Practical 4 - Investigation of the carbohydrates metabolised by yeast

This practical focuses on making measurements and observations, recording and presenting data, analysis, drawing conclusions and evaluating methods. You will also develop other assessed skills throughout the practical.

Intended learning outcomes

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

- Experience relevant methods, analysis and conclusion.
- Describe and explain the relationship between temperature and membrane permeability.
- Evaluate procedures

Safety Information

	You should wear eye protection throughout this practical.
	Methylene Blue is **harmful**. Avoid contact with eyes and skin. It will stain skin or clothes.

Background information

- Yeast can metabolise carbohydrates under two different conditions. When oxygen is present aerobic respiration occurs yielding a large amount of energy for the organism and producing carbon dioxide & water as waste products.
- However when oxygen is in short supply (anaerobic conditions) the yeast will break down the carbohydrate into ethanol & carbon dioxide with a much reduced energy output (alcoholic fermentation).
- Both of these forms of respiration in addition to most metabolic processes are catalysed by specific enzymes.
- The process of how efficient the yeast is in metabolising different carbohydrates can be monitored by observing the time taken for Methylene Blue to be discoloured

In this experiment you will investigate the relative efficiency with which different carbohydrates can be metabolised by yeast.

- Read the information above
- Identify and write down the dependent and independent variables
- Consider which type of carbohydrate (monosaccharide, disaccharide, polysaccharide) will be metabolised by the yeast and why. Explain your reasoning.
- Write down what you expect to happen as a hypothesis in which you make specific predictions about which carbohydrates you might expect yeast to metabolise.

- Identify any variables that should be controlled and outline how this should be done

Method

Preparations and making observations

1. Label seven boiling tubes A - G.
2. In tube A place 5cm^3 distilled water, in tube B 5cm^3 glucose, in tube C 5cm^3 fructose and continue with as many carbohydrates provided placing each tube in a rack.
3. Into each tube add 3 drops of Methylene blue.
4. Add 5cm^3 yeast solution to each tube noting the time.
5. Shake each tube to mix the contents and place back into the rack.
6. Do not disturb the tubes again but note the time taken for the blue colour to disappear from each tube.

Write-up

- Record your results in a clear table ensuring units are put in headers where possible.
- Represent the results of the experiment in a suitable chart to show type of carbohydrate against the time taken for the blue colour to disappear.
- Explain your findings in terms of enzymes activity and carbohydrate structure.
- Assess the reliability of the results obtained and suggest any modifications you could make to improve the experiment

Practical 4 - Lesson Plan

Investigation of the different carbohydrates metabolised by yeast.

Context

A practical investigation **s**et in the context of 9700 syllabus – Enzymes, biological molecules, respiration.

Key aims of the lesson

This practical is designed to develop the skills of observation, analysis and evaluation.

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 the relationship between temperature and the permeability of cell membranes.

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 –** 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 enzyme controlled reactions, biological molecules & respiration. Key points written on board
5 - 8	**Introduction to method –** Teacher briefly outlines method and answers any student questions on procedure. Teacher emphasises safety concerns with methylene blue
8 - 40	**Carrying out the practical –** students carry out the practical work. Whilst they are waiting for the colour change to occur they can write up the first part, identifying variables, hypothesis, results table.

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

Safety precautions:

- **Methylene blue is harmful and can be a skin irritant. Safety glasses should be worn. Additionally as it is a protein stain it will stain any natural material. Please emphasise to students the importance of safety when pipetting the methylene blue.**

Discussion / evaluation points should include:

- Why should the tubes remain still after the initial mixing?
- What is being measured by the methylene blue discolouration (i.e. removal of oxygen from the system by the aerobically respiring yeast) ?
- Suggest why some sugars are metabolised and others are not.
- Why was the yeast incubated for about 30 minutes before the experiment started?
- What was the purpose of the tube with distilled water and yeast solution?
- Ensure that the students are aware of what type of organism that yeast belongs to.
- Yeasts live in many different environments. Suggest why the following are suitable places for yeast growth

  a) fruit skin

  b) Human body
- What precautions could be undertaken to ensure that all the tubes remained at a constant temperature?
- for students unable to obtain a full set of results the following could be used for analysis. Please note that other students results may not agree with these ones.

Type of carbohydrate	Time taken for blue colour to disappear (minute:secs)
Glucose	6:15
Fructose	24:45
Galactose	No change
Lactose	No change
Maltose	25:30
Sucrose	8:40
Starch	42:00

Practical 4 - Technical information

The metabolism of different carbohydrates by yeast

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. $5cm^3$ of as many of the following carbohydrates as available. Each made up to 5% concentration – Fructose, Galactose, Glucose, Lactose, Maltose, Starch, Sucrose
2. $5cm^3$ distilled water
3. 7 boiling tubes (or as many as the number of carbohydrates available plus control)
4. Methylene blue, 3 drops per sample
5. $5cm^3$ yeast solution (prepared in advance) per sugar used
6. test tube rack
7. Timer
8. Safety glasses

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

The yeast should be prepared according to local conditions so that it is activated and ready for use.

Safety Precautions/Risks.

Methylene blue = H 

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