Chapter 12- Respiration in Plants

Respiration in plants is a crucial physiological process that involves the breakdown of organic molecules to release energy for various cellular activities. Here are key points regarding plant respiration:

Definition: Plant respiration is the metabolic process by which cells utilize oxygen to break down organic molecules, such as sugars, to produce energy in the form of ATP (adenosine triphosphate).

Cellular Respiration: Plants undergo aerobic cellular respiration, which occurs in the mitochondria. During this process, glucose is oxidized, and the energy released is used to generate ATP.

Stages of Respiration:

- Glycolysis: Takes place in the cytoplasm, where glucose is partially broken down to produce pyruvate and a small amount of ATP.
- Krebs Cycle (Citric Acid Cycle): Pyruvate is further broken down in the mitochondria, releasing carbon dioxide and producing NADH and FADH2.
- Electron Transport Chain (ETC): NADH and FADH2 donate electrons to generate a proton gradient across the mitochondrial membrane, leading to ATP synthesis.

Importance of Respiration in Plants:

- Energy Production: ATP generated through respiration powers various cellular processes, including active transport, biosynthesis, and maintenance of cell structure.
- Gas Exchange: Respiration facilitates the exchange of gases, with oxygen being taken up and carbon dioxide being released through stomata during the process.

There are two main types of respiration: aerobic respiration and anaerobic respiration.

Aerobic Respiration:

- Oxygen Requirement: Requires oxygen.
- Location: Takes place in the mitochondria of eukaryotic cells.
- Efficiency: Yields a higher amount of ATP (energy).
- End Products: Carbon dioxide and water are produced as byproducts.

Anaerobic Respiration:

- Oxygen Requirement: Occurs in the absence of oxygen.
- Location: Takes place in the cytoplasm of cells.
- Efficiency: Yields a lower amount of ATP compared to aerobic respiration.
- End Products: The byproducts vary; common end products include lactic acid or ethanol, depending on the organism.

Aerobic respiration	Anaerobic respiration
1) It takes place in the presence of oxygen.	1) It takes place in the absence of oxygen.
2) In aerobic respiration, complete oxidation of glucose takes place.	2) In anaerobic respiration, the glucose molecule is incompletely oxidised.
3) End products are CO_2 and water.	3) End products are either ethyl alcohol or lactic acid and CO_2.
4) Lot of energy is liberated (38 ATP).	4) Relatively small energy is liberated (2 ATP).
5) It occurs in plant's and animal's cells.	5) Occurs in many anaerobic bacteria and human muscle cells.
6) $C_6H_{12}O_6 + 6O_2 \rightarrow 6\,CO_2 + 6H_2O + 686$ K.cal	6) $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2 + 56$ K.cal

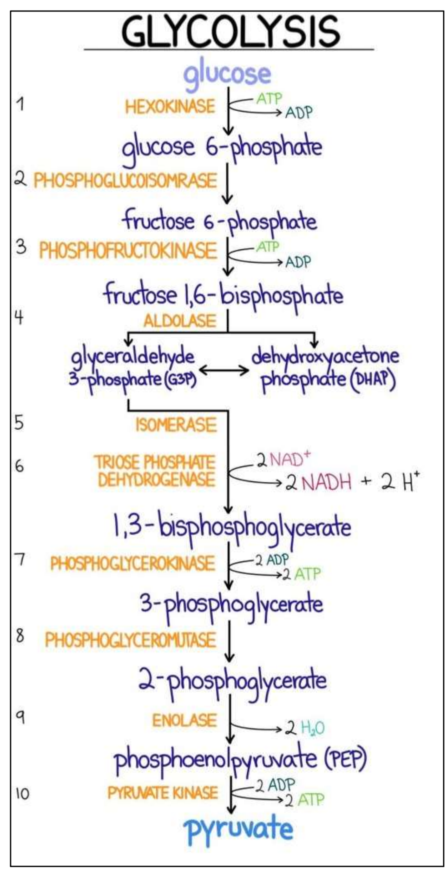
Aerobic respiration:

Aerobic respiration is the process by which cells convert nutrients, typically glucose, into energy in the presence of oxygen. This process occurs in the mitochondria of eukaryotic cells and involves a series of well-coordinated steps.

