Guidance for Topic 8 – Practical 1

Measuring the rate of photosynthesis using algae

Safety

Although great care has been taken in checking the accuracy of the information provided in this guidance, Cambridge University Press shall not be responsible for any errors, omissions or inaccuracies.

Teachers and technicians should always follow their school and departmental safety policies. You must ensure that you consult your employer's model risk assessments and modify them as appropriate to meet local circumstances before starting any practical work. Risk assessments will depend on your own skills and experience, the skills and experience of your students, and the facilities available to you. Everyone has a responsibility for his or her own safety and for the safety of others. The notes below should not be regarded as a risk assessment.

You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties any of your students may encounter.

Guidance

The purpose of the practical is to allow students to investigate the effect of light intensity on photosynthesis. Algae confined in alginate balls enable the quantity of plant material to be standardised and ensure that the experiment can be conducted on a laboratory scale. Use of hydrogencarbonate indicator provides an opportunity to revise the concept of indicators and a colorimeter is a useful way to introduce light absorbance in a wider context and give an opportunity for ICT.

Note that this practical may instead be used during study of Topic **2**, *Molecular biology*.

Apparatus and materials

Each student or pair will need:

- 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
- retort stand
- distilled water
- small sieve or strainer
- hydrogencarbonate indicator
- stopwatch or clock
- identical lamps (same wattage bulbs)
- light meter
- 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)

Setting up the practical

Scenedesmus sp. can be bought from suppliers of microbial cultures, and cultured easily under cool lamps over a period of days before the practical.

Calcium chloride is an **irritant**. Wear eye protection and gloves when making up the solution. Add 2 g calcium chloride to 100 cm^3 distilled water.

To make 3% sodium alginate solution, 3 g sodium alginate is added slowly to 100 cm^3 warm distilled water, stirring constantly. Allow the mixture to cool.

Supporting the practical

Students may need practice in preparing the alginate balls. If colorimeters are not available students will need a reference set of hydrogencarbonate indicator samples for a range of suitable pHs. Hydrogencarbonate should be freshly prepared and stored in closed containers.

Clearing up

Alginate balls can be disposed of in normal refuse. Solutions should be washed away with plenty of water.

Answers to questions

1 Absorbance indicates the degree of pH change in the different bottles and can be correlated with the rate of photosynthesis (and thus removal of carbon dioxide from the solution). At higher light intensities the rate of photosynthesis is greater.

2 Variables:

independent – light intensity

dependent – rate of photosynthesis

controlled – temperature, quantity of algae, volumes of solutions, background light, length of time the experiment is run

3 **a** accuracy – use a pH probe rather than indicator colour change to measure pH, ensure alginate balls are all the same size

b reliable – repeat the experiment, use more than one bottle at each light intensity

Guidance for Topic 8 – Practical 2

Using a redox indicator to show the activity of dehydrogenase enzyme

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You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties any of your students may encounter.

Guidance

This practical considers the effect of temperature on hydrogenase enzymes involved in respiration. It has the additional benefit of offering the opportunity to monitor the reaction using a redox indicator. Students are asked to present data appropriately and address the issue of error analysis.

Apparatus and materials

Each student or pair will need:

- a suspension of live, respiring yeast
- triphenyl tetrazolium chloride (TTC) solution
- distilled water
- test tubes
- 5 cm^3 syringes (or graduated pipettes)
- stirring rod
- thermometer
- stopwatch
- water baths at 5°C, 30°C, 35°C, 40°C and 50°C

Setting up the practical

TTC solution 1% w/v aqueous solution (**harmful**) is prepared by dissolving 1 g TTC in 100 cm^3 distilled water.

Supporting the practical

Students should be familiar with the need to replicate results at each temperature. If teaching time is insufficient for students to carry out three trials at every temperature, results can be shared within the class.

Answers to questions

1 As with other enzymes, dehydrogenase has an optimum temperature. The type of yeast may determine the exact temperature that students obtain from their experiments.

2 Replication allows errors to be identified and if a reading is anomalous it can be discarded from the calculation of average values. It is possible to calculate mean and standard deviation if several values are obtained and to plot error bars on the graph of the results.

3 Error is an indication of the accuracy of measuring equipment. Where the time taken for the reaction is several minutes an error of ±30 s is reasonable when timing with a manual stopwatch. If the times involved are shorter this error would be too great and an alternative, more accurate timer would be needed.

4 Students may suggest repeating the experiment using a smaller range of temperatures just above and just below the optimum obtained in this experiment.