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

Autonomous Institute Affiliated to VTU

August 2024 Supplementary Examinations

Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 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

1 a) Calculate the standard free-energy change ($\Delta G'^0$) for the reaction in which O_2 is reduced by the biological electron carrier $FADH_2$: $FADH_2 + ½\ O_2 \rightleftarrows FAD + H_2O$ with $E'^0_{FAD/FADH2} = -0.219$ V and $E'^0_{½\ O2/H2O} = 0.816$ V. **05**

b) Substantiate the statement "standard free energy changes are additive" with two examples. **05**

c) Calculate the actual free energy change [ΔG] for ATP hydrolysis at 25^0 C in the intact erythrocytes where the concentrations of ATP, ADP and Pi are 2.25, 0.25 and 1.65 mM respectively. (Given $\Delta G'^0 = -30.5$ kJ/mol) **05**

d) What are high energy compounds? Give any two example and write their structure. **05**

UNIT - II

2 a) i. When O_2 is added to an anaerobic suspension of cells consuming glucose at a high rate, the rate of glucose consumption declines greatly as the O_2 is used up, and accumulation of lactate ceases. This effect, first observed by Louis Pasteur in the 1860s, is characteristic of most cells capable of both aerobic and anaerobic glucose catabolism. **10**

a. Why does the accumulation of lactate cease after O_2 is added?
b. Why does the presence of O_2 decrease the rate of glucose consumption?
c. How does the onset of O_2 consumption slow down the rate of glucose consumption?

ii. Isocitrate dehydrogenase is found only in the mitochondrion, but malate dehydrogenase is found in both the cytosol and mitochondrion. Illustrate the role of cytosolic malate dehydrogenase.

b) Refer the figure 2b given below as a guide to answer the following questions. **10**

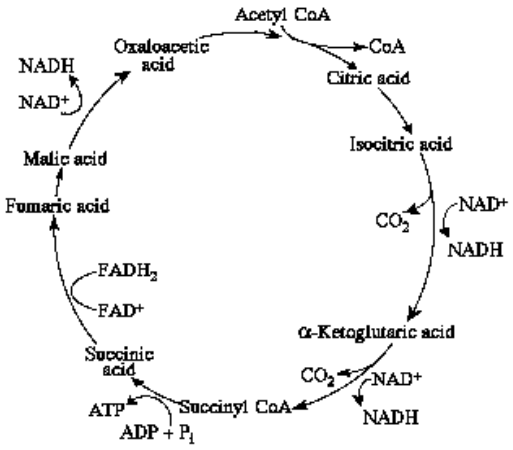


Figure 2b

i. What is oxidative phosphorylation? Starting with citric acid and ending with succinic acid in Figure 2b, what is the maximum number of ATP molecules that could be made through substrate-level phosphorylation?

ii. Refer to Figure 2b. Carbon skeletons for amino acid biosynthesis are supplied by intermediates of the Krebs cycle. Which intermediate would supply the carbon skeleton for synthesis of a 4-carbon amino acid?

iii. Refer to Figure 2b. Starting with α-ketoglutaric acid and ending with oxaloacetic acid, how many ATP molecules can be formed from oxidative phosphorylation?

iv. Refer to Figure 2b. How many ATP molecules can be made through substrate-level phosphorylation and oxidative phosphorylation if you started with α-ketoglutaric acid and ended with oxaloacetate?

v. Why is the oxidation of acetate so complicated in citric acid cycle?

OR

3 a) The degree of reduction of each carrier in the respiratory chain is determined by conditions in the mitochondrion. For example, when NADH/Succinate and O_2 are abundant, the steady-state degree of reduction of the carriers decreses 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 the state of oxidation of ubiquinone and cytochrome b, c_1, c, and a + a_3. **10**

i. Abundant NADH and O_2, but cyanide added

ii. Abundant NADH, but O_2 exhausted

iii. Abundant O_2, but Succinate exhausted

iv. Abundant NADH and O_2

v. Abundant Succinate and O_2, but oligomycin and DNP added

b) How does the liver Glucokinase enzyme differ from Hexokinase in its dependence on concentrations of reactant(s) and/or product(s)? How is this important to the role of the liver in regulating blood glucose? **05**

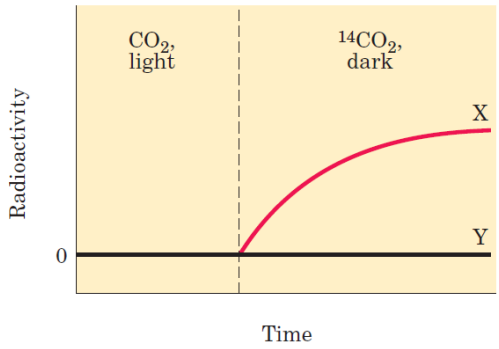
c) i. What are the unique (oxidative) reactions of the pentose phosphate pathway? **05**

ii. What is the significance of pentose phosphate pathway?

