Click to prove you're human

Photosynthesis is the process by which most plants make their own food. You might already be familiar with the basics of photosynthesis from watching houseplants grow. They at least need light and water, or else they will begin to wilt. But that's not all a plant needs for photosynthesis. In addition to the basic ingredients, the plant requires certain structures to make use of those ingredients, all so photosynthesis can happen. Photosynthesis requires multiple ingredients and structures. Focusing on the big things first, a plant needs leaves and roots, and, crucially, they also need sunlight and water. The leaves are where photosynthesis actually happens, but the first ingredient in photosynthesis is water, and most plants wouldn't be able to get water without roots. Primitive plants, like mosses, get away without having extensive roots because they tend to live in wet places. However, a tree is going to need those larger root systems.Once that water makes its way up to the leaf through the stem, it can be used for photosynthesis. The leaf, like the rest of the plant, is made of cells. To oversimplify a little bit, a leaf is a bunch of cells wrapped in a waxy cuticle that protects them. It's sort of like the leaf is laminated. That cuticle has holes called stomata, which can open to let the next ingredient in. That next ingredient is a gas called carbon dioxide, or CO2.The cuticle also helps gather the third and final ingredient, sunlight. Because the cuticle is transparent, it passively allows sunlight through the same way a glass window allows light into a room.Because of the cuticle and roots, the leaf cells have access to all the ingredients they need to carry out photosynthesis. Inside the cells that make up the bulk of the leaf are little structures called chloroplasts. The chloroplasts do most of the heavy lifting when it comes to photosynthesis, as they use the water that the roots drew up, along with the carbon dioxide and light that the cuticle and stomata let in.The chloroplasts are like little membrane sacs filled with a watery liquid called stroma. Within the stroma, you can find structures called thylakoids. If you could look into a chloroplast, you would see that the thylakoids look like little green discs stacked one on top of the other, much like how coins from the bank are stacked in paper rolls. The thylakoids are green because they are chock full of chlorophyll, the pigment that sets off the process of photosynthesis. Chlorophyll absorbs light. Specifically, when it is hit by a particle of light, called a photon, it transfers the energy from that photon to another particle called an electron. Because that excited electron goes away to continue photosynthesis outside of the chlorophyll, the chlorophyll molecule will need a new electron.Here's where water comes in. When chlorophyll is down an electron, it becomes incredibly electronegative. In this context, all that means is that it becomes strong enough to rip apart a water molecule so it can steal an electron to replace the one it lost. This also pumps free hydrogen into the stroma and oxygen molecules out into the air around the leaf.Those electrons and hydrogens all supply energy for the second part of photosynthesis, which happens in the stroma. In the watery stroma are a bunch of proteins called enzymes. Their job is to grab molecules of carbon dioxide and use the energy harvested by the chloroplasts to build that carbon dioxide into sugars called glucose. Glucose is the end result of photosynthesis, and while it has a lot of uses, it is primarily food for the plant. Glucose is why plants need photosynthesis.To review, the ingredients for photosynthesis are water, carbon dioxide **and light energy. These things are converted by photosynthesis into oxygen and glucose.** The plant gathers these ingredients using vital structures that help it transport those ingredients to other structures in the plant, where the photosynthesis takes place. Brennan, John. "What Do Plants Need To Carry Out Photosynthesis?" sciencing.com, . 30 September 2021. APA Brennan, John. (2021, September 30). What Do Plants Need To Carry Out Photosynthesis?. sciencing.com. Retrieved from Chicago Brennan, John. What Do Plants Need To Carry Out Photosynthesis? last modified March 24, 2022. Plant photosynthesis is the process of how sunlight, water, and carbon dioxide converge to create the energy that plants need. From food production to energy transfer. Plants are the primary carriers of photosynthesis. Still, other autotrophs can perform this process. All life on Earth depends on photosynthesis, and organisms can be grouped based on their direct or indirect requirements for this process. Among these, plants, algae, phytoplankton, and other autotrophic organisms directly engage in photosynthesis to generate their nourishment and support various biological activities. Photosynthesis is the process of converting light energy into chemical energy (food). The term is of Greek origin, derived from the words phos, which means light, and synthesis, which means combining. Plants are the primary carriers of photosynthesis. Still, other autotrophs can perform this process. For those wondering, autotrophic organisms are creatures that can make their food using sunlight and inorganic nutrients according to the science textbook Stream Ecology by professor J. David Allan. Aside from green plants, algae, and some microorganisms, like cyanobacteria and phytoplankton, can perform this biological process. As you might have guessed, photosynthesis isnt a one-step procedure. Its a cycle consisting of four primary steps. These are light absorption, electron transfer, ATP production, and carbon fixation. The first three reactions are light-dependent. The goal is to produce enough energy to synthesize the carbohydrates. Once that happens, the plant starts fixing carbon to make the food. Unlike the former reactions, this