SANT ATULANAND RESIDENTIAL ACADEMY

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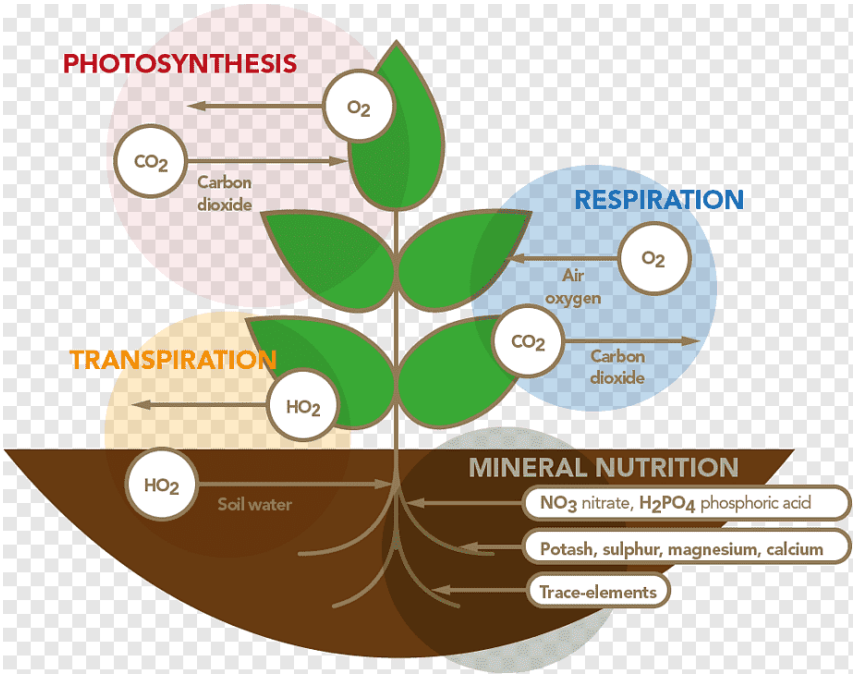
BIOLOGY PROJECT

RESPIRATION IN PLANTS

TERM-2



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Respiration in Plants

A BIOLOGY PROJECT

Certificate

This is to certify that this "Biology Project" on the topic "Respiration in Plants" has been successfully completed by Abhishek Mishra of class 11th B2 under the guidance of Mr Ajay Singh Sir during the academic year 2021-22.

Teacher

Mr. Ajay Singh

Acknowledgement

I express my special thanks to my Biology teacher, Mr. Ajay Singh Sir who always gave me guidance and helped me to know the subject. I had made this project from my heart and shown utmost sincerity to complete it. I am very thankful to all those people who helped me and guided me to make such a project. I also thank my parents who have provided me with all the resources required to make this project.

Preface

I'm pleased to submit project work in Biology of class 11th. We are extremely grateful to CBSE for introducing this project in Biology.

This project has given me ample opportunity to explore a varied area of the Biology Project. Thus increasing my understanding of the concepts studied.

The project work is strictly according to the guidelines of CBSE.

