Topic 8 – Practical 1

Measuring the rate of photosynthesis using algae

Safety

- No significant risks. Care should be taken with handling lamps as these can become hot.

Apparatus and materials

- culture of algae (*Scenedesmus* sp.)
- 50 cm^3 measuring cylinder or beaker
- 3% sodium alginate solution
- 10 cm^3 beaker
- stirring rod
- 25 cm^3 beaker
- 2% calcium chloride solution
- 10 cm^3 syringe barrel
- six translucent glass bottles with lids (McCartney bottles)
- black paper or cloth to cover one McCartney bottle
- heat filters (Perspex screens or cylinders filled with water)
- colorimeter with 550 nm filter (if a colorimeter is not available, a set of sealed bottles containing hydrogencarbonate indicator at different pHs can be used to provide a reference scale)
- retort stand
- distilled water
- small sieve or strainer
- hydrogencarbonate indicator
- stopwatch or clock
- identical lamps (same wattage bulbs)
- light meter

Introduction

In this practical, you will investigate the effect of light intensity on the rate of photosynthesis of green algae that are immobilised in alginate beads.

The rate of photosynthesis will be measured by monitoring the drop in concentration of carbon dioxide in the surroundings. Carbon dioxide dissolved in solution forms carbonic acid, which lowers the pH. Hydrogencarbonate is a pH indicator that changes colour as the concentration of carbon dioxide gas in an aqueous solution increases. When the carbon dioxide content is higher than 0.03%, the indicator's red color changes to yellow as the pH becomes more acidic. If the carbon dioxide content is lower than 0.03%, it changes from red to purple. A colour change to purple during photosynthesis shows a reduction in the percentage of carbon dioxide.

The algae in this experiment are subjected to different light levels from darkness to bright light. Light intensity can be measured, using a light meter, or calculated since the light intensity at a point is proportional to $1/d^2$, where d is the distance of the light source from the point.

Procedure

1 Place approximately 50 cm^3 of the culture of algae in a measuring cylinder or beaker and leave it to settle, so that a green sediment of cells forms at the bottom.

2 Decant the culture so that approximately 5 cm^3 of concentrated algal cells remains in the measuring cylinder or beaker.

3 Prepare algal balls in alginate as follows. Mix 5 cm^3 of concentrated algal culture with 5 cm^3 sodium alginate solution in a small (10 cm^3) beaker. Stir thoroughly.

4 Fix the barrel of a 10 cm^3 syringe above a 25 cm^3 beaker of calcium chloride solution, and pour the alginate mixture into the syringe so that it falls drop by drop into the calcium chloride.

5 Allow the drops to harden into beads and remove them from the calcium chloride using a small sieve or strainer.

6 Rinse the beads in distilled water and store in a closed bottle of distilled water in a cool place.

7 To investigate the rate of photosynthesis, place 25 algal balls in each of the six McCartney bottles. Measure a set volume of hydrogencarbonate indicator (approximately 10 cm^3, but this will depend on the size of your containers) and add this to each of the McCartney bottles. Replace the caps.

8 Note the starting colour of the indicator, and thereby estimate the pH, or measure its absorbance using a colorimeter and 550 nm filter.

9 Cover one bottle with black paper or cloth and place the others in different light intensities. These can be measured using the light meter. If a light meter is not available then identical lamps can be placed at different distances from the bottles containing algae. Place a heat filter between the bottle and the lamp used for illumination or use cool bulbs.

10 Check the colour of each bottle after 30 minutes and then at 60 minutes.

11 Measure the pH change in each bottle either by estimating the final pH from comparison with the reference set of indicator bottles or by measuring the absorbance of each one using the colorimeter.

12 Plot a graph of absorbance (or pH) against light intensity.

Questions and further work

1 Outline the conclusions you can draw from the graph of absorbance (or pH) against light intensity.

2 What are the key variables in this experiment? Which variables should be kept constant?

3 Evaluate the procedure. How could it be made:

a more accurate?

b more reliable?