

INTRODUCTION

This worksheet complements the animation series [Photosynthesis](#).

PROCEDURE

1. This animation series contains seven parts. Read the questions below for each part before watching it.
2. After watching each part, answer the questions in the spaces provided.
3. After completing all seven parts of the animation, answer the summary questions in Part 8.

QUESTIONS

PART 1: OVERVIEW

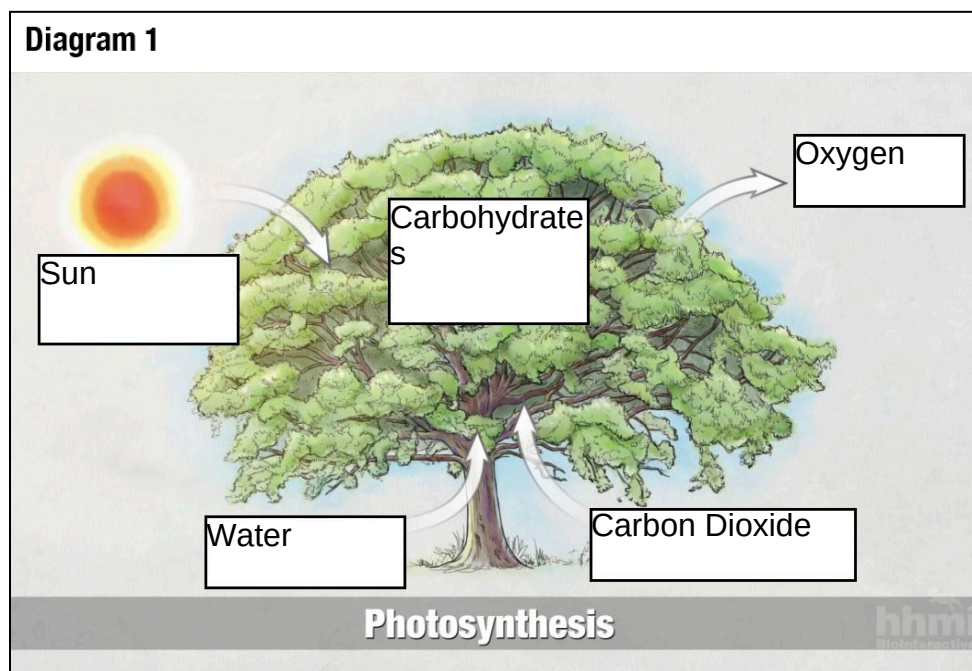
1. Which of the following kinds of organisms do photosynthesis? Select all that apply.

☒ plants
 ☐ fungi
 ☐ animals
 ☒ algae
 ☐ all bacteria
 ☒ some bacteria

2. What is the overall purpose of photosynthesis?

The overall purpose is to capture light energy from the sun and convert it to chemical energy in a series of reactions.