step is light-independent. All these chemical processes occur in the chloroplast, an organelle found in the leaves. It contains pigments that help absorb light to kick-start these reactions. As you know, plants use sunlight to make food. Still, this isnt the only ingredient necessary for photosynthesis. Water and carbon dioxide go into the mix to create carbohydrates (food). Not only that, but oxygen is also released as a by-product. To sum up all these steps, scientists represent photosynthesis with the following equation: 6CO2 + 6H2O + light energy C6H12O6 + 6O2 In some cases, light energy is represented by the arrow without writing it. Regardless, youll always find six carbon dioxide molecules as well as water in the reactants. Once the chlorophyll pigment in the chloroplasts absorbs enough sunlight, photosynthesis begins. As a result, the reactants undergo a series of steps to produce one sugar molecule and six oxygen molecules. Besides chlorophyll, three other things are needed for photosynthesis. These are light to fuel the reactions, water to provide electrons, and carbon dioxide to make sugars. Lets discuss photosynthesis ingredients in further detail! Before we jump into the role of light, lets discuss its characteristics. As you might know, light is electromagnetic radiation. This process happens when atoms absorb energy and heat up. As a result, electrons jump from their normal energy level to a higher one. The problem is that this excess energy makes the molecule unstable. To return to their original state, electrons lose this energy in the form of photons (light). Why is this important? Well, thats because the emitted light produced from this process has a dual nature a wave-like and a particle-like character. The former helps radiation travel through space, while the latter is responsible for exciting electrons. The question is this: what does sunlight do in photosynthesis? As you know, chloroplasts contain chlorophyll. This green pigment is responsible for absorbing sunlight. Still, other pigments contribute to this process. Once absorption takes place, electrons start jumping to a higher energy level and bounce back to their original state, releasing energy. Now, this process can happen in several ways: Electrons can lose the energy as heat or re-emit it as light. These pathways are a form of wasted energythe plant doesnt make use of them. Both the energy and the excited electrons transfer from the pigment to a neighboring molecule. And that brings us to the next essential ingredientwater. Water Following light absorption, pigments become excited, releasing photons (energy). The question is this: how do plants make use of the photons? Thats when water comes to the rescue. It helps solve two problems. For one, it replaces the electrons lost by plant pigments. Additionally, it supplies the plant with hydrogen ions. These ions, alongside the excited electrons, enter an energy transfer chain, producing ATP and NADPH molecules (chemical energy). As you might have guessed, these molecules further react to produce sugars. This process takes place in two reaction centers in plant pigments. These are known as photosystem I and photosystem II. Scientists Govindjee and Rajni Govindjee from University of Illinois describe this flow of energy using the Z-scheme. Heres a brief explanation of its steps: P680, a special chlorophyll in photosystem II (PSII), absorbs light and becomes excited. To become stable, P680 loses an electron (negative charge) and becomes P680+. Water gets split through photolysis, providing electrons to P680+. The energized electron released from PSII is passed along a series of protein carriers like a relay race. During this trip, positive hydrogen molecules (H+) are pumped across a membrane, creating a proton gradient. PSI joins the party by grabbing the electron from the relay race, activating another special chlorophyll pigment, P700. Combined with the proton released from PSII, NADP becomes NADPH, the molecule that fuels the reactions of building sugars. The released proton also powers ATP molecule production, providing more energy to the plant. Carbon Dioxide Now, you might wonder: why do plants perform all this hassle to make ATP and NADPH molecules? Thats where carbon dioxide gas steps in. You see, inside the chloroplasts, a mini-factory called the stroma is buzzing with activity. ATP, NADPH, and CO2 enter a cycle to form glucose as the final product. Unlike light and water reactions, this stage of photosynthesis isnt light-dependent. For the dark reaction, plant cells require different components. These include: Energy: ATP, a product of the light-dependent reaction, powers certain molecules in the cycle by losing a phosphate group. Reducing agent: NADPH donates electrons and hydrogen to bind with CO2. Enzymes: Ribulose-1,5-bisphosphate carboxylase/oxygenase (RuBisCO) is the primary enzyme in the dark reaction cycle. It facilitates the production of glyceraldehyde 3-phosphate (G3P), a three-carbon sugar used to make glucose. Oxygen is the primary by-product of photosynthesis. Based on the science journal Plant Physiology authors Karl-Josef Dietz, Ismail Turkan and Anja Krieger-Liszkay mention during water splitting (photolysis), oxygen molecules are released. The problem is that these species are highly reactive. To become stable, they react with cell proteins, lipids, and more, damaging them. For that reason, plants get rid of this by-product through two mechanisms: diffusion or respiration. During electron-transfer reactions, carrier proteins within the chloroplast membrane snag the oxygen. They then escort these molecules toward the cell wall. Through simple diffusion, this gas leaves the plant and exits through the stomata. Still, not all oxygen is kicked outside the cells. Plants make use of this gas during the respiration process. Several reasons make photosynthesis an essential process for plants. For one, this magical process produces