NCERT Solutions for Class-XI Biology

Chapter-14

1. Differentiate between
(a) Respiration and Combustion
(b) Glycolysis and Krebs' cycle
(c) Aerobic respiration and Fermentation

1. (a) Differences between respiration and combustion are as follows :

Respiration	Combustion
It takes place inside the living cells	It is a non-cellular process
It is a biochemical process	It is a chemical process
Energy is released in steps as chemical bonds are broken into steps	Energy is released in a single step as all chemical reactions take place simultaneously
Most of the energy is in the form of ATP	ATP formation does not occur
It requires enzymes	It is a non-enzymatic process

(b) Differences between glycolysis and Krebs' cycle are as follows:

Glycolysis	Krebs cycle
Glycolysis takes place inside the cytoplasm	It occurs inside mitochondria.
It is a straight or linear pathway	It is a cyclic process
This process is common to both aerobic and anaerobic respiration	This process occurs only in aerobic respiration
It breaks down one molecule of glucose into two molecules of pyruvate	It breaks down pyruvate completely into carbon dioxide, energy and water
It consumes two ATP molecules	It does not consume ATP

(c) Differences between aerobic respiration and fermentation are as follows:

Aerobic respiration	Fermentation
It is an intracellular process.	Fermentation can occur both intracellularly and extracellularly.
It is not economically exploited	It is economically exploited in production of wine, bread etc
Its uses oxygen to breakdown a respiratory substrate	It is an enzyme controlled breakdown and transformation of organic nutrients.

2. What are respiratory substrates? Name the most common respiratory substrate.

2. The compounds oxidised during the process of respiration are called respiratory substrates. Carbohydrates, especially glucose, act as respiratory substrates. Fats, proteins, and organic acids also act as respiratory substrates.

3. Give the schematic representation of glycolysis?

3. Schematic representation of glycolysis is as follows:

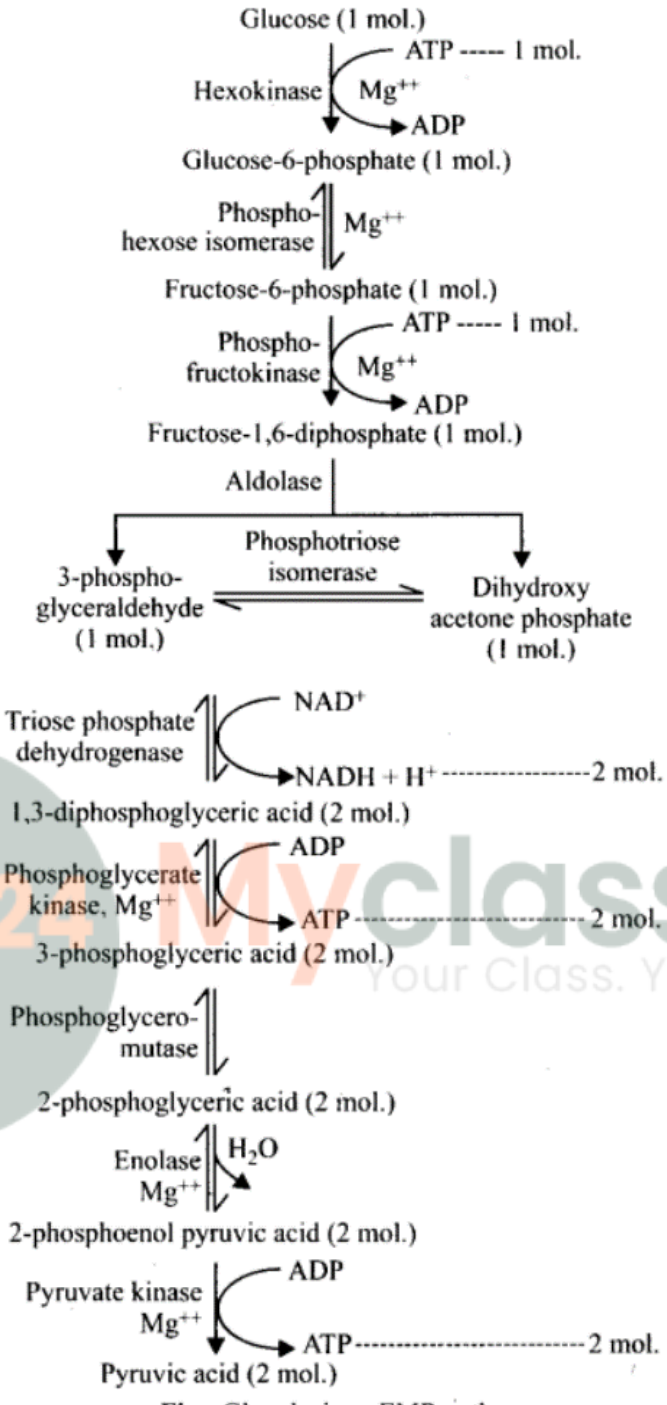


Fig.: Glycolysis or EMP-pathway.

