

6

The Endocrine System: Endocrine Glands and Hormone Actions

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Objectives

- Name the primary and secondary endocrine glands, and the hormones associated with each.
- Describe the links of the hypothalamus with the anterior and posterior pituitary lobes.
- Describe the role of tropic hormones in regulating the release of other hormones. Include feedback loops in your description.
- Describe the types of interactions between hormones acting on the same target cell, including additive, synergistic, and permissive interactions.

Key Terms

additive	hypothalamic-pituitary portal system	pituitary gland—posterior lobe
adrenal cortex	hypothalamus	primary endocrine organ
adrenal gland	mineralocorticoid	secondary endocrine organ
adrenal medulla	pancreas	sex hormone
adrenocorticoid	parathyroid gland	synergistic
antagonism	permissiveness	thymus
circadian rhythm	pineal gland	thyroid gland
endocrine gland	pituitary gland—anterior lobe	tropic hormone
glucocorticoid		

Overview

The endocrine system provides the long distance communication required by the body to integrate a number of organ systems to maintain homeostasis. The endocrine system is said to be “slow” because endocrine organs must release hormones through the interstitial space and into the bloodstream and these hormones travel a distance before binding to a receptor and eliciting an effect on the target tissue.

The hypothalamus and the pituitary gland are considered “the quarterback” of the endocrine system because these linked structures (via the hypothalamic portal system) are concurrently involved in most endocrine functions in the body. The pituitary gland is a primary endocrine organ that releases many tropic hormones (hormones that cause the release of other primary or secondary endocrine organs). Many hormone pathways are tightly regulated by a variety of methods including negative feedback, antagonism, addition, synergism, and permissiveness. Even with these regulatory controls, problems arise in maintaining hormone levels, as evidenced by the number of metabolic diseases related to abnormal hormone levels such as hyperthyroidism, insulin dependent diabetes, and Cushing’s disease. The complexity of the endocrine is also exemplified by Bill and Jane running a marathon and by the integrated nature of many systems required to complete that feat.

PRIMARY AND SECONDARY ENDOCRINE ORGANS

Completion

- For long distance communication the slow **(a)** system releases hormones from endocrine organs, also referred to as **(b)**. The two types of endocrine organs are **(c)** which secrete hormones and **(d)** which secrete hormones in addition to another function. Some **(e)** are in the **(e)** whereas others are in the body. The **(f)** and the **(g)** are believed to have an endocrine role in most systems in the body.

a. _____

e. _____

b. _____

f. _____

c. _____

g. _____

d. _____

Matching

- Match each hormone in the following list to its primary function: corticotropin releasing hormone (CRH), melatonin (M), T_3 and T_4 (T_3 and T_4), insulin (I), oxytocin (O), thyroid stimulating hormone (TSH), and epinephrine (E).

