Test Bank

to accompany

Life: The Science of Biology, Tenth Edition

Sadava • Hillis • Heller • Berenbaum

Chapter 8: Energy, Enzymes, and Metabolism

TEST FILE QUESTIONS

(By Amy Burnside)

Multiple Choice

1. The sum total of all the chemical reactions in a living structure is called its
a. energetics.
b. activity.
c. digestive power.
d. entropy.
e. metabolism.
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

2. In thermodynamic terms, water held back by a dam represents _____ energy.
a. electrical
b. irrigation
c. potential
d. kinetic
e. heat
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 3. Applying

3. Which of the following represents potential energy?
a. Chemical bonds
b. Concentration gradient
c. Electric charge imbalance
d. Both a and b
e. All of the above
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

4. A plant makes sugars via photosynthesis and is consumed by an herbivore. The herbivore in turn breaks down the sugars, producing energy it then uses to build a nest. Which of the following represents the energy transformation of this pathway?
a. Light → chemical → mechanical
b. Chemical → kinetic → heat
c. Heat → chemical → potential
d. Light → kinetic → chemical
e. Mechanical → heat → potential
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

5. The first law of thermodynamics states that the total energy in the universe is
a. decreasing.
b. increasing.
c. constant.
d. being converted to free energy.
e. being converted to matter.
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

6. Which of the following is neither created nor destroyed during its conversion?
a. Entropy
b. Energy
c. Free energy only
d. Thermal energy only
e. Potential energy only
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

7. How does the second law of thermodynamics apply to living organisms?
a. As energy transformations occur, free energy increases and unusable energy decreases.
b. All of the reactions in an organism require an input of energy.
c. The potential energy of ATP is converted to kinetic energy, as with muscle contractions.
d. Living organisms require a constant input of energy to maintain complex structures and order.
e. It does not apply to living organisms; the complexity of organisms contradicts the second law.
Answer: d

Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

8. During photosynthesis, plants use light energy to synthesize sugars from carbon dioxide. They do not make new energy in this process; they merely convert it from light energy to chemical energy. Photosynthesis is thus an illustration of
a. increasing entropy.
b. chemical equilibrium.
c. the first law of thermodynamics.
d. the second law of thermodynamics.
e. a spontaneous reaction.
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

9. In any closed system, the total energy includes usable and unusable energy. The unusable energy is a measure of the disorder of the system and is referred to as
a. free energy.
b. entropy.
c. enthalpy.
d. thermodynamics.
e. equilibrium.
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

10. A change in free energy is related to a change in
a. temperature.
b. entropy.
c. pressure.
d. Both a and b
e. All of the above
Answer: d
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

11. The ΔG of ATP hydrolysis is negative and the change in entropy is positive. The reaction, therefore,
a. requires energy.
b. is endergonic.
c. is exergonic.
d. will not reach equilibrium.

e. decreases the disorder in the system.
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 3. Applying

12. If the temperature of a reaction with a ΔG of –7.1 kJ/mol increases, what will happen to the ΔG of the reaction?

a. It will stay the same.
b. It will equal zero.
c. It will also increase.
d. It will decrease.
e. Not enough information is provided to make a determination.
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 3. Applying

13. A readily reversible reaction, in which reactants and products have almost the same free energies, is indicated by a

a. slightly negative ΔG.

b. change in free energy.

c. negative ΔG.

d. ΔG near zero.

e. large positive ΔG.

Answer: d
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

14. The standard free energy change for the hydrolysis of GTP (guanosine triphosphate) to GDP + P_i is –7.3 kcal/mol, similar to that of ATP. From this information, one can conclude that the
a. reaction will never reach equilibrium.
b. free energy of GDP and phosphate is higher than the free energy of GTP.
c. reaction requires energy.
d. reaction is endergonic.
e. reaction is exergonic.
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 3. Applying

15. Which of the following statements about the exergonic hydrolysis of maltose to glucose is true?
a. The reaction requires the input of free energy.
b. The free energy of glucose is larger than the free energy of maltose.
c. The reaction is not spontaneous.
d. The reaction releases free energy.
e. At equilibrium, the concentration of maltose is higher than the concentration of glucose.
Answer: d
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

16. Suppose that, in a closed system, there is an input of energy as 1 kJ of light. The light energy is converted to glucose, then ATP, and finally to mechanical energy. Which of the following statements about the amount of mechanical energy available is true?
a. There is 1 kJ of mechanical energy available to do work.
b. Entropy increases with each conversion, so less than 1 kJ of energy is available for mechanical work.
c. All of the reactions involved are anabolic, so there is 0.25 kJ of mechanical energy available.
d. All of the reactions involved are exergonic, so the kJ of mechanical energy produced is greater than the 1 kJ input.
e. All of the reactions involved are endergonic, so without constant input of energy, no mechanical energy is produced.
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

17. Chemical equilibrium
a. is a dynamic state.
b. represents a state of negative energy change.
c. represents a state of positive energy change.
d. is essential for normal cell functions.
e. is a state in which $\Delta G = 0$.
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

18. If the enzyme phosphohexoisomerase is added to a 0.3 M solution of fructose 6-phosphate, and the reaction is allowed to proceed to equilibrium, the final concentrations are 0.2 M glucose 6-phosphate and 0.1 M fructose 6-phosphate. What

would be the final concentration of glucose 6-phosphate if the initial concentration of fructose 6-phosphate were changed to 3 M?
a. 2 M
b. 3 M
c. 1 M
d. 0.2 M
e. 0.5 M
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 3. Applying

19. You make a solution of glucose 1-phosphate and let it come to chemical equilibrium with its isomer product glucose 6-phosphate. If you desire a larger amount of glucose 6-phosphate, what can you do to increase the concentration of glucose 6-phosphate in the solution?
a. Add more glucose.
b. Add more phosphate.
c. Add a higher concentration of reactant and allow it to make more product.
d. Add ATP as an energy source for the forward reaction ($\Delta G = -7.1$ kJ/mol) to make more product.
e. Add an enzyme to lower the ΔG of the reaction so more product is made.
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

20. Knowing the change in free energy (ΔG) of a reaction tells us
a. the equilibrium point of the reaction.
b. the rate of the reaction.
c. how fast equilibrium will be reached.
d. the optimum temperature for the reaction.
e. the activation energy.
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

21. When ADP gains a phosphate to form ATP,
a. free energy is released by the loss of a phosphate.
b. the reaction ends.
c. energy is consumed.
d. chemical energy is converted to light energy.
e. ribose loses an oxygen to become deoxyribose.
Answer: c

Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

22. Which of the following is an example of an exergonic reaction?
a. The beating cilia of a protozoan
b. Receptor-mediated endocytosis
c. Phagocytosis
d. Cellular respiration
e. The Na^+–K^+ pump
Answer: d
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

23. ATP can phosphorylate many different molecules. This means that ATP can
a. receive phosphate groups.
b. donate phosphate groups.
c. convert molecules to nucleic acids.
d. release a large amount of energy when hydrolyzed.
e. All of the above
Answer: b
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 1. Remembering

24. Fireflies
a. release a considerable amount of energy as heat.
b. light up to signal danger.
c. use ATP to drive luciferin oxidation.
d. are constantly converting light energy into chemical energy.
e. have a short life cycle due to rapid depletion of ATP.
Answer: c
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

25. What is the correct order in which the following molecules would be produced if phosphate ions were removed from ATP one at a time?
a. ATP, ADP, AMP, adenosine
b. AMP, ADP, ATP, adenosine
c. Adenosine, ATP, AMP, ADP
d. ATP, AMP, ADP, adenosine
e. ADP, adenosine, AMP, ATP
Answer: a
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 3. Applying

26. You are given a solution that contains a biochemical reaction and you are unsure whether ΔG is positive or negative. You suspect that the reaction might make use of the

ATP-ADP + P_i energy-coupling system. To test if it uses this system, and to determine if the reaction is exergonic or endergonic, you would add _____. If the reaction _____, you would conclude that it is _____.
a. ATP; lit up; exergonic
b. ATP; made more product; endergonic
c. ADP; made more product; exergonic
d. ADP; made phosphate ions; endergonic
e. ATP; produced a decrease in temperature; exergonic
Answer: b
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 5. Evaluating

27. Phosphorylation of ADP to ATP is endergonic, whereas the hydrolysis of ATP to ADP is exergonic. The two reactions are therefore said to be
a. substrates.
b. endergonic.
c. kinetic.
d. activated.
e. coupled.
Answer: e
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

28. In glycolysis, the exergonic reaction 1,3-diphosphoglycerate → 3-phosphoglycerate is coupled to the reaction ADP + P_i → ATP. Which of the following is most likely to be true about the reaction ADP + P_i → ATP?
a. The reaction never reaches equilibrium.
b. The reaction is spontaneous.
c. There is a large decrease in free energy.
d. The reaction is endergonic.
e. Temperature will not affect the rate constant of the reaction.
Answer: d
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 3. Applying

29. Which of the following statements about ATP is true?
a. The hydrolysis of ATP is endergonic.
b. ATP consists of adenine bonded to deoxyribose.
c. ATP releases a large amount of light energy when hydrolyzed.
d. An active cell requires about 100 molecules of ATP per second.
e. On average, ATP is consumed within one second of its formation.
Answer: e
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

30. In order for a coupled reaction to have a net ΔG of –3.3 kcal/mol,

a. the exergonic reaction needs to release more energy than the endergonic reaction requires.

b. both reactions need to have the same ΔG.

c. the ΔG of the endergonic reaction needs to be more negative than the ΔG of the exergonic reaction.

d. both reactions need to be exergonic.
e. both reactions need to endergonic.
Answer: a
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 3. Applying

31. When ATP is hydrolyzed, the reaction can make all of the following products *except* for
a. AMP.
b. ADP.
c. phosphate ions.
d. pyrophosphate ions.
e. water.
Answer: e
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 4. Analyzing

32. The phosphorylation of glucose to glucose-6-phosphate is a reaction with a ΔG of +4.0 kcal/mol. What is required for this reaction to take place?
a. The input of energy from hydrolysis of ATP
b. An increase in glucose concentration to push the reaction toward the product
c. The coupling of this reaction with an endergonic reaction
d. The addition of a noncompetitive inhibitor
e. Nothing is required; this is a spontaneous reaction.
Answer: a
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

33. Which of the following reactions will go the furthest toward completion?

a. A reaction with a ΔG of zero

b. A reaction with a ΔG of +2 kcal/mol

c. A reaction with a ΔG of +12 kcal/mol

d. A reaction with a ΔG of –2 kcal/mol

e. A reaction with a ΔG of –12 kcal/mol

Answer: e

Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 3. Applying

34. The ΔG of a reaction tells us all of the following *except* for

a. the rate of the reaction.
b. the direction of the reaction.
c. whether the reaction is exergonic or endergonic.
d. whether the reaction requires or releases energy.
e. whether a higher free energy is in the product or in the reactants.
Answer: a
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

