THE PHOTOSYNTHETIC BACTERIA pdf

1: Pigments in Photosynthetic Bacteria | Microbiology

Introduction. Photosynthetic bacteria have been around for longer than the Earth's atmosphere could sustain human life. It was only recently though that scientists began to unravel the mystery of how these micro-organisms execute the mechanisms of photosynthesis.

It was only recently though that scientists began to unravel the mystery of how these micro-organisms execute the mechanisms of photosynthesis. While scientists still have not been able to put all the pieces of the photosynthetic bacteria puzzle in the right places, they are actively studying them and are gaining valuable knowledge about the way they photosynthesize and how they have evolved. In fact, they believe that these micro-organisms may have had a huge impact on why the world evolved the way it did, and may show potential for life in places deemed uninhabitable, including extreme climates like Antarctica and even other planets. What are photosynthetic bacteria? Much like the name suggests, these micro-organisms are special types of bacteria that contain light absorbing pigments and reaction centers which make them capable of converting light energy into chemical energy. Cyanobacteria contain chlorophyll while other forms of bacteria contain bacteriochlorophyll. Although bacteriochlorophyll resembles chlorophyll, it absorbs light of a longer wavelength than chlorophyll. Bacteriochlorophyll a is the most common form of bacteriochlorophyll but other forms include b, c, d, e, f and g. Bacteria that contain bacteriochlorophyll do not use water as an electron donor and therefore do not produce oxygen. This is known as anoxygenic photosynthesis. Cyanobacteria perform photosynthesis using water as an electron donor in a similar manner to plants. This results in the production of oxygen and is known as oxygenic photosynthesis. Classification of Photosynthetic Bacteria Oxygenic photosynthetic bacteria perform photosynthesis in a similar manner to plants. They contain light-harvesting pigments, absorb carbon dioxide, and release oxygen. Cyanobacteria or Cyanophyta are the only form of oxygenic photosynthetic bacteria known to date. There are, however, several species of Cyanobacteria. This transformation meant that most anaerobic organisms that thrived in the absence of oxygen eventually became extinct and new organisms that were dependent on oxygen began to emerge. They are also known to be endosymbiont, which means they can live within the cells or body of another organism in a mutually beneficial way. Cyanobacteria also tend to live in extreme weather conditions, such as Antarctica, and are interesting to scientists because they may indicate a chance for life on other planets such as Mars. Purple bacteria can be divided into two main types â€” the Chromatiaceae, which produce sulfur particles inside their cells, and the Ectothiorhodospiraceae, which produce sulphur particles outside their cells. They cannot photosynthesize in places that have an abundance of oxygen, so they are typically found in either stagnant water or hot sulfuric springs. Instead of using water to photosynthesize, like plants and cyanobacteria, purple sulfur bacteria use hydrogen sulfide as their reducing agent, which is why they give off sulfur rather than oxygen. Purple bacteria are probably the most widely studied photosynthetic bacteria, being used for all sorts of scientific endeavors including theories on possible microbiological life on other planets. While these bacteria can tolerate small amounts of sulfur, they tolerate much less than purple or green sulfur bacteria, and too much hydrogen sulfide is toxic to them. These bacteria have been found deep in the ocean near a black smoker in Mexico, where they survived off the light of a thermal vent. They have also been found underwater near Indonesia. These bacteria can survive in extreme conditions, like the other types of photosynthetic bacteria, suggesting an evolutionary potential for life in places otherwise thought uninhabitable. Some are acidophilic meaning they thrive under very acidic conditions. However, not much is known about this grouping of bacteria, because they are fairly new, the first being found in They use a particular type of bacteriochlorophyll, labelled g, which differentiates them from other types of photosynthetic bacteria. They are photoheterotroph, which means that they cannot use carbon dioxide as their primary source of carbon. This type of bacteria uses filaments to move around. The color depends on the type of bacteriochlorophyll the particular organism uses. Useful Applications for Photosynthetic Bacteria Photosynthetic bacteria are currently being used in various applications which include water purification, bio-fertilizers, animal feed and bioremediation of chemicals among many others. They are used in the treatment of polluted water since they can grow and utilize toxic substances such as H2S or H2S In the video below, Dr. Jeffrey Way explains the science behind the innovation and the potential benefits of this technology.

2: Bacterial Photosynthesis

The photosynthetic purple bacteria use a variety of hydrogen donors in place of water (e.g. H 2 S or various organic compounds). In some anaerobic photosynthetic bacteria using hydrogen donors other than hydrogen or water (e.g. succinate) not only CO 2 is reduced to NADPH 2 but also atmospheric nitrogen is reduced to ammonia.

Photosynthetic Bacteria Photosynthetic bacteria are a unique species of microorganisms that use the sun as a source of energy. Bacteria contain a similar compound called bacteriochlorophyll, which allows them to also photosynthesize. There are three groups of photosynthetic bacteria: Chlorobiacae, Chromatiacae, and Rhodospirillacae. These three groups will be explained later on, but first, it will help to understand what photosynthesis is and how it provides energy to an organism. The process of photosynthesis is fairly simple and can be reduced to a chemical equation. The sun produces light energy which the bacteria can convert into chemical energy. The energy is primarily used to form carbohydrates a food source for the bacteria, but ultimately will make all the materials of the organism. While not a great deal is known about photosynthetic bacteria, scientists have applied facts known about plants to the bacteria, thinking that both organisms have the same processes. Although it is difficult to say, their theories seem to be correct. Photosynthesis takes place on the surface of the cell, which is known as the cell membrane , or a thin sheet that covers and protects the bacteria. Embedded in the cell membrane are reaction centers which specifically absorb light energy. These reaction centers exist in the forms of sacs, tubes, or sheets, depending on the amount of surface area that is needed. Rhodospirillacae are purple bacteria. They are a rod-shaped bacteria , although the length of each rod varies slightly. The purple color of the bacteria makes them distinctive and easy to identify in a mixture. These bacteria can use hydrogen gas as an organic electron donor or can also use succinate or malate, depending on the availability of each compound. Another type is Chromatiacae which is also a purple bacteria. They are short gram-negative rods. Unlike the Rhodospirillacae, they can use sulfur and sulphide as the electron donor. The last kind are the Chlorobiacae which are a green bacteria. They are also a sulfur bacteria. This is a short summary of the definition of photosynthesis, the different types of photosynthetic bacteria and how they differ from each other. It is important to note that other photosynthetic bacteria may exist and have not been identified yet. These bacteria primarily live in the water and can be difficult to find and isolate, especially if they exist in small quantities. However, these three types are the major and probably the most important kinds of photosynthetic bacteria.

3: What Are Chemosynthetic Bacteria? | Owlcation

The non-absorbed part of the light spectrum is what gives photosynthetic organisms their color (e.g., green plants, red algae, purple bacteria) and is the least effective for photosynthesis in the respective organisms.

