

Chapter-14

RESPIRATION IN PLANTS

POINTS TO REMEMBER

Aerobic respiration : Complete oxidation of organic food in presence of oxygen thereby producing CO_2 , water and energy.

Anaerobic respiration : Incomplete breakdown of organic food to liberate energy in the absence of oxygen.

ATPSynthetase : An enzyme complex that catalyses synthesis of ATP during oxidative phospho-relation.

Biological oxidation : Oxidation in a series of reaction inside a cell.

Cytochromes : A group of iron containing compounds of electron transport system present in inner wall of mitochondria.

Dehydrogenase : Enzyme that catalyses removal of H atom from the substrate.

Electron acceptor : Organic compound which recieve electrons produced during oxidation-reduction reactions.

Electron transport : Movement of electron from substrate to oxygen through respiratory chain during respiration.

Fermentation : Breakdown of organic substance that takes place in certain microbe like yeast under anaerobic condition with the production of CO_2 and ethanol.

Glycolysis : Enzymatic breakdown of glucose into pyruvic acid that occurs in the cytoplasm.

Oxidative phosphorylation : Process of formation of ATP from ADP and Pi using the energy from proton gradient.

Respiration : Biochemical oxidation food to release energy.

Respiratory Quotient : The ratio of the volume of CO_2 produced to the volume of oxygen consumed.

Proton gradient : Difference in proton concentration across the tissue membrane.

Mitochondrial matrix : The ground material of mitochondria in which

pyruvic acid undergoes aerobic oxidation through Kreb's cycle.

Abbreviations

ATP	–	Adenosine tri phosphate
ADP	–	Adenosine di phosphate
NAD	–	Nicotinamide Adenine dinucleotide
NADP	–	Nicotinamide Adenine dinucleotide Phosphate
NADH	–	Reduced Nicotinamide Adenine dinucleotide
PGA	–	Phosphoglyceric acid
PGAL	–	Phospho glyceraldehyde
FAD	–	Flavin adenine dinucleotide
ETS	–	Electron transport system
ETC	–	Electron transport chain
TCA	–	Tricarboxylic acid
OAA	–	Oxalo acetic acid
FMN	–	Flavin mono nucleotide
PPP	–	Pentose phosphate pathway

AEROBIC RESPIRATION

The overall mechanism of aerobic respiration can be studied under the following steps :

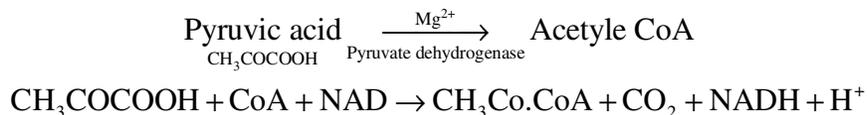
- (A) Glycolysis (EMP pathway)
- (B) Oxidative Decarboxylation
- (C) Kreb's cycle (TCA-cycle)
- (D) Oxidative phosphorylation

Glycolysis : The term has originated from the Greek word, *glycos* = glucose, *lysis* = splitting or breakdown means breakdown of glucose molecule.

- It is also called Embden-Meyerhof-Paranus pathway. (EMP pathway)
- It is common in both aerobic and anaerobic respiration.
- It takes place outside the mitochondria, in the cytoplasm.
- One molecule of glucose (Hexose sugar) ultimately produces two molecules of pyruvic acid through glycolysis.

- During this process 4 molecules of ATP are produced while 2 molecules of ATP are utilised. Thus net gain of ATP is of 2 molecules.

Oxidative decarboxylation : Pyruvic acid is converted into Acetyl CoA in presence of pyruvate dehydrogenase complex.



Tri Carboxylic Acid Cycle (Kreb's cycle) or Citric acid Cycle : This cycle starts with condensation of acetyl group with oxaloacetic acid and water to yield citric acid which undergoes a series of reactions.

- It is aerobic and takes place in mitochondrial matrix.
- Each pyruvic acid molecule produces 4 NADH + H⁺, one FADH₂, one ATP.
- One glucose molecule has been broken down to release CO₂ and eight molecules of NADH + H⁺, two molecules of FADH₂ and 2 molecules of ATP.

Electron transport system and oxidative phosphorylation : The metabolic pathway through which the electron passes from one carrier to another, is called Electron transport system and it is present in the inner mitochondrial membrane.

