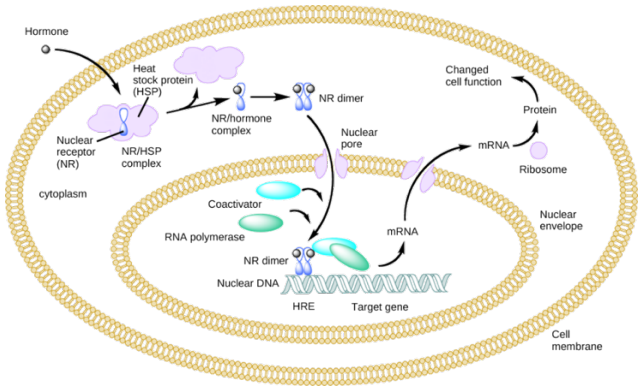
Biology 2e
Unit 7: Animal Structure and Function
Chapter 37: The Endocrine System

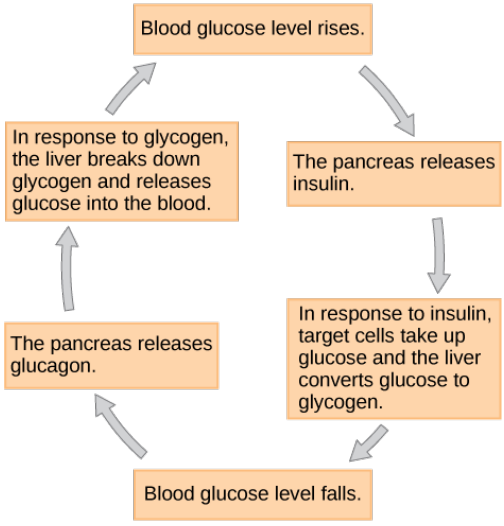
Visual Connection Questions

1. Heat shock proteins (HSP) are so named because they help refold misfolded proteins. In response to increased temperature (a "heat shock"), heat shock proteins are activated by release from the NR/HSP complex. At the same time, transcription of HSP genes is activated. Why do you think the cell responds to a heat shock by increasing the activity of proteins that help refold misfolded proteins?



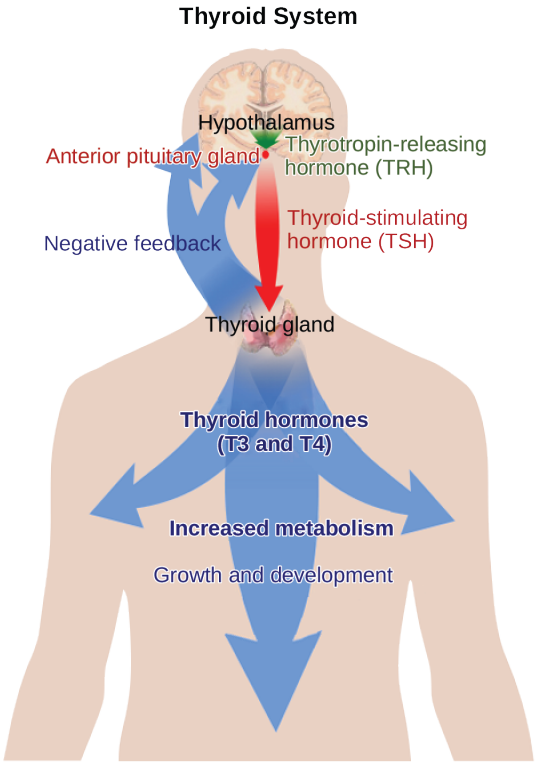
Proteins unfold, or denature, at higher temperatures.

2. Pancreatic tumors may cause excess secretion of glucagon. Type I diabetes results from the failure of the pancreas to produce insulin. Which of the following statement about these two conditions is true?



B. A pancreatic tumor and type I diabetes will both cause hyperglycemia.

3. Hyperthyroidism is a condition in which the thyroid gland is overactive. Hypothyroidism is a condition in which the thyroid gland is underactive. Which of the conditions are the following two patients most likely to have?



Patient A has symptoms associated with decreased metabolism, and may be suffering from hypothyroidism. Patient B has symptoms associated with increased metabolism, and may be suffering from hyperthyroidism.

Review Questions

4. A newly discovered hormone contains four amino acids linked together. Under which chemical class would this hormone be classified?

c. peptide hormone

5. Which class of hormones can diffuse through plasma membranes?

a. lipid-derived hormones

6. Why are steroids able to diffuse across the plasma membrane?

d. They are non-polar molecules.

7. A new antagonist molecule has been discovered that binds to and blocks plasma membrane receptors. What effect will this antagonist have on testosterone, a steroid hormone?

d. It will not affect testosterone-mediated signaling.

