U.S.N.										

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

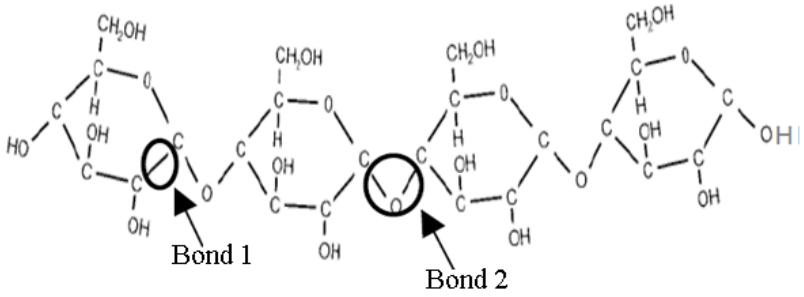
Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 23BT3PCBBM / 22BT3PCBBM **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.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

			UNIT - I	*CO*	*PO*	Marks
1	a)			*1*	*1*	**07 (1+2+ 2+2)**

i. Classify this polymer as a monosaccharide, oligosaccharide or polysaccharide.

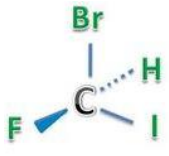
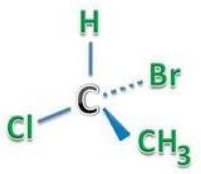
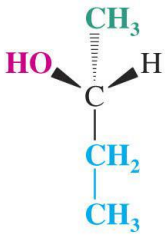
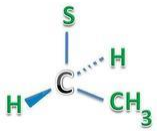
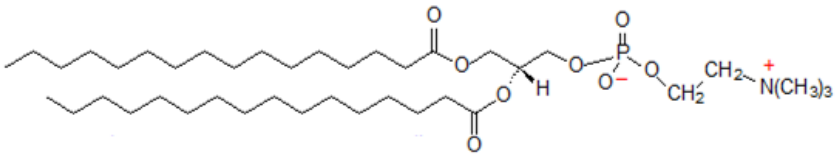
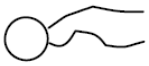
ii. From the following (*given in the table*), circle all the options that best characterize this polymer. Explain why you selected these options.

Hydrophobic	Polar	Hydrophilic	Nonpolar	Charged	Uncharged

iii. Which of the above bonds (*choose either bond 1 or bond 2*) is an example of glycosidic bond? Explain why you selected this option.

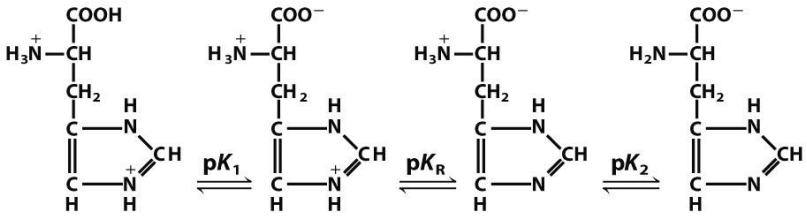
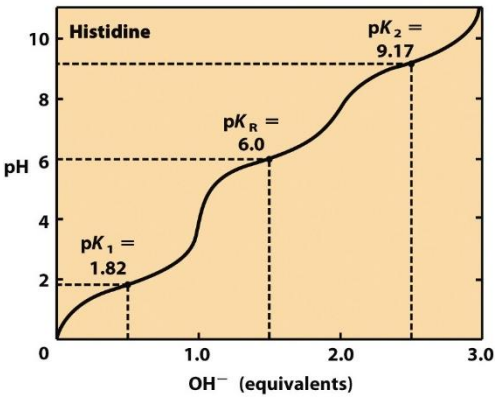
iv. From the following (*given in the table*), circle the type of bond or interaction that occurs between two such polymers, when they are placed in an aqueous environment. Explain why you selected this option(s).