In plants the photosynthetic process occurs inside chloroplasts, which are organelles found in certain cells. Chloroplasts provide the energy and reduced carbon needed for plant growth and development, while the plant provides the chloroplast with CO2, water, nitrogen, organic molecules and minerals necessary for the chloroplast biogenesis. Most chloroplasts are located in specialized leaf cells, which often contain 50 or more chloroplasts per cell. Each chloroplast is defined by an inner and an outer envelope membrane and is shaped like a meniscus convex lens that is microns in diameter Fig. For details of chloroplast structure, see Staehlin The inner envelope membrane acts as a barrier, controlling the flux of organic and charged molecules in and out of the chloroplast. Water passes freely through the envelope membranes, as do other small neutral molecules like CO2 and O2. There is evidence that chloroplasts were once free living bacteria that invaded a non-photosynthetic cell long ago. They have retained some of the DNA necessary for their assembly, but much of the DNA necessary for their biosynthesis is located in the cell nucleus. This enables a cell to control the biosynthesis of chloroplasts within its domain. Inside the chloroplast is a complicated membrane system, known as the photosynthetic membrane or thylakoid membrane , that contains most of the proteins required for the light reactions. The proteins required for the fixation and reduction of CO2 are located outside the photosynthetic membrane in the surrounding aqueous phase. The photosynthetic membrane is composed mainly of glycerol lipids and protein. The glycerol lipids are a family of molecules characterized by a polar head group that is hydrophilic and two fatty acid side chains that are hydrophobic. In membranes, the lipid molecules arrange themselves in a bilayer, with the polar head toward the water phase and the fatty acid chains aligned inside the membrane forming a hydrophobic core Fig. The photosynthetic membrane is vesicular, defining a closed space with an outer water space stromal phase and an inner water space lumen. The organization of the photosynthetic membrane can be described as groups of stacked membranes like stacks of pita or chapati bread with the inner pocket representing the inner aqueous space , interconnected by non-stacked membranes that protrude from the edges of the stacks Fig. Experiments indicate that the inner aqueous space of the photosynthetic membrane is likely continuous inside of the chloroplast. It is not known why the photosynthetic membrane forms such a convoluted structure. To understand the energetics of photosynthesis the complicated structure can be ignored and the photosynthetic membrane can be viewed as a simple vesicle. The chemical structure of chlorophyll a molecule is shown in Fig. Plants appear green because of chlorophyll, which is so plentiful that regions of the earth appear green from space. The absorption spectrum of chloroplast chlorophyll a and b and carotenoids along with the action spectrum of photosynthesis of a chloroplast is shown in Fig. Light is collected by pigment molecules that are bound to light- harvesting protein complexes located in the photosynthetic membrane. The light-harvesting complexes surround the reaction centers that serve as an antenna. Photosynthesis is initiated by the absorption of a photon by an antenna molecule, which occurs in about a femtosecond s and causes a transition from the electronic ground state to an excited state. Within s the excited state decays by vibrational relaxation to the first excited singlet state. The fate of the excited state energy is guided by the structure of the protein. Because of the proximity of other antenna molecules with the same or similar energy states, the excited state energy has a high probability of being transferred by resonance energy transfer to a near neighbor. Exciton energy transfer between antenna molecules is due to the interaction of the transition dipole moment of the molecules. Photosynthetic antenna systems are very efficient at this transfer process. A simple model of the antenna and its reaction center is shown in Fig. Photosystem II uses light energy to drive two chemical reactions - the oxidation of water and the reduction of plastoquinone. The photosystem II complex is composed of more than fifteen polypeptides and at least nine different redox components chlorophyll, pheophytin, plastoquinone, tyrosine, Mn, Fe, cytochrome b, carotenoid and histidine have been shown to undergo light-induced electron transfer Debus, However, only five of these redox components are known to be involved in transferring electrons from H2O to the plastoquinone pool - the water oxidizing manganese cluster Mn 4, the amino acid tyrosine, the reaction center chlorophyll P , pheophytin, and the plastoquinone molecules, QA and QB. Of these essential redox components, tyrosine, P, pheophytin, QA and QB have been shown to be bound to two key polypeptides that form the heterodimeric reaction center core of photosystem II D1 and D2. Recent work indicates that the D1 and D2 polypeptides also provide ligands for the Mn 4 cluster. The three-dimensional structure of photosystem II is not known. Our knowledge of its structure is guided by the known structure of the reaction center in purple bacteria and biochemical and spectroscopic data. Primary charge separation takes about a few picoseconds Fig. Subsequent electron transfer steps have been designed through evolution to prevent the primary charge separation from recombining. This is accomplished by transferring the electron within picoseconds from pheophytin to a plastoquinone molecule QA that is permanently bound to photosystem II. Although plastoquinone normally acts as a two-electron acceptor, it works as a one-electron acceptor at the QA-site. The electron on QA- is then transferred to another plastoquinone molecule that is loosely bound at the QB-site. Plastoquinone at the QB-site differs from QA in that it works as a two-electron acceptor, becoming fully reduced and protonated after two photochemical turnovers of the reaction center. The full reduction of plastoquinone requires the addition of two electrons and two protons, i. The reduced plastoquinone Fig. After which, an oxidized plastoquinone molecule finds its way to the QB-binding site and the process is repeated. Because the QB-site is near the outer aqueous phase, the protons added to plastoquinone during its reduction are taken from the outside of the membrane. Photosystem II is the only known protein complex that can oxidize water, resulting in the release of O2 into the atmosphere. Despite years of research, little is known about the molecular events that lead to water oxidation. Energetically, water is a poor electron donor. Four Mn ions are present in the water oxidizing complex. X-ray absorption spectroscopy shows that Mn undergoes light-induced oxidation. Water oxidation requires two molecules of water and involves four sequential turnovers of the reaction center. This was shown by an experiment demonstrating that oxygen release by photosystem II occurs with a four flash dependence Fig. Each photochemical reaction creates an oxidant that removes one electron. The net reaction results in the release of one O2 molecule, the deposition of four protons into the inner water phase, and the transfer of four electrons to the QB-site producing two reduced plastoquinone molecules reviewed by Renger, ; Klein et al. Photosystem II reaction centers contain a number of redox components with no known function. An example is cytochrome b, a heme protein, that is an essential component of all photosystem II reaction centers discussed by Whitmarsh and Pakrasi, If the cytochrome is not present in the membrane, a stable PS II reaction center cannot be formed. Although the structure and function of Cyt b remain to be discovered, it is known that the cytochrome is not involved in the primary enzymatic activity of PS II, which is the transfer of electrons from water to plastoquinone. Why PS II reaction centers contain redox components that are not involved in the primary enzymatic reactions is a puzzling question. The answer may be found in the unusual chemical reactions occurring in PS II and the fact that the reaction center operates at a very high power level. Photosystem II is an energy transforming enzyme that must switch between various high energy states that involve the creation of the powerful oxidants required for removing electrons from water and the complex chemistry of plastoquinone reduction which is strongly influenced by protons. Operating at such a high power level results in damage to the reaction center. It may be that some of the "extra" redox components in photosystem II may serve to protect the reaction center. Photosystem II has another perplexing feature. Many plants and algae have been shown to have a significant number of photosystem II reaction centers that do not contribute to photosynthetic electron transport e. Why plants devote resources for the synthesis of reaction centers that apparently do not contribute to energy conversion is unknown for reviews of photosystem II heterogeneity see Ort and Whitmarsh, ; Guenther and Melis, ; Govindjee, ; Melis, ; Whitmarsh et al. Photosystem I is composed of a heterodimer of proteins that act as ligands for most of the electron carriers Krauss et al. The reaction center is served by an antenna system that consists of about two hundred chlorophyll molecules mainly chlorophyll a and primary photochemistry is initiated by a chlorophyll a dimer, P In contrast to photosystem II, many of the antenna chlorophyll molecules in photosystem I are bound to the reaction center proteins. Also, FeS centers serve as electron carriers in photosystem I and, so far as is known, photosystem I electron transfer is not coupled to proton translocation. Primary charge separation occurs between a primary donor, P, a chlorophyll dimer, and a chlorophyll monomer Ao. The subsequent electron transfer events and rates are shown in Fig. Electrons are transferred between these large protein complexes by small mobile molecules plastoquinone and plastocyanin in plants. Because these small molecules carry electrons or hydrogen atoms over relatively long distances, they play a unique role in photosynthetic energy conversion. This is illustrated by plastoquinone PQ , which serves two key functions. Plastoquinone transfers electrons from the photosystem II reaction center to the cytochrome bf complex and carries protons across the photosynthetic membrane see Kallas, It does this by shuttling hydrogen atoms across the membrane from photosystem II to the cytochrome bf complex. Because plastoquinone is hydrophobic its movement is restricted to the hydrophobic core of the photosynthetic membrane. Plastoquinone operates by diffusing through the membrane until, due to random collisions, it becomes bound to a specific site on the photosystem II complex. The reduced plastoquinone molecule debinds from photosystem II and diffuses randomly in the photosynthetic membrane until it encounters a specific binding site on the cytochrome bf complex. The cytochrome bf complex is a membrane bound protein complex that contains four electron carriers, three cytochromes and an FeS center. The crystal structure has been solved for cytochrome f from turnip Martinez et al. In a complicated reaction sequence that is not fully understood, the cytochrome bf complex removes the electrons from reduced plastoquinone and facilitates the release of the protons into the inner aqueous space. The electrons are eventually transferred to the photosystem I reaction center. The protons released into the inner aqueous space contribute to the proton chemical free energy across the membrane. Electron transfer from the cytochrome bf complex to photosystem I is mediated by a small Cu-protein, plastocyanin PC. Plastocyanin is water soluble and operates in the inner water space of the photosynthetic membrane. The pathway of electrons is largely determined by the energetics of the reaction and the distance between the carriers. The electron affinity of the carriers is represented in Fig. It should be kept in mind that reaction conditions during photosynthesis are not in equilibrium. Subsequent to primary charge separation, electron transport is energetically downhill from a lower more negative to a higher more positive redox potential. It is the downhill flow of electrons that provides free energy for the creation of a proton chemical gradient. Photosynthetic membranes effectively limit electron transport to two dimensions. For mobile electron carriers, limiting diffusion to two dimensions increases the number of random encounters Whitmarsh, Furthermore, because plastocyanin is mobile, any one cytochrome bf complex can interact with a number of photosystem I complexes.