ETS comprises of the following :

- (i) NAD and NADH + H⁺
- (ii) FAD and FADH₂
- (iii) UQ
- (iv) Cyt b, Cyt c₁, Cyt c, Cyt a and Cyt a₃.

Oxygen acts as final hydrogen acceptor. Oxidative phosphorylation takes place in elementary particles present on the inner membrane of cristae of mitochondria. Synthesis of ATP from ADP and Pi using energy from proton gradient is called oxidative phosphorylation. In this process O₂ is the ultimate electron acceptor and it get reduced to water.

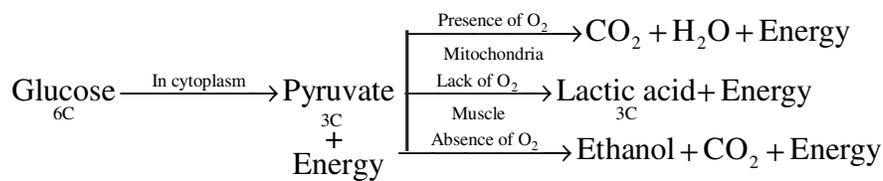
Total ATP Production

Process	Total ATP produced
1. Glycolysis	2ATP + 2NADH ₂ (6ATP) = 8ATP
2. Oxidative decarboxylation	2NADH ₂ (6ATP) = 6ATP
3. Kreb's Cycle	2GTP (2ATP) + 6NADH ₂ (18ATP) + 2FADH ₂ (4ATP) = 24ATP

Energy production in prokaryotes during aerobic respiration = 38 ATP

Energy production in eukaryotes during aerobic respiration = 38 – 2 = 36 ATP

(2ATP are used up in transporting 2 molecule of pyruvic acid in mitochondria.)



QUESTIONS

Very Short Answer Questions (1 mark each)

1. Name the molecule which is terminal acceptor of electron.
2. How many ATP molecules are produced from a molecule of glucose on it complet oxidation in eukaryotes ?
3. Where does ETC found in eukaryotic cell ?
4. Name the enzyme which convert sugar into glucose and fructose.
5. How many molecules of ATP are produced by the oxidation of one molecule of FADH₂ ?
6. Why do the person with sufficient white fibres get fatigued in a short period ?
7. Write the name of end product of glycolysis.
8. Name the first product formed in Kerb's cycle.

Short Answer Questions-II (2 marks each)

9. Differentiate between aerobic respiration and anaerobic respiration.
10. Mention two steps of glycolysis in which ATP is utilised.

11. Why does anaerobic respiration produces less energy than aerobic respiration ?
12. Define Respiratory Quotient. What is its value for fat and protein ?
13. Distinguish between glycolysis and fermentation.
14. What are respiratory substrates ? Name the most common respiratory substrate.

Short Answer Questions-I (3 marks each)

15. Give the schematic representation of an overall view of TCA cycle.
16. Where does electron transport system operative in mitochondria ? Explain the system giving the role of oxygen ?
17. Give a brief account of ATP molecules produced in aerobic respiration in eukaryotes.
18. Discuss The respiratory pathway is an amphibolic pathway.

Long Answer Questions (5 marks each)

19. What is glycolysis ? Where does glycolysis takes place in a cell ? Give schematic representation of glycolysis.

ANSWERS

Very Short Answers (1 marks)

1. Oxygen.
2. 36 ATP.
3. Mitochondrial membrane.
4. Invertase.
5. 2 ATP molecules.
6. due to formation of Lactic acid.
7. Pyruvic acid.
8. Citric acid.

Short Answers-II (2 marks)

9. Refer NCERT Book Chapter 14 (14.3 and 14.4).

- 10.** (i) ATP molecules are formed by direct transfer of Pi to ADP.
(ii) By oxidation of NADH.
- 11.** Refer NCERT Book Chapter 14, Page 230.
- 12.** Refer NCERT Book Page no. 236.
- 13.** Refer NCERT Book Page no. 229 and page no. 230.
- 14.** Refer NCERT Book Page no. 227.

Short Answers-I (3 marks)

- 15.** Refer NCERT Book, Fig. 14.3 Page no. 232.
- 16.** Refer NCERT Book Page no. 232 and page no. 233.
- 17.** Refer notes.
- 18.** Refer NCERT Book Page no. 235.

Long Answers (5 marks)

- 19.** Refer NCERT Book Page no. 228 and page no. 229.