35. The rate of a chemical reaction is the measure of how
a. many products are formed.
b. quickly the reaction reaches equilibrium.
c. much energy must be added for the reaction to occur.
d. much activation energy is required for the reaction to occur.
e. easily the reaction is inhibited.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

36. An RNA molecule that has enzyme activity is called
a. RNAse.
b. ribonuclease.
c. an allosteric enzyme.
d. a regulatory enzyme.
e. a ribozyme.
Answer: e
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

37. The phosphorylation of glucose to glucose-6-phospate has a ΔG of +4.0 kcal/mol. If hexokinase is added to speed up the rate of this reaction, the ΔG will

a. increase.
b. decrease.
c. stay the same.
d. increase, but only with an increase in enzyme amount.
e. decrease, but only with a decrease in enzyme amount.
Answer: c
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 4. Analyzing

38. What is a transition state in a chemical reaction?
a. The place where a substrate molecule binds to an enzyme
b. A reactant with potential energy that is higher than the product's
c. The combination of a substrate and an enzyme
d. The state at which the bonds of reactants are unstable
e. The active site where reactants are oriented
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

39. What type of macromolecule is an enzyme?
a. Protein
b. Carbohydrate
c. Lipid
d. Nucleic acid
e. Hydrocarbon
Answer: a
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

40. In a chemical reaction, transition-state intermediates have free energies that are
a. lower than either the reactants or the products.
b. lower than the reactants, but higher than the products.
c. higher than either the reactants or the products.
d. higher than the reactants, but lower than the products.
e. lower than the reactants, but the same as the products.
Answer: c
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

41. Which of the following affects the rate of a reaction?

a. ΔS

b. ΔG

c. ΔH

d. The activation energy
e. The overall change in free energy
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

42. The hydrolysis of sucrose to glucose and fructose is exergonic. However, if sucrose is dissolved in water and the solution is kept overnight at room temperature, there is no detectable conversion to glucose and fructose. Why?
a. The change in free energy of the reaction is positive.

b. The activation energy of the reaction is high.
c. The change in free energy of the reaction is negative.
d. This is a hydrolysis reaction, so it requires an input of energy.
e. The free energy of the products is higher than the free energy of the reactants.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 4. Analyzing

43. Which of the following will *not* increase the rate of conversion of reactant A to product B in the presence of enzyme C?
a. An increase in enzyme concentration
b. An increase in temperature to the optimum for the reaction
c. An increase in substrate concentration
d. The addition of a nonbiological catalyst that can carry out the same reaction
e. The addition of D, that can compete with A for binding on the active site
Answer: e
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 4. Analyzing

44. Trypsin and elastase are both enzymes that catalyze hydrolysis of peptide bonds. But trypsin only cuts next to lysine and elastase only cuts next to alanine. Why?
a. Trypsin is a protein, and elastase is not.
b. ΔG for the two reactions is different.
c. The shape of the active site for the two enzymes is different.
d. One of the reactions is endergonic, and the other is exergonic.
e. Hydrolysis of lysine bonds requires water; hydrolysis of alanine bonds does not.
Answer: c
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 4. Analyzing

45. The statement "enzymes are highly specific" means that specific
a. enzymes are found in specific cells.
b. reactions involving specific substrates are catalyzed by specific enzymes.
c. enzymes require specific concentrations of substrates.
d. reactions with specific activation energies are catalyzed by specific enzymes.
e. concentrations of substrates work with specific enzymes.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

46. An active site is the
a. part of the substrate that binds with an enzyme.
b. site where enzymes are found in cells.
c. site where energy is added to an enzyme catalyst.
d. part of the enzyme that binds with a substrate.
e. None of the above

Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

47. In some cases, a substrate–enzyme complex is stabilized by
a. hydrogen bonds.
b. covalent bonds.
c. ionic attractions.
d. hydrophobic interactions.
e. All of the above
Answer: e
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

48. The molecules that are acted on by an enzyme are called
a. products.
b. substrates.
c. carriers.
d. prosthetics.
e. effectors.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

49. The enzyme a-amylase increases the rate at which starch is broken down into smaller oligosaccharides by _____ of the reaction.
a. decreasing the equilibrium constant
b. increasing the change in free energy
c. decreasing the change in free energy
d. increasing the change in entropy
e. lowering the activation energy
Answer: e
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

50. The enzyme glyceraldehyde 3-phosphate dehydrogenase catalyzes the reaction glyceraldehyde 3-phosphate → 1,3-diphosphoglycerate. The binding of the glyceraldehyde 3-phosphate to the enzyme creates a(n)
a. transition state.
b. activation groove.
c. catalyst.
d. enzyme–substrate complex.
e. energy barrier.
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 3. Applying

51. The enzyme glucose oxidase binds the six-carbon sugar glucose and catalyzes its conversion to glucono-1,4-actone. Mannose is also a six-carbon sugar, but glucose oxidase cannot bind mannose. The specificity of glucose oxidase is based on the
a. free energy of the transition state.
b. activation energy of the reaction.
c. change in free energy of the reaction.
d. three-dimensional shape and structure of the active site.
e. rate constant of the reaction.
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 3. Applying

52. Binding of substrate to the active site of an enzyme is
a. reversible.
b. irreversible.
c. noncompetitive.
d. coupled.
e. allosteric.
Answer: a
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

53. Which of the following is an enzyme?
a. Manganese dioxide
b. Hemoglobin
c. Catalase
d. Hydrogen peroxide
e. Malathion
Answer: c
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

54. The enzyme sucrase increases the rate at which sucrose is broken down into glucose and fructose. Sucrase works by
a. increasing the amount of free energy of the reaction.
b. lowering the activation energy of the reaction.
c. decreasing the equilibrium constant of the reaction.
d. supplying energy to speed up the reaction.
e. changing the shape of the active site.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 3. Applying

55. Which of the following statements about enzymes is *false*?
a. Enzymes do not affect equilibrium.

b. Enzymes lower activation energy.
c. Enzymes are highly specific.
d. Enzymes can convert an endergonic to an exergonic reaction.
e. Enzymes can be recycled.
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 4. Analyzing

56. The presence of a catalyst affects the
a. amount of activation energy required.
b. overall energy change, or ΔG.
c. energy of the reactants.
d. energy of the products.
e. free energy of the transition state.
Answer: e
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

57. Which of the following statements about the enzyme amylase, which hydrolyzes starch to its component glucose molecules, is *false*?
a. Amylase changes shape when it binds to starch.
b. Amylase increases the activation energy of starch hydrolysis.
c. The active site of amylase is highly specific for starch.
d. Amylase may act by orienting the starch, inducing strain on the bonds holding the glucose molecules together or temporarily adding chemical groups during the reaction.
e. One amylase enzyme can carry out many repeated hydrolysis reactions.
Answer: b
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 4. Analyzing

58. Enzymes of the acid–base catalysis type contain
a. a metal ion bound to a side chain.
b. a prosthetic group.
c. a coenzyme.
d. acidic or basic amino acid side chains (R groups) in the active site.
e. a covalently activated active site.
Answer: d
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 1. Remembering

59. Enzymes may catalyze a reaction by _____ the substrates.
a. orienting
b. inducing strain in
c. adding chemical groups to
d. adding charges to
e. All of the above

Answer: e
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 2. Understanding

60. In the presence of alcohol dehydrogenase, the rate of reduction of acetaldehyde to ethanol increases as the concentration of acetaldehyde is increased. Eventually, the rate of the reaction reaches a maximum, at which point further increases in the concentration of acetaldehyde have no effect. Why?
a. All the alcohol dehydrogenase molecules are bound to acetaldehyde molecules.
b. At high concentrations of acetaldehyde, the activation energy of the reaction increases.
c. At high concentrations of acetaldehyde, the activation energy of the reaction decreases.
d. The enzyme is no longer specific for acetaldehyde.
e. At high concentrations of acetaldehyde, the change in free energy of the reaction decreases.
Answer: a
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 4. Analyzing

61. In order to determine if a reaction is at "saturation," you would add _____ and determine if the reaction rate _____.
a. ATP; increases
b. more substrate; increases
c. a competitive inhibitor; decreases
d. a downstream product; decreases
e. a noncompetitive inhibitor; decreases
Answer: b
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 3. Applying

62. The enzyme hexokinase converts glucose to glucose-6-phosphate in the presence of ATP. In order to determine the efficiency of hexokinase, you wish to conduct an experiment to calculate its "turnover number." To do so you would set up
a. a reaction with a maximum amount of hexokinase at optimal pH and temperature.
b. a reaction with a known amount of enzyme and saturation levels of glucose-6-phosphate at optimal pH and temperature.
c. a reaction with a known amount of enzyme and saturation levels of glucose at optimal pH and temperature.
d. multiple reactions at varying pH levels but with a constant amount of glucose, a constant temperature, and a known amount of enzyme.
e. multiple reactions with varying temperatures but a constant amount of glucose, constant pH levels, and a known amount of enzyme.
Answer: c
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 3. Applying

63. Many enzymes require ATP and ADP for a reaction to occur. These molecules temporarily bind to and then are released from the substrate before participating in other reactions. ATP and ADP are thus considered
a. side chains.
b. coenzymes.
c. a coupled reaction.
d. prosthetic groups.
e. cofactors.
Answer: b
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 2. Understanding

64. Enzymatic reactions can become saturated as substrate concentration increases because
a. enzymes have the maximum possible number of hydrogen atoms attached to them.
b. the concentration of substrate reaches a point at which it cannot increase any further.
c. substrates are inhibitors of enzymes at high concentrations.
d. the activation energy of the reaction reaches a point at which it cannot be lowered further.
e. there are limited enzyme molecules present.
Answer: e
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 2. Understanding

65. Competitive inhibitors of enzymes work by
a. fitting into the active site.
b. fitting into a site other than the active site.
c. altering the shape of the enzyme.
d. changing the enzyme into an inactive form.
e. increasing the activation energy of the enzyme-catalyzed reaction.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

66. Nerve gases such as sarin and malathion
a. block specific chemical transformations by inactivating specific enzymes.
b. have reversible effects on animals.
c. are proteins with a primary structure.
d. block the energy coupling cycle of ATP.
e. hydrogen bond to the active site of the enzyme.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

67. How do competitive and noncompetitive enzyme inhibitors differ from each other?

a. Competitive inhibitors bind to the active site, whereas noncompetitive inhibitors change the shape of the active site.
b. Competitive inhibitors have a higher energy of activation than noncompetitive inhibitors have.
c. They function at different pH values.
d. Noncompetitive enzyme inhibitors contain magnesium, whereas competitive inhibitors contain iron.
e. Noncompetitive enzyme inhibitors are reversible, whereas competitive inhibitors are irreversible.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

