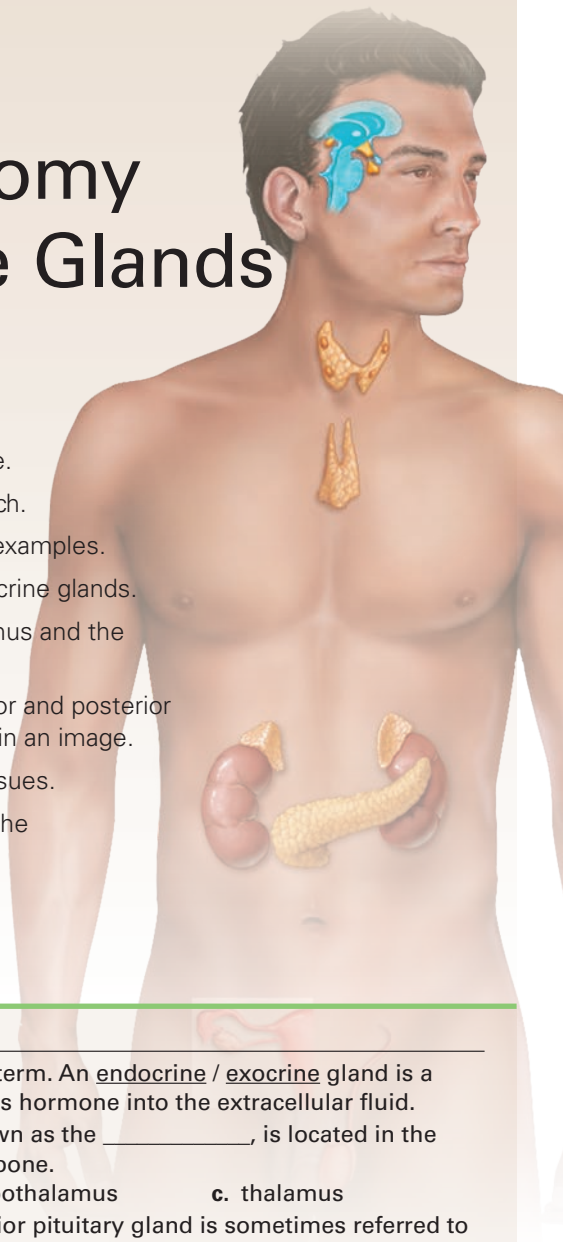
EXERCISE

27 Functional Anatomy of the Endocrine Glands



Objectives

- ☐ Identify the major endocrine glands of the body using an appropriate image.
- ☐ List the major hormones and discuss the target and general function of each.
- ☐ Explain how hormones contribute to body homeostasis using appropriate examples.
- ☐ Discuss some mechanisms that stimulate release of hormones from endocrine glands.
- ☐ Describe the structural and functional relationship between the hypothalamus and the pituitary gland.
- ☐ Correctly identify the histology of the thyroid, parathyroid, pancreas, anterior and posterior pituitary, adrenal cortex, and adrenal medulla by microscopic inspection or in an image.
- ☐ Name and identify the specialized hormone-secreting cells in the above tissues.
- ☐ Describe the pathology of hypersecretion and hyposecretion of several of the hormones studied.

Materials

- Human torso model
- Anatomical chart of the human endocrine system
- Compound microscope
- Prepared slides of the anterior pituitary and pancreas (with differential staining), posterior pituitary, thyroid gland, parathyroid glands, and adrenal gland

For instructions on animal dissections, see the dissection exercises (starting on page 705) in the cat and fetal pig editions of this manual.

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Pre-Lab Quiz

1. Define *hormone.* _____
2. Circle the correct underlined term. An endocrine / exocrine gland is a ductless gland that empties its hormone into the extracellular fluid.
3. The pituitary gland, also known as the _____, is located in the sella turcica of the sphenoid bone.
   a. hypophysis **b.** hypothalamus **c.** thalamus
4. Circle True or False. The anterior pituitary gland is sometimes referred to as the master endocrine gland because it controls the activity of many other endocrine glands.
5. The _____ gland is composed of two lobes and located in the throat, just inferior to the larynx.
   a. pancreas **c.** thymus
   b. posterior pituitary **d.** thyroid
6. The pancreas produces two hormones that are responsible for regulating blood sugar levels. Name the hormone that increases blood glucose levels. _____
7. Circle True or False. The gonads are considered to be both endocrine and exocrine glands.
8. This gland is rather large in an infant, begins to atrophy at puberty, and is relatively inconspicuous by old age. It produces hormones that direct the maturation of T cells. It is the _____ gland.
   a. pineal **c.** thymus
   b. testes **d.** thyroid
9. Circle the correct underlined term. Pancreatic islets / Acinar cells form the endocrine portion of the pancreas.
10. The outer cortex of the adrenal gland is divided into three areas. Which one produces aldosterone?
    a. zona fasciculata
    b. zona glomerulosa
    c. zona reticularis

The **endocrine system** is the second major control system of the body. Acting with the nervous system, it helps coordinate and integrate the activity of the body. The nervous system uses electrochemical impulses to bring about rapid control, whereas the more slowly acting endocrine system uses chemical messengers, or **hormones.**

The term *hormone* comes from a Greek word meaning "to arouse." The body's hormones, which are steroids or amino acid–based molecules, arouse the body's tissues and cells by stimulating changes in their metabolic activity. These changes lead to growth and development and to the physiological homeostasis of many body systems. Although hormones travel through the blood, a given hormone affects only a specific organ or organs. Cells within an organ that respond to a particular hormone are referred to as the **target cells** (also **target**) of that hormone. The ability of the target to respond depends on the ability of the hormone to bind with specific cellular receptors.

