Maulana Azad College

Department of Microbiology

DSCC 3- Biomolecules & Bioenergetics

Credit :4

Unit 1: Bioenergetics

Very short questions (1 mark)

1. There are certain compounds inside cell which have higher phosphoryl group transfer potential than ATP. Cite two examples of such compounds.
2. Explain the significance of the prime notation in the expression of free energy for biological systems?
3. Which one will undergo a higher change in entropy by a given amount of heat, a hot body or a cold body? Explain
4. Give one biologically relevant example each of an open system and a closed system.
5. Define standard free energy change of a reaction.
6. Draw the structure of a typical thioester and show the high energy bond.
7. What does a value of zero free energy indicate for a particular reaction?
8. Why is heat engine not a significant term for biological systems?

Short questions (2 marks)

1. ATP is known as a universal energy currency inspite of the presence of compounds having higher phosphoryl group transfer potential. Justify.
2. Why is work considered to be a path function?
3. What is metabolic charge transfer ratio?
4. Explain why in case of biological systems, the concentration of solutes is a major determinant of free energy change.
5. State the limitations of the first law of thermodynamics.
6. Explain intrinsic and extrinsic variables with examples.
7. Why will hydrolysis of ATP to ADP and Pi yield more free energy than that of ADP to AMP and Pi (assuming this hydrolysis to be occurring)?
8. What do you mean by a proper thermodynamic variable?
9. Highly ordered macromolecules are synthesized inside cells. Is it in accordance with the second law of thermodynamics? Explain

Broad questions (greater than 2 marks)

1. Define enthalpy. Show that under constant pressure, the enthalpy change of a system is equal to heat gained/lost by the system.

(1+3)

Head of the Department

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2. Arrive at a definition of free energy from the concept of entropy and second law of thermodynamics. (3)
3. Certain steps in metabolic pathway have a high positive free energy change whereas in case of certain others it is either close to zero or very slightly positive. Explain in each case the cellular strategy to drive these reactions in the forward direction?

(2+2)

4. Glucose 6 phosphate was hydrolysed enzymatically (at pH 7 and 25°C) to glucose and inorganic phosphate . The concentration of glucose-6-phosphate was 0.1 M at the start. At equilibrium, only 0.05% of the original glucose-6-phosphate remained. Calculate a) $K(prime)_{eq}$ for the hydrolysis of glucose-6 phosphate (b) ΔG(prime) for the hydrolysis reaction.

(2+2)

5. State the ways by which ATP is regenerated inside the cell. (3)
6. In glycolysis, the enzyme phosphofructokinase I catalyses the following reaction
7. Frutose-6-phosphate + ATP = Fructose 1,6 bisphosphate + ADP
8. Given the data below, calculate the equilibrium constant for the reactions R = 8.315 J/mol.K T = 25°C ATP to ADP + Pi Standard free energy change = -30.5 kJ/mole, Fructose 1,6 bisphosphate to fructose- 6-phosphate and Pi = -16 kJ/mole.
9. Glucose 6 phosphate was hydrolysed enzymatically (at pH 7 and 25°C) to glucose and inorganic phosphate . The concentration of glucose-6-phosphate was 0.1 M at the start. At equilibrium, only 0.05% of the original glucose-6-phosphate remained. Calculate a) $K(prime)_{eq}$ for the hydrolysis of glucose-6 phosphate (b) ΔG(prime) for the hydrolysis reaction.

(2+2)

10. Calculate the ΔpH across the inner mitochondrial membrane that is required at 25°C to drive the synthesis of ATP from ADP and Pi, under standard conditions?

(3)

Unit 2: Carbohydrates

Short questions (2 marks)

1. Describe structure of starch with diagram.
2. What is mutarotation? How did it help in postulating cyclic structure of glucose?
3. About how many glucose molecules are present in an amylopectin molecule having average molecular weight of 275000?
4. Explain why sucrose is a non-reducing sugar.
5. Explain why monosaccharides are always reducing in nature. Mention the reaction.
6. Which structural features differentiate cellulose from starch and glycogen?
7. State the structural relationship between alpha D glucosamine and N-acetylglucosamine
8. What are the main biological functions of polysaccharides?
9. Compare epimers with anomers with example.
10. Name the i) units ii) bonds present in the following disaccharides….
    a) Lactulose b) cellobiose c) maltose d) sucrose e) trehalose

Broad questions (4 marks)

1. Draw the chair form of
   D-Glucose b) L- mannose c) D-Galactose d) D- fructose
2. Draw the Fischer projection formula of
   D-fructose b) D-Glucose c) L- mannose d) D-Galactose
3. Draw the Howrath projection formula of
   D- Sucrose b) D-Maltose c) D-Lactose