68. The addition of the competitive inhibitor mevinolin slows the reaction HMG-CoA → mevalonate, which is catalyzed by the enzyme HMG-CoA reductase. In order to overcome the effects of mevinolin and increase the rate of the reaction you would
a. add more mevalonate.
b. add more HMG-CoA.
c. lower the temperature of the reaction.
d. add a prosthetic group.
e. lower the rate constant of the reaction.
Answer: b
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 3. Applying

69. You observe an enzymatic reaction that exhibits a standard relationship between reaction rate and substrate concentration as it converts substrate B to product C. When you add compound A, the creation of product C comes to a complete stop. You add large quantities of substrate B but still are unable to create product C in the presence of compound A. Compound A is therefore most likely a(n)
a. noncompetitive inhibitor.
b. competitive inhibitor.
c. coenzyme.
d. allosteric inhibitor.
e. Either a or d
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 5. Evaluating

70. A noncompetitive inhibitor inhibits binding of a substrate to an enzyme by
a. binding to the substrate.
b. binding to the active site.
c. lowering the activation energy.
d. increasing the ΔG of the reaction.
e. changing the shape of the active site.
Answer: e

Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

71. Which type of inhibitor can be overcome completely by the addition of more substrate?
a. Irreversible
b. Noncompetitive
c. Competitive
d. Prosthetic
e. Isotonic
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

72. An allosteric inhibitor
a. decreases the concentration of an inactive enzyme.
b. changes the shape of an enzyme.
c. increases the concentration of a product.
d. changes the shape of a substrate.
e. increases the concentration of an enzyme–substrate complex.
Answer: b
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

73. An experiment is carried out in which a small amount of allosteric inhibitor is added to tube A and no inhibitor is added to tube B. The full reaction is completed in tube B twice as quickly as it is completed in tube A. The allosteric inhibitor therefore acted by
a. decreasing the number of enzyme molecules.
b. increasing the amount of the active form of the enzyme.
c. decreasing the amount of the inactive form of the enzyme.
d. decreasing the amount of the active form of the enzyme.
e. increasing the amount of substrate.
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 3. Applying

74. The inhibition of enzyme activity by noncompetitive inhibitors can be reduced
a. by decreasing the concentration of allosteric enzymes.
b. by decreasing the concentration of substrate.
c. by increasing the concentration of competitive inhibitor.
d. by increasing the concentration of substrate.
e. only when they become unbound.
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

75. You are working with an enzyme and wish to determine its saturation point. You note that the reaction rate increases slowly at first, then increases dramatically over a narrow range of substrate concentrations, and then levels off, creating a sigmoid-like reaction curve. You thus determine that this enzyme is regulated by
a. temperature.
b. pH.
c. an allosteric mechanism.
d. a competitive inhibitor.
e. a coenzyme.
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 3. Applying

76. Which of the following statements about allosteric regulators is true?
a. The plot of reaction rate versus substrate concentration for allosteric regulators often displays a sigmoid curve.
b. All enzymes can be allosterically regulated.
c. Allosteric regulators affect substrate binding but do not affect enzyme structure.
d. Binding of allosteric regulators is nonspecific.
e. Allosteric regulators bind to the active site, blocking enzyme function.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

77. You have duplicated the threonine-to-isoleucine metabolic pathway and want to determine the saturation level of threonine. You slowly add increasing amounts of threonine and observe that the reaction rate first increases slowly and then decreases. You also note that increasing the amount of isoleucine decreases the rate of the reaction. You thus determine that the pathway is regulated by
a. feedback inhibition.
b. a noncompetitive inhibitor.
c. a competitive inhibitor.
d. a coenzyme.
e. a prosthetic.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

78. The process that involves an end product acting as an inhibitor of an earlier step in a metabolic pathway is called
a. feedback activation.
b. feedback inhibition.
c. positive feedback.
d. concerted activation.
e. competitive inhibition.
Answer: b

Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

79. Enzymes are highly sensitive to pH and temperature because
a. changes in the environment raise their activation energy.
b. changes in temperature and pH readily break their peptide bonds.
c. pH and temperature affect their three-dimensional structure and side-chain chemistry.
d. at extreme temperatures and pH levels, coenzymes add chemical groups to the substrate.
e. extremes of temperature and pH level change their ionization rate.
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

80. Which of the following environmental conditions does *not* affect enzyme function?
a. Temperature
b. pH
c. Hydrophobicity
d. Salt concentration
e. All of the above affect enzyme function.
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

81. End products of biosynthetic pathways often act to block the initial step in that pathway. This phenomenon is called
a. posterior inhibition.
b. denaturation.
c. branch pathway inhibition.
d. feedback inhibition.
e. binary inhibition.
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

82. Denatured enzymes are
a. ribozymes.
b. synthesized *in vitro*.
c. types of isozymes.
d. nonfunctional enzymes.
e. converted to coenzymes.
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

83. Which of the following is a group of enzymes that are important in allowing organisms to adapt to changes in their environment?
a. Isozymes
b. Coenzymes
c. Allosteric enzymes
d. Both a and c
e. Both b and c
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

84. If the temperature of an enzyme-catalyzed reaction is increased from 40°C to 70°C, the rate of the reaction
a. will increase indefinitely.
b. will decrease immediately.
c. will decrease to zero because the enzyme will become denatured.
d. will decrease and then increase.
e. cannot be determined without information regarding optimal temperature.
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

85. When organisms move from one environment to another, they sometimes synthesize variations of existing enzymes, which are called
a. coenzymes.
b. abzymes.
c. isozymes.
d. effectors.
e. activators.
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

Fill in the Blank

1. Cells cannot make energy because _____ cannot be created or destroyed.
Answer: energy
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

2. In the hydrolysis of ATP to ADP and P_i, ATP is the _____ and ADP and P_i are the _____.
Answer: reactant; products
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?

Bloom's Category: 1. Remembering

3. Heat, light, electricity, and motion are all examples of _____ energy.
Answer: kinetic
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

4. The energy in a system that exists due to position is called _____ energy.
Answer: potential
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

5. The building up of molecules in a living system is known as _____; the breaking down of molecules in a living system is known as _____.
Answer: anabolism; catabolism
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

6. The first law of thermodynamics states that _____ is neither created nor destroyed.
Answer: energy
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

7. The second law of thermodynamics states that the _____, or disorder, of the universe is constantly increasing.
Answer: entropy
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

8. When a drop of ink is added to a beaker of water, the dye molecules become randomly dispersed throughout the water. This is an example of an increase in _____.
Answer: entropy
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

9. If the ΔG of a spontaneous reaction is negative, indicating that the reaction releases free energy, the reaction is _____.
Answer: exergonic
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?

Bloom's Category: 2. Understanding

10. Cells mostly use _____ as an immediate source of energy to drive reactions.
Answer: ATP
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 1. Remembering

11. A reaction with a ΔG of –14.3 kcal/mol releases energy that is then used by a second reaction with a ΔG of +10.2 kcal/mol. The net free energy change of the coupled reactions is _____.
Answer: –4.3 kcal/mol
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 3. Applying

12. Enzymes function as biological _____.
Answer: catalysts
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

13. The amount of energy needed to start a reaction is known as its _____ energy.
Answer: activation
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

14. The enzyme phosphoglucoisomerase catalyzes the conversion of glucose 6-phosphate to fructose 6-phosphate. The region on phosphoglucoisomerase where glucose 6-phosphate binds is called the _____.
Answer: active site
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

15. A change in enzyme shape caused by substrate binding is called _____.
Answer: induced fit
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 1. Remembering

16. Although some enzymes consist entirely of one or more polypeptide chains, others possess a permanently bound nonprotein portion called a(n) _____.
Answer: prosthetic group
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 1. Remembering

17. Zinc or iron ions that bind to enzymes and aid in their function are called _____.
Answer: cofactors
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?

Bloom's Category: 1. Remembering

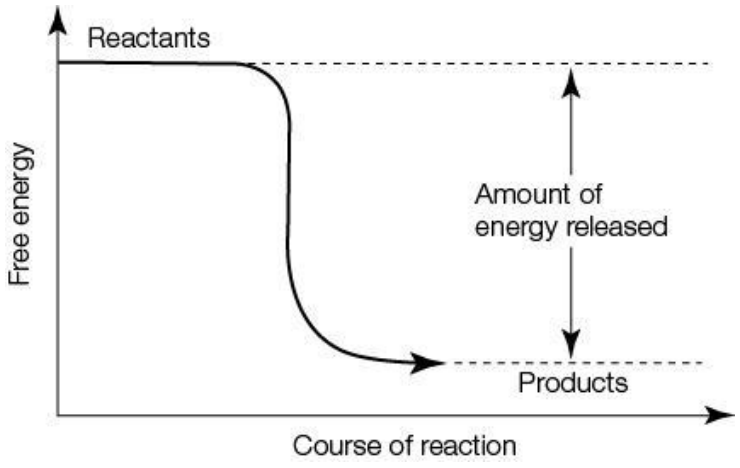
18. The chemical activities of a living organism are organized into _____ in which the product of one reaction is the reactant for the next reaction.
Answer: metabolic pathways
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

19. Variations of enzymes that allow organisms to adapt to changing environments are termed _____.
Answer: isozymes
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

20. When an enzyme is heated until its three-dimensional structure is destroyed, the enzyme is said to be _____.
Answer: denatured
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

Diagram

1.–2. Refer to the figure below showing the change in free energy resulting from a chemical reaction.

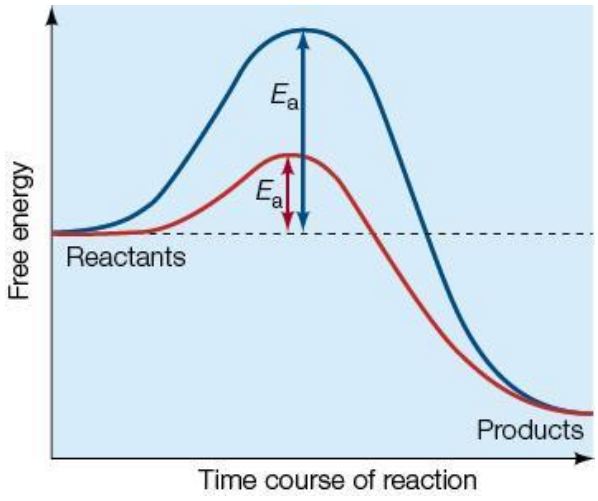


1. Which of the following statements about the reaction shown is true?
a. It is an endergonic reaction.
b. The reactants have less energy than the products.
c. ΔG is negative.
d. It is an example of a condensation reaction.
e. It is an anabolic reaction.
Answer: c

Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

2. Which of the following reactions is most likely to have a change in free energy similar to the one shown?
a. Hydrolysis of ATP
b. Synthesis of sucrose from glucose and fructose
c. Synthesis of ATP from ADP and P_i
d. Formation of oxyluciferin from luciferin
e. Formation of glucose-6-phosphate from glucose
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

3.–4. Refer to the figure below.

