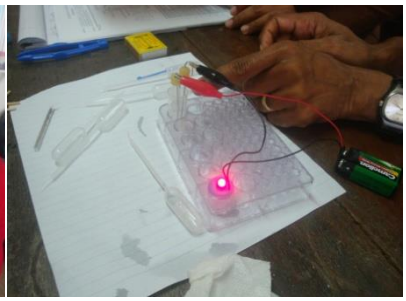
Microscience Manual

Biology Students' Manual

(DRAFT)

First 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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The Ministry of Education wishes to acknowledge the team of participants in the consultations for the selection of the Microscience Experiments relevant to the national curriculum for Biology, Chemistry and Physics.

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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 2.6

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

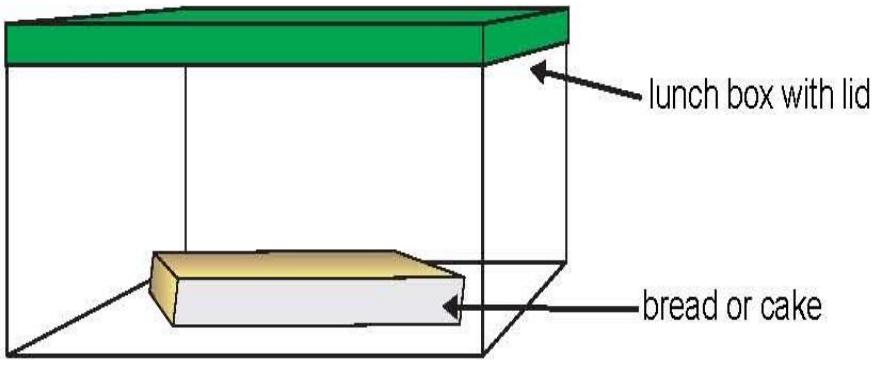
- Plastic lunch box with lid
- Forceps
- Hand lens
- Old, stale bread or cake which is not too dry
- Paper towel

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.

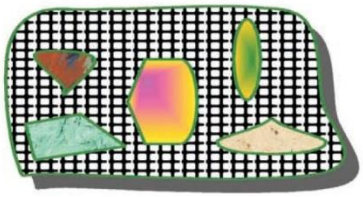
1. Work in groups so that each group uses a different piece of bread or cake. Note the manufacturer or baker, date of purchase or baking, and any other information; for example whether the bread is brown, wholewheat, white or rye - and so on.
2. Sprinkle a few drops of water on the food and place it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

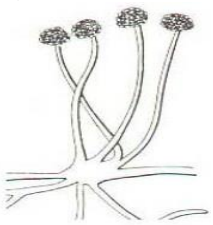
You will have to analyse the information in your table in order to answer some of these questions.

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)

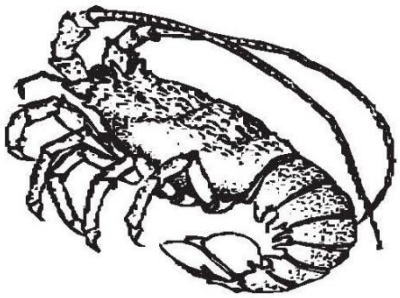
* To be obtained from your teacher

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?

