Chapter 23 Integration and Hormonal Regulation of Mammalian Metabolism

Multiple Choice Questions

1. Hormones: diverse structures for diverse functions
Page: 885 Difficulty: 2 Ans: D
The radioimmunossay (RIA) is based on competition of unlabeled and radiolabeled:

A) antibodies for binding to a hormone.
B) antibodies for binding to a receptor.
C) hormone for binding to a receptor.
D) hormone for binding to an antibody.
E) receptor for binding to a hormone.

2. Hormones: diverse structures for diverse functions
Page: 885 Difficulty: 2 Ans: D
One distinction between peptide and steroid hormones is that peptide hormones:

A) act through nonspecific receptors, whereas steroid hormones act through specific receptors.
B) are generally water-insoluble, whereas steroid hormones are water soluble.
C) are more stable than steroid hormones.
D) bind to cell surface receptors, whereas steroid hormones bind to nuclear receptors.
E) bind to their receptors with high affinity, whereas steroid hormones bind with low affinity.

3. Hormones: diverse structures for diverse functions
Page: 887 Difficulty: 1 Ans: D
Insulin is an example of a(n) _____ hormone.

A) catecholamine
B) eicosanoid
C) paracrine
D) peptide
E) steroid

4. Hormones: diverse structures for diverse functions
Page: 887 Difficulty: 2 Ans: D
The maturation of insulin from its precursor (preproinsulin) involves:

A) acetylation.
B) oxidation.
C) phosphorylation.
D) proteolysis.
E) reduction.

5. Hormones: diverse structures for diverse functions
Page: 888 Difficulty: 1 Ans: A
Epinephrine is an example of a(n) _____ hormone.

A) catecholamine
B) eicosanoid
C) paracrine
D) peptide
E) steroid

6. Hormones: diverse structures for diverse functions
Page: 888 Difficulty: 2 Ans: D
An example of an eicosanoid hormone is:

A) epinephrine.
B) retinoic acid.
C) testosterone.
D) thromboxane.
E) thyroxine.

7. Hormones: diverse structures for diverse functions
Page: 888 Difficulty: 2 Ans: C
An example of a steroid hormone is:

A) epinephrine.
B) retinoic acid.
C) testosterone.
D) thromboxane.
E) thyroxine.

8. Hormones: diverse structures for diverse functions
Page: 890 Difficulty: 2 Ans: A
The tropic hormones (such as thyrotropin, somatotropin, and luteinizing hormone) are produced and released by the:

A) anterior pituitary.
B) hypothalamus.
C) ovaries.
D) pancreas.
E) posterior pituitary.

9. Hormones: diverse structures for diverse functions
Page: 890 Difficulty: 2 Ans: E
The normal sequence of action of these components of the hormonal hierarchy is:

A) adrenal cortex → hypothalamus → anterior pituitary
B) anterior pituitary → adrenal cortex → hypothalamus
C) anterior pituitary → hypothalamus → adrenal cortex
D) hypothalamus → adrenal cortex → anterior pituitary
E) hypothalamus → anterior pituitary → adrenal cortex

10. Hormones: diverse structures for diverse functions
Page: 890 Difficulty: 2 Ans: D
In its role in the hormonal hierarchy, the hypothalamus produces and releases:

A) epinephrine.
B) insulin.
C) progesterone.
D) releasing factors.
E) thyroxine.

11. Tissue-specific metabolism: the division of labor
Pages: 893-896 Difficulty: 2 Ans: E
Which of the following statements about metabolism in the mammalian liver is *false*?

A) Most plasma lipoproteins are synthesized in the liver.
B) The enzymatic complement of liver tissue changes in response to changes in the diet.
C) The liver synthesizes most of the urea produced in the body.
D) The presence of glucose 6-phosphatase makes liver uniquely able to release glucose into the bloodstream.
E) Under certain conditions, most of the functions of the liver can be performed by other organs.