4: Photosynthetic Bacteria(PSB) Good Quality Reasonable Price - PANGOO

Purple and green bacteria and cyanobacteria are photosynthetic. Photosynthetic bacteria are able to produce energy from the sun's rays in a process similar to that used by plants. Instead of using chlorophyll to capture the sun's light, these bacteria use a compound called bacteriochlorophyll.

Bacterial photosynthesis is different from plant photosynthesis. The mechanism of photosynthesis, examples of photosynthetic bacteria and their importance such as in analysis of evolution of photosynthetic systems is discussed Bacterial photosynthesis Photosynthesis is synthesis of carbohydrate food from carbon dioxide in presence of light. In short, it is light dependent energy yielding process. Bacteria that utilize light energy in nutrition are phototrophic and hence photosynthetic. Photosynthesis in plants, algae and cyanobacteria is similar to bacterial photosynthesis in requirement for large amount of energy in the form of ATP Adenosine Tri-phosphate but different with respect to form of chemical reductants and resultant end products of photosynthesis. Water is chemical reductant of plants, algae and cyanobacteria. Inorganic compounds such as H2 or H2S and organic compounds lactate, succinate or malate are reductants of bacterial photosynthesis. Phototrophic bacteria using inorganic and organic chemical reductants are known as photolithotrophs and photoorganotrophs respectively. Bacterial photosynthesis is anoxygenic means end product or oxidation product is not oxygen like that in plants, algae and cyanobacteria. Principle groups of phototrophic bacteria are: Purple sulfur bacteria Chromatium sp. Photosynthesis in prokaryotic blue green algae or cyanobacteria resembles plants and higher algae regarding photosystem, pigments, reductants and end products. Bacteriochlorophyll is the principle light harvesting pigment of photobacteria. It is present as a, b, c, d or e types. It is different from plant chlorophyll in structure and light absorbing properties. Bacteriochlorophyll absorb light in infrared region wavelength of nm. They are not contained in chloroplasts instead scattered in cytoplasm and cell membrane system. Bacteria also contain carotenoids and other accessory pigments which absorb light of shorter wavelength and transfer energy to bacteriochlorophyll. Process of bacterial photosynthesis: Bacterial photosynthesis is based on cyclic photophosphorylation mechanism and only one pigment system PS-I is involved. During the process, bacteriochlorophyll absorbs light and this light energy raises the chlorophyll molecule to an excited state. Excited bacteriochlorophyll gives off an electron and becomes positively charged. It serves as a strong oxidising agent and electron acceptor. Some of the light energy is carried successively to electron transport system via electron. The first energy receiver is ferredoxin followed by ubiquinone, cytochrome b and to cytochrome f and finally back to excited bacteriochlorophyll. An electron thus completes the cycle of energy transfer beginning with and returning to bacteriochlorophyll, hence it is called cyclic photophosphorylation. Importance of bacterial photosynthesis: The most important usefulness of photobacteria is in analysis of evolution of photosynthetic systems. Since all photosynthetic bacteria still possess ancient arrangement and structure of their photosynthetic apparatus. It also gives an evolutionary evidence for origin of chloroplasts. The use of chemical reductants other than water by photosynthetic bacteria is a strong geological evidence to support the theory of ancient reducing atmosphere on the Earth. Genetic approaches involving mutational analysis and directed mutagenesis are very useful to study photosynthetic reaction centers, electron transfer mechanisms and gene arrangements; because this knowledge about plant photosynthesis is still in infancy. Photobacteria could have multiple biotechnological applications such as production also the overproduction if necessary of enzymes and pharmaceuticals for the simplest reason that no carbon source needs to be added in their growth medium. Photosynthetic bacteria find potential application in bioremediation of polluted aquatic environments since they can grow and utilize toxic substances like H2S or H2S2O3. The ongoing research is to use these bacteria to produce clean fuels using light energy in the process of photosynthesis.

5: Cyanobacteria - Wikipedia

Photosynthetic bacteria are a unique species of microorganisms that use the sun as a source of energy. Plants use a substance called chlorophyll to absorb the sun's rays and turn it into the nutrients needed for everyday maintenance and growth.

