

9

The Endocrine System

The endocrine system, vital to homeostasis, plays an important role in regulating the activity of body cells. By acting through blood-borne chemical messengers, called hormones, the endocrine system organs orchestrate cellular changes that lead to growth and development, reproductive capability, and the physiological homeostasis of many body systems.

This chapter covers the location of the various endocrine organs in the body, the general function of the various hormones, and the consequences of their hypersecretion or hyposecretion.

THE ENDOCRINE SYSTEM AND HORMONE FUNCTION—AN OVERVIEW

1. Complete the following statements by choosing answers from the key choices. Record the answers in the answer blanks.

Key Choices

- | | | |
|--------------------------|-------------------|------------------------------|
| A. Cardiovascular system | C. More rapid | E. Nervous system |
| B. Hormones | D. Nerve impulses | F. Slower and more prolonged |

- | | | |
|-------|----|---|
| _____ | 1. | The endocrine system is a major controlling system in the body. Its means of control, however, is much <u>(1)</u> than that |
| _____ | 2. | of the <u>(2)</u> , the other major body system that acts to maintain homeostasis. Perhaps the reason for this is that the endocrine system uses chemical messengers, called <u>(3)</u> , instead |
| _____ | 3. | of <u>(4)</u> . These chemical messengers enter the blood and are |
| _____ | 4. | carried throughout the body by the activity of the <u>(5)</u> . |
| _____ | 5. | |

2. Complete the following statements by choosing answers from the key choices. Record the answers in the answer blanks.

Key Choices

- | | | |
|-----------------------|-----------------------|--|
| A. Altering activity | F. Negative feedback | K. Steroid or amino acid-based |
| B. Anterior pituitary | G. Neural | L. Stimulating new or unusual activities |
| C. Hormonal | H. Neuroendocrine | M. Sugar or protein |
| D. Humoral | I. Receptors | N. Target cell(s) |
| E. Hypothalamus | J. Releasing hormones | |

- _____ 1. All cells do not respond to endocrine system stimulation. Only those that have the proper (1) on their cell membranes are activated by the chemical messengers. These responsive cells are called the (2) of the various endocrine glands. Hormones promote homeostasis by (3) of body cells rather than by (4). Most hormones are (5) molecules.
- _____ 2.
- _____ 3.
- _____ 4.
- _____ 5. The various endocrine glands are prodded to release their hormones by nerve fibers (a (6) stimulus), by other hormones (a (7) stimulus), or by the presence of increased or decreased levels of various other substances in the blood (a (8) stimulus). The secretion of most hormones is regulated by a (9) system, in which increasing levels of that particular hormone “turn off” its stimulus. The (10) is called the master endocrine gland because it regulates so many other endocrine organs. However, it is in turn controlled by (11) secreted by the (12). The structure identified as #12 is also part of the brain, so it is appropriately called a (13) organ.
- _____ 6.
- _____ 7.
- _____ 8.
- _____ 9.
- _____ 10.
- _____ 11.
- _____ 12.
- _____ 13.

3. For each key phrase, decide whether it better describes the mode of action of a steroid or amino acid-based hormone, and insert its key letter on the appropriate answer blank.

Key Choices

- | | |
|--|---|
| A. Binds to a plasma membrane receptor | D. Activates a gene to transcribe messenger RNA |
| B. Binds to a receptor in the cell's nucleus | E. Acts through a second messenger such as cyclic AMP |
| C. Is lipid soluble | |

Steroid hormones: _____ Amino acid-based hormones: _____

THE MAJOR ENDOCRINE ORGANS

4. Figure 9-1 depicts the anatomical relationships between the hypothalamus and the anterior and posterior lobes of the pituitary in a highly simplified way. First, identify each of the structures listed below by color coding and coloring them on the diagram. Then, on the appropriate lines write in the names of the hormones that influence each of the target organs shown at the bottom of the diagram. Color the target organ diagrams as you like.