Unit 3: Lipids

Short questions (2 marks)

1. Describe the structure of fatty acids.
2. Explain how saturated, monounsaturated, and polyunsaturated fatty acid structures differ from one another.
3. Predict how the number of carbons and the degree of unsaturation affect the melting points of fatty acids.
4. Explain how the structures of saturated and unsaturated triglycerides differ from one another.
5. Explain the difference in melting points of vegetable oils vs. animal fats.
6. What are eicosanoids? Give example.
7. Why stearic acid had a higher melting point than lauric acid.
8. Linolenic acid has a lower melting point than linoleic acid. Explain why.
9. What are complex lipid? Give example.
10. What are derived lipid? Give example.
11. How does a triglyceride obtained from plant differ from that of animal source?
12. Calculate the saponification number of palmitoylstearin. (M.W=862)
13. What are essential fatty acids?
14. Write down the structure of lecithin and cephalin.
15. What do you mean by Acid value of fat? Write its significance.
16. What is hardening of oil? How it is carried out?
17. Write the structure of glutathione. What is its function in cell?
18. What is volatile fatty acid number? Discuss its significance with example.
19. Write the structural features of palmitic acid.
20. What is saponification number? How it is determined?
21. Why most naturally occuring fatty acidscontain an even number of carbon atoms?

Broad questions (greater than 2 marks)

1. Describe the structure of waxes, how they are made, and the biological function of waxes.
2. Describe the general structure of triglycerides and list their biological functions.
3. Describe three reactions in which triglycerides are reactants.
4. Distinguish glycerophospholipids from sphingophospholipids.
5. Distinguish glyceroglycolipids from sphingoglycolipids.
6. Identify the structural component that is common to all steroids and identify three important members of this class of lipids.
7. Describe the structure and function of bile salts.
8. Describe the structure and function of lipoproteins. List different types of lipoproteins.

Unit 4: Proteins

Multiple choice questions (1 mark each)

1. There are 10 amino acids in a peptide. In how many ways it can fold?
   A) 20 B)10 C) 1024 D) 512
2. A protein while getting folded is trapped in a local minimum. Estimate the amount of energy to bring it to its native structure.
   A)10-15 kJ/mole B) 2-5 KJ/mole C) 80-100 KJ/mole D) 0.1 -0.5 KJ/mole

3. An alpha helix is expected to be found in which protein?
   A)Cytosolic B) Membrane C) Organellar D) All of the above

4. Which amino acid is more commonplace than others in the active site of a protein
   A)Glycine B) Lysine C) Histidine D) Threonine

5. An antiparallel beta pleated sheet is stronger than a parallel one because
   A) It has more number of hydrogen bonds B) It has additional hydrophobic interactions among residues C)The hydrogen bond donors and acceptors are aligned linearly D) All of the above

6. Some proteins can denature if stored in low temperatures for long time. What is the most likely cause?
   A)Disruption of salt bridges B) Disruption of hydrogen bonding C) Stabilisation of a local minimum from a dynamic ensemble D) Decrease in hydrophobic effect

7. Which residue in a protein is most likely to form hydrogen bond with water
   A)Aspartate B) Lysine C) Histidine D) Serine

8. Two atoms approach each other from infinite separation. After a certain point, they will feel mutual attraction. The magnitude of this attraction varies inversely as
   A)Square of the distance of separation B) 6th power of the distance C) 3rd power of the

distance D) 12th power of the distance.

9. Peptide bonds possess

   A)Partial double bonded character B) a finite dipole moment C) Resonance D) All of the above

10. Biological activity of a protein is seen when the protein has attained atleast

    A)Primary structure B) Secondary structure C) Tertiary structure D) Quaternary structure

Very short questions (1 mark each)

1. Name two prospective amino acids capable of forming a salt bridge.
2. What does global energy minima of a protein represent?
3. What does HbS represent?
4. Name one achiral amino acid found in proteins?
5. Draw a dipeptide and show the phi and psi dihedral angles.
6. What does increasing number of hydroxyproline residues in a tropocollagen indicate?
7. Give an example of a covalent bond necessary to stabilize the tertiary structure of a protein.
8. Why is glutathione moderately stable to hydrolysis by peptidases?
9. State the mechanism of action of Gramicidin D?
10. Give an example of a coiled coil structure.