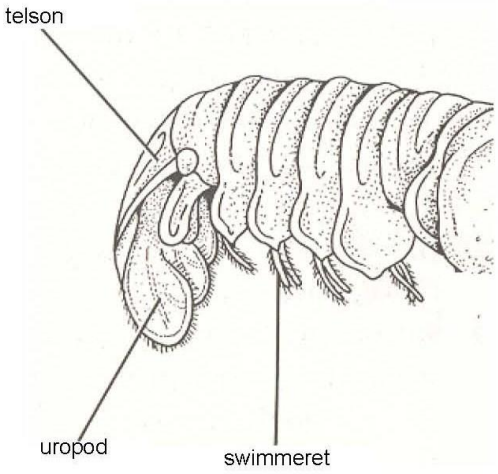
C The Abdomen

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

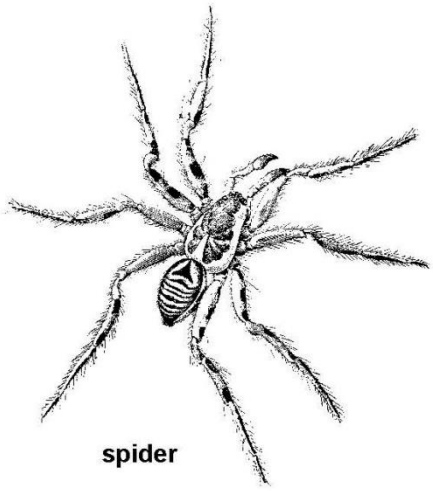
- Hand lens
- Glass container**
- Spider or spiders**
- Water
- Twig

** 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.



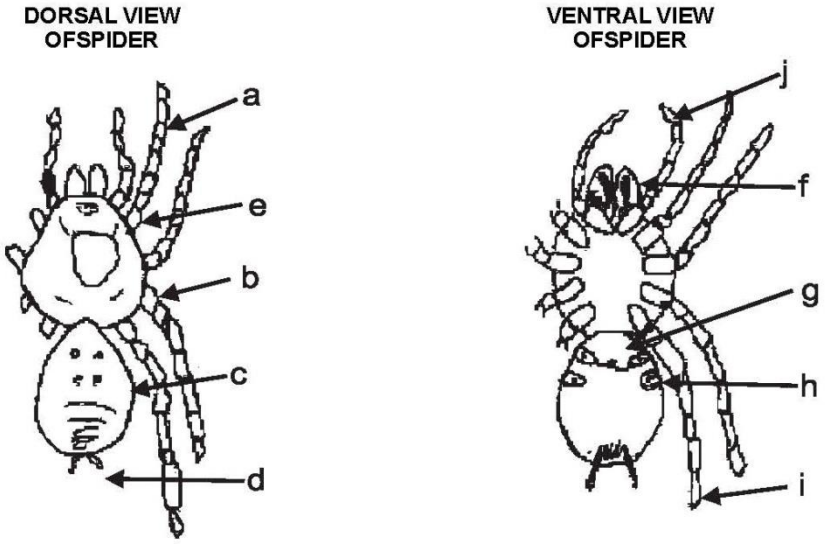
spider

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 2.7

Grade Level - 10

You Need

Apparatus: Comboplate®; 2 x propettes; Plastic lunch box; Thermometer.

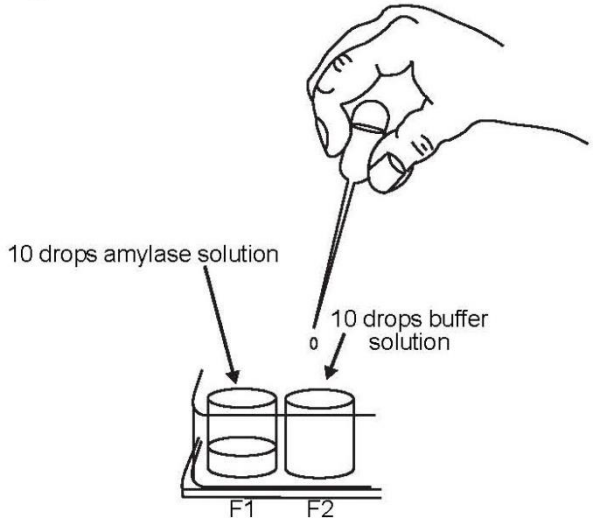
Chemicals: Starch suspension;Amylase solution; I_2 /KI solution (iodine solution); pH 6.5 buffer solution; Hot water; Tap water at room temperature.

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 I_2 /KI solution (iodine solution) to each of wells F1 and F2.
5. Observe any changes.

