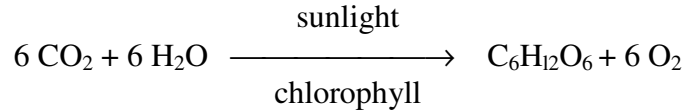


## PRE-LAB ACTIVITIES FOR PHOTOSYNTHESIS LAB

### CAM METABOLISM An Introduction

Photosynthesis is the process that plants use to convert CO<sub>2</sub> into carbohydrates (sugar). These carbohydrates are then stored (as starch) and are used by the plant for food. The basic formula for photosynthesis is



Scientists used to think that all plants did photosynthesis in exactly the same way, but in the last 30 years they have found that there are really at least three different ways that photosynthesis can occur. The three photosynthetic pathways are called C<sub>3</sub>, C<sub>4</sub>, and CAM.

Most plants use the C<sub>3</sub> metabolic pathway. In this type of photosynthesis, the CO<sub>2</sub> is "fixed" by attaching the carbon to the 5-carbon sugar RuBP (ribulose biphosphate) with the assistance of the enzyme RuBP carboxylase which will then be converted into sugar. The whole process takes place during the daytime.

A second type of photosynthesis is called C<sub>4</sub> and involves plants like corn and sugar cane. The C<sub>4</sub> pathway is used by plants that are found in environments that have high light levels, high temperatures, and a lot of water in the summer. In this method the CO<sub>2</sub> is first converted into malate (a 4-carbon sugar) and then into sugar by RuBP carboxylase. This method also takes place entirely during the daytime.

The third method of photosynthesis is called CAM (Crassulacean Acid Metabolism). This pathway is employed by succulent plants like ice plant, jade plant and aloe as well as some cactus. The CAM pathway is used by plants that live in environments that have high light levels, high temperatures but low levels of moisture in the summer. CAM photosynthesis takes place in two stages. The first stage takes place at night when the stoma of the plant are opened. CO<sub>2</sub> enters the leaf through the open stoma and is fixed and stored as an acid (usually malic acid). The second stage of the CAM process takes place during the daytime while the stoma are closed. The CO<sub>2</sub> is released from the malic acid and is then used to make sugar with the aid of RuBP carboxylase.

Recent studies with aquatic plants suggest that there may be other pathways as well.

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**PreLab Questions:**

1. What four materials are needed by all plants for photosynthesis to take place?
2. What two products are produced?
3. What is the main difference between the environments of C4 plants and CAM plants?
4. What might have caused plants to develop these different pathways?
5. Fill in the chart below about the three different pathways:

<b>Characteristics</b>	<b>C3</b>	<b>C4</b>	<b>CAM</b>
The type of photosynthesis used by most plants			
The type of photosynthesis done by many cactus and succulents			
The type of photosynthesis done by corn and sugar cane			
Involves the fixation of CO <sub>2</sub>			
Utilizes RuBP carboxylase			
Takes place entirely during the daytime			
Takes place partly during the night and partly during the day			
Uses malic acid to fix and store CO <sub>2</sub> until it can be used			
Found in environments with high light, high temps, low water			
Found in environments with high light, high temps, lots of water			

6. At what time would you expect to find the most malic acid in CAM plants?
7. When would you find the least amount of malic acid in CAM plants?
8. Write a hypothesis about the acid content of two different CAM plants, one of which has been in sunlight for 24 hours previous to testing and one that has been kept in the dark for 24 hours.

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## CAM Photosynthesis Post-Lab Questions

1. Plants which use CAM photosynthetic pathways close their stomata during the day. Describe what effect rapid closure of stomata would have on the internal concentrations of various molecules.
2. During the cool of evening CAM plants open their stomata. What gas is preferentially absorbed at this time? Explain how this gas is stored for daytime use?
3. If you were a researcher looking for new plant species which exhibited CAM photosynthesis, what biome or biomes would be most rewarding for you to explore?
4. Why would litmus paper not be an adequate indicator to separate CAM photosynthetic pathways from the C<sub>3</sub> and C<sub>4</sub> varieties of photosynthesis?
5. If the greenhouse effect persists and deepens which photosynthetic pathway (C<sub>3</sub>, C<sub>4</sub>, CAM) could benefit the most? Explain why.
6. Distinguish between photosynthesis and photo respiration in terms of end products.
7. What gas can compete with CO<sub>2</sub> for the binding site of the enzyme RuBP carboxylase?
8. The short supply of which factor will affect CAM photosynthesis the most? (light, temperature, water, photo respiration) Explain why.
9. What 4-carbon organic acid is responsible for the pH shift in this experiment?
10. All photosynthetic systems use chlorophyll to ultimately convert light energy to chemical energy. What possible role do other pigments such as carotenoids play in photosynthesis?
11. Explain the importance of calibrating the pH meter before taking a reading. List the steps needed to do this.
12. Which plant had a greater concentration of malic acid?
13. Remembering the basic anatomy of the leaf, explain the position of the stomata of the plant with the greater concentration of malic acid.

14. Draw a diagram of the whole event as seen in the day using the following concepts:

CO<sub>2</sub>

malic acid

sugar

sun