Practical 11 - Investigating the role of carbon dioxide in living organisms.

This practical focuses on manipulation and observations, recording and presenting data, analysis, drawing conclusions and evaluating methods. The practical also develops skills of using material in new and unfamiliar situations.

Intended learning outcomes

By the end of this practical you should be able to:

- Identify dependent and independent variables
- Make a hypothesis and express this in words
- Experience relevant methods, analysis and conclusion.
- Describe and explain the relationship between different living organisms and the production of carbon dioxide
- Evaluate procedures

Safety Information

	You should wear eye protection throughout this practical.
	Ethanol is **highly flammable**. There should be no flames in the same room.
	Bicarbonate indicator solution is **flammable**.

Background information

- Carbon dioxide is a gas found in the air at 0.04%
- Carbon dioxide dissolves in water to form carbonic acid thus reducing the pH
- When bicarbonate indicator solution is equilibriated with air it turns red/orange
- Bicarbonate indicator changes colour in different levels of pH
- You will remember from biology learnt in earlier courses that plants both respire and photosynthesise.
- Respiration glucose + oxygen ⟶ carbon dioxide + water + energy
- Photosynthesis carbon dioxide + water ⟶ glucose + oxygen
- The point at which the carbon dioxide released by plants from respiration, equals the carbon dioxide absorbed by plants for photosynthesis is called the plant's compensation point.

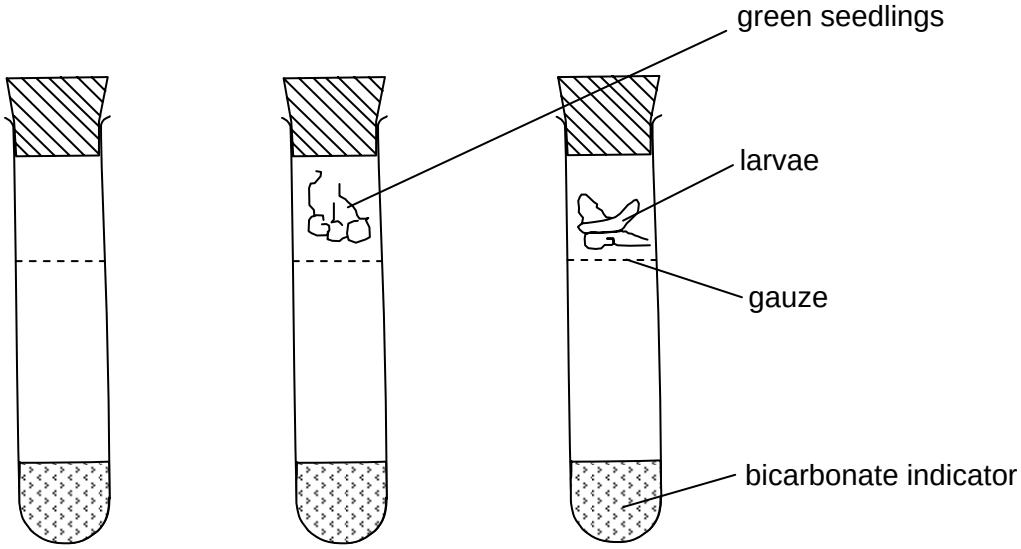
You will investigate the effect of different living organisms on bicarbonate indicator and use this information to devise an experiment to determine the compensation point in plants.

- Read the information above
- Identify and write down the dependent and independent variables
- Write down what you think will happen (do not worry about what the colour the indicator will be – you will discover that by doing the experiment)
- Identify any variables that should be controlled and outline how this should be done
- Write down a hypothesis to explain what will happen to the colour of the bicarbonate indicator when a plant is at its compensation point.

Method

Preparations and making observations

1. Rinse out three large test-tubes with distilled water and then with bicarbonate indicator solution.
2. Using a syringe or small measuring cylinder place 3 – 5 cm^3 of bicarbonate indicator solution into each test-tube.
3. Carefully place a piece of perforated gauze in each test-tube so that it is just above the indicator solution.
4. Place a rubber bung or cork into the first test-tube.
5. Carefully place three green seedlings onto the gauze in the second test-tube and seal with a rubber bung or cork.
6. Carefully place three fly larvae onto the gauze in the third test-tube and seal with a rubber bung or cork.
7. Place the three test-tubes near a bright light source such as a lamp or window



8. Check that the colour of the bicarbonate indicator solution in each test-tube is red/orange at the start of the experiment.
9. Leave the tubes for at least 30 minutes, comparing the colour of each indicator solution every ten minutes.
10. When the colours look different in all three test-tubes, note the final colour of the indicator in each of the three test-tubes.

