Short Answer Questions – II

Q. 1. What is oxidative decarboxylation? What is its significance for Kreb's cycle? [KVS Agra 2016]

Ans. Oxidative decarboxylation: Pyruvic acid in molecules enter in the mitochondria where each of them is converted into two carbon atoms-acetic acid. One carbon is released as CO_2. The removal of carbon dioxide from pyruvic acid is called decarboxylation.
Oxidative decarboxylation plays very significant role in Kreb's cycle. This step is called link reaction or transition reaction or gateway step as it links glycolysis with Krebs cycle.

Q. 2. How many ATP are produced during cellular respiration during- Glycolysis, Oxidative decarboxylation and Kreb's cycle? What is the net production of ATP? Define Respiratory Quotient. [KVS Guwahati 2016]

Ans. Complete aerobic breakdown of one molecule of hexose result in the release of ATP molecule.

(i) Glycolysis: Two molecules of NADPH are released during glycolysis.
The glycolysis also yields 4 ATP molecules out of which 2 ATP molecules are consumed.

Thus the glycolysis contributes a total of 2 ATP molecule.

(ii) 2 molecules of NADH produced in glycolysis also 6 ATR so the net gain of ATP is 6 ATP.

(iii) Oxidative decarboxylation: Two molecules of NADH are released during the oxidative decarboxylation and synthesis of acetyl Co A from pyruvic acid. Thus number of ATP molecules will be 2 x 3 = 6.

(iv) Kreb's cycle: Kreb's cycle releases 6 molecules of NADH and 2 molecules of $FADH_2$. The Kreb cycle also releases 2 ATP molecules, thus total number of ATP molecules produced during Kreb's cycle are $2 + 2 \times 2 + 6 \times 3 = 24$ molecules.

(v) Respiratory Quotient: Respiratory quotient is the ratio of the volume of carbon dioxide produced to the volume of oxygen consumed in respiration over a period of time. Its value can be one, zero, more than one and less than one.

Q. 3. Explain the process of ATP formation during aerobic respiration (in mitochondria) [DDE 2017]

Ans. The synthesis of ATP from ADP and inorganic phosphate using energy from proton gradient is called oxidative phosphorylation. This takes place in elementary particles present on the inner membrane of cristae of mitochondria. This process in mitochondria is catalyse by ATP synthetase. This complex has two major components-F_0 and F_1. F_0 acts as channel for proton and F_1 acts as on ATP synthetase.

Q. 4. Explain the role of oxygen, $F_0 – F_1$ particles and NADH in oxidative phosphorylation.

Ans. Role of oxygen: Oxygen drives the whole process by removing the hydrogen from the system. It acts as the final acceptor of hydrogen.

(i) Role of F_0 - F_1 particles: The F headpiece is a peripheral membrane protein complex and contains the site for synthesis of ATP from ADP and inorganic phosphate.

(ii) F_0 is an integral membrane protein complex that forms the channel through which proteins cross the inner membrane.

(iii) Role of NADH: When NADH is oxidised to NAD in the electron transport system, the energy released by the proton is used to phosphorylate ADP into ATP.

Q. 5. (i) What term is given to the process in yeast where incomplete oxidation of glucose takes place under anaerobic condition?

(ii) In which cycle does the complete oxidation of pyruvate takes place.

(iii) Explain why the synthesis of ATP through ETS is called oxidative phosphorylation?

[KVS Mumbai 2016]

Ans. (i) Fermentation

(ii) Kreb's cycle

(iii) During oxidation a considerable amount of energy is released in graded sequence. The energy so released is utilized by F_1 particle for the synthesis of ATP molecule from ADP.

The synthesis of ATP during oxidation of coenzymes is called oxidative phosphorylation. The F_1 particles contain 3 coupling factors and ATPase enzyme for the synthesis of ATP.

Oxidation of one molecule of reduced coenzyme ($NADH_2$) results in the formation of 3 ATP molecules while oxidation of $FADH_2$ leads to the synthesis of 2 ATP molecules.

Q. 6. List the three reasons as to why plants can get along without respiratory organs.

Ans. (i) Each plant part takes care of its own gas-exchange needs and there is very little transport of gases from one plant to another.

(ii) Plants respire at rates lower than that of animals.

(iii) The distance that gases must diffuse even in large bulky plants is not great. Almost all living cells in a plant have their surfaces exposed to air.

Q.7. What is oxidative decarboxylation? What happens during the process?

OR

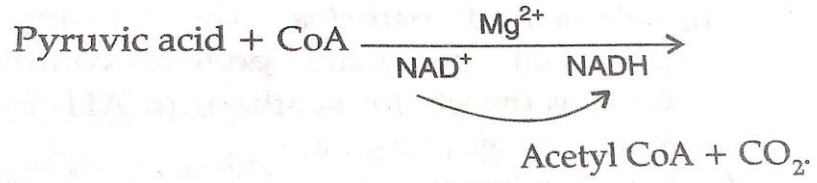
How the glycolysis is connected to the Kreb's cycle during aerobic respiration?