CONTENT

BOOK TITLE

AUTHOR

STUDENT'S NAME

SUBMISSION DATE

CLASS CODE

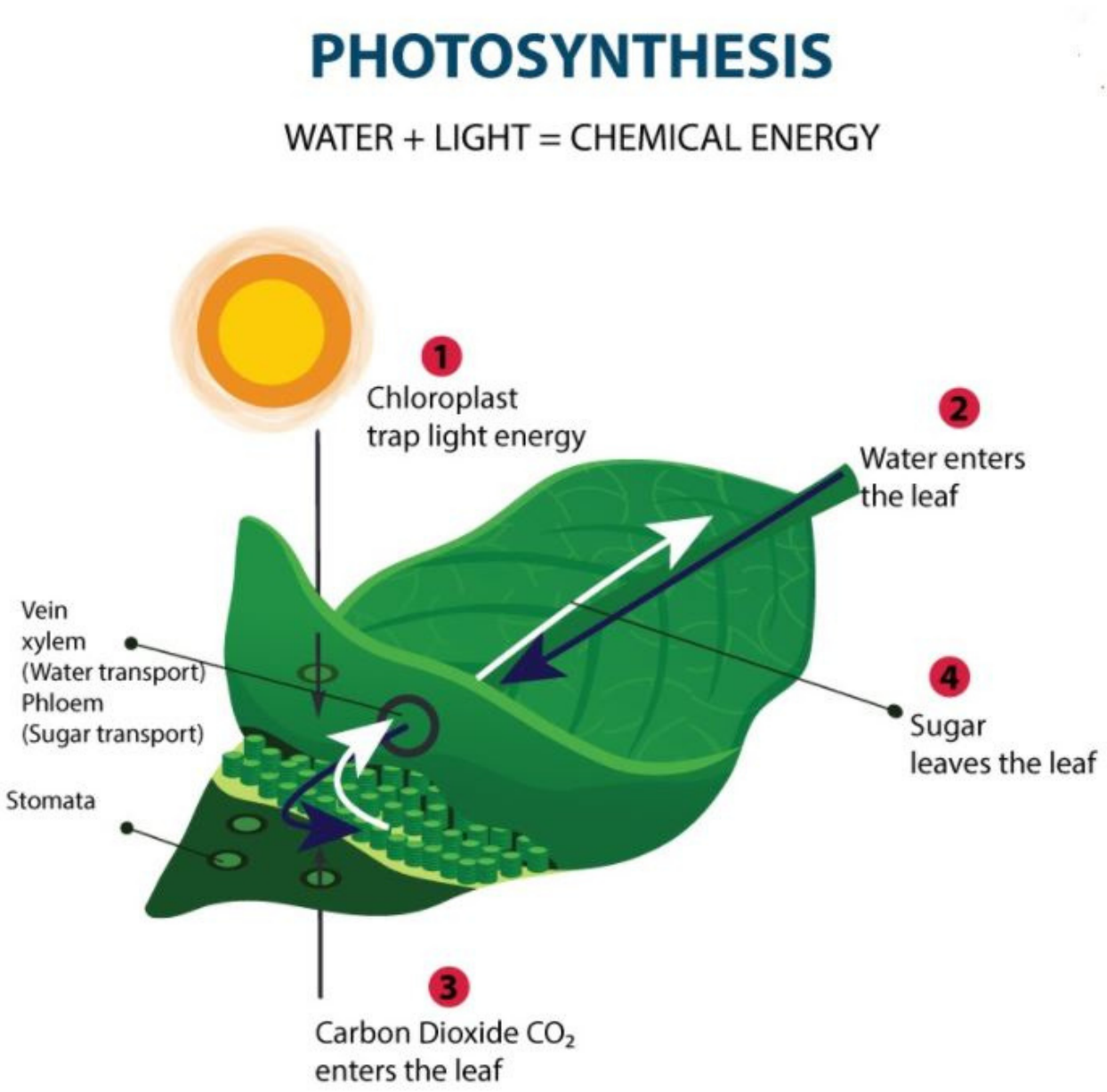
PROFESSOR'S NAME

Introduction

All living organisms, containing plants, get the energy necessary for their survival from a series of chemical reactions termed respiration. The process of respiration needs glucose to start the reactions which are changed into energy and later produce carbon dioxide and water as by-products. Plants respire with the help of lenticels and stomata (exist in stems and leaves individually) which carry out the function of the gaseous exchange.

Plant Respiration

The method by which cells get chemical energy by the consumption of oxygen and the liberating of carbon dioxide is called respiration. In order to carry on respiration, plant cells require oxygen and a means of disposing of carbon dioxide just as animal cells do. In plants, every part such as root, stem executes respiration as plants do not possess any particular organs like animals for the exchange of gases.



