Biology

(Chapter – 14)(Respiration in Plants)

(Class – XI)

Question 1:

Differentiate between

(a) Respiration and Combustion

(b) Glycolysis and Krebs' cycle

(c) Aerobic respiration and Fermentation

Answer 1:

(a) Respiration and combustion

	Respiration		Combustion
1.	It is a biochemical process.	**1.**	It is a physiochemical process.
2.	It occurs in the living cells.	**2.**	It does not occur in the living cells.
3.	ATP is generated	**3.**	ATP is not generated
4.	Enzymes are required	**4.**	Enzymes are not required
5.	It is a biologically-controlled process.	**5.**	It is an uncontrolled process.

(b) Glycolysis and Krebs cycle

	Glycolysis		Krebs cycle
1.	It is a linear pathway.	**1.**	It is a cyclic pathway.
2.	It occurs in the cell cytoplasm.	**2.**	It occurs in the mitochondrial matrix.
3.	It occurs in both aerobic and anaerobic respiration.	**3.**	It occurs in aerobic respiration.
4.	It generates 2 $NADH_2$ and 2 ATP molecules on the breakdown of one glucose molecule.	**4.**	It produces 6 $NADH_2$, $2FADH_2$, and 2 ATP molecules on the breakdown of two acetyl-CoA molecules.

(c) Aerobic respiration and fermentation

	Aerobic respiration		Fermentation
1.	Oxygen is used for deriving energy	**1.**	Occurs in the absence of oxygen
2.	Occurs in the cytoplasm and mitochondria	**2.**	Occurs in the cytoplasm
3.	End products are carbon dioxide and water	**3.**	End products are ethyl alcohol and carbon dioxide
4.	Complete oxidation of the respiratory substrate takes place	**4.**	Incomplete oxidation of the respiratory substrate takes place
5.	About 36 ATP molecules are produced	**5.**	Only 2 ATP molecules are produced

Question 2:

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

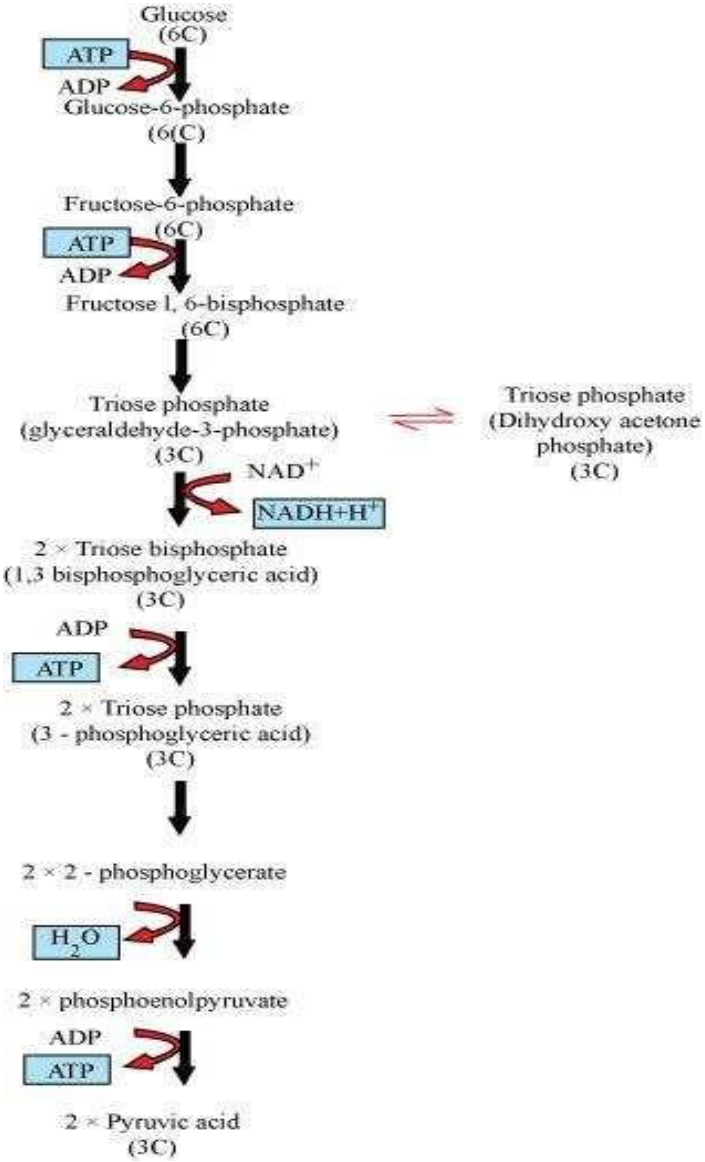
Answer 2:

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.