8. What effect will a cAMP inhibitor have on a peptide hormone-mediated signaling pathway?
d. It will prevent activation of protein kinases.

9. When insulin binds to its receptor, the complex is endocytosed into the cell. This is an example of _____ in response to hormone signaling.
d. Receptor down-regulation

10. Drinking alcoholic beverages causes an increase in urine output. This most likely occurs because alcohol:
a. inhibits ADH release

11. FSH and LH release from the anterior pituitary is stimulated by _____.
b. GnRH

12. What hormone is produced by beta cells of the pancreas?
c. insulin

13. When blood calcium levels are low, PTH stimulates:
d. osteoclasts

14. How would mutations that completely ablate the function of the androgen receptor impact the phenotypic development of humans with XY chromosomes?
a. Patients would appear phenotypically female.

15. A rise in blood glucose levels triggers release of insulin from the pancreas. This mechanism of hormone production is stimulated by:
a. humoral stimuli

16. Which mechanism of hormonal stimulation would be affected if signaling and hormone release from the hypothalamus was blocked?
b. hormonal and neural stimuli

17. A scientist hypothesizes that the pancreas's hormone production is controlled by neural stimuli. Which observation would support this hypothesis?
a. Insulin is produced in response to sudden stress without a rise in blood glucose.

18. Which endocrine glands are associated with the kidneys?
c. adrenal glands

19. Which of the following hormones is not produced by the anterior pituitary?
a. oxytocin

20. Recent studies suggest that blue light exposure can impact human circadian rhythms. This suggests that blue light disrupts the function of the _____ gland(s).
c. Pineal

Critical Thinking Questions

21. Although there are many different hormones in the human body, they can be divided into three classes based on their chemical structure. What are these classes and what is one factor that distinguishes them?
Although there are many different hormones in the human body, they can be divided into three classes based on their chemical structure: lipid derived, amino acid-derived, and peptide hormones. One of the key distinguishing features of the lipid derived hormones is that they can diffuse across plasma membranes whereas the amino acid-derived and peptide hormones cannot.

22. Where is insulin stored, and why would it be released?
Secreted peptides such as insulin are stored within vesicles in the cells that synthesize them. They are then released in response to stimuli such as high blood glucose levels in the case of insulin.

23. Glucagon is the peptide hormone that signals for the body to release glucose into the bloodstream. How does glucagon contribute to maintaining homeostasis throughout the body? What other hormones are involved in regulating the blood glucose cycle?
Glucagon acts in opposition to insulin, the peptide hormone that stimulates cells to take up glucose from the bloodstream, to maintain blood glucose within healthy levels. When glucagon is released into the blood in response to falling blood sugar levels, the liver catabolizes its glycogen stores to release glucose. If glucagon does not function properly, the blood sugar will drop too low from insulin signaling driving cellular uptake from the blood.

24. Name two important functions of hormone receptors.
The number of receptors that respond to a hormone can change, resulting in increased or decreased cell sensitivity. The number of receptors can increase in response to rising hormone levels, called up-regulation, making the cell more sensitive to the hormone and allowing for more cellular activity. The number of receptors can also decrease in response to rising hormone levels, called down-regulation, leading to reduced cellular activity.

25. How can hormones mediate changes?
Depending on the location of the protein receptor on the target cell and the chemical structure of the hormone, hormones can mediate changes directly by binding to intracellular receptors and modulating gene transcription, or indirectly by binding to cell surface receptors and stimulating signaling pathways.

26. Why is cAMP-mediated signal amplification not required in steroid hormone signaling? Describe how steroid signaling is amplified instead.

In steroid hormone signaling, the steroid interacts directly with its intracellular receptor rather than signaling through a second messenger like cAMP. The steroid-receptor complex then moves into the nucleus, and directly regulates the transcription of DNA. This will cause the cell to produce multiple copies of the target gene, amplifying the signal from the hormone at the transcriptional level rather than the second messenger level.

27. Name and describe a function of one hormone produced by the anterior pituitary and one hormone produced by the posterior pituitary.

In addition to producing FSH and LH, the anterior pituitary also produces the hormone prolactin (PRL) in females. Prolactin stimulates the production of milk by the mammary glands following childbirth. Prolactin levels are regulated by the hypothalamic hormones prolactin-releasing hormone (PRH) and prolactin inhibiting hormone (PIH) which is now known to be dopamine. PRH stimulates the release of prolactin and PIH inhibits it. The posterior pituitary releases the hormone oxytocin, which stimulates contractions during childbirth. The uterine smooth muscles are not very sensitive to oxytocin until late in pregnancy when the number of oxytocin receptors in the uterus peaks. Stretching of tissues in the uterus and vagina stimulates oxytocin release in childbirth. Contractions increase in intensity as blood levels of oxytocin rise until the birth is complete.

