7. Respiration

Respiration

- All living organisms require a continuous supply of energy for carrying out various life activities.
- Cellular respiration is the process of releasing energy from the breakdown of organic substances.
- The released energy is stored in the form of ATP.
- ATP is the energy currency of cell.
- The process of cellular respiration occurs in cytoplasm and mitochondria.
- It involves the consumption of oxygen and liberation of CO_2 and water.

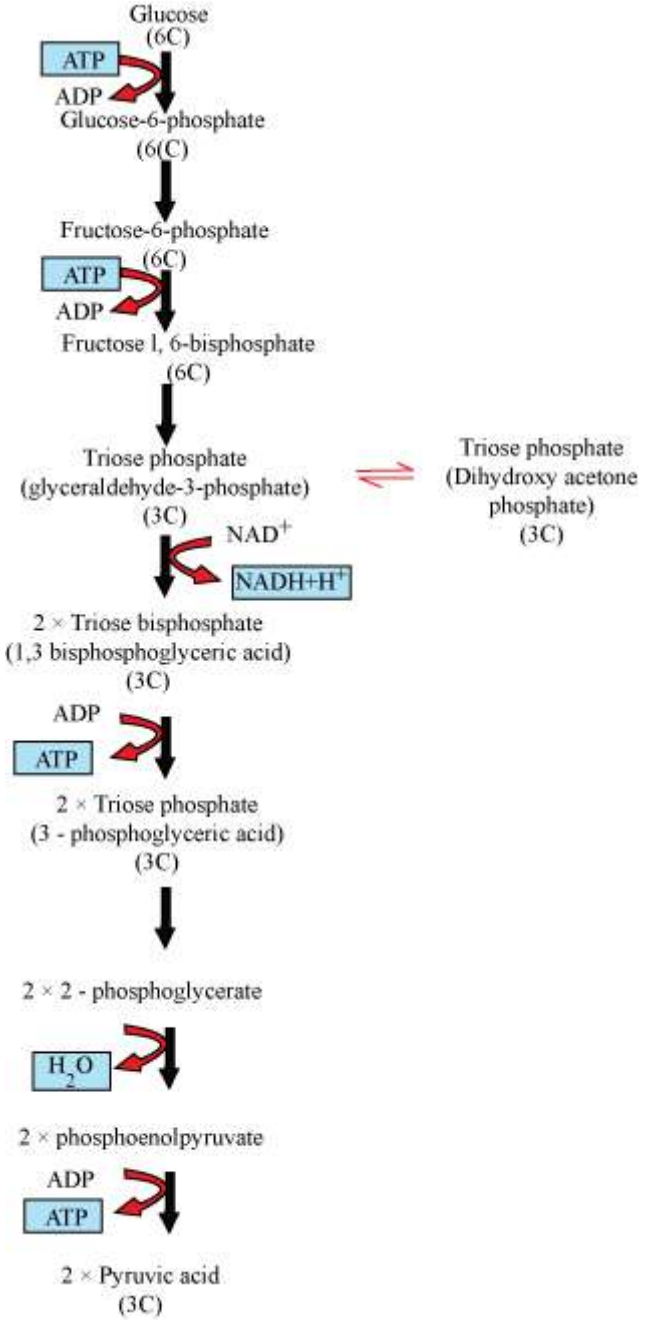
$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{Energy}$$

- **Respiratory substrate:** These are the compounds, which get oxidised during cellular respiration. Example: Carbohydrate, fats, proteins, etc.

Glycolysis

- It is a linear pathway that occurs in cell cytoplasm.
- It occurs in both aerobic and anaerobic respiration.
- It involves the partial breakdown of glucose into 2 molecules of pyruvic acid.
- In plants, as we know, sucrose is the end product of photosynthesis. Therefore, this sucrose is converted into glucose and fructose with the help of invertase enzyme.
- The process of glycolysis generates 2 $NADH_2$ and 2ATP molecules upon breakdown of one glucose molecule.