QUESTIONS

1. What is the colour of the I_2 /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 2.7

Grade Level - 10

You Need

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

Chemicals: Starch suspension;Amylase solution; pH 6.5 buffer solution; I_2/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 I_2/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 I_2 /KI solution (iodine solution) to the contents of well F2.
6. Two minutes from zero time, add 5 drops of I_2 /KI solution (iodine solution) to the contents of well F3.
7. Four minutes from zero time, add 5 drops of I_2 /KI solution (iodine solution) to the contents of well F4.
8. Eight minutes from zero time, add 5 drops of I_2 /KI solution (iodine solution) to the contents of well F5.
9. Sixteen minutes from zero time, add 5 drops of I_2/KI solution (iodine solution) to the contents of well F6.
10. Wait for 5 minutes.
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 with enzyme enters 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 2.8

Grade Level - 10

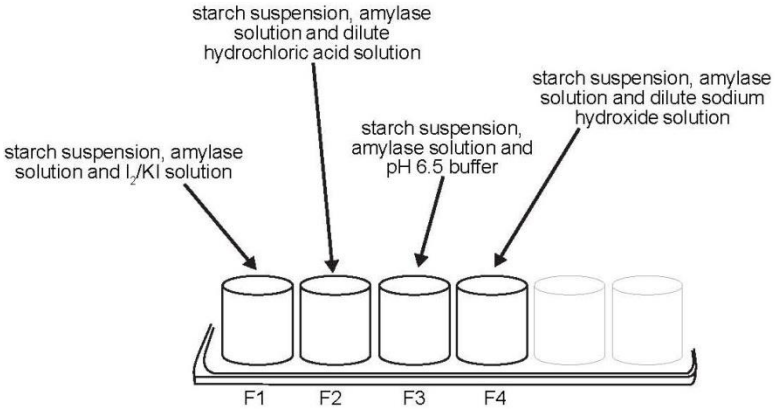
You Need

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

Chemicals: Starch suspension;Amylase solution; pH 6.5 buffer solution; I_2/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 I_2/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 I_2/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				

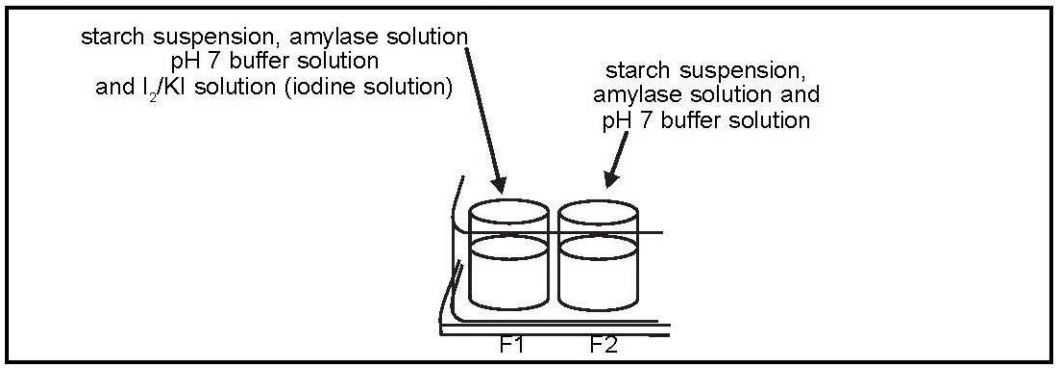
	9. Place the comboplate® on a sheet of white paper so that you can see the colours clearly. 10. Use the table to record your observations.
	QUESTIONS 1. What was the substrate in this investigation? 2. What was the enzyme in this investigation? 3. What do you think the end-products of the reaction are? 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 with enzyme enters 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 2.8

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; I_2/KI solution (iodine solution); Ice; Hot water. ***Use the plastic lunch boxes as water baths in the following way:**
	Between 0 ^{0}C and 10 ^{0}C • 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 ^{0}C and 10 ^{0}C is reached.
	Between 30 ^{0}C and 40 ^{0}C 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 ^{0}C and 40 ^{0}C is reached.
	Between 80 ^{0}C and 100 ^{0}C Repeat the procedure using another plastic lunch box and more hot water, in order to obtain a temperature between 80 ^{0}C and 100 ^{0}C.
	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 ^{0}C to10 ^{0}C 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 ^{0}C to 40 ^{0}C water bath. 4. Place the fourth comboplate® in a 80 ^{0}C to 100 ^{0}C 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 I_2/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.

