CHAPTER 12

QUICK CHECK

Page 311
1. Hormones are the chemical messengers of the endocrine system.
2. Nonsteroid hormones are whole proteins, shorter chains of amino acids, or simply versions of single amino acids. They work according to the second-messenger mechanism. The primary actions of small, lipid-soluble steroid hormones do not occur by the second-messenger mechanism. They pass directly intact through the cell membrane of the target organ cell.
3. A protein hormone acts as a “first messenger” (that is, it delivers its chemical message from the cells of an endocrine gland to highly specific membrane receptor sites on the cells of a target organ). After the hormone is attached to a specific receptor site (like a lock and key), a number of chemical reactions occur. These reactions activate molecules within the cell called second messengers, providing communication within a hormone’s target cells.

Page 316
1. The hormone insulin can be used to illustrate the affect of negative feedback on hormone levels in the blood. When released from endocrine cells in the pancreas, insulin lowers blood sugar levels. Elevated levels of blood sugar stimulate the release of insulin from the pancreas. Insulin causes the blood sugar levels to drop. Low blood sugar levels then cause the endocrine cells in the pancreas to cease the production and release of insulin.
2. If the usual target cells of a particular hormone have damaged receptors, too few receptors, or some other abnormality, they will not respond to that hormone properly. In other words, lack of target cell response could be a sign of hyposcretion or a sign of target cell insensitivity.
3. Surgical or chemical treatment of tumors or damaged tissue is useful in some cases. Another common strategy is the use of pharmacological preparations of hormones.
4. Prostaglandins are called tissue hormones because in many instances a prostaglandin is produced in a tissue and then diffuses only a short distance to act on cells within that tissue.

Page 318
1. The anterior pituitary has the structure of an endocrine gland, whereas the posterior pituitary has the structure of nervous tissue. Both the anterior and posterior pituitary secrete hormones. The anterior pituitary gland secretes several major hormones (TSH, ACTH, FSH, LH, GH, and prolactin). The posterior pituitary gland releases two hormones (ADH and oxytocin).
2. A tropic hormone stimulates another endocrine gland to grow and secrete its hormones.
3. A prolactinoma can cause changes in reproductive function, including breast tenderness or enlargement, abnormal milk production, infertility, and loss of sexual interest or function.
4. Actual production of releasing hormones occurs in the hypothalamus. Two groups of specialized neurons in the hypothalamus synthesize the posterior pituitary hormones, which then pass down along axons into the pituitary gland.

Page 321
1. The thyroid gland lies in the neck just below the larynx. The parathyroid glands are found on the back of the thyroid gland.
2. Thyroid gland
3. A goiter develops from low dietary intake of iodine. A goiter is produced when the thyroid gland enlarges in an attempt to compensate for a lack of iodine in the diet necessary for the synthesis of thyroid hormones.
4. Calcium
Quick Check and Active Learning
Answer Keys

Page 324
1. Although the adrenal gland appears as one organ, it is actually two separate endocrine glands (adrenal cortex and adrenal medulla).
2. Aldosterone, cortisol, sex hormones, epinephrine and norepinephrine
3. In stress conditions, the hypothalamus acts on the anterior pituitary gland to cause the release of ACTH, which stimulates the adrenal cortex to secrete glucocorticoids.
4. Cortisol

Page 327
1. Glucagon and insulin
2. Insulin decreases blood sugar level.
3. In type I diabetes, the pancreatic islets secrete too little insulin. Consequently, less glucose leaves the blood to enter the cells, so the blood glucose increases, sometimes to even three or more times the normal amount. Most cases of type II diabetes result from an abnormality of the insulin receptors or their signaling mechanism, preventing the normal effects of insulin on its target cells and thus raising blood glucose levels.

Page 328
1. The male sex glands produce testosterone. The female sex glands produce estrogen and progesterone.
2. The placenta is considered a gland because it produces chorionic gonadotropins.
3. 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 cyclic variation is thought to be an important timekeeping mechanism for the body’s internal clock and sleep cycle.

