Microscience Manual

Biology Students' Manual

Second Guyana Version Adaptation of Teaching and Learning Materials on Microscience Experiments

United Nations
Educational, Scientific and
Cultural Organization

Funded by UNESCO in collaboration with the Ministry of Education and the University of Guyana

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Contents

The Ministry of Education wishes to acknowledge the work of the consultations on selecting the Microscience Experiments for Biology, Chemistry and Physics which are relevant to the national curriculum.

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A Message from the Minister of Education

'The steady decline of enrolment of young people in science is cause for concern, and it is in this endeavour that UNESCO's work in Science Education aims to make a difference. In a world that is increasingly shaped by science and technology, the team recognizes this and has made it its mission to not only spread education but to make an interest in the Sciences a prominent and lasting feature wherever it is offered'.(UNESCO, 2011). One approach used by UNESCO is its **Global Micro-science Experiments Project** which provides developed and developing countries alike with new teaching tools. This Global Micro-science Experiments Project is a hands-on science education project that gives primary and secondary school students as well as university students the opportunity to conduct practical work in physics, chemistry and biology, using kits that come with booklets. The project thus contributes to capacity building, in areas where limited/no laboratory facilities are available. The experimental techniques that can be covered on a micro-scale include everything from separating the components of mixtures to measuring rates of reactions between chemicals.

The Ministry of Education, Guyana collaborated with UNESCO to initiate the Global Micro-science Experiments project as a pilot for fifteen secondary schools in 2012. Ninety-five percent (95%) of secondary schools are now equipped with the micro-science kits and supporting manuals. This project was embraced to support the Ministry's drive to improve enrolment in the single sciences. A twenty percent (20 %) increase in student enrolment was recorded since the introduction of this programme. We remain committed to transforming Guyana through Science and Technology in Education.

Guyana now leads UNESCO's Global Microscience Experiments Project in the Caribbean and is willing to partner CXC territories in providing assistance.

It is my sincere hope that this manual will be used to encourage interactive learning which fosters the development of critical thinking skills by students.

Hon. Dr. Priya D. Manickchand
Minister of Education
Guyana
April 2015

Introduction to the first Guyana version adaptation of UNESCO teaching and learning materials on micro science experiments

The contents of this document are recommended by the participants of UNESCO/Kingston/Ministry of Education, NCERD consultations on Micro-Science Experiments held in Georgetown (Guyana) on 27-30 June, 2011. The present materials correspond fully to the existing National Curriculum for teaching basic sciences at the different levels. The materials were selected by the participants of the working consultations. The participants worked with teaching and learning packages on microscience experiments which are available on UNESCO's website and are free for all types of adaptations and modifications. The different types of microscience kits donated by UNESCO/Kingston Office to Guyana can be used in practical classes. The experiments are classified according to grades and some were given first priority (refer to appendix 1). The 'priority one' experiments are recommended for the pilot of the microscience experiments. It is very clear that, new experiments can be developed and tested using the same kit, as proposed by the participants of the working consultations which included curriculum development specialists. Developing new materials can be recommended, as a second stage of the project development. It is noted that the microscience experiments, as a new methodology for hands on laboratory work by students, can work in conjunction with macroscience experiments. Furthermore the microscience kits can be used by teachers for demonstration purposes. We hope, that the Science Teachers in Guyana will find the microscience experiments methodology and teaching and learning materials, interesting and of great value for the enhancement of science education.

Participants of the working consultations

May 2012

EXPERIMENT 1 –WHAT MOULDS WILL GROW ON BREAD?

CSEC OBJECTIVE: Section A 3.6

Grade Level – 10

INFORMATION

When bread becomes mouldy it is being consumed by saprotrophs. These are organisms that feed off dead or decaying matter, including dead animals and plants. Many fungi, moulds, and bacteria are saprotrophs.

Saprotrophs play a very important role in any ecosystem - including the ecosystem in our own homes. The chemical components of dead organisms are recycled and therefore can be reused by plants and animals.

You Need

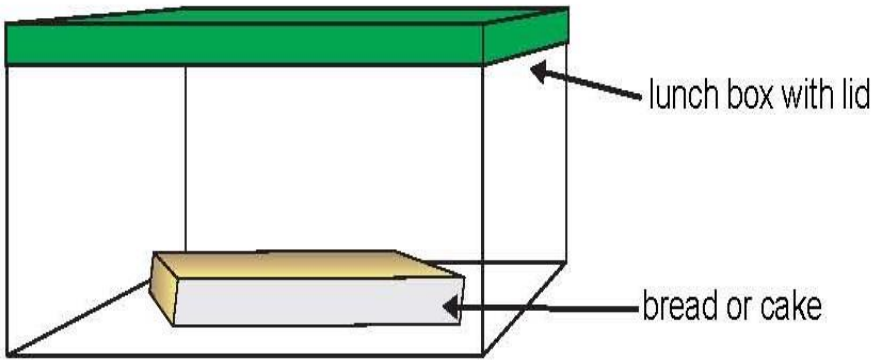
- Plastic lunch box with lid
- Forceps
- Hand lens
- Old, stale bread or cake which is not too dry
- Paper towel

What to do

Stage 1 Colonies of Moulds

The following preparation must be carried out at least one week before the observation stage of the investigation.

