

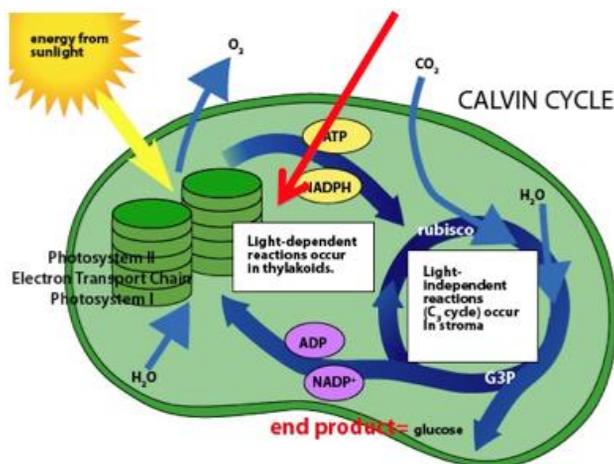


Name: _____ Date: _____ Group: _____

Sweet Sunshine

Lexile 1060L

- 1 Photosynthesis is the foundation of most life on earth. The basic chemistry of photo-synthesis was explained by several scientists in the 16th, 17th, and 18th centuries. Carbon dioxide (CO₂) and water (H₂O) combine in the presence of light to produce sugars (C₆H₁₂O₆) and oxygen gas (O₂). The actual structures responsible for photosynthesis were discovered more recently. These structures include chloroplasts and the proteins responsible for each chemical reaction. The overall chemical reaction for photosynthesis is:



- 2 Let's look in more detail at the structures that perform photosynthesis and the reactions they make happen. Plant cells that participate in photosynthesis contain chloroplasts. These are very important organelles that organize the parts necessary for photosynthesis. The name chloroplast is derived from Greek, where "chloro-" means "green" and "-plast" means "made" or "formed". Chloroplasts are surrounded by two membranes and contain some of their own DNA. Because of these two characteristics, scientists hypothesize that chloroplasts were once free-living bacteria that were taken in by primitive cells billions of years ago. The inside of a chloroplast contains fluid called stroma and stacks of thylakoid discs. Plant cells inherit their chloroplasts from their parent cell. As a plant cell grows larger, chloroplasts divide by pinching in half.
- 3 Plants mainly carry out photosynthesis in their green leaf structures. Leaves consist of several different layers of cells, and the cross section of a leaf looks a lot like a sandwich. Cells that participate in photosynthesis are located near the upper surface of the leaf, closer to the sunlight. The bottom surface of the leaf has small holes called stomata, which can be opened and closed by guard cells surrounding each stoma. Stomata allow CO₂ from the atmosphere to enter the leaves. CO₂ then diffuses into the photosynthetic cells. The water needed by photosynthesis is absorbed through the roots of the plant and transported to each leaf through tubes called xylem. Minerals such as magnesium also travel through the xylem. The sugars synthesized during photosynthesis travel through phloem to the roots, where they are stored. In addition to synthesizing sugars in photosynthesis, chloroplasts also synthesize other molecules, such as building blocks for fats and proteins.



- 4 Photosynthesis consists of two sets of linked reactions. The light-dependent reaction only occurs when sunlight shines on the plant. It converts light energy into chemical energy and releases O_2 . The light-independent reaction can occur in the absence of light. Stored chemical energy and CO_2 are converted into $C_6H_{12}O_6$. The speed of these reactions is tightly controlled so the plant is most efficient. Let's look at the light reaction in more detail first.
- 5 All the parts necessary for the light-dependent reaction are located in the membrane of the thylakoid discs inside the chloroplast. Having the proteins close together and in the proper order makes it easy for the steps to occur rapidly and in the right sequence. The first step in photosynthesis is light absorption. Chlorophyll is the most common pigment used to absorb light. It absorbs light best in the blue portion of the electromagnetic spectrum, followed by the red portion. Green is poorly absorbed and mostly reflected, providing the green color of leaves. Once chlorophyll has absorbed light, it splits an H_2O molecule into hydrogen ions (H^+) and oxygen (O_2), releasing one electron. This electron is passed from protein to protein, finally producing the energy currency of the cell, ATP, and another high energy molecule, NADPH. Both of these molecules are then used during the dark reaction.
- 6 The light-independent reaction occurs in the stroma, the fluid-filled inside of the chloroplast. Although light is not required, this reaction does not happen without the high energy molecules produced by the light-dependent reaction. RuBisCo is the enzyme that incorporates CO_2 into $C_6H_{12}O_6$. This process is called carbon fixation because it takes carbon from the atmosphere and incorporates it into plant tissue. RuBisCo is a large protein and probably the most abundant protein on earth. It requires a magnesium ion to be active. While most enzymes can react hundreds or even thousands of times per second, RuBisCo only fixes about three to ten CO_2 molecules in the same amount of time. During the whole cycle of carbon fixation and regeneration of the starting material, ATP and NADPH are consumed.
- 7 Scientists are interested in improving the efficiency of photosynthesis for two reasons. One, more efficient plants mean more food for hungry people and livestock. Two, the more photosynthesis happens on earth, the more carbon is removed from the atmosphere. Reducing the amount of carbon in the atmosphere can reduce the amount of heat trapped in the atmosphere, thereby lowering the greenhouse effect. Photosynthesis is not very efficient. Increasing the rate of sugar production by RuBisCo through genetically engineering the protein is one possible way to improve efficiency. Another is to increase the amount of sunlight absorbed. Plants only absorb about 10% of full sunlight. Light that is not absorbed cannot be used to synthesize sugars. Carbon nanotubes, small structures of carbon that look like porous hollow hoses, can be inserted into chloroplasts. Inside the chloroplasts the tubes absorb light, passing the energy along to the photosynthetic proteins. So far, scientists have shown that they can increase photosynthesis, but much work remains before a commercially successful crop that is safe for human and livestock consumption can be produced.



1 The carbon dioxide used in photosynthesis comes from

- A** the soil.
 - B** the sunlight.
 - C** the breakdown of plant proteins.
 - D** the atmosphere.
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2 Which of the following is NOT a characteristic of chloroplasts?
Chloroplasts —

- A** contain some of their own DNA.
- B** are made by each plant cell.
- C** are surrounded by two membranes.
- D** synthesize building blocks for proteins.



3 Some algae are red. Which wavelength of light do these algae absorb the least?

- A** Blue
 - B** Green
 - C** Red
 - D** Yellow
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4 The oxygen released during the light-dependent reaction comes from —

- A** sunlight
- B** sugars
- C** water
- D** carbon dioxide



- 5** Which of the statements below best describes the relationship between photosynthesis and global warming?
- A** Photosynthesis consumes carbon dioxide. Carbon dioxide contributes to global warming.
 - B** Photosynthesis produces oxygen. Increasing oxygen in the atmosphere will cool it down.
 - C** Photosynthesis requires sunlight. If more sunlight is absorbed by plants, less is available to warm the atmosphere.
 - D** Photosynthesis consumes water. Less water in the soil allows it to hold more heat.
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- 6** Scientists are trying to improve the efficiency of photosynthesis. Which of the following is LEAST likely to increase the efficiency of photosynthesis?
- A** Increasing the rate of reaction of RuBisCo.
 - B** Increasing the amount of water absorption through the roots.
 - C** Increasing the amount of sunlight absorbed by leaves.
 - D** Increasing the amount of sugar (carbohydrate) storage in roots.