Name:

Date:

Biology Lab Activities: Photosynthesis

Last updated: 04/22/25

> Background Questions

Read through the Photosynthesis: Reactants and Products article on the Visible Body Biology Learn Site.

Based on what you've learned in class, in your textbook, from the Biology Learn Site article, and from using Visible Body, answer the following questions about photosynthesis.

1. Fill in the blanks in the photosynthesis equation: 6 _____ + 6 H_2O → $C_6H_{12}O_6$ + 6 _____. The chemical reactions that occur during photosynthesis are driven by energy from the _____.

2. What are the reactants involved in photosynthesis?

3. What are the products of photosynthesis?

4. Where does photosynthesis take place inside plants?

5. In 2–3 sentences, explain why photosynthesis is important for a plant's survival.

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Lab 1: Plant Structures, Reactants, and Products of Photosynthesis

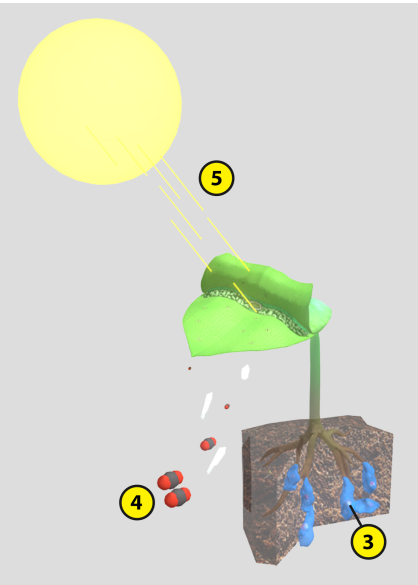
> <u>Activity 1: Label the reactants and products of photosynthesis</u>

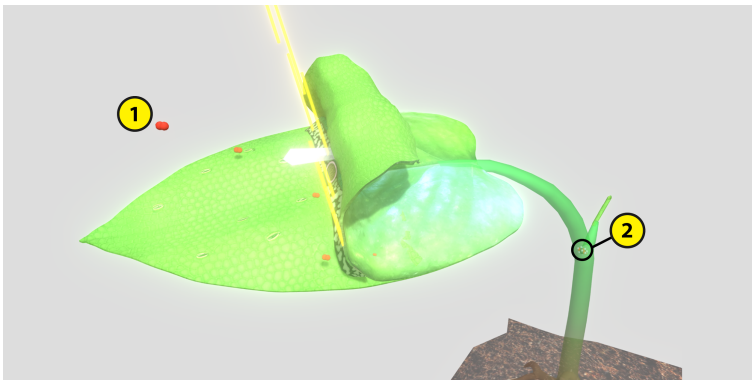
1. Launch the view
    - Launch Visible Body.
    - Browse or use the search function to view the Photosynthesis model.

2. Label the image below
    - Explore the 3D model of the plant going through photosynthesis to find the structures you need to label.
    - Fill in the blanks to label the structures from the list below.

<u>Word List:</u>

Carbon dioxide (CO_2) molecules ____
Glucose ($C_6H_{12}O_6$) molecule ____
Oxygen (O_2) molecules ____
Photons of light ____
Water (H_2O) molecules ____





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Lab 1: Plant Structures, Reactants, and Products of Photosynthesis

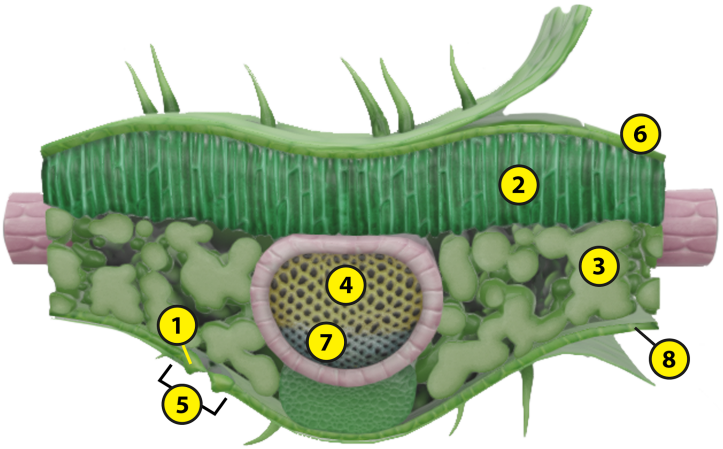
> Activity 2: Label the leaf structures involved in photosynthesis

1. Launch the view
    - Launch Visible Body.
    - From the top menu, select Study, then select Lab Activities (Biology). In the Photosynthesis and Cellular Respiration Labs section, launch view 2. Dicot Leaf.