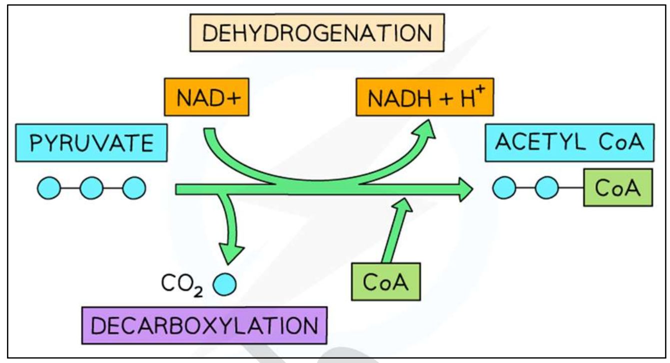
1. Glycolysis
2. Krebs cycle &
3. ETS and Oxidative phosphorylation.
4.

1. **Glycolysis:** Glycolysis is the initial stage of cellular respiration and is a universal metabolic pathway found in the cytoplasm of all living cells. It involves the breakdown of one molecule of glucose (a six-carbon sugar) into two molecules of pyruvate (a three-carbon compound). Glycolysis is an anaerobic process, meaning it does not require oxygen.

Ten steps of Glycolysis are given:

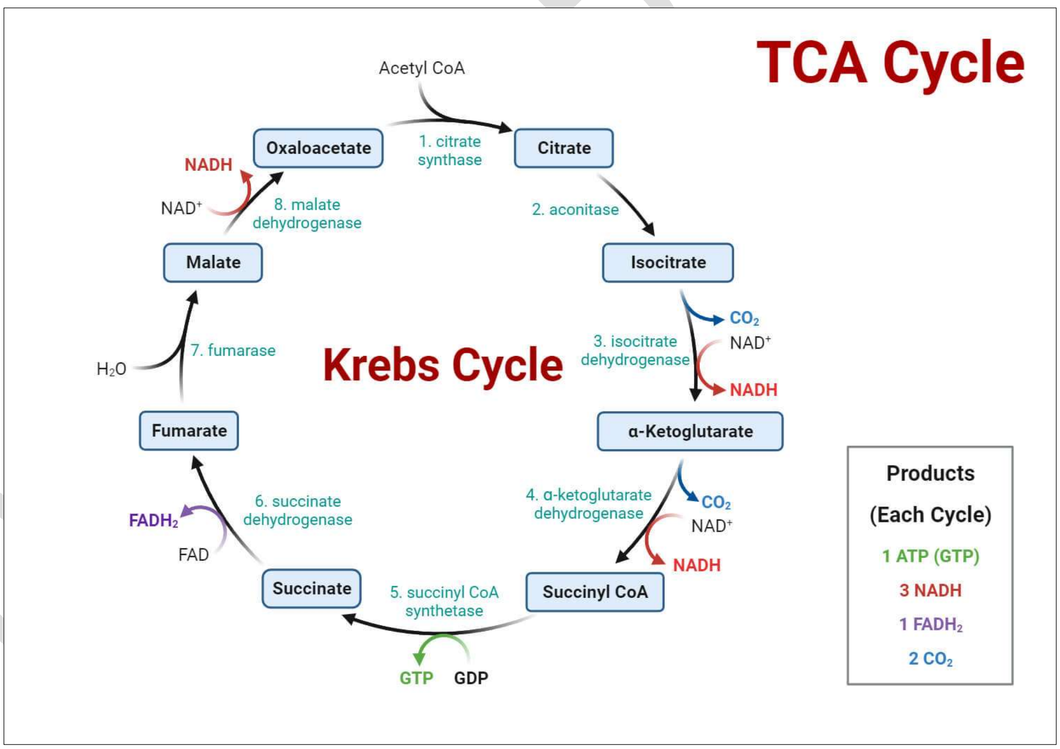


There occurs a link reaction between Glycolysis & Kreb's Cycle which is a crucial steps for Aerobic respiration. In this step, Acetyl CoA is formed from Pyruvate. Acetyl CoA enters inside Mitochondrial matrix to complete Krebs cycle.