Chloroplast and Thylakoid In photosynthetic bacteria, the proteins that gather light for photosynthesis are embedded in cell membranes. In its simplest form, this involves the membrane surrounding the cell itself. A typical plant cell contains about 10 to chloroplasts. The chloroplast is enclosed by a membrane. This membrane is composed of a phospholipid inner membrane, a phospholipid outer membrane, and an intermembrane space. Enclosed by the membrane is an aqueous fluid called the stroma. Embedded within the stroma are stacks of thylakoids grana , which are the site of photosynthesis. The thylakoids appear as flattened disks. The thylakoid itself is enclosed by the thylakoid membrane, and within the enclosed volume is a lumen or thylakoid space. Embedded in the thylakoid membrane are integral and peripheral membrane protein complexes of the photosynthetic system. Plants absorb light primarily using the pigment chlorophyll. The green part of the light spectrum is not absorbed but is reflected which is the reason that most plants have a green color. Besides chlorophyll, plants also use pigments such as carotenes and xanthophylls. These pigments are embedded in plants and algae in complexes called antenna proteins. In such proteins, the pigments are arranged to work together. Such a combination of proteins is also called a light-harvesting complex. Although all cells in the green parts of a plant have chloroplasts, the majority of those are found in specially adapted structures called leaves. Certain species adapted to conditions of strong sunlight and aridity , such as many Euphorbia and cactus species, have their main photosynthetic organs in their stems. The cells in the interior tissues of a leaf, called the mesophyll , can contain between , and , chloroplasts for every square millimeter of leaf. The surface of the leaf is coated with a water-resistant waxy cuticle that protects the leaf from excessive evaporation of water and decreases the absorption of ultraviolet or blue light to reduce heating. The transparent epidermis layer allows light to pass through to the palisade mesophyll cells where most of the photosynthesis takes place. Light-dependent reactions Main article: Light-dependent reactions In the light-dependent reactions , one molecule of the pigment chlorophyll absorbs one photon and loses one electron. This electron is passed to a modified form of chlorophyll called pheophytin , which passes the electron to a quinone molecule, starting the flow of electrons down an electron transport chain that leads to the ultimate reduction of NADP to NADPH. In addition, this creates a proton gradient energy gradient across the chloroplast membrane , which is used by ATP synthase in the synthesis of ATP. The chlorophyll molecule ultimately regains the electron it lost when a water molecule is split in a process called photolysis , which releases a dioxygen O2 molecule as a waste product. The overall equation for the light-dependent reactions under the conditions of non-cyclic electron flow in green plants is: The photosynthetic action spectrum depends on the type of accessory pigments present. For example, in green plants, the action spectrum resembles the absorption spectrum for chlorophylls and carotenoids with absorption peaks in violet-blue and red light. In red algae, the action spectrum is blue-green light, which allows these algae to use the blue end of the spectrum to grow in the deeper waters that filter out the longer wavelengths red light used by above ground green plants. The non-absorbed part of the light spectrum is what gives photosynthetic organisms their color e. The light-dependent reactions are of two forms: In the non-cyclic reaction, the photons are captured in the light-harvesting antenna complexes of photosystem II by chlorophyll and other accessory pigments see diagram at right. The absorption of a photon by the antenna complex frees an electron by a process called photoinduced charge separation. The antenna system is at the core of the chlorophyll molecule of the photosystem II reaction center. That freed electron is transferred to the primary electron-acceptor molecule, pheophytin. The electron enters a chlorophyll molecule in Photosystem I. There it is further excited by the light absorbed by that photosystem. The electron is then passed along a chain of electron acceptors to which it transfers some of its energy. The energy delivered to the electron acceptors is used to move hydrogen ions across the thylakoid membrane into the lumen. The cyclic reaction takes place only at photosystem I. Once the electron is displaced from the photosystem, the electron is passed down the electron acceptor molecules and returns to photosystem I, from where it was emitted, hence the name cyclic reaction. Water photolysis Main articles: Photodissociation and Oxygen evolution The NADPH is the main reducing agent produced by chloroplasts, which then goes on to provide a source of energetic electrons in other cellular reactions. Its production leaves chlorophyll in photosystem I with a deficit of electrons chlorophyll has been oxidized , which must be balanced by some other reducing agent that will supply the missing electron. The excited electrons lost from chlorophyll from photosystem I are supplied from the electron transport chain by plastocyanin. However, since photosystem II is the first step of the Z-scheme, an external source of electrons is required to reduce its oxidized chlorophyll a molecules. The source of electrons in green-plant and cyanobacterial photosynthesis is water. Two water molecules are oxidized by four successive charge-separation reactions by photosystem II to yield a molecule of diatomic oxygen and four hydrogen ions; the electrons yielded are transferred to a redox-active tyrosine residue that then reduces the oxidized chlorophyll a called P that serves as the primary light-driven electron donor in the photosystem II reaction center. That photo receptor is in effect reset and is then able to repeat the absorption of another photon and the release of another photo-dissociated electron. The hydrogen ions released contribute to the transmembrane chemiosmotic potential that leads to ATP synthesis. Oxygen is a waste product of light-dependent reactions, but the majority of organisms on Earth use oxygen for cellular respiration , including photosynthetic organisms. Light-independent reactions and Carbon fixation In the light-independent or "dark" reactions, the enzyme RuBisCO captures CO2 from the atmosphere and, in a process called the Calvin-Benson cycle , it uses the newly formed NADPH and releases three-carbon sugars, which are later combined to form sucrose and starch. The overall equation for the light-independent reactions in green plants is [24]: The simple carbon sugars produced by photosynthesis are then used in the forming of other organic compounds, such as the building material cellulose , the precursors for lipid and amino acid biosynthesis, or as a fuel in cellular respiration. The latter occurs not only in plants but also in animals when the energy from plants is passed through a food chain. The fixation or reduction of carbon dioxide is a process in which carbon dioxide combines with a five-carbon sugar, ribulose 1,5-bisphosphate , to yield two molecules of a three-carbon compound, glycerate 3-phosphate , also known as 3-phosphoglycerate. This product is also referred to as 3-phosphoglyceraldehyde PGAL or, more generically, as triose phosphate. Most 5 out of 6 molecules of the glyceraldehyde 3-phosphate produced is used to regenerate ribulose 1,5-bisphosphate so the process can continue. The triose phosphates not thus "recycled" often condense to form hexose phosphates, which ultimately yield sucrose , starch and cellulose. The sugars produced during carbon metabolism yield carbon skeletons that can be used for other metabolic reactions like the production of amino acids and lipids. Carbon concentrating mechanisms Overview of C4 carbon fixation In hot and dry conditions, plants close their stomata to prevent water loss. Some plants have evolved mechanisms to increase the CO2 concentration in the leaves under these conditions. C4 carbon fixation Plants that use the C4 carbon fixation process chemically fix carbon dioxide in the cells of the mesophyll by adding it to the three-carbon molecule phosphoenolpyruvate PEP , a reaction catalyzed by an enzyme called PEP carboxylase , creating the four-carbon organic acid oxaloacetic acid. Oxaloacetic acid or malate synthesized by this process is then translocated to specialized bundle sheath cells where the enzyme RuBisCO and other Calvin cycle enzymes are located, and where CO2 released by decarboxylation of the four-carbon acids is then fixed by RuBisCO activity to the three-carbon 3-phosphoglyceric acids. The physical separation of RuBisCO from the oxygen-generating light reactions reduces photorespiration and increases CO2 fixation and, thus, the photosynthetic capacity of the leaf. Many important crop plants are C4 plants, including maize, sorghum, sugarcane, and millet. Plants that do not use PEP-carboxylase in carbon fixation are called C3 plants because the primary carboxylation reaction, catalyzed by RuBisCO, produces the three-carbon 3-phosphoglyceric acids directly in the Calvin-Benson cycle. CAM plants have a different leaf anatomy from C3 plants, and fix the CO2 at night, when their stomata are open. CAM plants store the CO2 mostly in the form of malic acid via carboxylation of phosphoenolpyruvate to oxaloacetate, which is then reduced to malate. Decarboxylation of malate during the day releases CO2 inside the leaves, thus allowing carbon fixation to 3-phosphoglycerate by RuBisCO. Sixteen thousand species of plants use CAM. They cannot cross the membrane as they are charged, and within the cytosol they turn back into CO_2 very slowly without the help of carbonic anhydrase.

