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Have…Read more Cellular respiration is the process responsible for converting chemical energy, and the reactants/products involved in cellular respiration are oxygen, glucose (sugar), carbon dioxide, and water. While the exact steps involved in cellular respiration may vary from species to species, all living organisms perform some type of cellular respiration. Without cellular respiration, living organisms wouldn’t be able to produce the chemical energy they need, and their cells would not be able to carry out the tasks needed to sustain themselves. The Reactants Involved In Cellular Respiration Let’s take a closer look at the reactants of cellular respiration. “Laughter is a form of internal jogging. It moves your internal organs around. It enhances respiration. It is an igniter of great expectations.” — Norman Cousins Glucose, or sugar, has the chemical formula $C_6H_{12}O_6$. While this formula can potentially be applied to a variety of different molecules, depending on how the atoms within the molecule are arranged, most molecules with this chemical formula are sugars of one form or another. The most notable formation of $C_6H_{12}O_6$ is glucose, which is sometimes referred to as blood sugar or dextrose. The cells of animals convert glucose into a substance known as pyruvate through a process called glycolysis. The glycolysis process takes glucose and generates two molecules of ATP, or energy, with it. Dioxygen, frequently just called oxygen, it made up of two oxygen atoms and it is what vertebrates used to breathe. Oxygen makes up about 21% of our atmosphere and vertebrates bring oxygen into their lungs where it is absorbed by red blood cells that transport the oxygen to other parts of the body. While ATP can be generated without the use of oxygen, the utilization of oxygen lets the cells of the body more efficiently convert glucose into ATP. Vertebrates release carbon dioxide and water as the byproducts of cellular respiration. Carbon dioxide is released by many different microorganisms during not only the process of cellular respiration but also the process of fermentation. Plants use carbon dioxide to create their own energy, much as heterotrophic organisms use glucose and oxygen to create energy. The carbon dioxide will enter the cells of the plant through small holes in the leaves referred to as stomata. After the carbon dioxide has entered the cells of the plant, the chloroplasts within the cell will begin the process of photosynthesis and create carbohydrates as a result. Water, also referred to as dihydrogen monoxide, has the chemical formula H_2O. This molecule can be found everywhere on earth, and also within the cells of most organisms. In addition to carbon dioxide and sunlight, plants also need water to produce energy through photosynthesis. Water is held within the cells of a plant in structures referred to as vacuoles. The Balanced Chemical Equation For Cellular Respiration Now that we know what the reactants of cellular respiration are, let’s take a look at how they interact with one another. What follows cellular respiration’s balanced equation/formula: $C_6H_{12}O_6 + 6O_2$ –> $6CO_2 + 6H_2O$ + 38 ATP In plain English, this can be read as: Glucose + oxygen –> carbon dioxide + water + energy This is the basic cellular respiration process, During the course of cellular respiration, oxygen and glucose are utilized to create carbon dioxide, water, and energy. The oxygen that an organism breathes in is used to break down the sugars found in food. This produces heat energy, similar to how burning a piece of wood releases heat. With cellular respiration, after oxygen breaks down the sugar and its energy is released, carbon dioxide is released as a byproduct. The energy released by the breakdown of the sugar molecules is stored within the cells of the organism for later use. Some of the ATP that the cells use originates as a result of the reactions that transform glucose. Yet much of the ATP is made as a result of a process called oxidative phosphorylation, a phase of cellular respiration. Cellular respiration, in this case, aerobic respiration (respiration that uses oxygen), can be divided into four different steps and oxidative phosphorylation is the final step in the cellular respiration process. The Stages of Cellular Respiration The four stages of cellular respiration are: Glycolysis Link Reaction (pyruvate oxidation) Krebs cycle (Citric acid cycle) Electron transport chain The first stage of cellular respiration is referred to as glycolysis, and during this phase, glucose is hit with a number of different chemical transformations and converted into different molecules. Glycolysis happens within the cytosol/cytoplasm of cells, and it doesn’t actually need oxygen to occur. Aerobic respiration involves the conversion of glucose into two pyruvate molecules. When the two molecules of pyruvate become oxidized, two NADH are produced as a result. These two NADH molecules assist in carrying electrons to the other reactions within the