carbohydrates, an energy source for plants. Not only that, but many biological products are synthesized during photosynthesis. And if that wasnt enough, this process helps fight climate change. This directly benefits green life, as it ensures their growing conditions remain unchanged. Aside from the three essential ingredientslight, water, and carbon dioxideplants require other components to perform photosynthesis. These include chloroplast and pigments. Lets discuss them in further detail! Sure, chloroplasts contain pigments, which are essential for light absorption and photosynthesis. Still, theres more to these organelles than just the pigments. Heres a brief explanation of chloroplast components and their role in this biological process: Envelop: It consists of an inner and outer lipid bilayer. Its semi-permeable, regulating the transportation of several molecules, including glucose, oxygen, and carbon dioxide. Stroma: Its a protein-rich fluid that surrounds all the internal components of the chloroplast. Contains enzymes that carry out the dark reactions of photosynthesis. Thylakoids: These are chlorophyll-carrying membranous sacs. It carries out the light-dependent reactions. Grana: Its a stack of 10-20 thylakoids and makes the site where light energy is converted to chemical energy. While plant pigments can absorb sunlight, theyre not equal. Each color can absorb a particular wavelength. As you know, visible light is a spectrum that consists of seven colorsremember that glass prism experiment in high school? Each color has a particular wavelength. Sure, visible light ranges from 400 nm to 700 nm. Still, no pigment can cover the entire spectrumit only absorbs a specific range. The question is this: what pigments are involved in photosynthesis? Generally, three primary pigments take part in this process. These include: Carotenoids: These are red, orange, and yellow pigments. They exist at the lipid membrane and absorb between 400nm and 540 nm. Chlorophyll b: This green pigment absorbs wavelengths between 430 nm and 642 nm. Its primary function is to pass light to chlorophyll a. Chlorophyll a: The most abundant pigment in plants. Its range is between 372 nm and 642 nm. Photosynthesis converts sunlight, water, and carbon dioxide into sugars, like glucose. These molecules serve as primary fuel sources. Theyre the powerhouse, driving essential processes like respiration, growth, and reproduction. Aside from that, plants convert glucose into starch to store it as food. Since only chlorophyll-containing plants can perform photosynthesis, other cells are completely dependent on stored carbohydrates to function. Whats more, during photosynthesis, plants produce ATP and NADPH molecules. Both components serve as energy carriers, playing many roles in various biological processes according to the science journal Nature Communications (Article number: 3238) by Shey-Li Lim, Chia Pao Voon, Xiaoqian Guan, Per Gardestrm and Boon Leong Lim. Before a plant can produce food, it requires three primary components: water, light, and carbon dioxide. Still, that doesnt mean theyll carry out the process efficiently when these essentials are present. Thats because several factors, like light intensity, water and carbon dioxide concentration, as well as temperature, affect the photosynthetic rate. Heres a brief explanation of each: Since radiation is responsible for exciting electrons, its no surprise that light intensity impacts photosynthesis. For those wondering, the former measures the energy transmitted per unit area. The brighter the light is, the more photons it carries. Naturally, this excites more electrons, increasing the rate of photosynthesis. That said, too much sunlight can damage the leaves, burning them. The trick is to provide optimal light conditions for each species. This one might come as a surprise. After all, temperature isnt a component of photosynthesis. Interestingly, thats far from the truth. As you know, several enzymes play a role in light and dark reactions. The problem is that these chemicals require optimal temperatures to work. Cold conditions slow down enzyme movements. As the temperature increases gradually, molecule movement, or collision, increases. As a result, enzymes react with substrates quickly. Of course, this facilitates photosynthesis. Still, high temperatures above 68F can be too much of a good thing. Thats because enzymes are proteins. Consequently, theyre heat-sensitive. Temperatures exceeding 104F can damage these molecules and deactivate them. Carbon Dioxide and Water Concentration Carbon dioxide and water are raw materials for building plant food. Consequently, as the concentration of CO2 increases, the photosynthetic rate increases. According to Erik S. Runkle from Michigan State University this effect continues until CO2 reaches a saturating concentration of around 1000 ppm. At this point, the rate wont change. Likewise, water availability increases photosynthesis. Not only does limited water slow down light-dependent reactions, but it can also affect CO2 intake. Thats because plants close the stomata to reduce water vapor loss during drought. According to the law of conservation of energy, photosynthesis doesnt produce a new form of energy. Thats because its conservedyou cant create or destroy energy. During photosynthesis, solar energy is harvested and converted to glucose, a form of chemical energy. Plants metabolize this sugar molecule through glycolysis, oxidizing it to produce ATP and pyruvate. The latter molecule enters another cycle in the mitochondria, producing more ATP. Not to mention, light reactions also generate this energy-carrying moleculeall of which are essential for many biological processes. As mentioned earlier, carbon dioxide enters a dark reaction cycle to produce sugars. This process is known as the Clavin cycle or C3 photosynthesis. It has three primary steps: Carboxylation: CO2 is fixed by carboxylating RuBP, a 