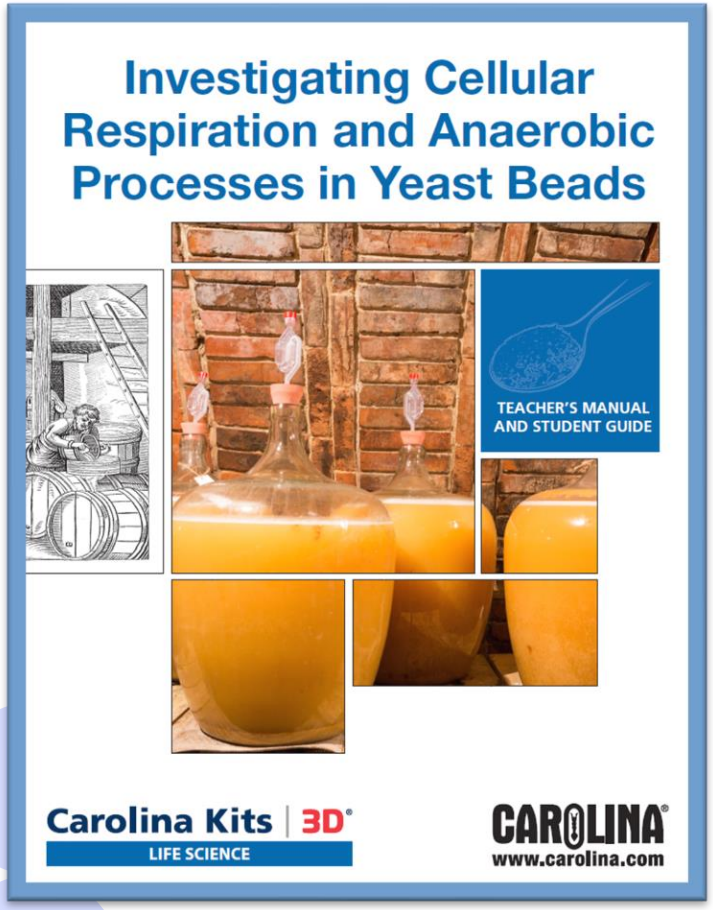
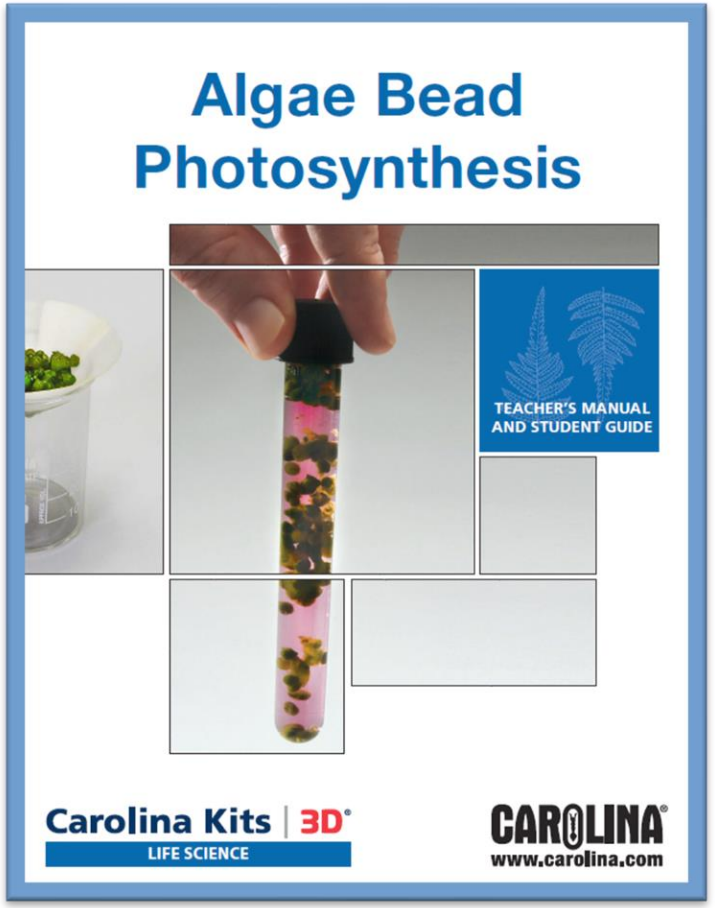
Cellular Respiration and Photosynthesis: Teaching Common Biology Concepts with Alginate Beads





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Safety Issues

- **Personal Protective Equipment**
  Gloves and safety goggles have been provided
- **Safety Tip**
  Clear your workspace of phones, papers, books, and other personal items.
- **Water**
  This workshop involves the use of water and other liquids please be sure that anything you don't want to get wet is put away.