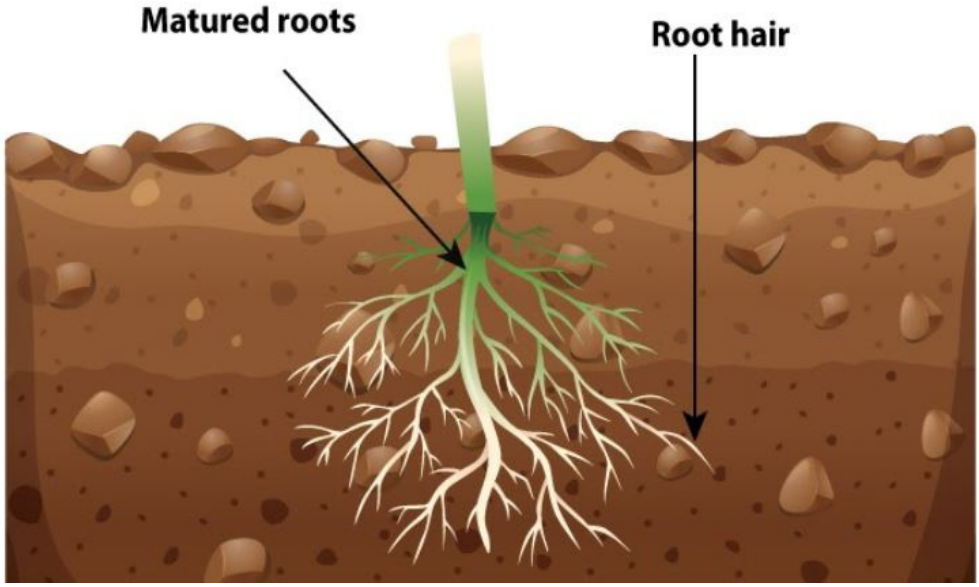
The method of respiration is written as:

Oxygen + Glucose → Water + Carbon Dioxide with Energy

We can conclude the same from the equation above as well that respiration uses oxygen and to produce carbon dioxide.

Respiration in Roots

In plants, respiration occurs with the help of roots. In soil oxygenated air is already present in spaces between soil particles. This oxygen is then absorbed into the roots with the help of root hair present on the roots. The hairs of the roots are in straight contact with them. In fact, a root hair is a lateral tubular outgrowth of the external epidermal cells of a root. The oxygen present among the soil particles diffuses into the root hairs. From root hairs, oxygen is transported to all the parts of roots for respiration. During the respiration process, oxygen is transformed into carbon dioxide gas which is spread in the opposite direction i.e. out of the roots by the same root hairs which complete the respiration process of roots.



Respiration in plants occurs throughout the day and night thereby carbon dioxide is formed. Though, during the day, the total of carbon dioxide CO2 released is insignificant compared to the volume of oxygen made as a result of photosynthesis. Therefore, one should not sleep underneath a tree at night

Respiration in Stems

In the plants taking herbaceous stem exchange of gases occurs through stomata and the carbon dioxide CO_2 formed during the process that gets diffused into the air with the help of stomata only. While in the plants having hard and woody stems the exchange of gases occurs through lenticels. Lenticels are usually loosely packed dead cells which are present as tiny pores on the bark of woody plants. These allow oxygen to pass to the intercellular spaces of the inside of tissues and carbon dioxide (CO_2) to be liberated into the atmosphere by the phenomena of diffusion which completes the process of respiration in stems.

Respiration in Leaves

In leaves, the exchange of respiratory gases occurs through very small pores called stomata. The stomata are present in big number on the lower side of leaves of the plant. Every stoma has a tiny pore at its center which is enclosed and regulated by two kidney-shaped cells known as guard cells. When the stoma opens the exchange of gases occur between the atmosphere and interior of the leaf by the method of diffusion and that completes the process of respiration in leaves.