1. Work in groups so that each group uses a different piece of bread or cake. Note the manufacturer or baker, date of purchase or baking, and any other information; for example whether the bread is brown, wholewheat, white or rye - and so on.
2. Sprinkle a few drops of water on the food and place it in the lunch box with the lid on as shown below.

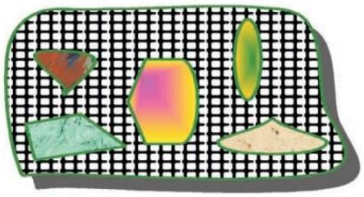


3. Examine the bread after about one week.
4. Observe the following using a hand lens to help you:

- how much of the bread is covered in mould (see below)
- how many different types of mould are present
- what colours the moulds are.

5. Draw a plan of your bread using squared paper. Indicate the colonies of mould

present, what colours they are and what areas they occupy. Use the example below to help you



Count the total number of squares covered by the bread and record your finding.
Count the total number of squares covered by each type of fungus and record your finding.
Now calculate the percentage of bread surface covered by each type of fungus.

Example calculation:

Number of squares covered by bread = 50
Number of squares covered by mould = 18
% bread covered by mould = 18/50 x 100
= **36 %**

6. Compare your findings with those of other groups. Tabulate the combined results in a table like the one below:
   Example

Type of Substrate	Age of Substrate	% Coverage	Number of Different Colonies
brown bread	3 days	50%	3
chocolate cake	1 week	80%	1

QUESTIONS

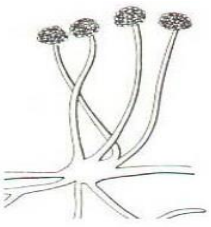
You will have to analyse the information in your table in order to answer some of these questions.

1. Which type of mould did you identify most frequently?
2. Did you notice that any type of mould was more common on any of the substrates?
3. What is happening to the bread or cake as the mould gets bigger?

Stage 2 Detailed Study of Bread Mould (Mucor / Rhizopus)

What to do

1 Select an example of mould which looks like the example given below. Use a hand lens to observe the hyphae, sporangia and the spores. (If a light microscope is available, you can also use this to observe the parts mentioned.)



EXTENSION ACTIVITY

	1. Leave the mould with its substrate in the lunch box with the lid on. Examine the contents of the lunch box every day for the following two weeks. Record all your findings. Pay careful attention to the increase or decrease in the size of any of the colonies. Use the squared paper method to help you obtain more accurate results.
	Stage 3 Examining a section of fungal mycelium - *Optional Activity* **You Need** • Light microscope • Dissecting needle • A few of the fungal threads which you grew in your comboplate • Glass slide • Coverslip • Propette • Water • White paper
	What to do 1. Make a temporary microscope slide*. 2. Place the slide under the lens of the light microscope and focus. 3. Identify fungal threads (hyphae), sporangia and spores. 4. Draw what you see. See the example alongside. ** Ask your teacher about preparing temporary microscope slides*.

EXPERIMENT 2 –WHAT IS THE STRUCTURE OF A CRUSTACEAN?

CSEC OBJECTIVE: Section A 1.1

Grade Level – 9

You Need

- Plastic lunch box
- Forceps
- Hand lens
- Petri dish
- Suitable crustaceans* (probably dead)

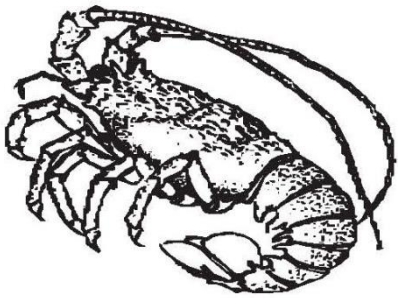
* To be obtained from your teacher

What to do

Observe the prawn or other crustacean and answer the questions which follow. Use a text to find out the meanings of words which you do not know.

A General characteristics

1. Feel the outer covering of the specimen. Why do you suppose the organisms in this group are called crustaceans?
2. Of what substances is the outer covering composed?
3. Into how many parts is the body divided?
4. Is the body clearly segmented?



crayfish

B The Cephalothorax

Examine the mouth and its appendages. These structures are all used in feeding.

1. How many antennae are there? Compare the antennae with respect to length and structure.
2. How many eyes are there? Are they sunken at the surface?
3. What is the carapace? What is its purpose?
4. Examine the walking limbs. How many are there? To what part of the body are they attached?
5. Are any of the limbs modified in any way? Explain.
6. Why is it important that the gills are attached to the walking legs?