Although the function of most hormone-producing glands is purely endocrine, the function of others (the pancreas and gonads) is mixed—both endocrine and exocrine. The endocrine glands release their hormones directly into the extracellular fluid, from which the hormones enter blood or lymph.

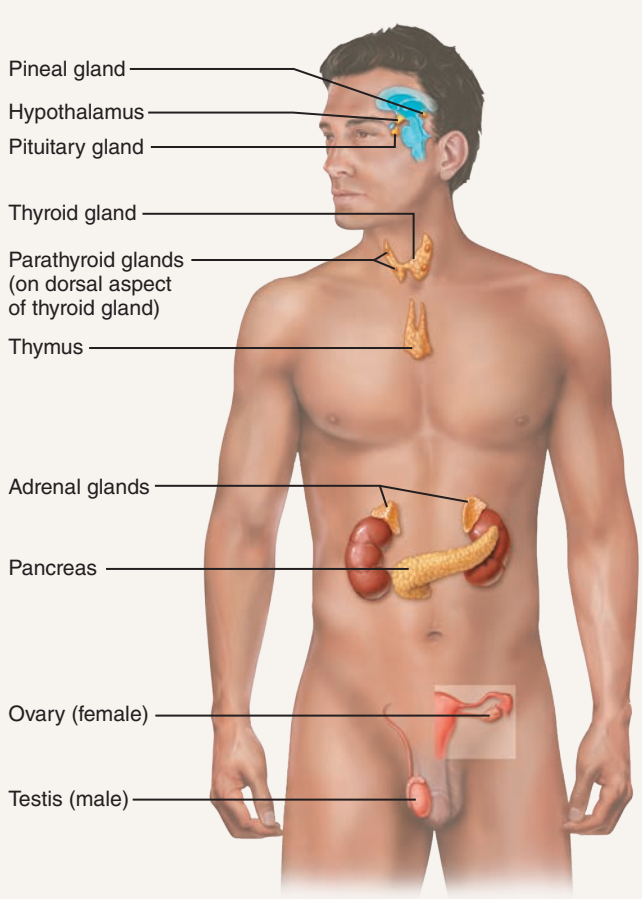

Figure 27.1 **Human endocrine organs.**

Activity 1

Identifying the Endocrine Organs

Locate the endocrine organs in **Figure 27.1**. Also locate these organs on the anatomical charts or torso model. As you locate the organs, read through Tables 27.1–27.4.

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Endocrine Glands

Pituitary Gland (Hypophysis)

The **pituitary gland,** or **hypophysis,** is located in the sella turcica of the sphenoid bone. It consists largely of two functional *lobes,* the **adenohypophysis,** or **anterior pituitary,** and the **neurohypophysis,** consisting of the **posterior pituitary** and the **infundibulum**—the stalk that attaches the pituitary gland to the hypothalamus (**Figure 27.2**).

The anterior pituitary produces and secretes a number of hormones, four of which are **tropic hormones.** The target organ of a tropic hormone is another endocrine gland.

Because the anterior pituitary controls the activity of many other endocrine glands, it is sometimes called the *master endocrine gland.* However, because *releasing* or *inhibiting hormones* from neurons of the ventral hypothalamus control anterior pituitary cells, the hypothalamus supersedes the anterior pituitary as the major controller of endocrine glands.

The ventral hypothalamic hormones control production and secretion of the anterior pituitary hormones. The hypothalamic hormones reach the cells of the anterior pituitary through the **hypophyseal portal system** (Figure 27.2), a complex vascular arrangement of two capillary beds that are connected by the hypophyseal portal veins.

The posterior pituitary is not an endocrine gland because it does not synthesize the hormones it releases. Instead, it acts as a storage area for two *neurohormones* transported to it via the axons of neurons in the paraventricular and supraoptic nuclei of the hypothalamus. Refer to **Table 27.1**, on pp. 409–410, which summarizes the hormones released by the pituitary gland.

Pineal Gland

The *pineal gland* is a small cone-shaped gland located in the roof of the third ventricle of the brain. Its major endocrine product is **melatonin,** which exhibits a diurnal (daily) cycle. It peaks at night, making us drowsy, and is lowest around noon. Recent evidence suggests that melatonin has anti-aging properties. Melatonin appears to play a role in the production of antioxidants.

Thyroid Gland

The *thyroid gland* is composed of two lobes joined by a central mass, or isthmus. It is located in the throat, just inferior to the larynx.

Parathyroid Glands

The *parathyroid glands* are found embedded in the posterior surface of the thyroid gland. Typically, there are two small