cell. Two molecules of ATP are also produced during this step. “By blending water and minerals from below with sunlight and CO_2 from above, green plants link the earth to the sky. We tend to believe that plants grow out of the soil, but in fact most of their substance comes from the air.” — Fritjof Capra Pyruvate oxidation is the next phase of cellular respiration and it occurs when the pyruvate made in glycolysis enters the innermost part of the mitochondria, the mitochondrial matrix. In this matrix the pyruvate will be linked together with a substance dubbed coenzyme A. This creates acetyl CoA, a new molecule with two carbons. More NADH is generated here, and carbon dioxide is released as a result. The Krebs cycle, sometimes referred to as the tricarboxylic acid cycle or just the citric acid cycle, is where oxaloacetic acid is combined with the acetyl CoA produced in the last step. This creates citric acid, which will then go through various reactions in a cycle. The final step of the citric acid cycle is to create more oxaloacetic acid, which sets up the cycle to begin again. Carbon dioxide is released during the citric acid cycle, and ATP, $FADH_2$, and NADH are produced here. The electrons within $FADH_2$ and NADH are then sent to the next portion of the cellular respiration process, the electron transport chain. The molecules of $FADH_2$ and NADH that were created during the previous cellular respiration steps will now transfer their electrons into the electron transport chain. This process of transferal is called oxidative phosphorylation. Since these molecules are now no longer weighted down with electrons, they become their simplest forms – FAD and NAD^+. The movement of the electrons across the electron transport chain releases energy. Protons are pushed out of the mitochondrial matrix by the process, creating a gradient. An enzyme called ATP synthase is used to create ATP, and it returns the protons to the matrix. The electron transport chain comes to an end when molecules of oxygen bond with protons and accept electrons, creating water. As for how much ATP is generated by this process, around 30 units of ATP are likely to be created. The process of oxidative phosphorylation will generate between 26 to 28 units of ATP, and substrate phosphorylation will typically generate between 4 to 6 more ATP units, for a total of between 30 to 34. However, setting up for glycolysis uses a bit of ATP so the actual yield is a few units lower. Anaerobic Respiration The previously mentioned processes occur when there is enough oxygen for aerobic respiration to take place. If there is not an adequate supply of oxygen, anaerobic respiration will take place instead. Anaerobic respiration can produce ATP without an oxygen supply, but it is much less efficient than aerobic respiration, producing around 1/18th the amount of energy that aerobic respiration does. Fermentation is one form of anaerobic respiration. Fermentation differs from other forms of energy production because in fermentation the glycolysis pathway is solely responsible for extracting ATP. Though glycolysis creates pyruvate, the pyruvate won’t proceed through the rest of the pathway. This means that the oxidization process, the Krebs/citric acid cycle, and the electron transport chain are all skipped. Because the electron transport chain isn’t operating during fermentation, NADH will not drop its electrons. “Fermentation is the exhalation of a substance through which the admixture of a ferment which, by virtue of its spirit, penetrates the mass and transforms it into its own nature.” — Andreas Libavius To compensate for the lack of oxidation, citric acid cycle, and electron transport chain, fermentation has a few extra reactions that will create NAD^+ from NADH. This is done by allowing NADH to take an organic molecule such as pyruvate and remove the electrons that it carries, ensuring that NAD^+ is created and that the glycolysis process can keep going. How Cellular Respiration Relates To Photosynthesis How is cellular respiration related to photosynthesis? To answer this let’s take a look at the chemical equation for photosynthesis. Here’s the equation for photosynthesis: $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ You may have noticed that this equation is basically the opposite of cellular respiration. The cells of animals combine hydrogen and oxygen to create water and carbon dioxide as a byproduct. Meanwhile, plants use carbon dioxide and water to power the photosynthetic process, releasing glucose and oxygen as the end products of this system. This intertwined and complex relationship is referred to as the carbon cycle. This is what allows molecules of carbon to be recycled and work their way through the whole biosphere, moving from plants to animals, to the atmosphere, and then back into plants. Photosynthesis is the process plants used to create the energy they need. Photosynthetic organisms have organelles within their cells called plastids, which have pigments in them capable of trapping certain wavelengths of light. The sunlight they trap is converted into carbohydrates by the plant cells. