĕr-sĕ-KRĒ-shŭn]
213. hyperthyroidism [hī-pĕr-THĪ-rŏyd-ĭzm] {hipertiroidismo}
214. hypoadrenalism [HĪ-pō-ă-DRĒN-ă-lĭzm] {hipoadrenalismo}
215. hypoglycemia [HĪ-pō-glī-SĒ-mē-ă] {hipoglucemia}
216. hypoglycemic [HĪ-pō-glī-SĒ-mĭk] {hipoglucémico}
217. hypoparathyroidism [HĪ-pō-pă-ră-THĪ-rŏyd-ĭzm] {hipoparatiroidismo}
218. hypophysectomy [hī-pŏf-ĭ-SĔK-tō-mē]
219. hypophysis [hī-PŎF-ĭ-sĭs] {hipófisis}
220. hyposecretion [HĪ-pō-sĕ-KRĒ-shŭn]
221. hypothalamus [HĪ-pō-THĂL-ă-mŭs] {hipotálamo}
222. hypothyroidism [HĪ-pō-THĪ-rŏyd-ĭzm] {hipotiroidismo}
223. inhibiting factor
224. insulin [ĬN-sū-lĭn] {insulina}
225. insulin-dependent diabetes mellitus (IDDM)
226. islets of Langerhans [LĂN-gĕr-hănz]
227. isthmus [ĬS-mŭs] {istmo}
228. ketoacidosis [KĒ-tō-ă-sĭ-DŌ-sĭs] {cetoacidosis}
229. ketosis [kē-TŌ-sĭs] {cetosis}
230. luteinizing [LŪ-tē-ĭn-ĪZ-ĭng] hormone (LH)
231. melanocyte-stimulating [mĕ-LĂN-ō-sīt, MĚL-ă-nō-sīt] hormone (MSH)
232. melatonin [mĕl-ă-TŌN-ĭn]
233. metabolism [mĕ-TĂB-ō-lĭzm]
234. mineralocorticoid [MĬN-ĕr-ăl-ō-KŌR-tĭ-kŏyd]
235. myxedema [mĭk-sĕ-DĒ-mă] {mixedema}
236. neurohypophysis [NŪR-ō-hī-PŎF-ĭ-sĭs]
237. noninsulin-dependent diabetes mellitus (NIDDM)
238. norepinephrine [NŌR-ĕp-ĭ-NĔF-rĭn] {norepinefrina}

Word

239. ovary [Ō-văr-ē] {ovario}
240. oxytocin [ŏk-sĭ-TŌ-sĭn] {oxitocina}
241. pancreas [PĂN-krē-ăs] {páncreas}
242. pancreat(o)
243. pancreatectomy [PĂN-krē-ă-TĔK-tō-mē]
244. pancreatitis [PĂN-krē-ă-TĪ-tĭs] {pancreatitis}
245. parathormone [păr-ă-THŌR-mōn] (PTH) {parathormona}
246. parathyroid(o)
247. parathyroidectomy [PĂ-răr-thī-rŏy-DĔK-tō-mē]
248. parathyroid [păr-ă-THĪ-rŏyd] gland {paratiroide}
249. parathyroid hormone (PTH)
250. pineal [PĬN-ē-ăl] gland
251. pituitary [pĭ-TŪ-ĭ-tār-ē] gland
252. polydipsia [pŏl-ē-DĬP-sē-ă] {polidipsa}
253. polyuria [pŏl-ē-YŪ-rē-ă] {poliuria}
254. postprandial [pōst-PRĂN-dē-ăl] blood sugar
255. radioactive immunoassay (RIA)
256. radioactive iodine therapy
257. radioactive iodine uptake
258. receptor [rē-SĔP-tōr] {receptor}
259. releasing factor
260. somatotrophic [SŌ-mă-tō-TRŌF-ĭk] hormone (STH)
261. steroid [STĔR-ŏyd, STĒR-ŏyd]
262. suprarenal [SŪ-pră-RĒ-năl] gland
263. sympathomimetic [SĬM-pă-thō-mĭ-MĔT-ĭk] {simpatomimético}
264. syndrome of inappropriate ADH (SIADH)
265. target cell
266. testis (*pl.*, testes) [TĔS-tĭs (TĔS-tēz)], testicle [TĔS-tĭ-kl] {testículo}
267. tetany [TĔT-ă-nē] {tetania}
268. thymectomy [thī-MĔK-tō-mē] {timectomía}
269. thymus [THĪ-mŭs] gland
270. thyr(o), thyroid(o)
271. thyroidectomy [thī-rŏy-DĔK-tō-mē] {tiroidectomía}
272. thyroid function test
273. thyroid [THĪ-rŏyd] gland
274. thyroid scan
275. thyroid-stimulating hormone (TSH)
276. thyrotoxicosis [THĪ-rō-tŏk-sĭ-KŌ-sĭs]
277. thyroxine [thī-RŎK-sēn, -sĭn] (T_4)
278. triiodothyronine [trī-Ī-ō-dō-THĪ-rō-nēn] (T_3)
279. Type I diabetes
280. Type II diabetes
281. urine sugar
282. vasopressin [vā-sō-PRĔS-ĭn]
283. virilism [VĬR-ĭ-lĭzm] {virilismo}

Abbreviations

Write the full meaning of each abbreviation.

Abbreviation

384. ACTH
385. ADH
286. CRH
287. DM
288. FSH
289. GH
290. GTT
291. HCG
292. IDDM
293. LH
294. MSH
295. NIDDM
296. PRL
297. PTH
298. STH
299. TSH

Name _____ Date _____

Chapter 15: Word- Building (20 questions—1 pts. each)

Using the following combining forms, complete the word that best fits the definition of each word relating to endocrine system listed below. Combining forms may be used more than once.

aden(o)	gonad(o)
adren(o)	pancreat(o)
adrenal(o)	parathyroid(o)
gluc(o)	thyr(o)
glyc(o)	thyroid(o)

1. Formation of sugar: _____ genesis
2. Calculus in the pancreas: _____ lith
3. Surgical removal of a gland: _____ ectomy
4. Causing destruction of thyroid cells: _____ lytic
5. Relating to the gonads: _____ al
6. Excision of an ovary or testis: _____ ectomy
7. Enlargement of the adrenal glands: _____ megaly
8. Inflammation of the thyroid: _____ itis
9. Acting on the pancreas: _____ tropic
10. Thyroid repair: _____ plasty
11. Glandular tumor: _____ oma
12. Glandular tumor in the muscles: _____ myoma
13. Arising from the pancreas: _____ genic
14. Incision into the thyroid: _____ tomy
15. Inflammation of the adrenal glands: _____ itis
16. Imaging of the pancreatic ducts: _____ graphy
17. Thyroid disorder: _____ pathy
18. Gland-forming cell: _____ blast
19. Stimulating the thyroid: _____ tropic
20. Benign glandular tumor: _____ lymphoma