Workshop Overview

Part 1: Yeast Beads: Cellular Respiration

- **Part 2: Algae Beads: Photosynthesis**

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Activity 1: Investigating Cellular Respiration and Anaerobic Processes in Yeast Beads

Related Performance Expectations

The activities in this kit build toward the following Performance Expectations of the Next Generation Science Standards*:

HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.

HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

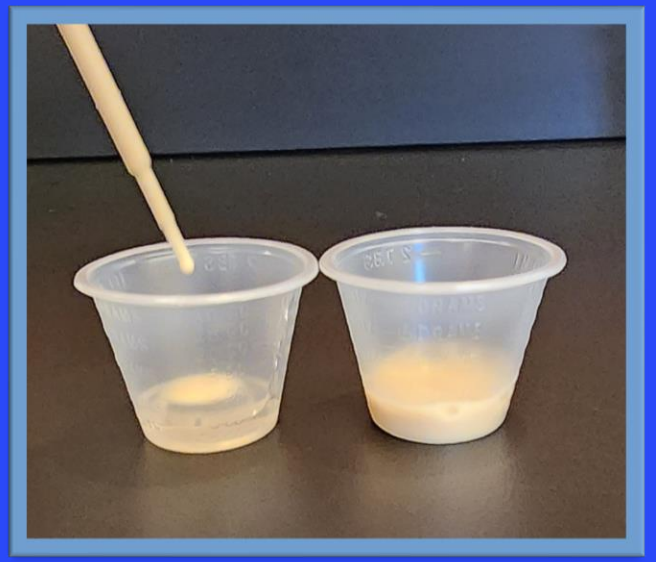
Three-Dimensional Learning

The activities in this kit address the following dimensions of the Next Generation Science Standards.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** • Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. **LS1.C: Organization for Matter and Energy Flow in Organisms** • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another.	**Energy and Matter** • Energy drives the cycling of matter within and between systems.

