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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 22BT3DCBBM **Max Marks: 100**
Course: Basics of Biomolecules **Date: 19.05.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) A freshly prepared solution of α-D-glucose shows a specific rotation of $+112^0$. Over time, the rotation of the solution gradually decreases and reaches an equilibrium value corresponding to $[\alpha]^{25}_D = +52.5^0$. In contrast, a freshly prepared solution of β-D-glucose has a specific rotation of $+19^0$. The rotation of this solution increases over time to the same equilibrium value as that shown by the α anomer. **08**

(i) Draw the Haworth perspective formulas of α and β forms of D-glucose. What feature distinguishes the two forms?

(ii) Why does the specific rotation of a freshly prepared solution of the α form gradually decrease with time? Why do solutions of the α and β forms reach the same specific rotation at equilibrium?

(iii) Calculate the percentage of each of the two forms of D-glucose present at equilibrium.

b) A buffer contains 0.010 mol of lactic acid (p*K*a =3.86) and 0.050 mol of sodium lactate per liter. (i) Calculate the pH of the buffer. (ii) Calculate the change in pH when 5 mL of 0.5 M HCl is added to 1 L of the buffer. (iii) What pH change would you expect if you added the same quantity of HCl to 1 L of pure water? **08**

c) Differentiate between homopolysaccharides and hetero polysaccharides with suitable examples. **04**

OR

2 a) Describe the common structural features and the differences for each pair: (a) cellulose and glycogen; (b) D-glucose and D-fructose; (c) maltose and sucrose. **06**

b) Calculate the concentrations of acetic acid (p*K*a = 4.76) and sodium acetate necessary to prepare a 0.2 M buffer solution at pH 5.0. **04**

c) Differentiate between anomers and epimers giving one example each. **05**

d) Draw the structural formula for α-D-glucosyl-(1→6)-D-mannosamine and circle the part of this structure that makes the compound a reducing sugar. **05**

UNIT - II

3 a) The melting points of a series of 18-carbon fatty acids are: stearic acid, 69.6^0 C; oleic acid, 13.4^0 C; linoleic acid, 5^0 C; and linolenic acid -11^0C. **08**

(i) What structural aspect of these 18-carbon fatty acids can be correlated with the melting point?

(ii) Draw the structures of the above fatty acids.

(iii) Branched-chain fatty acids are found in some bacterial membrane lipids. Would their presence increase or decrease the fluidity of the membranes (that is, give them a lower or higher melting point? Why?

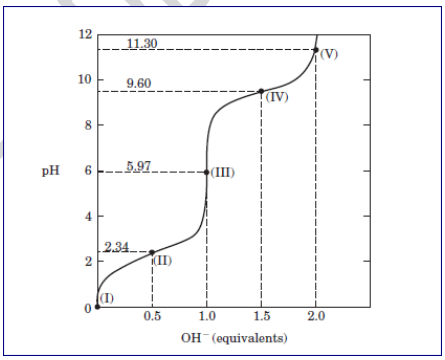
b) Complete hydrolysis of a glycerophospholipid yields glycerol, two fatty acids (16:1(Δ^9) and 16:0), phosphoric acid, and serine in the molar ratio 1:1:1:1:1. Name this lipid and draw its structure. **05**

c) What are sterols? Give the structure of a steroid nucleus and explain the role of steroid as hormones giving examples of three hormones and their function. **07**

UNIT - III

4 a) A 100 mL solution of 0.1 M glycine at pH 1.72 was titrated with 2 M NaOH solution. The pH was monitored and the results were plotted as shown in the following graph. The key points in the titration are designated I to V. **06**

For each of the statements **(i)** to **(vi),** *identify* the appropriate key point in the titration and *justify* your choice.



(i) The pH is equal to the p*K*a of the carboxyl group.

(ii) Glycine has its maximum buffering capacity.

(iii) The *average* net charge of glycine is zero.

(iv) These are the *worst* pH regions for buffering power

(v) This is the end of the titration.

(vi) The *average* net charge of glycine is -1.

b) Classify the following amino acids based on the properties of their "R" group and draw their structure. **06**

Amino acid	
(i)	Serine
(ii)	Aspartic acid
(iii)	Lysine
(iv)	Tyrosine

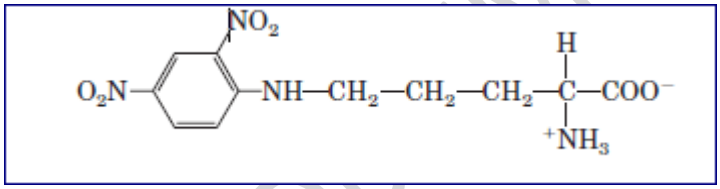
c) Extracts from the bacterium *Bacillus brevis* contain a peptide with antibiotic properties. This peptide forms complexes with metal ions and seems to disrupt ion transport across the cell membranes of other bacterial species, killing them. The structure of the peptide has been determined from the following observations. **08**

(a) Complete acid hydrolysis of the peptide followed by amino acid analysis yielded equimolar amounts of Leu, Orn, Phe, Pro, and Val. Orn is ornithine, an amino acid not present in proteins but present in some peptides.