2. Label the image below
    - Explore the 3D model of the dicot plant leaf to find the structures you need to label.
    - Fill in the blanks to label the structures from the list below.

Word List:

Guard cells ____
Lower epidermis ____
Palisade mesophyll ____
Phloem ____
Spongy mesophyll ____
Stoma ____
Upper epidermis ____
Xylem ____



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Lab 1: Plant Structures, Reactants, and Products of Photosynthesis

> Activity 3: Label a chloroplast

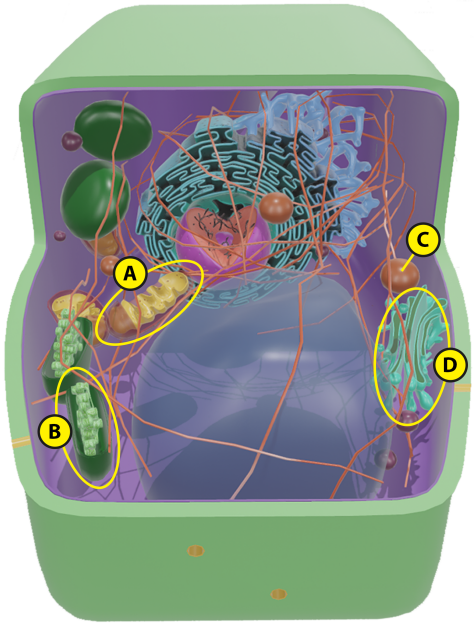
Part A: Identify a chloroplast in a plant cell

1. Launch the view
    - Launch Visible Body.
    - Browse or use the search function to view the Plant Cell model.

2. Identify the chloroplast in the labeled image below:
    - Explore the 3D model of the plant cell to find the structure you need to identify.

Identification Activity

In the following labeled image, which structure is the chloroplast: A, B, C, or D?



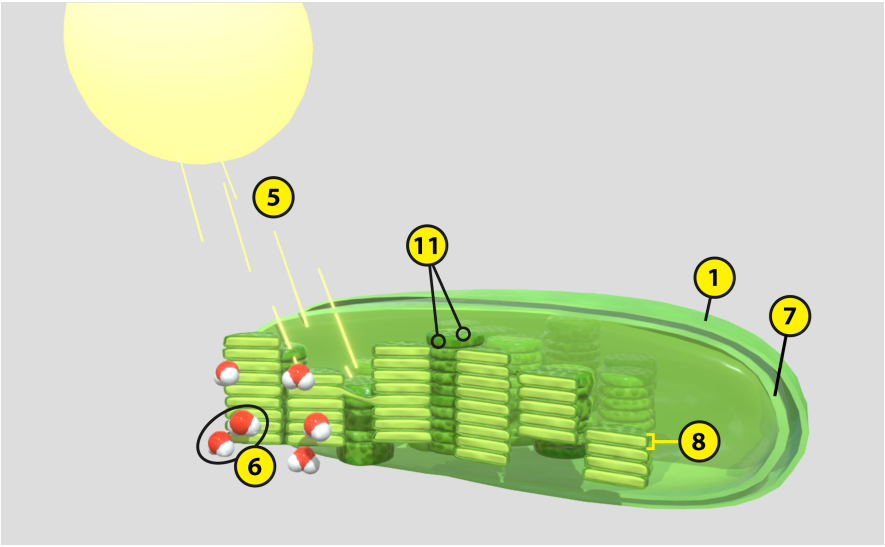
Part B: Label the chloroplast structures and the reactants and products of photosynthesis

