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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: IV**

Branch: Biotechnology **Duration: 3 hrs.**

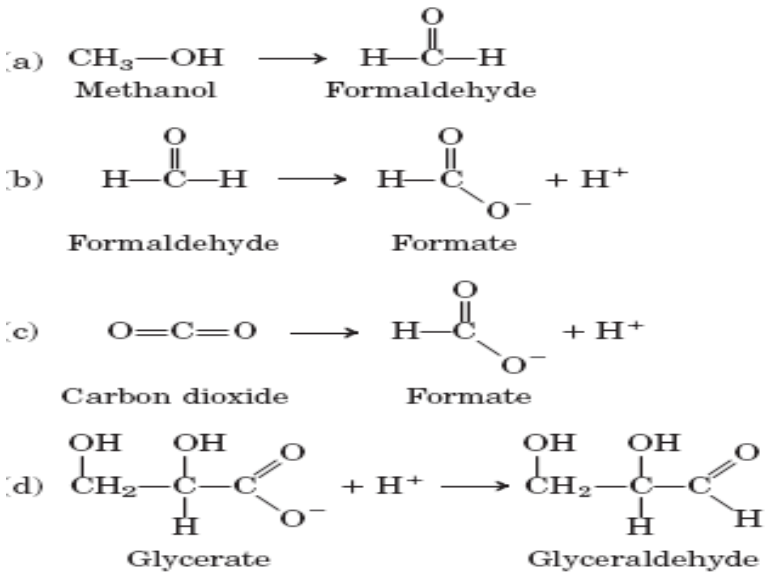
Course Code: 23BT4PCBAB /22BT4PCBAB /19BT4DCBAB **Max Marks: 100**

Course: Biochemistry & Bioenergetics

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

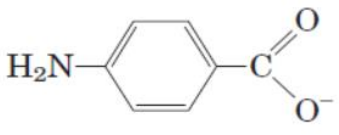
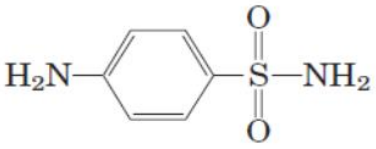
		UNIT - I	CO	PO	Marks
1	a)	Consider the following inter conversion : Fructose-6-Phosphate ⇔ Glucose-6-Phospahate Keq^{10}=1.97 i) Calculate the ΔG^{10} at 25^0C ii.) If the concentration of Fructose-6-Phosphate is adjusted to 1.25M and that of Glucose-6-Phospahate is 0.5M, Calculate ΔG^{10} at 25^0C	CO2	PO1	**8**
	b)	Identify the direction of each of the following reactions when the reactants are initially present in equimolar amounts? Justify (a) ATP + creatine $\rightleftharpoons$ creatine phosphate + ADP (b) ATP + glycerol $\rightleftharpoons$ glycerol 3-phosphate + ADP (c) ATP + pyruvate $\rightleftharpoons$ phosphoenolpyruvate + ADP (d) ATP + glucose $\rightleftharpoons$ glucose 6-phosphate + ADP The Standard free energies of hydrolysis is given below	CO2	PO1	**8**
	c)	For each of the metabolic transformations in (a) through (e), determine whether oxidation or reduction has occurred	CO2	PO1	**4**

Compound	kcal mol^{-1}	kJ mol^{-1}
Phosphoenolpyruvate	-14.8	-61.9
1,3-Bisphosphoglycerate	-11.8	-49.4
Creatine phosphate	-10.3	-43.1
ATP (to ADP)	- 7.3	-30.5
Glucose 6-phosphate	- 3.3	-13.8
Glucose 1-phosphate	- 5.0	-20.9
Pyrophosphate	- 4.6	-19.3
Glycerol 3phosphate	-2.2	-9.2