12. Tissue-specific metabolism: the division of labor
Page: 894 Difficulty: 2 Ans: D
Glucokinase:

A) acts in the conversion of liver glycogen to glucose 1-phosphate.
B) converts fructose-6-phosphate to glucose-6-phosphate
C) converts glucose 6-phosphate to fructose 6-phosphate.
D) is a hexokinase isozyme found in liver hepatocytes.
E) is found in all mammalian tissues.

13. Tissue-specific metabolism: the division of labor
Page: 898 Difficulty: 2 Ans: B
In skeletal muscle:

A) amino acids are an essential fuel.
B) at rest, fatty acids are the preferred fuel.
C) large quantities of triacylglycerol are stored as fuel.
D) phosphocreatine can substitute for ATP as the direct source of energy for muscle contraction.
E) stored muscle glycogen can be converted to glucose and released to replenish blood glucose.

14. Tissue-specific metabolism: the division of labor
Page: 899 Difficulty: 2 Ans: C
The Cori cycle is:

A) the conversion of lactate to pyruvate in skeletal muscle to drive glycogen synthesis.
B) the interconversion between glycogen and glucose l-phosphate.
C) the production of lactate from glucose in peripheral tissues with the resynthesis of glucose from lactate in liver.
D) the synthesis of alanine from pyruvate in skeletal muscle and the synthesis of pyruvate from alanine in liver.
E) the synthesis of urea in liver and degradation of urea to carbon dioxide and ammonia by bacteria in the gut.

15. Tissue-specific metabolism: the division of labor
Page: 900 Difficulty: 2 Ans: A
Which one of the following statements is true?

A) The brain prefers glucose as an energy source, but can use ketone bodies.
B) Muscle cannot use fatty acids as an energy source.
C) In a well-fed human, about equal amounts of energy are stored as glycogen and as triacylglycerol.
D) Fatty acids cannot be used as an energy source in humans because humans lack the enzymes of the glyoxylate cycle.
E) Amino acids are a preferable energy source over fatty acids.

16. Hormonal regulation of fuel metabolism
Page: 902 Difficulty: 1 Ans: D
When blood glucose is abnormally high, the pancreas releases:

A) epinephrine.
B) glucagon.
C) glucose.
D) insulin.
E) trypsin.

17. Hormonal regulation of fuel metabolism
Page: 904 Difficulty: 2 Ans: B
When blood glucose is abnormally low, the pancreas releases:

A) epinephrine.
B) glucagon.
C) glucose.
D) insulin.
E) trypsin.

18. Hormonal regulation of fuel metabolism
Page: 904 Difficulty: 2 Ans: E
An elevated insulin level in the blood:

A) inhibits glucose uptake by the liver.
B) inhibits glycogen synthesis in the liver and muscle.
C) results from a below-normal blood glucose level.
D) stimulates glycogen breakdown in liver.
E) stimulates synthesis of fatty acids and triacylglycerols in the liver.

19. Hormonal regulation of fuel metabolism
Page: 906 Difficulty: 2 Ans: E
The largest energy store in a well-nourished human is:

A) ATP in all tissues.
B) blood glucose.
C) liver glycogen.
D) muscle glycogen.
E) triacylglycerols in adipose tissue.

20. Hormonal regulation of fuel metabolism
Pages: 908-909 Difficulty: 2 Ans: D
Elevated epinephrine levels do *not* normally stimulate:

A) fatty acid mobilization in adipose tissue.
B) gluconeogenesis in liver.
C) glycogen breakdown in muscle.
D) glycogen synthesis in liver.
E) glycolysis in muscle.

21. Hormonal regulation of fuel metabolism
Page: 908 Difficulty: 3 Ans: B
Epinephrine triggers an increased rate of glycolysis in muscle by:

A) activation of hexokinase.
B) activation of phosphofructokinase-1.
C) conversion of glycogen phosphorylase a to glycogen phosphorylase b.
D) inhibition of the Cori Cycle
E) the Pasteur effect.