(b) The molecular weight of the peptide was estimated to be about 1,200.

(c) The peptide failed to undergo hydrolysis when treated with the enzyme carboxypeptidase. This enzyme catalyzes the hydrolysis of the carboxyl-terminal residue of a polypeptide unless the residue is Pro or, for some reason, the C-terminal amino acid doesn't contain a free carboxyl group.

(d) Treatment of the intact peptide with 1-fluoro-2,4-dinitrobenzene, followed by complete hydrolysis and chromatography, yielded only free amino acids and the following derivative (2,4 dinitrophenyl ornithine)



(e) Partial hydrolysis of the peptide followed by chromatographic separation and sequence analysis yielded the following di- and tripeptides.

dipeptides	tripeptides
Leu–Phe	Pro–Val–Orn
Phe–Pro	Val–Orn–Leu
Orn–Leu	Phe–Pro–Val
Val–Orn	

Based on the above information deduce the sequence of the peptide antibiotic.

(Hint: assume mol.wt. of average residue = 110 and the peptide is cyclic in nature)

UNIT - IV

5 a) Two major models have been proposed to explain the cooperative binding of ligands to multi subunit proteins. List the two models and explain their salient features. **10**

b) Our growing understanding of how proteins fold allows researchers to make predictions about protein structure based on primary amino acid sequence data. **10**

Ile Ala His Thr Tyr Gly Pro Phe Glu Ala Met Cys Lys Trp Glu Ala Gln Pro Asp Met Glu Cys Ala Phe His Arg

(i) In the amino acid sequence above, where would you predict that bends or

turns would occur?
(ii) Where might intra chain disulfide cross-linkages be formed?
(iii) Assuming that this sequence is part of a larger globular protein, indicate the probable location (the external surface or interior of the protein) of the following amino acid residues: Asp, Ile, Thr, Ala, Gln, Lys. Explain your reasoning.

OR

6 a) Explain in detail the Ramachandran plot or stearic contour diagram taking any one example. Add a note on its significance. **08**

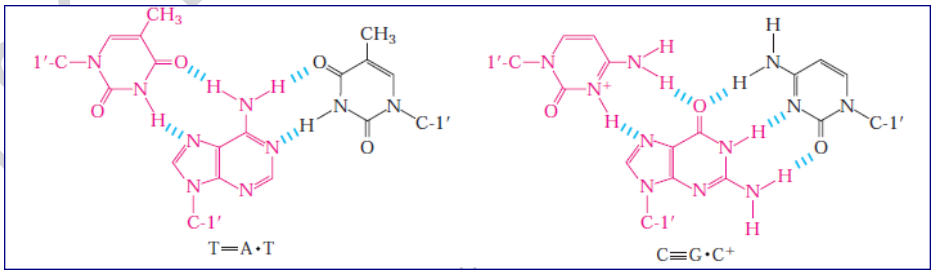
b) What is the effect of the following changes on the O_2 affinity of hemoglobin? **04**
(i) A drop in the pH of blood plasma from 7.4 to 7.2.
(ii) A decrease in the partial pressure of CO_2 in the lungs from 6 kPa (holding one's breath) to 2 kPa (normal).
(iii) An increase in the BPG level from 5 mM (normal altitudes) to 8 mM (high altitudes).
(iv) An increase in CO from 1.0 parts per million (ppm) in a normal indoor atmosphere to 30 ppm in a home that has a malfunctioning or leaking furnace.

c) Protein folding in cells probably involves multiple pathways." Justify this statement explain the thermodynamics of protein folding with the help of a suitable diagram. **08**

UNIT – V

7 a) Draw the following structures and rate their relative solubilities in water (most soluble to least soluble): deoxyribose, guanine, phosphate. How are these solubilities consistent with the three-dimensional structure of double-stranded DNA? **10**

b) Identify the type of DNA shown below. What is the unique feature of these type of DNA. **05**



c) Explain why the absorption of UV light by double-stranded DNA increases when the DNA is denatured. What is this effect called? **05**

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