Floating Disks
An Investigation of Photosynthesis
Student-Centered Investigation

This document is divided into three sections. The first two pages provide teacher tips for leading the student-centered investigation. Pages three and four are instructions for the students and the last two pages provide a step-by-step guide for the students to develop their investigation.

Student-Centered Investigation Tips:
Students may need help identifying an appropriate student-centered laboratory investigation. If necessary encourage them by asking questions:

- Was there anything in the first experiment that we took for granted? How could we check that?
- What factors other than light intensity can impact the rate of photosynthesis?
- What other light conditions might affect photosynthesis?
- How critical is the baking soda to photosynthesis?
- What do we know about living systems and homeostasis?
- What do we know about the effects of pollution on living systems?
- How can we measure cellular respiration in the disks?
- How does the size or shape of the leaf pieces alter the results?

If you want the students go further and design their own experiment, students can discuss options while they are waiting for the results on day 1. On day 2, more plant material and solutions will be needed. Below is a list investigations regarding photosynthesis that students could pursue:

Students can test a variety of conditions including:

- Effect of different light intensities/light colors
- Effect of temperature changes
- Effect of concentration or type of various common household substances
- Effect of increased oxygen or carbon dioxide (concentration of sodium bicarbonate)
- Effect of surface area of the leaf disk
- Effect of concentration/type of various common substances
- Quantitative determination of oxygen and/or carbon dioxide consumption under varying conditions using Vernier probes or other appropriate equipment
- Effect of varying leaf pieces with respect to species, age, color, etc.
Student-Centered Investigation Lab Preparation:

Although it is impossible to anticipate all of the additional supplies students might request for a self-directed experiment, following supplies are suggested:

- Additional beakers, syringes, transfer pipettes, etc.
- Instructions for students to make solutions
- Light timers
- A range of lights, screens, and filters
- Household substances such as liquid soap, detergent, food coloring, salt, sugar, etc.
- Water baths
- Instructions for making molar solutions
- Equipment for time lapse photography
- Vernier interface, oxygen gas probes, sample chambers
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Introduction:
In the Floating Disk Photosynthesis lab you investigated the effect of varying light condition on the rate of photosynthesis. For the second part of this lab, you will use scientific methods to measure how changes in other parameters change photosynthetic rate. Scientific methods are principles and procedures used to pursue knowledge about the natural world. There is no one set way to do science, but scientific methods often involve:

- Making observations
- Asking questions
- Formulating hypotheses
- Test hypotheses with experiments or observational studies
- Collecting data
- Analyzing data and making conclusions
- Communicating results

Working with your lab group, brainstorm experimental questions about other factors that may or may not affect photosynthetic rates that you could investigate. Formulate a hypothesis and discuss with your group a possible experiment that would allow you to test your hypothesis. Discuss your ideas with the lab instructor to confirm availability of supplies. Once you have instructor approval, use the Student-Centered Investigation Lab Notebook worksheet to plan your experiment in detail.

Formulating a Hypothesis:
When formulating a hypothesis consider:

- Is your hypothesis testable?
- What are your dependent and independent variables?
- Is your hypothesis “directional?” Does it allow you to measure the dependent variable when the independent variable is manipulated?

Experimental Design:
As you develop your experiment design consider the following questions:

- What is your experimental control(s)? The initial experiment should have provided you with some information about what starting conditions you might want to consider for your control.
- What experimental procedure will you use?
- Calculate the amounts of all reagents you will need for your experiment ahead of time and record this information in the Lab Procedure section of your Lab Notebook handout.
- What experimental outputs will you measure? Consider both qualitative (descriptive) and quantitative (measured) data.
- How will you collect the data? Create a data collection table in the Experimental Data section of the handout.
- How will you analyze your results? Can you perform a quantitative or statistical analysis of your data?
Record your experimental design in the Student-Centered Investigation handout. Any steps that are the same as the Floating Disks protocol may be listed as: FD (Floating Disk) # (the number of the step you are using). Be sure to design an appropriate data collection table. Once you have completed your experimental design you may conduct your experiment! Be sure to gather all of the required supplies and reagents (appropriate amounts) BEFORE you start to collect any data.

**Post-Lab Analysis:**

After conducting your experiment and collecting your data, you will need to analyze your data, interpret your results, and make final conclusions regarding your hypothesis:

**Analyze data**
- Can you perform a statistical analysis?
- Can you graph or chart your data?
- Can you organize descriptive data in a table?

**Interpret results and make conclusions**
- Did your experiment yield interpretable data? Does the data indicate changes that should be made to the experimental design?
- Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables based on the data you collected.
- Does your data answer your experimental question?
- Does your data support or refute your experimental hypothesis?
- What did you learn from doing this experiment?
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Lab Notebook

Date:
Student Scientists:
School:
Experimental Question:
Experimental Hypothesis:

Lab Procedure (List all experimental procedures):

Experimental Data (Record and organize your data):
Analyze Data (Use mathematical operations to summarize data):

Interpret Results and Make Conclusions (Describe the effect of the parameter on photosynthesis and the chemical reaction rate):

What questions do you have about the experiment or the results?

Based on your results are there other experiments you would like to perform?