5-carbon molecule, to form two molecules of 3-phosphoglycerate (3-PGA). RuBPCO enzyme facilitates this step. Reduction: During this step, 3-PGA is reduced to form glyceraldehyde-3 phosphate (GAP), a 3-carbon molecule used to make glucose. ATP and NADPH provide energy for this reaction. Regeneration: This complex process requires ATP to produce glucose. Other molecules are recycled to produce RuBP, which helps fixate more CO2. Around 95% of plants use the C3 pathway. Interestingly, some tropical plants contain a special structure in the leaves known as Kranzs anatomy. These plants developed a different pathway, C4 photosynthesis, to reduce water vapor loss while letting CO2 in through the stomata. Unlike C3, the C4 cycle produces a 4-carbon acidoxaloacetate. This chemical is then reduced, forming malate, which is used to make soluble sugars. As you know, photosynthesis releases oxygen as a byproduct. This gas can either exit the plant or be used in respiration. For those wondering, cellular respiration is the opposite of photosynthesis. Produced sugars are broken down in the presence of oxygen, releasing water, CO2, and ATP. This process takes place in the mitochondria and consists of a series of cycles. These are glycolysis, the citric acid cycle (TCA), and oxidative phosphorylation. Cellular respiration is essential as it converts carbohydrates to energy (ATP), which is necessary for plant growth and other biological functions, including photosynthesis. Photosynthesis is the most important biological process for plants. It helps all types of plants produce their food and provides energy for growth. Here are some of the benefits of this reaction: Energy production: Sugars are the primary fuel in plants. It plays a role in growth, reproduction, stress response, and more! Without carbohydrates, plants become stunted and eventually wither away. Synthesis of essential components: Aside from fueling, sugars help build structural components like cellulose. Additionally, plant cells can convert carbohydrates and store them as fat or combine them with nitrates to form amino acids (building blocks of proteins). Climate regulation: CO2 gas is responsible for the greenhouse effect, which causes the earth to become warmer. Plants can fight off climate change and protect the environment by filtering excess CO2 from the atmosphere through photosynthesis. Photosynthesis is the primary source of energy for all life forms on Earth. It helps maintain energy transfer in ecosystems. The process starts by converting solar energy into chemical energy. Plants make use of the latter to grow and reproduce. Herbivores, aka plant eaters, consume these greens. As a result, they transfer the captured solar energy up the food chain. Carnivores then feed on these animals, further transferring the energy. All life on Earth needs photosynthesis. You can classify these organisms into groups based on their direct or indirect needs. Plants, algae, phytoplankton, and other autotrophic organisms rely on this process directly. They use it to make their food and fuel different biological functions. Herbivores, carnivores, and omnivores indirectly depend on this process, as it ensures the food web remains stable. Additionally, decomposers also benefit from photosynthesis indirectly. These microorganisms feed on dead organic matter, returning nutrients to the soil. Aside from food and energy, living organisms need photosynthesis byproducts for respiration. Most life on Earth depends on photosynthesis.The process is carried out by plants, algae, and some types of bacteria, which capture energy from sunlight to produce oxygen (O2) and chemical energy stored in glucose (a sugar). Herbivores then obtain this energy by eating plants, and carnivores obtain it by eating herbivores.The processDuring photosynthesis, plants take in carbon dioxide (CO2) and water (H2O) from the air and soil. Within the plant cell, the water is oxidized, meaning it loses electrons, while the carbon dioxide is reduced, meaning it gains electrons. This transforms the water into oxygen and the carbon dioxide into glucose. The plant then releases the oxygen back into the air, and stores energy within the glucose molecules.ChlorophyllInside the plant cell are small organelles called chloroplasts, which store the energy of sunlight. Within the thylakoid membranes of the chloroplast is a light-absorbing pigment called chlorophyll, which is responsible for giving the plant its green color. During photosynthesis, chlorophyll absorbs energy from blue- and red-light waves, and reflects green-light waves, making the plant appear green.Light-dependent Reactions vs. Light-independent ReactionsWhile there are many steps behind the process of photosynthesis, it can be broken down into two major stages: light-dependent reactions and light-independent reactions. The light-dependent reaction takes place within the thylakoid membrane and requires a steady stream of sunlight, hence the name light-dependent reaction. The chlorophyll absorbs energy from the light waves, which is converted into chemical energy in the form of the molecules ATP and NADPH. The light-independent stage, also known as the Calvin cycle, takes place in the stroma, the space between the thylakoid membranes and the chloroplast membranes, and does not require light, hence the name light-independent reaction. During this stage, energy from the ATP and NADPH molecules is used to assemble carbohydrate molecules, like glucose, from carbon dioxide.C3 and C4 PhotosynthesisNot all forms of photosynthesis are created equal, however. There are different types of photosynthesis, including C3 photosynthesis and C4 photosynthesis. C3 photosynthesis is used by the majority of plants. It involves producing a three-carbon compound called 3-phosphoglyceric acid during the Calvin Cycle, which goes on to become glucose. C4 photosynthesis, on the other hand, produces a four-carbon intermediate compound, which