Answers to Questions for Comprehension

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Q1. The axons of motor neurons, for example, lie in close proximity to specific muscles or glands (effectors). An appropriate stimulus will elicit an immediate response from the effector in milliseconds. A hormone, on the other hand, may be released at a great distance from its target organ. The target organ is waiting for the arrival of a hormone. Hormones must travel through the blood to their target cells and bind to the cell membranes in order to change the activity of the cell. This process can take from several seconds to several days to occur, and the responses tend to be more prolonged.

Q2. A hormone is a chemical that is produced by an endocrine (ductless) gland. When the endocrine gland receives a signal from the nervous system or from another hormone, it releases its hormone into the bloodstream. The hormone travels to its target cells, binds to the cell membranes, and then changes the activity of the cell. For example, the pancreas (endocrine gland) produces the hormone insulin. Insulin is released into the bloodstream and affects its target cells by making them more permeable to glucose.

Q3. Four reasons why the distinction between the nervous and endocrine systems is sometimes blurred are:

- Sometimes nervous system tissues secrete hormones.
- Several chemicals function as both neurotransmitters and hormones, depending on their location in the body.
- The endocrine and nervous systems both include responses that are regulated by negative feedback loops.
- The regulation of several physiological processes involves both the nervous and endocrine systems acting in conjunction with each other.

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Q4. Berthold's experiments showed that, because the replaced organs were not connected to any nerves, the testes must have released something into the rooster's bloodstream that caused developmental changes in the male birds.

Q5. Challenges to researchers include the following:

- It is difficult to get useful information because different hormones often work together and one hormone can, in some cases, compensate for another that is missing.
- Some glands produce more than one hormone.
- The concentration of most hormones is extremely low.
- Hormones are not released on a continual basis. Their release can be triggered by environmental factors, or may follow a pattern that repeats over hours, weeks, or years.

Q6. Two technologies used to study the endocrine system:

- Nuclear scanning devices such as PET and high-powered microscopes have allowed scientists to visualize glands, hormones, and target-cell membranes.
- Fluorescent stains are used to colour the different hormones in a tissue sample.
- To view endocrine glands in the living body, doctors can have patients ingest capsules containing a small amount of radioactive material—effectively the same amount of radiation someone would receive from a standard X ray. This radioactive dye accumulates in a specific gland, which makes the gland easier to distinguish in PET scans or by other nuclear scanning techniques.

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Q7. The two groups of hormones are lipid-soluble (composed of lipids) and water-soluble (composed of amino acids). Lipid-soluble hormones can easily diffuse through the lipid bilayer of the cell membranes and bind to their receptor proteins inside the target cell.

Water-soluble hormones cannot diffuse across the cell membrane. Typically, a water-soluble hormone will bind to a receptor protein on the surface of a target cell.

Q8. Each target cell contains receptor proteins. Circulating hormones bind to their specific receptor proteins, like a key into a lock. When the hormone binds to its receptor, this triggers other reactions in the target cell. In other words, the target cell receives and responds to the chemical message sent by the hormone.

Q9. Thyroxine is secreted by the thyroid gland; human growth hormone is secreted by the anterior pituitary; cortisol is secreted by the adrenal cortex; antidiuretic hormone is secreted by the posterior pituitary; insulin is secreted by the pancreas; glucagon is secreted by the pancreas.

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Q10. When the blood plasma becomes too concentrated (if a person is dehydrated), receptors in the hypothalamus detect this and send a neural signal to the posterior pituitary gland to release ADH. ADH targets the nephrons of the kidneys, causing them to become more permeable to water. As a result, the body excretes less (but more concentrated) urine, and blood pressure increases. The hypothalamus detects this and sends a signal to the posterior pituitary to stop secreting ADH.

Q11. A tropic hormone is a hormone that stimulates other endocrine glands to release their hormones.

Q12. Typically, the hypothalamus secretes a releasing hormone into the anterior pituitary gland. This causes the anterior pituitary to release a tropic hormone into the bloodstream. The tropic hormone then stimulates the target gland to release a third hormone into the blood. The third hormone travels to another target tissue and produces an effect. This system is controlled by a negative feedback loop in which the third hormone also prevents further release of the first two hormones in the pathway.

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Q13. hGH increases protein synthesis, increases metabolic breakdown and release of fats stored in adipose (fat) tissue, increases cell division and growth, especially the growth of cartilage, bone, and muscle (specifically, hGH stimulates the growth of muscles, connective tissues, and the growth plates at the end of the long bones, which causes elongation of these bones).

Q14. Two benefits of synthetic hGH are that larger quantities can be produced and that it is safer than the hGH obtained from human cadavers.

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Q15. The thyroid gland is like a metabolic thermostat because, in the same way that a thermostat responds to the level of heat in a building, the thyroid gland responds to the level of thyroxine in the body, shutting off production and secretion when levels are high and stimulating production and secretion when levels are low.

Q16. The primary effect of thyroxine is to increase the rate at which the body metabolizes fats, proteins, and carbohydrates for energy. Thyroxine does not have one specific target organ but especially stimulates the cells of the heart, skeletal muscles, liver, and kidneys to increase the rate of cellular respiration. Thyroxine also plays an important role in the growth and development of children by influencing the organization of various cells into tissues and organs.