4. What are the main steps in aerobic respiration? Where does it take place?

4. The major steps in aerobic respiration and the sites where they occur are listed in the given table.

Step		Site of occurrence	
1.	Glycolysis	**1.**	Cytoplasm
2.	Krebs cycle	**2.**	Matrix of mitochondria
3.	Electron system transport	**3.**	Inner mitochondrial membrane
4.	Oxidative phosphorylation	**4.**	F_0-F_1 particles in the inner mitochondrial membrane

5. Give the schematic representation of an overall view of Krebs cycle.

5.

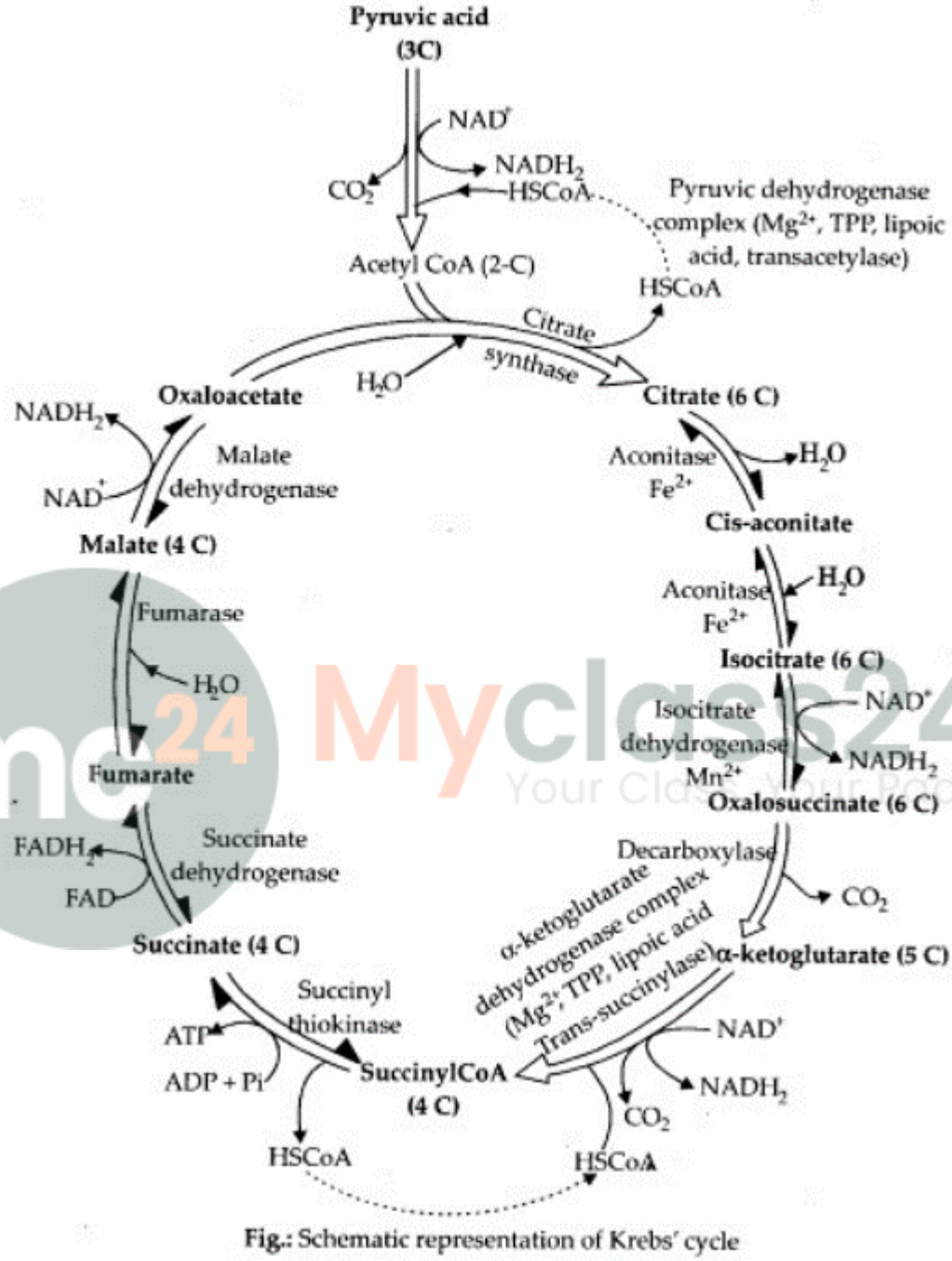
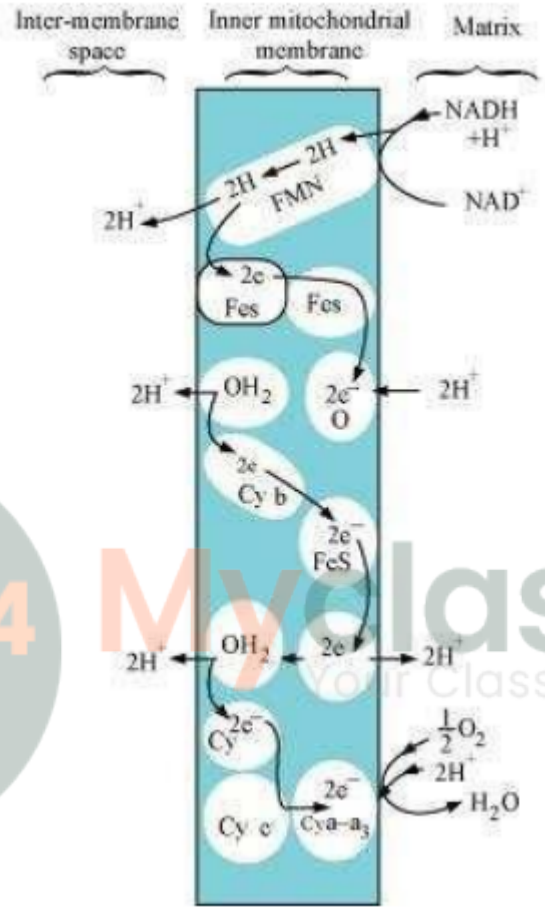


