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# Word equation for aerobic cellular respiration

Respiration is the process of releasing energy from the breakdown of glucose. Respiration takes place in every living cell, all of the time and all cells need to respire in order to produce the energy that they require. What is the energy used for? The energy produced during respiration is used in many different ways, some examples of what it is used for are: Working your muscles Growth and repair of cells Building larger molecules from smaller ones i.e. proteins from amino acids Allowing chemical reactions to take place Absorbing molecules in active transport Keeping your body temperature constant Sending messages along nerves Types of Respiration There are two main types of respiration, aerobic and anaerobic we will look at each one of these in detail now. 1. Aerobic Respiration Aerobic means "with air". This type of respiration needs oxygen for it to occur so it is called aerobic respiration. The word equation for aerobic respiration is: Glucose + Oxygen Carbon dioxide + Water + Energy The chemical equation is: C6H12O6 + 6O2 6CO2 + 6H2O + 2900 kJ/mol It is important that you learn both the word and chemical equation. In the above equations we see that glucose is broken down by oxygen to release energy with carbon dioxide and water being produced as by-products of the reaction. Approximately 2900 kJ of energy is released when one mole of glucose is broken down. The released energy is used to make a special energy molecule called Adenosine triphosphate (ATP). ATP is where the energy is stored for use later on by the body. Aerobic respiration occurs in plants as well as animals. Oxygen enters plant cells through the stomata. Plants produce their food via photosynthesis and release energy from it through the process of respiration. Below is a reminder of what the equation for photosynthesis is: (Energy via sunlight) Carbon dioxide + Water Glucose + Oxygen Comparing the two equations we can see that aerobic respiration works in the opposite way to photosynthesis. During the day both photosynthesis and respiration are taking place at the same time, though photosynthesis is occurring at a faster rate. At night when there is no light only respiration takes place. 2. Anaerobic Respiration Anaerobic means without air ("an" means without). Sometimes there is not enough oxygen around for animals and plants to respire, but they still need energy to survive. Instead they carry out respiration in the absence of oxygen to produce the energy they require this is called anaerobic respiration. Our muscles need oxygen and glucose to respire aerobically and produce the energy they require, these are carried to the muscle via the blood. However if we were to carry out vigorous exercise our heart and lungs would not be able to get sufficient oxygen to our muscles in order for them to respire. In this case muscles carry out anaerobic respiration. The word and chemical equation for anaerobic respiration in is: Glucose Lactic acid + Energy C6H12O6 2C3H6O3 + 120 kJ/mol As you can see anaerobic respiration is not as efficient as aerobic and only a small amount of energy is released. This is because glucose can only be partially broken down. As well as this inefficiency a poisonous chemical, lactic acid is also produced, if this builds up in the body it stops the muscles from working and causes a cramp. To rid the body of lactic acid oxygen is needed, the amount of oxygen required to break down the lactic acid is referred to as the oxygen debt. b) In Plants The oxygen supply to plants can also run out, this happens for example if the soil gets waterlogged. In this case they have to obtain their energy via anaerobic respiration. Below is the word and chemical equation for anaerobic respiration in plants: Glucose Ethanol + Carbon dioxide + Energy C6H12O6 2C2H5OH + 2CO2 + Energy When the above reaction occurs in yeast cells it is referred to as fermentation. Fermentation is the process used for baking bread and brewing alcohol. Cellular respiration is the process through which cells convert sugars into energy. To create ATP and other forms of energy to power cellular reactions, cells require fuel and an electron acceptor which drives the chemical process of turning energy into a useable form. Eukaryotes, including all multicellular organisms and some single-celled organisms, use aerobic respiration to produce energy. Aerobic respiration uses oxygen – the most powerful electron acceptor available in nature. Aerobic respiration is an extremely efficient process allows eukaryotes to have complicated life functions and active lifestyles. However, it also means that they require a constant supply of oxygen, or they will be unable to obtain energy to stay alive. Prokaryotic organisms such as bacteria and archaebacteria can use