3. On Diagram 1, fill in the labels with photosynthesis's main inputs and outputs of matter and energy.



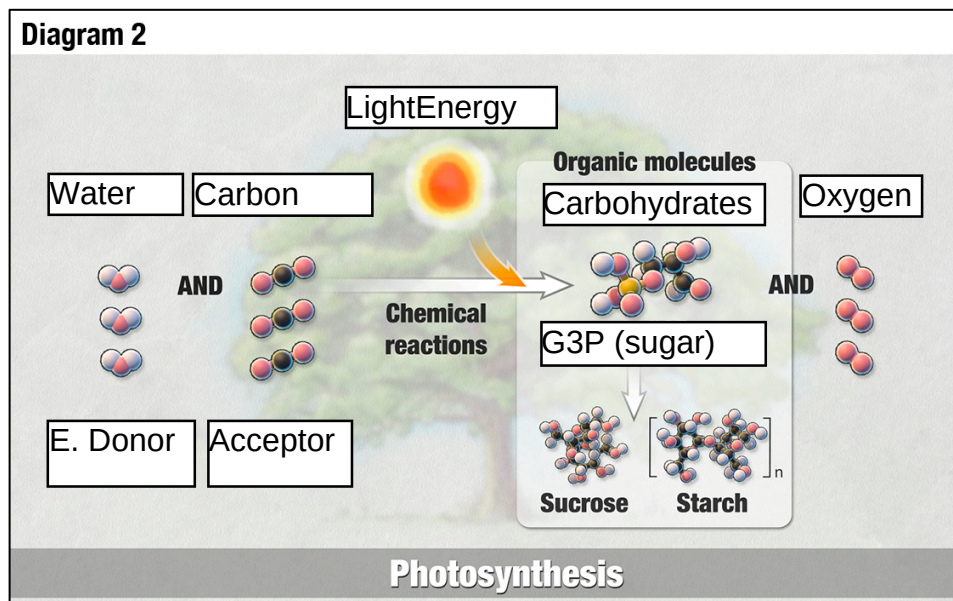
PART 2: CHEMICAL PROCESS

1. Complete the following sentence.

Photosynthesis is a set of Chemical reactions in which Light energy is converted to Chemical energy.

2. On Diagram 2, fill in the labels with the following descriptions. Some of the objects have multiple labels.

- water (H_2O)
- carbon dioxide (CO_2)
- oxygen (O_2)
- G3P (sugar)
- electron acceptor
- electron donor
- carbohydrates
- energy input

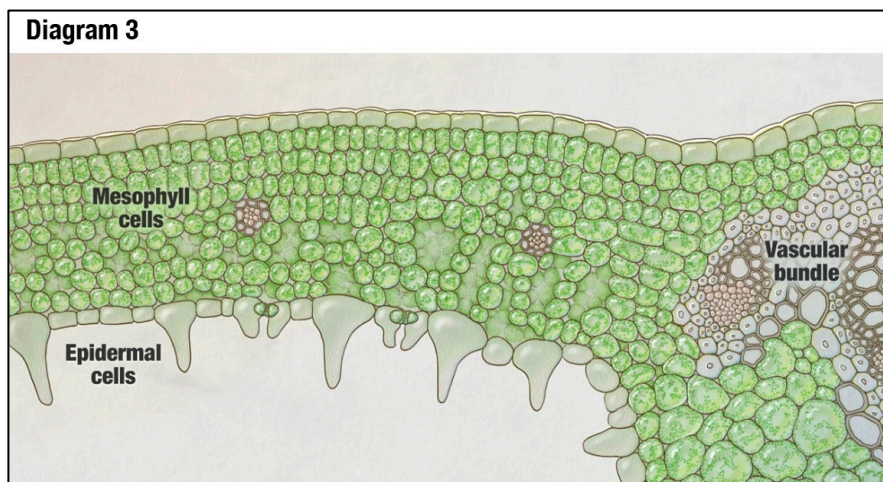


PART 3: LEAF STRUCTURE

1. In what plant structures does photosynthesis occur? Make your description as specific as you can. Photosynthesis takes place inside plant cells in small things called Chloroplasts.

2. On Diagram 3, complete the following tasks.

- Draw how CO_2 gets into the leaf.
- Draw how O_2 gets out of the leaf.
- Label the name of the structure through which these gases pass.



3. What structure is used to transport organic molecules from the leaf to other parts of the plant? The vascular bundle is used to transport organic molecules from the leaf to other parts of the plant.

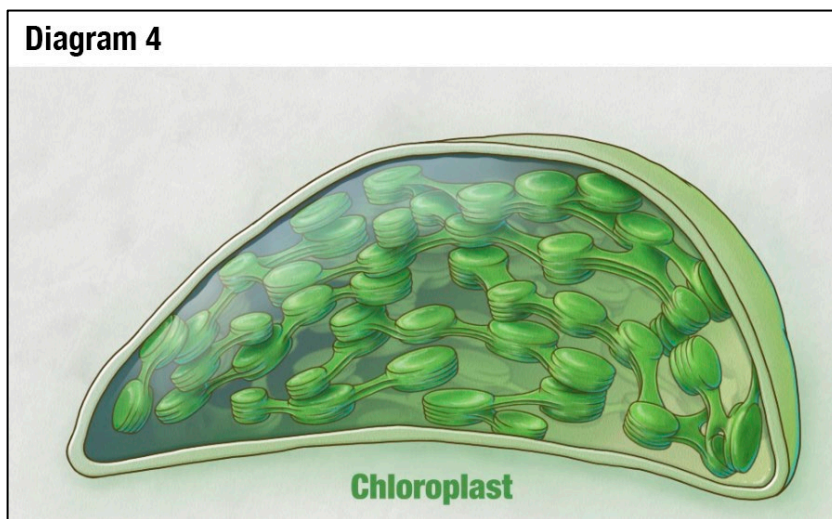
4. Why are leaves green?