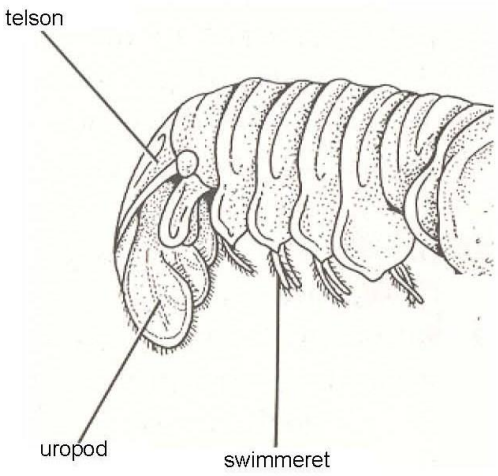
C The Abdomen

NOTE 1: This part of the crayfish is sometimes called the "tail". It is not a tail like the tail of a vertebrate. If people buy crayfish tails in a shop, they are actually buying the abdomen

of the crayfish.

NOTE 2: If you are looking at a dead crab, you will notice that the abdomen is reflexed and tucked under the cephalothorax.

Use the diagram below to help you identify parts of the abdomen.



Examine the posterior part of the abdomen. Identify the telson and the uropods. Locate the anus on the ventral surface of the telson. Locate the pleopods (swimmerets) on the ventral surface of the abdomen.

1. What is the function of the pleopods (swimmerets), do you think?
2. What is the function of the uropod?

EXPERIMENT 3 –WHAT IS THE STRUCTURE OF A SPIDER?

CSEC OBJECTIVE: Section A 1.1

Grade Level – 9

INFORMATION

Spiders, like insects, crustaceans and myriapods are arthropods. In this activity you will examine one or more spiders and find out in what ways they are similar and different from other arthropods.

Observe the spiders and their behaviour. DO NOT ANNOY THEM. DO NOT TOUCH THEM.

You Need

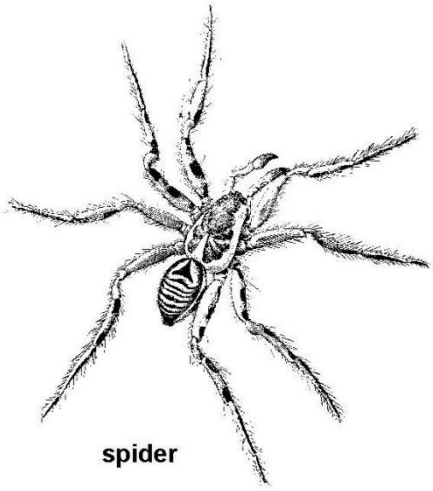
- Hand lens
- Glass container**
- Spider or spiders**
- Water
- Twig

** Your teacher will explain what to do so that you can best observe the spiders.

Answer the questions to the best of your ability. DO NOT interfere with the spiders.

What to do

Observe the spiders and answer the questions which follow. Use a text to find out the meanings of words which you do not know.



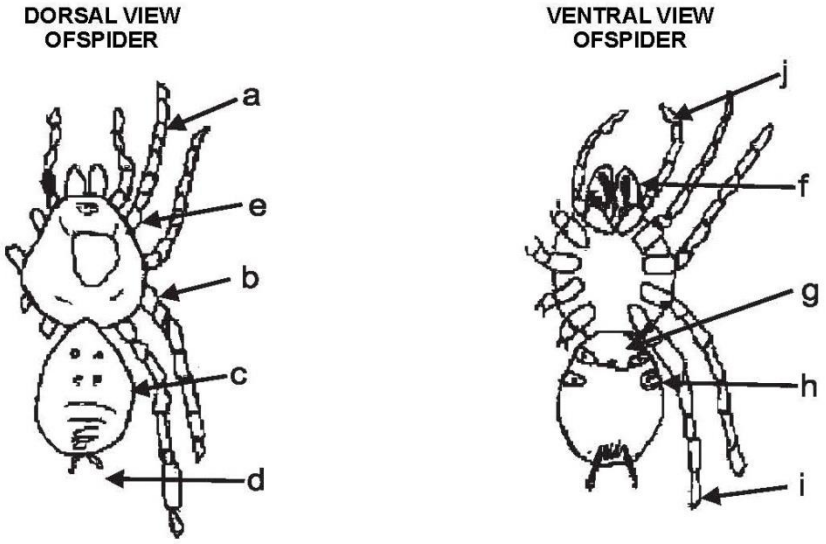
spider

QUESTIONS

1. What is the outer covering called?
2. Describe the substance forming the outer covering.
3. Into how many parts is the true body divided?
4. Is the body clearly segmented?
5. How many walking appendages are there?
6. From which body part do they arise?
7. Study the dorsal surface of the spider and locate the following structures:
   a) eyes - how many there are and their position
   b) pedipalps - their position and possible function

c) anus.

8. Study the ventral surface and identify the following:
   a) chelicerae - position and possible function
   b) reproductive opening
   c) openings to book lungs
   d) spinnerets (if present - not all spiders spin).
9. Watch a spider feeding. Which structures do they use when they feed?
10. Refer to the diagram below. In your notebook, write the letters a to j underneath one another. Beside each letter, write the correct label.