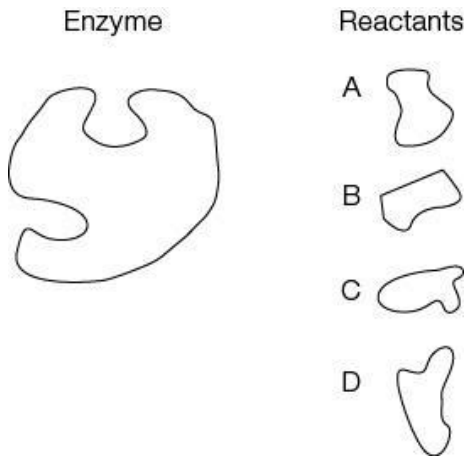


3. Which curve of the graph represents a catalyzed reaction and which curve represents an uncatalyzed reaction?
a. The top is catalyzed and the bottom is uncatalyzed.
b. The bottom is catalyzed and the top is uncatalyzed.
c. Both are catalyzed.
d. Both are uncatalyzed.
e. The value of ΔG is needed to answer this question.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 4. Analyzing

4. The curve of the graph tells us that
a. the change in free energy of both reactions is negative.

b. the change in free energy of both reactions is positive.
c. the catalyzed reaction has a greater amount of free energy than the uncatalyzed reaction.
d. the change in free energy is the same for both reactions.
e. Both a and d
Answer: e
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 4. Analyzing

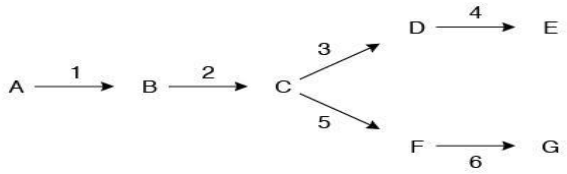
5.–6. Refer to the diagram below showing an enzyme and four reactants.



5. Based on the diagram, the enzyme is likely to bind reactants
Answer: A and C
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 3. Applying

6. If you wanted to permanently block the function of the enzyme shown, you could add
a. a molecule that can covalently bind the active sites.
b. more product.
c. a noncompetitive inhibitor.
d. an allosteric inhibitor.
e. a competitive inhibitor.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

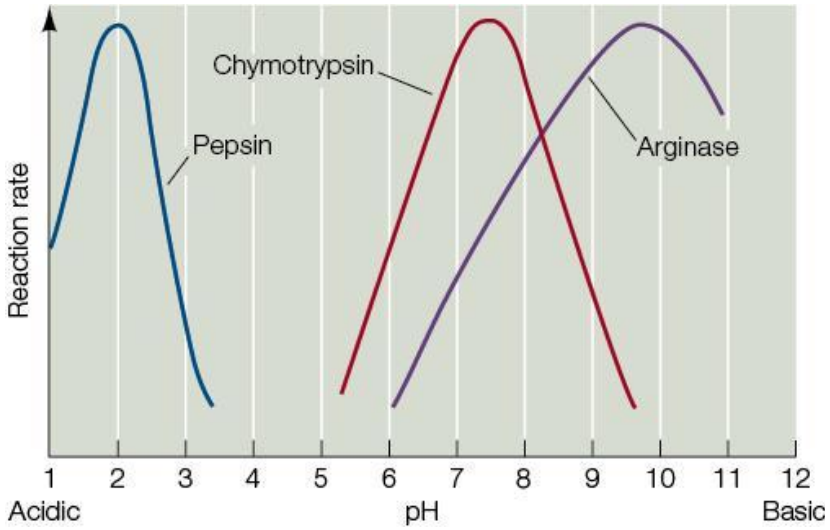
7.–8. Refer to the diagram below showing a metabolic pathway. Reactants and products are designated by capital letters; enzymes are designated by numbers.



7. If enzyme 2 is inactive, what product(s) would be produced from the metabolic pathway?
Answer: B
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

8. If end product E allosterically inhibits enzyme 1, a buildup of E in the cell will result in _____ production of _____.
a. reduced; G
b. reduced; A
c. increased; G
d. increased; E
e. increased; D
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

9.–10. Refer to the diagram below showing the activity of several enzymes at varying pH levels.



9. Based on the diagram, what is the pH at which pepsin would exhibit the most activity?
a. 1.0

b. 1.5
c. 2.0
d. 2.8
e. 3.4
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

10. Based on the diagram, achieving the maximum rate of both chymotrypsin and arginase activity in the same reaction would require a pH of about
a. 6.8.
b. 7.2.
c. 7.5.
d. 8.2.
e. 9.0.
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

DIAGNOSTIC QUIZ QUESTIONS (from BioPortal)

(By Amy Burnside)

1. Why is the statement, "ATP creates energy for life," *incorrect*?
a. Energy is required to make ATP.
b. It is a violation of the second law of thermodynamics.
c. It is a violation of the first law of kinetics.
d. It is a violation of the first law of thermodynamics.
e. Life produces ATP.
Answer: d
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

2. Which of the following statements disagrees with the second law of thermodynamics?
a. The disorder of a system decreases overall with time.
b. Chemical energy may be converted to light energy.
c. Only a portion of the total energy of a system is available to do work.
d. Potential energy may be used to do work.
e. During energy conversion some energy can be lost as heat.
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

3. Entropy

a. is the total energy in a system.
b. tends to decrease the total energy in the universe.
c. when multiplied times the absolute temperature is the useable energy in a system.
d. tends to increase in a spontaneous reaction.
e. is represented in equations by the letter "H."
Answer: d
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

4. The synthesis of complex molecules is _____, whereas their degradation is _____. Synthesis occurs with _____ in entropy.
a. endergonic; exergonic; an increase
b. endergonic; exergonic; a decrease
c. exergonic; endergonic; no change
d. exergonic; endergonic; an increase
e. endergonic; exergonic; no change
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

5. A reaction that has a negative ΔG

a. is endergonic.

b. proceeds more rapidly than a reaction with a neutral ΔG.

c. is spontaneous.

d. cannot be used to drive a reaction with a positive ΔG.

e. must have a negative change in enthalpy.
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

6. Suppose the reaction A→B has a large, negative ΔG. The reaction would proceed _____, at equilibrium _____ would be present, and _____.
a. from A to B; mostly B would be present; insufficient information is given to predict the rate of the reaction.
b. from B to A; mostly A would be present; the reaction would be slow
c. from A to B; mostly B would be present; the reaction would be fast
d. from A to B; mostly B would be present; the reaction would be slow
e. Not enough information is provided.
Answer: a

Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 4. Analyzing

7. If ΔG for a reaction is positive, the reaction

a. is spontaneous.
b. could drive an energy-requiring process.
c. is endergonic.

d. would have a positive ΔH.

e. would proceed quickly.
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

8. Which of the following parameters is indicative of how far and in what direction a reaction will progress?
a. The concentration of reactants

b. The change in free energy of the reaction (ΔG)

c. The concentration of products

d. The change in enthalpy of the reaction (ΔH)

e. The overall size of the system in which the reaction occurs
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 1. Remembering

9. Which of the following statements about ATP is *false*?
a. The synthesis of ATP is an endergonic reaction.
b. The hydrolysis of ATP to ADP and P_i is an exergonic reaction.
c. The phosphate bond energy of ATP cannot be harnessed for work.
d. ATP is a building block of RNA.
e. The phosphate bond energy of ATP may be transformed into light.
Answer: c
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 3. Applying

10. The correct order of the four derivatives of ATP from the least number of attached phosphate groups to most number of attached phosphate groups is
a. ADP, ATP, adenosine, and AMP.
b. ATP, ADP, AMP, and adenosine.
c. adenosine, ATP, ADP, and AMP.
d. adenosine, AMP, ADP, and ATP.

e. AMP, ADP, ATP, and adenosine.
Answer: d
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

11. To be metabolized, glucose must be converted to glucose 6-phosphate. However, at equilibrium, a mixture of glucose and phosphate at concentrations that exist in cells would contain little glucose 6-phosphate. How do cells circumvent this problem?
a. An enzyme raises the activation energy barrier to favor glucose 6-phosphate formation.
b. An enzyme changes the equilibrium constant for the reaction to favor glucose 6-phosphate formation.
c. ATP is used as the donor of the phosphate group, and the formation of glucose 6-phosphate is endergonic.
d. ATP is used as the donor of the phosphate group, and thus the formation of glucose 6-phosphate is exergonic.
e. Phosphate from the hydrolysis of ADP is used to phosphorylate glucose.
Answer: d
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 3. Applying

12. You are given two reactions; reaction A has a ΔG of −7.3 and reaction B has a ΔG of +4.0. The overall coupled reaction would be _____ with an overall ΔG of _____.
a. exergonic; −10.3
b. endergonic; −3.3
c. exergonic; −3.3
d. endergonic; +3.3
e. exergonic; +10.3
Answer: c
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 3. Applying

13. The binding of a substrate to an enzyme
a. is always covalent.
b. is irreversible.
c. is nonspecific.
d. may involve hydrogen bonds and van der Waals interactions.
e. does not induce shape changes in the enzyme.
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Page: 151
Bloom's Category: 2. Understanding

14. Which of the following is *not* a way that enzymes increase a rate of a reaction?
a. Orienting substrates
b. Inducing strain on the substrate

c. Reacting chemically with the substrate
d. Donating a proton to the substrate
e. Permanently binding the substrate
Answer: e
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 3. Applying

15. A prosthetic group of an enzyme is
a. easily dissociated from the enzyme.
b. an organic molecule usually made up of amino acids.
c. required by some enzymes in order to function as a catalyst.
d. permanently altered by the reaction catalyzed by the enzyme.
e. consumed in the enzymatic reaction.
Answer: c
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 2. Understanding

16. In a reaction catalyzed by an enzyme,
a. the enzyme's structure is permanently modified.
b. the rate of the reaction is linearly dependent on the substrate concentration.
c. the enzyme does not affect the equilibrium constant for the reaction.
d. substrate binding is nonspecific.
e. the rate of the reaction is unaffected by temperature.
Answer: c
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 2. Understanding

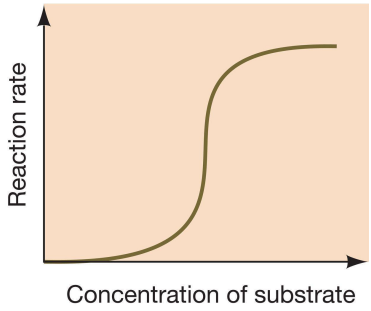
17. Which of the following effectors of enzyme activity is *least* likely to be utilized by cells?
a. Allosteric inhibitors
b. Allosteric activators
c. Competitive inhibitors
d. Noncompetitive inhibitors
e. Irreversible inhibitors
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 2. Understanding

18. A competitive inhibitor of an enzyme-catalyzed reaction
a. always interferes with product release.
b. inhibits to the same extent at all substrate concentrations.
c. cannot bind to the active site.
d. binds to an allosteric site.
e. is usually structurally similar to the substrate.
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?