			<table><tr><td>Ionic bond</td><td>Covalent bond</td><td>Hydrogen bonds</td><td>Van der Waals forces</td></tr></table>			
	b)	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 water?	*2*	*1*	**07 (2+3+2)**
	c)	Describe one common structural feature and difference for each pair: i. Starch and Glycogen ii. Cellulose and Chitin iii. Trehalose and Sucrose	*1*	*1*	**06 (2+2+2)**
		OR			
2	a)	i. Gentiobiose (β-D-glucopyranosyl-(1 → 6)-D-gluco pyranose) 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 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.	*1*	*1*	**09 (5+3+1)**
	b)	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?	*2*	*1*	**04**
	c)	i. Describe R, S system of nomenclature of chiral compounds. ii. Designate the following isomers using R, S system of nomenclature.	*3*	*2*	**07 (3+4)**

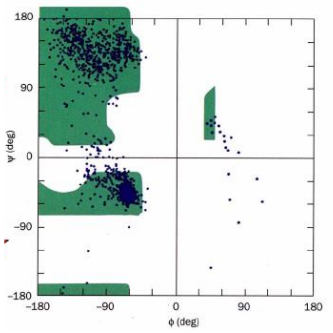
			A	B	C	D			
									
			UNIT - II						
	3	a)	Membranes are made up of many components and, in some membranes, phospholipids are the major component. Below is an example of a saturated phospholipid.  i. Draw a square around the portion of the molecule that is hydrophobic and a circle around the portion that is hydrophilic. Phospholipids are also sometimes represented like this:  ii. Using the simplified structure above, draw what a lipid bi-layer looks like in an aqueous environment. Explain what causes the lipids to create this formation. In your depiction of a lipid bi-layer drawn above what type of force is acting with reasons …….. iii. between the phosphoglycerol (hydrophilic) component and the fatty acid? iv. between the phosphogroup and the surrounding aqueous environment? v. between the fatty acid groups of different phospholipids molecules?	*3*	*2*	**10 (2+2+ 2+2+2)**
		b)	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	*3*	*1*	**05**

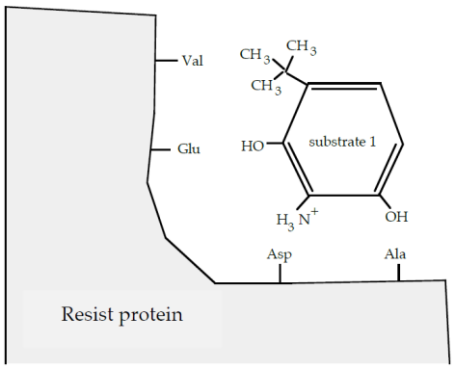
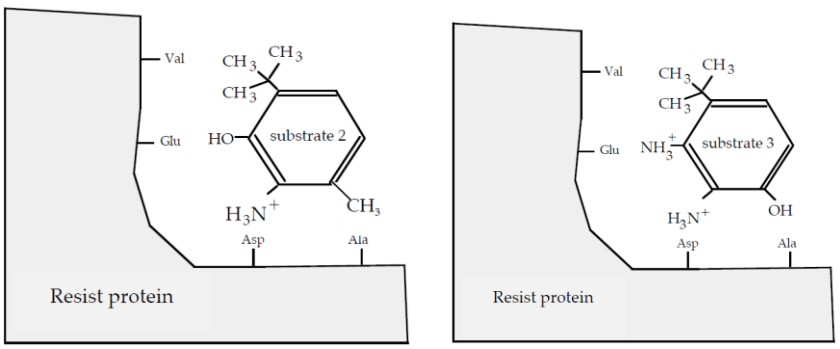
			the membrane. In particular, there is always a mixture of saturated and unsaturated phospholipids. Will you explain with a diagram why a membrane containing unsaturated phospholipids would be more fluid than a membrane made exclusively of saturated phospholipids?			
		c)	Complete hydrolysis of a glycerophospholipid yields glycerol, two fatty acids [16:1(Δ^9) and 16:0], phosphoric acid, and serine in the molar ratio 1:1:1:1. Name the lipid and draw the structure.	*3*	*2*	**05**
			OR			
	4	a)	For each class of lipids on the left, put a check mark **(✓)** in the column under the components found in these lipids. If only some of the lipids in a category contain a component, write **"some"** in the box. Is the compound a membrane lipid? The first one has been done for you as an example.	*3*	*2*	**10**
		b)	The melting points of a series of fatty acids are: oleic acid, 13.4 ºC; linoleic acid, -5 ºC; and linolenic acid, -11 ºC. i. What structural aspect of these fatty acids can be correlated with the melting point? Provide a molecular explanation for the trend in melting points. ii. Draw (only schematic representation) all the possible triacylglycerols that can be constructed from glycerol, palmitic acid, and oleic acid. Rank them in order of increasing melting point	*3*	*1*	**5 (2+3)**