a. _____ lowers blood glucose levels

b. _____ stimulates the “fight-or-flight” response

c. _____ regulates circadian rhythms

d. _____ stimulates the release of ACTH

e. _____ stimulates uterine contractions

f. _____ increase basal metabolic rate

g. _____ stimulates the secretion of thyroid hormones

Labeling

3. Label the primary and secondary endocrine organs on Figure. 6.1

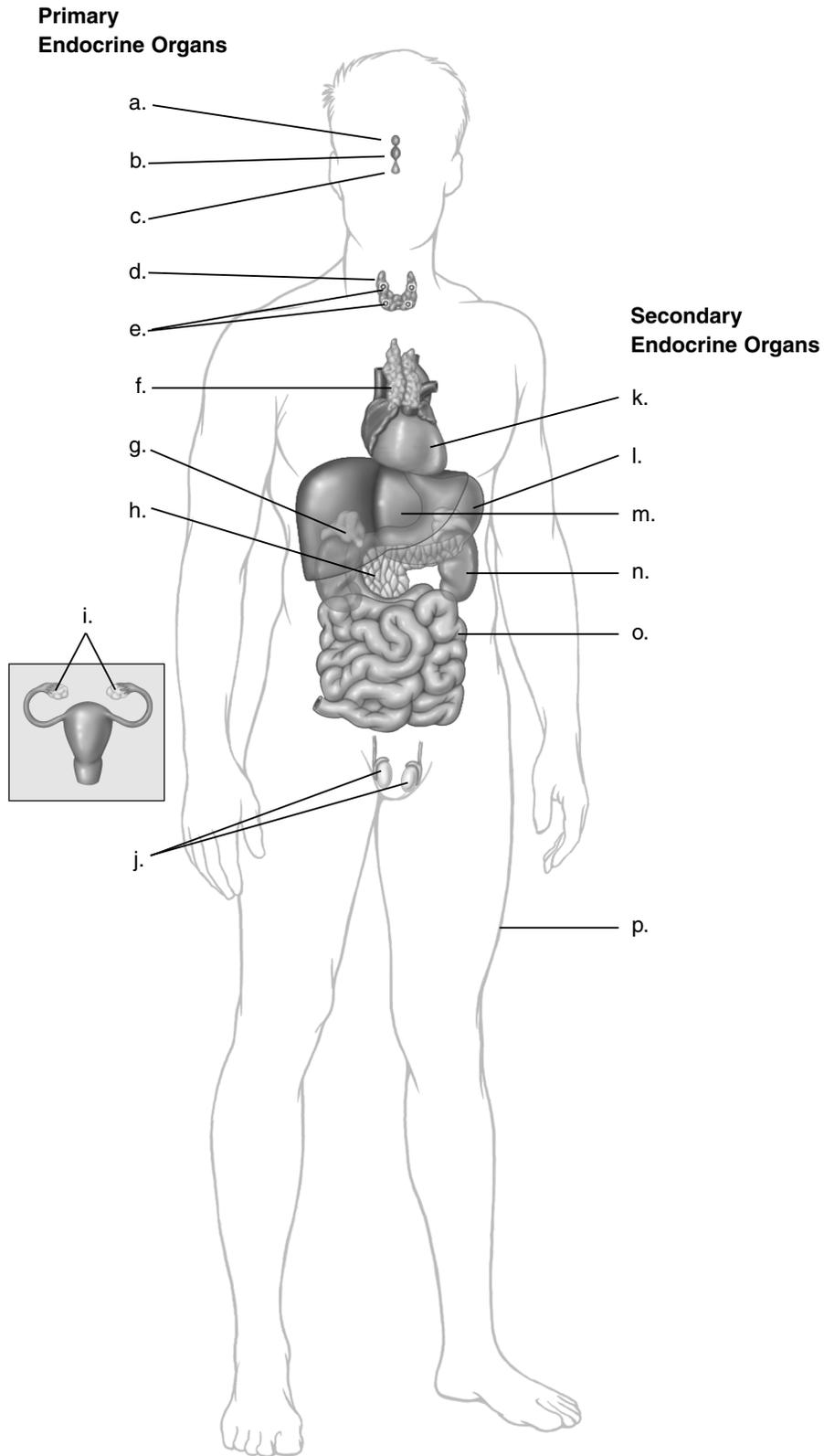


FIGURE 6.1

True/False

Label the following statements as true (T) or false (F). If false, change the statement to make it true.

4. _____ Epinephrine is secreted by the posterior pituitary gland.
5. _____ Follicle stimulating hormone (FSH) is secreted by the ovaries.
6. _____ Calcitonin is secreted by the thyroid gland.
7. _____ Antidiuretic hormone (ADH) is secreted by the hypothalamus.
8. _____ Glucagon is secreted by the adrenal cortex.
9. _____ Most of the hypothalamic and anterior pituitary hormones are peptides.
10. _____ The inhibition of a hypothalamic tropic hormone by the anterior pituitary hormone whose secretion it stimulates is called long loop negative feedback.
11. _____ Mineralocorticoids are produced by cells in the zona glomerulosa of the adrenal cortex.

Multiple Choice

Select the best answer from the choices given.

12. Which of the following primary endocrine organs would be considered structurally and functionally separate glands?
 - a. adrenal glands and the kidneys
 - b. anterior and posterior pituitary glands
 - c. adrenal cortex and adrenal medulla
 - d. individual parathyroid glands
 - e. a and b
 - f. b and c
13. The hypothalamic-pituitary portal system is a system of _____ that interconnects the _____.
 - a. neurosecretory cells : hypothalamus and anterior pituitary gland
 - b. neurosecretory cells : hypothalamus and posterior pituitary gland
 - c. capillaries : hypothalamus and anterior pituitary gland
 - d. capillaries : hypothalamus and posterior pituitary gland
 - e. capillaries : anterior and posterior pituitary glands
14. A tropic hormone is _____.
 - a. a hormone found only in people who live in warm climates
 - b. a hormone that acts only on the hypothalamus
 - c. the last hormone secreted in a pathway
 - d. a hormone that regulates the secretion of other hormones
 - e. a hormone secreted by the gonads
15. Which of the following hormones is released in direct response to thyrotropin releasing hormone?
 - a. thyroid stimulating hormone
 - b. thyroid hormone
 - c. parathyroid hormone
 - d. calcium
 - e. luteinizing hormone