6: Bacteriology - Purple Non-Sulfur Photosynthetic Bacteria

Photosynthetic bacteria are phototropic, meaning they are able to produce their own food from photosynthesis within themselves. Or, to put in a more complicated way: Excepts from the following page: Chapter 2 Photosynthetic bacteria Photosynthetic bacteria convert light energy into chemical free.

Introduction Although the process of photosynthesis is most commonly associated with plants and algae, much of our understanding of the molecular basis for light energy capture and photochemical energy transduction has come from studies of photosynthetic bacteria. Space precludes a detailed description of the different types of photosynthetic bacteria, and so this article will focus in the main on the most heavily studied group of anoxygenic phototrophs, with only brief mention of their less well-known cousins. The cyanobacteria, which carry out a process of oxygenic photosynthesis common to that found in green plants and algae, are not covered in this article. Accordingly, the bibliography at the end of the article includes some general works that provide more detailed and comprehensive information, and in some instances, in-the-text citations are to recent review articles rather than original research papers. Regarding general works, in particular, the reader is guided to a book by Blankenship , which provides a detailed and accessible account of the light reactions of photosynthesis, and the underlying physical chemistry, and also to a recent book edited by Hunter et al. Energy Transduction in the Anoxygenic Photosynthetic Bacteria The bacteria that use chlorophyll-type molecules to exploit sunlight as an energy source comprise the purple phototrophic bacteria, green sulphur bacteria, green filamentous bacteria, the heliobacteria and the cyanobacteria. All but the last of these transduce light energy into a biologically-useful form without the generation of oxygen from the oxidation of water, and are classed as anoxygenic photosynthetic bacteria. The most heavily-studied group are the purple phototrophic bacteria, for a variety of reasons including metabolic flexibility, genetic accessibility, and the relatively simple and modular nature of their photosynthetic apparatus. In general terms, the strategy for solar energy utilization in all organisms that contain chlorophyll Chl or bacteriochlorophyll BChl is the same. Light energy is captured by pigment molecules in the light harvesting or "antenna" region of the photosystem, and is stored temporarily as an excited electronic state of the pigment. Excited state energy is channeled to the reaction centre region of the photosystem, a pigment-protein complex embedded in a charge-impermeable lipid bilayer membrane. Arrival of the excited state energy at a particular bacteriochorophyll BChl , or pair of BChls in the reaction centre triggers a photochemical reaction that separates a positive and negative charge across the width of the membrane. Charge separation initiates a series of electron transfer reactions that are coupled to the translocation of protons across the membrane, generating an electrochemical proton gradient [protonmotive force pmf] that can be used to power reactions such as the synthesis of ATP. The minimal photosynthetic unit in purple phototrophic bacteria comprises a reaction centre RC surrounded by a light harvesting complex called LH1. Together these form the so-called RC-LH1 complex, and this is capable of converting light energy into a pmf in partnership with a second membrane-embedded electron transfer protein, the cytochrome cyt bc1 complex termed bc1 below. In some species, light harvesting capacity is augmented by one or more types of peripheral antenna complex, termed LH2, LH3, and so on. A number of general reviews on the structure and mechanism of the purple bacterial photosystem have been published Hu et al. The main light harvesting pigment in purple photosynthetic bacteria is not chlorophyll but bacteriochlorophyll BChl , a closely related magnesium porphyrin that has a more saturated tetrapyrrole ring Figure 1A. This causes BChl to absorb at significantly longer wavelengths than chlorophyll in the near infrared, the absorbance spectrum being dictated by the details of the conjugated electron system of the macrocycle Blankenship, Figure 1A. Light harvesting is also carried out by a variety of carotenoids that provide the main pigmentation in the visible region of the spectrum, and so make purple bacteria purple or a variety of other colours. Figure 1B shows the absorbance spectrum of photosynthetic membranes prepared from Rhodobacter Rba. A The structure of bacteriochlorophyll a. Carbon and oxygen atoms that form part of the electron system are shown in yellow and red, respectively, with other carbon and oxygen atoms in white and orange. The central Mg magenta sphere is coordinated in-plane by the four pyrrole nitrogens blue , plus a fifth out-of-plane ligand donated by the protein not shown. The five rings are numbered as shown, and the labelled carbonyl groups provide additional potential points of attachment to the protein. X-ray crystallography and other structural techniques have revealed that the light harvesting pigment-proteins of purple bacteria have a cylindrical architecture. The LH2 pigment-protein from Rhodopseudomonas acidophila. Views are parallel left and perpendicular right to the plane of the membrane. The 18 B BChls which absorb strongly at nm are shown as spheres, in alternating red and orange, and the nine B BChls which absorb strongly at nm are shown as green sticks with the central Mg shown as a sphere. The macrocycles of the B and B BChls are arranged perpendicular and parallel, respectively, to the plane of the membrane. The BChls of LH2 form two rings that are arranged approximately in the plane of the membrane. These "B" BChls have a prominent absorbance band at nm. The second ring comprises nine "B" BChls, which are arranged with the macrocycle of each BChl parallel to the plane of the membrane, and gives rise to a prominent absorbance band at nm. The LH2 complex also contains light harvesting carotenoids, although for clarity these are not shown in Figure 2. Peripheral LH complexes from other species show variations on this theme, e. The LH2 from Rba. To date a high resolution X-ray crystal structure for a RC-LH1 complex has not been reported, and the most detailed information available is from a 4. This shows a central RC surrounded by a cylindrical LH1 with a roughly oval cross section in the membrane plane. LH1 contains carotenoids and single type of "B" BChl, arranged in a ring with each BChl macrocycle perpendicular to the membrane. The nm absorbance band of the Rba. The 30 B BChls are shown as spheres, in alternating red and orange, their macrocycles being arranged perpendicular to the plane of the membrane. The central RC is shown as ribbons and spheres for polypeptides and cofactors, respectively see Figure 4. The function of this component is unclear, but it has been speculated that it is related to the PufX polypeptide, which is a minor component of the RC-LH1 complex in Rhodobacter Rba. The function of the carotenoids and BChls of the antenna is to feed the RC with excited state energy. The following is a brief summary of the heavily-studied Rba. The BChl, BPhe and quinone cofactors are arranged within a protein scaffold