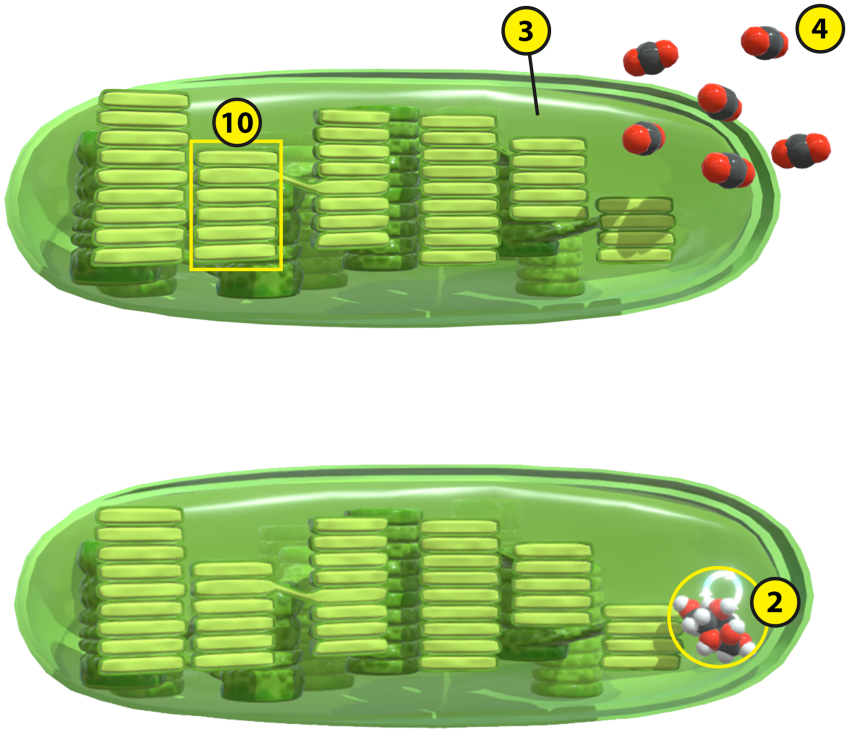
1. Launch the view
    - Launch Visible Body.
    - Browse or use the search function to view the Chloroplast (Photosynthesis) model.

2. Label the image below
    - Explore the 3D model of the chloroplast going through photosynthesis to find the structures you need to label.
    - Fill in the blanks to label the structures from the list below.

Word List:

Carbon dioxide (CO_2) molecules ____
Chlorophyll ____
Glucose ($C_6H_{12}O_6$) molecule ____
Granum ____
Inner membrane ____
Outer membrane ____
Oxygen (O_2) molecules ____
Photons of light ____
Stroma ____
Thylakoid ____
Water (H_2O) molecules ____





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Lab 1: Plant Structures, Reactants, and Products of Photosynthesis

> Activity 4: Explore the roles plant structures play in photosynthesis

Refer to your labeled plant leaf and chloroplast models from Activities 2 and 3 and the content in Visible Body. Based on what you've learned, match each of the following plant structures with the brief description of its role in photosynthesis.

Structures:

a. Stomata
b. Guard cells
c. Palisade mesophyll
d. Spongy mesophyll
e. Chloroplast
f. Thylakoid
g. Stroma
h. Xylem
i. Phloem

Descriptions:

___ This leaf layer contains long, cylindrical cells with many chloroplasts; the majority of photosynthesis takes place inside these cells.
___ This thick fluid inside the chloroplast contains enzymes, ATP, and NADPH that help to convert carbon dioxide (CO_2) and water (H_2O) to glucose ($C_6H_{12}O_6$).
___ This vascular structure carries the glucose ($C_6H_{12}O_6$) produced during photosynthesis to other parts of the plant.
___ These cells open and close the leaf's stomata, allowing gases to move into and out of the leaf during photosynthesis.
___ This plant cell organelle is the main site of photosynthesis.
___ This leaf layer contains cells with small spaces between them to allow gases to flow through the leaf during photosynthesis.
___ These holes in the leaf's lower epidermis allow carbon dioxide (reactant) to enter the leaf and oxygen (product) to exit the leaf.
___ This vascular structure carries water (reactant) from the roots to the leaf for photosynthesis.