EXPERIMENT 4 – THE ACTION OF AMYLASE ON STARCH

CSEC OBJECTIVE: Section B 2.9

Grade Level – 10

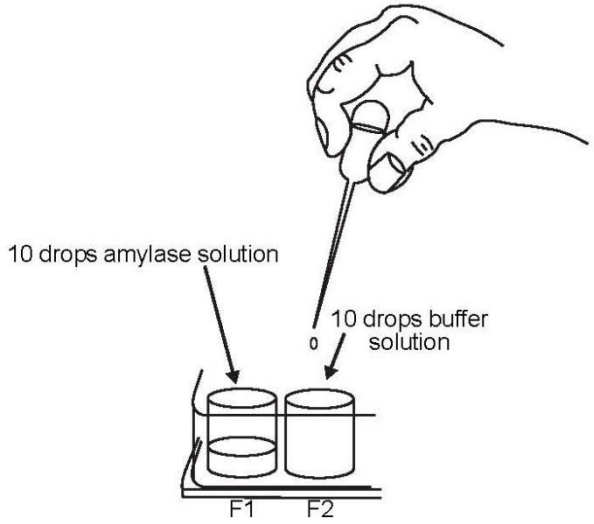
You Need

Apparatus: Comboplate®; 2 x propettes; Plastic lunch box; Thermometer.
Chemicals: Starch suspension;Amylase solution; I2 /KI solution (iodine solution);
pH 6.5 buffer solution; Hot water; Tap water at room temperature.
Use the plastic lunch box as a water bath in the following way:

- Pour a little tap water at room temperature into the container.
- Slowly add hot water, stirring occasionally until a temperature of between 30 oC and 40 oC is reached.

What to do

1. Add 20 drops of starch suspension to each of wells F1 and F2 of the comboplate®.
2. Add 10 drops of amylase solution to well F1 and 10 drops of buffer solution to well F2 of the comboplate®. See the figure below.



3. Float the comboplate® on a water bath at between 30 oC and 40 oC for 10 minutes.

CARE
DO NOT LET WATER FROM THE WATER BATH ENTER ANY OF THE COMBOPLATE® WELLS.

4. After 10 minutes add 5 drops of I2 /KI solution (iodine solution) to each of wells F1 and F2.
5. Observe any changes.

QUESTIONS

1. What is the colour of the I2 /KI solution (iodine solution)?
2. What happens when we add iodine solution to starch suspension or to a food which

	contains starch? 3. What is the colour of the mixture in well F2 after iodine solution has been added? 4. What does this observation suggest? 5. What is the colour of the solution in well F1 after iodine solution has been added? 6. What does this observation suggest? 7. What substance did well F1 have which well F2 did not have? 8. What did the amylase do? 9. Where do we find amylase in ourselves? 10. Amylase is an enzyme. What sort of enzyme is it?

EXPERIMENT 5 – THE ACTION OF AMYLASE ON STARCH OVER A PERIOD OF TIME

CSEC OBJECTIVE: Section B 2.8

Grade Level – 10

You Need

Apparatus: Comboplate®; 2 x propettes; Stopwatch or clock.

Chemicals: Starch suspension;Amylase solution; pH 6.5 buffer solution; I2/KI solution (iodine solution).

What to do

1. Add 20 drops of starch suspension to each of wells F1 to F6 of the comboplate®.
2. Add 10 drops of amylase solution and 10 drops of buffer to each of wells F1 to F6 of the comboplate®.
3. Add 5 drops of I2/KI solution (iodine solution) to the contents of well F1 immediately. This well represents the situation before amylase has acted on the starch. In other words it shows the zero time situation.
4. Start measuring the time from zero time.
5. One minute from zero time, add 5 drops of I2 /KI solution (iodine solution) to the contents of well F2.
6. Two minutes from zero time, add 5 drops of I2 /KI solution (iodine solution) to the contents of well F3.
7. Four minutes from zero time, add 5 drops of I2 /KI solution (iodine solution) to the contents of well F4.
8. Eight minutes from zero time, add 5 drops of I2 /KI solution (iodine solution) to the contents of well F5.
9. Sixteen minutes from zero time, add 5 drops of I2/KI solution (iodine solution) to the contents of well F6.
10. Wait for 5 minutes.
11. 11 During this time, copy the table below. It represents the F wells of the comboplate®. You will use the table to record the final colours of the mixtures in the appropriate wells.

Table to Show the Effect of Amylase on Starch over a Period of Time

Well	F1	F2	F3	F4	F5	F6
Colour						

12. Place the comboplate® on a sheet of white paper so that you can see the colours clearly.
13. Use the table to record your observations.

	QUESTIONS 1. What was the substrate in this investigation? 2. What was the enzyme in this investigation? 3. What do you think the end-products of the reaction are? 4. What do your observations suggest? 5. Amylase acts in the mouth which has a pH around 7. What do you suppose happens when the food and enzyme is swallowed into the stomach which has a pH around 2 to 3?