formed by the L- and M-polypeptides in two approximately symmetrical membrane-spanning branches Figure 4B. The arrival of excitation energy at a "special pair" of nm-absorbing BChls denoted P at the periplasmic end of the RC triggers a membrane-spanning four-step electron transfer along the A-branch of cofactors, which results in the reduction of a quinone at the so-called QB site near the cytoplasmic side of the membrane Jones, Overall structure and cofactors of the RC from Rba. A The cofactors spheres are encased by the largely intra-membrane L and M polypeptides beige and light-green ribbons, respectively. The H polypeptide has an extra-membrane domain, and a single anchoring -helix salmon ribbons. B The cofactors are shown as sticks, with Mg and Fe atoms shown as purple or brown spheres, respectively. Hydrocarbon side chains of the BChl, BPhe and quinone cofactors are truncated for clarity. Carbon atoms are coloured thus: Oxygens and nitrogens are shown in red and blue, respectively. The BChl, BPhe, and quinone cofactors are arranged in two membrane-spanning branches around an axis of two-fold pseudo-symmetry that connects P with the Fe atom. As outlined below, the RC operates as a light-powered cytochrome c2: The X-ray crystal structure of the Rba. At the core of the bc1 is a cyt b, comprising a membrane-spanning helix bundle encasing two hemes termed bL and bH. These form a membrane-spanning electron transfer chain that links a ubiquinol oxidase site near the periplasmic side of the membrane Qo with a quinone reductase site near the periplasmic side Qi. The bc1 also contains a Rieske iron sulphur Fe-S protein containing a 2Fe-2S centre and a cyt c1, both of which have domains on the periplasmic side of the membrane, and a single membrane-spanning -helix. Each Rieske protein connects across the dimer, the membrane-spanning -helix associating with one monomer, and the extra-membrane domain associating with the second monomer. Overall structure and cofactors of the bc1 dimer from Rba. A In the view presented, parallel to the plane of the membrane, one half is shown as a solid object, and the second half as ribbons and spheres for the protein and cofactors, respectively. Each monomer comprises a cyt b beige , cyt c1 green and Rieske Fe-S protein pink. B View in the plane of the membrane of a stick model of the cofactors of one half of the bc1 dimer. Heme Fe atoms are shown as small spheres, and the FeS centre as large spheres. Oxygens, nitrogens, irons and sulphurs are shown in red, blue, brown and yellow, respectively. Photosystem Mechanism The purple bacterial photosystem is capable of harvesting light energy over a range of wavelengths see above. Energy absorbed in the Soret or Qx regions is converted to the lowest-energy Qy excited state through internal conversion. The final step involves the transfer of excited state energy to the P dimer of BChls in the RC, triggering photochemical charge separation. Funneling of excited state energy into the RC is therefore achieved by having red-shifted low-energy BChls closest to the RC. Energy transfer in the purple bacterial photosystem. Lifetimes in picoseconds ps are given for the energy transfer events indicated by the arrows. Energy absorbed by antenna carotenoids is passed to neighbouring BChls. Double-headed arrows indicate femtosecond fs energy migration within the B or B pigment rings. The excited state lifetime of BChl is of the order of a few nanoseconds, which means that energy absorbed by antenna pigments has to be funneled to the RC on a time scale of a few tens to hundreds of ps. This arrangement, where the charge-separating Chls or BChls of the RC are separated from the light-harvesting Chls or BChls of the antenna by an exclusion zone formed by the protein scaffold, is also a feature of the structure of both PS1 and PS2 of oxygenic photosynthesis. This architecture appears to have two principal functions, to ensure that unproductive back transfer of excitation energy detrapping is slow compared to productive charge-separation which takes place in a few ps , and to ensure that the efficiency of membrane-spanning charge separation is not interfered with by unwanted electron transfer reactions between RC and antenna BChls. The process of photochemical charge separation is described in detail in the related module by Yocum on RCs. A summary of the reactions catalysed by the Rba. Acquisition of excited state energy converts P into a sufficiently powerful reductant to be able to donate an electron to the adjacent BA BChl. A second light-induced charge separation results in double reduction of the QB quinone, delivery of the second electron being accompanied by the uptake of two protons from the cytoplasm to form ubiquinol [dihydroquinone QH2]. These mobile products are then used as substrates by the bc1 Figure 5 Hunte et al. Oxidation of QH2 takes place at a site Qo near the periplasmic side of the membrane and is a bifurcated reaction, one electron being used to reduce cyt c2 by passage through the so-called high-potential chain formed by the Rieske Fe-S protein and cyt c1 Figure 5 , accompanied by the release of a proton. A notable feature of this reaction is a large scale change in the conformation of the Rieske protein, that moves the Fe-S centre away from the Qo site and towards the cyt c1 heme. This movement prevents the second electron from being passed to the Rieske Fe-S centre. Instead, accompanied by release of the second proton, the second electron is passed back across the membrane via two b-type hemes to a second quinone reductase site Qi. Oxidation of a second QH2 at the Qo site results in the reduction of a second cyt c2 via the high potential chain, and double reduction and protonation of the quinone at the Qi site. Figure 7 summarises the movement of quinone and cyt c2 between binding sites on the RC and bc1, and the proton translocation that is powered by sunlight. Light driven cyclic electron transfer and proton pumping. The RC acts in partnership with the bc1 to translocate protons across the photosynthetic membrane, transducing sunlight into the energy of the protonmotive force. Dashed black arrows show the movement of reducing equivalents between the RC and bc1, or between the cytoplasmic and periplasmic side sides of the bc1, by the mobile carriers ubiquinol and cyt c2. Blue arrows show sites for the uptake of protons from the cytoplasm, and red arrows the site of proton release into the periplasm. The migration of electrons internal to the RC and bc1 is not shown. The view of the bc1 dimer shows the Qi site of one monomer, and the Qo site of the second monomer Summaries of this process from the points of view of redox potential and free energy are shown in Figure 8. Figure 8B shows operation of the RC from the standpoint of free energy. However, part of this energy is preserved in the form of the energy of the pmf formed through the proton translocation that is coupled to electron flow. This pmf is then used to power a variety of energy-requiring reactions, including ATP synthesis, active transport, motion of the bacterial flagellum, and so on. Redox potential and energetics of electron transfer in the Rba.

7: Difference between Plant Photosynthesis and Bacterial Photosynthesis ~ Biology Exams 4 U

Start studying Photosynthetic bacteria. Learn vocabulary, terms, and more with flashcards, games, and other study tools.