splits into carbon dioxide and a three-carbon compound during the Calvin Cycle. A benefit of C4 photosynthesis is that by producing higher levels of carbon, it allows plants to thrive in environments without much light or water.The National Geographic Society is making this content available under a Creative Commons CC-BY-NC-SA license. The License excludes the National Geographic Logo (meaning the words National Geographic + the Yellow Border Logo) and any images that are included as part of each content piece. For clarity the Logo and images may not be removed, altered, or changed in any way. Photosynthesis is the process by which green plants create energy from sunlight. It occurs at the cellular level in the leaves of plants and is the way in which they produce oxygen and carbohydrates. The oxygen is released into the atmosphere, and the carbohydrates, simple sugars, are used by the plant for growth. In order to carry out photosynthesis, green plants need several ingredients. Chlorophyll, the pigment in plants that makes them green, is essential to the photosynthetic process. This chemical is produced naturally by all green plants and its role in photosynthesis is to absorb light. That light energy triggers the chemical reaction we know as photosynthesis. The process cannot work without an energy input, and this comes from the sun. The sun starts the first reaction in photosynthesis, which is known as the light-dependent process. During this stage of photosynthesis, as the sunlight excites the chlorophyll, water is split into oxygen and hydrogen, and the oxygen is released into the atmosphere. As any gardener knows, plants take in water from the ground through their roots. The water travels up the stem of the plant through a complex transport system and arrives in the leaves, to be used as a raw material during photosynthesis. This gas is abundantly available in the atmosphere around plants. Most plants have a protective waxy layer over their leaves, which prevents them from drying out. Normally, this would also prevent a gas such as carbon dioxide from entering the leaf. But the leaf also has special openings, called stomata, that allow the gas to enter the leaf's cells. Once photosynthesis has taken place, the oxygen produced also leaves the cells via the stomata. Carbon dioxide is bonded with the hydrogen produced in the first light dependent process, to make carbohydrates.McGraw Hill Higher Education: Photosynthesis, Respiration and Transpiration Winston, Beth. "Materials Needed For Photosynthesis" sciencing.com, . 23 April 2018. APA Winston, Beth. (2018, April 23). Materials Needed For Photosynthesis. sciencing.com. Retrieved from Chicago Winston, Beth. Materials Needed For Photosynthesis last modified March 24, 2022. Our A-Level Biology revision guides have been created specifically for each of the main examination boards, AQA, OCR, Edexcel A/B, Edexcel IAL and CIE. Choose your exam board below to access the free sample notes, as well as the full, premium quality, revision notes that will help you to secure the best possible marks in your A-Level Biology exams. Looking to get started with your A-Level Biology revision quickly? Select your exam board below to go straight to the materials that matter to you. View AQA revision View OCR revision View Edexcel A revision View Edexcel B revision View Edexcel IAL revision View CIE revision View WJEC revision View Eduqas revision Whether you are studying for A-Level Biology yourself, or you are teaching and tutoring A-Level Biology students, we provide everything you need to pass A-Level Biology whichever exam board you use. Are you an A-Level Biology teacher? If so, check out our teaching resources page here. A-Level (A2/AS) Biology Examination booklets offering hundreds of pages of exam-style questions (and mark schemes) across all examination boards including AQA, OCR, Edexcel A/B, Edexcel IAL & CIE. View notes A comprehensive list of past papers to practise your exam question answers and highlight revision topics you need to work on. View papers We operate a number of educational websites for teachers and students in science and maths. Take a look at our other websites below: 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. The process of photosynthesis Photosynthesis takes place in the part of the plant cell containing chloroplasts, these are small structures that contain chlorophyll. For photosynthesis to take place, plants need to take in carbon dioxide (from the air), water (from the ground) and light (usually from the sun).What 5 things do plants need for photosynthesis?Plants have specific needs light, air, water, nutrients, and space to survive and reproduce. Almost all plants need these five things to survive: Light. Air.What do plants take in and out during photosynthesis?Answer: During photosynthesis, plants take in carbon dioxide and release oxygen. Plants take in carbon dioxide (CO2) and water (H2O) from the air and soil during photosynthesis. The plant then releases the oxygen into the atmosphere while storing energy in the glucose molecules.What are the 4 things plants need?These needs include: light, air, water, a source of nutrition, space to live and grow and optimal temperature. There is an easy acronym to help remember basic plant needs, these are the things that plants need to survive and thrive.What 3 items are needed for photosynthesis to occur?This process is called photosynthesis and is performed by all plants, algae, and even some microorganisms. To perform photosynthesis, plants need three things: carbon dioxide, water, and sunlight.What do leaves produce during photosynthesis?During photosynthesis, plants produce glucose from simple inorganic molecules carbon dioxide and water using light.What plant part is most responsible for photosynthesis?Chloroplasts are plant organelles that are responsible for photosynthesis and most of the plants metabolism takes place in parenchyma cells. Excess