Floating Disks
An Investigation of Photosynthesis
Student Materials

Introduction ........................................................................................................................................... 2
Lab Protocol ........................................................................................................................................ 3
Data Collection Worksheet .................................................................................................................. 5
Pre-Lab Questions ............................................................................................................................... 6
Post-Lab Questions and Analysis ......................................................................................................... 7
Floating Disks
Introduction

Plants use the process of photosynthesis to convert light energy into glucose, a carbohydrate that plant cells use for food. Photosynthesis occurs in the chloroplasts of plant cells. For photosynthesis to occur, the energy from the sun needs to be trapped in special molecules. One such molecule is chlorophyll, which mostly absorbs light in the red and blue ranges of the visible light spectrum. Green light is largely reflected, which is why most plants are green.

Photosynthesis can be divided into two parts, light dependent reactions and light independent reactions. During the light dependent reactions, sunlight excites electrons in chlorophyll and these high-energy electrons are used to make ATP. The high-energy electrons do not return to chlorophyll, but water can donate electrons to replace those lost. The process of losing electrons converts water to oxygen and H^+. In the light independent reactions (also called the Calvin cycle), the ATP formed from sunlight provides the energy to make glucose from CO₂.

The overall equation for photosynthesis can be written as:

\[ 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{light energy} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \]

Look at the equation. Can you think of a way to measure the rate of photosynthesis? Write your ideas here: ________________________________________________________________

_______________________________________________________________________

_______________________________________________________________________

In this lab, leaf disks will be used to measure the rate of photosynthesis under various light conditions. The leaf disks will be put into a solution of baking soda (sodium bicarbonate, NaHCO₃) and detergent. The baking soda is a source of carbon, and the detergent acts as a wetting agent that makes it easier for the solution to infiltrate the leaf disk. By using a syringe to create a vacuum, the gases in the intercellular air spaces (Figure 1) will be pulled out of the leaf disk. The gases are replaced by the baking soda/detergent solution. This makes the leaf disks denser than the solution and they should sink. As the cells in the leaf disks photosynthesize, the liquid inside the leaf will be replaced by oxygen gas. The gas will increase the buoyancy of the disk and it will float to the surface.

Why do leaves float in water? _____________________________________________

_______________________________________________________________________

Figure 1. Anatomy of a Leaf.
Floating Disks
Lab Protocol

Materials: Check your workstations to make sure all supplies are present before beginning the lab.

<table>
<thead>
<tr>
<th>Student Workstation:</th>
<th>Common Workstation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3 fresh young leaves or about 8 plant</td>
<td>light sources</td>
</tr>
<tr>
<td>seedlings</td>
<td></td>
</tr>
<tr>
<td>35 mL baking soda/detergent solution</td>
<td></td>
</tr>
<tr>
<td>2 sections of drinking straw (5 cm)</td>
<td></td>
</tr>
<tr>
<td>1 100 mL beaker or small cup</td>
<td></td>
</tr>
<tr>
<td>1 50 mL or 100 mL graduated cylinder</td>
<td></td>
</tr>
<tr>
<td>1 250 mL beaker</td>
<td></td>
</tr>
<tr>
<td>3 10 mL syringes</td>
<td></td>
</tr>
<tr>
<td>1 piece of aluminum foil (10 cm²)</td>
<td></td>
</tr>
</tbody>
</table>

Procedure:

Set up the syringes:

1. Using the 100-mL graduated cylinder, add 35 mL of baking soda/detergent solution to the 100-mL beaker or small cup. (Note: your teacher may have done this for you already.)

2. As shown in Figure 2, use the straw to punch out 5 leaf disks. Important! Make sure you avoid the mid vein of the leaf.

3. Remove the plunger from the syringe and gently blow the disks out of the straw and into the syringe (Figure 3). Repeat steps 2 and 3 so that you have a total of 10 disks.

4. Replace the plunger, being careful not to crush the leaf disks.

5. Draw 8 mL (or cc) of the baking soda/detergent solution into the syringe.

6. Invert the syringe (hold it tip up), and gently push the plunger up to remove the air.

Figure 2. Leaf punching technique.

Figure 3. Technique for transferring leaf disks to syringe.
7. Put your thumb over the tip of the syringe and pull the plunger, creating a vacuum that will pull the gases out of the leaf disk (Figure 4). Hold the vacuum for 5 seconds, tapping the syringe to see if the leaf disks sink. Remove your thumb and if there is air at the tip of the syringe, gently push the air out.

8. Repeat steps 6 and 7 until all the disks sink. **Caution:** You can damage the leaf disks if you repeat the vacuum too many times. Check with your teacher if you have any disks floating after 2 times.

9. Place the syringe plunger down in the 250-mL beaker. Repeat steps 3–8 to set up two additional syringes with leaf disks. (3 syringes total)

**Set up the experimental conditions and control:**

10. Note any floating disks in the data table for Time 0. Wrap one syringe with foil to block out all the light.

11. Place the foil wrapped syringe and one other syringe plunger down in a 250-mL beaker and place the beaker very close to the light.

12. Place the third syringe in a second beaker in ambient (room) light. Note any floating disks in the data table for Time 0.

**Collect data:**

13. Check the syringes every five minutes. Record the number of disks that have risen during each 5-minute interval in the appropriate place in the data table provided on page 5.

Figure 4. Technique for “pulling a vacuum.” This process removes the gases from the intercellular spaces of the leaf.
## Floating Disks
### Data Collection Worksheet

Name:  

Other group members:  

Class/period:  

Date:  

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>Number of Floating Leaf Disks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bright light</td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>15</td>
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<tr>
<td>35</td>
<td></td>
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<tr>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

Observations
Floating Disks
Pre-Lab Questions

Directions: After reading through the introduction and protocol for the Floating Disks lab, answer the questions below.

1. What is the role of the baking soda in this experiment?

2. What is the purpose of an experimental control?

3. Which syringe serves as the control in this experiment? Explain why you made this choice.

4. Will the disks in each of the tubes react the same? Explain your answer.

5. Why will the disks float to the top of the syringes?
Floating Disks
Post-Lab Questions and Analysis

Directions: After completing the Floating Disks lab, answer the questions below.

1. In which tube did all (or most) of the leaf disks float first? Does this result match your prediction from the pre-lab questions?

2. In general, you would assume that increasing the amount of light will increase the rate of photosynthesis. Explain why the increase in photosynthesis causes more disks to float. Does the data you collected support this assumption.

3. If the leaf disks were boiled, what type of results would you expect? Explain your answer.