16. Posterior pituitary gland hormones _____.
- are synthesized by the anterior pituitary gland and transported to the posterior pituitary gland through portal capillaries
 - are synthesized by neurons within the hypothalamus and travel within secretory vesicles to the neural endings in the posterior pituitary gland
 - are synthesized by neurons within the hypothalamus and travel to the posterior pituitary through a portal capillary system
 - are synthesized by cells within the posterior pituitary gland
 - are synthesized by endocrine cells within the hypothalamus and transported to the posterior pituitary through a portal capillary system
17. Hormones are secreted _____.
- directly onto an external or internal surface of the body
 - directly into the blood
 - directly into the interstitial fluid from which they diffuse into the blood
 - directly onto cellular receptors
 - only by primary endocrine glands
18. Which of the following cell types of the pancreas secretes insulin?
- alpha cells
 - beta cells
 - delta cells
 - somatostatin cells
 - somatomedin cells
19. Which of the following statements is true regarding secondary endocrine organs?
- Their primary purpose is to secrete hormones.
 - In addition to their primary purpose, they also secrete hormones.
 - They secrete only tropic hormones.
 - They secrete only androgens and estrogens.
 - They are present only after puberty.
20. Which of the following hormones is secreted by the kidneys?
- atrial natriuretic peptide
 - gastrin
 - somatomedins
 - secretin
 - erythropoietin

Sequencing

21. List the following in the order in which they occur in a stimulatory tropic hormone pathway.
- Hypothalamic tropic hormone travels through the portal vein in the infundibulum.
 - Anterior pituitary hormone causes a hormone to be released from another endocrine gland.
 - Hypothalamic hormone is secreted into capillaries within the hypothalamus.
 - Hypothalamic hormone enters capillary bed in the anterior pituitary gland.
 - Anterior pituitary hormone is secreted into the blood.

Sequence: _____

Completion

22. Complete the following table, listing the hormones secreted by the anterior and posterior pituitary glands, the hypothalamic tropic hormones that affect the release of anterior pituitary hormones, whether the effect of the tropic hormone is stimulatory or inhibitory, and the type of stimulus that causes the release of posterior pituitary hormones. Put an * by the anterior pituitary hormones that are tropic hormones.

Anterior Pituitary Hormone	Hypothalamic Tropic Hormone(s)	Stimulatory (+) or Inhibitory (-) Effect
Posterior Pituitary Hormone	Release Stimulus	

Challenge Questions

23. Why do hypothalamic tropic hormones have a greater effect than anterior pituitary tropic hormones?
24. Under what circumstances would the placenta be considered an endocrine gland, and why?

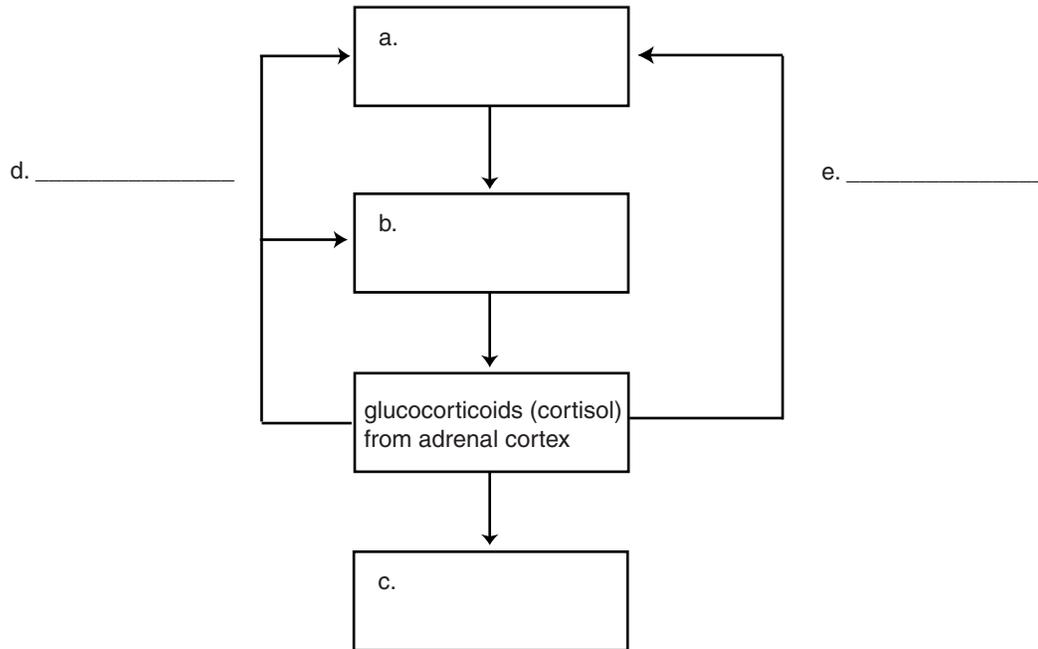
25. List all the hormones that come from primary or secondary endocrine organs that influence blood glucose levels, and those that influence blood calcium levels.