Q17. Hypothyroidism occurs when the thyroid produces extremely low quantities of thyroxine. If there is insufficient thyroxine in the blood, there will be no signal to stop the secretion of TSH by the anterior pituitary. The relentless stimulation of the thyroid gland by TSH causes a goitre (an enlargement of the thyroid gland).

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Q18. The short-term response to stress is commonly referred to as the fight-or-flight response. Like the nerve impulses of the sympathetic nervous system, the hormones of the adrenal medulla prepare the body for fight-or-flight by increasing metabolism.

Q19. The hypothalamus stimulates the sympathetic division of the autonomic nervous system and the adrenal medulla glands during the short-term, fight-or-flight response. Both the sympathetic neurons and the adrenal glands release epinephrine and norepinephrine, which help prepare the body for fight-or-flight by increasing metabolism.

Q20. The following chart summarizes the major physiological changes that occur in the short-term and long-term stress response.

Short-term stress response	Long-term stress response
■ heart rate and blood pressure increase ■ blood flow to the heart and muscles increases ■ breathing rate increases ■ rate of metabolism increases ■ blood glucose rises	■ sodium ions and water are absorbed by the kidney ■ blood volume and pressure increase ■ protein and fat metabolism is stimulated, which releases glucose ■ inflammation is reduced and immune cells are suppressed

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Q21. Cortisol raises blood sugar levels by promoting 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 released back into the blood.

Q22. One of the ways the body fights disease is by inflammation, in which cells of the immune system attack foreign material, such as invading bacteria. Cortisol is a natural anti-inflammatory in the body, which is probably why sustained high levels of cortisol make people more susceptible to infection.

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Q23. Aldosterone stimulates the nephrons of the kidneys to increase the absorption of sodium into the bloodstream. This increases the solute concentration of the blood, which then draws in more water from the nephrons, raising blood pressure.

Q24. Addison's disease is caused by damage to the adrenal cortex. However, the symptoms of the disease would result from the loss of the glucocorticoids, mineralocorticoids, and gonadocorticoids. The symptoms of Addison's disease include hypoglycemia (low blood sugar), sodium and potassium imbalances, rapid weight loss, and general weakness. Low aldosterone results in a loss of sodium and water from the blood due to increased urine output. As a result, blood pressure drops. A person with this condition needs to be treated within days, or the severe electrolyte imbalance will be fatal.

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Q25. The two types of cells in the pancreas are the alpha cells and the beta cells. The beta cells of the pancreas secrete insulin, which decreases blood glucose levels. The alpha

cells of the pancreas secrete glucagon, which increases blood glucose levels.

Q26. To maintain homeostasis, insulin is released from the pancreas into the blood when blood glucose levels go above the normal range. Insulin decreases blood sugar levels. If blood glucose levels go below normal, the pancreas releases glucagon which raises the blood glucose levels.

Q29. The effects of long-term high levels of blood glucose can lead to blindness, kidney failure, nerve damage, and gangrene in the limbs. Diabetes can also be fatal if not properly treated.

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Q27. The symptoms of diabetes mellitus are fatigue, an acetone odour to the breath, glucose in urine, and high urine output and thirst. The following explains these symptoms:

- Fatigue: Insulin circulates throughout the body and acts on specific receptors to make the target cells more permeable to glucose. Diabetes mellitus results when the body does not produce enough insulin, or does not respond properly to insulin. As a result, levels of blood glucose tend to rise sharply after meals, and remain at significantly high levels. Without insulin, cells remain relatively impermeable to glucose and cannot obtain enough from the blood. The individual experiences fatigue as the cells become starved for glucose.
- Acetone breath: If glucose can't get into the cells, the body compensates by switching to protein and fat metabolism for energy. Fat metabolism releases ketones (such as acetone) as a toxic by-product, which can be smelled on the breath.
- Glucose in urine: The kidneys are incapable of reabsorbing all of the glucose that is filtered through them from blood, and so glucose is excreted in the urine.
- High urine output and thirst: Glucose being excreted in urine changes the osmotic gradient across the nephrons of the kidneys. Large volumes of water therefore follow the glucose by osmosis into the kidney tubules and it gets excreted. The loss of excess quantities of water in the urine triggers the thirst response.

Q28. Hyperglycemia is high blood glucose levels.

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Q30. In type 1 diabetes (also called juvenile diabetes), the immune system produces antibodies that attack and destroy the beta cells of the pancreas. As a result, the beta cells degenerate and are unable to produce insulin.

Q31. The risk factors associated with type 2 diabetes are unhealthy diet and weight gain.

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Q32. By tying off a dog's pancreatic duct with some string, Banting and his research team were able to remove some islets of Langerhans from the dog's pancreas, and then isolate insulin from the islets. They then found a way to isolate insulin from the pancreas of embryonic calves. They worked with a biochemist from the U of A to purify the extracted insulin and used it to successfully treat a boy with diabetes.

Q33. To check blood glucose levels, insert a test strip with a drop of blood into a blood glucose monitor.