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Written By Y_C Last Modified 07-05-2024 In plants, respiration can be regarded as the reversal of the photosynthetic process. Like photosynthesis, respiration involves gas exchange with the environment. Unlike photosynthesis, respiration can occur at any time of day or night, and it occurs not just in the leaves, but also in the stem and roots. Plants breathe throughout their lives because the plant cell requires energy to exist; yet, plants breathe in a unique way known as cellular respiration. Photosynthesis is a cellular respiration process in which plants create glucose molecules by collecting energy from sunlight and converting it to glucose. Plant breathing is demonstrated in a number of live studies. All plants respire in order to keep their cells active and alive. The method by which cells get chemical energy by the consumption of oxygen and the release 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. There are two main types of respiration. Aerobic RespirationThis type of respiration takes place in the mitochondria of all eukaryotic entities. Food molecules are completely oxidised into carbon dioxide, water, and energy is released in the presence of oxygen. This type of respiration is observed in all the higher organisms and necessitates atmospheric oxygen. Anaerobic RespirationThis type of respiration occurs within the cytoplasm of prokaryotic entities such as yeast and bacteria. Here, lesser energy is liberated as a result of incomplete oxidation of food in the absence of oxygen. Ethyl alcohol and carbon dioxide are produced during anaerobic respiration. The volume of inspiration (inhale) and expiration (exhale) determines the normal rate of respiration. Respiratory rate is another name for breathing rate. The rate of respiration has a considerable impact on the health and growth of plants. Plant physiology is a primary determinant of respiration rate, with each species respiring differently depending on its adaptations to the local environment. Plant respiration rates are influenced by a variety of external conditions, in addition to intrinsic variances across plant kinds. Agriculture and horticulture, as well as the ecology of natural regions and food preservation, could all be affected significantly. One of the most critical elements regulating plant respiration is the life stage. A seed emits a burst of respiration after it has absorbed enough water to germinate and power its emergence from the seed casing. Branches expand and root tips burrow into the dirt as leaves emerge. As they utilise energy to grow, these sections begin to breathe rapidly. The rate of respiration decreases as the roots, branches, and leaves mature. When fruits and seeds are maturing, respiration increases, and energy use peaks when the fruit is fully ripe. After this time, respiration decreases considerably, with many annual plants dying completely after fruiting, while perennials may lose older and damaged leaves. Oxygen Content of the Atmosphere: The percentage of oxygen in the surrounding atmosphere greatly influence the rate of respiration. But the reduction of the oxygen content of the air, however, causes no significant lowering in the respiratory rate until the percentage drops to about 10%. At 5% oxygen definite retardation of respiration occurs. As shown in the graph, with the increase of oxygen concentration in the atmosphere, the rate of respiration also increases, but this effect is not as accelerating as might be expected. This response of plants and their parts depends upon several factors. The plant tissues which ordinarily have a low rate of respiration are not as seriously affected by low concentration of oxygen as those which have a higher rate of respiration. In certain plants, like rice, on removal of oxygen the rate of respiration in terms of total carbon dioxide produced actually increases. This indicates that anaerobic respiration comes into action when oxygen is no longer available and that the plant, if it has to make up for the relative inefficiency of this system, has to respire faster. Graph: Effect of different percentage of oxygen supply on the rate of respiration of isolated plant tissues. Like most chemical reactions, the rate of respiration is greatly influenced by temperature. Estimation of Q 10 of the process for a rise in temperature from 8° to 18 °C gives a Q 10 of 2, indicating a chemical reaction. If the rise is at a much higher starting temperature, say between 20° and 30°C, then the Q 10 may fall below 2. It should be borne in mind that different plants or plant parts may show considerable variation in regard to optimum temperature for respiration. In certain cases the rate of respiration increases at lower temperature. E. F. Hopkins (1925) reported that the rate of respiration in white potatoes increases if the temperature in lowered to just abovezing point. This increase in the rate of respiration is primarily due to increase in the quantity of respirable