Bloom's Category: 3. Applying

19. An enzyme, which is a component of a metabolic pathway, is allosterically regulated by a downstream intermediate of that particular metabolic pathway. Which of the following is a likely role for this particular enzyme?
a. It regulates the pathway through a feedback inhibition mechanism.
b. It is inhibited by upstream intermediates of the pathway.
c. It acts by degrading other enzymes in the pathway.
d. It irreversibly binds to the product of its pathway step, reducing product concentration.
e. It senses the optimal temperature for the pathway by denaturing at excessively high temperature.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 3. Applying

20. Working in the laboratory, you generate an enzyme activity curve for an unknown enzyme. The curve is shown below.



Which of the following statements best explains the shape of this curve?
a. The enzyme has multiple active sites. As the enzyme binds substrate at one site, it increases affinity for binding substrate at other active sites.
b. The enzyme has a single active site. As the enzyme binds substrate, the activity of the enzyme stalls until it can clear the active site.
c. The enzyme has multiple active sites. As the substrate concentration increases, all sites must be equally bound for the reaction to proceed.
d. The enzyme has multiple active sites. Substrate binding at each of the sites is dependent upon the temperature of the reaction.
e. The enzyme has a single active site. Substrate binding at this particular site occurs within a narrow pH range, termed the equivalence point.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

LEARNINGCURVE QUESTIONS (from BioPortal)

(By Author)

1. All of the following are examples of potential energy *except*
a. chemical bonds.
b. concentration gradients.
c. electrical charge imbalance.
d. muscle contractions.
e. electromagnetic radiation stored as photons.
Answer: d
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Easy
Bloom's Category: 2. Understanding

2. Anabolic reactions
a. require an input of energy.
b. are the breakdown of complex molecules into more simple components.
c. always occur in the absence of catabolic reactions.
d. are examples of kinetic energy.
e. require light.
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Easy
Bloom's Category: 2. Understanding

3. The synthesis of the enzyme lipase would be classified as anabolic because
a. the resulting enzyme can catalyze the breakdown of lipids for energy.
b. energy is captured in the peptide bonds between the amino acids that compose lipase.
c. synthesis of lipase increases entropy as compared to the free amino acids.
d. an increase in temperature is required to make the enzyme.
e. free amino acids have greater free energy than the lipase enzyme.
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Hard
Bloom's Category: 3. Applying

4. Regarding coupled reactions, the breakdown of carbohydrates could be linked to
a. catabolism of proteins.
b. muscle contractions.
c. anabolism of lipids.
d. conversion of ATP to ADP.
e. an exothermic reaction.
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?

Difficulty: Hard
Bloom's Category: 3. Applying

5. Fireflies illuminate their abdomens through the conversion of chemical energy to light. With respect to the second law of thermodynamics, which of the following events is occurring in this example?
a. Disorder of the system decreases.
b. Entropy of the system increases.
c. Energy is being created.
d. Total free energy of the system increases.
e. Enthalpy of the system increases.
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Easy
Bloom's Category: 2. Understanding

6. ΔG of a reaction is dependent upon all of the following *except*
a. the free energy of the products.
b. the free energy of the reactants.
c. the change in enthalpy.
d. the change in entropy.
e. the change in the activation energy.
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Easy
Bloom's Category: 2. Understanding

7. A reaction with a negative ΔG
a. releases energy.
b. consumes energy.
c. has products with a higher free energy than the reactants.
d. is endergonic.
e. is anabolic.
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Easy
Bloom's Category: 2. Understanding

8. The hydrolysis of sucrose into glucose and fructose by the enzyme sucrase
a. increases entropy.
b. is endergonic, leading to a decrease in temperature.
c. is an example of anabolism.
d. consumes free energy.

e. will have a $\Delta G = 0$ due to the presence of sucrose.

Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Hard
Bloom's Category: 4. Analyzing

9. If the conversion of glucose-1-phosphate to glucose-6-phosphate proceeded to completion, how much glucose-6-phosphate would there be if the starting concentration of glucose-1-phosphate were 0.1 M?
a. 0.1 M
b. 0.0 M
c. 0.05 M
d. 0.095 M
e. 0.005 M
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Medium
Bloom's Category: 4. Analyzing

10. At a chemical equilibrium of 14:1 reactants to products, what would be the final concentration of the reactants if the input concentration were 3.0 M?
a. 3.0 M
b. 1.5 M
c. 2.8 M
d. 0.2 M
e. 0.1 M
Answer: c
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Hard
Bloom's Category: 3. Applying

11. Which of the following reactions will progress the farthest toward completion?

a. A reaction with $\Delta G = 0$

b. A reaction with $\Delta G = -14$ kcal/mol

c. A reaction with $\Delta G = +14$ kcal/mol

d. A reaction with $\Delta G = -28$ kcal/mol

e. A reaction with $\Delta G = +28$ kcal/mol

Answer: d

Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Medium
Bloom's Category: 3. Applying

12. What would happen to the value of ΔG for the reaction in which phosphoenolpyruvate is converted to pyruvate (ΔG = –23 kJ/mol) when it reaches equilibrium?
a. Nothing would happen.
b. ΔG would become more negative.
c. ΔG would become more positive.
d. ΔG would depend on the activity of its enzyme pyruvate kinase.
e. ΔG would equal 0.
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Medium
Bloom's Category: 3. Applying

13. In a biological system you want to determine if the conversion of A to B is at equilibrium. Which of the following is a reasonable method to use to answer this question?
a. Measure the rate of conversion from A to B and compare it to the rate at which B converts to A.
b. Measure the change in free energy at varying temperatures.
c. Add more A and see if B decreases.
d. Measure the concentrations of A and B and see if they are equal.
e. Add the competitive inhibitor C to see if the reaction stops.
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Hard
Bloom's Category: 4. Analyzing

14. In order to calculate the ΔG for the conversion of fructose 6-phosphate to fructose 1,6-bisphosphate you set up the reaction at 25°C with 1 M reactants and
a. change the concentration of the product.
b. change the temperature.
c. add 1 M of product.
d. alter the pH.

e. maintain one atmospheric pressure.
Answer: e
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Medium
Bloom's Category: 3 Applying

15. Which of the following could we infer about a chemical reaction with a high change in entropy (ΔS) and no corresponding change in enthalpy (ΔH)?

a. Total ΔG of the reaction will decrease.
b. The disorder of the system will decrease.
c. The temperature at which the reaction occurs will change.
d. The reaction is anabolic in nature.
e. The reaction is highly complex.
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Difficulty: Medium
Bloom's Category: 3. Applying

16. The energy currency of cells is
a. light.
b. heat.
c. glucose.
d. ATP.
e. nucleic acids.
Answer: d
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Easy
Bloom's Category: 1. Remembering

17. In solution, ATP is readily hydrolyzed into
a. ribose and three phosphate ions.
b. ADP and two pyrophosphate ions.
c. AMP and two pyrophosphate ions.
d. ADP and adenosine.
e. adenine and three phosphate ions.
Answer: c
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Medium
Bloom's Category: 2. Understanding

18. Which type of reaction is used to break down ATP into ADP and P_i?
a. Hydrolysis
b. Condensation

c. Phosphorylation
d. Glycosylation
e. Deamination
Answer: a
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Medium
Bloom's Category: 2. Understanding

19. ATP serves a role in all of the following *except*
a. acting as a building block for nucleic acids.
b. phosphorylation of molecules, transferring stored energy.
c. releasing energy for endergonic reactions.
d. the assembly of phospholipid bilayers.
e. conversion of potential to kinetic energy.
Answer: d
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Medium
Bloom's Category: 2. Understanding

20. The creation of ATP from ADP requires the addition of
a. an electron.
b. a phosphate ion.
c. a hydrogen.
d. an adenosine.
e. a hydroxyl group (–OH).
Answer: b
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Easy
Bloom's Category: 2. Understanding

21. The energy required to convert ATP into ADP is
a. greater than the energy formed by the hydrolysis of ATP.
b. less than the energy created by the hydrolysis of ATP.
c. less than the energy needed by the reverse reaction.
d. more than the reverse reaction of ADP to ATP.
e. equal to the energy produced by the condensation of ATP.
Answer: e
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Easy
Bloom's Category: 2. Understanding

22. The conversion of A to B, which is an endergonic reaction, can proceed if it is
a. coupled with the hydrolysis of ATP.
b. coupled with the condensation of ADP.
c. coupled with the formation of water bonds.
d. isolated from water molecules.

e. coupled with a reaction that requires energy.
Answer: a
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Medium
Bloom's Category: 2. Understanding

23. How would you test whether a given reaction is endergonic?
a. Add ATP and see if the reaction creates more product.
b. Add ADP and see if the reaction creates phosphate ions.
c. Add adenine and see if the reaction makes reactants instead of product.
d. Add phosphate and see if the reaction creates ATP.
e. Add water and see if the reaction produces ADP.
Answer: a
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Hard
Bloom's Category: 3. Applying

24. Firefly bioluminescence occurs through the reaction of luciferin with luciferase. Attempting to impress your friend, you find these reagents in the lab, mix them together, and no bioluminescence occurs. What other reagent in the laboratory could you add to generate light and therefore impress your friends?
a. Purified AMP
b. Add more purified luciferase
c. Add oxyluciferin
d. Hold the test tube under a strong light source
e. Purified ATP
Answer: e
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Hard
Bloom's Category: 4. Analyzing

25. During the metabolism of glucose, the conversion of glucose to glucose 6-phosphate cannot proceed without the hydrolysis of ATP. Why is this so?
a. Light energy needs to be converted to chemical energy.
b. Glucose 6-phosphate has a lower free energy than glucose.
c. The reaction is spontaneous.
d. There is a large decrease in free energy.
e. The reaction is endergonic.
Answer: e
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Hard
Bloom's Category: 4. Analyzing

26. Where is the energy of a molecule of ATP contained?
a. The 3′ –OH bond of the ribose sugar
b. The P~O bond

c. In the N–C bonds of the adenine base group
d. In hydrogen bonds with another ATP molecule
e. In solution with H_2O
Answer: b
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Easy
Bloom's Category: 1. Remembering