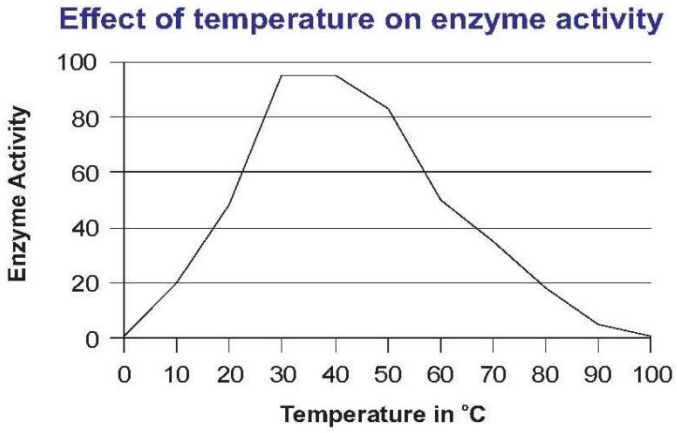


9. After 10 minutes, add 5 drops of I_2/KI solution (iodine solution) to the contents of well F2.
10. Place the comboplate® on a sheet of white paper so that you can see the colours clearly.
11. Record your observations of the colour in well F2 as shown below:

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

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 ^{0}C to 40 ^{0}C?
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(s) 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 2.7 – 2.8

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 2.7

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. 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 2.5

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.

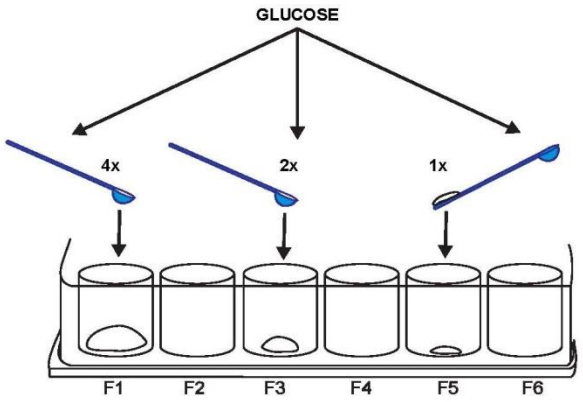
Chemicals: Glucose/dextrose powder ($C_6H_{12}O_6(s)$); Benedict's solution; Tap water; Boiling water.

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

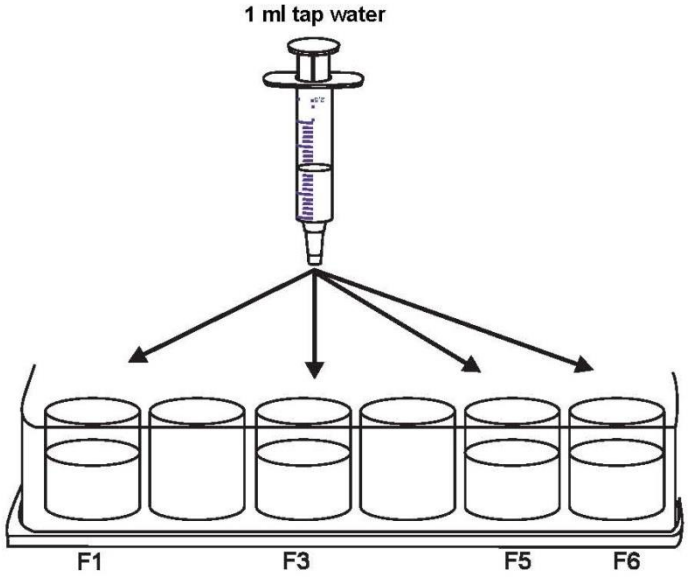
Fill a plastic container (such as a large bowl or your lunch box or an empty, 2 litre ice cream container) with boiling water from a kettle or cooking pot. It is best if each learner has their own water bath. If large containers are used, more than one learner can use them together, provided that the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