Types of Respiration

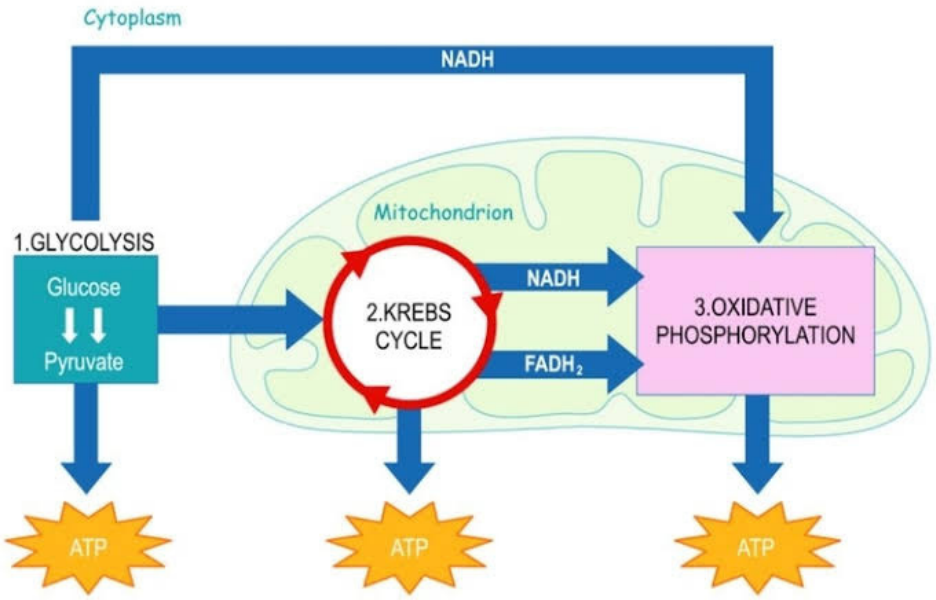
There are two kinds of respiration that we categorize on the basis of the absence or presence of oxygen:

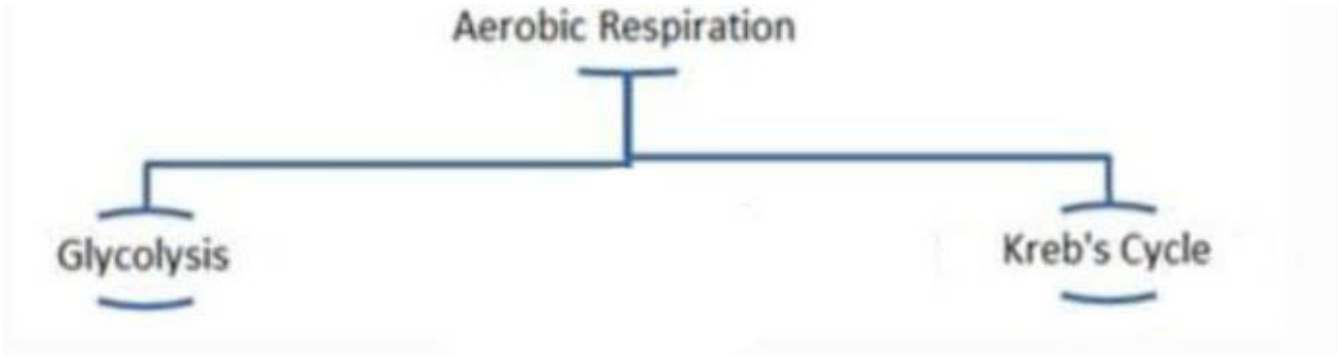
- **Aerobic Respiration**

The respiration that occurs in the presence of oxygen is named aerobic respiration due to 'air' which has oxygen. The aerobic respiration contains utilization of oxygen for the breaking of chemical bonds in glucose to liberate energy in high volumes. It is the central source of energy for plants. Animals and plants that use oxygen for respiration are aerobes. Mostly all the animals have aerobic respiration.

