Name _____ **Period** _____

Chapter 6: An Introduction to Metabolism

This chapter on energy transfer and enzyme action is fundamental to your understanding of numerous topics discussed later in the course. AP Biology Big Idea 2 deals with energy transfer, and EK 4.B.1 includes how enzymes function and are regulated. Your careful study of this chapter will help you in both important areas.

Concept 8.1 An organism's metabolism transforms matter and energy, subject to the laws of thermodynamics

The totality of an organism's chemical reactions is called *metabolism*. As a whole, metabolism manages the material and energy resources of the cell in intersecting pathways.

1. There are two types of reactions in metabolic pathways: *anabolic* and *catabolic*.
   a. Which reactions release energy?
   b. Which reactions consume energy?
   c. Which reactions build up larger molecules?
   d. Which reactions break down molecules?
   e. Which reactions are considered "uphill"?
   f. What type of reaction is photosynthesis?
   g. What type of reaction is cellular respiration?
   h. Which reactions require enzymes to catalyze reactions?

2. *Energy* is the capacity to cause change, do work, or move matter against opposing forces. It exists in various forms. Contrast *kinetic energy* with *potential energy*.

3. Which type of energy does water behind a dam have? A mole of glucose?

4. According to the first law of thermodynamics, what can and cannot happen to energy?

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5. The second law of thermodynamics is sometimes called the "you always lose rule." Why is that an apt expression?

6. What is meant by a *spontaneous process*?

Concept 8.2 The free-energy change of a reaction tells us whether the reaction occurs spontaneously

7. What is *free energy*? What is its symbol?

8. Once we know the value of ΔG for a process, we can use it to predict whether it will be spontaneous. For an exergonic reaction, is ΔG negative or positive?

9. Is cellular respiration an endergonic or an exergonic reaction? What is ΔG for this reaction?

10. Is photosynthesis endergonic or exergonic? What is the energy source that drives it?

11. To summarize, if energy is released, ΔG must be positive/negative. (Circle your choice.)

Concept 8.3 ATP powers cellular work by coupling exergonic reactions to endergonic reactions

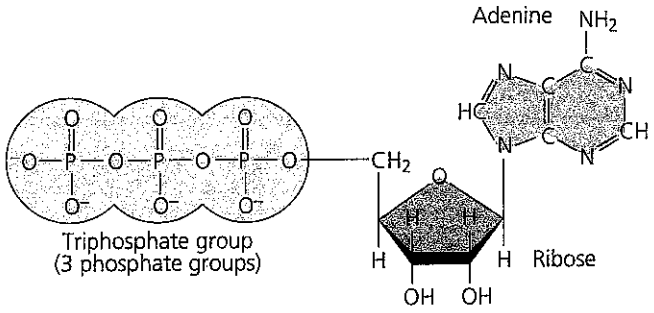
12. List the three main kinds of work that a cell does. Give an example of each.

    a.

    b.

    c.

13. Here is a molecule of ATP. Label it. Use an *arrow* to show which bond is likely to break.



    a. By what process will that bond break?

    b. Explain the name *ATP* by listing all the molecules that make it up.

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14. When the terminal phosphate bond is broken, a molecule of inorganic phosphate P_i is formed, and energy is _____.

    For this reaction: ATP $\rightarrow$ ADP + P_i, ΔG = _____.

    Is this reaction endergonic or exergonic? _____

15. What is *energy coupling*?

16. In many cellular reactions, a phosphate group is transferred from ATP to some other molecule in order to make the second molecule less stable. What term is now used to describe the second molecule?

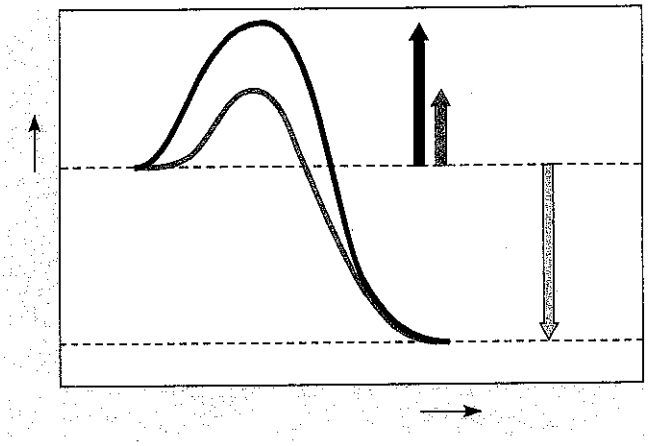
17. Look for this amazing bit of trivia on page 151 in your text: If you could not regenerate ATP by phosphorylating ADP, how much ATP would you need to consume each day?

