U.S.N.										

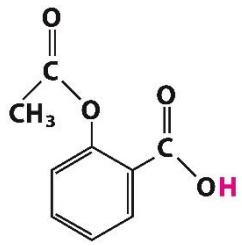
B.M.S. College of Engineering, Bengaluru-560019

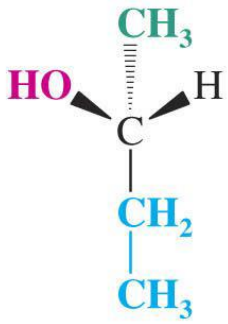
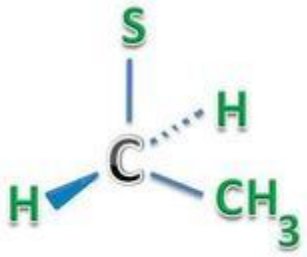
Autonomous Institute Affiliated to VTU

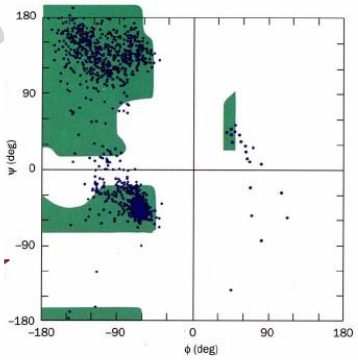
August 2024 Supplementary Examinations

Programme: B.E. **Semester: III**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 19BT3DCBBM **Max Marks: 100**
Course: Basics of Biomolecules

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)	(i) Gentiobiose (β-D-glucopyranosyl-(1→6)-D-glucopyranose) is a disaccharide found in some plant glycosides. Draw the structure of gentiobiose based on its systematic name. Is it a reducing sugar? Does it undrgo mutaroation? (ii) Why does the specific rotation of a freshly prepared solution of the α-D-glucose gradually decreases with time? Why do solutions of the α and β forms of D-glucose reach the same specific rotation at equilibrium? (iii) Calculate the percentage of each of the two forms of D-glucose present at equilibrium.	**10**
		b)	(i) Aspirin is a weak acid with a pKa of 3.5.  It is absorbed into the blood through the cells lining the stomach and the small intestine. Absorption requires passage through the plasma membrane, the rate of which is determined by the polarity of the molecule: charged and highly polar molecules pass slowly, whereas neutral hydrophobic ones pass rapidly. The pH of the stomach contents is about 1.5, and the pH of the contents of the small intestine is about 6. Is more aspirin absorbed into the bloodstream from the stomach or from the small intestine? Clearly justify your choice. (ii) Which of these compounds would be the best buffer at pH 5.0: Formic acid (pKa = 3.8), Acetic acid (pKa = 4.76), or Ethylamine (pKa = 9.0)? Briefly justify your answer.	**07**
		c)	In a hospital laboratory, a 10.0 mL sample of gastric juice, obtained several hours after a meal, was titrated with 0.1 M NaOH to neutrality; 7.2 mL of NaOH was required. The patient's stomach contained no ingested food or drink., thus assume that no buffers were present. What was the pH of the gastric juice?	**03**

			OR	
	2	a)	A buffer contains 0.010 mol of lactic acid (pKa = 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	**08**
		b)	(i) Describe R, S system of nomenclature of chiral compounds. Designate the following isomers using R, S system of nomenclature.   (ii) In the monosaccharide derivatives known as sugar alcohols, the carbonyl oxygen is reduced to a hydroxyl group. For example, D-glyceraldehyde can be reduced to glycerol. However, this sugar is no longer disignated D or L, why?	**07**
		c)	You have been observing an insect that defends itself from enemies by secreting a caustic liquid. Analysis of the liquid shows it to have a total concentration of formate plus formic acid (Ka = 1.8 X 10^{-4}) of 1.75 M; the concentration of formate ion is 0.025 M. What is the pH of the secretion?	**05**
			UNIT –II	
	3	a)	A common structural feature of membrane lipids is their amphipathic nature. For example, in phosphatidylcholine, the two fatty acid chains are hydrophobic and the phosphocholine head group is hydrophilic. For each of the following membrane lipids, name the components that serve as the hydrophobic and hydrophilic units: (i) Phosphatidylethanolamine (ii) Sphingomyelin (iii) Galactosylcerebroside (iv) Ganglioside	**08**
		b)	What are steroids? Can you write the structure and biological functions any two steroids?	**07**

		c)	In reality, membranes are composed of several different types of lipids, as well as proteins. One reason why there are multiple types of lipids is to ensure that the membrane remains fluid so that proteins, lipids and small molecules can move through and within the membrane. In particular, there is always a mixture of saturated and unsaturated phospholipids. Give an explanation with diagram of why a membrane containing unsaturated phospholipids would be more fluid than a membrane made exclusively of saturated phospholipids.	**05**
			UNIT -III	
	4	a)	A protein is subjected to end group analysis by Edman degradation. The liberated PTH-amino acids are found to be present with a molar ratio of two parts Val, one part Ala and one part Phe. i. What is Edman's reagent? Write its structure. ii. What conclusions can be drawn about the nature of the protein? iii. What is the most important difference between the Edman degradation and other methods of N-terminal residue identification? How does Edman degradation work?	**10**
		b)	How are amino acids classified? Write the name and structure of one amino acid under each class.	**10**
			UNIT-IV	
	5	a)	Refer the Ramachandran plot given below to answer the following questions.  (i) What does the Ramachandran plot represent? (ii) What are the parameters shown on the Ramachandran plot and what do they characterize? (iii) Why is the lower right quadrant a "forbidden" region in the Ramachandran plot? (iv) What makes Glycine a special amino acid when it comes to Ramachandran plots?	**07**