Question 3:

Give the schematic representation of glycolysis?

Answer 3:



Question 4:

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

Answer 4:

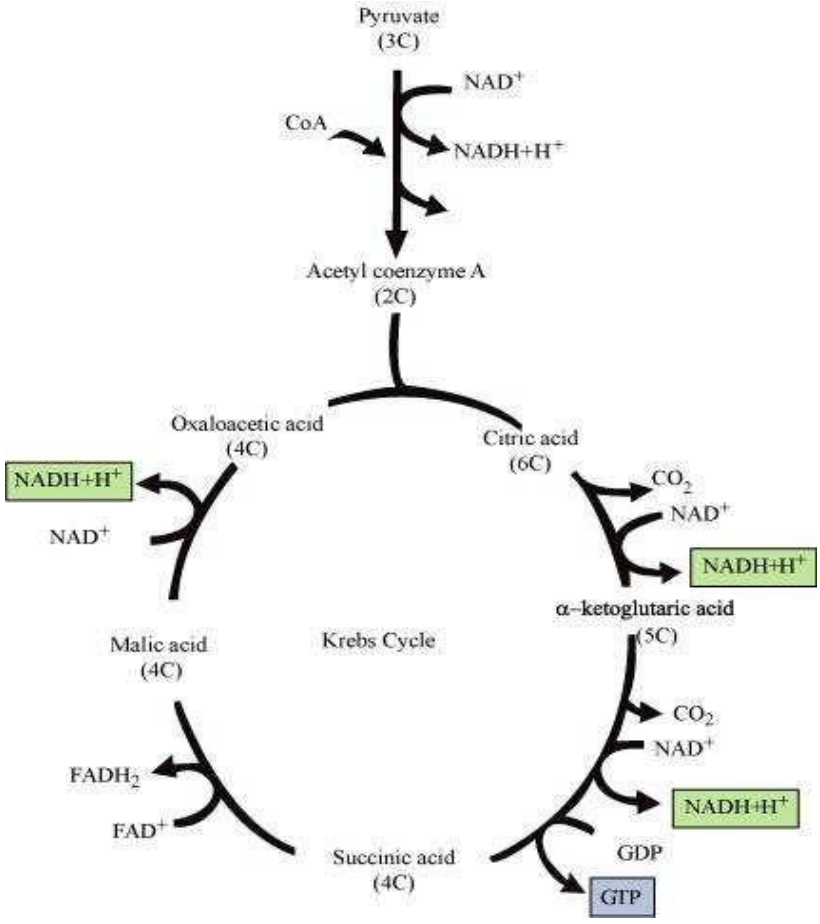
The major steps in aerobic respiration and the sites where they occur are listed in the given table.

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

Question 5:

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

Answer 5:



Question 6:

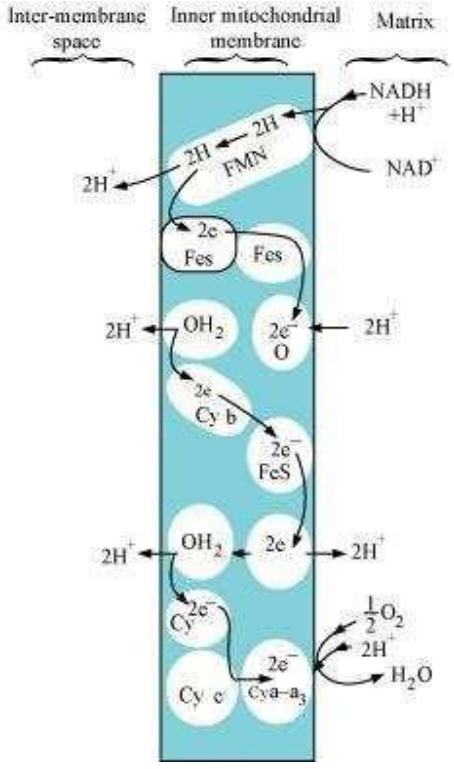
Explain ETS.