Steps of glycolysis



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  - Lactic acid fermentation
  - Alcoholic fermentation
  - Aerobic respiration (Krebs cycle)

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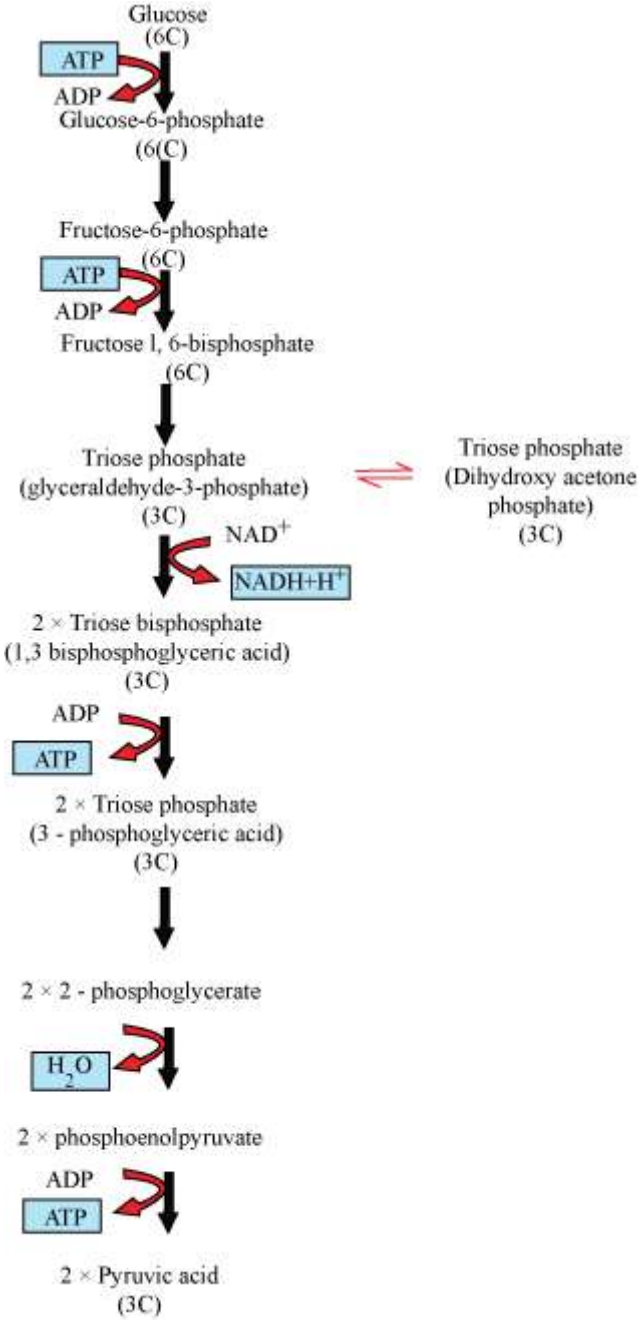