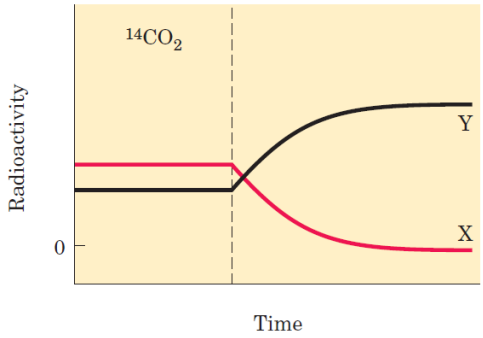
UNIT - III

4 a) i. Calvin and his colleagues used the unicellular green alga *Chlorella* to study the carbon-assimilation reactions of photosynthesis. They incubated $^{14}CO_2$ with illuminated suspensions of algae and followed the time course of appearance of ^{14}C in two compounds, X and Y, under two sets of conditions. Suggest the identities of X and Y, based on your understanding of the Calvin cycle. **10**

a. Illuminated *Chlorella* were grown with unlabelled CO_2, then the light was turned off and $^{14}CO_2$ was added (vertical dashed line in the graph below). Under these conditions, X was the first compound to become labelled with ^{14}C; Y was unlabelled.

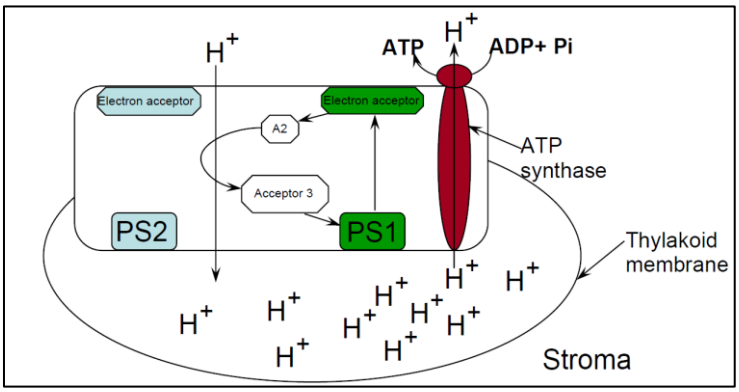


b. Illuminated *Chlorella* cells were grown with $^{14}CO_2$. Illumination was continued until all the $^{14}CO_2$ had disappeared (vertical dashed line in the graph below). Under these conditions, X became labelled quickly but lost its radioactivity with time, whereas Y became more radioactive with time.

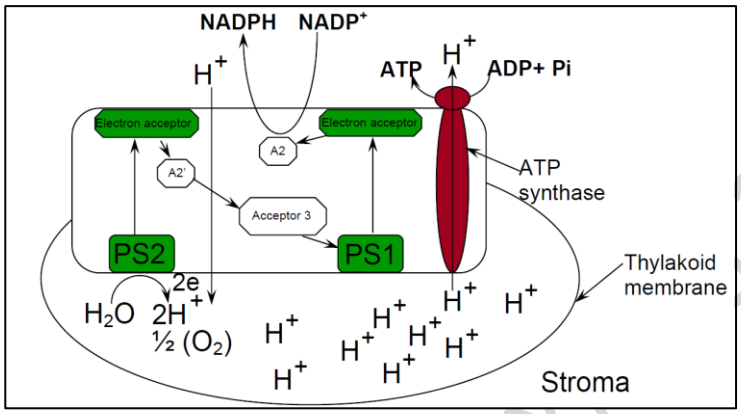


ii. When a suspension of green algae is illuminated in the absence of CO_2 and then incubated with $^{14}CO_2$ in the dark, $^{14}CO_2$ is converted to [^{14}C]glucose for a brief time. What is the significance of this observation with regard to the CO_2-assimilation process, and how is it related to the light reactions of photosynthesis? Why does the conversion of $^{14}CO_2$ to [^{14}C]glucose stop after a brief time?

b) Below are the schematics for cyclic and noncyclic photophosphorylation. **10**



Schematic 1



Schematic 2

i. Identify each schematic and discuss the order of steps in each process.
ii. What are the main differences between the two processes?
iii. What is the ATP made in photosynthesis used for?

UNIT - IV

5 a) What is β-oxidation? Describe the β-oxidation of palmitic acid and add a note on its energetics. **10**

b) The first reaction in the biosynthesis of fatty acid is a formal Claisen condensation involving the activated acetyl and malonyl groups to form acetoacetyl-ACP, simultaneously releasing a molecule of CO_2 which is the same carbon originally introduced into malonyl-CoA from HCO_3^- by the acetyl-CoA carboxylase reaction. Why do the cells go to the trouble of adding CO_2 to make a malony group from an acetyl group, only to lose the CO_2 during the formation of acetoacetate? **05**

c) Free stearate is activated to its coenzyme A derivative (Stearoyl-CoA) in the cytosol before it enters the mitochondria for β-oxidation. If Stearoyl-CoA and [^{14}C]coenzyme A are added to liver homogenate, Stearoyl-CoA isolated from the cytosolic fraction is radioactive, but that isolated from the mitochondrial fraction is nonradioactive. Give the possible reason for this. **05**

UNIT - V

6 a) Elucidate the pathway leading to the denovo synthesis of AMP and GMP. **10**

b) Explain briefly major pathways of pyrimidine catabolism in animals. **10**

OR

7 a) Write out urea cycle giving names and structures of substrates and products, and the name of each enzyme. What is the energetic cost of urea synthesis? **10**

b) What is transamination? Name the coenzyme involved in the transamination reaction and write its structure. Explain the significance of oxidative deamination in the catabolism of amino acids. **10**

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