22. Obesity and the regulation of body mass
Pages: 910-911 Difficulty: 2 Ans: C
Long-term maintenance of body weight is regulated by the hormone:

A) adiposin.
B) hypothalmin.
C) leptin.
D) obesin.
E) testosterone.

23. Obesity and the regulation of body mass
Page: 914 Difficulty: 2 Ans: D
Among its numerous metabolic effects, the protein leptin:

A) decreases the production of glucocorticoids.
B) inactivates the enzyme 5'-AMP-activated protein kinase (AMPK).
C) increases the production of sex hormones.
D) makes muscle and liver cells more sensitive to insulin.
E) raises the production of thyroid hormone.

24. Obesity and the regulation of body mass
Page: 914 Difficulty: 2 Ans: B
The peptide hormone adiponectin, produced in adipose tissue, circulates in the blood and:

A) enhances fatty acid synthesis in liver cells.
B) increases the rate of β-oxidation of fatty acids in muscle cells.
C) inhibits glucose uptake and catabolism in muscle and liver cells.
D) reduces the transport of fatty acids into muscle cells.
E) stimulates gluconeogenesis in liver cells.

Short Answer Questions

25. Hormones: diverse structures for diverse functions
Page: 882 Difficulty: 2
What is a major problem in isolating a new hormone once a bioassay has been developed?

Ans: Because hormones are very potent they are often present in tissue in very small amounts. As a result, very large amounts of tissue are needed as the starting material for the isolation of the hormone.

26. Hormones: diverse structures for diverse functions
Page: 886 Difficulty: 2
Name three general classes of hormones and give an example of each.

Ans: (1) peptide (e.g., insulin, glucagon); (2) catecholamine (e.g., epinephrine); (3) steroid (e.g., testosterone, progesterone); (4) eicosanoids (e.g., prostaglandins, thromboxanes). (See Table 23-1 on p. 886.)

27. Hormones: diverse structures for diverse functions
Page: 888 Difficulty: 2
Some hormones trigger very rapid responses, whereas for others the response takes much longer to develop. What generalization about the mechanisms of action of these two types of hormones can explain the differences in response times?

Ans: Fast-acting hormones affect the activity of preexisting cellular enzymes. Slow-acting hormones alter gene expression thereby changing the levels of active cellular components.

28. Hormones: diverse structures for diverse functions
Page: 888 Difficulty: 2
What distinguishes eicosanoids from other potent biological signaling molecules such as epinephrine?

Ans: Eicosanoids are paracrine hormones: they generally do not move long distances between their points of release and their points of action.

29. Hormones: diverse structures for diverse functions
Page: 888 Difficulty: 2
Which class of hormones acts via nuclear receptors? Give an example of this type of hormone and briefly describe its mode of action.
Ans: Steroid hormones. Examples are the sex hormones testosterone and estradiol. They pass through the plasma membrane and interact with receptor proteins in the nucleus. The hormone-receptor complex interacts with DNA and alters the expression of specific genes.

30. Hormones: diverse structures for diverse functions
Page: 890 Difficulty: 2
How do hormonal cascades result in large amplification of the original signal?

Ans: At each level a small quantity of the signal molecule activates a larger number of molecules at the next level. When this occurs over several levels this multiplicative effect can result in several millionfold amplification of the original signal. (See Fig. 23-8, p. 890.)

31. Tissue-specific metabolism: the division of labor
Page: 895 Difficulty: 2
Describe five possible fates for glucose 6-phosphate in the liver.

Ans: Possible answers include: (1) conversion to liver glycogen; (2) dephosphorylation and release of glucose into bloodstream; (3) oxidation via the pentose phosphate pathway; (4) oxidation via glycolysis and the citric acid cycle; (5) oxidation to acetyl-CoA, which then serves as precursor for synthesis of triacylglycerols, phospholipids, and cholesterol. (See Fig. 23-13, p. 895.)