___ This disc-shaped structure within the chloroplast captures light energy and begins the process of photosynthesis.

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Lab 1: Plant Structures, Reactants, and Products of Photosynthesis

> Activity 5: Explore the reactants and products of photosynthesis

Refer to your labeled reactants and products of photosynthesis from Activities 1 and 3 and the content in Visible Body. Based on what you've learned, complete the following table on the molecules involved in photosynthesis.

Molecule Type	Reactant/ Product	Where It Comes From	How It Enters/Exits the Plant	Where It Goes	Its Significance
Carbon Dioxide	Reactant	From the _____ that surrounds the plant	Enters through the leaf's _____	Into the _____ inside the leaf's cells	It is converted into _____ during photosynthesis.
Oxygen	Product	Made in the _____ of chloroplasts	Exits through the leaf's _____	Into the _____ that surrounds the plant	It is a byproduct of photosynthesis essential for _____.
Glucose	Product	Made in the _____ of chloroplasts		Sugars travel through the _____ to the different parts of the plant	It provides _____ that fuels all the plant's activities.
Water	Reactant	From the _____ that surrounds the plant's roots	Enters through the **root hairs** of the plant	Travels through the _____ into the chloroplasts inside the leaf's cells	It is split during photosynthesis to create _____ and convert NADP+ to NADPH.

Based on what you've learned from labeling the photosynthesis model and completing the table, fill in the blanks to balance the photosynthesis equation:

Sunlight + _____ CO_2 + 6 _____ → _____ $C_6H_{12}O_6$ + 6 _____.

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Lab 2: Observe Photosynthesis—Floating Leaf Disk Experiment

Adapted from Brad Williamson at the Cornell Institute for Biology
With contributions from Kimberley Nichols at Coldwater High School and Biology Teachers at Marlborough High School

Introduction

Under normal circumstances, leaf disks should float in water because leaves have air-filled spaces between their cells. However, if you submerge a leaf in a solution and apply a vacuum (using a syringe), the spaces in the leaf will fill with liquid, causing it to sink.

In this lab, you will expose leaf disks to different conditions to observe what's necessary for photosynthesis to occur. You'll expose the leaf disks to a bicarbonate solution, consisting of water, baking soda, and liquid soap. The liquid soap breaks down the hydrophobic, waxy leaf cuticle to help the leaf disks absorb the baking soda, which represents the carbon dioxide.

The leaf disks sink because you have replaced the spaces originally filled with gases with the liquid solution. Once all the leaf disks have sunk in the bicarbonate solution, you'll apply a light source to initiate the chemical reactions of photosynthesis, which convert carbon dioxide and water into glucose and oxygen. When the oxygen gas collects within and around the leaf disks, they begin to float again.

Materials

- Baking soda (sodium bicarbonate)
- Distilled water
- Liquid soap
- 2 plastic syringes (10 cc, without needles)
- Spinach leaves
- Hole punch
- 3 clear plastic cups
- Graduated cylinder
- Timer
- Light source

- Black paper
- Cardboard
- 2 heat sinks

Experiment

Create your solutions:

1. To create your bicarbonate solution, mix ⅛ tsp of baking soda and 1 drop of liquid soap with 300 ml of water. If the solution has bubbles, add more baking soda until the bubbles are gone.
2. To create your distilled water solution, mix 1 drop of liquid soap with 200 ml of distilled water.