materials (such as soluble carbohydrates) which tend to accumulate in Irish potato at temperature slightly above 0°C. At temperatures higher than the optimum for respiration, the rate of respiration (in terms of oxygen utilized and CO_2 produced) falls due to inter-conversions of respirable materials. For instance, fats may be formed from carbohydrates by a reaction in which carbon dioxide is utilized and oxygen produced. At very high temperatures, the rate of respiration falls significantly and may even come to standstill because of protoplasmic injuries. Graph: Showing the effect of temperature on the rate of respiration Light has indirect effects on the rate of respiration. With the increase in light intensity, the temperature of the surrounding atmosphere also increases thus affecting the rate of respiration. Secondly, the quantity of respirable material in the plant largely depends upon the rate of photosynthesis which is directly influenced by light and thirdly, stomata remain open during daylight and hence rapid exchange of gases takes place through them. Effect of Water Content: Over a certain range, water content of the plant tissue greatly influence its rate of respiration. In most of the storage able seeds the moisture content is kept below the point which allows a rapid respiration. With the increase in moisture content, the rate of respiration is likely to go up with the result a rapid loss of viability will occur and at the same time the temperature will also rise and the grain may be spoiled. Graph: The effect of Various moisture contents on the rate of Respiration Unlike most green tissues, xerophytes, lichens and leafy mosses (Sphagnum species) can be brought to an air-dry condition at low humidity without any apparent loss in their viability. The rate of respiration is normally not affected by an increase of carbon dioxide concentration in the surrounding atmosphere up to 19%, but as the concentration increases from 10% to 80%, a progressive decrease in respiration occurs.Specific response to higher CO_2 concentration varies with the particular kind of tissue and plant. The effect of CO_2 concentration is more significant when the temperature and oxygen supply are low. At a very high concentration of CO_2 the plant tissues are injured or even killed. The rate of respiration is higher in young growing tissues because they have more protoplasm than older tissues. Their faster rate of respiration helps the cells’ meristematic activities by supplying a lot of energy. The rate is affected by the degree of hydration of the protoplasm in the cells, and mechanical injury to plant tissues accelerates respiration. In plants, respiration can be regarded as the reversal of the photosynthetic process. All plants respire in order to keep their cells active and alive. There are two main types of respiration – anaerobic and prokaryotic – both involve the exchange of gases with the environment. Respiratory rate is another name for breathing rate. Plant respiration rates are influenced by a variety of external conditions, in addition to intrinsic variances across plant kinds. Some of these factors are light intensity, carbon di oxide concentration, and water content. Agriculture and horticulture could all be affected significantly by the rate of respiration of plants. Q1. What is the effect of carbon dioxide on the rate of respiration in plants?Ans: As the carbon dioxide concentration increases, the rate of respiration in plants decreases. This is because high CO_2 concentration would result in the closing of the stomata. Thus the rate of respiration is inversely proportional to the concentration of carbon dioxide. Q2. How does temperature affect the respiration rate of plants?Ans: The increase in temperature enhances the rate of cellular respiration. It is due to the heat speeds up the reactions, which means the kinetic energy is higher. It means reactions speed up and the rate of cellular respiration increases. Q3. What happens to a plant if the temperature is too high?Ans: When soil temperature rises above an optimum threshold, plant water and nutrient uptake can be impeded, causing damage to plant components. Q4. Does the rate of respiration change during day and night?Ans: No. however, since plants only photosynthesise during the day, the relative release of CO_2 might be different. Q5. Does CO_2 concentration affect respiration?Ans: The rate of respiration is normally not affected by an increase of carbon dioxide concentration in the surrounding atmosphere up to 19%, but as the concentration increases from 10% to 80%, a progressive decrease in respiration occurs.Specific response to higher CO_2 concentration varies with the particular kind of tissue and plant. Learn the Mechanism of Respiration We hope this detailed article on Factors Affecting Respiration was helpful. If you have any doubts, let us know in the comment section below. Our team will get try to solve your queries at the earliest. We're fetching your file...Please wait a moment while we retrieve your file from its home on the internet