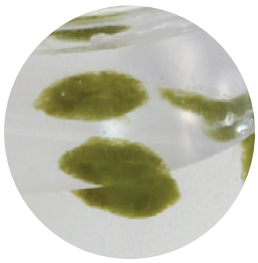
# Using Algae Beads as a Model for Photosynthesis

*A Carolina Essentials™ Investigation*



## Overview

Students are introduced to photosynthesis in a hands-on activity with fresh water algae. By creating algae beads (made of algae and sodium alginate solution), they indirectly observe the change in concentration of oxygen in algae beads that are exposed to different amounts of light. Students make qualitative and quantitative observations of the algae culture tubes for a period of 4 days. Students develop a model of photosynthesis as oxygen is trapped in the algae beads, changing the density of the beads and causing them to rise to the surface.

**Life Science, Biology—Photosynthesis**
**Grades: 8–12**

## Essential Question

How does photosynthesis transform light energy into stored chemical energy?

## Activity Objectives

1. Create green algae spheres for use in photosynthesis experiments.
2. Observe algae beads for evidence of photosynthesis.

## Next Generation Science Standards* (NGSS)

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| **Developing and Using Models**<br>Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.<br>• Use a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-LS1-5) | **LS1.C: Organization for Matter and Energy Flow in Organisms**<br>The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1.C) | **Energy and Matter**<br>The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (HS-LS1.C)<br>• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. (HS-PS4-4)<br>• Systems can be designed to cause a desired effect. (HS-PS4-5) |

## Safety Procedures and Precautions

Students will need lab safety goggles, aprons, and safety gloves.

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### TIME REQUIREMENTS

| PREP | ACTIVITY |
|---|---|
| 30 min | 30-45 min |

Teacher Prep: 30 min
**3-4 weeks prior to student activity**
Student Activity: 30–45 min for bead preparation
10 min for 3 additional days to make observations

### SAFETY REQUIREMENTS

### MATERIALS (PER GROUP)

Thick green algae culture (*Chlorella*, *Ankistrodesmus*, or other freshwater species)
2 culture tubes per student or group, 15 mL
3 mL 2% (by mass) sodium alginate solution per tube
30 mL 3% (by mass) calcium chloride solution in a 250-mL beaker per student or group
1 plastic spoon per student or group
1 distilled water in wash bottle per student or group
1 pipet per student or group
Aluminum foil

### HELPFUL LINKS

Making Algae Beads

### REFERENCE KITS

Algae Bead Photosynthesis

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## Teacher Preparation and Disposal

Use a highly concentrated algae culture that appears dark green. If beginning with a non-concentrated culture, allow it to grow for 3 to 4 weeks under constant lighting to achieve desired population density. It should appear dark green prior to use. The algae beads can be stored in the distilled water and refrigerated for approximately 2 weeks.

Wash contents down a lab sink/drain using plenty of water. Dispose of any waste in accordance with local regulations

## Student Procedure

1. Place 5 mL of green algae culture into a culture tube.
2. Add 2.5 mL of 2% sodium alginate solution to the tube, place the cap on the tube, and mix for 1 to 2 minutes.
3. Collect some of the mixture into your pipet.
4. Hold the pipet over a beaker containing 3% calcium chloride ($CaCl_2$) solution. The calcium chloride solution should be cold..
5. Gently depress the bulb on your pipet to release the algae mixture drop by drop into the beaker. Do this slowly and uniformly. As the algae mixture drops in the calcium chloride, the algae will be immobilized inside of a bead. Your mixture should allow you to make approximately 100 algae beads.
6. Collect your beads using the plastic spoon provided and rinse them using the distilled water in the wash bottle.
7. Transfer the beads to your clean culture tubes and fill the tubes with distilled water.
8. Tightly wrap one tube with aluminum foil so no light can penetrate.
9. Place the tubes in a well-lit area designated by your teacher.

## Teacher Preparation and Tips

*If not using a pre-concentrated culture, prepare the algae culture 3 to 4 weeks prior to the activity to ensure a high concentration of algae. The culture should be dark green.*

*Prepare the $CaCl_2$ solution a day prior to use and refrigerate it. Keep it cold throughout the procedure*

*Make sure students are not squirting algae into the $CaCl_2$ solution. Each drop should form a bead.*

*The time can vary to fit your schedule, but allow a minimum of 30 to 45 minutes.*

## Data and Observations

| Observations | Not wrapped (color, position in tube) | Wrapped (color, position in tube) |
|---|---|---|
| Day 1 | *Algae is dark green and beads are spread throughout.* | *Same* |
| Day 2 | *Algae beads are still green. Some are beginning to rise.* | *Few if any rise* |
| Day 3 | *Most algae beads are now at the surface.* | *Few if any rise* |
| Day 4 | *All the beads are at the surface.* | *Few if any rise* |

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## Analysis

1. Explain the differences in results between the covered and uncovered tubes.

   *The uncovered tube has the light necessary to photosynthesize, but the covered one does not.*

2. What causes the algae beads to float to the surface?

   *The build-up of oxygen trapped inside the beads.*

3. Use the evidence you gathered to develop a model explaining the relationship between the position of algae beads in the tube and photosynthesis.

   $6CO_2 + 6H_2O \quad C_6H_{12}O_6 + 6O_2$

   *The oxygen gas produced during photosynthesis in the unwrapped tube is trapped in the algae beads. As oxygen gas builds up, the density of a bead decreases, allowing the bead to float to the surface. Algae beads do not come to the surface in the wrapped tube because without light, the algae cannot photosynthesize.*

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## TEACHER NOTES