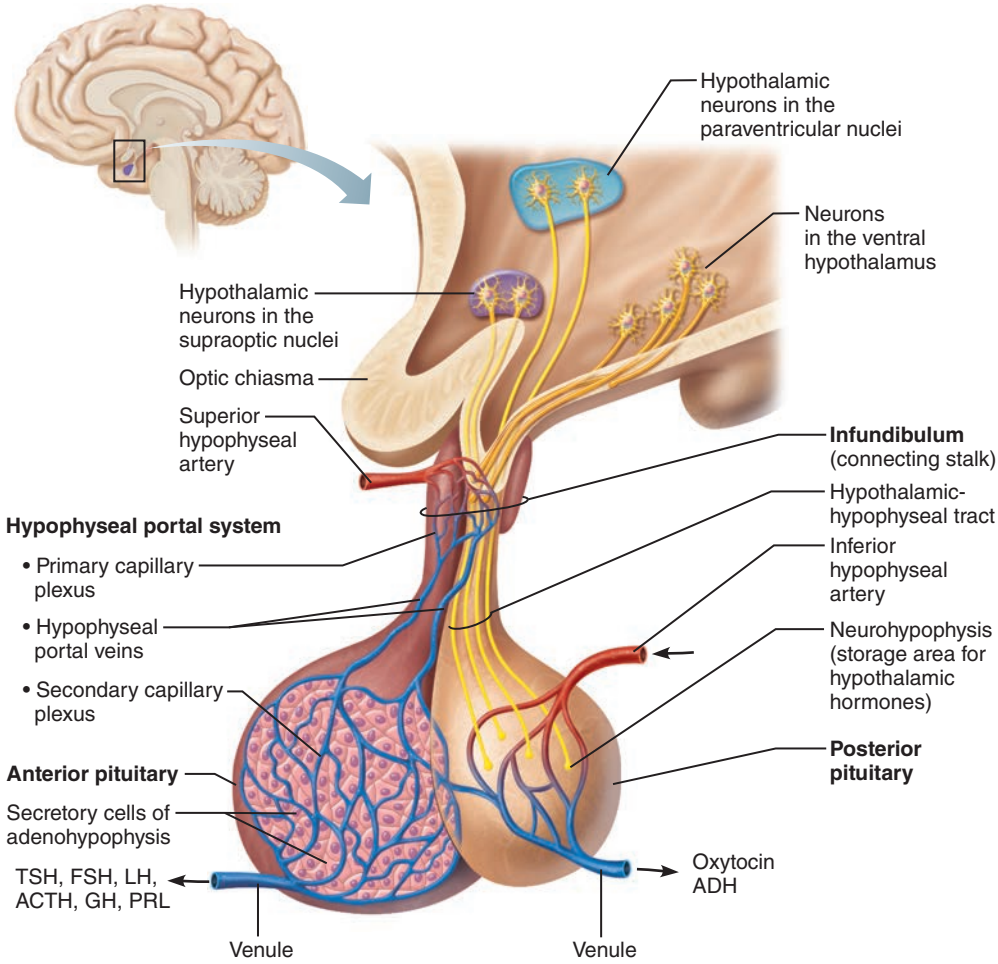

Figure 27.2 Hypothalamus and pituitary gland. Neural and vascular relationships between the hypothalamus and the anterior and posterior lobes of the pituitary are depicted.

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Table 27.1A Pituitary Gland Hormones (Figure 27.2)

Hormone	Stimulus for release	Target	Effects
Anterior Pituitary Gland: Tropic Hormones			
Thyroid-stimulating hormone (TSH)	Thyrotropin-releasing hormone (TRH)*	Thyroid gland	Stimulates the secretion of thyroid hormones (T_3 and T_4)
Follicle-stimulating hormone (FSH)	Gonadotropin-releasing hormone (GnRH)*	Ovaries and testes (gonads)	**Females**—stimulates ovarian follicle maturation and estrogen production **Males**—stimulates sperm production
Luteinizing hormone (LH)	Gonadotropin–releasing hormone (GnRH)*	Ovaries and testes (gonads)	**Females**—triggers ovulation and stimulates ovarian production of estrogen and progesterone **Males**—stimulates testosterone production
Adrenocorticotropic hormone (ACTH)	Corticotropin-releasing hormone (CRH)*	Adrenal cortex	Stimulates the release of glucocorticoids and androgens (mineralocorticoids to a lesser extent)
Anterior Pituitary Gland: Other Hormones (Not Tropic)			
Growth hormone (GH)	Growth hormone–releasing hormone (GHRH)*	Liver, muscle, bone, and cartilage, mostly	Stimulates body growth and protein synthesis, mobilizes fat and conserves glucose
Prolactin (PRL)	A decrease in the amount of prolactin-inhibiting hormone (PIH)*	Mammary glands in the breasts	Stimulates milk production (lactation)

* Indicates hormones produced by the hypothalamus.

oval glands on each lobe, but there may be more and some may be located in other regions of the neck.

Table 27.2 summarizes the hormones secreted by the thyroid and parathyroid glands.

Thymus

The *thymus* is a bilobed gland situated in the superior thorax, posterior to the sternum and overlying the heart. Conspicuous in the infant, it begins to atrophy at puberty, and by old age it is relatively inconspicuous. The thymus produces several different families of peptide hormones, including **thymulin, thymosins,** and **thymopoietins.** These hormones are thought to be involved in the development of T lymphocytes and the immune response, but their roles are poorly understood. They appear to act locally as paracrines.

Adrenal Glands

The two *adrenal,* or *suprarenal, glands* are located atop the kidneys. Anatomically, the **adrenal medulla** develops from neural crest tissue, and it is directly controlled by the sympathetic nervous system. The medullary cells respond to this stimulation by releasing a hormone mix of **epinephrine** (80%) and **norepinephrine** (20%), which act with the sympathetic nervous system to elicit the fight-or-flight response to stressors. Table 27.3 summarizes the hormones secreted by the adrenal glands.

The gonadocorticoids are produced throughout life in relatively insignificant amounts; however, hypersecretion of these hormones produces abnormal hairiness **(hirsutism)** and masculinization. ✚

Pancreas

The *pancreas,* located behind the stomach and close to the small intestine, functions as both an endocrine and exocrine gland. It produces digestive enzymes as well as insulin and glucagon, important hormones concerned with the regulation of blood sugar levels. Table 27.4 summarizes two of the hormones produced by the pancreas.

