What Are the Four Major Methods of Producing ATP?

Updated May 29, 2019 *By Alicia Prince*

ATP, or Adenosine triphosphate, is a necessary fuel for all cells in the body and functions in three main ways. ATP is crucial in transporting substances between cell

into two molecules of pyruvic acid and two molecules of ATP. These molecules are then used as energy by various systems in the body. In eukaryotic organisms, or organisms with a membrane bound nucleus, glycolysis occurs in the cytosol.

Oxidative Phosphorylation

Oxidative phosphorylation also produces ATP and is a major producer of ATP in organisms -- 26 out of 30 molecules of ATP generated from glucose are produced through oxidative phosphorylation. In oxidative phosphorylation, ATP is produced when electrons flow from chemicals known as NADH or FADH (nicotinamide adenine dinucleotide and flavin adenine dinucleotide respectively) to oxygen.

Beta Oxidation

Beta oxidation is a process that converts lipids into energy. Part of this process produces ATP, which is then used to produce acetyl CoA. Furthermore, beta oxidation takes place in the mitochondria and is closely related to the conversion of ATP to AMP. Beta oxidation also involves the fatty acid cycle, which resembles the citric acid cycle.

Aerobic Respiration

Aerobic respiration is the final way that ATP is formed. Aerobic respiration also uses glucose to produce ATP and as the name indicates, oxygen must be present for the process to occur. Without oxygen, aerobic respiration converts to anaerobic respiration, which only produces 2 ATP compared to aerobic respirations 34.

Cellular Respiration...

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Is the Krebs Cycle Aerobic or Anaerobic?

Updated December 05, 2018 *By Janice Davis*

The major difference between anaerobic and aerobic conditions is the requirement of oxygen. Anaerobic processes do not require oxygen while aerobic processes do require oxygen. The Krebs cycle, however, is not that simple. It is a part of a complex

complex process consists of several interdependent components such as glycolysis, the Krebs cycle, and the electron transport chain. Overall, the process requires 6 molecules of oxygen for every molecule of glucose. The chemical formula is $6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + ATP$ energy.

The Krebs Cycle Predecessor: Glycolysis

Glycolysis occurs in the cytoplasm of the cell, and it must precede the Krebs Cycle. The process requires the use of two ATP molecules, but as glucose is broken down from a six-carbon sugar molecule into two three-carbon sugar molecules, four ATP and two NADH molecules are created. The three-carbon sugar, known as pyruvate, and NADH are shuttled to the Krebs Cycle to create more ATP under aerobic conditions. If no oxygen is present, pyruvate is not allowed to enter the Krebs cycle and it is further oxidized to produce lactic acid.

Krebs Cycle

The Krebs Cycle occurs in the mitochondria, which is also known as the power house of the cell. After pyruvate arrives from the cytoplasm, each molecule is completely broken down from a three-carbon sugar into a two-carbon fragment. The resulting molecule is attached to a co-enzyme, which starts the Krebs Cycle. As the two-carbon fragment travels through the cycle, it has net production of four molecules of carbon dioxide, six molecules of NADH, and two molecules of ATP and $FADH_2$.

The Importance of the Electron Transport

is heavily dependent on oxygen, deeming it an aerobic process.

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Updated March 13, 2019 *By David Chandler*

Aerobic respiration, anaerobic respiration and fermentation are methods for living cells to produce energy from food sources. While all living organisms conduct one or more of these processes, only a select group of organisms are capable of *photosynthesis* which allows them to produce food from sunlight. However, even in these organisms, the food produced by photosynthesis is converted into cellular energy through cellular respiration.

A distinguishing feature of aerobic respiration as compared to fermentation pathways is the prerequisite for oxygen and the much higher yield of energy per molecule of glucose.

Glycolysis

Glycolysis is a universal beginning pathway conducted in the cytoplasm of cells for breaking down glucose into chemical energy. The energy released from each molecule of glucose is used to attach a phosphate to each of four molecules of adenosine diphosphate (ADP) to produce two molecules of adenosine triphosphate (ATP) and an additional molecule of NADH.