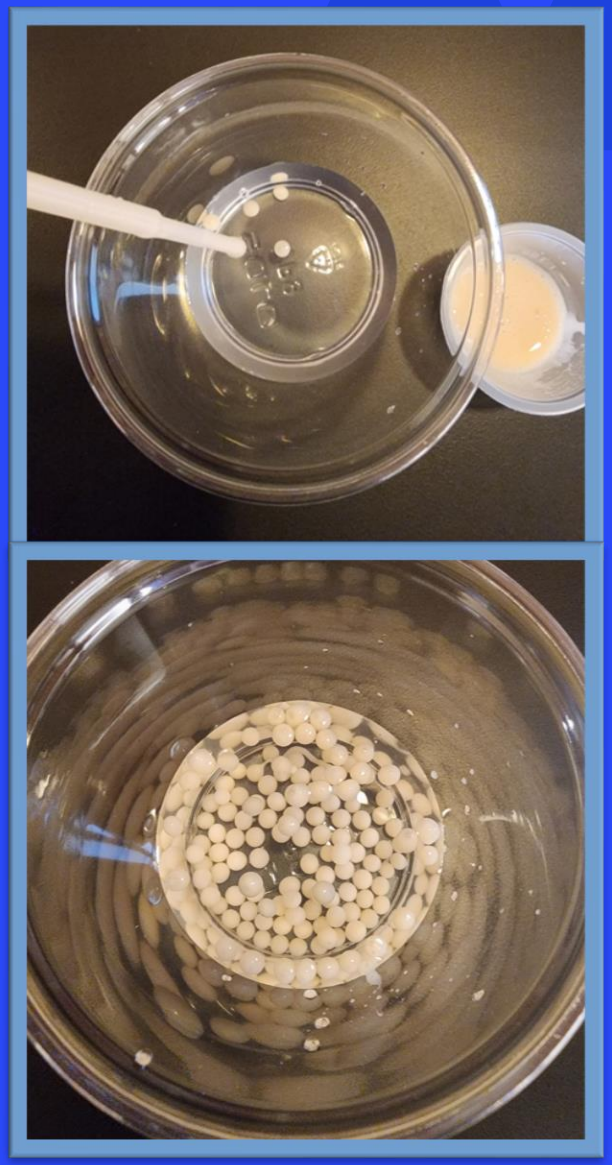
Procedure – Making Yeast Beads

1. Fill a 9 oz plastic cup approximately 1/4 of the way full with calcium chloride.
2. Use a clean pipet to transfer 5 mL of sodium alginate solution to a plastic medicine cup.
3. Add 5 mL of the yeast culture to the medicine cup containing sodium alginate.
4. Gently mix the yeast solution and the alginate mixture with the tip of the pipet. Be careful not to introduce air bubbles into the mixture.
5. Carefully draw the sodium alginate–yeast mixture into the pipet.



Procedure – Making Yeast Beads

6. Hold the pipet approximately 4 cm above the calcium chloride solution and then slowly drip the mixture into the plastic cup containing calcium chloride. Yeast beads will appear and begin to congeal on contact with the calcium chloride solution.
7. Continue to create additional yeast beads with the remaining sodium alginate–yeast mixture.
8. Allow the formed beads to remain in the calcium chloride solution for approximately 1 minute.



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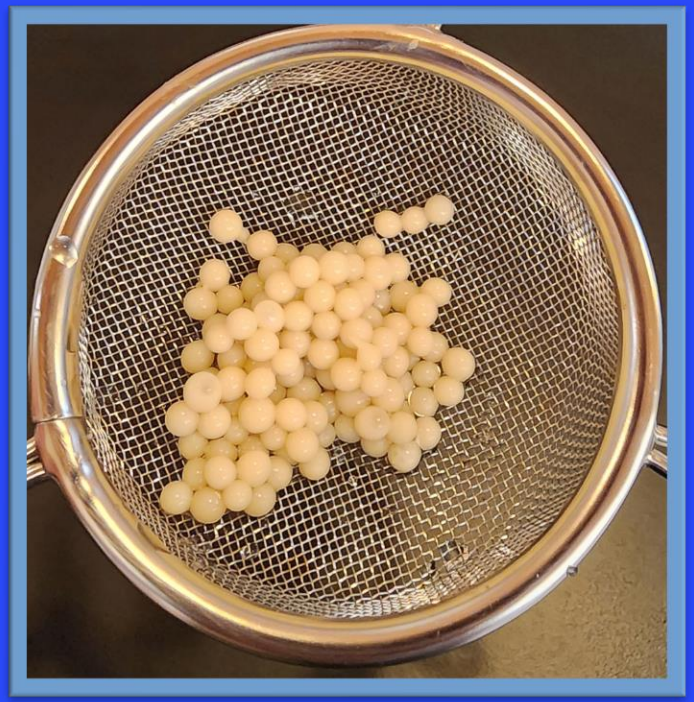
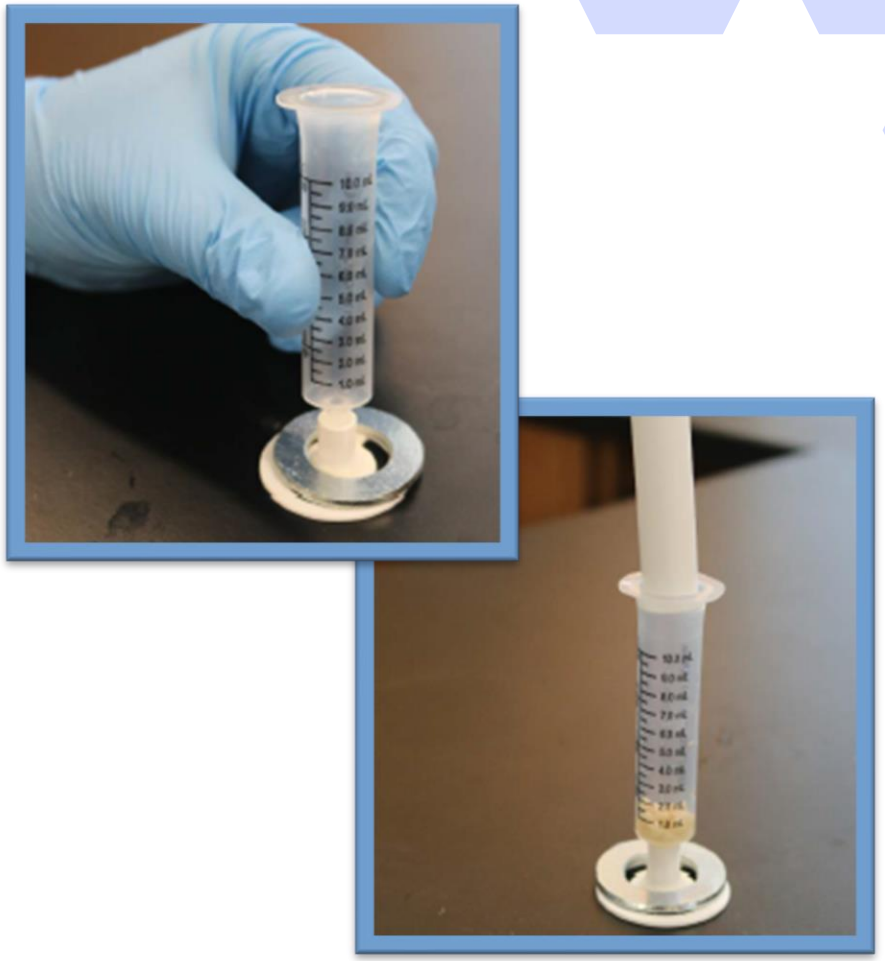
Procedure – Making Yeast Beads