Short questions (2 marks each)

1. Several oil droplets poured on water coalesce to a single droplet immediately. This effect is even pronounced if the water is at higher temperature. Explain this behaviour.
2. What are 3_{10} helix and pi helix?
3. Explain the significance of glutathione as a cellular anti-oxidant.
4. Differentiate between a domain and a motif of a protein
5. Why is proline known as a helix breaker?
6. What is methemoglobin?
7. What is a zwitterions?
8. Why is alanine chiral but beta alanine achiral?
9. Catalytic sites of enzymes are often located in the loops rather than in ordered secondary structure elements. Explain.
10. State the mechanism of action of Gramicidin D.

Broad questions (more than 2 marks)

1. What are non-ribosomal peptides? How are they synthesized? (1+3)
2. What is 6-12 potential? Explain its significance in terms of protein folding. (2+2)
3. Discuss the forces responsible for stabilisation of secondary structure of a protein. (4)
4. What is a Ramachandran plot? Draw a typical plot and show the tentative co-ordinates of
5. alpha helix b) beta pleated sheet and c) poly glycine 2+ {1+1+1)
6. Explain Bohr effect with respect to haemoglobin molecule. (3)
7. Haemoglobin and Myoglobin have different structures depending upon differential needs. Explain. (3)

8. Draw the titration curves of aspartic acid and lysine and obtain an equation to determine the isoelectric pH in each case. (2+2)
9. Design a biochemical experiment by which you can distinguish between
    a) a free amino acid and a peptide
    b) b) a protein and a peptide

(2+2)

Unit 5: Enzymes

Very short questions (1 mark each)

1. Why enzymes are called biological catalyst?
2. How enzymes differ from inorganic catalists?
3. What is E.C number of enzyme?
4. Define Km
5. Define enzyme activity (U)
6. What is Turnover Number?
7. Define Vmax
8. What are Suicide inhibitors?
9. Define zymogens.
10. Define ribozymes.
11. What are abzymes?
12. What do you mean by rate-limiting enzymes?
13. Define allosteric enzymes.
14. What do you mean by isozyme?
15. Define single-displacement and double-displacement (ping-pong) reactions with examples.

Short questions (2 marks each)

1. Write the properties of allosteric enzymes.
2. Write the basic differences between simple enzymes and allosteric enzymes
3. Give example of two enzymes each that function in alkaline pH and acidic pH
4. Write the biological importance of isozymes.
5. What is the kinetic behavior of enzymes catalyzing bimolecular reactions?
6. Write the significance of K_m of an enzyme
7. Write its significance of V_{max} of an enzyme
8. Write the importance of *catalytic efficiency*.
9. Write the effect of pH on enzyme activity.

10. Write the effect of temperature on enzyme activity.
11. Define irreversible enzyme inhibition with examples.
12. Define reversible enzyme inhibition with examples.
13. Define single-displacement enzymatic reaction with example.
14. Define double-displacement (ping-pong) enzymatic reaction with example.

Broad questions (3 marks)

1. Derive the Michaelis–Menten equation of enzyme kinetics.
2. Compare the kinetic parameters of competitive, non- competitive and un competitive enzyme inhibitions.
3. Write short note on the MWC model and the KNF model of allosteric enzyme.
4. Explain negative and positive cooperativity of allosteric enzymes

Unit 6: Vitamins

Very short questions (1 mark each)

1. Write the different types of vitamins
2. Name the fat soluble Vitamins
3. Niacin is the chemical name of which Vitamin?
4. Name the Vitamin that protects us from Pellagra disease?
5. Retinol is the scientific name of which Vitamin?
6. Where Vitamin C is present?
7. Liver damage is caused due to the overdose of which vitamin?
8. Name a substance that makes a vitamin metabolically ineffective?
9. Name the vitamin which is essential for the health of the brain?
10. Deficiency of which vitamin causes Beri-Beri?
11. What vitamin is called anti-aging factor?
12. What is the deficiency symptoms of vitamin K?
13. What are the two active forms of vitamin D?

Short questions (2 marks each)

1. What is anti-vitamin? Give an example
2. Megaloblastic anemia is caused due to deficiency of which vitamin?
3. What is pro-vitamin? Give an example
4. Write the names of the vitamins that takes part in blood clotting and serves as a hormone precursor?
5. What are the two vitamers of vitamin K?
6. What is vitamin? What is sunshine vitamin?
7. Write the deficiencies of fat soluble vitamins
8. What are the characteristics of vitamin?

9. Write the differences between fat-soluble and water soluble vitamins
10. Write the names of different groups of vitamin A.
11. How vitamin A absorbed in our body?
12. Write the dietary sources of vitamin D?
13. State the functions of vitamin E.
14. Write the chemical names of fat-soluble vitamin.

Broad questions (3 marks)

1. Write the chemical names of each of the vitamin in vitamin B complex.
2. Write the biological importance of vitamins.