It is because of chloroplasts, the organelle where photosynthesis takes place

PART 4: CHLOROPLASTS

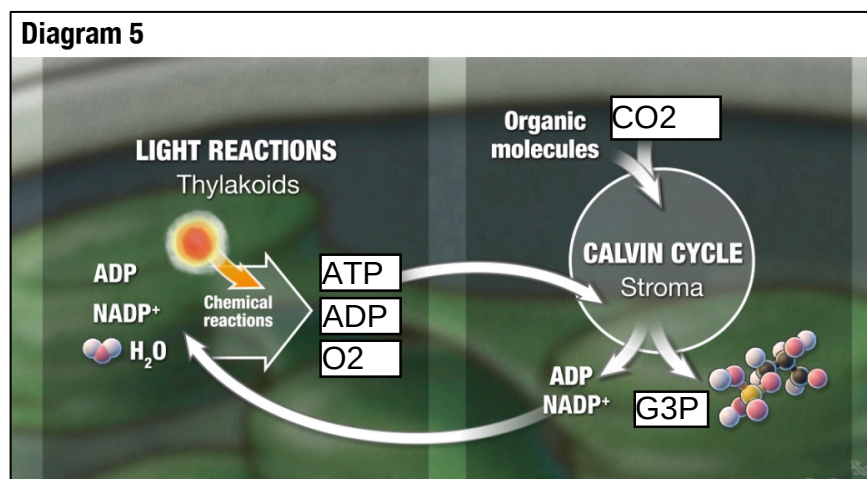
1. On Diagram 4, label the following items. Multiple labels may apply to the same part of the diagram.

- location of the light reactions
- location of the Calvin cycle
- thylakoid
- stroma



2. On Diagram 5, fill in the labels with the following descriptions to show the connections between the light reactions and the Calvin cycle.

- carbon dioxide (CO_2)
- oxygen (O_2)
- G3P (sugar)
- ATP
- NADPH



3. How does a plant increase its biomass?

A plant increases its biomass through the formation of new organic molecules.

PART 5: LIGHT REACTIONS

Photosystems I and II (PSI and PSII)

1. What is the function of the photosystems?

The function is that it transforms light energy to chemical energy

2. On Diagram 6, complete the following tasks.

- Label PSI and PSII.
- Draw the path of the electron transport chain.



The Events of the Light Reactions

- For **PSII**, the **cytochrome complex**, and **PSI**, draw and label what happens at that structure on Diagram 6. Then describe the events in a bulleted list in Table 1.

Table 1: Descriptions of the steps in the light reactions.		
Structure	What is happening with matter?	What is happening with energy?
PSII	Photons enter and go to the chlorophyll, water also enters and goes to the chlorophyll, from there it moves on.	The energy is transferring further into the reaction.
cytochrome complex	H ⁺ enters through it, while the chlorophyll from the last part enters.	The energy gets spent bringing the H ⁺
PSI	Photons enter the chlorophyll.	Gets spent sending the chlorophyll out.