The Gonads

The *female gonads,* or *ovaries,* are paired, almond-sized organs located in the pelvic cavity. In addition to producing the female sex cells (ova), the ovaries produce two steroid hormone groups, the estrogens and progesterone. The endocrine and exocrine functions of the ovaries do not begin until the onset of puberty.

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Table 27.1B Pituitary Gland Hormones (Figure 27.2)

Hormone	Stimulus for release	Target	Effects
Posterior Pituitary Gland (Hormones That Are Synthesized by the Hypothalamus and Stored in the Posterior Pituitary)			
Oxytocin*	Nerve impulses from hypothalamic neurons in response to cervical/uterine stretch or suckling of an infant	Uterus and mammary glands	Stimulates powerful uterine contractions during birth and stimulates milk ejection (let-down) in lactating mothers
Antidiuretic hormone (ADH)*	Nerve impulses from hypothalamic neurons in response to increased blood solute concentration or decreased blood volume	Kidneys	Stimulates the kidneys to reabsorb more water, reducing urine output and conserving body water

* Indicates hormones produced by the hypothalamus.

Table 27.2 Thyroid and Parathyroid Gland Hormones

Hormone(s)	Stimulus for release	Target	Effects
Thyroid Gland			
Thyroxine (T_4) and Triiodothyronine (T_3), collectively referred to as thyroid hormone (TH)	Thyroid-stimulating hormone (TSH)	Most cells of the body	Increases basal metabolic rate (BMR); regulates tissue growth and development.
Calcitonin	High levels of calcium in the blood	Bones	No known physiological role in humans. When the hormone is supplemented at doses higher than normally found in humans, it does have some pharmaceutical applications.
Parathyroid Gland (Located on the Posterior Aspect of the Thyroid Gland)			
Parathyroid hormone (PTH)	Low levels of calcium in the blood	Bones and kidneys	Increases blood calcium by stimulating osteoclasts and by stimulating the kidneys to reabsorb more calcium. PTH also stimulates the kidneys to convert vitamin D to calcitriol, which is required for the absorption of calcium in the intestines.

Table 27.3 Adrenal Gland Hormones

Cortical area	Hormone(s)	Stimulus for release	Target	Effects
Adrenal Cortex				
Zona glomerulosa	Mineralcorticoids: mostly aldosterone	Angiotensin II release and increased potassium in the blood (ACTH only in times of severe stress)	Kidneys	Increases the reabsorption of sodium and water by the kidney tubules. Increases the secretion of potassium in the urine.
Zona fasciculata	Glucocorticoids: mostly cortisol	ACTH	Most body cells	Promotes the breakdown of fat and protein, promotes stress resistance, and inhibits the immune response.
Zona reticularis	Gonadocorticoids: androgens (most are converted to testosterone and some to estrogen)	ACTH	Bone, muscle, integument, and other tissues	In females, androgens contribute to body growth, contribute to the development of pubic and axillary hair, and enhance sex drive. They have insignificant effects in males.
Cells	**Hormone(s)**	**Stimulus for release**	**Target**	**Effects**
Adrenal Medulla				
Chromaffin cells	Catecholamines: epinephrine and norepinephrine	Nerve impulses from preganglionic sympathetic fibers	Most body cells	Mimics sympathetic nervous system activation, "fight-or-flight response."

Table 27.4 Pancreas and Gonad Hormones

Hormone	Stimulus for release	Target(s)	Effects
Pancreas			
Insulin	Increased blood glucose levels, parasympathetic nervous system stimulation	Most cells of the body	Accelerates the transport of glucose into body cells; promotes glycogen, fat, and protein synthesis
Glucagon	Decreased blood glucose levels, sympathetic nervous system stimulation	Primarily the liver and adipose	Accelerates the breakdown of glycogen to glucose, stimulates the conversion of lactic acid into glucose, releases glucose into the blood from the liver
Ovaries (Female Gonads)			
Estrogens	Luteinizing hormone (LH) and follicle-stimulating hormone (FSH)	Most cells of the body	Promote the maturation of the female reproductive organs and the development of secondary sex characteristics
Estrogens and progesterone (together)	LH and FSH	Uterus and mammary glands	Regulate the menstrual cycle and promote breast development
Testes (Male Gonads)			
Testosterone	LH and FSH	Most cells of the body	Promotes the maturation of the male reproductive organs, the development of secondary sex characteristics, sperm production, and sex drive

The paired oval *testes* of the male are suspended in a pouchlike sac, the scrotum, outside the pelvic cavity. In addition to the male sex cells (sperm), the testes produce the male sex hormone, testosterone. Both the endocrine and exocrine functions of the testes begin at puberty. (For a more detailed discussion of the function and histology of the ovaries and testes, see Exercises 42 and 43.) Table 27.4 summarizes the hormones produced by the gonads.

Microscopic Anatomy of Selected Endocrine Glands

Activity 2

Examining the Microscopic Structure of Endocrine Glands

Obtain a microscope and one of each assigned slide. Compare your observations with the images (**Figure 27.3a–f**).

Thyroid Gland

1. Scan the thyroid under low power, noting the **follicles,** generally spherical sacs containing a pink-stained material *(colloid)*. Stored T_3 and T_4 are attached to the protein colloidal material stored in the follicles as **thyroglobulin** and are released gradually to the blood. Compare the tissue viewed to the photomicrograph of thyroid tissue (Figure 27.3a).