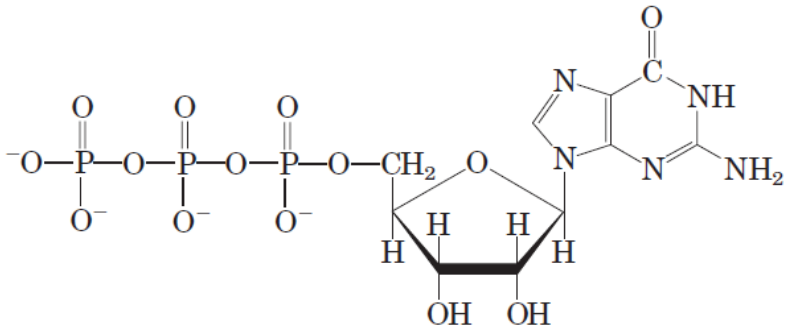
	Fatty Acid	**Glycerol**	**Sphingosine**	**Phosphate**	**Carbohydrate**	**Membrane lipid?**
Triacylglycerol	✓	✓				
Sphingomyelin						
Phospahtidylethanolamine						
Ganglioside						
Plasmalogen						
Triolein						

		c)	Compositional analysis of a certain lipid shows that it has exactly one mole of fatty acid per mole of inorganic phosphate. Could this a glycerophospholipid? A ganglioside? A sphingomyelin? Substantiate your answer with the explanation.	*3*	*2*	**05**
			UNIT - III			
	5	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?	*4*	*1*	**08 (3+2+ 3)**
		b)	Write the symbol for the following amino acids. i. Glutamate ii. Phenylalanine iii. Asparagine iv. Lysine v. Tyrosine	*1*	*1*	**05 (1x5)**
		c)	Indicate whether the following statements concerning histidine are true or false. Refer to the following titration curve.   	*3*	*2*	**07 (1x7)**

			i. At pH 1.82 there are equal amounts of form 1 and form 2. ii. The α-carboxyl group is half dissociated at pH 9.17. iii. Histidine would be a good buffer at pH values near 1.8 and 9.2. iv. Histidine has biological importance because the pK_a of its side chain is close to physiological pH. v. Histidine's pI is between pH 1.82 and 6.0. vi. The average net charge on the Histidine at pH 9.17 is –1.0. vii. Histidine will migrate towards anode at pH 7.6 when placed in an electric field.			
			OR			
	6	a)	A group of peptides that influence nerve transmission in certain parts of the brain has been isolated from normal brain tissue. These peptides are known as opioids, because they bind to specific receptors that also bind opiate drugs, such as morphine and naloxone. Opioids thus mimic some of the properties of opiates. Some researchers consider these peptides to be the brain's own pain killers. Using the information below, determine the amino acid sequence of the opioid leucine enkephalin. Explain how your structure is consistent with each piece of information. i. Complete hydrolysis by 6 M HCl at 110 C followed by amino acid analysis indicated the presence of Gly, Leu, Phe, and Tyr, in a 2:1:1:1 molar ratio. ii. Treatment of the peptide with 1-fluoro-2,4-dinitrobenzene followed by complete hydrolysis and chromatography indicated the presence of the 2,4-dinitrophenyl derivative of tyrosine. No free tyrosine could be found. iii. Complete digestion of the peptide with pepsin followed by chromatography yielded a dipeptide containing Phe and Leu, plus a tripeptide containing Tyr and Gly in a 1:2 ratio.	*4*	*2*	**10 (3+3+4)**
		b)	What is isoelectric point? How do you calculate the pI of glycine like amino acids?	*3*	*2*	**05**
		c)	State the cleavage pattern of the following polypeptide by the indicated agents.	*3*	*2*	**05**