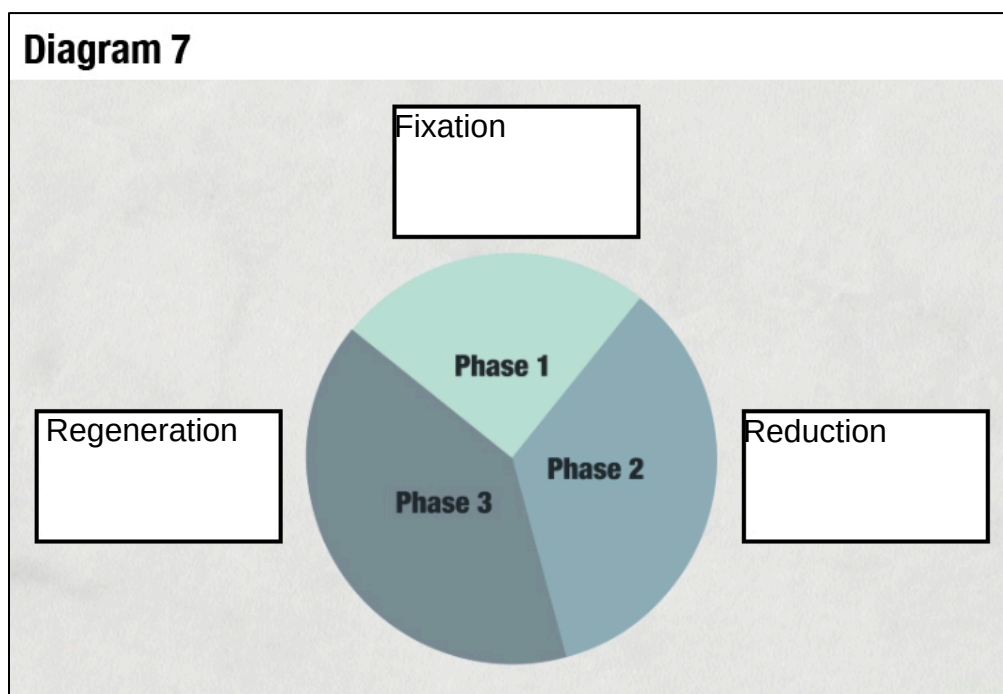
- At the end of the electron transport chain, where is the light energy that was absorbed and converted by chlorophyll stored? List **two** answers.
 - Chlorophyll of PSI
 - ATP Synthase

Chemiosmosis and ATP Synthase

5. Label the ATP synthase on Diagram 6.
6. Describe how the proton (H^+) gradient is used to make ATP.
ADP and P_i get added together while adding the H^+ that is exiting the ATP synthase to make ATP.
7. What two molecules bring chemical energy from the light reactions to the next stage of photosynthesis, the Calvin cycle?
 - 1) ATP
 - 2) NADPH

PART 6: CALVIN CYCLE

1. Label Diagram 7 with the three phases of the Calvin cycle.



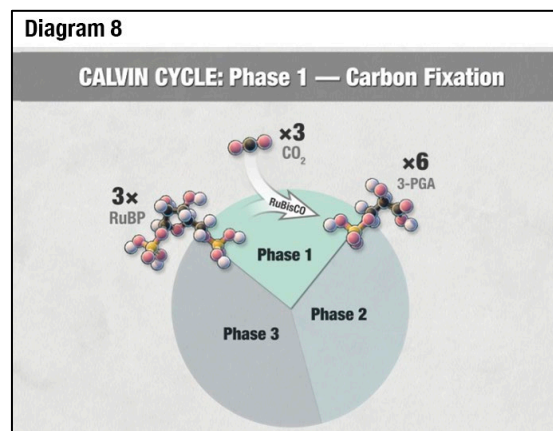
Briefly describe what is going on in each phase and answer the questions shown.

Phase 1 (Diagram 8)

Description:

In organic carbon, in the form of carbon dioxide from the air, is incorporated into organic molecules, a process known as carbon fixation.

What enzyme catalyzes the reaction in this phase?
The enzyme rubisco catalyzes the reaction.



Phase 2 (Diagram 9)

Description:

The organic molecules accept electrons, a process known as reduction.

Phase 3 (Diagram 10)

Description:

A large set of reactions use the other five molecules of G3P and energy from three molecules of ATP to produce three molecules of RuBP.

Why is the series of reactions in the Calvin cycle called a "cycle"?

It is because it continues on and on, it uses the same materials, in the same order, it repeats itself, and it uses some of the left over products.