Write-up

- Record your results in a clear table.
- Explain why one of the test-tubes contained no living material
- Explain your findings using your knowledge of respiration and photosynthesis
- Assess the reliability of the results obtained and suggest any modifications you could make to improve the experiment
- Plan and describe, but do not carry out an experiment using the same technique, to determine the compensation point in plants.

Practical 11 - Lesson Plan

Investigating the role of carbon dioxide in living organisms.

Context

A practical investigation set in the context of 9700 syllabus – Gaseous exchange

Key aims of the lesson

This practical is designed to develop the skills of observation, analysis and evaluation and using knowledge gained in a new and different context

Intended learning outcomes

By the end of the practical and the write-up the student should be able to

- Experience relevant methods, analysis, conclusions and evaluation.
- Describe and explain how an experimental method can be adapted to discover when a plant is at its compensation point.

Resources required

White board or flipchart and suitable pens or blackboard and chalk

Practical materials specified on the Technical Information Sheet.

Copies of the student worksheets.

Planned activities

Timings/ minutes	**Teacher/ Student Activities**
End of previous lesson	**Preparation –** 2 page student worksheet given out for students to read in preparation for the practical lesson. To consider identification of the variables, formulate a hypothesis and review previous learning on cell membranes
0 - 3	**Introduction** to the aims, intended outcomes and shape of the lesson – teacher led oral presentation
3 - 5	**Context –** review of pH indicators such as litmus and universal indicator and that carbon dioxide dissolves to form an acidic solution.
5 - 8	**Introduction to method –** Teacher briefly outlines method and answers any student questions on procedure. Teacher emphasises safety concerns and ethics when handling living material such as fly larvae which must not suffer undue stress.
8 - 40	**Carrying out the practical –** students carry out the practical work..
40 - 50	**Obtain results –** Students enter results into table and clear away apparatus as soon as they have finished

50 - 60	**Drawing together the threads –** Teacher led discussion on the skills that have been developed as well as discussion on results obtained. Practical write up to be completed in following lesson or as homework activity

Useful information

Discussion / evaluation points should include:

- what colour bicarbonate indicator tuned in different situation
- the cause of the colour change in the bicarbonate indicator
- what other variables could have affect the results and which variables should be controlled
- how the procedure could be improved to increase reliability
- how the procedure could be modified to determine the compensation point in plants

A numerical value of the compensation point can be determined by using a light metre. The light reading should be taken as close to the plant as possible at the time when the plant is at its compensation point.

For students unable to obtain accurate data, the following table of results may be used.

		no living material	seedlings	fly larvae
colour of bicarbonate indicator	start	red/orange	red/orange	red/orange
	end	red/orange	purple	yellow

Practical 11 - Technical information

Investigating the role of carbon dioxide in living organisms.

The apparatus and materials required for this practical are listed below.

The amount of apparatus listed is for one student or one group of students if they are to work in groups.

1. 3 large test-tubes each fitted with a rubber bung or cork
2. gauze or similar to support the specimens in the test-tubes whilst at the same time allowing the transfer of gases
3. supply of distilled water to rinse each test-tube.
4. 40 cm^3 of bicarbonate indicator solution, sufficient to rinse each test-tube and have sufficient remaining to place 5cm^3 into each test-tube.

   The stock solution of indicator can be prepared by dissolving 0.2g of thymol blue and 0.1g of cresol red in 20cm^3 of ethanol. Also prepare a solution by adding 0.84g of pure sodium bicarbonate to 900 cm^3 of distilled water. Add the dyes to this solution and make up to 1 dm^3. To prepare the indicator for use, pipette 25cm^3 of stock solution into a graduated flask and make up to 250 cm^3 with distilled water.

   The solution should be equilibriated with air by aspirating atmospheric air through the solution until it is orange/red in colour.
5. 3 germinated seeds such that they have developed green leaves and are photosynthesising. Cress seeds that have been placed on moist cotton wool in a Petri dish will germinate and develop leaves in only a few days. Times will vary depending upon local conditions.
6. 3 large fly larvae that are active and not approaching pupation
7. 10cm^3 graduated pipette or measuring cylinder or syringe

Additionally each student will require access to a sink and running water.

Commercial bicarbonate indicator solution is available from most chemical wholesalers, however it is possible to make up the solution in the laboratory as described above.

<u>Safety Precautions/Risks.</u>

Ethanol = F 

Bicarbonate indicator solution = F 

A risk assessment should be carried out as a matter of course.