An Introduction to Metabolism Review

Chapter 8

1. Draw a diagram to illustrate the term metabolic pathway.

2. Distinguish between catabolic and anabolic reactions. (Catabolic pathways are exergonic and produce simpler molecules from more complex ones. Anabolic pathways are endergonic and produce complex molecules from simpler ones.)

3. Use the second law of thermodynamics to explain the diffusion of a molecule across a membrane. (The second law is the trend toward randomization, or increasing entropy. When the concentrations of a substance on both sides of a membrane are equal, the distribution is more random than when they are unequal. Diffusion increases entropy, making it energetically favorable (i.e., spontaneous).)

4. Cells and organisms are highly ordered which makes them appear to violate the second law of thermodynamics. Explain how, in reality, they do not. (Organisms convert complex molecules into simpler molecules, increasing the entropy of their surroundings. The energy released is used to decrease the entropy of the cell or organism.)

5. Cellular respiration uses glucose and releases carbon dioxide. Glucose has more free energy than carbon dioxide. Use this information to predict whether cellular respiration is spontaneous or not. Justify your prediction. Explain why cellular respiration is exergonic and describe what happens to the energy released from glucose. (Cellular respiration is spontaneous because it involves a decrease in free energy. The loss of free energy makes the process exergonic. The energy released from glucose is used to do work and is lost as heat.)

6. The waste product of cellular respiration, CO_2, must be eliminated from an organism. Use the concept of metabolic disequilibrium to explain why this is important. (If the CO_2 were not eliminated, the reactions producing it would reach equilibrium and no more ATP could be made.)

7. Explain how the hydrolysis of ATP is used to couple exergonic reactions to endergonic reactions in order to do work in cells. (Energy released from an exergonic reaction is used to phosphorylate ADP. When the terminal phosphate bond is hydrolyzed, the energy released can be used to drive an endergonic reaction. Alternatively, the terminal phosphate of ATP can be transferred to an intermediate molecule. The phosphorylated intermediate molecule is now more reactive.)

8. Draw a graph to show the change in free energy during a reaction not catalyzed by an enzyme and the same reaction catalyzed by an enzyme. Use the graph to describe how an enzyme speeds up the reaction.

9. Describe the basis of enzyme specificity. (The active site of an enzyme has a specific three-dimensional shape which matches that of the substrate.)

10. Malonate is an inhibitor of succinate dehydrogenase. Describe how you would determine if malonate is a competitive or noncompetitive inhibitor. (In the presence of malonate, increase the concentration of the normal substrate (succinate) and see whether the rate of reaction increases. If it does, malonate is a competitive inhibitor.)

11. Explain why the rate of an enzyme-catalyzed reaction does not increase indefinitely with increasing substrate concentration. (The enzyme reaches the point of saturation. The rate of the reaction is, ultimately, limited by the rate at which reactants can diffuse into, and products diffuse out of, the active site.)

12. Draw a graph showing the effect of both temperature and pH on enzyme activity. Explain

13. Describe the difference between competitive and noncompetitive inhibition. (A competitive inhibitor fits into the active site of the enzyme, thereby ‘competing’ with the substrate. A noncompetitive inhibitor fits into an inhibitor site, separate from the active site. There is no competition with the substrate.)

14. Describe how feedback inhibition can regulate a metabolic pathway. (In feedback inhibition, a molecule in a metabolic pathway acts as an inhibitor of an enzyme in the pathway. As the concentration of the molecule increases, so does the inhibition, slowing down the production of the molecule. As the concentration of the molecule decreases, so does the inhibition, increasing the speed of production.)