Fig.: Schematic representation of Krebs' cycle

6. Explain ETS.

6. ETS or electron transport system is located in the inner mitochondrial membrane. It helps in releasing and utilizing the energy stored in NADH+H+ and FADH2. NADH + H+, which is formed during glycolysis and citric acid cycle, gets oxidized by NADH dehydrogenase (complex I). The electrons so generated get transferred to ubiquinone through FMN. In a similar manner, FADH2 (complex II) generated during citric acid cycle gets transferred to ubiquinone. The electrons from ubiquinone are received by cytochrome bc1 (complex III) and further get transferred to cytochrome c. The

cytochrome c acts as a mobile carrier between complex III and cytochrome c oxidase complex, containing cytochrome a and a3, along with copper centres (complex IV). During the transfer of electrons from each complex, the process is accompanied by the production of ATP from ADP and inorganic phosphate by the action ATP synthase (complex V). The amount of ATP produced depends on the molecule, which has been oxidized. 2 ATP molecules are produced by the oxidation of one molecule of NADH. One molecule of FADH2, on oxidation, gives 3 ATP molecules.



7. Distinguish between the following:
(a) Aerobic respiration and Anaerobic respiration
(b) Glycolysis and Fermentation
(c) Glycolysis and Citric acid Cycle

7. (a) Differences between aerobic and anaerobic respiration are as follows:

Aerobic respiration	Anaerobic respiration
It occurs in the presence of O_2	It occurs in the absence of O_2
It involves the exchange of gases between the organism and the environment.	The exchange of gases is absent.
It occurs in the cytoplasm and mitochondria	It only occurs in the cytoplasm.
It always releases carbon dioxide and water as the end product.	End products vary.

(b) Differences between glycolysis and fermentation are as follows:

Glycolysis	Fermentation

It is the first step of respiration which occurs without the requirement of oxygen and is common to both aerobic and anaerobic modes of respiration	It is anaerobic respiration or respiration which does not require oxygen.
Glycolysis produces pyruvic acid	Fermentation produces different products such as ethanol and lactic acid.
It produces two molecules of NADH per glucose molecule	It uses NADH produced during glycolysis.

