Long Answer Type Question

Q. 1. Where does glycolysis occur in cell? Describe the sequence of reactions in it. Mention the end product. [KVS Agra 2017]

Ans. Glycolysis: Glycolysis means "the splitting of sugar". A glucose molecule is converted into 2 molecules of pyruvic acid during glycolysis. It occurs in cytoplasm of the cell. **Sequence of reactions is Glycolysis:**

Step 1: The enzyme hexokinase phosphorylates (adds a phosphate group to) glucose in the cell's cytoplasm. In the process, a phosphate group from ATP is transferred to glucose producing glucose 6-phosphate.

Step 2: The enzyme phosphohexo seisomerase converts glucose 6-phosphate into its isomer fructose 6-phosphate.

Glucose - 6 - phosphate -Phospho hexose isomerase Fructose - 6 - phosphate

Step 3: The enzyme phosphofructokinase uses another ATP molecule to transfer a phosphate group to from fructose 1, 6-phosphate.

Step 4: The enzyme aldolase splits fructose 1, 6 bisphosphate into two sugars that are isomers of each other. These two sugars are dihydroxyacetone phosphate and glyceraldehyde phosphate.

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Fructose 1, 6 bisphosphate Aldolase
Glyceraldehyde 3– Phosphate (GAP) +
Dihydroxyacetone 3-phosphate
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Step 5: The enzyme triose phosphate isomerase rapidly inter-converts the molecules dihydroxyacetone phosphate into glyceraldehyde 3-phosphate. Glyceraldehyde 3-phosphate is removed as soon as it is formed to be used in the next step of glycolysis.

isomerase Glyceraldehyde 3 phosphate **Net result for steps 4 and 5** : Fructose 1,6-bisphosphate $(C_6H_{14}O_{12}P_2) \rightarrow 2$ molecules of glyceraldehyde 3-phosphate $(C_3H_7O_6P)$

Step 6: The enzyme triose phosphate dehydrogenase serves two functions in this step. First the enzyme transfers a hydrogen (H⁻) from glyceraldehyde phosphate to the oxidizing agent nicotinamide adenine dinucleotide (NAD⁺) to form NADH. Next triose phosphate dehydrogenase adds a phosphate (P) from the cytosol to the oxidized glyceraldehyde phosphate to form 1, 3-bisphosphoglycerate. This occurs for both molecules of glyceraldehyde 3-phosphate produced in step 5.

Glyceraldehyde 3- phosphate + H_3PO_4 + NAD^+ \longrightarrow 1,3 bisphospho glycerate + NADH + H^+

Step 7: The enzyme phosphoglycerokinase transfers a P from 1,3-bisphosphoglycerate to a molecule of ADP to form ATP This happens for each molecule of 1,3-bisphosphoglycerate. The process yields two 3-phosphoglycerate molecules and two ATP molecules. **Step 8:** The enzyme phosphoglyceromutase relocates the P from 3-phosphoglycerate from the third carbon to the second carbon to form 2-phosphoglycerate.



Step 9: The enzyme enolase removes a molecule of water from 2- phosphoglycerate to form phosphoenolpyruvate (PEP). This happens for

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each molecule of 2-phosphoglycerate \xrightarrow{\text{Enolase}} phosphoenol pyruvate + H<sub>2</sub>O.
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Step 10: The enzyme pyruvate kinase transfers a P from PEP to ADP to form pyruvate and ATP. This happens for each molecule of phosphoenolpyruvate + pyruvate kinase+2 ADP2 molecules of pyruvate +2ATP.

End products are 2 pyruvate molecules and 2 ATP molecules.

Q. 2. Schematically represent the steps of glycolysis. [KVS Silchar 2017]



Q. 3. What is pentose phosphate pathway? Explain the process.

Ans. (i) It is also called as hexose monophosphate shunt, because this pathway occurs in presence of oxygen, and involves direct oxidation of glucose-6-phosphate.

(ii) In PPP for every six molecules of glucose, one is completely oxidised to CO_2 and H_2O , while the other five are regenerated. Oxidation of glucose is linked to the formation of NADPH₂.

(iii) Glucose is phosphorylated to glucose 6-phosphate by ATP.

(iv) Glucose 6-PO₄ undergoes two dehydrogenation through a number of intermediates to yield ribulose-5-phosphate, two molecules of NADPH + H⁺ and a molecule of CO₂.

(v) Complete oxidation of a molecule of glucose produces 12 molecules of NADPH+H⁺, which is equivalent to 36 ATP molecules.

(vi) Thus, the energy released in the oxidation of glucose via this pathway is almost equal to that of common pathway that liberates 38 ATP molecules per molecule of glucose.

Pentose phosphate pathway occurs in cytoplasm but takes the help of mitochondria for producing ATP.