nutrients, often in the form of starch grains, are also stored in these cells. What part of a plant is adapted for photosynthesis?The leaf is a plant organ adapted to carry out photosynthesis. The table describes some of its adaptations: A leaf usually has a large surface area, so that it can absorb a lot of light. Its top surface is protected from water loss, disease and weather damage by a waxy layer. What are two things plants make for photosynthesis?What is photosynthesis? Photosynthesis is a chemical reaction that takes place inside a plant, producing food for the plant to survive. Carbon dioxide, water and light are all needed for photosynthesis to take place. Photosynthesis happens in the leaves of a plant. What do plant give off during photosynthesis?Plants use carbon dioxide in a process known as photosynthesis. During photosynthesis, plants give off oxygen as a waste product. Carbon dioxide moves from the air into the leaves of plants through tiny openings in the plants leaves. How can financial brands set themselves apart through visual storytelling? Our experts explainhow.Learn MoreThe Motorsport Images Collections captures events from 1895 to todays most recentcoverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of EditorsPicks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explainhow.Learn MoreThe Motorsport Images Collections captures events from 1895 to todays most recentcoverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of EditorsPicks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explainhow.Learn MoreThe Motorsport Images Collections captures events from 1895 to todays most recentcoverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of EditorsPicks.Browse Editors' Favorites Plants manufacture their own food. The process that is involved in the making of the food is called photosynthesis. Photosynthesis involves the production of glucose from simple inorganic molecules like water and carbon dioxide in the presence of sunlight. Light is an essential factor and source of energy for the chemical reaction that happens during photosynthesis. It is an endothermic process. A green pigment known as chlorophyll absorbs the light. This pigment is located in the chloroplasts of the plant cells. The exact location of these cells is mesophyll palisade cells. Plant leaves are the main organs where photosynthesis occurs. However, other parts also that are exposed to light will possess chlorophyll and do photosynthesis. The air fulfils the requirement of carbon dioxide that is required during photosynthesis. Carbon dioxide enters leaves through a pore-like structure on leaves, called stomata. The roots bring in the water and transport it to leaves through xylem tissues. Oxygen is the product that is released in the atmosphere during photosynthesis. Although some of its parts are used for respiration by the plant itself, rest is released to the environment and is sued by other animals and microorganisms. Rate of photosynthesis is high in the day time due to the presence of sunlight, and thus oxygen is released more in comparison to the night time. Biosynthesis The product glucose made during the photosynthetic reaction is used by the plant in respiration. It is the most basic unit of nutrition that helps in the survival of plant and biosynthesis of other materials in the plant. Factors affecting photosynthesis There are many factors that affect the rate of photosynthesis: Intensity of light The concentration of carbon dioxide Temperature Amount of chlorophyll Plants in more lighting conditions tend to make more chlorophyll, resulting in more photosynthesis When some disease affects the number of chlorophyll, the rate of photosynthesis is also negatively affected. Rate of photosynthesis can also be measured in the lab by observing these factors: Rate of release of oxygen Rate of intake of carbon dioxide Rate of glucose or carbohydrate production Note These factors are not highly reliable as plants use oxygen and glucose during respiration. Intensity of light Light is essential for photosynthesis to occur, without its rate of photosynthesis decreases as we see in the night time. Increase in the intensity of the light increases the rate of photosynthesis. However, limiting factor can still decrease the frequency of photosynthesis even if the light is optimally present. The limiting factor is an important factor of which there is a shortage in plant or surrounding environment. Plants do not support very high intensities of light, and the rate is inhibited in this light. However, this amount of light does not occur in nature. The concentration of carbon dioxide The combination of water and carbon dioxide is used as a reactant in photosynthesis chemical reaction. The rise in the concentration of carbon dioxide increases the rate of photosynthesis. However, the concept of limiting factor also applies here. Temperature The enzymes are critical in the chemical reaction involved in photosynthesis. For enzymes to work, the temperature plays an important role as the enzymes work only under a certain scale of temperatures. Low temperatures would mean lower molecular collisions between substrates and enzymes and thus decrease in the rate of photosynthesis. However, high temperatures lead to denaturation of enzymes and will also decrease the rate of photosynthesis. Chlorophyll Light energy is absorbed by chlorophyll which is then used in the conversion of carbon dioxide and water into glucose. The green colour of the chlorophyll reflects the green light and absorb the red and blue portions of the spectrum. Leaves with higher amounts of chlorophyll absorb the light in a better way and thus ensure an optimal rate of photosynthesis. The point of compensation As you can notice in the graph, the rate of photosynthesis is compared against the different factors. The graphs are a little different when the production of oxygen or carbon dioxide intake is used to measure