AP Chapter 8 Study Guide: Enzymes and Metabolism

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Teacher's Note: *Chapter 8 expands on the protein portion of chapter 5. Essentially, this chapter concerns enzymatic function. No other topic has been tested more. Free response questions concerning the enzyme lab have occurred in '10, '05,'00,'94,'89, and three other years. The chapter begins with some general information on metabolism and energy transformation. Yes, there is some physics here……but remember, modern biologists are mechanists and living things must obey the physical laws of the universe. Sure there are some formulas, but don't get overly concerned. The important part of the chapter revolves around enzymes. So read pgs 141-150 and answer the following questions on metabolism, energy transformation and ATP.*

1. The sum total of an organism's chemical reactions is called it's _____
2. Metabolic pathways that build are called _____ pathways.
3. Metabolic pathways that breakdown things are called _____ pathways.
4. Circle one: Condensation reactions joining amino acids to produce a polypeptide would be considered a(n) **anabolic** or **catabolic** pathway.
4. Circle one: Total hydrolysis of a polysaccharide to glucose molecules would be an example of a(n) **anabolic** or **catabolic** pathway.
5. _____ is the capacity to cause change or do work.
6. Differentiate between potential and kinetic energy. _____

   _____

   _____
7. Differentiate between thermal and chemical energy. _____

   _____

   _____
8. State the first law of thermodynamics: _____

   _____
9. State the second law of thermodynamics: _____

   _____
10. The portion of a system's energy that can perform work is called _____

11. Convert the following formula to words: $\Delta G=\Delta H-T\Delta S$. _____

_____

12. The relationship between free energy and total energy (enthalpy) is (circle one) **proportional**

    or **inverse**

13. The relationship between free energy and temperature is (circle one) **proportional** or

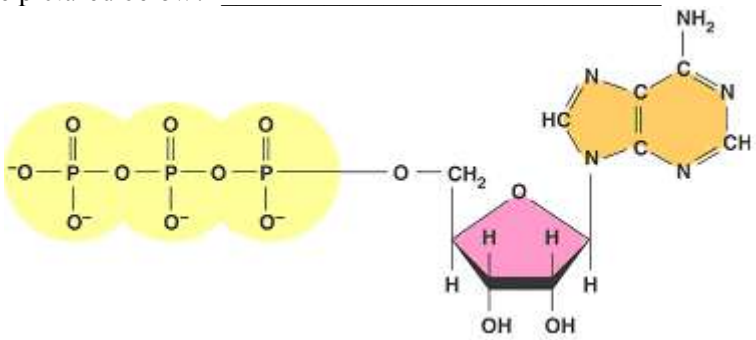
    inverse

14. The relationship between free energy and entropy is (circle one) **proportional** or **inverse**

15. Place the following terms on their proper side of the chart: anabolic pathways, catabolic pathways, high energy products, low energy products, high energy reactants, low energy reactants, increased entropy, decreased entropy, high stability products, low stability products, high stability reactants, low stability reactants, net energy gain, net energy loss.

Endergonic Reactions	**Excergonic Reactions**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

16. What is the molecule pictured below? _____



17. What are the three main components of ATP? _____

_____ _____

18. How does ATP make a stable, non-reactive molecule less stable and reactive? _____

_____

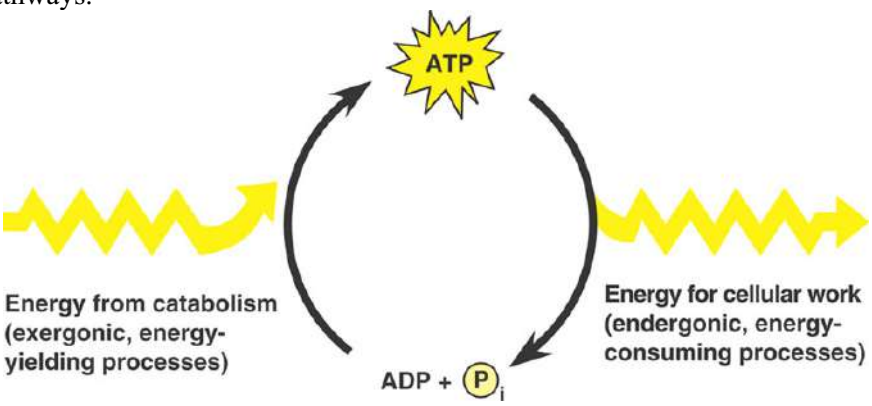
19. When ATP phosphorylates another molecule, what two molecules result? _____

and _____

20. What is the ATP cycle? _____

_____

21. Examine the diagram below and then explain why ATP is said to be the link between an organism's anabolic and catabolic pathways.



_____

_____

_____

By now, I know this will sound cliché, but this next reading is the most important one of the year. Enzyme catalysts are the most important molecules in an organism's body. So if you are feeling tired or distracted, walk away from your book right now! Come back when you can give pgs 150-157 your whole, undivided attention!!!.