- Hypothalamus
- Anterior pituitary
- Turk's saddle of the sphenoid bone
- Posterior pituitary

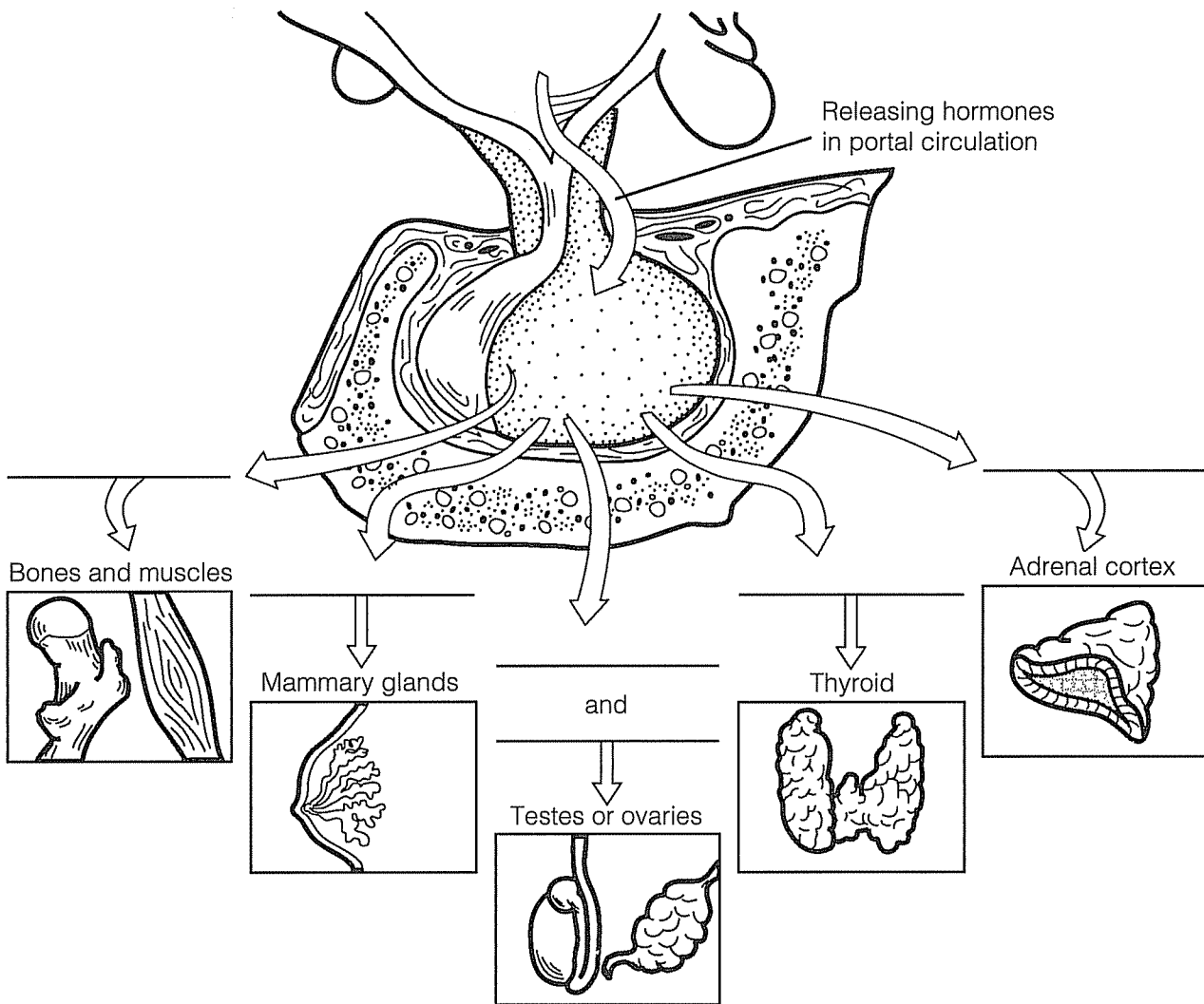


Figure 9-1

5. Figure 9-2 is a diagram of the various endocrine organs of the body. Next to each letter on the diagram, write the name of the endocrine-producing organ (or area). Then select different colors for each and color the corresponding organs in the illustration. To complete your identification of the hormone-producing organs, name the organs (not illustrated) described in items K and L.

