Chapter 13: Review Answers

Student Textbook pages 464–465

Answers to Understanding Concepts Questions

1. The human nervous system is equipped to sense and respond to continuous change within the body and in its external environment. It regulates body structures and processes to maintain homeostasis despite fluctuations in the internal and external environment. The hormones of the endocrine glands regulate the organs and systems of the body to maintain homeostasis.

2. (a) The pituitary gland is often referred to as the "master gland" because it releases tropic hormones that control hormonal secretions from the thyroid, liver, adrenal cortex, and the gonads.

(b) The anterior pituitary is regulated by the hypothalamus, which secretes hormones that either stimulate or inhibit the release of other hormones from the anterior pituitary.

The posterior pituitary is considered part of the nervous system. The posterior pituitary does not produce any hormones; instead, it stores and releases the hormones ADH and oxytocin, which are produced in the hypothalamus and transferred to the posterior pituitary by neuronal axons.

3. ACTH is an example of a tropic hormone because it is released by the anterior pituitary and travels through the blood to the adrenal cortex, which it stimulates to release glucocorticoid hormones (e.g., cortisol).

4. Technology such as the scanning electron microscope, fluorescence microscope, and nuclear imaging scans have allowed scientists to visualize glands, hormones, and target cell membranes in greater detail.

5. This statement is incorrect. The correct statement would be that the beta cells of the pancreas secrete *insulin*, and the alpha cells secrete a hormone (glucagon) that *raises* blood glucose levels.

6. The following chart summarizes how each hormone affects blood glucose levels.

Hormone	Effects on blood glucose levels
cortisol	raises levels (longer acting than epinephrine)
epinephrine	raises levels
insulin	lowers levels
glucagon	raises levels

7. Increasing levels of TSH would stimulate the thyroid gland to produce more thyroxine. Increasing levels of thyroxine would have a negative effect (negative feedback) on the release of TSH from the anterior pituitary.

8. The adrenal medulla (middle region of the adrenal gland) produces two closely related hormones: epinephrine and norepinephrine (also called adrenaline and noradrenaline). These hormones regulate the short-term response to stress commonly referred to as the fight-or-flight response.

The adrenal cortex (outer region of the adrenal gland) responds to long-term stressful situations by releasing glucocorticoid and mineralocorticoid hormones. It also releases gonadocorticoid hormones.

9. The levels of hGH are high in children who are actively growing. However, as the person reaches adulthood and the skeleton is completed, the levels of hGH decrease. hGH and other growth factors increase protein synthesis; cell division and growth, especially the growth of cartilage, bone, and muscle; and the metabolic breakdown and release of fats stored in adipose tissue.

10. Glucagon and insulin are antagonists because they have opposite effects on blood glucose levels. Glucagon increases blood glucose levels while insulin lowers blood glucose levels.

11. (a) Without iodine, the thyroid gland cannot synthesize thyroxine (T_4). Lower levels of thyroxine would decrease the rate at which the body metabolizes fats, proteins, and carbohydrates for energy.

(b) A condition called a goitre results from insufficient iodine in the diet. If thryoxine cannot be made, there is no signal to stop the secretion of TSH by the anterior pituitary. The relentless stimulation of the thyroid gland by TSH causes a goitre (enlargement of the thyroid gland). In Canada it is uncommon for anyone to develop a goitre because salt refiners add iodine to salt.

12. When you are startled, the adrenal medulla is stimulated by neurons from the sympathetic nervous system to

release the hormone epinephrine. This hormone triggers an increase in breathing rate, heart rate, blood pressure, blood flow to the heart and muscles, and the conversion of glycogen to glucose in the liver.

When the brain detects danger, it directs the hypothalamus to secrete a releasing hormone. The releasing hormone stimulates the anterior pituitary gland to secrete ACTH. ACTH stimulates the adrenal cortex to release cortisol. Cortisol often works in conjunction with epinephrine, but is longer lasting. Cortisol promotes the breakdown of muscle protein into amino acids. The amino acids are taken out of the blood by the liver, where they are used to make glucose, which is then released back into the blood.