Hydrothermal Vent Source Chemosynthetic Bacteria Chemosynthetic bacteria are organisms that use inorganic molecules as a source of energy and convert them into organic substances. Chemosynthetic bacteria, unlike plants, obtain their energy from the oxidation of inorganic molecules, rather than photosynthesis. Chemosynthetic bacteria use inorganic molecules, such as ammonia, molecular hydrogen, sulfur, hydrogen sulfide and ferrous iron, to produce the organic compounds needed for their subsistence. Most chemosynthetic bacteria live in environments where sunlight is unable to penetrate and which are considered inhospitable to most known organisms. An organism that produces organic molecules from organic carbon is classified as a chemoheterotroph. Chemoheterotrophs are at the second level in a food chain. All living organisms obtain their energy in two different ways. The means by which organisms obtain their energy depends on the source from which they derive that energy. Some organisms obtain their energy from the sun by the process of photosynthesis. These organisms are known as phototrophs because they can make their own organic molecules using sunlight as a source of energy. Among the organisms that can use sunlight as a source of energy include plants, algae and some species of bacteria. The organic molecules produced by phototrophs are used by other organisms known as heterotrophs, which derive their energy from phototrophs, that is to say, they use the energy from the sun, indirectly, by feeding on them, producing the organic compounds for their subsistence. Heterotrophs include animals, humans, fungi, and some species of bacteria, such as those found in the human intestines. Photosynthesis Phototroph Source Chemosynthesis The second way in which organisms can obtain their energy is through chemosynthesis. Organisms living in regions where sunlight is not available produce their energy by the process of chemosynthesis. During chemosynthesis, bacteria use the energy derived from the chemical oxidation of inorganic compounds to produce organic molecules and water. This process occurs in the absence of light. The survival of many organisms living in the ecosystems of the world depends on the ability of other organisms to convert inorganic compounds into energy that can be used by these and other organisms. Plants, algae, and bacteria have the ability to use sunlight, water, and carbon dioxide CO_2 and convert them into organic compounds necessary for life in a process called photosynthesis. Photosynthesis may take place in marine or terrestrial environments where the producing organisms are able to use sunlight as a source of energy. Chemosynthesis occurs in environments where sunlight is not able to penetrate, such as in hydrothermal vents at the bottom of the ocean, coastal sediments, volcanoes, water in caves, cold seeps in the ocean floor, terrestrial hot springs, sunken ships, and within the decayed bodies of whales, among many others. Chemosynthetic bacteria use the energy stored within inorganic chemicals to synthesize the organic compounds needed for their metabolic processes. The dissolved chemicals, including hydrogen sulfide, methane, and reduced sulfate metals, form chimney-like structures known as black smokers. Hydrothermal vents are located very deep into the ocean where sunlight is unable to penetrate; therefore, the organisms that live at hydrothermal vents obtain their energy from the chemicals ejected out from the ocean crust. The giant tube worm Riftia pachyptila lives in a symbiotic relationship with sulfur-oxidizing bacteria. Since the energy from the Sun cannot be utilized at such depths, the tube worm absorbs hydrogen sulfide from the vent and provides it to the bacteria. The bacteria capture the energy from the sulfur and produces organic compounds for both the tube worm and the bacteria. Extremophiles are organisms that thrive under conditions that are considered detrimental for most organisms. These organisms can live in habitats where no other organisms can, and are capable of tolerating a wide range of hostile environmental conditions. These organisms are termed based on the conditions in which they grow, thus, some are thermophiles, psychrophiles, acidophiles, halophiles, etc. There are extremophiles that are able to grow in more than one habitat and are termed polyextremophiles. Microbes are extremely adaptable to harsh environment conditions and it is believed that extremophiles could be found in every unimaginable place on Earth. Extremophiles are organisms that can live in very harsh environments. Although most of them are microbes, there are some which do not fall into the classification of archaea and bacteria It is believed that the first organisms inhabiting the Earth were chemosynthetic bacteria that produced oxygen and later evolved into animal and plant-like organisms. Some organisms that rely on chemosynthesis to derive the energy they need include nitrifying bacteria, sulfur-oxidizing bacteria, sulfur-reducing bacteria, iron-oxidizing bacteria, halobacterium, bacillus, clostridium, and vibrio, among others. Chemosynthetic Bacteria Questions must be on-topic, written with proper grammar usage, and understandable to a wide audience. Do chemosynthetic organisms convert energy, stored within inorganic molecules, into chemical energy for primary production? Chemosynthetic organisms-also called chemoautotrophs-use carbon dioxide, oxygen and hydrogen sulfide to produce sugars and amino acids that other living creatures can use to survive. They are the primary producers in their food web. An example of this is the bacteria living inside the tubeworms in a hydrothermal vent.

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8: Photosynthetic | Define Photosynthetic at www.enganchecubano.com

Chemosynthetic bacteria are organisms that use inorganic molecules as a source of energy and convert them into organic substances. Chemosynthetic bacteria, unlike plants, obtain their energy from the oxidation of inorganic molecules, rather than photosynthesis. Chemosynthetic bacteria use inorganic.

Another early word for it was photosyntax. Barnes, made a year ago before the American Association at Madison, who clearly pointed out the need of a distinctive term for the synthetical process in plants, brought about by protoplasm in the presence of chlorophyll and light. He proposed the word "photosyntax," which met with favor. In the discussion Professor MacMillan suggested the word "photosynthesis," as etymologically more satisfactory and accurate, a claim which Dr. Barnes showed could not be maintained. The suggestion of Dr. Barnes not only received tacit acceptance by the botanists of the association, but was practically approved by the Madison Congress in the course of a discussion upon this point. The process in green plants and certain other organisms by which carbohydrates are synthesized from carbon dioxide and water using light as an energy source. Published by Houghton Mifflin Company. In plants and algae, photosynthesis takes place in organelles called chloroplasts. Photosynthesis is usually viewed as a two-step process. First, in the light reactions, the energy-providing molecule ATP is synthesized using light energy absorbed by chlorophyll and accessory pigments such as carotenoids and phycobilins, and water is broken apart into oxygen and a hydrogen ion, with the electron of the hydrogen transferred to another energy molecule, NADPH. In these light-independent or dark reactions, carbon is broken away from carbon dioxide and combined with hydrogen via the Calvin cycle to create carbohydrates. Some of the carbohydrates, the sugars, can then be transported around the organism for immediate use; others, the starches, can be stored for later use. See Note at transpiration. Show More A Closer Look: Almost all life on Earth depends on food made by organisms that can perform photosynthesis, such as green plants, algae, and cyanobacteria. These organisms make carbohydrates from carbon dioxide and water using light energy from the Sun. They capture this energy with various pigments which absorb different wavelengths of light. The most important pigment, chlorophyll a, captures mainly blue and red light frequencies, but reflects green light. In plants, the other pigments are chlorophyll b and carotenoids. The carotenoids are usually masked by the green color of chlorophyll, but in temperate environments they can be seen as the bright reds and yellows of autumn after the chlorophyll in the leaves has broken down. The energy gathered by these pigments is passed to chlorophyll a. During the light reactions, the plant uses this energy to break water molecules into oxygen O2 , hydrogen ions, and electrons. The light reactions produce more oxygen than is needed for cellular respiration, so it is released as waste. During the dark reactions, the plant uses hydrogen ions and the electrons to make carbon dioxide into carbohydrates. Within the leaf of a green plant, photosynthesis takes place in chlorophyll-containing chloroplasts in the columnlike cells of the palisade layer and in the cells of the spongy parenchyma. The cells obtain carbon dioxide from air that enters the leaf through holes called stomata, which also allow excess oxygen to escape. Water from the roots is brought to the leaf by the vascular tissues called xylem, while the carbohydrates made by the leaf are distributed to the rest of the plant by the vascular tissue called phloem. Photosynthesis also produces the sugars that feed the plant. Show More Note Green plants depend on chlorophyll to carry out photosynthesis.

9: The Process of Bacterial Photosynthesis and its Importance

Bacteria - Cyanobacteria and Anoxygenic Photosynthetic Bacteria Photosynthesis in Plants This is a colored transmission electron micrograph (TEM) of two chloroplasts seen in the leaf of a pea plant Pisum sativum.