22. Enzymes cannot change ΔG for a reaction. Enzymes cannot make an endergonic reaction excergonic, but enzymes can speed up reactions that would occur anyway. How do enzymes

accomplish this? _____

23. What is the name of the specific molecule a particular enzyme binds to? _____

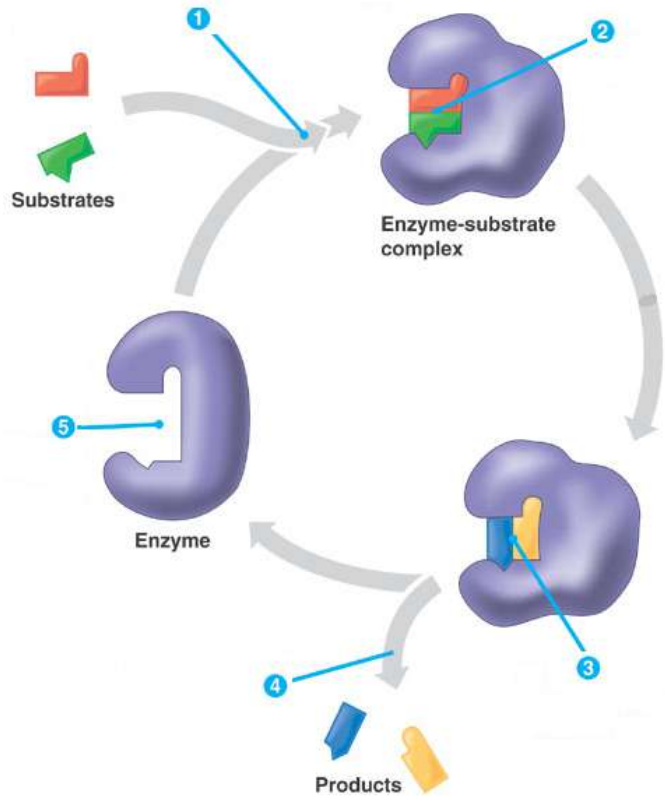
24. Enzymes and substrate are said to be specific, like a lock and a key. In what way is this a good analogy?

_____

In what way is this analogy lacking? (*Hint: think induced fit*) _____

_____

Examine the catalytic cycle of an enzyme below:



25. Briefly describe what is occurring at

#1. _____

#2. _____

#3. _____

#4. _____

#5. _____

26. List four ways the active site of an enzyme can lower E_A and speed up a reaction.

#1. _____

#2. _____

#3. _____

#4. _____

We are now going to examine the factors that affect the rate of enzyme activity. Environmental factors such as pH and temperature, concentration of substrate molecules, the presence or absence of inhibitors and activators all play important roles. These factors are explored in AP

lab #2, so it is critical that you have a clear understanding of their role in determining the speed of reactions.

27. Do enzymes have eyes? Can they "see" their substrate and run over to it with their legs or fly to it with wings or swim to it with fins? (These are rhetorical questions and a written response is not required.) Then explain how an enzyme "finds" its way to its substrate.

_____

_____

28. Would an enzyme be more likely to collide with a substrate molecule in an environment rich in substrate or one in which there is little substrate? _____

Below is a simple formula for describing an enzymatic reaction

E	+	S	→	E/S	→	E	+	P
Enzyme		Substrate		Enzyme/substrate complex		Enzyme		Product

29. As an enzymatically catalyzed reaction runs, what happens to the amount of

    a) substrate? _____

    b) product? _____

    c) enzyme? _____

30. Assuming that no more enzyme or substrate is added to the reaction vessel, would the rate of a reaction be faster at the beginning or end? _____

    Explain why. _____

31. Assuming that a particular enzyme is not cold or heat adapted, would the rate of an enzymatically catalyzed reaction be faster at 10^{o}C or at 37^{o}C? _____ Why do you think this is so? (a molecular level response is required) _____

    _____

32. Most enzymes have an optimal pH. Describe what would happen to the rate of an enzymatically catalyzed reaction if the pH was shifted to become slightly more acidic or basic? _____

    What would be the affect of drastically shifting the pH? _____

    _____

33. At a college party you are asked to dance by someone you have never met before. However, you feel inhibited. Does this mean you will continue to be a wallflower or will you be "shakin' it" on the dance floor? _____

34. As your unknown and unrequited love despondently retreats, you gaze across the room and notice "the one for you," your "soul mate,"the "love" of your life has walked into the room. You quickly make your way over to them, but unfortunately, many others approach him/her also. You are suddenly in competition. Now explain what competitive inhibition is

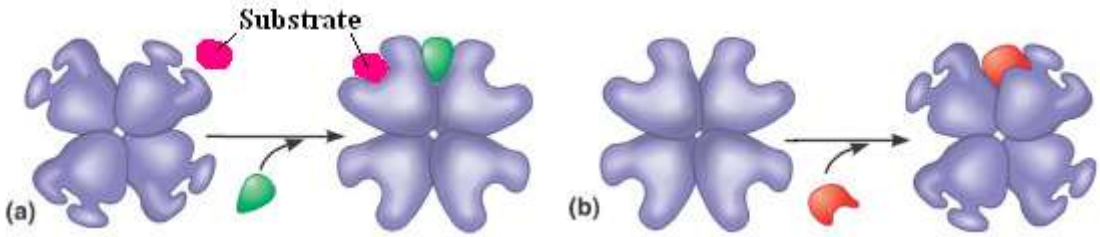
_____

_____

35. How is a noncompetitive inhibitor different? _____

_____

36. An allosteric site is a portion of a protein molecule that will accept activator or inhibitory molecules. The acceptance of these molecules will contort the active site into one that will accept or deny substrate. Will an allosteric activator make an enzyme more or less likely to bond with its substrate? _____ What about an allosteric inhibitor? _____



37. Is diagram (a) an allosteric inhibitor or allosteric activator? _____

38. Is diagram (b) an allosteric inhibitor or allosteric activator? _____

39. Often times, an enzyme will have multiple active sites like the enzymes pictured above. Sometime the acceptance of a substrate molecule into an active site will stabilize the other active sites causing the chance of binding with a substrate to increase. This interaction is called _____.

40. Sometimes the product of a metabolic pathway serves as its own inhibitor. This type of enzyme regulation is called _____ _____