EXPERIMENT 6 – THE EFFECT OF pH ON THE ACTION OF AMYLASE ON STARCH

CSEC OBJECTIVE: Section B 2.9

Grade Level – 10

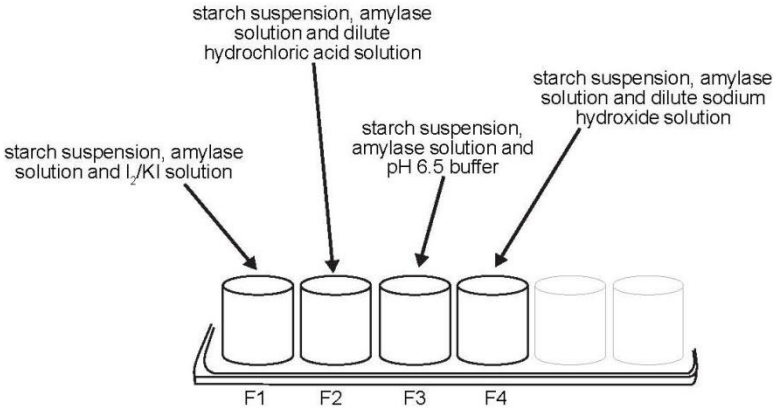
You Need

Apparatus: Comboplate®; 5 x propettes; Stopwatch or clock.

Chemicals: Starch suspension;Amylase solution; pH 6.5 buffer solution; I2/KI solution (iodine solution);
Dilute hydrochloric acid (0.1 M); Dilute sodium hydroxide solution (0.1 M).

What to do

1. Add 20 drops of starch suspension to each of wells F1 to F4 of the comboplate®.
2. Add 10 drops of amylase solution to each of wells F1 to F4 of the comboplate®.



3. Add 5 drops of I2/KI solution (iodine solution) to the contents of well F1 immediately. This represents the situation before amylase has acted on the starch. In other words it is the blank.
4. Add 10 drops of dilute hydrochloric acid solution to well F2 of the comboplate®.
5. Add 10 drops of pH 6.5 buffer solution to well F3 of the comboplate®.
6. Add 10 drops of dilute sodium hydroxide solution to well F4 of the comboplate®.
7. After 10 minutes, add 5 drops of I2/KI solution (iodine solution) to each of wells F2 to F4.
8. During the 10 minute wait, copy the table below. It represents the F wells of the comboplate®. You will use the table to record the final colours of the mixtures in the appropriate wells.

Table to Show the Effect of Amylase on Starch in Solutions of Different pH

Well	F1	F2	F3	F4
Solution				
Colour				

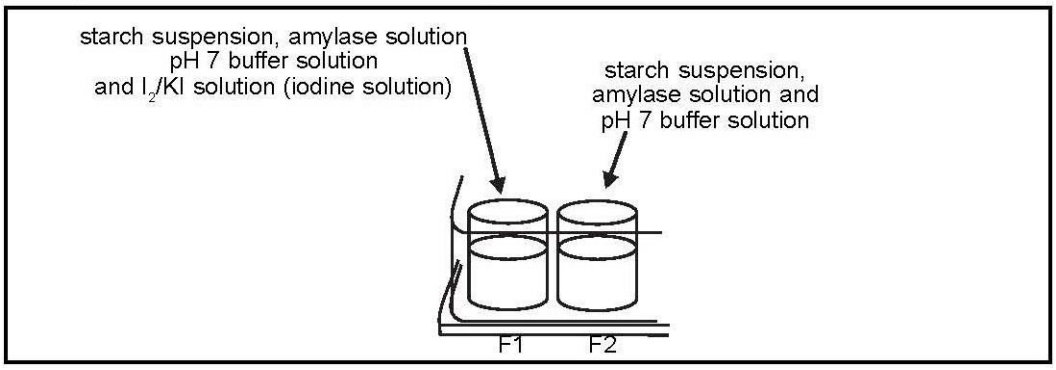
	9. Place the comboplate® on a sheet of white paper so that you can see the colours clearly. 10. Use the table to record your observations.
	QUESTIONS 1. What was the substrate in this investigation? 2. What was the enzyme in this investigation? 3. What do you think the end-products of the reaction are? 4. What do your observations suggest? 5. Amylase acts in the mouth which has a pH around 7. What do you suppose happens when the food and enzyme is swallowed into the stomach which has a pH around 2 to 3? 6. Explain your answer in terms of the lock-and-key theory of enzyme activity.