Bdellovibrio, Myxococcus, Campylobacter, Helicobacter Purple bacteria contain Bchl a, Bchl b and show the photosynthetic membranes in flat sheets lamellae. Certain bacteria Chromatium sp. The colour of the purple bacteria shows brown, pink brown-red, purple-violet based on carotenoid contents. The internal membrane extends to give rise to photosynthetic pigments. The photosynthetic pigments and internal membrane are influenced by light intensity. At high intensity, photo-apparatus is inhibited, whereas the cells get packed with membranes when grown at low light intensity. Carotenoids give rise to purple colour; mutants lack carotenoids are blue green reflecting the actual colour of BChl a. Purple bacteria are of two types: They are Gram-negative bacteria which contain BChl a and BChl b and grow chemolithotrophically in dark with thiosulphate as eâ€" donor. They are also chemoorganotrophs; utilize acetate, pyruvate and few other compounds. The cells of purple-sulphur bacteria are larger than green bacteria and packed with intracellular sulfide deposition. They are found in anoxic zone of lakes and sulphur springs obligate anaerobe. They contain vesicles that are enclosed within a thin membrane that is not directly associated with the cell membrane called vesicular thylakoid. They are photolithotrophs and motile in nature e. Ectothiorhodospiraceae old name Rhodospirillaceae: They also contain BChl a and b and use low concentration of sulphide. The concentration of sulphide utilized by purple-sulphur bacteria proved toxic to this category of bacteria. Earlier, scientists thought that these bacteria are unable to use sulphide as an eâ€" donor for the reduction of CO2 to cell material, hence named them non-sulphur. They deposit sulphur extracellularly. This group is most versatile energetically due to broad requirements and are photo-organotrophs i. They also grow as chemoorganotrophs and require vitamins. They are heterogenous group due to the presence of both polar and peritrichous flagella. Some can utilize methanol for phototrophic growth when grown anaerobically. The following reaction occurs inside their cell: Examples of purple non-sulphur bacteria are Rhodomicrobium, Rhodopseudomonas, Rhodospirillum, Rhodocyclus, etc. Instead of green in colour, these are brown due to the presence of carotenoids components. Hence, colour is not a suitable basis for these bacteria. These vesicles are enclosed within a thin membrane devoid of bilayer but consist of transporter proteins located in the cytoplasmic membrane. They do not require vitamins for their growth. Green bacteria are of two types: Green sulphur bacteria and Green non-sulphur bacteria. They are non-motile, rods, spiral and cocci. Some have appendages i. Chlorosomes are present in the cell. They do not possess gas vesicles Chlorobium except in Pelodictyon. They are strictly anaerobic and obligate phototroph. Most of them assimilate simple oxygenic substances for photosynthetic growth if sulphur source is present. Some Chloroflexus grow chemoorganotrophically, hence they are non-sulphur green type. Examples of these bacteria are Chlorobium, Prostheochloris, Pelodictyon, Chloroherpeton. The green non-sulphur bacteria are filamentous, gliding bacteria, thermophilic in nature. The chlorosomes are present when grown anaerobically. They are photoheterotrophic and photoautotrophic and show gliding movement. They do not deposit sulphur. Based on 16S rRNA sequencing and other morphological and biochemical characters, helicobacter are quite different with other anoxygenic photosynthetic bacteria. They are Gram-positive, rod shaped, motile either by gliding or by means of flagella. The heliobacteria are green in colour. The baeteriochlorophyll is associated with the cytoplasmic membrane; hence lamellae and chlorosomes are absent. The endospores contain a dipicolinic acid similar to Bacillus and Clostridium. Most of the heliobacteria are found in tropical soils of paddy fields. One group, prochlorophytes lack phycobilins, but contain both bacteriochlorophyll a and b. They are mostly represented by Gram-negative cyanobacteria having only membrane. Many possess extracellular sheath called glycocalyx or capsule or merely mucilage or slime. The flagella are not present but they show gliding movement. The light harvesting pigments are phycobilin proteins, phycoerythrin, phycocyanin, bacteriochlorophyll a and carotenoids but sheath capsule may contain yellow pigment called scytonemin or red-blue pigment gloeocapsin which may mask cellular pigmentation. Phycobilins form phyobilisomes on both surfaces on double unit internal membrane called thylakoids. Bacteriochlorophyll a and carotenoids are part of it. Photosynthesis is oxygenic and autotrophic but chemoautotrophy also occurs. Photosynthates get accumulated in the form of glycogen, polyphosphate granules. Carboxysomes and gas vesicles are present. Heterocysts have modified thylakoids containing low contents of photosynthetic pigments and lack of photosystem II. Akinetes are thick walled resistant storage cells. Some non symbiotic bacteria lack typical cyanobacteria wall is termed cyanelles. They are put into the following five sub-groups: They are unicellular or non-filamentous aggregates of cells held together by outer walls or a gel-like matrix. Binary fission occurs on one, two or three planes symmetric or asymmetrically or by budding. Examples of the members are Gloeothece, Synechococcus, Gloeocapsa, Gloeobacter. In the members of this group, reproduction takes place by internal multiple fission with production of daughter cells smaller than Vi the parent or by multiple and binary fission e. Binary fission occurs in one plane only. Trichomes are composed of cells which do not differentiate into heterocysts or akinetes e. Spirulina, Arthospira, Oscillatropia, Phormidium, Lyngbya. Some genera also produce akinetes e. Cylindrospermum, Anabaena, Nodularia, Calothrix, Nostoc. Binary fission occurs periodically or commonly in more than one plane giving rise to mulitseriate trichomes or trichomes with true branches or both e. On the other hand, group II in section 19 of Prochloron was first discovered as an extracellular symbiont growing either on the surface or within the cloacal cavity of marine colonial ascidian invertebrates. These bacteria are unicellular, spherical and 8. In addition, Prochlorothrix is free living, consists of cylindrical cells that form filaments. It has been found in Dutch lakes. The DNA has a high mol. They have bacteriochlorophylls a and b and lack accessory red or blue bilin pigment e. The prochlorophytes bear the following characters: This shows evolution of thylakoid from single to paired form. The chlorophyta consists of both chlorophyll a and chlorophyll b. Porphyrobacter neustonensis, an aerobic bacteriochlorophyll synthesizing budding bacterium from fresh water and Roseobacter denitrificans was discovered by Fuert and others in the year The genus Erythromicrobium sibericus was isolated by Yukov and his Research team in the year , while it is interesting to note the discovery of one photosynthetic as well as nitrogen fixing Rhizobium B T Ai by Evans and others in Pseudomonas radiora is again an interesting photosynthetic bacteria. Metabolism in Photosynthetic Bacteria: The green bacteria are strictly aerobic organisms that are obligately photosynthetic. The purple bacteria contain two groups: Lipids containing short chain fatty acids are suitable substrate. The photosynthetic bacteria found in deeper water are called meromictic where conditions are anaerobic but light is available. They are helpful in early evolutionary forms of life due to their independence without oxygen. The bacteriochlorophylls shows absorption spectrum in an acetone-methanol mixture near ultra-red spectrum at nm. Most of the photosynthetic bacteria contain bacteriochlorophyll as given in Table

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