Concept 8.4 Enzymes speed up metabolic reactions by lowering energy barriers

18. What is a *catalyst*?

19. What is *activation energy* (E_A)?

20. Label the *x*-axis of this graph "Progress of the Reaction" and the *y*-axis "Free Energy."



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Label E_A on this sketch, both with and without an enzyme.

a. What effect does an enzyme have on E_A?

b. Label ΔG. Is it positive or negative?

c. How is ΔG affected by the enzyme?

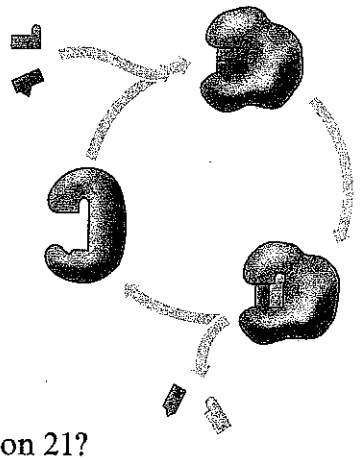
21. Label this figure while you define each of the following terms:

enzyme

substrate

active site

products



22. What is meant by *induced fit*? How is it shown in the figure in question 21?

23. Explain how protein structure is involved in enzyme specificity.

24. Enzymes use a variety of mechanisms to lower activation energy. Describe four of these mechanisms.

a.

b.

c.

d.

25. Many factors can affect the rate of enzyme action. Explain each factor listed here.

a. initial concentration of substrate

b. pH

c. temperature

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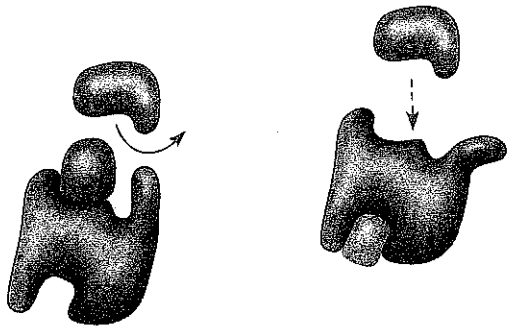
26. Recall that enzymes are globular proteins. Why can extremes of pH or very high temperatures affect enzyme activity?

27. Name a human enzyme that functions well in pH 2. Where is it found?

28. Distinguish between *cofactors* and *coenzymes*. Give examples of each.

29. Compare and contrast *competitive inhibitors* and *noncompetitive inhibitors*. Label each type of inhibitor in this figure.



30. Many toxins and poisons cause irreversible enzyme inhibition. Select one example and explain why it is so deadly.

Concept 8.5 Regulation of enzyme activity helps control metabolism

31. What is *allosteric regulation*?

32. How is allosteric regulation somewhat like noncompetitive inhibition? How might it be different?

33. Explain the difference between an allosteric activator and an allosteric inhibitor.

34. Although it is not an enzyme, hemoglobin shows *cooperativity* in binding O_2. Explain how hemoglobin works in the gills of a fish.

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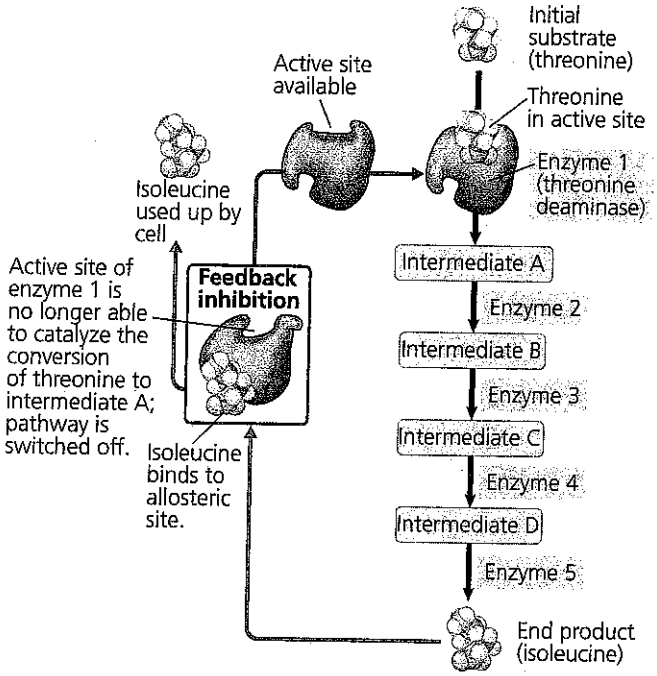
35. Study this figure from your book (Figure 8.21) and answer the questions that follow.



a. What is the substrate molecule that initiates this metabolic pathway?

b. What is the inhibitor molecule?

c. What type of inhibitor is it?

d. When does it have the most significant regulatory effect?

e. What is this type of metabolic control called?

Test Your Understanding Answers

Now you should be ready to test your knowledge. Place your answers here:

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

6. _____ 7. _____

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