Diagram 9

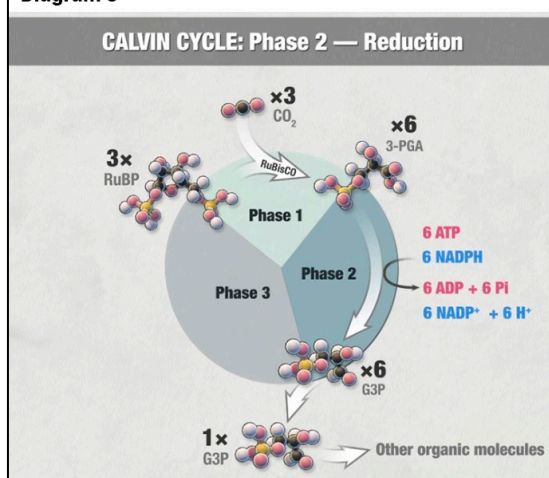
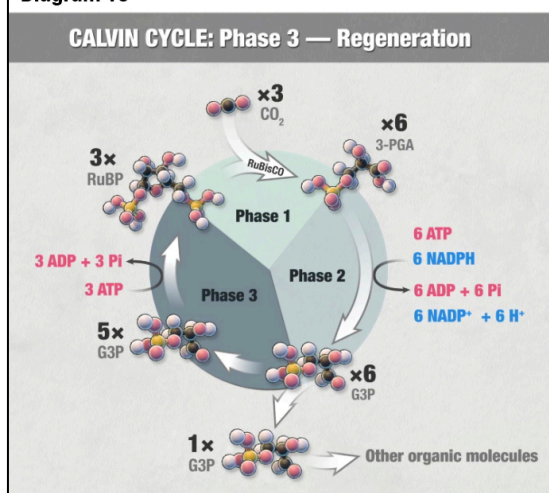


Diagram 10

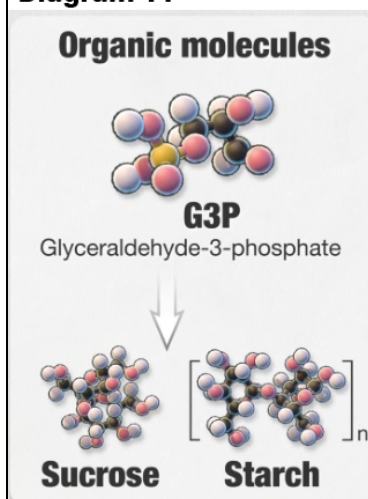


- At the end of the Calvin cycle, what molecules have the energy that originally came from light?
NADPH and ATP

PART 7: BIOSYNTHESIS

- Complete the following sentence based on Diagram 11.
Glyceraldehyde-3-phosphate (G3P) can be used by plant cells to make Sucrose and Starch.
- Which molecule in Diagram 11 is used to transport energy to other parts of the plant?
Sucrose
- Which molecule in Diagram 11 is stored in the plant for later use as an energy source?
Starch

Diagram 11



PART 8: TEST YOUR KNOWLEDGE

1. Based on everything you've learned from the animations, what is the overall purpose of photosynthesis?
The overall purpose is to help feed and keep the plants alive.

2. Describe how oxygen gas (O_2) is produced during photosynthesis. Include the specific structures in the plant where the reaction occurs.

While the tree takes in energy from the sun, water and carbon dioxide form carbohydrates which over time releases oxygen.

3. Describe the path of an electron from a molecule of water to the sugar G3P.

The electron from a molecule of water goes with H^+ to the ATP Synthase, to which it joins the sugar G3P.

4. Describe how ATP is produced in the light reactions.

An electron goes through PSII then goes to the cytochrome complex then to PSI to which it goes to the ATP synthase.

5. Which of the following statements best explains how the energy in a photon of light is stored in a molecule of the sugar G3P? C

- a. Light energy directly provides energy to RuBP and CO_2 , which produce G3P in the Calvin cycle.
- b. Light energy directly provides energy to ATP synthase, which produces ATP during the light reactions.
- c. Light energy energizes electrons to make ATP and NADPH, which provide energy to produce G3P in the Calvin cycle.

6. When three molecules of carbon dioxide (CO_2) react with three molecules of RuBP during the Calvin cycle, six molecules of the sugar G3P are produced. One G3P molecule exits the Calvin cycle during Phase 2. What happens to the other five G3P molecules?

The remaining five G3P molecules help ATP change into 3ADP and 3Pi before continuing on with the process to make 3RuBP.