ACTIVE LEARNING

Review Questions
1. Endocrine glands are ductless glands that secrete their products into intercellular spaces where they diffuse into the blood and are carried throughout the body. Exocrine glands are glands that secrete their products into ducts that empty on a body surface or in a body cavity.
2. A hormone is a substance that is secreted by an endocrine gland and is carried throughout the body by the blood. A target organ is an organ that is able to respond to a specific hormone. When an endocrine gland produces too much of a hormone, it is called hypersecretion. When an endocrine gland produces too little of a hormone, it is called hyposecretion.
3. The most widely accepted theory of nonsteroid protein hormone action is the second messenger hypothesis. According to this concept, the nonsteroid protein hormone acts as a first messenger. The receptor for this hormone is on the cell membrane of the target cell. After the hormone is attached to its specific receptor, a number of chemical reactions occur. These reactions activate molecules within the cell called second messengers. An example of this occurs when the hormone-receptor interaction changes ATP molecules in the cell to cyclic AMP. Cyclic AMP serves as a second messenger, delivering information inside the cell that regulates the cell’s activity.
4. Steroid hormones can pass intact directly through the cell membrane of the target cell. Once inside the cell, steroid hormones pass through the cytoplasm and enter the nucleus where they bind with a receptor to form a hormone-receptor complex. This complex acts on the DNA that ultimately causes the formation of a new protein in the cytoplasm that then produces the specific effect of that hormone in the target cell.
5. A negative feedback loop is a mechanism that returns the body to a homeostatic set point. It is called negative because it reverses the movement of some regulated substance away from the homeostatic set point and moves it back toward the set point. An example would be the regulation of the blood
6. A positive feedback loop is a mechanism that amplifies the movement away from a homeostatic set point rather than back toward it. An example would be during labor, the muscle contraction that pushes the baby through the birth canal becomes stronger and stronger by means of a positive feedback loop that regulates the secretion of the hormone oxytocin.

7. Prostaglandins are also called tissue hormones because they frequently are produced in a tissue and diffuse only a short distance, acting on cells within that tissue. Typical hormones influence and control activities of widely separated organs. Prostaglandins can influence respiration, blood pressure, gastrointestinal secretions, and the reproductive system.

8. The pituitary gland is a small structure that is really two endocrine glands. One is called the anterior pituitary gland or the adenohypophysis. The other is called the posterior pituitary gland or neurohypophysis. Adeno- means “gland” and the adenohypophysis has the structure of an endocrine gland. Neuro- means “nervous” and the neurohypophysis has the structure of nervous tissue. The pituitary gland lies deep in the cranial cavity in the small depression in the sphenoid bone called the sella turcica (Turkish saddle). A stem-like structure, the pituitary stalk, attaches the gland to the hypothalamus.

9. The four tropic hormones are as follows.
   1. Thyroid stimulating hormone (TSH) stimulates the secretion of thyroid hormones.
   2. Adrenocorticotropic hormone (ACTH) stimulates the secretion of adrenal cortex hormones.
   3. Follicle stimulating hormone (FSH) stimulates the development of ovarian follicles and the secretion of estrogen in females. In males, it stimulates seminiferous tubules of the testes to grow and produce sperm.
   4. Luteinizing hormone (LH) stimulates maturation of the ovarian follicle and the ovum in females. It also stimulates secretion of estrogen, triggers ovulation, and stimulates the development of the corpus luteum. In males, it stimulates interstitial cells of the testes to secrete testosterone.

10. Growth hormone stimulates growth in all organs and mobilizes food molecules, causing an increase in blood glucose concentration.

11. The cause of both gigantism and acromegaly is the hypersecretion of growth hormone. If it occurs in the early years of life while growth is still occurring, the result is gigantism. If it occurs later in life when normal growth has stopped, the result is acromegaly.