			i. Ser-Ala-Phe-Lys-Pro-Trp-Pro by Chymotrypsin ii. Thr-Cys-Gly-Met-Asn by CNBr iii. Val-Trp-Lys-Pro-Arg-Glu-Gly-Lys-Pro by Trypsin iv. Comment on the application of these agents in amino acid sequencing.			**(1+1+ 1+2))**
			UNIT - IV			
	7	a)	Refer to 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?	*4*	*1*	**07 (1+2+ 2+2)**
		b)	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? ii. How do you classify these amino acids into different groups based on the side chain (R) group? These 12 amino acids also make up an α-helix in lysozyme. iii. What level of protein structure does α-helix represent? iv. Do the side chains of the amino acids in a helix point into or out of the helix? v. What type of bond is primarily responsible for maintaining this helical structure? vi. What part of the amino acid participates in this bond (side chain or backbone)?	*4*	*1*	**13 (1+5+ 1+1+1 +1+1 +2)**

			vii. How many full turns are in this α-helix? viii. What is the length of the helix (in Angströms) in the direction of the helix axis?			
			OR			
	8	a)	In analyzing differences between drug resistant fungi and drug sensitive fungi, you have discovered a protein that exists only in the drug resistant fungi. You named this the Resist protein and design substrates that you hope will bind to it.  i. Give the name for the strongest intermolecular interaction between substrate 1 as shown and the side chains of following amino acids on the Resist protein. Choose from ionic bond, covalent bond, hydrogen bond, and van der Waals forces. Amino acid | Strongest interaction Val | Glu | Asp | Ala | You make the following additional substrates.  ii. What is the strongest interaction that now exists between the Ala of the Resist protein and substrate 2?	*4*	*1*	**08 (4+1+ 1+2)**

			iii. What is the strongest interaction that now exists between the Glu of the Resist protein and substrate 3? iv. Which substrate (Substrate 1/Substrate 2/Substrate 3) would you expect to bind the most tightly to the Resist protein? Explain why you made this choice.			
		b)	You are studying a tri-peptide with the sequence Val-Trp-Asn. Draw the structure of this tri-peptide at pH 7. Indicate which parts of the molecule are planar and explain why. On the drawing, indicate the Φ and ψ angles.	*3*	*2*	**07 (4+2+1)**
		c)	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.	*4*	*1*	**05**
			UNIT - V			
	9	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?	*3*	*2*	**10 (1+1+1+2+2+1+1+1)**

			The nucleotide (**N**) shown above is a part of the following DNA sequence in its deoxygenated form. 5'GGCCA**N**ACCA3' For the nucleic acid sequence that is given above… vi. Which nucleotide (G/C/A/N) has a free phosphate group? vii. Which nucleotide (G/C/A/N) 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?			
		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? v. Why the absorption of UV light by double-stranded DNA increases when the DNA is denatured?	*4*	*1*	**10 (3+2+1+2+2)**
			OR			
	10	a)	Draw the tetra-nucleotide sequence 5'-GACT-3' which is a part of DNA.	*3*	*2*	**5**
		b)	A deoxyribonucleotide is an organic molecule that is the building block of DNA. A deoxyribonucleotide is made up of three parts: a nitrogenous base, a deoxyribose and a phosphate group with different relative solubility in water. i. Rate following their relative solubility in water (most soluble to least soluble): deoxyribose, adenine, phosphate. ii. How are these solubilities consistent with the three-dimensional structure of double-stranded DNA?	*3*	*1*	**5 (3+2)**
		c)	What is DNA denaturation and Tm? Why does the absorption of UV light by double stranded DNA increase with the denaturation of DNA?	*3*	*1*	**5**
		d)	Compare the important features of A, B and Z forms of DNA.	*3*	*1*	**5**

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