What to do

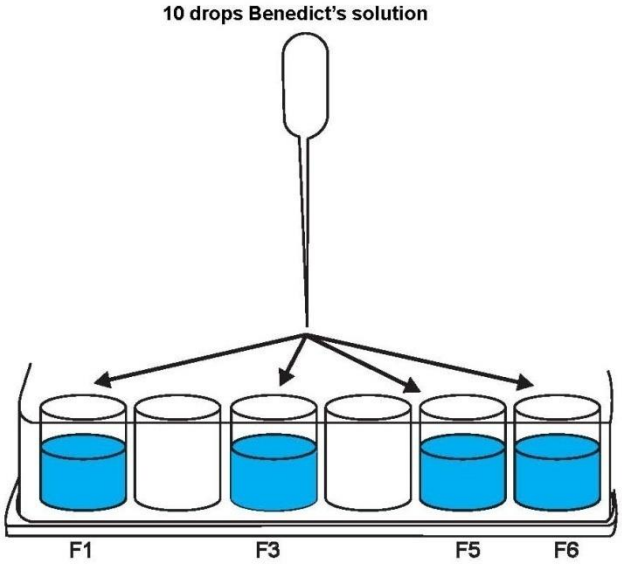
1. Using the spoon of the plastic microspatula, place four level spatulas of glucose/dextrose powder into well F1.
2. Similarly, place two level spatulas of the glucose/dextrose powder into well F3.
3. Turn the spatula around and using the narrow end, place one level spatula of the glucose/dextrose powder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

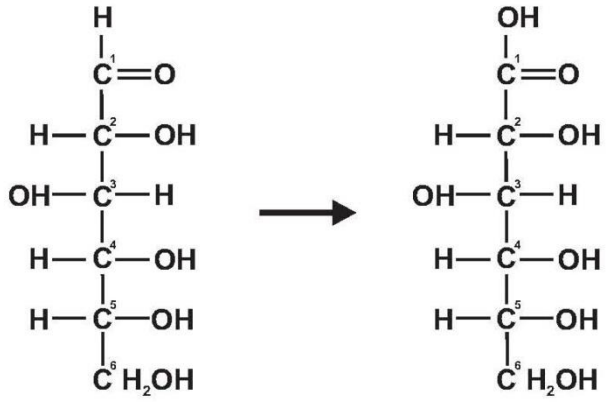
EXTENSION QUESTIONS

(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)?