32. Tissue-specific metabolism: the division of labor
Pages: 895-896 Difficulty: 2
Describe five possible fates of amino acids arriving in the liver after intestinal uptake.

Ans: Possible answers include: (1) synthesis of nucleotides; (2) synthesis of hormones; (3) synthesis of other nitrogenous products such as porphyrins; (4) deamination, followed by oxidation of carbon skeleton for energy; (5) synthesis of proteins for export to plasma; (6) synthesis of proteins for liver; (7) export of free amino acids to other tissues. (See Fig. 23-14, p. 896.)

33. Tissue-specific metabolism: the division of labor
Page: 897 Difficulty: 2
Describe five possible fates for fatty acids in the liver.

Ans: Possible answers include: (1) conversion to triacylglycerol or cholesterol esters for export in plasma lipoproteins; (2) conversion into hepatocyte phospholipids; (3) oxidation and conversion to ketone bodies for export to other tissues; (4) β oxidation to acetyl-CoA, and further oxidation via citric acid cycle for ATP production; (5) β oxidation to acetyl-CoA, followed by synthesis of cholesterol from acetyl-CoA; (6) binding to serum albumin for transport to heart and skeleton. (See

Fig. 23-15, p. 897.)

34. Hormonal regulation of fuel metabolism
Pages: 902-909 Difficulty: 2
Compare in general terms the effects of epinephrine, glucagon, and insulin on glucose metabolism.

Ans: Epinephrine and glucagon cause an increase in the blood glucose level. Epinephrine acts when a higher than normal level of glucose is required; glucagon acts when the level is unusually low. Both stimulate gluconeogenesis and glycogen breakdown and decrease glycolysis and glycogen synthesis. Insulin causes a decrease in blood glucose levels; it acts by increasing glycogen synthesis, glycolysis, and glucose uptake by cells as well as by decreasing glycogen breakdown.

35. Hormonal regulation of fuel metabolism
Page: 909-910 Difficulty: 3
Suppose you are responsible for formulating the diet for a 4-year-old boy with diabetes. How do you decide what kind and amount of carbohydrate and protein to include in the diet? What compounds would you monitor in blood and urine and why?

Ans: The growing boy will need enough protein to furnish the essential amino acids for synthesis of new proteins and enough carbohydrate to provide for his energetic needs and to maintain a normal level of blood glucose. It is essential to avoid excess carbohydrates and calories that might lead to ketoacidosis. To find the correct balance between dietary intake and insulin, the levels of glucose and ketone bodies in blood and urine must be monitored.

36. Obesity and the regulation of body mass
Pages: 910-913 Difficulty: 2
What is leptin? How does it function in the long-term maintenance of body mass?

Ans: Leptin is a small polypeptide that is produced in adipocytes and is carried by the blood to the brain. It is produced when there are adequate stores of lipid in the adipocytes and interacts with a receptor in the hypothalamus. This interaction produces a cascade of effects that tend to suppress appetite and increase energy expenditure.

37. Obesity and the regulation of body mass
Page: 913 Difficulty: 2
Describe the signaling cascade initiated by leptin binding to its receptor.

Ans: Binding of leptin to its receptor in the hypothalamus causes the receptor to dimerize. The soluble cytoplasmic "Janus kinase" (JAK) can now bind to receptor, become activated, and phosphorylate tyrosine residues on the receptor's intracellular domain. These residues in turn become docking sites for three of the STAT transcription factors, positioning them for phosphorylation by JAK as well. The phosphorylated STATs then dimerize and can migrate into the nucleus, where they activate transcription of specific genes, including that for proopiomelanocortin, from which α-melanocyte-stimulating hormone (α-MSH) is produced. The signal that α-MSH conveys to the brain is to "stop eating!"