9. Place the strainer over and partly into the empty plastic cup. Separate the beads from the calcium chloride by pouring the bead–calcium chloride mixture into the filter.



Procedure – Experiment

1. Remove the plunger from the syringe.
2. Place a washer over the base of the syringe stand.
3. Use a plastic spoon to fill the syringe to the 3.0-mL mark with yeast beads.
4. Carefully insert the plunger approximately 2 mm into the opening of the syringe chamber, just far enough to loosely connect the two pieces.



Procedure – Experiment

5. Invert the respirometer and tap the inverted respirometer to dislodge yeast beads from the tip.
6. Slowly compress the plunger on the inverted syringe to the 3.0-mL mark, being careful not to expel any yeast beads from the tip of the syringe.

Procedure – Experiment

7. Draw up 3 mL of sugar solution by placing the tip of the syringe in the sugar solution and then slowly drawing up solution to the 6.0-mL graduated mark on the syringe.
8. Being careful not to depress the white plunger, fit the respirometer back onto the base of the syringe stand with washer.
9. Observe the respirometer over time.

Discussion

- What did you see?
- Why do you think you saw that?
- What would you expect to see in a syringe that did not have glucose added?

Activity 2: Algae Bead Photosynthesis

Related Performance Expectations

The activities in this kit build toward the following Performance Expectations of the Next Generation Science Standards*:

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Three-Dimensional Learning

The activities in this kit address the following dimensions of the Next Generation Science Standards:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**Energy and Matter** • Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Procedure – Making Algae Beads

1. Use the tip of a pipet to stir the algal culture and resuspend the algal cells so that they are evenly distributed in the solution.
2. Use a clean pipet to transfer 5 mL of sodium alginate solution to a plastic medicine cup.
3. Add 5 mL of the concentrated algae to the medicine cup containing sodium alginate.
4. Gently mix the concentrated algae and the alginate mixture with the tip of the pipet. Be careful not to introduce air bubbles into the mixture.
5. Depress the pipet bulb, and then carefully draw the sodium alginate–algae mixture into your pipet.
6. Hold the pipet approximately 1 cm above the calcium chloride solution and then slowly drip the mixture into the solution. Algae beads will form on contact with the calcium chloride solution.
7. Continue to drip the remainder of the mixture, and then dispose of the pipet used to form the beads.

Procedure – Making Algae Beads

9. Place the strainer over and partly into the empty plastic cup. Separate the beads from the calcium chloride by pouring the bead–calcium chloride mixture into the strainer.
10. Fill the 15-mL conical tube halfway with algae beads.
11. Add 15 drops of bicarbonate indicator solution to the algae beads in the tube.
12. Fill the tube with spring water and secure the cap.