[KVS 2012 – 13]

Ans. Pyruvic acid generated in the cytosol, is transported to mitochondria, and before it enters Kreb's cycle, operative in mitochondria, one of the three carbon atoms of pyruvic acid is oxidised to carbon dioxide in a reaction called oxidative decarboxylation.

(i) Pyruvate is first decarboxylated and then oxidised by the enzyme pyruvate dehydrogenase.

(ii) The remaining 2-carbon acetate unit is readily accepted by a sulphur containing compound, Coenzyme A to form acetyl coenzyme A.



Q. 8. Name the end products of aerobic and anaerobic glycolysis. List two ways by which molecules of ATP are produced in glycolysis during aerobic respiration in a cell.

Ans. End product of glycolysis which is common to both aerobic and anaerobic modes of respiration is pyruvic acid.

Molecules of ATP are produced in two ways in glycolysis by:

(i) Direct transfer of phosphate from biphosphoglycerate to ADP.

(ii) During formation of phosphoenol pyruvate. The phosphate radical picks up energy which helps in the production of ATP.$^{+}$.

Q. 9. (i) When and where does anaerobic respiration occur in man and yeast?

(ii) Why is less energy produced during anaerobic respiration than in aerobic respiration?

(iii) Where is the respiratory electrons transport system located in a cell?

(iv) What compound is the terminal electron acceptor in aerobic respiration?

Ans. (i) In man, it occurs during the heavy exercise in the muscles. In yeast, the anaerobic respiration occurs in fermentation.

(ii) It is because of the following: (a) the end products of anaerobic respiration can be further oxidised to release energy, (b) the regeneration of NAD does not yield ATP, as the electrons are not transported to oxygen.

(iii) In the membranes of mitochondria.

(iv) Oxygen.

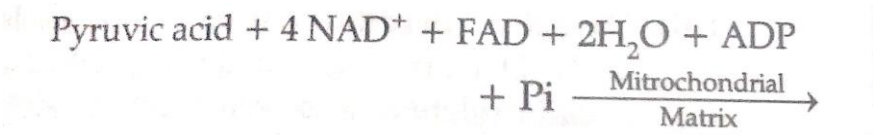
Q. 10. Write the significance of citric acid cycle. [V. Imp.]

Ans. Significance of citric acid cycle:

(i) It explains the process of breaking of pyruvate into CO_2 and water. It is major pathway of generation of ATP.

(ii) More energy is released (24 ATP) in this process, as compared to glycolysis.

(iii) In Kreb's cycle, carbon skeletons are obtained for use in growth and maintenance of the cell. Many intermediate compounds are formed. They are used in the synthesis of other biomolecules like amino acids, nucleotides, chlorophyll, cytochromes and fats. Succinyl CoA is the starting molecule for synthesis of chlorophyll. Amino acids are synthesized from a-ketoglutaric acid, pyruvic acid, and oxaloacetic acid.



$3CO_2 + 4NADH + 4H^+ + FADH_2 + ATP$

Q. 11. What are the two crucial events in anaerobic respiration? Where does these take place?

Ans. The two important events in the aerobic respiration are:

(i) The complete oxidation of pyruvate by the stepwise removal of all the hydrogen atoms with the release of three molecules of carbon dioxide of three molecules of carbon dioxide.

(ii) The passing on of the electrons removed as part of the hydrogen atoms to molecular O_2 along with the synthesis of ATP.

The first step takes place in the matrix of the mitochondria while the second step occurs in the inner membrane of mitochondria.

Q. 12. Why anaerobic respiration yields much less energy than aerobic respiration?

Ans. Anaerobic respiration yields much less energy than aerobic respiration. The main reasons are:

(i) There is incomplete breakdown of respiratory substrate.

(ii) One of the end product of anaerobic respiration is organic that still contains energy.

(iii) $NADH_2$ produced during glycolysis is often reutilized.

(iv) Regeneration of NAD^+ from $NADH_2$ does not produce ATP.

(v) Electron transport chain is absent.

(vi) Oxygen is not used for accepting electrons and protons.

Q. 13. What is the significance of Pentose Phosphate pathway?

Ans. The significance of Pentose phosphate pathway are:

(i) PPP constitutes an alternate pathway for the breakdown of carbohydrates in respiration.

(ii) It produces ribose-5-phosphate, which is used in the synthesis of nucleic acid.

(iii) Erythrose-4-phosphate produced in PPP is required for the synthesis of lignin, anthocyanin, IAA and a number of other compounds.