CHAPTER 4 READING QUESTIONS

These reading questions are designed to help you focus your reading on the most important points in the chapter. They are arranged using chapter section headers so that the file can be easily edited to reflect the material covered in class.

4.1 ENERGY IN BIOLOGICAL SYSTEMS

1. What are the properties of living organisms? (Tbl. 4.1)

2. Contrast the energy capture and storage processes of plants and animals. (Fig. 4.1)

Energy Is Used to Perform Work

3. Define energy.

4. List three kinds of work in biological systems and give an example of each.

5. What is a concentration gradient?

Energy Comes in Two Forms: Kinetic and Potential

6. Describe the difference between kinetic energy and potential energy. Give an example of each. (Fig. 4.2)

Energy Can Be Converted from One Form to Another

7. The amount of energy lost in the transformation from potential energy to kinetic energy depends on the _____ of the process.

8. How is potential energy stored in biological systems?

Thermodynamics Is the Study of Energy Use

9. State the first law of thermodynamics.

10. State the second law of thermodynamics.

11. What is entropy?

4.2 Chemical Reactions

Energy Is Transferred between Molecules during Reactions

12. Combine these words into a sentence that explains their relationship: reaction, product, molecule(s), substrate, and reactant.

13. How do we measure the rate of a chemical reaction?

14. What is the relationship between free energy and chemical bonds?

Activation Energy Gets Reactions Started

15. What is the activation energy of a reaction? (Fig. 4.3a)

Energy Is Trapped or Released during Reactions

16. Compare and contrast endergonic reactions and exergonic reactions. Describe the free energy of the products in each reaction type. (Fig. 4.3b, c)

17. An important biological example of an exergonic reaction is the hydrolysis of ATP to yield ADP. Write out this chemical reaction. Identify the bond that releases the most energy.

Coupling Endergonic and Exergonic Reactions

18. How are exergonic and endergonic reactions coupled in the body? Give some examples. (Fig. 4.4)

Net Free Energy Change Determines Reaction Reversibility

19. Compare and contrast reversible reactions with irreversible reactions. How does the net free energy determine the reversibility of a reaction? Are most biological reactions reversible or irreversible? (Fig. 4.5)

4.3 Enzymes

20. Define enzymes and substrates.

Enzymes Are Proteins

21. What are isozymes? How are they useful in medical diagnoses? (Tbl. 4.3)

Reaction Rates Are Variable

22. How do we measure the rate of an enzymatic reaction?

23. What factors can alter the rate of an enzymatic reaction? In mammals, which two factors are of primary significance?

Enzymes May Be Activated, Inactivated, or Modulated

24. What are coenzymes? What are vitamins?

25. Describe two ways enzymes can be inactivated. (Fig. 4.6)

Enzymes Lower Activation Energy of Reactions

26. How does an enzyme lower the activation energy of a reaction? (Fig. 4.7)

Enzymatic Reactions Can Be Categorized

27. What is the term for the process of adding a phosphate group to a molecule? What type of enzyme carries out this function?

28. Briefly describe the categories of enzymatic reactions listed below. Define key terms (e.g., oxidized, reduced) where appropriate. Include specific examples or representative enzymes when possible. (Tbl. 4.4)

- oxidation-reduction reactions
- hydrolysis-dehydration reactions
- addition-subtraction-exchange reactions

- ligation reactions
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4.4 Metabolism

29. Define metabolism.

30. Distinguish between catabolic and anabolic reactions.

31. Define kilocalorie (kcal).

32. What is a metabolic pathway? What are intermediates? (Fig. 4.8)

Cells Regulate Their Metabolic Pathways

33. List five ways cells can regulate metabolism.

Enzyme Modulation

34. What is feedback inhibition? What role does it play in modulation of enzymes? (Fig. 4.9)

Reversible Reactions

35. What is the advantage of having a reaction that is regulated by two enzymes (one for the forward direction and one for the reverse direction)? (Fig. 4.10)

Compartmentalizing Enzymes in the Cell

36. What advantage does a cell gain by isolating some enzymes within specific intracellular compartments?

Ratio of ATP to ADP

37. What role does the ratio of ATP to ADP play in the regulation of metabolic reactions?

ATP Transfers Energy between Reactions

38. Describe the structure of ATP.

39. What roles does ATP play in the body?

40. Compare aerobic and anaerobic pathways. Which one produces more ATP?

Catabolic Pathways Produce ATP

41. For each of the following pathways: What key substrate(s) enter(s) each pathway? What key product(s) come(s) out of each pathway? What are the fates of these key products? Which pathways require oxygen?

    Glycolysis (Fig. 4.12)

    The citric acid cycle (Fig. 4.13)

    The electron transport system (ETS) (Fig. 4.14)

42. Describe oxidative phosphorylation and the chemiosmotic theory.

One Glucose Molecule Can Yield 30–32 ATP

43. Explain how the net energy yield for glucose metabolism can vary.

Anaerobic Metabolism Makes 2 ATP

44. Describe how pyruvate is a branch point for metabolic pathways. (Fig. 4.16)

45. What is the net energy yield from the conversion of one glucose to lactate? (Fig. 4.15a)

Proteins Are the Key to Cell Function

46. What makes proteins highly variable and highly specific?

The Protein "Alphabet"

47. What is a codon? (Fig. 4.17)

Unlocking DNA's Code

48. What is a gene?

49. What is the difference between constitutively active genes and regulated genes?

50. Diagram the processes involved in protein synthesis. (Fig. 4.18)

DNA Guides the Synthesis of RNA

51. Describe the process of transcription, beginning with the activation of the promoter region of a gene and ending with the release of an mRNA strand. What is the role of RNA polymerase? (Fig. 4.19)

Alternative Splicing Creates Multiple Proteins from One DNA Sequence

52. Explain the relationship between introns, exons, mRNA processing, RNA interference, and alternative splicing. (Figs. 4.18, 4.20)

53. What are the advantages of alternative splicing?

mRNA Translation Links Amino Acids

54. Using the following terms, outline the process of translation: mRNA, rRNA, tRNA, ribosomes, ribosomal subunits, ribosome-mRNA complex, codon, anticodon, dehydration synthesis, peptide bond, termination, and ribonuclease. (Fig. 4.21)

Protein Sorting Directs Proteins to Their Destination

55. What is a signal sequence?

56. What happens to proteins that bear a signal/targeting sequence? What happens to proteins that lack a targeting sequence?

Proteins Undergo Posttranslational Modification

57. Briefly describe each of the following possible posttranslational protein modifications. Give examples when possible.

- protein folding
- cross-linkage
- cleavage
- glycosylation and phosphorylation

- assembly into polymeric proteins