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

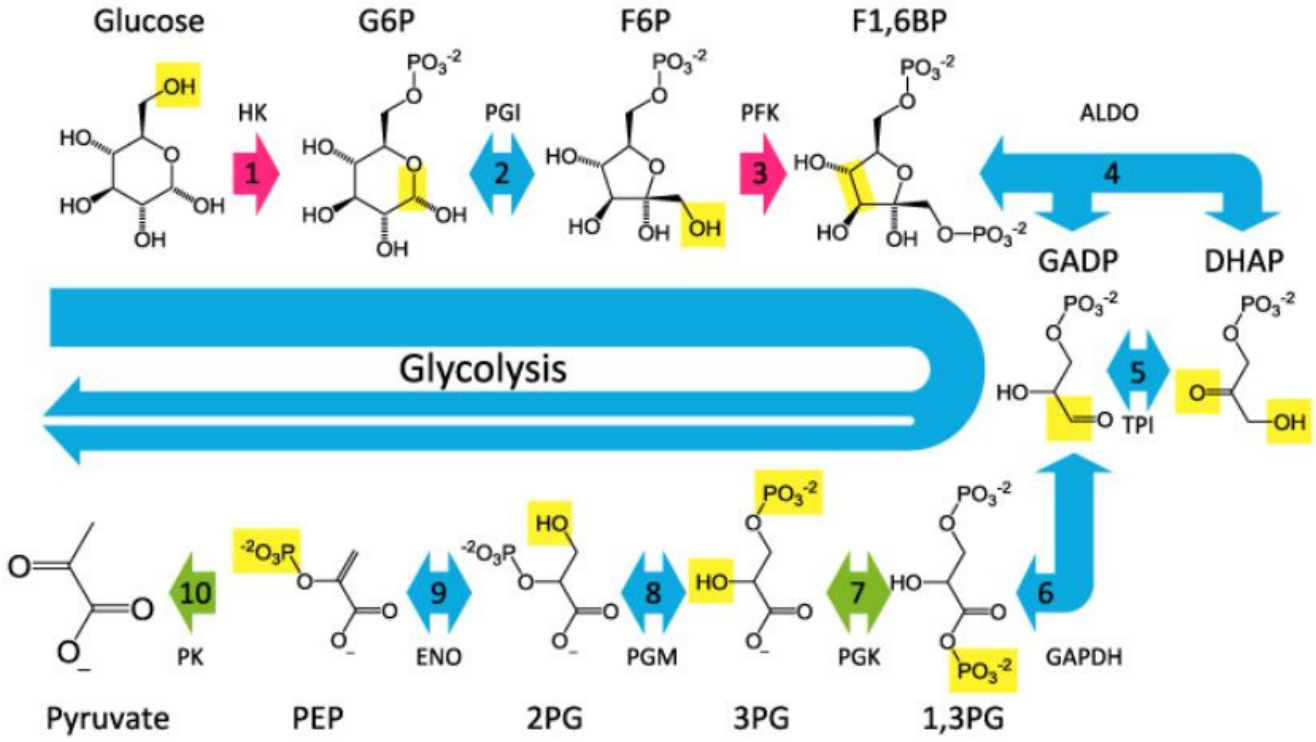
All the organisms that gain energy by aerobic respiration cannot exist without oxygen. This is due to no oxygen there; they cannot get energy from the food which they consume. Aerobic respiration takes more energy because a complete breaking of glucose takes place during respiration with the use of oxygen.





- **Glycolysis**

Glycolysis is the process in which glucose is broken down to produce energy. It produces two molecules of pyruvate, ATP, NADH and water. The process takes place in the cytosol of the cell cytoplasm, in the presence or absence of oxygen.Glycolysis is the primary step of cellular respiration. In the absence of oxygen, the cells take small amounts of ATP through the process of fermentation.



Glycolysis Pathway

The glycolysis pathway occurs in the following stages:

Stage 1

- A phosphate group is added to glucose in the cell cytoplasm, by the action of enzyme hexokinase.
- In this, a phosphate group is transferred from ATP to glucose forming glucose,6-phosphate.

Stage 2

Glucose-6-phosphate is isomerized into fructose,6-phosphate by the enzyme phosphoglucomutase.

Stage 3

The other ATP molecule transfers a phosphate group to fructose 6-phosphate and converts it into fructose 1,6-bisphosphate by the action of enzyme phosphofructokinase.

Stage 4

The enzyme aldolase converts fructose 1,6-bisphosphate into glyceraldehyde 3-phosphate and dihydroxyacetone phosphate, which are isomers of each other.

Step 5

Triose-phosphate isomerase converts dihydroxyacetone phosphate into glyceraldehyde 3-phosphate which is the substrate in the successive step of glycolysis.

Step 6

This step undergoes two reactions:

- The enzyme glyceraldehyde 3-phosphate dehydrogenase transfers 1 hydrogen molecule from glyceraldehyde phosphate to nicotinamide adenine dinucleotide to form NADH + H+.
- Glyceraldehyde 3-phosphate dehydrogenase adds a phosphate to the oxidized glyceraldehyde phosphate to form 1,3-bisphosphoglycerate.

Step 7

Phosphate is transferred from 1,3-bisphosphoglycerate to ADP to form ATP with the help of phosphoglycerokinase. Thus two molecules of phosphoglycerate and ATP are obtained at the end of this reaction.