K Small glands that ride
"horseback" on the thyroid

L Endocrine-producing
organ present only in
pregnant women

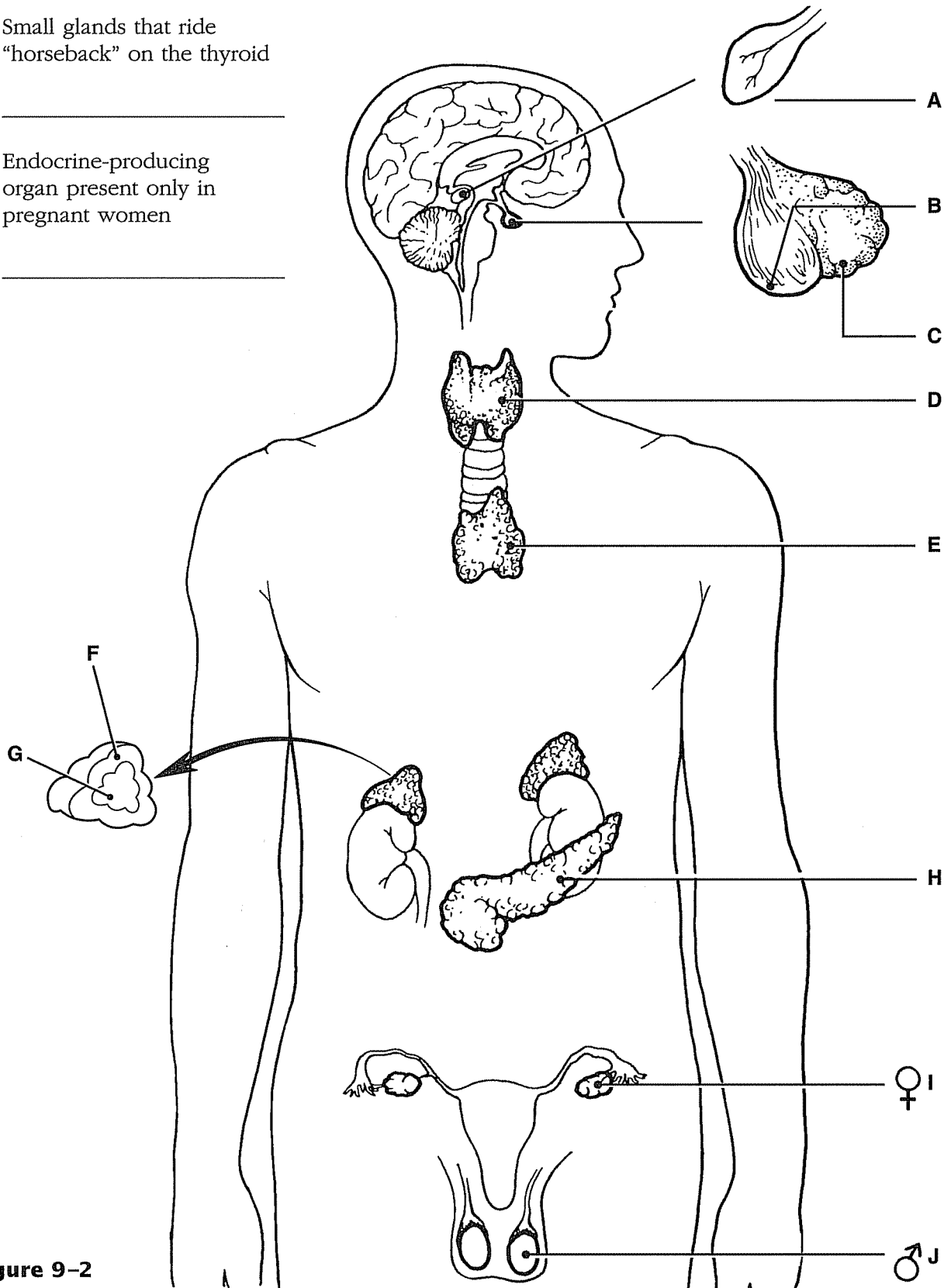


Figure 9-2

6. For each of the following hormones, indicate the organ (or organ part) producing or releasing the hormone by inserting the appropriate letters from Figure 9–2 in the answer blanks.