28. Describe one direct action of growth hormone (GH).

Hormonal regulation is required for the growth and replication of most cells in the body. Growth hormone (GH), produced by the anterior pituitary, accelerates the rate of protein synthesis, particularly in skeletal muscles and bones. Growth hormone has direct and indirect mechanisms of action. The direct actions of GH include: 1) stimulation of fat breakdown (lipolysis) and release into the blood by adipocytes. This results in a switch by most tissues from utilizing glucose as an energy source to utilizing fatty acids. This process is called a glucose-sparing effect. 2) In the liver, GH stimulates glycogen breakdown, which is then released into the blood as glucose. Blood glucose levels increase as most tissues are utilizing fatty acids instead of glucose for their energy needs. The GH mediated increase in blood glucose levels is called a diabetogenic effect because it is similar to the high blood glucose levels seen in diabetes mellitus.

29. Researchers have recently demonstrated that stressed people are more susceptible to contracting the common cold than people who are not stressed. What kind of stress must the infected patients be experiencing, and why does it make them more susceptible to the virus?

The stressed patients that catch a cold must be chronically (long-term) stressed. Long-term stress results in the production of glucocorticoids, such as cortisol. These hormones inhibit the function of the immune system, which makes people more susceptible to infectious diseases.

30. How is hormone production and release primarily controlled?

Hormone production and release are primarily controlled by negative feedback. In negative feedback systems, a stimulus causes the release of a substance whose effects then inhibit

further release. In this way, the concentration of hormones in blood is maintained within a narrow range. For example, the anterior pituitary signals the thyroid to release thyroid hormones. Increasing levels of these hormones in the blood then feed back to the hypothalamus and anterior pituitary to inhibit further signaling to the thyroid gland.

31. Compare and contrast hormonal and humoral stimuli.

The term humoral is derived from the term humor, which refers to bodily fluids such as blood. Humoral stimuli refer to the control of hormone release in response to changes in extracellular fluids such as blood or the ion concentration in the blood. For example, a rise in blood glucose levels triggers the pancreatic release of insulin. Insulin causes blood glucose levels to drop, which signals the pancreas to stop producing insulin in a negative feedback loop. Hormonal stimuli refer to the release of a hormone in response to another hormone. A number of endocrine glands release hormones when stimulated by hormones released by other endocrine organs. For example, the hypothalamus produces hormones that stimulate the anterior pituitary. The anterior pituitary in turn releases hormones that regulate hormone production by other endocrine glands. For example, the anterior pituitary releases thyroid stimulating hormone, which stimulates the thyroid gland to produce the hormones T_3 and T_4. As blood concentrations of T_3 and T_4 rise they inhibit both the pituitary and the hypothalamus in a negative feedback loop.

32. Oral contraceptive pills work by delivering synthetic progestins to a woman every day. Describe why this is an effective method of birth control.

Progestins, including progesterone, are hormones that help to control the fertility cycle in women. When progesterone is released, it inhibits the production of GnRH in the hypothalamus. Without GnRH, FSH and LH are not produced in the pituitary gland, so the ovaries are not signaled to mature and release an ovum. If progesterone is delivered to the body every day, it will continuously inhibit this cycle.

33. What does aldosterone regulate, and how is it stimulated?

The main mineralocorticoid is aldosterone, which regulates the concentration of ions in urine, sweat, and saliva. Aldosterone release from the adrenal cortex is stimulated by a decrease in blood concentrations of sodium ions, blood volume, or blood pressure, or an increase in blood potassium levels.

34. The adrenal medulla contains two types of secretory cells, what are they and what are their functions?

The adrenal medulla contains two types of secretory cells, one that produces epinephrine (adrenaline) and another that produces norepinephrine (noradrenaline). Epinephrine is the primary adrenal medulla hormone accounting for 75–80 percent of its secretions. Epinephrine and norepinephrine increase heart rate, breathing rate, cardiac muscle contractions, and blood glucose levels. They also accelerate the breakdown of glucose in skeletal muscles and stored fats in adipose tissue. The release of epinephrine and norepinephrine is stimulated by neural impulses from the sympathetic nervous system. These neural impulses originate from the hypothalamus in response to stress to prepare the body for the fight-or-flight response.

35. How would damage to the posterior pituitary gland affect the production and release of ADH and inhibiting hormones?

Damage to the posterior pituitary gland would prevent the release of ADH and oxytocin into the body. However, the hypothalamus's ability to produce ADH would not be affected. The hypothalamus would also still be able to produce and release inhibiting hormones to regulate the anterior pituitary.