Step 8

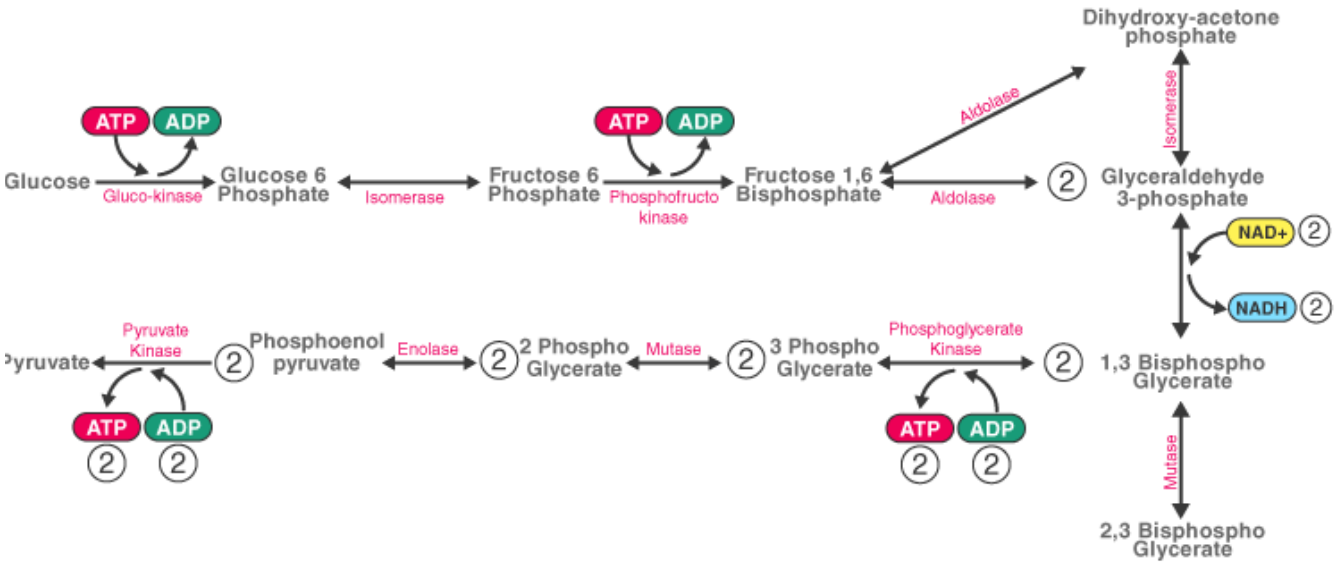
The phosphate of both the phosphoglycerate molecules is relocated from the third to the second carbon to yield two molecules of 2-phosphoglycerate by the enzyme phosphoglyceromutase.

Step 9

The enzyme enolase removes a water molecule from 2-phosphoglycerate to form phosphoenolpyruvate.

Step 10

A phosphate from phosphoenolpyruvate is transferred to ADP to form pyruvate and ATP by the action of pyruvate kinase. Two molecules of pyruvate and ATP are obtained as the end products.