2. Observe the tissue under high power. Notice that the walls of the follicles are formed by simple cuboidal or squamous epithelial cells. The **parafollicular,** or **C, cells** you see between the follicles produce calcitonin.

When the thyroid gland is actively secreting, the follicles appear small. When the thyroid is hypoactive or inactive, the follicles are large and plump, and the follicular epithelium appears to be squamous.

Parathyroid Glands

Observe the parathyroid tissue under low power to view its two major cell types, the parathyroid cells and the oxyphil cells. Compare your observations to the photomicrograph of parathyroid tissue (Figure 27.3b). The **parathyroid cells,** which synthesize parathyroid hormone (PTH), are small and abundant. The function of the scattered, much larger **oxyphil cells** is unknown.

Pancreas

1. Observe pancreas tissue under low power to identify the roughly circular **pancreatic islets** (also called *islets of Langerhans*), the endocrine portions of the pancreas. The islets are scattered amid the more numerous **acinar cells** and stain differently (usually lighter), which makes it possible to identify them. The deeper-staining acinar cells form the major portion of the pancreatic tissue. Acinar cells produce the exocrine secretion of digestive enzymes. Alkaline fluid produced by duct cells accompanies the hydrolytic enzymes. (See Figure 27.3c.)

2. Focus on islet cells under high power. Notice that they are densely packed and have no definite arrangement (Figure 27.3c). In contrast, the cuboidal acinar cells are arranged around secretory ducts. In Figure 27.3c, it is possible to distinguish the **alpha (α) cells,** which stain darker and produce glucagon, from the **beta (β) cells,** which stain lighter and synthesize insulin. If differential staining is used, the beta cells are larger and stain gray-blue, and the alpha cells are smaller and appear bright pink.

Pituitary Gland

1. Observe the general structure of the pituitary gland under low power to differentiate the glandular anterior pituitary from the neural posterior pituitary.

2. Using the high-power lens, focus on the nests of cells of the anterior pituitary. When differential stains are used, it is possible to identify the specialized cell types that secrete the specific hormones. Using Figure 27.3d as a guide, locate the reddish pink–stained **acidophil cells,** which produce growth hormone and prolactin, and the **basophil cells,** stained blue to purple in color, which produce the tropic hormones (TSH, ACTH, FSH, and LH). **Chromophobe cells,** the third cellular population, do not take up the stain and appear colorless. The role of the chromophobe cells is controversial, but they apparently are not directly involved in hormone production.

3. Now focus on the posterior pituitary, where two hormones (oxytocin and ADH) synthesized by hypothalamic neurons are stored. Observe the nerve fibers of hypothalamic neurons. Also note the **pituicytes** (Figure 27.3e).

WHY THIS MATTERS | **Growth Hormone Uses and Abuses**

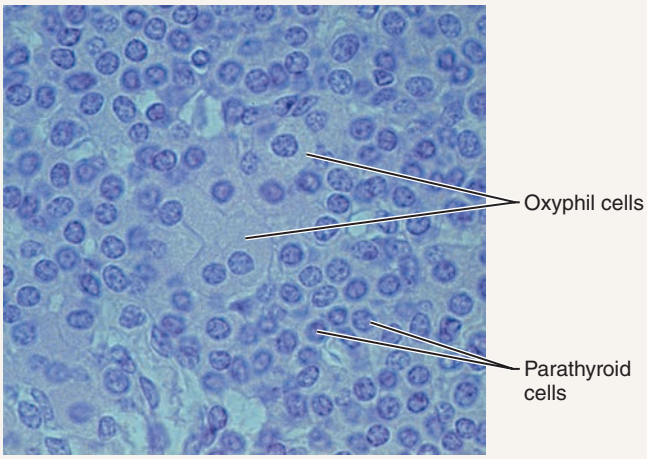
Growth hormone is an anabolic hormone that contributes to tissue building while mobilizing fat stores. Its primary targets include cartilage, bone, and muscle. Growth hormone was first approved by the U.S. Food and Drug Administration (FDA) for the treatment of children with growth disorders. Since then it has been approved to treat muscle-wasting disease associated with HIV/AIDS and a small number of other disorders. Ironically, growth hormone is more famous for its abuse than for its therapeutic applications. For example, athletes inject growth hormone to improve strength, speed, and endurance; actors use growth hormone as a chemical "fountain of youth" to smooth wrinkles and decrease body fat. ■

Adrenal Gland

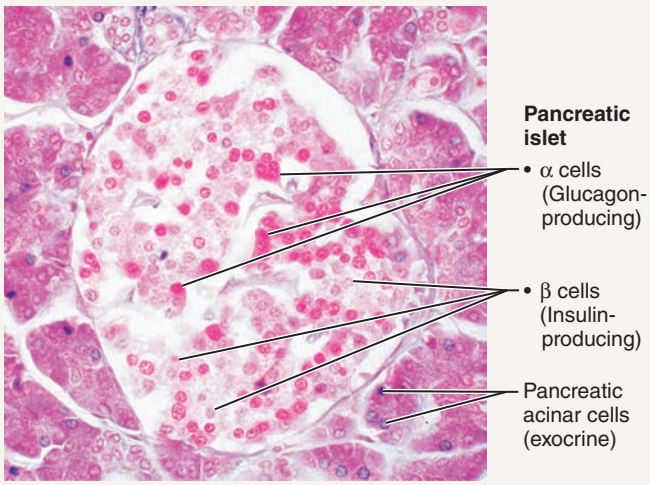
1. Hold the slide of the adrenal gland up to the light to distinguish the cortex and medulla areas. Then scan the cortex under low power to distinguish the differences in cell appearance and arrangement in the three cortical areas. Refer to Figure 27.3f as you work. In the outermost **zona glomerulosa,** where most mineralocorticoid production occurs, the cells are arranged in spherical clusters. The deeper intermediate **zona fasciculata** produces glucocorticoids. Its cells are arranged in parallel cords. The innermost cortical zone, the **zona reticularis** produces sex hormones and some glucocorticoids. The cells here stain intensely and form a branching network.