						
			OR			
2	a)		Calculate the ΔG^{10} and ΔG for the reaction at 25^0C if pyruvate and NADH are present in 0.5M concentration and lactate and NAD^+ are present in 5M concentration. Pyruvate + NADH + H^+ →Lactate+ NAD^+. E^{10} NAD^+/NADH= - 0.32V and E^{10} Pyruvate/lactate = - 0. 185V	*CO2*	*PO1*	**10**
	b)		What are high energy compounds. Draw the structure of ATP and explain the factors responsible for high energy character of ATP.	*CO1*	*PO1*	**10**
			UNIT - II			
3	a)		The citric acid cycle has eight enzymes: citrate synthase, aconitase, isocitrate dehydrogenase, α-ketoglutarate dehydrogenase, succinyl-CoA synthetase, succinate dehydrogenase, fumarase, and malate dehydrogenase. (a) Write a balanced equation for the reaction catalyzed by each enzyme. (b) For each enzyme determine which of the following describes the type of reaction(s) catalyzed: condensation (carbon–carbon bond formation); dehydration (loss of water); hydration (addition of water); decarboxylation (loss ofCO_2); oxidation-reduction; substrate-level phosphorylation; isomerization.	*CO4*	*PO2*	**8**
	b)		The degree of reduction of each carrier in the respiratory chain is determined by conditions in the mitochondrion. For example, when NADH and O_2 are abundant, the steady-state degree of reduction of the carriers decreases as electrons pass from the substrate to O_2. When electron transfer is blocked, the carriers before the block become more reduced and those beyond the block become more oxidized. For each of the conditions below, predict and justify the state of oxidation of ubiquinone and cytochromes *b*, c_1, *c*, and *a* & a_3. i) Abundant NADH and O_2, but cyanide added ii) Abundant NADH, but O_2 exhausted iii) Abundant NADH and O_2	*CO3*	*PO2*	**6**

		c)	^{14}C-labeled glyceraldehyde-3-phosphate was added to a yeast extract. After a short time, fructose 1,6-bisphosphate labeled with^{14}C at C-3 and C-4 was isolated. i) What was the location of the^{14}C label in the starting glyceraldehyde 3-phosphate? ii) Where did the second ^{14}C label in fructose 1,6-bisphosphate come from? Explain.	*CO3*	*PO2*	**6**
			OR			
	4	a)	Explain the mechanism of rotational catalysis of ATP synthesis with neat labelled diagrams.	*CO3*	*PO2*	**8**
		b)	Two of the steps in the oxidative decarboxylation of pyruvate to acetyl-CoA do not involve any of the three carbons of pyruvate yet are essential to the operation of the PDH complex. i) Identify the reactions ii) Explain the mechanism of action of PDH complex	*CO4*	*PO2*	**8**
		c)	When the antibiotic valinomycin is added to actively respiring mitochondria, several things happen: the yield of ATP decreases, the rate of O_2 consumption increases, and the pH gradient across the inner mitochondrial membrane increases. Does valinomycin act as an uncoupler or an inhibitor of oxidative phosphorylation? Justify your answers.	*CO3*	*PO2*	**4**
			UNIT - III			
	5	a)	When the [NADPH]/[$NADP^+$] ratio in chloroplasts is high, photophosphorylation is predominantly cyclic. Why? Explain illustrating the Z scheme. Is O_2 evolved during cyclic photophosphorylation? Is NADPH produced.	*CO4*	*PO2*	**10**
		b)	Photorespiration is an expense paid by C_3 plants during Photosynthesis. Justify	*CO4*	*PO2*	**10**
			OR			
	6	a)	If a maize (corn) plant is illuminated in the presence of $^{14}CO_2$, after about 1 second, more than 90% of all the radioactivity incorporated in the leaves is found at C-4 of malate, aspartate and oxaloacetate. Only after 60 seconds does ^{14}C appear at C-1 of 3-phosphoglycerate. Explain showing the steps involved.	*CO4*	*PO2*	**10**
		b)	Given some $^{14}CO_2$ and all the tools typically present in a biochemistry research lab, how would you design a simple experiment to determine whether a plant was a typical C4 plant or a CAM plant?	*CO4*	*PO2*	**4**
		c)	With a neat labelled diagram, explain the structure of a chloroplast.	-	-	**6**