Clinical Questions

26. What symptoms would you expect to see in a child with an anterior pituitary lobe tumor resulting in the oversecretion of growth hormone?
27. A friend of yours has been diagnosed as having a tumor in the infundibulum, which is blocking the neuronal pathway between the hypothalamus and pituitary gland but is not affecting the hypothalamic-pituitary portal system. The release of what hormone or hormones will be adversely affected by this situation, and what types of symptoms might your friend experience?
28. What clinical symptoms might you expect to see in a person experiencing hypothyroidism (lower than normal secretion of thyroid hormones)?

Concept Map

29. Fill in the blanks in the following concept map depicting the mechanism by which glucocorticoid secretion is regulated. Use a (+) to indicate steps that are stimulatory and a (–) to indicate steps that are inhibitory. In the boxes, indicate the hormone released and the gland from which it comes. In the final box of the pathway, indicate the target cell responses. Also label the arrows indicating short loop and long loop negative feedback.



HORMONE ACTIONS AT THE TARGET CELL

Multiple Choice

Select the best answer from the choices given.

30. Which of the following influence the magnitude of a target cell's response to a hormone?
- concentration of free hormone in the blood
 - types of receptors on the target cell
 - whether or not the hormone is a second messenger
 - a and b
 - b and c
31. The concentration of free hormone in the blood depends on which of the following?
- rate of hormone secretion
 - rate at which the hormone is metabolized
 - the rate of anaerobic ATP synthesis within the cells
 - the number of cells in the body with active sodium-potassium pumps
 - the amount of hormone transported bound to carrier proteins
- a. 1,2,3,4,5 c. 1,2,5 e. 2,4,5
 b. 1,3,5 d. 3,4,5

32. Neural signals directly regulate hormone secretion by the _____.
- hypothalamus, anterior pituitary gland, and adrenal cortex
 - anterior pituitary, posterior pituitary, and adrenal cortex
 - hypothalamus, anterior pituitary, and adrenal medulla
 - hypothalamus, posterior pituitary, and adrenal medulla
 - anterior pituitary, posterior pituitary, and adrenal medulla
33. Humoral signals that regulate hormone secretion include _____.
- ions, prostaglandins, and metabolites
 - prostaglandins, metabolites, and minerals
 - ions, vitamins, and minerals
 - vitamins, metabolites, and minerals
 - ions, hormones, and metabolites
34. The hormones transported in the blood bound to carrier molecules are _____.
- epinephrine and norepinephrine
 - steroid and thyroid hormones
 - ACTH and prolactin
 - oxytocin and ADH
 - peptide hormones and catecholamines
35. Which of the following is **not** true of hormone metabolism?
- Hormones that bind to receptors on target cells are often metabolized by the target cell itself.
 - Hormones bound to membrane receptors can be internalized and degraded by lysosomal enzymes.
 - Hormones can be metabolized by enzymes in the liver.
 - Hormones are usually metabolized by enzymes in the kidneys.
 - Hormones can be metabolized by enzymes in the blood.
36. The release of which of the following hormones is not directly affected by circadian rhythms?
- growth hormone releasing hormone
 - corticotropin releasing hormone
 - antidiuretic hormone
 - ACTH
 - prolactin

True/False

Label the following statements as true (T) or false (F). If false, change the statement to make it true.