12. ADH (or antidiuretic hormone) accelerates the reabsorption of water from urine in the kidney tubules back into the blood. This conserves the body’s water supply.

13. Diabetes insipidus is the result of a hyposecretion of ADH. This results in large volumes of dilute urine being formed, causing dehydration and electrolyte imbalance.

14. Prolactin stimulates breast development during pregnancy and milk secretion (milk let-down) after pregnancy. Oxytocin stimulates uterine contraction at the end of pregnancy. It is thought to initiate and maintain labor and stimulates the release of milk into the breast ducts.

15. The hypothalamus produces ADH and oxytocin. These hormones pass down along axons into the posterior pituitary gland where they are released. Release of ADH and oxytocin into the blood is controlled by nervous stimulation. The hypothalamus also produces substances called releasing and inhibiting hormones. These hormones are produced in the hypothalamus and travel directly through a specialized blood capillary system to the anterior pituitary gland, causing or inhibiting the release of hormones into the general circulation.

16. Both T₃ and T₄ are produced by the thyroid gland. T₄ is the more abundant and contains four atoms of iodine. T₃ is the more potent and contains three atoms of iodine. The thyroid gland is unique in that most endocrine glands do not store the hormones they release; the thyroid gland does store a considerable amount of the hormones it releases.

17. Calcitonin decreases the concentration of calcium in the blood by first acting on bone to inhibit its breakdown. An increase in calcitonin secretion causes blood calcium concentration to decrease to its normal level. Parathyroid hormone (PTH) increases the concentration of calcium in the blood. PTH
stimulates bone-resorption cells to increase their breakdown of the bone’s hard matrix. The released calcium then moves out of the bone into blood, thus increasing the blood’s calcium level.

18. Both cretinism and myxedema are caused by a hyposecretion of thyroid hormones. If the hyposecretion occurs during the formative years, it results in cretinism, which is characterized by a low metabolic rate, retarded growth and sexual development, and mental retardation. If the hyposecretion occurs later in life, it results in myxedema, which is characterized by a low metabolic rate, lessened mental and physical vigor, weight gain, loss of hair, and an accumulation of fluid that is most noticeable around the eyes.

19. The outer zone of the adrenal cortex secretes hormones called mineralocorticoids; the main mineralocorticoid is the hormone aldosterone. The middle zone of the adrenal cortex secretes glucocorticoids; the main glucocorticoid is cortisol. The innermost zone of the adrenal cortex secretes small amounts of sex hormones that resemble testosterone.

20. The most noticeable features of Cushing syndrome are the so-called moon face and buffalo hump on the upper back. These develop because of the redistribution of body fat. People with this syndrome also have elevated blood sugar levels and suffer frequent infections. Addison disease is characterized by muscle weakness, reduced blood sugar levels, nausea, loss of appetite, and weight loss.

21. Aldosterone regulates electrolyte and fluid homeostasis.

22. Glucocorticoids stimulate gluconeogenesis, causing an increase in blood glucose concentration. They also have antiinflammatory, antiimmunity, and antiallergy effects.

Critical Thinking

23. Nonsteroid protein hormones are unable to enter the cell; therefore, they must use a secondary messenger to affect the activity inside the cell. Because steroid hormones are able to enter the cell, a secondary messenger is not necessary.

24. The balance of blood calcium levels is significant because our cells are extremely sensitive to changing amounts of blood calcium. They cannot function normally with either too much or too little calcium. For example, with too much blood calcium, brain cells and heart cells do not function normally; a person becomes mentally disturbed and the heart may stop altogether. However, with too little blood calcium, nerve cells become overactive, sometimes causing the muscles to go into spasms.

25. The cause of goiter is the inability of the thyroid gland to make thyroid hormone because of a lack of iodine. If dietary iodine is supplied, the goiter is reduced. There is no functional problem associated with the thyroid gland in a simple goiter.

