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# PROCESS OF RESPIRATION

Respiration is an important process, it is carried out by humans through inhaling oxygen from the atmosphere and exhaling carbon dioxide. Plants and animals perform respiration to gain energy and be alive. In this article you will learn about the process of Respiration its 4 important

## What is Respiration?

**Respiration**- a process in living organisms involving the production of energy, typically with the intake of oxygen and the release of carbon dioxide from the oxidation of complex organic substances.

## Types of respiration

There are different types of respiration with different processes.

- Aerobic respiration
- Anaerobic respiration

## What is Aerobic Respiration?

**Aerobic respiration:** it is a process of cellular respiration that takes place in the presence of oxygen gas to produce energy from food. The end product of this process is water and carbon dioxide.

**For Example:** plants, animals, humans, mammals, and birds.

***The chemical formula for aerobic respiration:***

**Glucose ($C_6H_{12}O_6$) + Oxygen 6($O_2$) → Carbon-dioxide 6($CO_2$) + Water 6 ($H_2O$) + Energy (ATP)**

## What is Anaerobic Respiration?

**Anaerobic respiration:** it is a process that takes place in the absence of oxygen. In this process, energy is obtained when oxygen is not present around.

**Example:** fermentation of yeast and alcoholic fermentation.

***The chemical formula for anaerobic respiration:***

**Glucose($C_6H_{12}O_6$) → Alcohol 2($C_2H_5O$ H) + Carbon dioxide 2($CO_2$) + Energy (ATP )**

**PHASES OF RESPIRATION IN ORGANISMS**

Respiration occurs in the cytoplasm and around the plasma membrane in prokaryotic cells. In eukaryotic cells, respiration takes place in the cytoplasm and mitochondria, which is also considered as the powerhouse of the cells.

This process is very much similar to the internal combustion of the car engine, wherein organic compounds and oxygen go in, while water and carbon dioxide comes out. The energy that is liberated powers the automotive (or cell).

## The three phases of Respiration are:

- **Glycolysis**
- **Oxidative phosphorylation**
- **Citric Acid Cycle**

**Glycolysis**

Glycolysis is a cytoplasmic pathway that breaks down glucose into two three-carbon compounds and generates energy. Glucose is trapped by phosphorylation, with the help of the enzyme hexokinase. Adenosine triphosphate (ATP) is used in this reaction and the product, glucose-6-P, inhibits hexokinase. Glycolysis takes place in 10 steps, five of which are in the preparatory phase and five are in the pay-off phase. Phosphofructokinase is the rate-limiting enzyme. ATP is generated by substrate-level phosphorylation by high-energy compounds, such as 1,3-bisphosphoglycerate and phosphoenolpyruvate.

Glycolysis is used by all cells in the body for energy generation. The final product of glycolysis is pyruvate in aerobic settings and lactate in anaerobic conditions. Pyruvate enters Kreb's cycle for further energy production.

**STEPS FOR GLYCOLYSIS**

- A phosphate group is added to glucose.
- In this, the phosphate group is transferred to ATP to form glucose, 6-phosphate
- Glucose-6-phosphate is isomerized into fructose,6-phosphate by the enzyme phosphoglucomutase.
- The other ATP molecule transfers a phosphate group to fructose 6-phosphate and converts it into fructose 1,6-bisphosphate by the action of the enzyme phosphofructokinase.
- The enzyme aldolase converts fructose 1,6-bisphosphate into glyceraldehyde 3-phosphate and dihydroxyacetone phosphate, which are isomers of each other.
- Triose-phosphate isomerase converts dihydroxyacetone phosphate into glyceraldehyde 3-phosphate which is the substrate in the successive step of glycolysis.

## 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.
- 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.
- 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.
- 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.
- 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.

**Points to remember in this process**

- In this process, the glucose molecule is broken down into two molecules.
- This process takes place in the cytoplasm of the plant.
- 6 enzymes are involved in this process.
- The end products of the reaction include 2 pyruvate, 2 ATP, and 2 NADH molecules.

