BIO LAB:
ALGAL BALLS

TEACHER

LEVEL: Year 11-12 | TOPIC: CELLS | TIME REQUIREMENT: 45 mins

CURRICULUM ALIGNMENT

- *In eukaryotic cells, specialised organelles facilitate biochemical processes of photosynthesis, cellular respiration, the synthesis of complex molecules (including carbohydrates, proteins, lipids and other biomacromolecules), and the removal of cellular products and wastes (ACSBL049)*
- *Cells require inputs of suitable forms of energy, including light energy or chemical energy in complex molecules, and matter, including gases, simple nutrients, ions, and removal of wastes, to survive (ACSBL044)*
- *The cell membrane separates the cell from its surroundings and controls the exchange of materials, including gases, nutrients and wastes, between the cell and its environment (ACSBL045)*
- *Photosynthesis is a biochemical process that in plant cells occurs in the chloroplast and that uses light energy to synthesise organic compounds. The overall process can be represented as a balanced chemical equation (ACSBL052)*

BACKGROUND

During photosynthesis, radiant energy is converted into organic substances that can be stored within the plant to support the growth, reproduction, and metabolism. Plants metabolize the sugars that form as a result of sunlight, carbon dioxide, and water reacting. Reliably studying photosynthesis first hand can be a difficult and require precise setting up. When no sunlight is available, respiration will dominate and the pH will decrease through the release of CO_2. Algal Ball Photosynthesis kits offer an easier, more accurate method of studying photosynthesis; that is perfect for use within the classroom. Algal balls are stored in small vials filled with hydrogen carbonate indicator solution. The encapsulated algae balls absorb the CO_2 from the solution they are stored in during the process of photosynthesis. As a result of the lowered CO_2 levels, the pH of the solution will rise. The reduced levels of carbonic acid can be monitoring via the colour changes that occur due to the hydrogen carbonate indicator.

Following this practical, students will have the opportunity to tangibly observe photosynthesis. Students will be tasked with conducting 4 small experiments and observing the changes occurring within the vial. Students observe how the colour changes from yellow/orange to purple when the algal balls and solution are placed under a light source as photosynthesis takes up dissolved CO_2 and the pH rises. Additionally, students create a light filter to observe its effects. Beyond this, students are tasked with storing the vial in the dark for a short period and observing the colour change from purple to yellow/orange as respiration occurs and the pH falls. Students will also vary the number of algal balls and light intensity to explore how different levels affect the algae. This is a great practical to introduce students to the basic principles of photosynthesis in a fun, simple and interactive way.

TEACHER TIP

You can compare the colour of the indicator solution in your experimental vials to a set of standard vials that contain solutions of boric acid / borax buffers coloured with hydrogen carbonate indicator.

MATERIALS

- 1 Container of 60 algal balls in distilled water
- 5 Empty 7mL vials
- 1 Bottle (50mL) of hydrogen carbonate indicator
- 6 Plastic pipettes
- Light source
- Coloured transparent film

SAFETY PRECAUTIONS

- Wear appropriate personal protective equipment (PPE).
- Know and follow all regulatory guidelines for the disposal of laboratory wastes.
- Avoid direct contact with any culture.
- Wash and dry your hands thoroughly before and after any experiment.

SOUTHERN Biological

PREPARATION - BY LAB TECHNICIAN

Algal ball culture Care

1. Remove the algal ball container from its packaging as soon as it arrives and loosen the lid It will help to loosen the lid to allow for airflow.
2. If you do not plan to use it immediately, store away from direct sunlight or areas of high heat. A lab bench situated away from a window is ideal. Place in an uncovered ice cream container or similar to prevent accidental spillage.
3. We recommend using the algal balls as early as you can; otherwise, they are best used within 2 weeks.

Experiment Preparation

1. Rinse the vials for your experiment with approximately 1mL of hydrogen carbonate indicator solution. To do this, replace the cap on the vial and shake the container. Next, pour the rinse liquid into the second vial and repeat until you have rinsed all required vials. Discard the rinse liquid from the last vial.
2. Divide the correct number of algal balls into each vial.
3. Use a plastic pipette to add 3mL of hydrogen carbonate indicator to each vial.
4. Note colour changes in the indicator solution as the CO_2 concentration and the pH change.

METHOD - STUDENT PRACTICAL

Experiment 1: Exposure to light and dark

1. Prepare a vial of algal balls and hydrogen carbonate indicator.
2. Position the vial near a light source, but do not expose it to too much heat. Observe any colour changes.
3. After the vial has been exposed to light, place it in the dark for a short time and observe any colour change.

Experiment 2: Coloured light filter

1. Prepare a vial of algal balls and hydrogen carbonate indicator.
2. Position the vial near a light source, but do not expose it to too much heat.
3. Wrap a piece of coloured transparent film around the vial and observe how the coloured light filtering into the vial impacts the rate of photosynthesis.

Experiment 3: Varying the number of algal balls per vial

1. Prepare a vial of algal balls and hydrogen carbonate indicator.
2. Experiment with varying number of Algal balls within the vial. You can either prepare 1-5 vials with varying numbers of balls or use the same vial. To use the same vial start with the greatest number of balls and expose to light as per the experiment; then, remove balls as you repeat the experiment.
3. Place each vial the same distance from a light source and identify whether the number of balls correlates with the rate of change of pH.

Experiment 4: Varying the light intensity

1. Prepare 5 or more vials of algal balls and hydrogen carbonate indicator.
2. Place 8 balls in each vial and place the vials at varying measured distances from a light source.
3. Ensure no vial casts a shadow on any other. Observe how the rate of change of pH is influenced by the light intensity.

OBSERVATIONS AND RESULTS

Exposure to light and dark expected results

After exposing the vial to a light source, the colour in the solution should change from yellow/orange to purple as photosynthesis absorbs the CO_2 and the pH rises. After placing the vial in the dark, you should observe the colour in the vial change from purple to yellow/orange as respiration occurs and the pH falls. Respiration and photosynthesis occur simultaneously in the algal cells. As more light becomes available, photosynthesis dominates. However, as conditions become darker, photosynthesis is retarded and respiration takes over as the main process.

Evaluating your results

Hydrogen carbonate indicator is sensitive enough to change colour as CO_2 dissolves in water to form carbonic acid. The indicator is a red/orange colour in water that is in equilibrium with the CO_2 in the air. The colour shifts through orange to yellow as the concentration of dissolved CO_2 rises and the pH falls, and it shifts through red to purple as the concentration of dissolved CO_2 falls and the pH rises. A rise in the concentration of CO_2 occurs during respiration as the algae breaks down sugars to release energy, CO_2 and water. A fall in the concentration of CO_2 occurs during photosynthesis as the algae produces carbohydrates by taking up CO_2 and water and absorbing light energy.