- | | | |
|----------------------|------------------------|---------------------------|
| _____ 1. ACTH | _____ 8. Glucagon | _____ 15. PTH |
| _____ 2. ADH | _____ 9. Insulin | _____ 16. Growth hormone |
| _____ 3. Aldosterone | _____ 10. LH | _____ 17. Testosterone |
| _____ 4. Cortisone | _____ 11. Melatonin | _____ 18. Thymosin |
| _____ 5. Epinephrine | _____ 12. Oxytocin | _____ 19. Thyrocalcitonin |
| _____ 6. Estrogen | _____ 13. Progesterone | _____ 20. Thyroxine |
| _____ 7. FSH | _____ 14. Prolactin | _____ 21. TSH |

7. Name the hormone that best fits each of the following descriptions. Insert your responses in the answer blanks.

- | | |
|-------|--|
| _____ | 1. Basal metabolic hormone |
| _____ | 2. Programs T lymphocytes |
| _____ | 3. Most important hormone regulating the amount of calcium circulating in the blood; released when blood calcium levels drop |
| _____ | 4. Helps to protect the body during long-term stressful situations such as extended illness and surgery |
| _____ | 5. Short-term stress hormone; aids in the fight-or-flight response; increases blood pressure and heart rate, for example |
| _____ | 6. Necessary if glucose is to be taken up by body cells |
| _____ | 7. _____ 8. |
| _____ | 9. _____ 10. Four tropic hormones |
| _____ | 11. Acts antagonistically to insulin; produced by the same endocrine organ |
| _____ | 12. Hypothalamic hormone important in regulating water balance |
| _____ | 13. _____ 14. Regulate the ovarian cycle |
| _____ | 15. _____ 16. Directly regulate the menstrual or uterine cycle |
| _____ | 17. Adrenal cortex hormone involved in regulating salt levels of body fluids |
| _____ | 18. Necessary for milk production |

8. Name the hormone that would be produced in inadequate amounts in the following conditions. Place your responses in the answer blanks.

- _____ 1. Sexual immaturity
- _____ 2. Tetany
- _____ 3. Excessive urination without high blood glucose levels; causes dehydration and tremendous thirst
- _____ 4. Goiter
- _____ 5. Cretinism; a type of dwarfism in which the individual retains childlike proportions and is mentally retarded
- _____ 6. Excessive thirst, high blood glucose levels, acidosis
- _____ 7. Abnormally small stature, normal proportions
- _____ 8. Miscarriage
- _____ 9. Lethargy, falling hair, low basal metabolic rate, obesity (myxedema in the adult)

9. Name the hormone that would be produced in excessive amounts in the following conditions. Place your responses in the answer blanks.

- _____ 1. Lantern jaw; large hands and feet (acromegaly in the adult)
- _____ 2. Bulging eyeballs, nervousness, increased pulse rate, weight loss (Graves' disease)
- _____ 3. Demineralization of bones; spontaneous fractures
- _____ 4. Cushing's syndrome—moon face, depression of the immune system
- _____ 5. Abnormally large stature, relatively normal body proportions
- _____ 6. Abnormal hairiness; masculinization

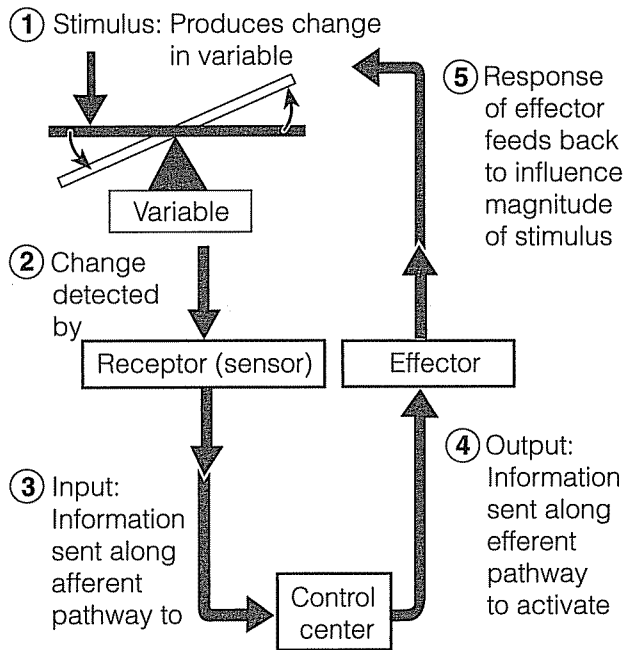
10. List the cardinal symptoms of diabetes mellitus, and provide the rationale for the occurrence of each symptom.

