Chapter 5 – Metabolism: Energy and Enzymes

Complete using BC Biology 12, pages 154 - 175

5.1 Energy Transformations & Metabolism

1. **Metabolism:**

2. ________________ (a) refers to the breaking down of molecules while ________________ (b) refers to the building up, or synthesis, of molecules.

3. In a chemical reaction, ________________ (a) are the substances that participate in a reaction (____________ (b) in the reaction below), while the ________________ (c) are the substances that form as the result of a reaction (____________ (d) in the reaction below).

   \[ A + B \rightarrow C + D \]

4. **Free energy (\(\Delta G\)):**

5. **Exergonic reactions:**

   a. Examples:

6. **Endergonic reactions:**

   a. Examples:

**ATP: Energy for Cells**

7. ATP is the common ________________ (a). When cells require energy they “spend” ATP.

   The more ________________ (b) the organism the ________________ (c) the demand for ATP.

   However, the amount on hand at any one moment is ________________ (d) because ATP is constantly being generated from ________________ (e) and a molecule of ________________ (f).

8. Place the appropriate letters next to each statement (use Figure 5.1 on page 158 to help)

   En = endergonic  Ex = exergonic

   a. ________ Energy is released as the reaction occurs.

   b. ________ Energy is required to make the reaction go.

   c. ________ Reaction used by the body for muscle contraction and nerve conduction.

   d. ________ \(\text{ATP} \rightarrow \text{ADP} + (P)\).

   e. ________ \(\text{ADP} + (P) \rightarrow \text{ATP}\)

9. Label this diagram, using these terms:

   ATP

   ADP

   -P (release of phosphate)

   +P (additional of phosphate)
10. Explain whether an anabolic reaction is more likely to be exergonic or endergonic. 

5.2 Enzymes & Metabolic Pathways

11. Metabolic pathway: ____________________________

12. While it is possible to write an ________________ (a) equation for a pathway as if the beginning (b) went to the end ________________ (c) in one step, actually many specific steps occur in between.

13. Consider the following diagram of a metabolic pathway:

\[ A \rightarrow B \rightarrow C \rightarrow D \rightarrow E \rightarrow F \rightarrow G \]

a. A – F are ________________

b. B – G are ________________

c. E₁ – E₆ are ________________

d. A is a ________________ for the first enzyme and B is the product

14. Enzyme: ____________________________

15. Substrate: ____________________________

**Energy of Activation**

16. Energy of activation: ____________________________

17. Enzymes lower the amount of energy required for ________________ (a) to occur. Nevertheless, the addition of the enzyme does not change the ________________ (b) of the reaction. Without the enzyme, the reaction rate will be ________________ (c). By lowering the energy of activation, the enzyme ________________ (d) of the reaction.

18. Draw and label a diagram of the energy of activation using the following terms:

- energy of activation (with enzyme)
- energy of activation (without enzyme)
- energy of reactants
- energy of products
- free energy
- progress of the reaction
How Enzymes Function

19. Write the equation used to indicate that an enzyme forms a complex with its substrate (include all labels).

20. Label this diagram, using the following terms
   - active site
   - enzyme (twice)
   - enzyme-substrate complex
   - products
   - substrate
   
   a.  
   b.  
   c.  
   d.  
   e.  
   f.  

21. Is the reaction above a synthetic reaction or a degradative reaction? ____________________________
    How do you know? ____________________________

22. What is the induced fit model and how does it differ from the model cell biologists used previously?
    ____________________________

23. If enzymes are so important for chemical reactions, then why is only a small amount of enzyme needed in a cell?
    ____________________________

24. Why are enzymes named after their substrate (e.g. maltase speeds breakdown of maltose)? ______________

Factors Affecting Enzymatic Speed

25. Complete each statement with the term increases or decreases.
   a. Enzyme activity _________________________ as substrate concentration increases.
   b. Raising the temperature generally _________________________ the rate of an enzymatic reaction.
   c. Boiling an enzyme drastically _________________________ the rate of the reaction.
   d. Changing the pH toward the optimum pH for an enzyme _________________________ the rate of the reaction.
   e. Introducing a competitive inhibitor _________________________ the availability of an enzyme for its normal substrate.
   f. Due to feedback inhibition, the affinity of the active site for the substrate _________________________
26. **Denatured:** ________________________________

27. Describe how the concentration of a specific product is always kept within a certain range (hint: read section on enzyme activation). ________________________________

28. Enzyme inhibition occurs when the substrate is unable to bind to the active site of an enzyme.
   There are two types of enzyme inhibitors *(not in your textbook, will be completed with teacher)*
   a. ________________________________
      i. Examples: ________________________________
   b. ________________________________
      i. Examples: ________________________________

29. Many enzymes require an ________________________________ *(a)* ion or an organic, but ________________________________ *(b)*, helper to function properly. The inorganic ions are metals such as ________________________________ *(c)*, these helpers are called ________________________________ *(d)*. The organic, non-protein molecules are called ________________________________ *(e)* and ________________________________ *(f)* are often components of these, becoming part of the coenzyme’s molecular structure.

30. A deficiency of any one of these ________________________________ *(a)* results in a lack of the coenzyme and therefore a lack of certain ________________________________ *(b)*. Niacin deficiency results in a skin disease called ________________________________ *(c)* and a riboflavin deficiency results in ________________________________ *(d)*.

5.3 Metabolic Rate & the Thyroid and Parathyroid Glands pages 164 - 165

31. The **thyroid gland** is located in the ____________ and the **parathyroid glands** are embedded behind the thyroid gland.

32. Explain the difference the two hormones produced by the thyroid gland.
   a. triiodothyronine *(T₃)*: ________________________________
   b. thyroxine *(T₄)*: ________________________________

33. Where do we get the iodine necessary to produce these hormones? ________________________________

34. How do the thyroid hormones increase metabolic rate? ________________________________

35. Describe the functional relationship between **calcitonin** and **parathyroid hormone**. ________________________________
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31. Don’t draw a graph, just explain.

__________________________________________

__________________________________________

32.

__________________________________________

33.

__________________________________________

34.

__________________________________________

35.

__________________________________________

37. Think of the processes discussed in Chapter 3.

38.

__________________________________________

__________________________________________
39. Create a graph below.

Mark the review questions using the answer key on pages 533 - 534