<table>
<tr><td></td><td></td><td>b)</td><td>Lysozyme consists of 129 amino acids. The order of 12 amino acids numbered 4 through 15 in lysozyme is as follows. Gly–Arg–Cys-Glu-Leu-Ala-Ala-Ala-Met-Lys-Arg-His
(i) What level of protein structure does this represent?
These 12 amino acids also make up an α-helix in lysozyme.
(ii) What level of protein structure does α-helix represent?
(iii) Do the side chains of the amino acids in a helix point into or out of the helix?
(iv) What type of bond is primarily responsible for maintaining this helical structure?
(v) What part of the amino acid participates in this bond (side chain or backbone)?
(vi) How many full turns are in this α-helix?
(vii) What is the length of the helix (in Angströms) in the direction of the helix axis?</td><td>09</td></tr>
<tr><td></td><td></td><td>c)</td><td>Protein A has a binding site for ligand X with a K_d of 10^{-6} M. Protein B has a binding site for ligand X with a K_d of 10^{-9} M. Which protein has a higher affinity for ligand X? Explain your reasoning. Convert the K_d to K_a for both proteins.</td><td>04</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td></tr>
<tr><td></td><td>6</td><td>a)</td><td>i. Which set of binding data is likely to represent cooperative ligand binding to an oligomeric protein?

A
<table><tr><th>Ligand (mM)</th><th>θ</th></tr><tr><td>0.1</td><td>0.3</td></tr><tr><td>0.2</td><td>0.5</td></tr><tr><td>0.4</td><td>0.7</td></tr><tr><td>0.7</td><td>0.9</td></tr></table>
B
<table><tr><th>Ligand (mM)</th><th>θ</th></tr><tr><td>0.2</td><td>0.1</td></tr><tr><td>0.3</td><td>0.3</td></tr><tr><td>0.4</td><td>0.6</td></tr><tr><td>0.6</td><td>0.8</td></tr></table>
ii An antibody binds to an antigen with a K_d of 5×10^{-8} M. At what concentration of antigen will θ be (a) 0.2 and (b) 0.8
iii If you have a solution containing 1×10^6 molecules of myoglobin and θ = 0.8, how many myoglobin molecules have oxygen bound?</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>You are studying a di-peptide with the sequence Glu-Ile. Draw the structure of this di-peptide at pH 7. Indicate which parts of the molecule are planar and explain why. On the drawing, indcate the Φ and ψ angles.</td><td>06</td></tr>
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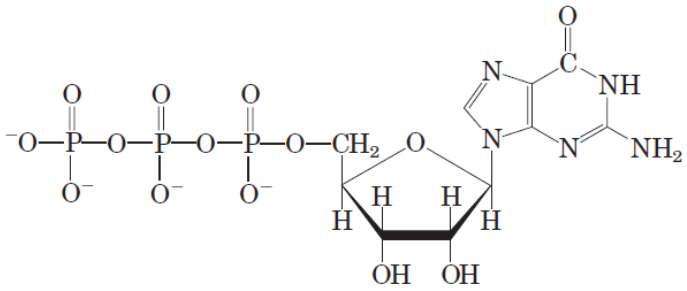
		c)	Super secondary structures or motifs, α/β domains and α/β barrels are the building blocks of proteins. Explain the features of TIM barrel and Greek key motif	**04**
			UNIT -V	
	7	a)	The following diagram represents a nucleotide that serves as a monomer for ribonucleic acid (RNA).  (i) Classify this nucleotide as purine or pyrimidine nucleotide. (ii) Besides serving as a monomer of RNA, what is the other major role of this nucleotide within a cell? (iii) Box the group or atom that you would remove, so that the nucleotide drawn above can serve as a monomer for DNA. (iv) What type of bonds would hold two such adjacent nucleotides together in a growing nucleic acid chain? Circle the group(s) that would participate in the formation of this bond if the nucleotide shown above, was added to the growing nucleic acid chain. (v) Name the type of bonds that the above nucleotide will form with its complementary nucleotide. How many of these bonds would you expect between this nucleotide pair? The nucleotide (**N**) shown above is a part of the following nucleic acid sequence. 5'GGCCA**N**ACCA3' For the nucleic acid sequence that is given above… (vi) Which nucleotide base (A/T/G/C/U) has a free phosphate group? (vii) Which nucleotide base (A/T/G/C/U) has a free hydroxyl group? (viii) If adenine nucleotide is added to the above nucleic acid sequence in a cell, would it be added to the 5' end or the 3' end?	**10**

		b)	In samples of DNA isolated from two unidentified species of bacteria, X and Y, adenine makes up 32% and 17%, respectively, of the total bases. i. What relative proportions of adenine, guanine, thymine, and cytosine would you expect to find in the two DNA samples? ii. What assumptions have you made? One of these species was isolated from a hot spring (64 ºC). iii. Suggest which species is the thermophilic bacterium. iv. What is the basis for your answer? Why the absorption of UV light by double-stranded DNA increases when the DNA is denatured?	**10**

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