Cortisol also prompts the breakdown of fat cells, which also releases glucose.

13. (Note: Students should review the discussion of norepinephrine in Chapter 11 as well as in this chapter.) Norepinephrine is released by neurons of the sympathetic nervous system and by the cells of the adrenal medulla. The sympathetic neurons release norepinephrine as a neurotransmitter, which has an excitatory effect on its target muscles. In response to a stressor, neurons of the sympathetic nervous system carry a signal from the hypothalamus directly to the adrenal medulla. These neurons (rather than hormones) stimulate the adrenal medulla to secrete norepinephrine (as well as epinephrine). This hormone triggers an increase in breathing rate, heart rate, blood pressure, blood flow to the heart and muscles, and the conversion of glycogen to glucose in the liver. The main difference is that the response to danger by the nervous system is much faster than that of the endocrine system. However, the effects of norepinephrine released by the adrenal medulla last much longer.

14. Aldosterone targets the kidney, where it promotes the renal absorption of sodium ions into the bloodstream. This increase in the solute concentration of the blood draws more water from the nephrons in the kidney, resulting in higher blood pressure. Higher blood pressure would be an advantage as a stress response because more oxygen would be available to the tissues in less time. This response takes place over a much longer period of time than the short-term fight-or-flight response. Note: Students may recognize that high blood pressure, if it continues for a long time, can be harmful to the body.

15. If hypothyroidism develops during childhood, a condition known as cretinism can result. Individuals with cretinism are stocky and shorter than average; without hormonal injections, they will have mental developmental delays. Adults with hypothyroidism tend to feel tired much of the time, have a slow pulse rate and puffy skin, and experience hair loss and weight gain.

Answers to Applying Concepts Questions

16. The anterior pituitary produces six different hormones, so the effects of the lack of all those hormones will be confusing to interpret. The hypothalamus also produces hormones which are stored in the posterior pituitary gland. Without the pituitary, hormones such as ADH and oxytocin would not show up in the tests.

17.

Letter on diagram	Name of hormonal imbalance	Endocrine gland or glands involved	Hormones involved	Symptoms of the condition
A	diabetes insipidus	posterior pituitary	ADH	excessive urination and extreme thirst
	acromegaly	anterior pituitary	hGH	bones and soft tissues widen, face widens, ribs thicken, feet and hands enlarge
B	hyperthyroidism	thyroid gland	thyroxine	anxiety, insomnia, heat intolerance, irregular heartbeat
B	hypothyroidism	thyroid gland	thyroxine	slow pulse, puffy skin, hair loss, feel tired, weight gain
	goitre			enlarged thyroid gland
C	Addison's disease	adrenal cortex	aldosterone	hypoglycemia, sodium and potassium imbalances, rapid weight loss, general weakness

Letter on diagram	Name of hormonal imbalance	Endocrine gland or glands involved	Hormones involved	Symptoms of the condition
D	diabetes mellitus	pancreas	insulin	high blood sugar, thirst, glucose in urine, low energy, large volumes of urine

18. Hormones affected by a damaged anterior pituitary gland and the effects on the body include:

- hGH: lack of stimulation for the growth of muscles, connective tissue, and the growth plates at the end of the long bones
- follicle-stimulating hormone and luteinizing hormone: reduced production of egg and sperm cells
- prolactin: for a female, lack of production of milk after childbirth
- ACTH: lack of production of cortisol and aldosterone during a stress response
- thyroid-stimulating hormone: lack of stimulation of thyroid to produce thyroxine; therefore metabolism is lowered

19. The problem lies with the thyroid gland. TSH is produced by the anterior pituitary in response to low levels of thryoxine in the blood. This problem could result in the development of a goitre (enlarged thyroid gland).

20. If the tumour is affecting the adrenal cortex, there could be an overproduction of female or male sex hormones, an overproduction of cortisol, and an overproduction of aldosterone. If the tumour is affecting the adrenal medulla, there could be an overproduction of epinephrine and norepinephrine.