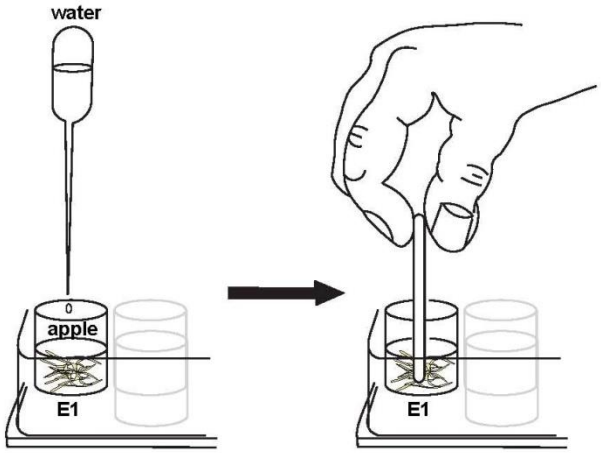
glucose gluconic acid

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

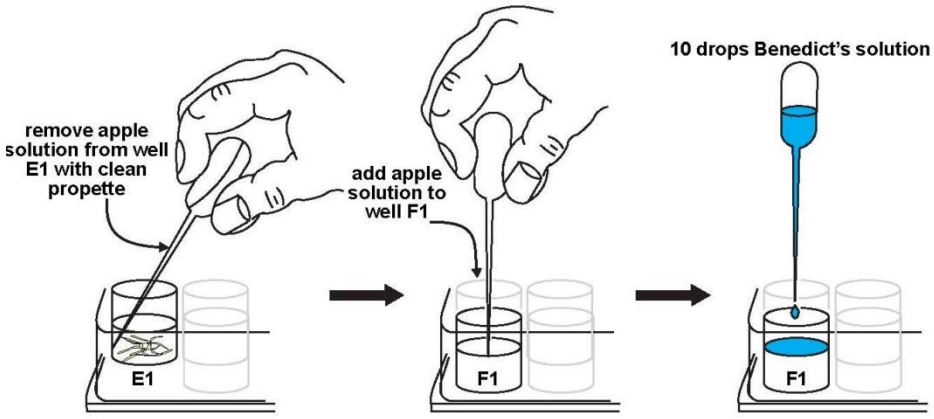
EXPERIMENT 11 – DOES THE FOOD WE EAT CONTAIN REDUCING SUGARS?

CSEC OBJECTIVE: Section B 2.5

Grade Level - 9&10

	Introduction: The greater the concentration of reducing sugar present in a particular food, the greater the amount of copper(II) ions that are reduced to copper(I) ions. However, in the Benedict's test, the blue colour of the Benedict's solution does not change to red all at once, even if a food sample contains a high concentration of reducing sugar. A series of colour changes occurs as the reduction proceeds. These are always in the same order, making it possible to compare, approximately, the concentration of reducing sugar present in different samples.
	You Need **Apparatus:** Comboplate®; 1 x glass rod; 6 x thin stemmed propettes; 1 x kitchen grater or sharp knife; 1 x water bath maintained at boiling temperature; 1 x 2 ml syringe. **Chemicals:** Tap water; 1 x fresh apple; 1 x fresh carrot; 1 x fresh potato; Cooked white rice; Cooked white mealie meal; Fresh milk; Benedict's solution. **NOTES** • The water bath can be constructed as described in Activity 1. • Any food items available may be tested, not necessarily those listed above.
	What to do 1. Finely grate a portion of each of the apple, carrot and potato. Clean the grater before grating each new food. (If a grater is not available, scrape across the flesh of each item with a sharp knife.) 2. Fill 1/3 of well E1 with the grated apple. 3. Add water from a propette to the apple, until well E1 is half full. Using the glass rod, grind the apple in the water. 

4. Fill 1/3 of well E2 with grated carrot. Add water until the well is half full. Wipe the glass rod clean and use it to grind the carrot in the water.
5. Fill 1/3 of well E3 with grated potato. Treat the potato as you have the apple and carrot.
6. Fill 1/3 of well E4 with cooked white rice. Wipe the glass rod clean and use it to break the rice into smaller pieces before adding any water to the well.
7. Add water to well E4 until the well is half full. Stir the rice in the water with the glass rod.
8. Fill 1/3 of well E5 with the cooked mealie meal. Add water to the well until it is half full. Rinse the glass rod and use it to stir the mealie meal in the water.
9. Using a clean propette, suck up the solution from well E1. The pieces of apple will be too large to enter the stem of the propette.
10. Add all of the solution from the propette into well F1.
11. Add 10 drops of Benedict's solution with a propette to the solution in well F1. Stir the solution thoroughly with a microspatula.



12. Using another propette, suck up the carrot solution from well E2 and transfer all of the solution to well F2. Add 10 drops of Benedict's solution and stir to mix.
13. Repeat step 12 with the potato solution from well E3, dispensing the solution into well F3.
14. Repeat step 12, this time transferring the rice solution from well E4 into well F4.
15. Using a clean propette, insert the tip just under the surface of the mealie meal solution in well E5. The larger particles of meal should have settled and you can remove all of the solution above the solid material without blocking the propette stem.
16. Transfer this solution to well F5 and add the 10 drops of Benedict's solution. Stir to mix.
17. Rinse a propette with water and use it to add 10 drops of fresh milk into well F6. Add 10 drops of Benedict's solution and stir to mix.
18. Pour freshly boiled water into the water bath. Carefully float the comboplate® in the water bath.
19. Leave the comboplate® in the hot water for approximately 3 minutes. After 3 minutes, add about 1 cup more of freshly boiled water to the water bath.
20. Leave the comboplate® for a further 3 - 4 minutes. Note what happens to the solutions in the wells while the comboplate® is being heated. Remove the comboplate® from the water bath and enter your results in Table 1.