EXPERIMENT 7 – THE EFFECT OF TEMPERATURE ON THE ACTION OF AMYLASE ON STARCH

CSEC OBJECTIVE: Section B 2.9

Grade Level – 10

	You Need **Apparatus:** 4 x comboplate®s; 5 x propettes; *4 x plastic lunch boxes; 4 thermometers; Stopwatch or clock. **Chemicals:** Starch suspension;Amylase solution; pH 6.5 buffer solution; I2/KI solution (iodine solution); Ice; Hot water. ***Use the plastic lunch boxes as water baths in the following way:**
	Between 0 0C and 10 0C • Pour a little tap water at room temperature into one of the lunch boxes. • Slowly add ice, stirring occasionally until a temperature of between 0 0C and 10 0C is reached.
	Between 30 0C and 40 0C Similarly, using another plastic lunch box, • Pour a little tap water at room temperature into one of the lunch boxes. • Slowly add hot water, stirring occasionally until a temperature of between 30 0C and 40 0C is reached.
	Between 80 0C and 100 0C Repeat the procedure using another plastic lunch box and more hot water, in order to obtain a temperature between 80 0C and 100 0C.
	Room Temperature Use plain tap water for the water bath at room temperature. Keep checking the temperatures of the water in the water baths. Add either hot or cold water as necessary in order to maintain the correct temperature range.
	What to do Four comboplate®s as well as four water baths are needed. We suggest you work in four groups, each group taking responsibility for a different temperature set-up. 1. Place the first comboplate® in a 0 0C to10 0C water bath (i.e. in a water bath of icy or very cold water). 2. Place the second comboplate® in a water bath at room temperature. 3. Place the third comboplate® in a 30 0C to 40 0C water bath. 4. Place the fourth comboplate® in a 80 0C to 100 0C water bath (i.e. in a water bath with very hot water). **Follow steps 5 to 10 for each of the four comboplate®s** 5. Add 20 drops of starch suspension to each of wells F1 and F2. 6. Add 10 drops of pH 7 buffer solution to each of wells F1 and F2. 7. Add 10 drops amylase solution to each of wells F1 and F2. 8. Add 5 drops of I2/KI solution (iodine solution) to the contents of well F1 immediately. This reaction represents the situation before amylase has reacted with the starch. Each comboplate® should look like the situation pictured below.

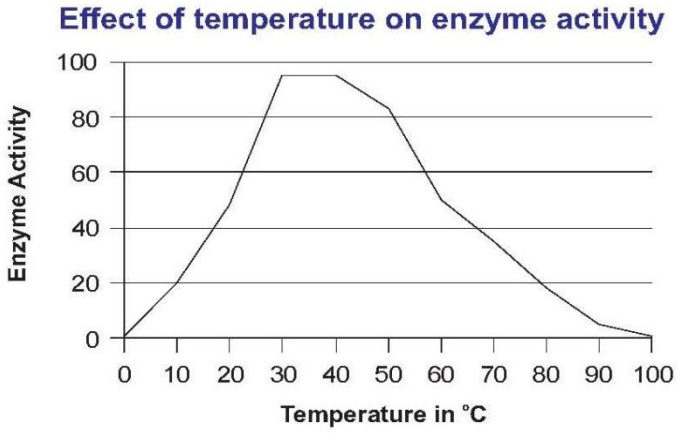


9. After 10 minutes, add 5 drops of I2/KI solution (iodine solution) to the contents of well F2.
10. Place the comboplate® on a sheet of white paper so that you can see the colours clearly.
11. Record your observations of the colour in well F2 as shown below:

Comboplate® 1 (0 0C to 10 0C):
Comboplate® 2 (room temperature):
Comboplate® 3 (30 0C to 40 0C):
Comboplate® 4 (80 0C to 100 0C):

QUESTIONS

1. What are the possible variables in this investigation?
2. What was the altered variable in this investigation?
3. What do your observations suggest?
4. What is the significance of a temperature around 30 0C to 40 0C?
5. What do you suppose happens to the enzyme at low temperatures?
6. What do you suppose happens to the enzyme at high temperatures?
7. An experiment, similar to the one which you have just done, was conducted in order to determine the effect of temperature on an enzyme. The enzyme was allowed to react for half an hour. The results of the experiment are shown in the graph below.



7.1 What is the optimum temperature for this enzyme?
7.2 At which temperature does the enzyme function at 20% activity?
7.3 How do you suppose enzyme activity is measured?
7.4 Why does the enzyme activity not reach 100%?

EXPERIMENT 8 – THE ACTION OF THE ENZYME CATALASE ON HYDROGEN PEROXIDE

CSEC OBJECTIVE: Section B 2.8 – 2.9

Grade Level – 10

INFORMATION

Nearly all living tissue contains an enzyme called ***catalase***. This enzyme speeds up the decomposition of hydrogen peroxide into water and oxygen. Oxygen is a gas which bubbles through the solution as it is being produced. The more catalase present, the more quickly the oxygen is produced and therefore the more bubbly or fizzy the solution appears.

You Need

Apparatus: 1 x comboplate®; 1 x 2 ml syringe; Small knife* (not in kit).

Chemicals: 12 ml hydrogen peroxide ** (provided by your teacher); Pieces of living tissue (carrot, onion, apple, liver, meat, potato etc).

What to do

1. Cut small pieces of the tissue, about the size of a pea, and place one piece of each type into wells F1 to F6.
2. In your book, write down the types of tissue in a table like the one below.
3. Use the syringe to add 2 ml of the hydrogen peroxide solution to each of the wells with the tissue.
4. Observe any changes.