26. The pituitary gland is functioning correctly in responding to the low level of thyroid hormone by the release of TSH. The thyroid is not functioning properly because it is not responding to the high levels of TSH in the blood by producing more thyroid hormone.

27. If there were too few insulin receptors in the cells or the receptors in the cells were damaged in some way, the cells would be unable to respond to a normal level of insulin. The blood glucose level would be high, but the pancreas would be producing a normal level of insulin and the person would be diagnosed with diabetes mellitus.

Chapter Test

1. Exocrine
2. Endocrine, hormones
3. nonsteroid, steroid
4. target cell or target organ
5. cyclic AMP (cAMP)
6. cell membrane, nucleus
7. prostaglandins
8. Posterior pituitary (neurohypophysis)
9. Anterior pituitary (adenohypophysis)
10. posterior pituitary, hypothalamus
11. d. all of the above
12. b. accelerates water reabsorption in the kidney
13. c. Prolactin
14. b. Oxytocin
15. c. Prolactinoma
16. d. Glycogenolysis
Quick Check and Active Learning

Answer Keys

17. d. has the opposite effect of calcitonin
18. f. made in the outermost layer of the adrenal cortex
19. i. made by the middle layer of the adrenal cortex
20. a. released by the adrenal medulla; prolongs the effect of the sympathetic nervous system
21. e. made by the alpha cells in the pancreatic islets
22. c. made in the pancreatic islets; decreases blood glucose levels
23. h. the hormone made in the placenta and detected by home pregnancy tests
24. g. the most significant hormone released by the pineal gland
25. b. made in the heart; helps regulate blood sodium
26. g. hypersecretion of growth hormone in the early years of life
27. d. hypersecretion of growth hormone after the normal growth years
28. j. hyposcretion of ADH, causing the production of a large volume of urine
29. a. an inherited hyperthyroidism with exophthalmos
30. b. hyposcretion of thyroid hormone in later life leading to lessened physical and mental vigor
31. e. an enlarged thyroid gland as a result of dietary deficiency of iodine
32. h. hyposcretion of thyroid hormone in the formative years resulting in physical, mental, and sexual retardation
33. f. a condition caused by a hypersecretion of glucocorticoids
34. c. hyposcretion of insulin causing an increased blood glucose level
35. i. a condition caused by high secretions of melatonin, causing depression in winter

Case Studies

1. George’s excessive level of activity and his abnormal heart rhythm (atrial fibrillation) are common characteristics of hyperthyroidism. Hypersecretion of thyroid hormone (T3 and T4) causes a general increase in the metabolism of all cells and therefore increases activity in all organs. The heart is no exception, so many sufferers of hyperthyroidism experience heart problems, such as atrial fibrillation. George’s physicians will probably recommend surgical removal or destruction (via radiation) of some of the thyroid tissue in an attempt to reduce thyroid hormone secretion to normal levels.

2. George’s surgeons will, as in any surgical procedure, be careful to avoid unnecessary injury to local blood vessels, nerves, and other tissues. Not only must George’s surgeons be careful to avoid damaging George’s trachea and larynx, they will probably be careful to avoid damaging or removing his parathyroid glands. As you know, these glands are necessary because they produce parathyroid hormone (PTH), which is essential to the vital calcium balance of the body.

3. Lynn’s condition, type I diabetes mellitus, is caused by a reduction of insulin secretion by the pancreatic islets as described in the text. This fact suggests the most common form of treatment, which is insulin therapy. Usually, several small doses of insulin are injected into a person’s body each day. There are a number of additional measures, such as diet control and exercise, that often supplement insulin therapy. Tissue grafts and other new methods of treatment are also being explored. Type I DM results from hyposcretion of insulin; the hormone that allows glucose to enter cells. The hyperglycemia associated with diabetes results from accumulation of nutrients (glucose) that would otherwise have entered the cells for catabolism. Thus, without sufficient insulin, the excess glucose is not available for cell use and the body’s cells literally “starve in the midst of plenty.”