- 1. _____

- 2. _____

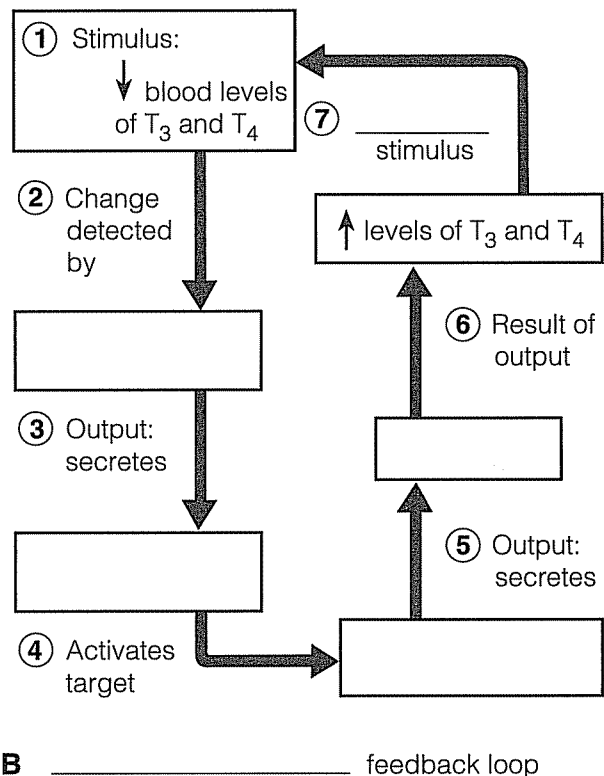
- 3. _____

11. The activity of many end organs is regulated by negative feedback. Figure 9–3A shows the basic elements of a homeostatic control system. Figure 9–3B shows a feedback loop with selected parts missing. Assume, for this system, that the stimulus that initiates it is declining T_3 and T_4 levels in the blood which produces a drop in metabolic rate. Fill in the information missing in the boxes to correctly complete this feedback loop. Also indicate whether it is a negative or positive feedback loop.



A

Figure 9–3



12. Circle the term that does not belong in each of the following groupings.

- Posterior lobe Hormone storage Nervous tissue Anterior lobe
- Steroid hormone Protein hormone Second messenger Membrane receptors
- Catecholamines Norepinephrine Epinephrine Cortisol
- Calcitonin Increases blood Ca^{2+} Thyroid gland Enhances Ca^{2+} deposit
- Glucocorticoids Steroids Aldosterone Growth hormone

OTHER HORMONE-PRODUCING TISSUES AND ORGANS

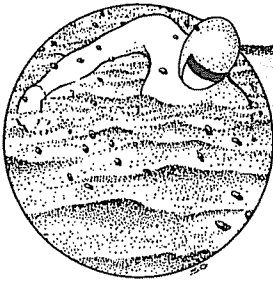
13. Besides the major endocrine organs, isolated clusters of cells produce hormones within body organs that are usually not associated with the endocrine system. A number of these hormones are listed in the table below. Fill in the missing information (blank spaces) on these hormones in the table.