Tissue	Effect

5. Decide which tissue has the greatest effect on the hydrogen peroxide and which tissue has the least effect.
6. In the table, write the word "greatest" next to the tissue which had the greatest effect and the word "least" next to the tissue which had the least effect.

Rinse the comboplate® (not down the drain - use a waste bucket) and shake it dry.

QUESTIONS

1. What is the effect of the enzyme catalase on hydrogen peroxide?
2. Suggest another name for the enzyme catalase.

HINT: *Enzymes are often named after the substrate on which they act.*

EXPERIMENT 9 – WHAT IS THE EFFECT OF THE ENZYME RENNIN ON MILK?

CSEC OBJECTIVE: Section B 2.8

Grade Level – 10

	You Need **Apparatus:** 1 x comboplate®; 1 x 2 ml syringe; propettes; Lunch box. **Chemicals: Fresh full cream** milk; Enzyme **rennin** solution; Warm water.
	What to do 1. Using the syringe, add 1,5 ml milk to each of wells F1 and F2. 2. Using a propette, add 10 drops of water to the contents of well F1. 3. Using a clean propette, add 10 drops of rennin solution to the contents of well F2. 4. Float the comboplate on warm water in the lunch box as for some of the previous activities. 5. 5 Observe any changes.
	QUESTIONS 1. What is the effect of the enzyme rennin on milk? 2. We can say that rennin curdles or coagulates milk. It converts a soluble protein to an insoluble protein. Specifically, it converts **caseinogen** to **casein**. In other words, casein is not soluble in water. That is why the curdled mixture looks lumpy. In your notebook, draw a diagram of what you think curdled milk would look like if we could see it under high magnification. Rennin acts on milk and milk products before other proteolytic enzymes act on these substrates. Rennin actually prepares milk for further digestion by other enzymes. 3. The young of mammals produce the enzyme rennin in far higher quantities than adults do. Try to suggest a reason WHY baby mammals produce more rennin than adults do. 4. How have we used our knowledge of rennin in industry?

EXPERIMENT 10 – BENEDICTS TEST FOR REDUCING SUGAR

CSEC OBJECTIVE: Section B 2.7

Grade Level – 9&10

Introduction:

All monosaccharides, and some disaccharides, have the ability to reduce copper(II) to copper(I) in alkaline solution. These sugars are referred to as reducing sugars. During the reduction, the sugars are oxidised to their corresponding acids. Benedict's solution contains copper(II) sulphate in an alkaline medium. Positive tests for a reducing sugar with this solution are indicated by a series of colour changes as the copper(II) sulphate is reduced to copper(I) oxide. The purpose of this investigation is to establish what the colour changes are that indicate the presence of reducing sugars.

You Need

Apparatus: Comboplate®; 1 x plastic microspatula; 1 x thin stemmed propette; 1 x 2 ml syringe; *1 x water bath maintained at boiling temperature.

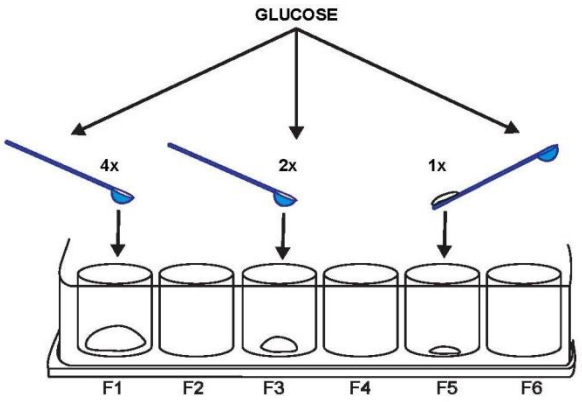
Chemicals: Glucose/dextrose powder ($C_6H_{12}O_6(s)$); Benedict's solution; Tap water; Boiling water.

*** Make a boiling water bath in the following way.**

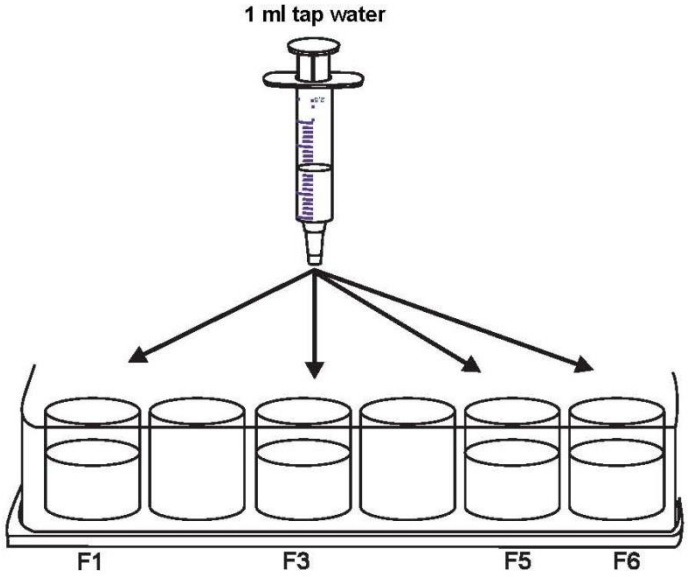
Fill a plastic container (such as a large bowl or your lunch box or an empty, 2 litre ice cream container) with boiling water from a kettle or cooking pot. It is best if each learner has their own water bath. If large containers are used, more than one learner can use them together, provided that the bath does not become too crowded with comboplates® so that they topple over when the container is replenished with boiling water.