37. _____ Hormones secreted at a relatively steady rate facilitate normal cellular processes, rather than “triggering” a target cell response.
38. _____ Many hormones are secreted according to a circadian rhythm.
39. _____ When hormones are transported in the blood bound to carrier proteins, the hormone binds to the receptor only while it is bound to the carrier protein.

40. _____ Steroids and thyroid hormones have a longer biological half-life than peptides and amines.
41. _____ A single hormone may have receptors on different types of cells.

Completion

Fill in the blanks to complete the following narrative.

42. **(a)** levels of **(b)** ions in the blood stimulate cells in the adrenal **(c)** to secrete aldosterone. Aldosterone stimulates the **(d)** to secrete potassium ions which lowers the **(e)** level of potassium.

a. _____

d. _____

b. _____

e. _____

c. _____

Challenge Question

43. Why can plasma levels of steroid and thyroid hormones remain elevated even when the rate of secretion of these hormones is at its normal resting level?

A Question About Bill and Jane

44. Prior to the marathon, Bill drank plenty of coffee and also had a big breakfast filled with carbohydrates. With regard to the endocrine hormones discussed in this chapter, what effect does Bill's pre-race meal have on his hormonal status during the race?

ABNORMAL SECRETION OF HORMONES AND HORMONE INTERACTIONS

Completion

45. Endocrine cells alter hormone secretion in response to neural signals and **(a)**. The rate of hormone secretion can be variable, as for melatonin, involved in the regulation of **(b)**. For other hormones, the rate of secretion is more constant as for **(c)**, which is necessary for the maintenance of normal metabolism and nervous system function in adults. The transport of hormones can alter their effect, for example, the presence of **(d)** can enhance the half-life of hormones. Most hormones are metabolized by enzymes in the **(e)**.

- a. _____ d. _____
b. _____ e. _____
c. _____

Multiple Choice

46. Acromegaly is an example of _____ by _____.
a. hyposecretion : growth hormone d. hypersecretion : thyroid hormone
b. hypersecretion : growth hormone e. hyposecretion : insulin
c. hyposecretion : thyroid hormone
47. In primary hypersecretion of thyroid hormone _____.
a. blood levels of tropic hormones are normal
b. blood levels of tropic hormones are higher than normal due to positive feedback
c. blood levels of tropic hormones are lower than normal due to negative feedback
d. blood levels of thyroid hormones are normal
e. blood levels of thyroid hormones are lower than normal due to negative feedback
48. In secondary hypersecretion of thyroid hormone _____.
a. blood levels of tropic hormones are normal
b. blood levels of tropic hormones are higher than normal due to positive feedback
c. blood levels of tropic hormones are lower than normal due to negative feedback
d. blood levels of thyroid hormones are normal
e. blood levels of thyroid hormones are higher than normal due to positive feedback
49. The combined effects of insulin and glucagon on blood glucose are _____.
a. additive d. agonistic
b. synergistic e. antagonistic
c. permissive
50. The combined effects of epinephrine and thyroid hormones on bronchioles are _____.
a. additive d. agonistic
b. synergistic e. antagonistic
c. permissive

Matching

51. Match the following statements to the term to which each best applies: hypersecretion (ER), hyposecretion (O), primary secretion disorder (PSD), secondary secretion disorder (SSD), antagonism (A), additive effect (AE), synergistic effect (SE), and permissiveness (P).
- a. _____ Two or more hormones produce a similar response in the body; the net effect equals the sum of the individual effects.
 - b. _____ The effects of two or more hormones oppose each other.
 - c. _____ excessive secretion of a hormone
 - d. _____ insufficient secretion of a hormone
 - e. _____ abnormal secretion of a hormone that originates in the endocrine gland that secretes the hormone
 - f. _____ The presence of one hormone is needed in order for another hormone to exert its actions.
 - g. _____ abnormal secretion of a hormone that originates in the anterior pituitary or hypothalamus
 - h. _____ two or more hormones produce a similar response in the body; the net effect is greater than the sum of the individual effects

Short Answer

Answer the following question in 1–4 sentences.

52. Name two hormones that have antagonistic functions to each other.

Clinical Questions

53. Explain what would happen to a person's thyroid hormone, TSH, and TRH levels if they were experiencing a thyroid disorder resulting from a primary hyposecretion.
54. Explain what would happen to a person's thyroid hormone, TSH, and TRH levels if they were experiencing a thyroid disorder resulting from a secondary hypersecretion that originated in the anterior pituitary gland.