27. How much energy is released when 1.0 moles of ATP are hydrolyzed?
a. 0.73 kcal
b. 730 kcal
c. 7.3 kcal
d. 21.7 kcal
e. 30 kcal
Answer: c
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Easy
Bloom's Category: 1. Remembering

28. If you starve a cell in the laboratory, depriving it of all available ATP, which of the following cellular processes would you expect to cease?
a. Cell–cell signaling would stop.
b. Transport of cargo along microtubules would stop.
c. Anabolic reactions in the cell would cease.
d. Active uptake of materials through the membrane would stop.
e. All of the above
Answer: e
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Medium
Bloom's Category: 3. Applying

29. Within the cell, when an exergonic reaction and an endergonic reaction are coupled and the resulting reaction is *not* spontaneous, which is a reasonable conclusion regarding these coupled processes?
a. The reactions can only occur in the absence of heat and need to be placed on ice.
b. These processes likely require a third reaction that involves ATP synthesis to proceed.
c. These processes likely require a third reaction that involves ATP hydrolysis to proceed.
d. The two reactions each involve the catabolism of some substrate.
e. Neither the endergonic reaction nor the exergonic reaction from the coupled process require ATP.
Answer: c
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Hard
Bloom's Category: 3. Applying

30. Which of the following statements regarding ATP is *not* true?

a. The average person produces about 40 kg of ATP per day.
b. The average person hydrolyzes about 40 kg of ATP per day.
c. ATP is readily hydrolyzed in water.
d. ATP is chemically stable and can be stored easily for extensive periods of time.
e. ATP can be moved around the cell for its optimal use at a different location.
Answer: d
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Difficulty: Hard
Bloom's Category: 3. Applying

31. An enzyme

a. decreases the ΔG of a reaction.

b. increases the rate of reaction in only one direction.
c. creates an energy barrier for a reaction.
d. is always a protein.
e. is not affected by its three-dimensional structure.
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Easy
Bloom's Category: 1. Remembering

32. Which term describes the mode at which substrates will react?
a. Ground state
b. Reactant state
c. Product state
d. Transition state
e. Radiated state
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Easy
Bloom's Category: 1. Remembering

33. Which of the following choices best summarizes the energy level of each stage of an *exergonic* chemical reaction?
a. Products > transition state > reactants
b. Reactants > transition state > products
c. Products > reactants > transition state
d. Transition state > products > reactants
e. Reactants > products > transition state
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Medium
Bloom's Category: 2. Understanding

34. If all that is required to drive a chemical reaction is heat, why can't we speed up biological chemical reactions by heating the cell?

a. High energy costs are prohibitive for the whole cell.
b. Excess heat would indiscriminately speed up all chemical reactions, including desirable and undesirable reactions, as well as denature the biological compounds involved.
c. Organisms that have self-regulated body temperature, such as mammals, already heat their chemical reactions and do not need external heat sources.
d. Excess heat would slow down the rate of product formation for many chemical reactions.
e. Evenly heating the entire cell is technically difficult, mainly due to high concentrations of hydrophobic molecules in the phospholipid bilayer.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Medium
Bloom's Category: 2. Understanding

35. Transition-state intermediates have higher energies than the reactants and/or product because
a. energy has been supplied to the system to increase the ground state of the products.
b. energy has been used to supply the enzyme to the reaction.
c. the chemical bonds of the reactants have been stretched and stressed to near-breaking.
d. the transition state is further along the time course of the reaction.
e. the reactants have been completely used up to form products.
Answer: c
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Medium
Bloom's Category: 2. Understanding

36. Which of the following best summarizes the energy level of each stage of an *endergonic* chemical reaction?
a. Products > transition state > reactants
b. Reactants > transition state > products
c. Products > reactants > transition state
d. Transition state > products > reactants
e. Reactants > products > transition state
Answer: a
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Hard
Bloom's Category: 4. Analyzing

37. Which term describes the location on the enzyme where the substrates are bound?
a. Inactive site
b. Allosteric site
c. Active site
d. Inhibition site
e. Helical site
Answer: c

Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Easy
Bloom's Category: 1. Remembering

38. The term for the reactants in an enzyme catalyzed reaction is
a. enzymatic reactants.
b. the participants.
c. the substrates.
d. the products.
e. enzymatic products.
Answer: c
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Easy
Bloom's Category: 1. Remembering

39. Upon examination of a reaction with three components A, B, and C, it is determined that C is the enzyme for the conversion of B into A. Which of the following would increase the speed of formation of A?
a. Add more B.
b. Add more C.
c. Remove B.
d. Remove C.
e. There is not enough information.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Hard
Bloom's Category: 3. Applying

40. Which of the following examples best illustrates the nature of the enzyme–substrate interaction?
a. The repulsion of two similarly charged particles, like two electrons
b. The attraction of two oppositely charged particles, like a proton and an electron
c. An adhesive property of the enzyme and substrate that allows them to stick together
d. A perfect fit of substrate with the active site of an enzyme, akin to a lock-and-key fit
e. Irreversible binding of the substrate to the active site, like welding two pieces of metal together
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Hard
Bloom's Category: 4. Analyzing

41. Which of the following is the correct general equation for an enzyme-catalyzed reaction?
a. $E \rightarrow S + P$
b. $P + S \rightarrow E + P \rightarrow EP$
c. $S \rightarrow E + P$

d. E + S → ES → E + P
e. P → E + P → EP → S
Answer: d
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Easy
Bloom's Category: 1. Remembering

42. Based on the dissociation constant for a theoretical enzyme, anyase, which of the following substrates will produce the highest level of anyase–substrate complexes?
a. Substrate "A," $K_D = 10^{-7}$M
b. Substrate "B," $K_D = 10^{-4}$M
c. Substrate "C," $K_D = 10^{0}$M
d. Substrate "D," $K_D = 10^{4}$M
e. Substrate "E," $K_D = 10^{7}$M
Answer: a
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Hard
Bloom's Category: 3. Applying

43. Which of the following statements is true regarding enzyme–substrate (ES) complexes?

a. The formation of an ES complex helps to lower the ΔG of the reaction, favoring product formation.

b. The formation of an ES complex helps to lower the ΔH of the reaction, favoring product formation.
c. The formation of an ES complex helps to favor achieving the transition state, favoring product formation.
d. The formation of an ES complex helps to convert the chemical reaction from exergonic to endergonic.
e. The formation of an ES complex helps to convert the chemical reaction from endergonic to exergonic.
Answer: c
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Hard
Bloom's Category: 4. Analyzing

44. Considering the reaction that converts glucose 1-phosphate to glucose 6-phosphate, which of the following changes to the reaction would *not* affect the ΔG of the reaction?

a. Decrease in glucose 1-phosphate
b. Increase in temperature
c. Decrease in pH
d. Increase in enzyme concentration
e. Change in pressure
Answer: d

Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Medium
Bloom's Category: 4. Analyzing

45. Which of the following best describes the means by which enzymes function in an enzyme-catalyzed reaction?
a. Enzymes lower the energy barrier necessary to achieve the transition state of a reaction.
b. Enzymes lower the concentration of the products, thereby driving the reaction to favor product formation.
c. Enzymes lower the concentration of the substrates, thereby driving the equilibrium to favor product formation.
d. Enzymes absorb the change in enthalpy (ΔH), permitting a reaction to proceed.
e. Enzymes are completely used up in the course of the reaction and therefore favor product formation.
Answer: a
Textbook Reference: 8.3 What Are Enzymes?
Difficulty: Medium
Bloom's Category: 2. Understanding

46. Which of the following best describes how enzymes work?
a. Enzymes orient substrates for chemical reactions.
b. Enzymes induce strain in the substrate for chemical reactions.
c. Enzymes can temporarily add chemical groups to substrates.
d. Both a and c
e. a, b, and c
Answer: e
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Easy
Bloom's Category: 4. Analyzing

47. Which of the following is an example of an enzyme changing the orientation of a substrate to lower the activation energy?
a. Alignment of the substrate atoms so they are brought into proximity with each other, favoring the chemical reaction
b. Altering the hydrophobicity of a substrate (e.g., making a hydrophobic molecule hydrophilic)
c. Induced fit alters the shape of the enzyme and favors expulsion of the substrate
d. Alignment of two different substrates such that their reactive atoms are held as far apart as possible
e. Chemically cleaving the substrate so that the small substrate fragments can enter solution more easily
Answer: a
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Medium
Bloom's Category: 2. Understanding

48. Which of the following components of an enzyme may be a direct participant in making substrates more chemically reactive?
a. The primary sequence of the enzyme
b. The peptide bonds of the enzyme
c. The amino acid side chains of the enzyme
d. The amino-terminus of the enzyme
e. The carboxy-terminus of the enzyme
Answer: c
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Easy
Bloom's Category: 1. Remembering

49. Which of the following can participate in an enzymatic reaction as electron donors or acceptors?
a. Hydrophobic side chains in the active site
b. Metal ions bound to amino acid side chains in the active site
c. Peptide bonds that are exposed to the active site of an enzyme
d. Both a and c
e. None of the above
Answer: b
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Hard
Bloom's Category: 4. Analyzing

50. Which of the following would be the best method to identify the maximum efficiency of an unknown enzyme in solution?
a. Heat the enzyme solution to boiling.
b. Cool the enzyme solution to freezing.
c. Measure the amount of substrate converted to product in a given period of time.
d. Measure the amount of product converted to substrate in a given period of time.
e. Alter the reaction condition pH until the reaction stops.
Answer: c
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Hard
Bloom's Category: 3. Applying

51. The formation of covalent bonds between active site side chains and the substrate is an example of _____ catalysis, whereas the transfer of protons between active site side chains and the substrate is an example of _____ catalysis.
a. metal ion; acid–base
b. metal ion; covalent
c. covalent; acid–base
d. binding; protonation
e. reversible; acid–base
Answer: c

Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Hard
Bloom's Category: 2. Understanding

52. Some enzymes change their shapes when they bind with their substrates. This shape change is called
a. a transition.
b. a reaction.
c. adaptation.
d. induced fit.
e. altered ground state.
Answer: d
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Easy
Bloom's Category: 1. Remembering

53. What features of the active site allow it to recognize and bind the substrate?
a. The active site shape is specific for the substrates.
b. The active site shape is specific for the products.
c. The active site is highly versatile and can bind a wide variety of molecules.
d. The active site is buried deep within a hydrophobic region of the enzyme.
e. The active site has a different shape than the substrate.
Answer: a
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Easy
Bloom's Category: 1. Remembering

54. Often the active site of an enzyme is much smaller relative to the rest of the enzyme. Which of the following are possible roles of the rest of the macromolecule?
a. It provides a framework so that the amino acids of the active site are properly positioned in relation to the substrate(s).
b. It participates in significant changes in protein shape and structure that result in induced fit.
c. It provides binding sites for regulatory molecules.
d. Both a and c
e. a, b, and c
Answer: d
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Medium
Bloom's Category: 2. Understanding