2. Switch to higher power to view the large, lightly stained cells of the adrenal medulla, which produce epinephrine and norepinephrine. Notice their clumped arrangement.

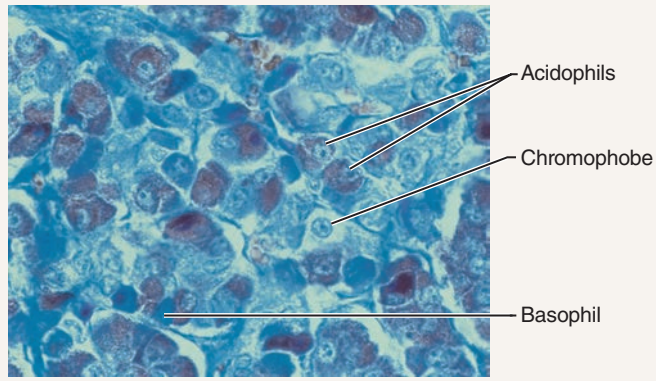
(a) Thyroid gland (360×)



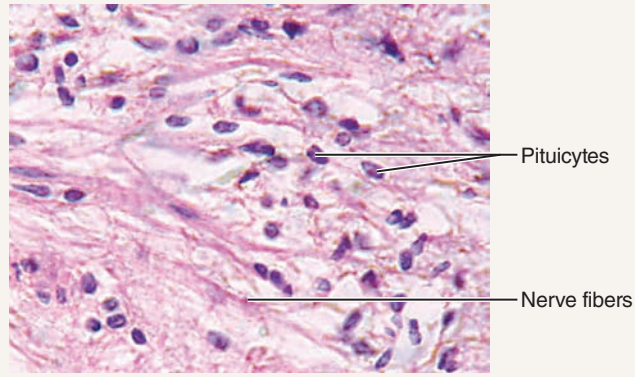
(b) Parathyroid gland (375×)



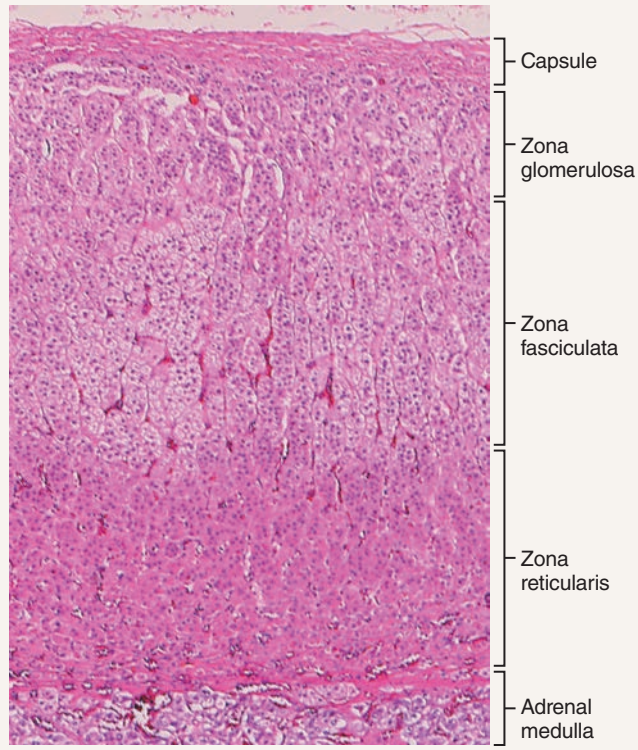
(c) Pancreatic islet (205×)



(d) Anterior pituitary (380×)



(e) Posterior pituitary (345×)



(f) Adrenal gland (60×)

Figure 27.3 Microscopic anatomy of selected endocrine organs.

Endocrine Disorders

Many endocrine disorders are a result of either hyposecretion (underproduction) or hypersecretion (overproduction) of a given hormone. The characteristics of select endocrine disorders are summarized in **Table 27.5**. As you read through the table, recall the targets for the hormones and the effects of normal secretion levels.

Table 27.5 Summary of Select Endocrine Homeostatic Imbalances

Hormone	Effects of hyposecretion	Effects of hypersecretion
Growth hormone	*In children:* **pituitary dwarfism,** which results in short stature with normal proportions	*In children:* **gigantism,** abnormally tall *In adults:* **acromegaly,** abnormally large bones of the face, feet, and hands
Antidiuretic hormone	**Diabetes insipidus,** a condition characterized by thirst and excessive urine output	**Syndrome of inappropriate ADH secretion,** a condition characterized by fluid retention, headache, and disorientation
Thyroid hormone	*In children:* **cretinism,** mental retardation with a disproportionately short-sized body *In adults:* **myxedema,** low metabolic rate, edema, physical and mental sluggishness	**Graves' disease,** elevated metabolic rate, sweating, irregular heart rate, weight loss, protrusion of the eyeballs, and nervousness
Parathyroid hormone	**Hypoparathyroidism,** neural excitability with tetany (muscle spasms) and convulsions	**Hyperparathyroidism,** loss of calcium from bones, causing deformation, and spontaneous fractures
Insulin	**Diabetes mellitus,** which results in an inability of cells to take up and utilize glucose and in loss of glucose in the urine (may be due to hyposecretion or hypoactivity of insulin)	**Hypoglycemia,** which results in low blood sugar and is characterized by anxiety, nervousness, tremors, and weakness