Table 1

WELL	FOOD SOLUTION	COLOUR OF SOLUTION AFTER HEATING

Rinse the comboplate®, syringe and propettes with water.

QUESTIONS

Q1. How is the colour of the solution related to the concentration of reducing sugar detected in the food during the time specified? (Hint: look at the results for Activity 1.)

Q2. Which food contains the highest concentration of reducing sugar/s? Explain.

Q3. Which food contains the lowest concentration of reducing sugar/s? Give a reason for your answer.

Q4. What is the answer to the focus question?

EXTENSION QUESTIONS

Q5. Besides the colour change that occurred, what other change did you notice in the appearance of the milk when it was heated with Benedict's solution?

Q6. Why did the appearance of the milk change?

EXPERIMENT 12 – HOW CAN ONE TEST FOR THE PRESENCE OF A NON-REDUCING SUGAR IN FOOD?

CSEC OBJECTIVE: Section B 2.5
Grade Level – 9&10

Introduction:
Some disaccharides, such as sucrose, are unable to reduce the copper(II) sulphate in Benedict's solution to copper(I) oxide. In these disaccharide molecules, the functional groups that could be involved in the redox reaction, are linked together in a glycosidic bond. Such disaccharides are called non-reducing sugars. The purpose of this investigation is to discover how the reducing sugars test can be modified to detect the presence of a non-reducing sugar in a food substance.

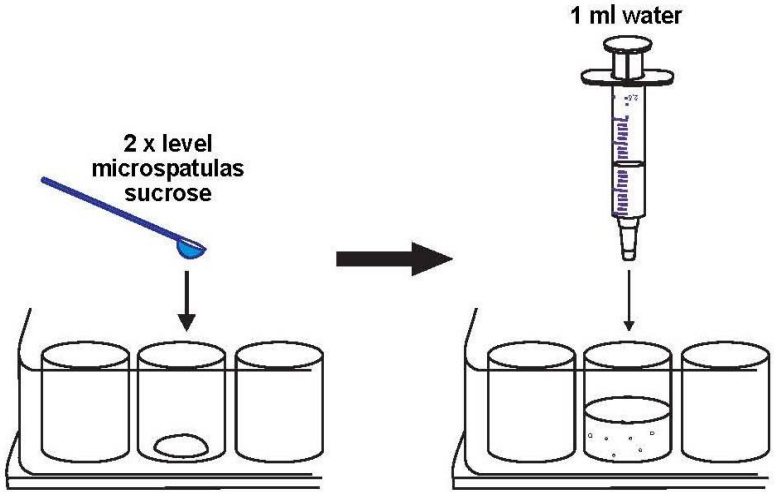
You Need

Apparatus: 1 x comboplate®; 2 x plastic microspatulas; 1 x 2 ml syringe; 2 x thin-stemmed propettes; 1 x water bath maintained at boiling temperature; 1 x cold water bath.
Chemicals: Sucrose/table sugar ($C_{12}H_{22}O_{11}(s)$); Benedict's solution;
Hydrochloric acid (HCl(aq)) [5.5 M]; Sodium bicarbonate/baking soda ($NaHCO_3(s)$);
Tap water.

