18/MHS06/066

Osoikhia Ebehiremen Emmanuella

MCB 202

Medical laboratory science

Describe the mechanism in aerobic respiration .

Answer

Aerobic respiration is a biological process in which food glucose is converted into energy in the presence of oxygen. The chemical equation of aerobic respiration is as given below-

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| --- |
| **Glucose (C6H12O6) + Oxygen 6(O2) → Carbon-dioxide 6(CO2) + Water 6 (H2O) + Energy (ATP)** |

According to the above-given chemical equation, energy is released by splitting the glucose molecules with the help of oxygen gas. At the end of the chemical reaction, energy, water molecules, and carbon dioxide gas are released as the by-products or end products of the reactions.

The 2900 kJ of energy is released during the process of breaking the glucose molecule and in turn, this energy is used to produce ATP – Adenosine Triphosphate molecules which are used by the system for various purposes.

Aerobic respiration process takes place in all **multicellular organisms** including animals, plants and other living organisms.

During the respiration process in plants, the oxygen gas enters the plant cells through the stomata, which is found in the epidermis of leaves and stem of a plant. With the help of the photosynthesis process, all green plants synthesize their food and thus releases energy.

## **Steps of Aerobic Respiration**

### Overall Equation

The equation for aerobic respiration describes the reactants and products of all of its steps, including glycolysis. That equation is:

*1 glucose + 6 O2 → 6 CO2+ 6 H2O + 38 ATP*

In summary, 1 molecule of six-carbon glucose and 6 molecules of oxygen are converted into 6 molecules of carbon dioxide, 6 molecules of water, and 38 molecules of ATP. The reactions of aerobic respiration can be broken down into four stages, described below.

### **Glycolysis**

Glycolysis is the first stage of aerobic respiration and occurs in the cytoplasm of the cell. It involves the splitting of 1 six-carbon sugar molecule into 2 three-carbon pyruvate molecules. This process creates two ATP molecules.

The overall equation is as follows:

*C6H12O6 + 2 ADP + 2 PI + 2 NAD+ → 2 Pyruvate + 2 ATP + 2 NADH + 2 H+ + 2 H2O*

This process reduces the co-factor NAD+ to NADH. This is important, as later in the process of cellular respiration, NADH will power the formation of much more ATP through the mitochondria’s electron transport chain.

In the next stage, pyruvate is processed to turn it into fuel for the citric acid cycle, using the process of oxidative decarboxylation.

### **Oxidative decarboxylation of pyruvate**

*2 (Pyruvate– +* [*Coenzyme*](https://biologydictionary.net/coenzyme/) *A + NAD+ → Acetyl CoA + CO2 + NADH)*

Oxidative decarboxylation, sometimes referred to as the link reaction or the transition reaction, is the link between glycolysis and the citric acid cycle. It, like glycolysis, takes place in the cytoplasm. In this process, pyruvate is combined with coenzyme A to produce acetyl-CoA.

This transition reaction is important because acetyl-CoA is an ideal fuel for the citric acid cycle, which can in turn power the process of oxidative phosphorylation in the mitochondria, which produces huge amounts of ATP.

More NADH is also created in this reaction. This means more fuel to create more ATP later in the process of cellular respiration.

**The citric acid**

The citric acid cycle, also called the tricarboxylic acid cycle or the Krebs cycle, is a series of redox reactions that begins with Acetyl CoA. These reactions take place in the matrix of the mitochondria of eukaryotic cells. In prokaryotic cells, it takes place in the cytoplasm. The overall reaction is as follows:

*2 (ACETYL COA + 3 NAD+ + FAD + ADP + PI → CO2 + 3 NADH + FADH2 + ATP + H+ + COENZYME A)*

The reaction occurs twice for each molecule of glucose, as there are two pyruvates and hence two molecules of Acetyl CoA generated to enter the citric acid cycle.

Both NADH and FADH2 – another carrier of electrons for the electron transport chain – are created. All the NADH and FADH2 created in the preceding steps now come into play in the process of oxidative phosphorylation.

In summary, for each round of the cycle, two carbons enter the reaction in the form of Acetyl CoA. These produce two molecules of carbon dioxide. The reactions generate three molecules of NADH and one molecule of FADH. One molecule of ATP is produced.

### Oxidative phosphorylation

Oxidative phosphorylation is the primary energy providing stage of aerobic respiration. It uses the folded membranes within the cell’s mitochondria to produce huge amounts of ATP.

*34 (ADP + PI+ NADH + 1/2 O2 + 2H+ → ATP + NAD+ + 2 H2O)*

In this process, NADH and FADH2 donate the electrons they obtained from glucose during the previous steps of cellular respiration to the electron transport chain in the mitochondria’s membrane.

The electron transport chain consists of a number of protein complexes that are embedded in the mitochondrial membrane, including complex I, Q, complex III, cytochrome C, and complex IV.

All of these ultimately serve to pass electrons from higher to lower energy levels, harvesting the energy released in the process. This energy is used to power proton pumps, which power ATP formation.

Just like the sodium-potassium pump of the cell membrane, the proton pumps of the mitochondrial membrane are used to generate a concentration gradient which can be used to power other processes.

The protons that are transported across the membrane using the energy harvested from NADH and FADH2 “want” to pass through channel proteins from their area of high concentration to their area of low concentration.

Specifically, the channel proteins are ATP synthases, which are enzymes that make ATP. When protons pass through ATP synthase, they drive the formation of ATP.

This process is why mitochondria are referred to as “the powerhouses of the cell.” The mitochondria’s electron transport chain makes nearly 90% of all the ATP produced by the cell from breaking down food.

This is also the step that requires oxygen. Without oxygen molecules to accept the depleted electrons at the end of the electron transport chain, the electrons would back up, and the process of ATP creation would not be able to continue.