			UNIT - IV			
	7	a)	Elucidate the pathway for synthesis of cholesterol	*CO4*	*PO2*	**8**
		b)	Free palmitate is activated to its coenzyme A derivative (palmitoyl-CoA) in the cytosol before it can be oxidized in the mitochondrion. If palmitate and [^{14}C]coenzyme-A are added to a liver homogenate, palmitoyl-CoA isolated from the cytosolic fraction is radioactive, but that isolated from the mitochondrial fraction is not. Explain.	*CO4*	*PO2*	**4**
		c)	When the acetyl CoA produced during β oxidation in the liver exceeds the capacity of the TCA cycle, the excess acetyl CoA forms ketone bodies. This occurs in severe uncontrolled diabetes as the tissues oxidize large amounts of fatty acids. What are ketone bodies? Explain the mechanism of formation	*CO5*	*PO2*	**8**
			OR			
	8	a)	In the initial stages of fatty acid synthesis, in the condensation reaction catalyzed by ketoacyl-ACP synthase, a four-carbon unit is synthesized by the combination of a two-carbon unit and a three-carbon unit, with the release of CO2. (i) Identify the two-carbon unit, a three-carbon unit and four-carbon unit. (ii) Give the reaction catalyzed by ketoacyl-ACP synthase. (iii) What is the thermodynamic advantage of this process over one that simply combines two two-carbon units?	*CO4*	*PO2*	**6**
		b)	How many turns of the fatty acid oxidation cycle are required for complete oxidation of arachidic acid to acetyl-CoA? Give the sequence of steps for its oxidation to acetyl-coA	*CO4*	*PO2*	**10**
		c)	What changes in metabolic pattern would result from a mutation in the muscle carnitine acyltransferase I in which the mutant protein has lost its affinity for malonyl-CoA but not its catalytic activity?	*CO5*	*PO2*	**4**
			UNIT - V			
	9	a)	In a study conducted some years ago, cats were fasted overnight then given a single meal complete in all amino acids except arginine. Within 2 hours, blood ammonia levels increased from a normal level of 18 μg/L to 140μg/L, and the cats showed the clinical symptoms of ammonia toxicity. A control group fed with an amino acid diet in which arginine was replaced by ornithine showed no unusual clinical symptoms. i. What was the role of fasting in the experiment? ii. What caused the ammonia levels to rise in the experimental group? iii. Why did the absence of arginine lead to ammonia toxicity? iv. Is arginine an essential amino acid in cats? Why or why not? v. Why can ornithine be substituted for arginine	*CO5*	*PO2*	**10**

		b)	PRPP is essential for recycling of nucleotides by salvage pathway. Justify	*CO4*	*PO2*	**6**
		c)	The diazo compound O-(2-diazoacetyl)-L-serine, known also as azaserine is a powerful inhibitor of glutamine amido - transferases. If growing cells are treated with azaserine, what intermediates of nucleotide biosynthesis would accumulate? Explain	*CO5*	*PO2*	**4**
			OR			
	10	a)	Why are Carbamoyl phosphate and aspartate required for the synthesis of urea? List the sequence of reactions involved in the synthesis of urea.	*CO5*	*PO2*	**6**
		b)	Name and draw the structure of the α-keto acid resulting when each of the following amino acids undergoes transamination with α-ketoglutarate: (a) aspartate, (b) alanine	*CO1*	-	**4**
		c)	Some bacteria require p-aminobenzoate which is an important component of formyl tetrahydrofolate in the culture medium for normal growth. Their growth is severely inhibited by the addition of sulfanilamide, one of the earliest sulfa drugs. Moreover, in the presence of this drug, 5-aminoimidazole-4-carboxamideribonucleotide (AICAR) accumulates in the culture medium. These effects are reversed by addition of excess p-aminobenzoate. i. Identify the nucleotide pathway involved ii. Show the structure of the nucleotide marking the origin of its atoms. iii. Addition of what atom is being inhibited in the above situation? iv. Why does AICAR accumulate in the presence of sulfanilamide? v. identify the enzyme and the reaction involved leading to accumulation of AICAR  *p*-Aminobenzoate  Sulfanilamide	*CO5*	*PO2*	**10**

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