Hormone	Chemical makeup	Source	Effects
Gastrin	Peptide		
Secretin		Duodenum	
Cholecystokinin	Peptide		
Erythropoietin		Kidney in response to hypoxia	
Active vitamin D ₃		Skin; activated by kidneys	
Atrial natriuretic peptide (ANP)	Peptide		
Human chorionic gonadotropin (hCG)	Protein		
Leptin		Adipose tissue	

DEVELOPMENTAL ASPECTS OF THE ENDOCRINE SYSTEM

14. Complete the following statements by inserting your responses in the answer blanks.

- _____ 1. Under ordinary conditions, the endocrine organs operate smoothly until old age. However, a (1) in an endocrine organ may lead to (2) of its hormones. A lack of (3) in the diet may result in undersecretion of thyroxine. Later in life, a woman experiences a number of symptoms such as hot flashes and mood changes, which result from decreasing levels of (4) in her system. This period of a woman's life is referred to as (5), and it results in a loss of her ability to (6). Because (7) production tends to decrease in an aging person, adult-onset diabetes is common.
- _____ 2.
- _____ 3.
- _____ 4.
- _____ 5.
- _____ 6.
- _____ 7.



INCREDIBLE JOURNEY

A Visualization Exercise for the Endocrine System

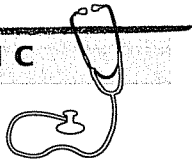
...you notice charged particles shooting pell-mell out of the bone matrix. . .

15. Where necessary, complete statements by inserting the missing words in the answer blanks.

- _____ 1. For this journey, you will be miniaturized and injected into a vein of your host. Throughout the journey, you will be traveling in the bloodstream. Your instructions are to record changes in blood composition as you float along, and to form some conclusions as to why they are occurring (that is, which hormone is being released).
- _____ 2.
- _____ 3.
- _____ 4.
- _____ 5. Bobbing gently along in the slowly moving blood, you realize that there is a sugary taste to your environment; however, the sweetness begins to decrease quite rapidly. As the glucose levels of the blood have just decreased, obviously (1) has been released by the (2), so that the cells can take up glucose.
- _____ 6.
- _____ 7.
- _____ 8. A short while later you notice that the depth of the blood in the vein you are traveling in has diminished substantially. To remedy this potentially serious situation, the (3) will have to release more (4), so the kidney tubules will reabsorb more water. Within a few minutes the blood becomes much deeper; you wonder if the body is psychic as well as wise.
- _____ 9.

As you circulate past the bones, you notice charged particles shooting pell-mell out of the bone matrix and jumping into the blood. You conclude that the (5) glands have just released PTH, because the (6) levels have increased in the blood. As you continue to move in the bloodstream, the blood suddenly becomes sticky sweet, indicating that your host must be nervous about something. Obviously, his (7) has released (8) to cause this sudden increase in blood glucose.

Sometime later, you become conscious of a humming activity around you, and you sense that the cells are very busy. Your host's (9) levels appear to be sufficient, since his cells are certainly not sluggish in their metabolic activities. You record this observation and prepare to end this journey.

AT THE CLINIC

16. Pete is very short for his chronological age of 8. What physical features will allow you to determine quickly whether to check GH or thyroxine levels?

17. A young girl is brought to the clinic by her father. The girl fatigues easily and seems mentally sluggish. You notice a slight swelling in the anterior neck. What condition do you suspect? What are some possible causes and their treatments?

18. A 2-year-old boy is brought to the clinic by his anguished parents. He is developing sexually and shows an obsessive craving for salt. Blood tests reveal hyperglycemia. What endocrine gland is hypersecreting?

19. When the carnival came to a small town, the local health professionals and consumer groups joined forces to enforce truth-in-advertising laws to protect selected employees of the carnival. They demanded that the fat man, the dwarf, the giant, and the bearded lady be billed as “people with endocrine system problems” (which of course removed all the sensationalism usually associated with these attractions). Identify the endocrine disorder in each case and explain how (or why) the disorder produced the characteristic features of these four showpeople.

20. The brain is “informed” when we are stressed and the hypothalamus responds by secreting a releasing hormone called corticotropin-releasing hormone (CRH) which helps the body deal with the stressors. Outline this entire sequence, starting with CRH and ending with the release of cortisol. (Be sure to trace the hormone through the hypophyseal portal system and out of the pituitary gland.)

21. Mrs. Jackson claims she is not menstruating and reports that her breasts are producing milk, although she has never been pregnant. What hormone is being hypersecreted?