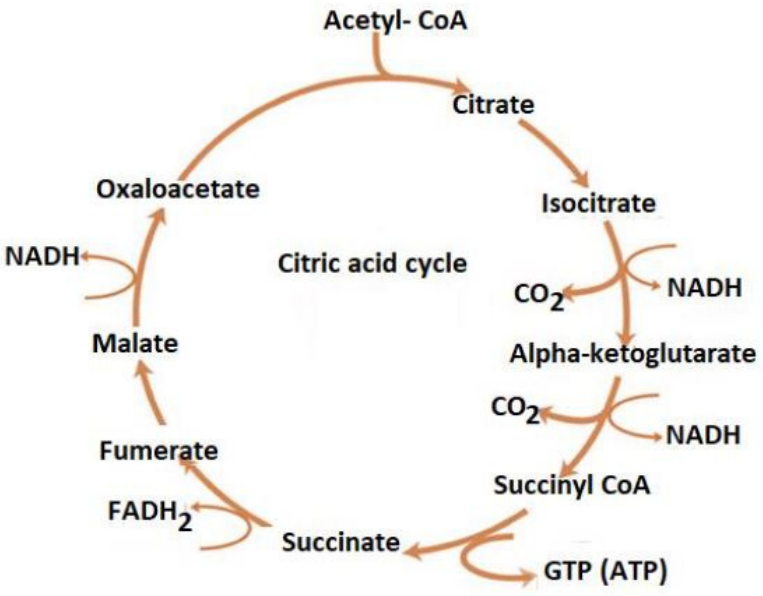


Key Points of Glycolysis

- It is the process in which a glucose molecule is broken down into two molecules of pyruvate.
- The process takes place in the cytoplasm of plant and animal cell.
- Six enzymes are involved in the process.
- The end products of the reaction include 2 pyruvate, 2 ATP and 2 NADH molecules.

Kreb's Cycle

- Kreb's cycle takes place in the mitochondrial matrix.
- Several intermediate compounds are formed, which contain three carboxylic groups and therefore the process is called a tricarboxylic acid cycle (TCA).
- First, the condensation of acetyl group with oxaloacetic acid (OAA) and water takes place to yield citric acid, catalyzed by the enzyme citrate synthase and a molecule of CoA is released.
- Citrate is then isomerized to isocitrate, which is followed by two successive steps of decarboxylation, leading to the formation of α-ketoglutaric acid and then succinyl-CoA.
- Succinyl-CoA is oxidized to OAA allowing the cycle to continue and during the conversion of succinyl-CoA to succinic acid, a molecule of GTP is synthesized.
- In a coupled reaction, GTP is converted to GDP with the simultaneous synthesis of ATP from ADP.
- Pyruvic acid + 4 NAD+ + FAD+ + 2H2O + ADP + Pi à 3CO2 + 4NADH + 4H+ + FADH2 + ATP
- During the process, 8NADH2, 2FADH2, 2 GTPs are formed.



Fermentation

- Fermentation is the incomplete oxidation of glucose under anaerobic conditions by sets of reactions.
- Fermentation is of two types
- Alcohol fermentation
- Lactic acid fermentation.
- In alcohol fermentation, pyruvic acid is converted to CO_2 and ethanol by pyruvic acid decarboxylase and alcohol dehydrogenase.