55. The conversion of glucose to glucose 6-phosphate is an enzyme catalyzed reaction, during which the enzyme hexokinase folds around the substrates (glucose and ATP) to exclude water molecules from the reaction site. This change in hexokinase is an example of
a. increasing solvent exclusion.

b. increasing solvent accessibility.
c. induced fit.
d. hydrophilic interactions.
e. metal ion exchange.
Answer: c
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Medium
Bloom's Category: 2. Understanding

56. A particular enzyme is used to convert substrate A into product B. If you wished to use this enzyme in another reaction with a different substrate, which of the following substrates could theoretically be acted on by the same enzyme?
a. A molecule with the same charge as A
b. A molecule with the same molecular weight as A
c. A molecule with the same atomic composition as A, but with different structure
d. A molecule with the same number of carbons as A
e. A molecule with a nearly identical three-dimensional shape as A
Answer: e
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Hard
Bloom's Category: 3. Applying

57. A key difference between coenzymes and inorganic cofactors is that
a. inorganic cofactors are not covalently bound to the enzyme, whereas coenzymes are.
b. coenzymes are carbon-containing molecules, whereas inorganic cofactors are usually ions.
c. coenzymes are usually ions, whereas inorganic cofactors are typically carbon-containing molecules.
d. inorganic cofactors have intrinsic catalytic activity, whereas coenzymes do not.
e. coenzymes have intrinsic catalytic activity, whereas inorganic cofactors do not.
Answer: b
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Medium
Bloom's Category: 1. Remembering

58. The activity of an enzyme was examined in the laboratory, as it catalyzed the formation of a product molecule, B, from a substrate, A. This reaction was carried out in an aqueous solution consisting of water and copper sulfate at a pH of 7. While attempting to repeat the experiment, you instead use a solution of pure distilled water (pH = 7) and observe that the rate of formation of B has decreased dramatically. What is the most likely explanation for this result?
a. The atmospheric pressure in the lab has changed, slowing down enzyme function.
b. The enzyme needs another carrier protein, like BSA, to function.
c. Product "B" is unstable and cannot be measured.
d. The enzyme needs copper ions to act as cofactors for optimal enzyme activity.
e. There is insufficient information to conclude what is happening.

Answer: d
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Hard
Bloom's Category: 4. Analyzing

59. Which of the following affects the reaction rate of an enzyme-catalyzed reaction?
a. The product concentration
b. The altitude at which the chemical reaction is occurring
c. Addition of a different enzyme to the reaction
d. Addition of more product to the reaction
e. The concentration of the substrate
Answer: e
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Easy
Bloom's Category: 2. Understanding

60. Which is an example of saturation of an enzyme-catalyzed reaction?
a. The number of substrate molecules is much smaller than the number of available enzyme molecules.
b. The number of product molecules is much larger than the number of substrate molecules.
c. The number of substrate molecules is much larger than the number of product molecules.
d. The number of substrate molecules is much larger than the number of available enzyme molecules.
e. The number of available enzyme molecules is in equilibrium with the number of substrate molecules.
Answer: d
Textbook Reference: 8.4 How Do Enzymes Work?
Difficulty: Medium
Bloom's Category: 3. Applying

61. Computer-based models, aimed at simulating the different biochemical pathways in a cell are frequently used in
a. evolutionary biology.
b. biochemistry.
c. microscopy.
d. systems biology.
e. microbiology.
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Easy
Bloom's Category: 1. Remembering

62. In cells, multiple biochemical pathways are all interconnected and often run simultaneously. Which elements act as regulatory checkpoints on these diverse pathways?
a. Carbohydrates
b. Enzymes
c. Lipids
d. Protons
e. Phosphate groups
Answer: b
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Medium
Bloom's Category: 2. Understanding

63. The binding of an effector molecule to an enzyme that produces a change in enzyme shape is termed a(n) _____ regulator.
a. covalent
b. ionic
c. malleable
d. allosteric
e. transformative
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Easy
Bloom's Category: 1. Remembering

64. An inhibitor that binds to the active site of an enzyme and cannot be removed without destroying the enzyme is known as a(n) _____ inhibitor.
a. irreversible
b. reversible
c. destructive
d. allosteric
e. competitive
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Easy
Bloom's Category: 1. Remembering

65. An inhibitor that binds to the active site is termed a(n) _____ inhibitor, whereas an inhibitor that binds to the enzyme–substrate complex is termed a(n) _____ inhibitor. These methods of inhibition are all examples of _____ inhibition.
a. competitive; noncompetitive; allosteric
b. competitive; uncompetitive; allosteric
c. uncompetitive; competitive; reversible
d. competitive; uncompetitive; reversible
e. competitive; uncompetitive; irreversible
Answer: d

Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Medium
Bloom's Category: 1. Remembering

66. The binding of an effector molecule on a regulatory site of an enzyme causes an alteration of the geometry of the active site and loss of enzymatic activity. This effector binding is freely reversible. This is an example of
a. passive enzymatic regulation.
b. competitive inhibition.
c. noncompetitive inhibition.
d. irreversible inhibition.
e. isosteric regulation.
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Medium
Bloom's Category: 2. Understanding

67. When working in the laboratory, you note the activity of an enzyme in a cell. Upon isolating and purifying the enzyme from the cell, you find that the enzyme no longer has any activity. Addition of cell extract (but not substrate) back to the test tube restores enzymatic activity. Which of the following is the most likely conclusion that can be drawn from these observations?
a. The enzyme was denatured during the isolation process.
b. The cell extract contained an effector molecule that stabilized the enzyme in an active conformation.
c. The cell extract contained an irreversible inhibitor.
d. Purification of the enzyme deprived it of product.
e. The substrate was limiting the reaction.
Answer: b
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Hard
Bloom's Category: 3. Applying

68. When generating an activity curve of a newly discovered enzyme, the resultant plot of enzyme activity versus substrate concentration has a sigmoidal (S-curve) appearance. Such an activity curve is highly indicative of which type of enzyme?
a. A noncompetitively inhibited enzyme
b. A competitively inhibited enzyme
c. A nonallosteric enzyme
d. A multisubunit allosteric enzyme
e. An irreversibly phosphorylated enzyme
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Hard
Bloom's Category: 3. Applying

69. Which of the following conclusions regarding allosterically regulated enzymes would be valid?
a. Allosterically regulated enzymes likely have quaternary structure.
b. The enzyme is locked in a rigid conformation, indicating that induced fit does not occur.
c. The allosteric regulatory sites are distinct from the active site and may even be on different subunits.
d. Both a and b
e. Both a and c
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Hard
Bloom's Category: 4. Analyzing

70. Which of the following is a likely explanation for why a cell might down-regulate a metabolic pathway?
a. The continuous production of a molecule that is no longer needed is energetically wasteful.
b. The cell can readily obtain the product from the environment.
c. The cell needs an intermediate from this metabolic pathway as a component of another, parallel pathway.
d. Both a and b
e. a, b, and c
Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Medium
Bloom's Category: 2. Understanding

71. Some kinases can affect the activity of an enzyme by the addition of phosphate groups, which can then be removed, much like an "on/off" switch. These modifications are an example of
a. kinase activity.
b. phosphatase activity.
c. reversible phosphorylation.
d. irreversible phosphorylation.
e. light-switch mechanism.
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Medium
Bloom's Category: 2. Understanding

72. Which of the following environmental conditions can affect an enzyme's activity?
a. Temperature
b. Enzyme concentration
c. pH of the reaction
d. Both a and b

e. Both a and c
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Easy
Bloom's Category: 1. Remembering

73. Which of the following enzymes would have activities that are most sensitive to changes in pH?
a. Enzymes with nonpolar side chains at the active site
b. Enzymes with amino ($–NH_2$) or carboxy (–COOH) side chains at the active site
c. Enzymes with metal ions bound to nonpolar side chains at the active site
d. Enzymes with structurally smaller side chains (e.g., –H) at the active site
e. Enzymes with structurally rigid side chains (e.g., proline residues) at the active site
Answer: b
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Hard
Bloom's Category: 4. Analyzing

74. A group of enzymes that catalyze the same reaction but have different amino acid compositions and physical properties are known as
a. schizozymes.
b. homozymes.
c. isozymes.
d. heterozymes.
e. schizoheterozymes.
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Easy
Bloom's Category: 1. Remembering

75. Which of the following enzymes are most likely to be *unaffected* by an increase in temperature?
a. Enzymes isolated from bacteria that colonize geothermal vents at the bottom of the ocean
b. Enzymes isolated from the gut of fish that live in temperate lakes and streams
c. Enzymes isolated from the intestines of mammals
d. Enzymes isolated from the lymph of shrimp species that live in the Arctic Ocean
e. Enzymes isolated from the bloodstream of tropical birds
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Difficulty: Hard
Bloom's Category: 3. Applying

STUDY GUIDE QUESTIONS

(By Mark Sarvary)

1. ATP is necessary for the conversion of glucose to glucose 6-phosphate. Splitting ATP into ADP and P_i releases energy into what form that is used by the cell?
a. Potential energy
b. Kinetic energy
c. Entropic energy
d. Enthalpic energy
e. Heat energy
Answer: b
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 2. Understanding

2. Before ATP is split into ADP and P_i, it holds what type of energy?
a. Potential energy
b. Kinetic energy
c. Entropic energy
d. Enthalpic energy
e. Physical energy
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

3. Which of the following statements concerning energy transformations is true?
a. Increases in entropy reduce usable energy.
b. Energy may be created during transformation.
c. Potential energy increases with each transformation.
d. Increases in temperature decrease total amount of energy available.
e. Decreases in entropy reduce usable energy.
Answer: a
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

4. A reaction has a ΔG of –20 kcal/mol. This reaction is
a. endergonic, and equilibrium is far toward completion.
b. exergonic, and equilibrium is far toward completion.
c. endergonic, and the forward reaction occurs at the same rate as the reverse reaction.
d. exergonic, and the forward reaction occurs at the same rate as the reverse reaction.
e. of an indeterminate nature, according to the information provided.
Answer: b
Textbook Reference: 8.1 What Physical Principles Underlie Biological Energy Transformations?
Bloom's Category: 2. Understanding

5. ATP hydrolysis is

a. endergonic.
b. exergonic.
c. chemoautotrophic.
d. anabolic.
e. None of the above
Answer: b
Textbook Reference: 8.2 What Is the Role of ATP in Biochemical Energetics?
Bloom's Category: 1. Remembering

6. Enzymes are biological catalysts and function by
a. increasing the free energy in a system.
b. lowering the activation energy of a reaction.
c. lowering entropy in a system.
d. increasing the temperature near a reaction.
e. altering the equilibrium of a reaction.
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