the rate of photosynthesis. The line does not cross through the start. This is due to the respiration process that uses oxygen and carbon dioxide. For example when the graph is plotted with light intensity against carbon dioxide. The light intensity at which the rate of respiration is equal to the rate of photosynthesis is called the compensation point. Factors affecting photosynthesis Water Water is one of the big limiting factors in photosynthesis in the UK. Water is used by plants in various other processes hence plotting a graph for the water is certainly not a reliable and viable option. The most important function of water is its use as a solvent in all kinds of chemical reactions that occur in cells. Light The intensity of light is directly responsible for the rate of photosynthesis. You will see the fluctuation in intensity due to the difference in the earths receptivity of sunlight that keeps changing. This rate not only changes in day and night but also changes with the change in seasons throughout the year. Carbon dioxide The emissions of greenhouse gases have been rising increasing leading to an increase in carbon dioxide content. However, atmosphere accounts for only 0.04 percent of carbon dioxide which quite low in terms of the amount that is required for photosynthesis. Temperature Photosynthesis occurs even temperatures as low as 0 degrees and as high as 50-degree Celsius. The right temperature for most of the plants ranges between 15 degrees to 40-degree Celsius. The growth of crop plants is affected when temperature affect the rate of photosynthesis. According to some scientists, the rise in temperature due to global warming will negatively affect the growth of plants. Chlorophyll The compensation point for plants grown in bright light conditions and shade conditions is different. The lower compensation point signifies the low light condition and thus are seen in shade-loving plants while the compensation rate is higher for light-loving plants. Lower compensation point means that their rate of photosynthesis will be more than the rate of respiration Higher compensation point means that their rate of photosynthesis will be less than the rate of respiration. Photosynthesis is the chemical process by which plants, algae, and some bacteria use the energy from sunlight to transform carbon dioxide (a greenhouse gas) from the atmosphere, and water, into organic compounds such as sugars. These sugars are then used to make complex carbohydrates, lipids, and proteins, as well as the wood, leaves, and roots of plants. The amount of organic matter made by photosynthesizing organisms in an ecosystem is defined as the productivity of that ecosystem. Energy flows through the biosphere as organisms (including some animals) eat photosynthesizing organisms (called herbivores), and as organisms then eat those herbivores (carnivores), etc., to get their energy for growth, reproduction, and other functions. This energy is acquired through the process of cellular respiration, which usually requires oxygen. Oxygen is a byproduct of photosynthesis. About 70% of the oxygen in the atmosphere that we breathe comes from algae in the ocean. Atmospheric oxygen from photosynthesis also forms the ozone layer, which protects organisms from harmful high-energy ultraviolet (UV) radiation from the Sun. Because photosynthesis also requires water, the availability of water affects the productivity and biomass of the ecosystem, which in turn affects how much and how rapidly water cycles through the ecosystem.Fossil fuels are derived from the burial of photosynthetic organisms, including plants on land (which primarily form coal) and plankton in the oceans (which primarily form oil and natural gas). While buried, the carbon in the organic material is removed from the carbon cycle for thousands of years to hundreds of millions of years. The burning of fossil fuels has dramatically increased the exchange of carbon from the ground back into the atmosphere and oceans. This return of carbon back into atmosphere as carbon dioxide is occurring at a rate that is hundreds to thousands of times faster than it took to bury it, and much faster than it can be removed by photosynthesis or weathering. Thus, the carbon dioxide released from the burning of fossil fuels is accumulating in the atmosphere, increasing average temperatures and causing ocean acidification.A simplified diagram showing the overall inputs carbon dioxide, water, and sunlight, and products oxygen and sugar (glucose), of photosynthesis.The rate of photosynthesis in ecosystems is affected by various environmental conditions, including:Climatic conditions, such as the amount of sunlight available at different latitudes, temperature, and precipitation For example, ecosystems at low latitudes, such as tropical rainforests, have higher productivity and biomass than ecosystems near the poles because of they receive more sunlight and rainfall than regions at higher latitudes.Nutrients, especially nitrogen and phosphorus, which when limited can decrease productivity, but when abundant can increase productivity and biomass. Photosynthesizing organisms extract nutrients from the environment, and return them to the soil when they die and decay.Numerous other abiotic environmental factors, including soil quality (often related to nutrient levels), wildfires, water acidity, and oxygen levels.Species interactions, including the resources species provide for each other, and how they compete for resources such as water, light, and/or space. Species that reduce or increase the success of other species alter population sizes, thus affecting productivity and biomass.Evolutionary processes that can change the growth and reproduction rates of photosynthesizing organisms over time, as well as the growth and reproduction of rates of the organisms that eat them.Humans have altered the rate of photosynthesis, and in turn productivity, in ecosystems through a