Group Challenge

Odd Hormone Out

Each box below contains four hormones. One of the listed hormones does not share a characteristic that the other three do. Work in groups of three, and discuss the characteristics of the four hormones in each group. On a separate piece of paper, one student will record the characteristics for each hormone for the group. For each set of four hormones, discuss the possible candidates for the "odd hormone" and which characteristic it lacks based upon your recorded notes. Once you have come to a consensus among your group, circle the hormone that doesn't belong with the others and explain why it is singled out. Sometimes there may be multiple reasons why the hormone doesn't belong with the others.

1. Which is the "odd hormone"?		**Why is it the odd one out?**
ACTH	oxytocin	
LH	FSH	
2. Which is the "odd hormone"?		**Why is it the odd one out?**
aldosterone	cortisol	
epinephrine	ADH	
3. Which is the "odd hormone"?		**Why is it the odd one out?**
PTH	testosterone	
LH	FSH	
4. Which is the "odd hormone"?		**Why is it the odd one out?**
insulin	cortisol	
calcitonin	glucagon	

EXERCISE 27

REVIEW SHEET

Functional Anatomy of the Endocrine Glands

Name _____ Lab Time/Date _____

Gross Anatomy and Basic Function of the Endocrine Glands

1. Both the endocrine and nervous systems are major regulating systems of the body; however, the nervous system has been compared to an airmail delivery system, and the endocrine system to the Pony Express. Briefly explain this comparison.

_____

_____

_____

2. Define *hormone.* _____

_____

3. Chemically, hormones belong chiefly to two molecular groups, the _____

and the _____.

4. Define *target cell.* _____

_____

5. If hormones travel in the bloodstream, why don't all tissues respond to all hormones? _____

_____

6. Identify the endocrine organ described by each of the following statements.

_____ 1. located in the throat; bilobed gland connected by an isthmus

_____ 2. found atop the kidney

_____ 3. a mixed gland, located behind the stomach and close to the small intestine

_____ 4. paired glands suspended in the scrotum

_____ 5. ride "horseback" on the thyroid gland

_____ 6. found in the pelvic cavity of the female, concerned with ova and female hormone production

_____ 7. found in the upper thorax overlying the heart; large during youth

_____ 8. found in the roof of the third ventricle of the brain

7. The table below lists the functions of many of the hormones you have studied. From the keys below, fill in the hormones responsible for each function, and the endocrine glands that produce each hormone. Glands may be used more than once.

Hormones Key:

ACTH	FSH	prolactin
ADH	glucagon	PTH
aldosterone	insulin	T_3/T_4
cortisol	LH	testosterone
epinephrine	oxytocin	TSH
estrogens	progesterone	

Glands Key:

adrenal cortex	parathyroid glands
adrenal medulla	posterior pituitary
anterior pituitary	testes
hypothalamus	thyroid gland
ovaries	
pancreas	

Function	Hormone(s)	Synthesizing Gland(s)
Regulate the function of another endocrine gland (tropic)	1.	
	2.	
	3.	
	4.	
Maintain salt and water balance in the extracellular fluid	1.	
	2.	
Directly involved in milk production and ejection	1.	
	2.	
Controls the rate of body metabolism and cellular oxidation	1.	
Regulates blood calcium levels	1.	
Regulate blood glucose levels; produced by the same "mixed" gland	1.	
	2.	
Released in response to stressors	1.	
	2.	
Drive development of secondary sex characteristics in males	1.	
Directly responsible for regulation of the menstrual cycle	1.	
	2.	

8. Although the pituitary gland is sometimes referred to as the master gland of the body, the hypothalamus exerts control over the pituitary gland. How does the hypothalamus control both anterior and posterior pituitary functioning?

_____

_____

9. Indicate whether the release of the hormones listed below is stimulated by (A) another hormone; (B) the nervous system (neurotransmitters, or neurosecretions); or (C) humoral factors (the concentration of specific nonhormonal substances in the blood or extracellular fluid).

_____ 1. ACTH
_____ 2. calcitonin
_____ 3. estrogens
_____ 4. insulin
_____ 5. norepinephrine
_____ 6. parathyroid hormone
_____ 7. T_4/T_3
_____ 8. testosterone
_____ 9. TSH, FSH

10. Name the hormone(s) produced in *inadequate* amounts that directly result in the following conditions.

_____ 1. tetany
_____ 2. excessive urine output without high blood glucose levels
_____ 3. loss of glucose in the urine
_____ 4. abnormally small stature, normal proportions
_____ 5. low BMR, mental and physical sluggishness

11. Name the hormone(s) produced in *excessive* amounts that directly result in the following conditions.

_____ 1. large hands and feet in the adult, large facial bones
_____ 2. nervousness, irregular pulse rate, sweating
_____ 3. demineralization of bones, spontaneous fractures

Microscopic Anatomy of Selected Endocrine Glands

12. Choose a response from the key below to name the hormone(s) produced by the cell types listed.

Key: a. calcitonin
b. GH, prolactin
c. glucagon
d. glucocorticoids
e. insulin
f. mineralocorticoids
g. PTH
h. T_4/T_3
i. TSH, ACTH, FSH, LH