Glucose -> 2 Ethyl alcohol + $2NADH_2$ + 2ATP

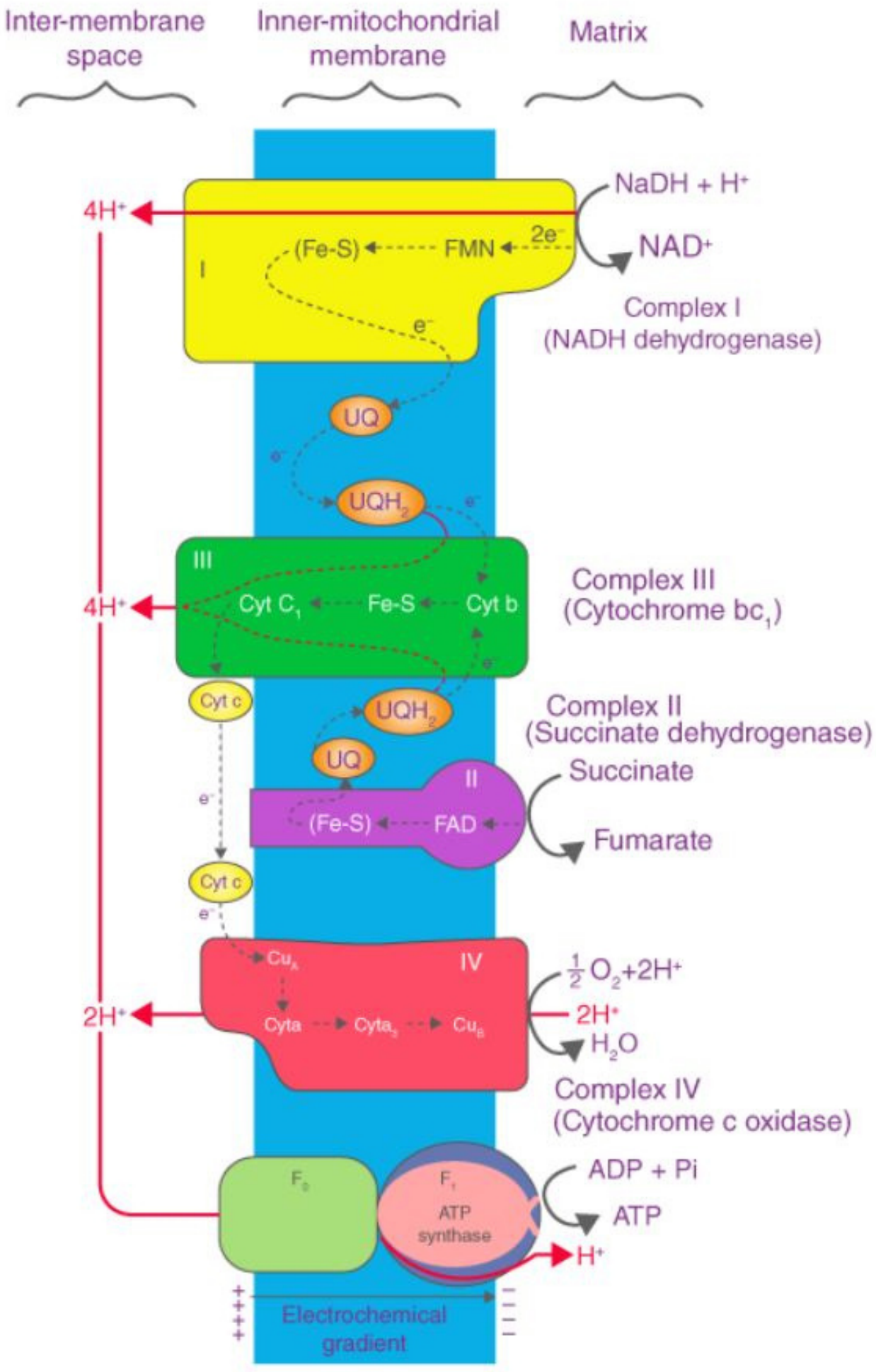
- In lactic acid fermentation, lactic acid is produced from pyruvic acid by lactate dehydrogenase.

Glucose -> 2 Lactic acid + 2 ATP.

- In eukaryotes, these steps take place within the mitochondria and this requires O_2.

ELECTRON TRANSPORT SYSTEM

- The metabolic pathway through which the electron passes from one carrier to another is called the electron transport system (ETS).
- The electron transport system takes place in the inner mitochondrial membrane.
- Electron transport chain comprises of the following:
- Complex I: NADH dehydrogenase
- Complex II: succinate dehydrogenase
- Complex III: cytochromes bc1
- Complex IV: cytochromes a-a3
- Complex V: ATP synthase
- NADH2 is oxidized by NADH dehydrogenase and electrons are then transferred to ubiquinone located in the inner mitochondrial membrane.
- FADH2 is oxidized by succinate dehydrogenase and transferred electrons to ubiquinone.
- The reduced ubiquinone is then oxidized with the transfer of electrons via cytochromes bc1 complex to cytochrome c.
- Cytochrome c is a small protein attached to the outer surface of the inner membrane and transfers electrons from complex III to complex IV.
- When electrons are transferred from one carrier to another via complex I to complex IV, they are coupled to ATP synthesis of ATP from ADP and Pi.
- Oxygen plays a vital role in removing electrons and hydrogen ions and finally helps in the production of H2


Inter-membrane space
Inner-mitochondrial membrane
Matrix
NaDH + H+
4H+
2e-
(Fe-S)
FMN
I
NAD+
e-
Complex I
(NADH dehydrogenase)
UQ
UQH2
III
4H+
Cyt C1
Fe-S
Cyt b
Complex III
(Cytochrome bc1)
Cyt c
UQH2
Complex II
(Succinate dehydrogenase)
UQ
II
Succinate
(Fe-S)
FAD
Fumarate
Cyt c
CuA
IV
½ O2+2H+
2H+
Cyta
Cyta3
CuB
2H+
H2O
Complex IV
(Cytochrome c oxidase)
F0
F1
ATP synthase
ADP + Pi
ATP
H+
Electrochemical gradient

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