Create your leaf disks:

3. Use the hole punch to punch 30 disks from the spinach leaves, avoiding the veins and edges of each leaf.

Create your bicarbonate solution samples:

Remove any gases (carbon dioxide or oxygen) from the spinach leaves using the following steps:

4. Infuse the bicarbonate solution into the leaf disks:
    a. Put 10 leaf disks into the syringe barrel and replace the plunger, slowly pressing it to remove excess air without crushing the leaf disks.
    b. Place the tip of the syringe into the **bicarbonate solution** and pull about 3 ccs of the solution into the syringe.
    c. Depress the plunger until there isn't any air inside the syringe.
    d. Cover the tip of the syringe with your finger and draw back the plunger to create a vacuum. Hold for 10 seconds, while swirling the leaf disks and solution and flicking the side of the syringe to keep the leaf disks submerged in the solution.
    e. You may need to repeat Step D a few times to get the leaf disks to sink to the bottom of the syringe. If they don't sink, you may need to add more liquid soap to your solution and try again.

5. Fill a clear plastic cup about halfway with the **bicarbonate solution** and add the leaf disks and solution from the syringe. The leaf disks should sink to the bottom of the cup.
6. Repeat Steps 4 and 5 to create a sample (in a separate cup) that you will expose to dark conditions. Once you've created this sample, wrap black paper around the cup and place cardboard over the top of the cup.

Create your distilled water sample:
Remove any gases (carbon dioxide or oxygen) from the spinach leaves using the following steps:

7. Infuse the distilled water solution into the leaf disks:
    a. Put 10 leaf disks into the syringe barrel and replace the plunger, slowly pressing it to remove excess air without crushing the leaf disks.
    b. Place the tip of the syringe into the **distilled water solution** and pull about 3 ccs of the solution into the syringe.
    c. Depress the plunger until there isn't any air inside the syringe.
    d. Cover the tip of the syringe with your finger and draw back the plunger to create a vacuum. Hold for 10 seconds, while swirling the leaf disks and solution and flicking the side of the syringe to keep the leaf disks submerged in the solution.
    e. You may need to repeat Step D a few times to get the leaf disks to sink to the bottom of the syringe. If they don't sink, you may need to add more liquid soap to your solution and try again.

8. Fill a plastic cup about halfway with the **distilled water solution** and add the leaf disks and solution from the syringe. **Note: These leaves will be deprived of carbon dioxide throughout the experiment.**

Conduct the experiment

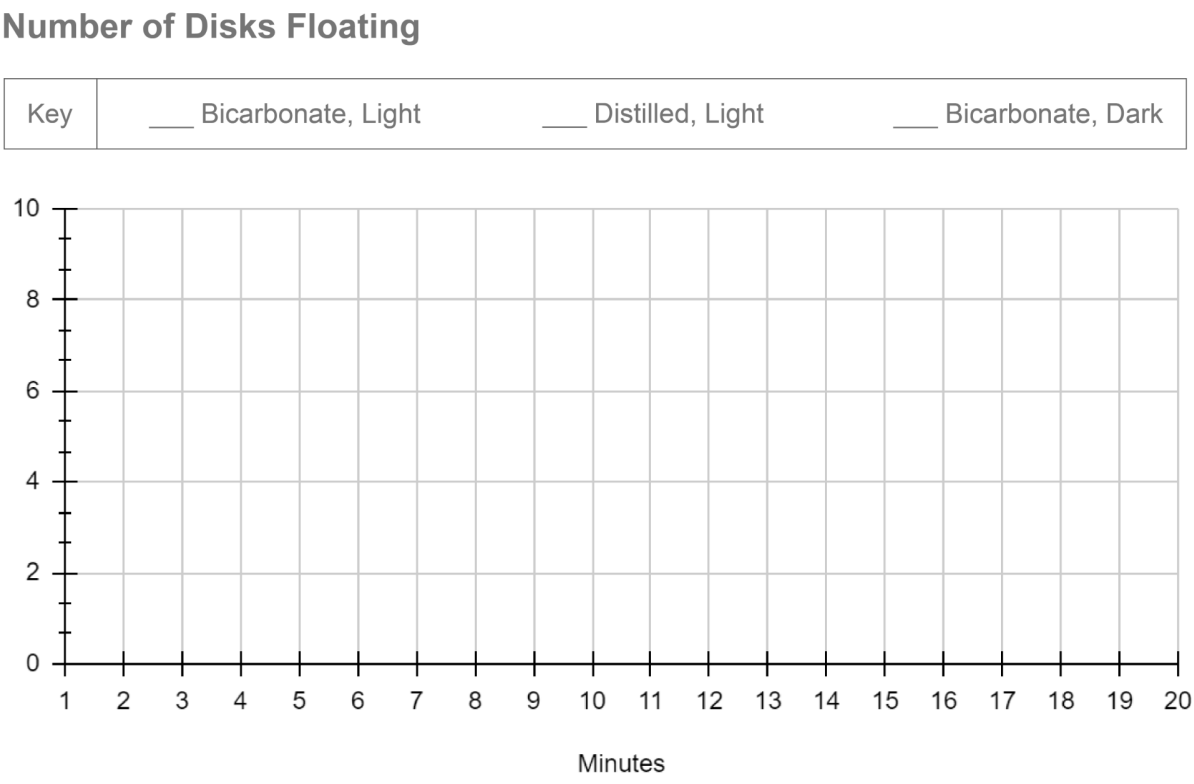
9. Apply a light source and record your observations in the table on the following page:
    a. Place the 2 cups without the black paper and cardboard under a light source. Place a heat sink on top of each cup to absorb the heat from the light source and prevent it from heating the solutions in the cups.
        i. Turn on the light source and start the timer.
        ii. At the end of each minute, record how many disks are floating, continuing until they are all floating (this should take about 20 minutes).
    b. Keep the third cup with the black paper and cardboard away from the light and record how many leaf disks are floating at the end of each minute.