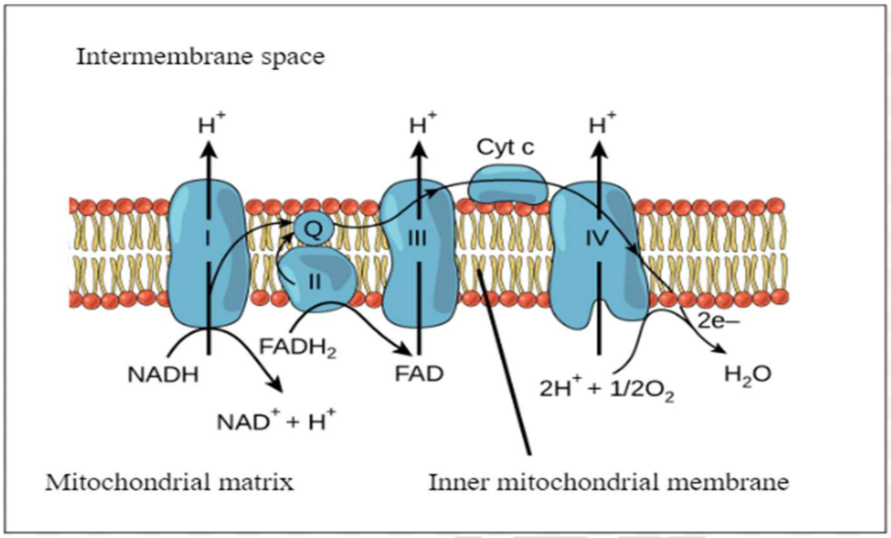
2. **<u>Kreb's Cycle:</u>** The Krebs Cycle, also known as the Citric Acid Cycle or Tricarboxylic Acid (TCA) Cycle, is a series of chemical reactions that take place in the mitochondrial matrix of eukaryotic cells. It is a crucial component of aerobic cellular respiration, which is the process by which cells extract energy from organic molecules in the presence of oxygen.

   The graphical representation of Kreb's cycle is given below:



3. **<u>ETS and Oxidative Phosphorylation:</u>** The Electron Transport Chain and Oxidative Phosphorylation are intimately linked. The Electron Transport Chain generates a proton gradient, and as protons flow back into the mitochondrial matrix through ATP synthase, ATP is synthesized. This process is referred to as oxidative phosphorylation because ATP is produced through the phosphorylation of ADP, and the energy for this phosphorylation

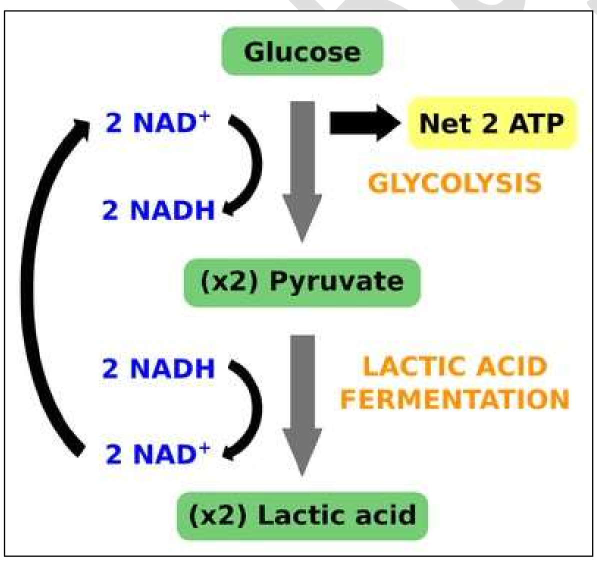
comes from the oxidation (loss of electrons) of NADH and FADH2 in the Electron Transport Chain. Together, ETS and oxidative phosphorylation are crucial for the efficient production of ATP in aerobic respiration.

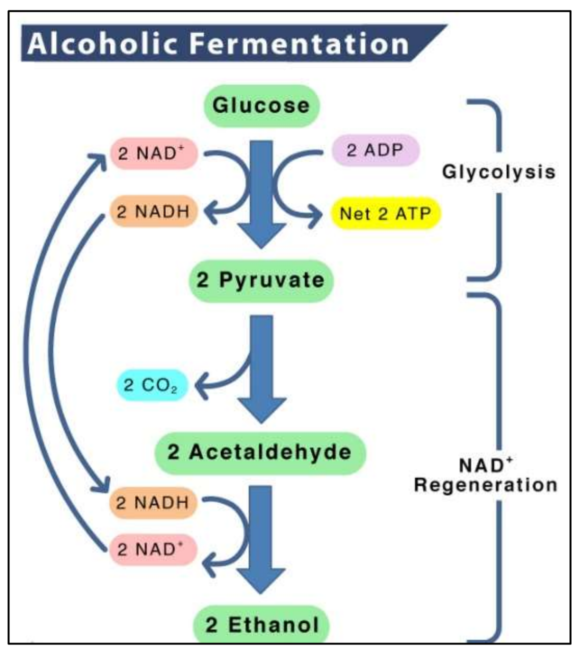


Anaerobic respiration:

Anaerobic respiration is a cellular process that occurs in the absence of oxygen. While not as efficient as aerobic respiration, which occurs in the presence of oxygen, anaerobic respiration allows cells to generate energy from organic compounds. This process is commonly observed in various microorganisms, some plants, and certain animal tissues.

Two types: Lactic acid Fermentation & Alcoholic Fermentation:





- Why Respiration is an Amphibolic Pathway? Explain?