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Tricarboxylic Acid Cycle

- **Aerobic respiration**

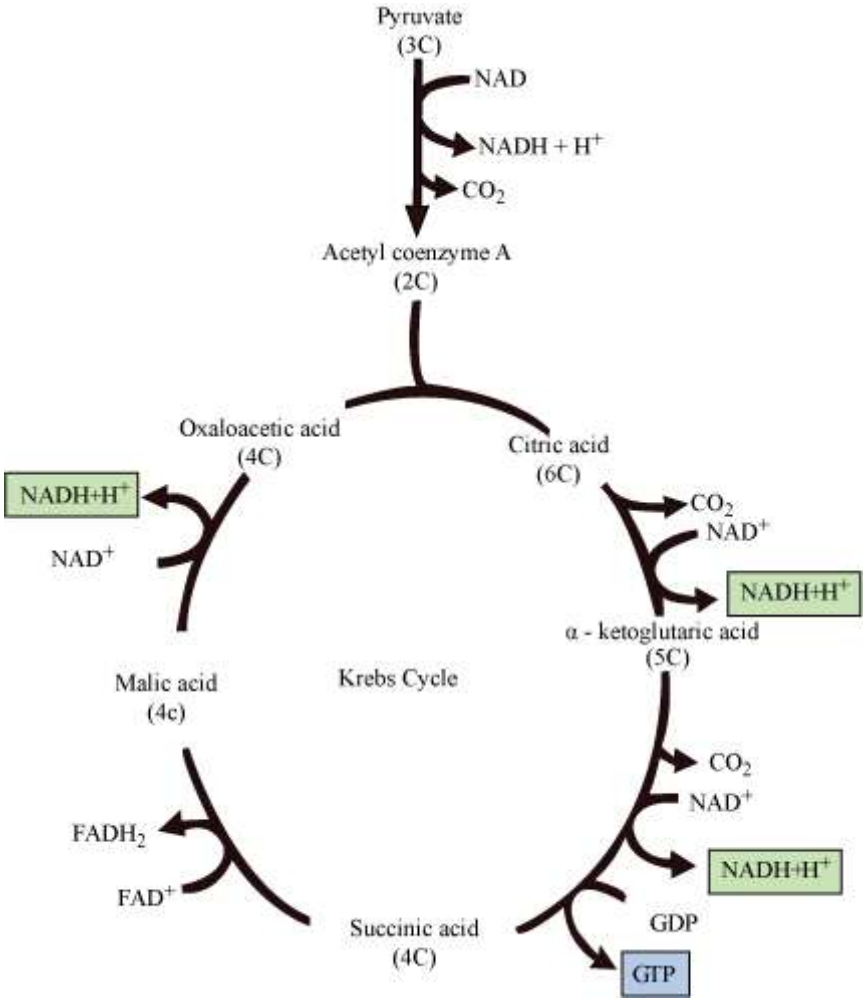
- Pyruvate synthesised by the glycolytic catabolism in cytoplasm enters the mitochondrial matrix and undergoes oxidative decarboxylation.

$$\text{Pyruvic acid} + \text{CoA} + \text{NAD}^+ \xrightarrow[Mg^{2+}]{\text{Pyruvate dehydrogerase}} \text{Acetyl CoA} + \text{CO}_2 + \text{NADH} + \text{H}^+$$

- The acetyl CoA synthesized by **oxidative phosphorylation** then enters Krebs' cycle.

- **Krebs' cycle (Tricarboxylic acid)**

- It is a cyclic process that occurs in mitochondrial matrix.



- The process of Krebs cycle produces $6NADH_2$, $2FADH_2$, and 2ATP molecules on the breakdown of two acetyl CoA molecules.

$$\text{Pyruvic acid} + 4NAD^+ + FAD^+ + 2H_2O + ADP + Pi \xrightarrow[\text{Matrix}]{\text{Mitochondrial}} 3CO_2 + 4NADH + 4H^+ + FADH_2 + ATP$$

Electron Transport System and Oxidative Phosphorylation

- **Electron Transport System**

- By the end of citric acid cycle, glucose molecule is completely oxidised. But, the energy is not release unless NADH and FADH are completely oxidised through electron transport chain.
- It occurs in mitochondrial matrix.
- It is the process where electron passes from one carrier to another via complex I to IV.

- **Oxidative Phosphorylation** is the process in which electrons are transferred from electron donors to oxygen (electron acceptor).

- The enzyme involved in oxidative phosphorylation is **ATP synthase.**
- For every two protons passing through $F_0 - F_1$ complex, one molecule of ATP is synthesised.

Amphibiolic Pathway and Respiratory Quotient

- **Amphibolic Pathway**

- Respiratory pathway involves both anabolic and catabolic pathways. Hence, respiration is termed as amphibolic pathway.

- **Respiratory quotient**

- Respiratory quotient (RQ) = $\frac{\text{Volume of } CO_2 \text{ evolved}}{\text{Volume of } O_2 \text{ consumed}}$
- Respiratory quotient (RQ) depends on type of respiratory substrate used.

- RQ when carbohydrates are used as substrate = 1
- RQ when fats (Tripalmitin) are used as substrate = 0.7
- RQ when proteins are used as substrate = 0.9