_____ 1. parafollicular cells of the thyroid
_____ 2. follicular cells of the thyroid
_____ 3. beta cells of the pancreatic islets
_____ 4. alpha cells of the pancreatic islets
_____ 5. basophil cells of the anterior pituitary
_____ 6. zona fasciculata cells
_____ 7. zona glomerulosa cells
_____ 8. parathyroid cells
_____ 9. acidophil cells of the anterior pituitary

WHY THIS MATTERS

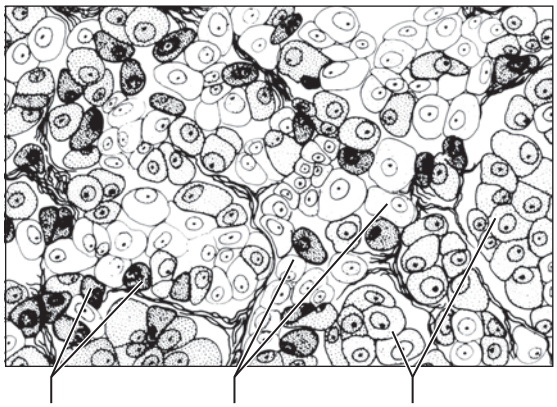
13. Explain why growth hormone is an anabolic hormone. _____

_____

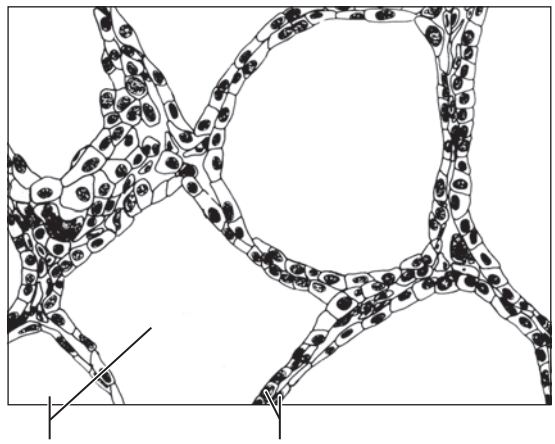
14. Considering the primary target organs of growth hormone, explain why growth hormone is not a tropic hormone. _____

_____

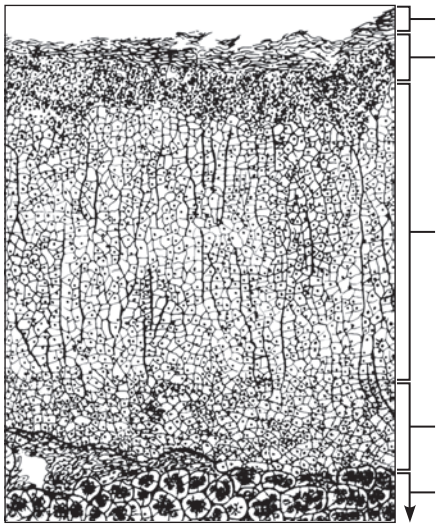
15. Six diagrams of the microscopic structures of the endocrine glands are presented here. Identify each and *name all structures indicated by a leader line or bracket*.



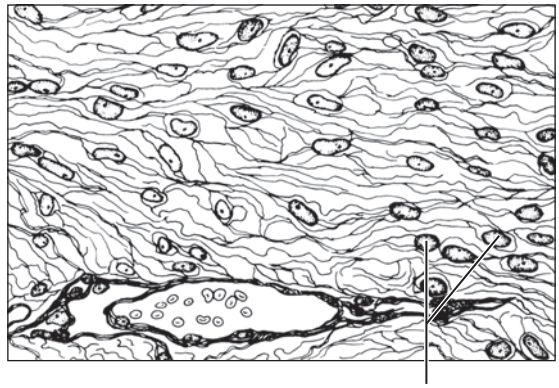
(a) _____



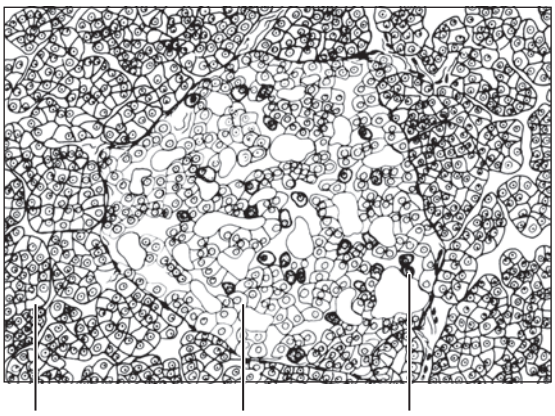
(d) _____



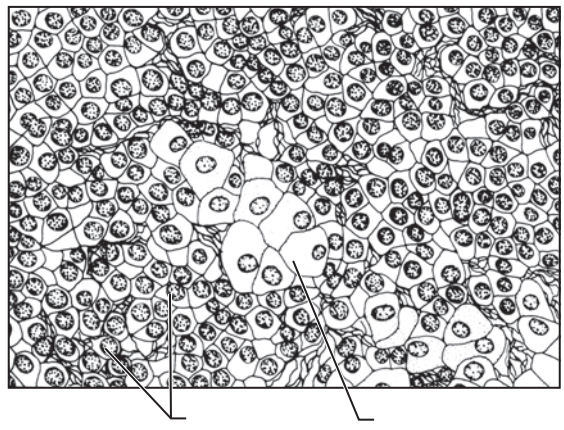
(b) _____



(e) _____



(c) _____



(f) _____