Answer 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 $FADH_2$. $NADH + H^+$, 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, $FADH_2$ (complex **II**) generated during citric acid cycle gets transferred to ubiquinone. The electrons from ubiquinone are received by cytochrome bc_1 (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 a_3, 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 $FADH_2$, on oxidation, gives 3 ATP molecules.



Question 7:

Distinguish between the following:

(a) Aerobic respiration and Anaerobic respiration

(b) Glycolysis and Fermentation

(c) Glycolysis and Citric acid Cycle

Answer 7:

(a) Aerobic respiration and Anaerobic respiration

	Aerobic respiration		Anaerobic respiration
1.	It uses oxygen for deriving energy.	1.	It occurs in the absence of oxygen.
2.	It occurs in cytoplasm and mitochondria.	2.	It occurs in cytoplasm.
3.	The end products of aerobic respiration are carbon dioxide and water.	3.	The end products of fermentation are ethyl alcohol and carbon-dioxide.
4.	Complete oxidation of respiratory substrate takes place.	4.	Incomplete oxidation of respiratory substrate takes place.
5.	36-38 ATP molecules are produced.	5.	Only 2 ATP molecules are produced.

(b) Glycolysis and Fermentation

	Glycolysis		Fermentation
1.	Glycolysis occurs during aerobic and anaerobic respiration.	1.	Fermentation is a type of anaerobic respiration.
2.	Pyruvic acid is produced as its end product.	2.	Ethanol or lactic acid is produced as its end product.

(c) Glycolysis and citric acid cycle

	Glycolysis		Citric acid cycle (Krebs cycle)
1.	It is a linear pathway.	1.	It is a cyclic pathway.
2.	It occurs in the cell cytoplasm.	2.	It occurs in the mitochondrial matrix.
3.	It occurs in both aerobic and anaerobic respiration.	3.	It occurs in aerobic respiration.
4.	One glucose molecule breaks down to generate 2 $NADH_2$ and 2 ATP molecules.	4.	It produces 6 $NADH_2$, 2 $FADH_2$, and 2 ATP molecules on breakdown of two acetyl-coA molecules.

Question 8:

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

Answer 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.

Question 9:

Discuss "The respiratory pathway is an amphibolic pathway."

Answer 9:

Respiration is generally assumed to be a catabolic process because during respiration, various substrates are broken down for deriving energy. Carbohydrates are broken down to glucose before entering respiratory pathways. Fats get converted into fatty acids and glycerol whereas fatty acids get converted into acetyl CoA before entering the respiration. In a similar manner, proteins are converted into amino acids, which enter respiration after deamination.

During synthesis of fatty acids, acetyl CoA is withdrawn from respiratory pathway. Also, in the synthesis of proteins, respiratory substrates get withdrawn. Thus, respiration is also involved in anabolism. Therefore, respiration can be termed as amphibolic pathway as it involves both anabolism and catabolism.

Question 10:

Define RQ. What is its value for fats?

Answer 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.

Question 11:

What is oxidative phosphorylation?

Answer 11:

Oxidative phosphorylation is a process in which electrons are transferred from electron donors to oxygen, which acts as electron acceptor. The oxidation-reduction reactions are involved in the formation of proton gradient. The main role in oxidative phosphorylation is played by the enzyme ATP synthase (complex V). This enzyme complex consists of F_0 and F_1 components. The F_1 headpiece is a peripheral membrane protein complex and contains the site for ATP synthesis from ADP and inorganic phosphate. F_0 component is a part of membrane protein complex, which acts as a channel for crossing of the protons from inner mitochondrial membrane to the mitochondrial matrix. For every two protons passing through F_0–F_1 complex, synthesis of one ATP molecule takes place.

Question 12:

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

Answer 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.