Uva Wellassa University of Sri Lanka
Faculty of Science and Technology
Science and Technology Degree Programme
200 Level First Semester Examination – July 2016
SCT 221-3 Biochemistry

Uva Wellassa University

Instructions to candidates
Duration: Three (03) hours
Number of questions: Five (05)
Mark allocation: 100 marks
Answer all questions

1.

a.

$$H_2O(\text{solid}) \longrightarrow H_2O(\text{liquid}) \qquad \Delta H = +5.9\ \text{kJ/mol}$$
$$H_2O(\text{liquid}) \longrightarrow H_2O(\text{gas}) \qquad \Delta H = +44.0\ \text{kJ/mol}$$

Briefly explain why the heat of vaporization of water is so high compared to its heat of fusion. (2 marks)

b.

i. Write down the Van't Hoff equation for osmosis and define all the terms. (1 mark)

ii. There are approximately 6.15 g of NaCl per Liter of plasma. Calculate the osmotic pressure contribution (in kPa) by NaCl at 25^{0}C. Molar mass of NaCl = 58.4 g mol^{-1} R = 8.314 J mol^{-1} K^{-1} (2 marks)

c. Briefly explain in terms of osmolarity, what happens to a cell in a
i. hypertonic solution (2 marks)
ii. hypotonic solution (2 marks)

d. Explain using chemical equations, the role of the bicarbonate buffer system in maintaining the body pH. (4 marks)

e. Explain the roles of the following physical properties of water in sustaining life
i. high specific heat of water (2 marks)
ii. high degree of internal cohesion of water due to hydrogen bonding (2 marks)

f. pK_a of phenolphthalein is 9.3 at 25^{0}C. Calculate the ratio of its anionic form to acid form at pH = 8.2 and pH = 10. (3 marks)

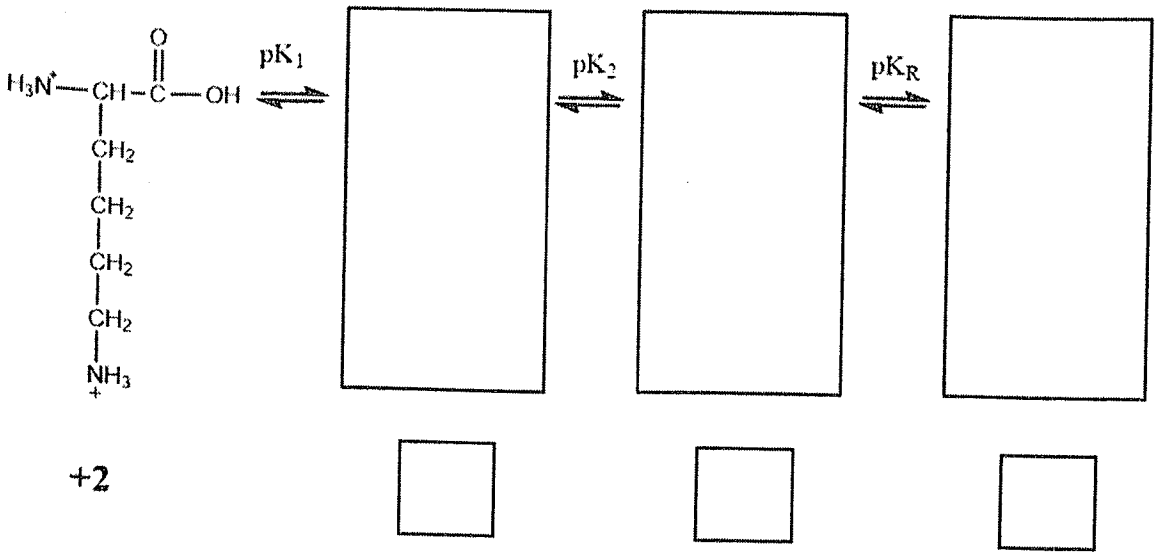
2.

a. "The zwitterionic form of an amino acid can act as an acid or a base" explain using necessary chemical equations. (3 marks)

b. Draw the structure of the oligopeptide AFGTD (given in 1-letter nomenclature). (5 marks)

50

c. For lysine (K), pK_1 (-COOH) = 2.18, pK_2 ($-NH_3^+$) = 8.95, pK_R (R group) = 10.53. Draw the structures (in the bigger boxes) for the following equilibria. Write down the corresponding net charges (in the smaller boxes). (6 marks)



d. Write short notes on the following techniques.
   i. Size-exclusion chromatography (3 marks)
   ii. Electrophoresis (SDS-PAGE) (3 marks)

3.

a. Explain the concept of "allostery" using hemoglobin as an example. (4 marks)

b. Draw schematic diagrams for the oxygen dissociation curves for hemoglobin and myoglobin. Label the curves and the axes. (4 marks)

c. Using the dissociation curves above, describe why hemoglobin is more suitable for oxygen transport than myoglobin. (4 marks)

d. Describe "Bohr effect" using necessary oxygen dissociation curves. (4 marks)

e. Briefly describe how lack of vitamin C leads to connective tissue damage (scurvy). (4 points)

4.

a. "In order to catalyze reactions, an enzyme must be complementary to the reaction transition state, and not to its substrate" explain using necessary diagrams. (4 marks)

b. Write an expression for the Michaelis-Menten equation and define all the terms. (2marks)

c. Chemical equation for the simple Michaelis-Menten model is given by

$$\mathrm{E} + \mathrm{S} \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} \mathrm{ES} \xrightarrow{k_2} \mathrm{E} + \mathrm{P}$$

where S is the substrate, E is the enzyme, ES is the enzyme-substrate complex, P is the product and k_1, k_{-1}, and k_2 are constants.

Starting with the expressions for rates of formation and breakdown of ES, and using steady state approximation, derive the Michaelis-Menten equation. (4 marks)

d. Show mathematically that K_M is equivalent to the substrate concentration at which V_0 is one-half V_{max}. (3 marks)

e. Explain how V_{max} and K_M can be found using a Lineweaver-Burk plot. (3 marks)

f. Draw schematic Lineweaver-Burk plots to compare the case of "no inhibitor" with
   i. competitive inhibition (2 marks)
   ii. uncompetitive inhibition (2 marks)

5.

a. Draw the single strand structure of the ribo-oligonucleotide ATG indicating the 5' end and the 3' end (the nitrogenous base portions of the nucleotides may be represented schematically as boxes for your convenience). Label the phosphodiester bonds. (4 marks)

b. Describe the Hershey-Chase experiment carried out in 1952 to prove that DNA, not protein, carries the genetic information. (4 marks)

c. Briefly describe the concept "central dogma of molecular biology". (4 marks)

d. Briefly describe the steps in DNA transcription. (4 marks)

e. Describe the process of intron splicing. (4 marks)