What to do

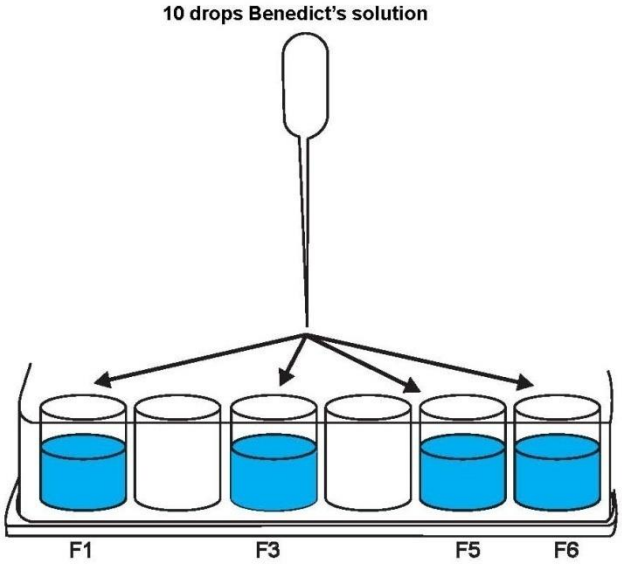
1. Using the spoon of the plastic microspatula, place four level spatulas of glucose/dextrose powder into well F1.
2. Similarly, place two level spatulas of the glucose/dextrose powder into well F3.
3. Turn the spatula around and using the narrow end, place one level spatula of the glucose/dextrose powder into well F5.



4. Use the 2 ml syringe to dispense 1.0 ml of tap water into each of wells F1, F3, F5 and F6.



5. Stir the contents of wells F1, F3 and F5 with the microspatula to dissolve the glucose.
6. Use a propette to add 10 drops of the Benedict's solution into each of wells F1, F3, F5 and F6. Stir the contents of the wells to thoroughly mix the solutions.



What is the colour of each solution in wells F1, F3, F5 and F6?

7. Pour freshly boiled water into the water bath. Carefully float the comboplate® in the water.
8. Leave the comboplate® in the hot water for about 5 minutes. Note what happens to the solutions in the wells while the comboplate® is being heated.
9. After 5 minutes, immediately remove the comboplate® from the water bath and enter your results in Table 1 below.

WELL	COLOUR CHANGE OBSERVED DURING HEATING	FINAL COLOUR OF SOLUTION AFTER 5 MINUTES

Rinse the comboplate®, syringe and propettes with water.

QUESTIONS

Q1. Why did the colour of the Benedict's solution change when it was heated with each of the glucose solutions?

Q2. Which well contained the highest concentration of glucose? Explain.

Q3. What do you notice about the colour changes observed in well F1?

Q4. Which well contained the lowest concentration of glucose? Explain.

Q5. What do you notice about the colour changes observed in well F5?

Q6. From your answers to questions 3 and 5, deduce the relationship between the concentration of reducing sugar present in a sample, and the colour change/s observed in the Benedict's test within a specified time period.

Q7. Why did the colour of the solution in well F6 show no change?

Q8. How can one test for the presence of reducing sugars in food?

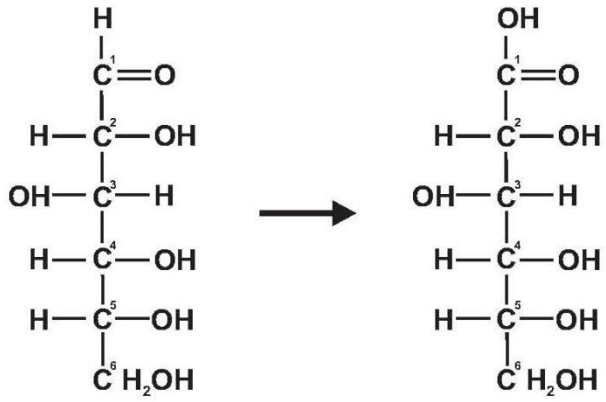
EXTENSION QUESTIONS

(These questions are aimed at students who also have a chemistry background.)

Q9. What was the purpose of testing water with the Benedict's solution?

Q10. Write down the ionic equation for the reduction of copper sulphate to copper oxide.

Q11. When glucose is oxidised, gluconic acid is formed. (See below.) Which functional group in glucose do you think is responsible for the reduction of copper(II) to copper(I)?



glucose gluconic acid

Q12. Give a reason for your answer to question 5.