other forms of respiration, which are somewhat less efficient. This allows them to live in environments where eukaryotic organisms could not, because they do not require oxygen. Examples of different pathways for how sugars are broken down by organisms are illustrated below: More detailed articles on aerobic respiration and anaerobic respiration can be found on this site. Here we will give an overview of the different types of cellular respiration. The equation for aerobic respiration shows glucose being combined with oxygen and ADP to produce carbon dioxide, water, and ATP: C6H12O6 (glucose)+ 6O2 + 36 ADP (depleted ATP) + 36 Pi (phosphate groups)→ 6CO2 + 6H2O + 36 ATP You can see that once it is completely broken down, the carbon molecules of glucose are exhaled as six molecules of carbon dioxide. In lactic acid fermentation, one molecule of glucose is broken down into two molecules of lactic acid. The chemical energy that was stored in the broken glucose bonds is moved into bonds between ADP and a phosphate group. C6H12O6 (glucose) + 2 ADP (depleted ATP) + 2 Pi (phosphate groups) → 2 CH3CHOHCOOH (lactic acid) + 2 ATP Alcohol fermentation is similar to lactic acid fermentation in that oxygen is not the final electron acceptor. Here, instead of oxygen, the cell uses a converted form of pyruvate to accept the final electrons. This creates ethyl alcohol, which is what is found in alcoholic beverages. Brewers and distillers use yeast cells to create this alcohol, which are very good at this form of fermentation. C6H12O6 (glucose) + 2 ADP (depleted ATP) + 2 Pi (phosphate groups)→ 2 C2H5OH (ethyl alcohol) + 2 CO2 + 2 ATP Glycolysis is the only step which is shared by all types of respiration. In glycolysis, a sugar molecule such as glucose is split in half, generating two molecules of ATP. The equation for glycolysis is: C6H12O6 (glucose) + 2 NAD+ + 2 ADP + 2 Pi → 2 CH3COCOO− + 2 NADH + 2 ATP + 2 H2O + 2H+ The name "glycolysis" comes from the Greek "glyco," for "sugar" and "lysis" for "to split." This may help you to remember that glycolysis it the process of splitting a sugar. In most pathways, glycolysis starts with glucose, which is then split into two molecules of pyruvic acid. These two molecules of pyruvic acid are then processed further to form different end products, such as ethyl alcohol or lactic acid. Reduction is the next part of the process. In chemical terms, to "reduce" a molecule means to add electrons to it. In the case of lactic acid fermentation, NADH donates an electron to pyruvic acid, resulting in the end products of lactic acid and NAD+. This is helpful to the cell because NAD+ is necessary for glycolysis. In the case of alcoholic fermentation, pyruvic acid undergoes an additional step in which it loses an atom of carbon in the form of CO2. The resulting intermediate molecule, called acetaldehyde, is then reduced to produce NAD+ plus ethyl alcohol. Aerobic respiration takes these processes to another level. Instead of directly reducing intermediates of the Krebs cycle, aerobic respiration uses oxygen as the final electron receptor. But first, the electrons and protons bound to electron carriers (such as NADH), are processed through the electron transport chain. This chain of proteins within the mitochondrial membrane uses the energy from these electrons to pump protons to one side of the membrane. This creates an electromotive force, which is utilized by the protein complex ATP synthase phosphorylate a large number of ATD molecules, creating ATP. The main product of any cellular respiration is the molecule adenosine triphosphate (ATP). This molecule stores the energy released during respiration and allows the cell to transfer this energy to various parts of the cell. ATP is used by a number of cellular components as a source of energy. For example, an enzyme may need energy from ATP to combine two molecules. ATP is also commonly used on transporters, which are proteins that function to move molecules across the cell membrane. Carbon dioxide is a universal product created by cellular respiration. Typically, carbon dioxide is considered a waste product and must be removed. In an aqueous solution, carbon dioxide creates acidic ions. This can drastically lower the pH of the cell, and eventually will cause normal cellular functions to cease. To avoid this, cells must actively expel carbon dioxide. While ATP and carbon dioxide are regularly produced by all forms of cellular respiration, different types of respiration rely on different molecules to be the final acceptors of the electrons used in the process. All cells need to be able to obtain and transport energy to power their life functions. For cells to continue living, they must be able to operate essential machinery, such as pumps in their cell membranes which maintain the cell's internal environment in a way that's suitable for