## Oxidative phosphorylation

The synthesis of ATP by phosphorylation of ADP for which energy is obtained by electron transport and which takes place in the mitochondria during aerobic respiration this process is called oxidative phosphorylation

**Steps for oxidative phosphorylation**

- Reduced NADH and FADH2 transfer their electrons to molecules near the beginning of the transport chain. After transferring the electrons, they get oxidized to NAD+ and FAD and are utilized in other steps of cellular respiration.
- The electrons move from a higher energy level to a lower energy level, thereby releasing energy. Some of the energy is used to move the electrons from the matrix to the intermembrane space. Thus, an electrochemical gradient is established.
- The electrons are then transferred to the oxygen molecule which splits in half and uptakes H+ to form water.
- The H+ ions pass through an enzyme called ATP synthase while flowing back into the matrix. This controls the flow of protons to synthesize ATP.
- Oxidative phosphorylation uses the chemical reactions that release energy to drive a chemical reaction that requires energy. These 2 sets of reactions are coupled and interrelated. The electrons that flow through the electron transport chain is an exergonic process and the synthesis of ATP is an endergonic process. These two processes are ingrained within a membrane. As a result, energy will be transmitted from the electron transport chain to ATP synthase by the movement of proteins. This process is termed as chemiosmosis. Endergonic Process is a chemical reaction in which energy is absorbed. There will be a

change in free energy and it is always positive. Exergonic Process is a chemical reaction in which there will be a positive flow of energy from the system to the surrounding environment. Chemical reactions are also considered exergonic when they are spontaneous.

- Most of the biochemical catabolic processes like the citric acid cycle, glycolysis, beta-oxidation, etc. produce the coenzyme NADH. It consists of electrons having high transfer potential. These reactions release a huge amount of energy on oxidation. These reactions are also known to be uncontrollable reactions since the energy within the cells is not released at once. The electrons are separated from the NADH and then passed to the oxygen with a series of enzymes releasing a small amount of energy. All these series of enzymes having complexes is known as electron transport chain.This chain can be seen in the inner layer or membrane of mitochondria. The salts of succinic acid are also oxidized by this electron chain transport system.
  In the case of eukaryotes, the enzymes make use of energy that has been released in the electron transport system from the oxidation of NADH that pumps protons across the inner membrane of the mitochondria. This results in the generation of the electrochemical gradient across the membrane. This can be considered as one of the best examples to understand the concept of oxidative phosphorylation.

**CTRIC ACID CYCLE**

This cycle is also known as tricarboxylic cycle or Kreb's cycle. Two ATP molecules are produced in each phase of the citric acid cycle and it takes place within the mitochondrial matrix of a cell. The electrons generated in Kreb’s cycle move across the mitochondrial matrix.

**DIFFERENCE BETWEEN AEROBIC AND ANAEROBIC RESPIRATION**

**Aerobic respiration**

- Oxygen is present when the respiration process is going to take place.
- Gases are exchanged in the form of respiration.
- It can be found in cytoplasm and mitochondira.
- Glucose breaks down into carbon dioxide and water.
- It can be found in humans, birds and animals.

**Anaerobic respiration**

- Oxygen is absent in the process of respiration.
- Gases are not exchanged in the process of respiration.
- It can be found in cytoplasm.
- Glucose breaks down into ethyl alcohol, carbon dioxide and energy.
- Lower organisms such as bacteria and yeast use this type. In other organisms, it occurs during heavy activities.

**DIFFERENCE BETWEEN GYLCOLYSIS AND KREB'S CYCLE**

**Glycolysis**

- It is the first step of respiration yielding two molecules of pyruvic acid after the partial breakdown of a glucose molecule in a set of enzymatic processes
- Occurs in all the living organisms
- No carbon dioxide evolved
- Oxygen not required for this process
- Four ATP molecules are produced in the glycolysis for each glucose molecule
- Consumes 2 molecules of ATP for initial phosphorylation of substance molecules
- Net gain of two molecules of ATP and two molecules of NADH gained for every molecule of glucose broken down
- Occurs as a linear sequence

**Kreb's cycle**

- Krebs Cycle is the second step of aerobic respiration in which pyruvate is oxidized completely into inorganic substances forming carbon dioxide.
- Occurs in aerobes
- Carbon dioxide evolved
- Oxygen is required for Krebs Cycle
- One ATP or GTP molecule is produced by substrate-level phosphorylation in each turn of the Kreb's cycle
- Doesn't consume ATP
- Each turn of the Krebs cycle yields three molecules of NADH and two molecules of FADH2
- Occurs as a cyclic sequence

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