21. The symptoms described are those of hypothyroidism. The thyroid is the endocrine gland associated with these symptoms.

22. The man is likely suffering from diabetes insipidus or diabetes mellitus. The doctor could do a urinalysis test. If there were high levels of glucose in the urine, the doctor would suspect diabetes mellitus.

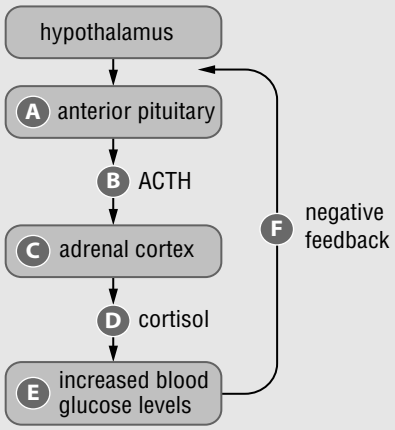
23. (a) Students could hypothesize that overcrowding would produce a similar stress response in humans.

(b) Students might suggest comparing subjects living in a crowded city with those living in a more rural setting. One possible suggestion could be doing blood tests and comparing the levels of hormones associated with long-term stress such ACTH or cortisol. Other possibilities would be to study the rates of stress-related illnesses in the two subject groups. For example, they could compare the incidence of heart attacks and strokes between the two groups.

(c) No, it would be unlikely that you could conclusively link this observation to overcrowding. There are many other factors such as age, gender, race, diet, and exposure to toxic chemicals that could influence the results of this investigation.

24. Following exercise, the person with diabetes mellitus would require more sugar. Even though a person with diabetes mellitus has higher than normal blood glucose levels, exercise can lower blood glucose levels to below normal levels. Taking insulin would further lower blood glucose levels (hypoglycemia) which could cause health problems for the individual. (Note: Some students might use the term diabetic coma even though it isn't mentioned in the student textbook).

25. Regulation of ACTH (Note: This is one possible answer; students may also choose aldosterone.)



Answers to Making Connections Questions

26. Steroid hormones, such as testosterone, estrogen, and cortisol, are lipid-based. Therefore, it is important to include lipids in the diet to provide the building blocks necessary for the synthesis of these hormones.

27. Students' answers will depend on personal point of view. High-performance athletes in the school may think it would be a good idea if it helped improve their chances of securing a scholarship. Others may think that taking any performance-enhancing drug is unethical (cheating). Other students will bring up the issue of health risks associated with taking hGH when the individual is still growing.

28. This question will likely stimulate fierce debate within the class. Some students will feel that the use of animals to study endocrine functions is beneficial and has helped millions of people. This group could bring up the work of Banting and Best and how they used dogs to isolate insulin. Other students in the class will believe that it is cruel and/or unethical to use animals for medical research. These students could include a discussion of computer modelling as an alternative method of research.

29. Some contributing factors to increased incidence of type 2 diabetes include:

- Decreased activity (Canadians are more sedentary than ever before)
- Increased consumption of fast foods that are very high in fat and carbohydrates
- Increased consumption of pre-packaged foods that are high in fat and high in salt

Any one of these factors could be addressed through conducting educational campaigns, changing eating habits, and increasing the amount of physical activity.

30. (a) At time 0, both people likely ate a meal.

(b) Person A likely has diabetes mellitus because his/her blood sugar levels increased dramatically and took much longer to return to normal.

(c) Person A would likely have taken insulin to get his/her blood glucose levels under control.

(d) The pancreas in Person B released insulin, which made the target cell membranes more permeable to glucose. As a result, blood glucose levels decreased.

(e) In both cases, blood glucose levels would decrease. In both cases, glucagon would be released by the pancreas into the blood to help increase blood glucose levels.

(f) The hormone released after 5 hours would be glucagon. Glucagon would stimulate the release of glucose stored in the liver, muscles, and fat tissue.

(g) After exercise, the person with diabetes would have to eat something or drink a pre-sweetened drink to raise his/her blood glucose level. However, this individual would have to closely monitor his/her blood glucose level to make sure that it didn't get too high.