life. The most common "energy currency" of cells is ATP – a molecule which stores a lot of energy in its phosphate bonds. These bonds can be broken to release that energy and bring about changes to other molecules, such as those needed to power cell membrane pumps. Because ATP is not stable over long periods of time, it is not used for long-term energy storage. Instead, sugars and fats are used as a long-term form of storage, and cells must constantly process those molecules to produce new ATP. This is the process of respiration. The process of aerobic respiration produces a huge amount of ATP from each molecule of sugar. In fact, each molecule of sugar digested by a plant or animal cell yields 36 molecules of ATP! By comparison, fermentation usually only produces 2-4 molecules of ATP. Anaerobic respiration processes used by bacteria and archaebacteria yield smaller amounts of ATP, but they can take place without oxygen. Below, we'll discuss how different types of cellular respiration produce ATP. Eukaryotic organisms perform cellular respiration in their mitochondria – organelles that are designed to break down sugars and produce ATP very efficiently. Mitochondria are often called "the powerhouse of the cell" because they are able to produce so much ATP! Aerobic respiration is so efficient because oxygen is the most powerful electron acceptor found in nature. Oxygen "loves" electrons – and its love of electrons "pulls" them through the electron transport chain of the mitochondria. The specialized anatomy of the mitochondria – which bring together all the necessary reactants for cellular respiration in a small, membrane-bound space within the cell – also contributes to the high efficiency of aerobic respiration. In the absence of oxygen, most eukaryotic cells can also perform different types of anaerobic respiration, such as lactic acid fermentation. However, these processes do not produce enough ATP to maintain the cell's life functions, and without oxygen, cells will eventually die or cease to function. Fermentation is the name given to many different types of anaerobic respiration, which are performed by different species of bacteria and archaebacteria, and by some eukaryotic cells in the absence of oxygen. These processes can use a variety of electron acceptors and produce a variety of byproducts. A few types of fermentation are: Alcoholic fermentation – This type of fermentation, performed by yeast cells and some other cells, metabolizes sugar and produces alcohol and carbon dioxide as byproducts. This is why beers are fizzy: during fermentation, their yeasts release both carbon dioxide gas, which forms bubbles and ethyl alcohol. Lactic acid fermentation – This type of fermentation is performed by human muscle cells in the absence of oxygen, and by some bacteria. Lactic acid fermentation is actually used by humans to make yogurt. To make yogurt, harmless bacteria are grown in milk. The lactic acid produced by these bacteria gives yogurt its distinctive sharp-sour taste and also reacts with milk proteins to create a thick, creamy texture. Proprionic acid fermentation – This type of fermentation is performed by some bacteria, and is used to make swiss cheese. Proprionic acid is responsible for the distinctive sharp, nutty flavor of Swiss cheese. The gas bubbles created by these bacteria are responsible for the holes found in the cheese. Acetogenesis – Acetogenesis is a type of fermentation performed by bacteria, which produces acetic acid as its byproduct. Acetic acid is the distinctive ingredient in vinegar which gives it its sharp, sour taste and smell. Interestingly, the bacteria that produce acetic acid use ethyl alcohol as their fuel. This means that to produce vinegar, a sugar-containing solution must be first fermented with yeast to produce alcohol, then fermented again with bacteria that turn the alcohol into acetic acid! Methanogenesis is a unique type of anaerobic respiration that can only be performed by archaebacteria. In methanogenesis, a fuel source carbohydrate is broken down to produce carbon dioxide and methane. Methanogenesis is performed by some symbiotic bacteria in the digestive tracts of humans, cows, and some other animals. Some of these bacteria are able to digest cellulose, a sugar found in plants that cannot be broken down through cellular respiration. Symbiotic bacteria allow cows and other animals to obtain some energy from these otherwise undigestible sugars! Respiration releases energy from glucose in the form of ATP. This occurs in all living cells. Aerobic respiration (with oxygen) releases more energy than anaerobic respiration (without oxygen). If you're seeing this message, it means we're having trouble loading external resources on our website. If you're behind a web filter, please make sure that the domains *.kastatic.org and *.kasandbox.org are unblocked.