variety of activities, including:Deforestation, habitat destruction, and urbanization, which remove plants and trees from the environment and disrupt ecosystems.Agricultural activities that increase the amount of crops available to feed the growing global human population.The use of fertilizers for agricultural activities that increase the amount of nutrients, especially nitrogen and phosphorous, in soil or water. These nutrients increase plant and algae growth, including growth of species that are toxic to other organisms. Increased nutrients is not always a good thing. For example, in aquatic environments, nutrient-rich runoff can cause large amounts of algae to grow when these algae die, they are consumed by bacteria which can reduce oxygen levels in the water, killing fish and other species. This process is known as eutrophication.Human freshwater use, which can limit the amount of water available for plants and trees in an ecosystem.The release of pollutants and waste, which can reduce growth and reproduction or kill plants.Activities that release carbon dioxide and other greenhouse gases that cause global warming, such as the burning of fossil fuels, agricultural activities, and deforestation. Increasing carbon dioxide levels may increase photosynthesis rates in some plants, but this can also make plants less nutritious. Increasing average global land and ocean temperatures and changes in precipitation patterns also affect plant and algae growth, and can make certain species more susceptible to disease.Activities such as the burning of fossil fuels, agricultural activities, and deforestation that release carbon dioxide into the atmosphere, which is absorbed by the ocean causing acidification. The decreasing pH of ocean waters (along with ocean warming) causes physiological stress for many plant and algae species, which can decrease growth, reproduction, species population sizes, and biomass.The increase in carbon dioxide to the atmosphere is also thought to impact global photosynthesis rates. During photosynthesis, plants convert carbon dioxide to biomass such as sugars and wood. However, the same enzyme (rubisco) that fixes carbon dioxide can also use oxygen. When oxygen is used, plants undergo a process known as photorespiration where biomass is not produced and instead carbon dioxide is emitted to the atmosphere (see this teaching resource for more information). Photorespiration is often considered a negative process for plants. It has been proposed that as carbon dioxide levels rise in the atmosphere rates of photorespiration will decrease and rates of photosynthesis will increase. This change is termed carbon dioxide fertilization and demonstrates the complex interactions between life and climate change.Introducing invasive species that compete with native plant or algae species for nutrients, water, light, or other resources, reducing native species populations.Earth system model about photosynthesisThe Earth system model below includes some of the processes and phenomena related to photosynthesis. These processes operate at various rates and on different spatial and temporal scales. For example, carbon dioxide is transferred among plants and animals over relatively short time periods (hours-weeks), but the deforestation alters ecosystems over decades to centuries, or longer. Can you think of additional cause and effect relationships between photosynthesis and other processes in the Earth system?Explore the Earth SystemClick the bolded terms (e.g. respiration, productivity and biomass, and burning of fossil fuels) on this page to learn more about these process and phenomena. Alternatively, explore the Understanding Global Change Infographic and find new topics that are of interest and/or locally relevant to you.InvestigateLearn more in these real-world examples, and challenge yourself toconstruct a modelthat explains the Earth system relationships.The bacteria that changed the worldLinks to Learn More Matt Cardy/Getty Images News/Getty Images Photosynthesis can only occur when a plant has access to water, carbon dioxide, sunlight and chlorophyll. Plant cells naturally produce chlorophyll, and they draw carbon dioxide directly from the air. Water and sunlight must be acquired from external sources.Plants take up carbon dioxide through apertures in their leaves called stomata. These dilate and constrict in response to ambient carbon in the air. They absorb water through their root systems. Sunlight is taken up by the leaves themselves, which are densely packed with chlorophyll-rich organelles called chloroplasts. These chloroplasts use the energy from sunlight to recombine the CO2 with the H2O to produce sugar and O2, which is molecular oxygen that is secreted through the stomata. MORE FROM REFERENCE.COM Photosynthesis is one of the most important reactions on this planet.Let's have a look at the word "Photo" means light, Synthesis means to make - and that's exactly what it does. So, plants harness the energy from the sun to make food.Photosynthesis happens in the leaves of all green plants. Without photosynthesis there would be no oxygen in our atmosphere and life as we know it would not exist. It happens inside the chloroplasts, which are found in leaf cells and other green parts of the plant.Chloroplasts contain a substance called chlorophyll, which gives the plant its green colour. Chlorophyll absorbs sunlight and uses its energy to convert carbon dioxide and water into glucose. Oxygen is also produced.Time for a demo here.Here we have the aquatic plant named Cabomba. It's very fast at growing and particularly efficient at photosynthesizing.We're going to have a look at two things.First, the oxygen produced.If photosynthesis is happening, the gas collected in the tube over the last 30 minutes should be oxygen. If it is oxygen, it will re-light this glowing splint.Wicked!Second thing, light!The good thing about using underwater plants is that you can actually