Ans: Respiration is an Amphibolic Pathway because It has:

Dual Functionality:

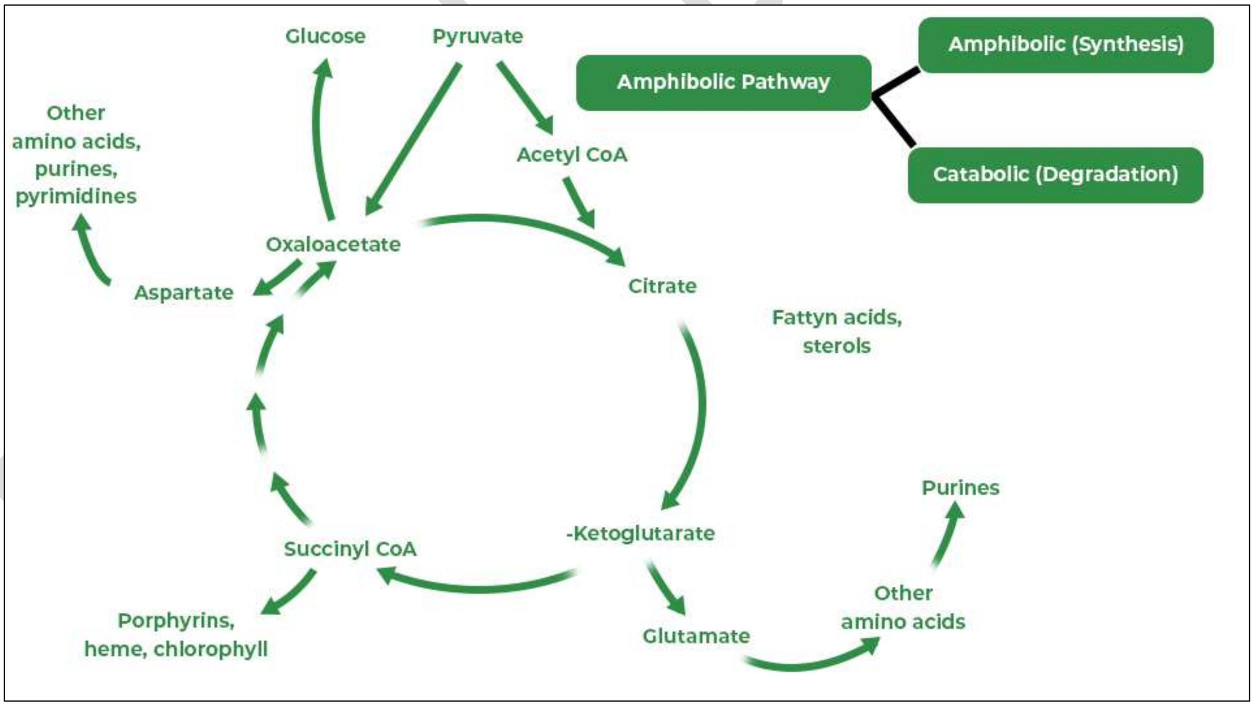
Respiration serves both catabolic and anabolic functions. It involves the breakdown (catabolism) of complex organic molecules to release energy and the synthesis (anabolism) of molecules crucial for cellular structure and function.

Energy Production and Biomolecule Synthesis:

The pathway produces ATP through catabolic processes like glycolysis and oxidative phosphorylation, while also providing intermediates that contribute to the synthesis of amino acids, lipids, and other cellular components.

Flexibility and Adaptability:

Respiration's amphibolic nature allows cells to adapt to varying metabolic demands, balancing energy production with the cell's need for building blocks, showcasing its flexibility in supporting different cellular processes.



Respiratory Quotient

The respiratory quotient (RQ) is a ratio that represents the volume of carbon dioxide produced to the volume of oxygen consumed during a specific metabolic process, such as cellular respiration. It provides insights into the type of substrates (such as carbohydrates, fats, or proteins) being used by an organism for energy production.

The respiratory quotient is calculated using the following formula:

$$RQ = \frac{\text{Volume of } CO_2 \text{ produced}}{\text{Volume of } O_2 \text{ consumed}}$$

The RQ values can range from 0.7 to 1.0 and beyond, indicating different types of substrates being metabolized:

RQ = 1.0: Indicates the metabolism of pure carbohydrates (e.g., glucose) where the same number of moles of CO_2 is produced as the number of moles of O_2 consumed.

RQ < 1.0: Indicates the metabolism of fats or proteins, as more oxygen is consumed relative to the production of carbon dioxide. **(Protein: 0.9 & Fats: 0.7)**

RQ > 1.0: Uncommon in biological systems, but in certain situations, it might suggest incomplete combustion or metabolic pathways involving substances like alcohols.