7. Which of the following contributes to the specificity of enzymes?
a. Each enzyme has a wide range of temperature and pH optima.
b. Each enzyme has an active site that interacts with many substrates.
c. Substrates themselves may alter the active site slightly for optimum catalysis.
d. Enzymes are more active at higher temperatures.
e. All of the above
Answer: d
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 2. Understanding

8. Coenzymes and cofactors, as well as prosthetic groups, assist enzyme function by
a. stabilizing three-dimensional shape.
b. assisting with the binding of enzyme and substrate.
c. maintaining active sites in an active configuration.
d. reversibly binding to the enzyme to regulate the enzyme's activity.
e. a, b, and c only
Answer: e
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 2. Understanding

9. Which of the following statements about enzymes is true?
a. They are consumed by the enzyme-mediated reaction.
b. They are not altered by the enzyme-mediated reaction.
c. They raise activation energy.
d. They can be composed of RNA or proteins.
e. They are only rarely regulated.
Answer: b

Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

10. Ascorbic acid, which is found in citrus fruits, acts as an inhibitor to catecholase, the enzyme responsible for the browning reaction in fruits such as apples, peaches, and pears. One explanation for the inhibiting function of ascorbic acid could be its similarity, in terms of size and shape, to catechol, the substrate of the browning reaction. If this explanation is correct, then this inhibition is most likely an example of _____ inhibition.
a. competitive
b. indirect
c. noncompetitive
d. allosteric
e. feedback
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

11. Metabolism is organized into pathways that are linked in which of the following ways?
a. All cellular functions feed into a central pathway.
b. All steps in the pathway are catalyzed by the same enzyme.
c. The product of one step in the pathway functions as the substrate in the next step.
d. Products of the pathway accumulate and are secreted from the cell.
e. Different substrates are acted on by the same enzyme.
Answer: c
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 1. Remembering

12. Which of the following represents an enzyme- catalyzed reaction? (E = enzyme, P = product, S = substrate)

a. $E + P \rightarrow E + S$

b. $E + S \rightarrow E + P$

c. $E + S \rightarrow P$

d. $E + S \rightarrow E$

e. $P + S \rightarrow E$

Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 1. Remembering

13. In the pathway $A + B \rightarrow C + D$, enzyme X facilitates the reaction. If compound D inhibits enzyme X, one would conclude that

a. enzyme X is an allosteric inhibitor of the above reaction.
b. compound D is an allosteric stimulator of the above reaction.
c. compound D is a competitive inhibitor of the above reaction.
d. enzyme X is subject to feedback stimulation.
e. compound D is a coenzyme in the above reaction.
Answer: a
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

14. Suppose you are studying a new species that has never been studied before. It lives in acidic pools in volcanic craters where temperatures normally stay above 90°C and often reach 100°C. You determine that the species has a surface enzyme that catalyzes a reaction leading to its protective coating, and you decide to study this enzyme in the laboratory. At what temperature would optimal activity of this enzyme most likely be found?

a. 0°C

b. 37°C

c. 55°C

d. 95°C

e. 105°C

Answer: d
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

15. Enzymes alter the _____ of a reaction.

a. ΔG value

b. activation energy
c. equilibrium
d. rate
e. Both a and b
Answer: b
Textbook Reference: 8.3 What Are Enzymes?
Bloom's Category: 2. Understanding

16. You fill two containers with identical amounts of reactants A and B and enzymes 1–4. If product D inhibits enzyme 2 and product F is an allosteric stimulator of enzyme 1, what will be the final result if you add extra product D to the second container? (Assume that the experiment lasts long enough for the reactions in both containers to go to completion.)
a. The concentration of product C will increase compared to the first container and there will be no change in the concentration of product F compared to the first container.
b. The concentration of reactants A and B will increase relative to the first container.

c. The concentration of product F will increase in the second container because more of D is converted back to C.
d. The concentration of products E and F will both increase in the second container, since D inhibits enzyme 2.
e. The concentration of product F will increase relative to the first container, since enzyme 2 will have been inhibited from converting as much of C into D.
Answer: e
Textbook Reference: 8.5 How Are Enzyme Activities Regulated?
Bloom's Category: 4. Analyzing

17. Suppose you are given an unlabeled enzyme and told to add a compound to the container that will irreversibly bind to the enzyme and increase its function. You ask for information about the enzyme, but your instructor simply hands you a list of possible compounds. Based on what you have learned about the enzyme partners below, which one is the best choice?
a. Coenzyme A
b. Zinc (Zn^{2+})
c. Flavin
d. ATP
e. NAD
Answer: c
Textbook Reference: 8.4 How Do Enzymes Work?
Bloom's Category: 3. Applying

CHAPTER REVIEW QUESTIONS (from Textbook)

1. Coenzymes differ from enzymes in that coenzymes are
a. only active outside the cell.
b. polymers of amino acids.
c. smaller molecules, such as vitamins.
d. specific for one reaction.
e. always carriers of high-energy phosphate.
Answer: c
Bloom's Category: 1. Remembering

2. Which statement about thermodynamics is true?
a. Free energy is used up in an exergonic reaction.
b. Free energy cannot be used to do work.
c. The total amount of energy can change after a chemical transformation.
d. Free energy can be kinetic but not potential energy.
e. Entropy has a tendency to increase.
Answer: e
Bloom's Category: 1. Remembering

3. The active site of an enzyme

a. never changes shape.
b. forms no chemical bonds with substrates.
c. determines, by its structure, the specificity of the enzyme.
d. looks like a lump projecting from the surface of the enzyme.
e. changes the ΔG of the reaction.

Answer: c
Bloom's Category: 1. Remembering

4. The molecule ATP is
a. a component of most proteins.
b. high in energy because of the presence of adenine.
c. required for many energy-transforming biochemical reactions.
d. a catalyst.
e. used in some exergonic reactions to provide energy.
Answer: c
Bloom's Category: 1. Remembering

5. In an enzyme-catalyzed reaction,
a. a substrate does not change.
b. the rate decreases as substrate concentration increases.
c. the enzyme can be permanently changed.
d. strain may be added to a substrate.
e. the rate is not affected by substrate concentration.
Answer: d
Bloom's Category: 1. Remembering

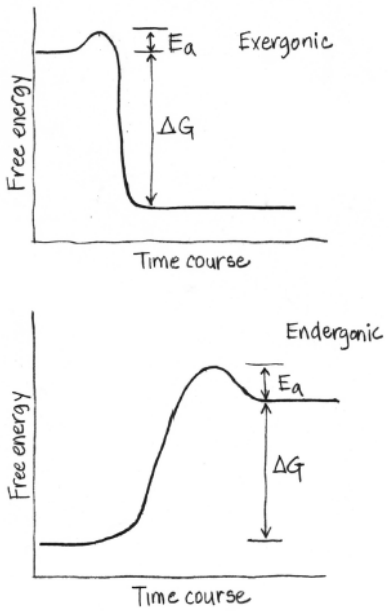
6. Which statement about enzyme inhibitors is *not* true?
a. A competitive inhibitor binds to the active site of the enzyme.
b. An allosteric inhibitor binds to a site on the active form of the enzyme.
c. A noncompetitive inhibitor binds to a site other than the active site.
d. Noncompetitive inhibition cannot be completely overcome by the addition of more substrate.
e. Competitive inhibition can be completely overcome by the addition of more substrate.
Answer: b
Bloom's Category: 1. Remembering

7. What makes it possible for endergonic reactions to proceed in organisms?
Answer: Endergonic reactions are coupled in time and space with exergonic reactions, which release the energy needed for the endergonic reactions.
Bloom's Category: 2. Understanding

8. Consider two proteins: one is an enzyme dissolved in the cytosol of a cell, the other is an ion channel in its plasma membrane. Contrast the structures of the two proteins, indicating at least two important differences.
Answer: A cytoplasmic enzyme generally has a globular structure with a hydrophilic exterior and an active site for substrate binding. An ion channel generally has a more

linear structure with a hydrophobic membrane-spanning region and no active site.
Bloom's Category: 3. Applying

9. Plot free energy versus the time course of an endergonic reaction, and the same for an exergonic reaction. Include the activation energy on both plots. Label E_a and ΔG on both graphs.
Answer:



Bloom's Category: 3. Applying

10. When potatoes are peeled, the enzyme polyphenol oxidase causes discoloration by catalyzing the oxidation of certain molecules, using O_2 as a substrate. Explain the following observations:
a. If potatoes are peeled under water and kept there, browning is reduced.

b. Potatoes that have been boiled at 100°C and then sliced do not turn brown.

c. If lemon juice (pH 3) is applied to newly peeled potatoes, they do not brown.
Answer: (a) The presence of water may prevent O_2 from reaching the enzyme. (b) Boiling denatures proteins, so polyphenol oxidase is irreversibly altered by boiling and its active site is destroyed. (c) Proteins have an optimal pH at which ionized R groups are appropriately charged to give the protein its tertiary structure. A pH 3 of may not be that optimal pH for polyphenol oxidase, so the enzyme is denatured and inactive.
Bloom's Category: 3. Applying

11. Consider an enzyme that is subject to allosteric regulation. If a competitive inhibitor (not an allosteric inhibitor) is added to a solution containing such an enzyme, the ratio of enzyme molecules in the active form to those in the inactive form increases. Explain this observation.

Answer: See Figure 8.17. A competitive inhibitor binds to the active site of the enzyme and shifts the equilibrium to enzyme molecules in the active form.
Bloom's Category: 5. Evaluating

12. In humans, hydrogen peroxide (H_2O_2) is a dangerous toxin produced as a by-product of several metabolic pathways. The accumulation of H_2O_2 is prevented by its conversion to harmless H_2O, a reaction catalyzed by the appropriately named enzyme catalase. Air pollutants can inhibit this enzyme and leave individuals susceptible to tissue damage by H_2O_2. How would you investigate whether catalase has an allosteric or a nonallosteric mechanism, and whether the pollutants are acting as competitive or noncompetitive inhibitors?

$$2\,H_2O_2 \xrightarrow{\text{Catalase}} O_2 + 2\,H_2O$$

Answer: To determine whether catalase has an allosteric or nonallosteric mechanism, perform an experiment with varying amounts of substrate and plot rate of catalase versus substrate concentration. An S-shaped curve will indicate an allosteric mechanism. A hyperbolic curve indicates a nonallosteric enzyme.
To determine if a pollutant is a competitive or noncompetitive inhibitor, add the pollutant to the catalase to lower the rate of reaction, then add increasing amounts of substrate. A competitive inhibitor will be removed from the active site and the rate of reaction will increase. A noncompetitive inhibitor will not allow the rate to increase as more substrate is added. (There are more sophisticated kinetic experiments that you will learn in a biochemistry course).
Bloom's Category: 4. Analyzing