(c) Differences between glycolysis and Citric acid Cycle are as follows:

Glycolysis	Citric acid cycle
It takes place inside the cytoplasm	It takes place in mitochondria
It is the first step of respiration in which glucose is broken down to the level of pyruvate.	It is the second step of respiration wherein an active acetyl group is broken down completely

8. What are the assumptions made during the calculation of net gain of ATP?

8. For theoretical calculation of ATP molecules, various assumptions are made, which are as follows.

(a) It is assumed that various parts of aerobic respiration such as glycolysis, TCA cycle, and ETS occur in a sequential and orderly pathway.

(b) NADH produced during the process of glycolysis enters into mitochondria to undergo oxidative phosphorylation.

(c) Glucose molecule is assumed to be the only substrate while it is assumed that no other molecule enters the pathway at intermediate stages.

(d) The intermediates produced during respiration are not utilized in any other process.

9. Discuss "The respiratory pathway is an amphibolic pathway."

9. Amphibolic pathway is the one which is used for both breakdown (catabolism) and build-up (anabolism) reactions. Respiratory pathway is mainly a catabolic process which serves to run the living system by providing energy. The pathway produces a number of intermediates. Many of them are raw materials for building up both primary and secondary metabolites. Acetyl CoA is helpful not only in Krebs' cycle but is also raw material for synthesis of fatty acids, steroids, terpenes, aromatic compounds and carotenoids, a-ketoglutarate is organic acid which forms glutamate (an important amino acid) on amination. OAA (Oxaloacetic acid) on amination produces asparate. Both aspartate and glutamate are components of proteins. Pyrimidines and alkaloids are other products. Succinyl CoA forms cytochromes and chlorophyll.

Hence, fatty acids would be broken down to acetyl CoA before entering the respiratory pathway when it is used as a substrate. But when the organism needs to synthesise fatty acids, acetyl CoA would be withdrawn from the respiratory pathway for it. Hence, the respiratory pathway comes into the picture both during breakdown and synthesis of fatty acids. Similarly, during breakdown and synthesis of proteins too, respiratory intermediates form the link. Breaking down processes within the living organism is catabolism, and synthesis is anabolism. Because the respiratory pathway is involved in both anabolism and catabolism, it would hence be better to consider the respiratory pathway as an amphibolic pathway rather than as a catabolic one.

10. Define RQ. What is its value for fats?

10. Respiratory quotient (RQ) or respiratory ratio can be defined as the ratio of the volume of CO_2 evolved to the volume of O_2 consumed during respiration. The value of respiratory quotient depends on the type of respiratory substrate. Its value is one for carbohydrates. However, it is always less than one for fats as fats consume more oxygen for respiration than carbohydrates.

It can be illustrated through the example of tripalmitin fatty acid, which consumes 145 molecules of O_2 for respiration while 102 molecules of CO_2 are evolved. The RQ value for tripalmitin is 0.7.

11. What is oxidative phosphorylation?

11. Oxidative phosphorylation is the synthesis of energy rich ATP molecules with the help of energy liberated during oxidation of reduced co-enzymes (NADH, $FADH_2$) produced in respiration. The enzyme required for this synthesis is called ATP synthase. It is considered to be the fifth complex of electron transport chain. ATP synthase is located in FT or head piece of $F_0 - F_1$ or elementary particles. The particles are present in the inner mitochondrial membrane. ATP synthase becomes active in ATP formation only where there is a proton gradient having higher concentration of H^+ or protons on the F_0 side as compared to F x side (chemiosmotic hypothesis of Peter Mitchell).

Increased proton concentration is produced in the outer chamber or outer surface of inner mitochondrial membrane by the pushing of proton with the help of energy liberated by passage of electrons from one carrier to another. Transport of the electrons from NADH over ETC helps in pushing three pairs of protons to the outer chamber while two pairs of protons are sent outwardly during electron flow from $FADH_2$. The flow of protons through the F0 channel induces F_1 particle to function as ATP-synthase. The energy of the proton gradient is used in attaching a phosphate radical to ADP by high energy bond. This produces ATP. Oxidation of one molecule of $NADH_2$ produces 3 ATP molecules while a similar oxidation of $FADH_2$ forms 2 ATP molecules.

12. What is the significance of step-wise release of energy in respiration?

12. The process of aerobic respiration is divided into four phases – glycolysis, TCA cycle, ETS, and oxidative phosphorylation. It is generally assumed that the process of respiration and production of ATP in each phase takes place in a step-wise manner. The product of one pathway forms the substrate of the other pathway. Various molecules produced during respiration are involved in other biochemical processes. The respiratory substrates enter and withdraw from pathway on necessity. ATP gets utilized wherever required and enzymatic rates are generally controlled. Thus, the step-wise release of energy makes the system more efficient in extracting and storing energy.