Table for Your Results

Minutes	Bicarbonate Solution in Light Conditions	Distilled Water in Light Conditions	Bicarbonate Solution in Dark Conditions
	Number of Disks Floating	Number of Disks Floating	Number of Disks Floating
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Graph Your Results

Graph all three sets of data points from the table on the graph and add the color or pattern used to indicate each condition in the space next to its label in the key.



Questions

Based on your observations during this lab activity and what you've learned about leaf structure and the process of photosynthesis, answer the following questions.

1. Based on what you know about the structure of leaves, why do you think soap is necessary to get the leaf to absorb the solutions?

2. Why do you think the leaf disks sank when they absorbed the bicarbonate solution?

3. Why do you think the leaf disks started floating again in the bicarbonate solution when you applied the light source?

4. Based on your observations of the samples in light vs. dark conditions, is light necessary for photosynthesis to occur? Explain your answer using evidence from the data.

5. Based on your observations of the samples in bicarbonate solution vs. distilled water, are both carbon dioxide and water necessary for photosynthesis to occur?

6. Write the formula (or chemical equation) for photosynthesis. Put the reactants on the left side of the arrow and the products on the right side of the arrow.

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Lab 3: Put It Together—Photosynthesis in the Chloroplast

Refer to your labeled reactants and products of photosynthesis image from Lab 1, Activity 1 and your labeled chloroplast image from Lab 1, Activity 3 to complete the following activities.

1. In the space that follows, draw a chloroplast (or paste a screenshot of your drawing). Your drawing should include the following:
    a. Inside the chloroplast, draw the thylakoids and stroma.
    b. Outside the chloroplast, draw the sun and photons, carbon dioxide (CO_2) molecules, water (H_2O) molecules, oxygen (O_2) molecules, and glucose ($C_6H_{12}O_6$) molecules with arrows showing how they move into or out of the chloroplast.

2. Based on your drawing and what you've learned about photosynthesis, put the following steps of photosynthesis into the correct order (from 1–5).
    ___ Chlorophyll within plant cells absorb photons from the sun.
    ___ Carbon dioxide and water (the reactants) enter the chloroplast.

___ Within the chloroplast's stroma, carbon dioxide and water are converted into glucose.
___ Within the chloroplast's thylakoids, light energy splits the water molecules, producing the byproduct oxygen.
___ The leaf releases oxygen into the surrounding air.

3. In your own words, briefly describe the photosynthesis equation.

4. The equation for cellular respiration is $C_6H_{12}O_2 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ (approximately) 38 ATP. Based on this equation and what you've learned about photosynthesis, how do these two processes relate to each other?