The energy stored in the phosphate bond is used in other cellular reactions and is

mitochondria and converted to acetyl CoA, which is then combined with oxaloacetate to produce citric acid in the first stage of the citric acid cycle.

The subsequent series converts the citric acid back into oxaloacetate and produces energy-carrying molecules along with way called NADH and $FADH_2$.

Each turn of the Krebs cycle is capable of producing one molecule of ATP, and an additional 17 molecules of ATP through the electron transport chain. Since glycolysis yields two molecules of pyruvate for use in the Krebs cycle, the total yield for aerobic respiration is 36 ATP per molecule of glucose in addition to the two ATP produced during glycolysis.

The terminal acceptor for the electrons during the electron transport chain is oxygen.

Fermentation

Not to be confused with anaerobic respiration, fermentation occurs in the absence of oxygen within the cytoplasm of cells and converts pyruvate into a waste product to produce the energy carrying molecules needed to continue glycolysis. Since the only energy produced during fermentation is through glycolysis, the total yield per molecule of glucose is two ATP.

While the energy production is substantially less than aerobic respiration, fermentation allows the conversion of fuel to energy to continue in the absence of oxygen. Examples of fermentation include lactic acid fermentation in humans and other animals and ethanol fermentation by yeast. The waste products are either

These processes are important contributors to the cycling of nutrients within soils as well as allowing these organisms to colonize areas uninhabitable by other organisms.

Photosynthesis

Unlike the various cellular respiration pathways, photosynthesis is used by plants, algae and some bacteria to produce the food needed for metabolism. In plants, photosynthesis occurs in specialized structures called chloroplasts while photosynthetic bacteria typically carry out photosynthesis along membranous extensions of the plasma membrane.

Photosynthesis can be divided into two stages: the light-dependent reactions and the light-independent reactions.

During the light-dependent reactions, light energy is used to energize electrons removed from water and produce a proton gradient that in turn produces high energy molecules that fuel the light-independent reactions. As the electrons are stripped from water molecules, the water molecules are broken down into oxygen and protons.

The protons contribute to the proton gradient but the oxygen is released. During the light-independent reactions, the energy produced during the light reactions is used to produce sugar molecules from carbon dioxide through a process called the Calvin Cycle.

The Calvin Cycle produces one molecule of sugar for every six molecules of carbon

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Respiration in Plants & Animals

oxygen. This balancing process of complementary systems is known as respiration and photosynthesis.

Photosynthesis

the conversion of sunlight into a molecule of adenosine triphosphate (ATP). This ATP is a storage container of energy which can be accessed by life forms other than plants. According to Estrella Mountain Community College, this is the process activated in plants when converting energy from the sun into oxygen.

Plants take in sunlight, water and carbon dioxide molecules and release oxygen molecules.

Respiration

As stated on TutorVista.com, "respiration can be broadly defined as the breakdown of organic compounds into simpler compounds accompanied by the release of energy in the form of ATP." This is the process we call, at the most basic level, "breathing." Plants and animals breathe, but animals, including humans, require plants to convert the energy of the sun into oxygen.

Animal life receives oxygen molecules, and—after a process called internal respiration and cellular respiration takes place inside the animal or human body—exudes carbon dioxide molecules.

External Respiration

External respiration is the process wherein animal life receives air from the environment and in a gaseous exchange returns the air to the environment in another form. This gaseous exchange takes place in all life forms, from insects to fish to human beings to plants, including algae and fungus.

Internal Respiration

Internal respiration is the distribution process in the body of an animal wherein oxygen is carried via the lungs and bloodstream throughout the body and broken down and converted into cellular energy.

Cellular Respiration

Cellular respiration is the conversion process that is initiated in the cytoplasm and finishes in the mitochondria, with the end product being carbon dioxide molecules. The cellular system is like a furnace burning energy, and the byproduct of that combustion is carbon dioxide. After being exuded into the atmosphere, that carbon dioxide becomes an element in the continuing process of photosynthesis.

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