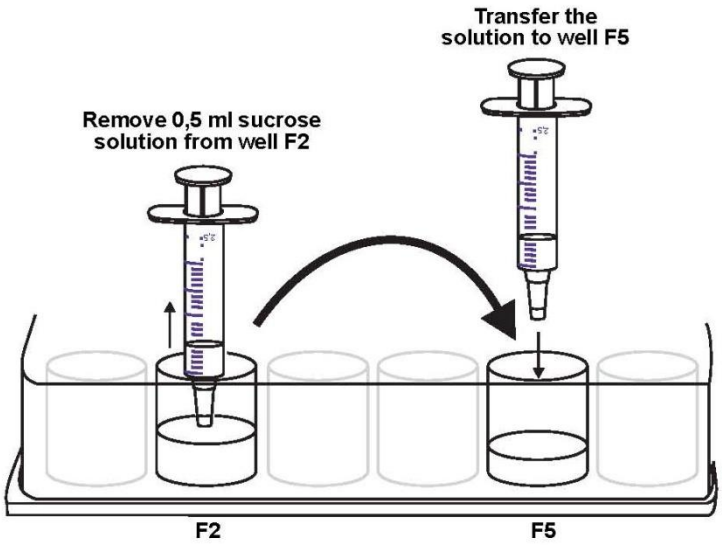
*** Make a boiling water bath in the following way:**
Fill a plastic container (such as a large bowl or your lunch box or an empty, 2 litre ice cream container) with boiling water from a kettle or cooking pot. It is best if each learner has their own water bath. If large containers are used, more than 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

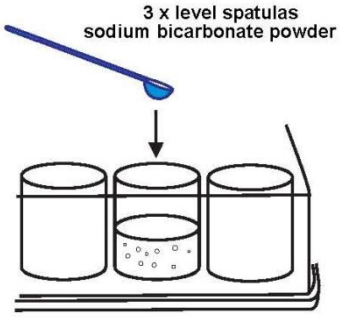
1. Using the spoon of a plastic microspatula, place 2 level spatulas of the sucrose into well F2.
2. Add 1,0 ml of tap water to the sucrose with the syringe. Stir to dissolve the sucrose.



3. Remove 0,5 ml of the sucrose solution with the syringe and transfer this to well F5.



4. Add 10 drops of Benedict's solution into the sucrose solution in well F2 only.
5. Fill the water bath with freshly boiled water. Float the comboplate® carefully in the water bath for a few minutes. *(See Question 1)*
6. Remove the comboplate® from the water bath.
7. Use a clean propette to add 3 drops of 5.5 M hydrochloric acid to the sucrose solution in well F5. Stir the contents with a microspatula.
8. Place the comboplate® in the boiling water bath for 1½ minutes. Remove the comboplate® from the hot water and place it in cold water for about 1 minute.
9. Remove the comboplate® from the cold water. Place 3 level spatulas of sodium bicarbonate with the spoon of a clean microspatula into well F5 to neutralise the solution. *(See Question 2)*
10. Add 10 drops of Benedict's solution to well F5. Stir the solution to mix.
12 Pour out the cooled water from the boiling water bath and add more freshly boiled water.
13 Return the comboplate® to the boiling water bath and leave for 5 - 7 minutes. *(See Question 3)*



Rinse the comboplate® and remaining equipment with water.

QUESTIONS

Q1. Does the colour of the solution in well F2 change after floating the comboplate in the water bath for a few minutes? What does this observation imply?

Q2. What happens when the sodium bicarbonate is added to the acidified sucrose solution?

Q3. What happens to the colour of the solution in well F5 during heating? What does this observation imply?

Q4. From your observations, what do you think is the function of the hydrochloric acid in this experiment?
Explain your answer.

Q5. Which reducing sugar/s caused the Benedict's solution to change colour? Give a reason

	for your answer. Q6. What is the name given to the reaction in this experiment where hydrochloric acid breaks up the disaccharide to form its constituent monosaccharides? Q7. What is the answer to the focus question?
	EXTENSION QUESTIONS Q8. What other biological compound will perform the same function as the hydrochloric acid in hydrolyzing sucrose? The following questions are aimed at students with a chemistry background. Q9. Write down the chemical equation for the reaction of the sodium bicarbonate with the acidified (HCl (aq)) sucrose solution. Q10. Use your answer to question 9 to explain why "fizzing" was heard when the sodium bicarbonate was added.

EXPERIMENT 13 – IODINE TEST FOR STARCH

CSEC OBJECTIVE: Section B 2.5

Grade Level – 9&10

You Need

Apparatus: 1 x comboplate®; 1 x plastic microspatula; 3 x thin stemmed propettes.

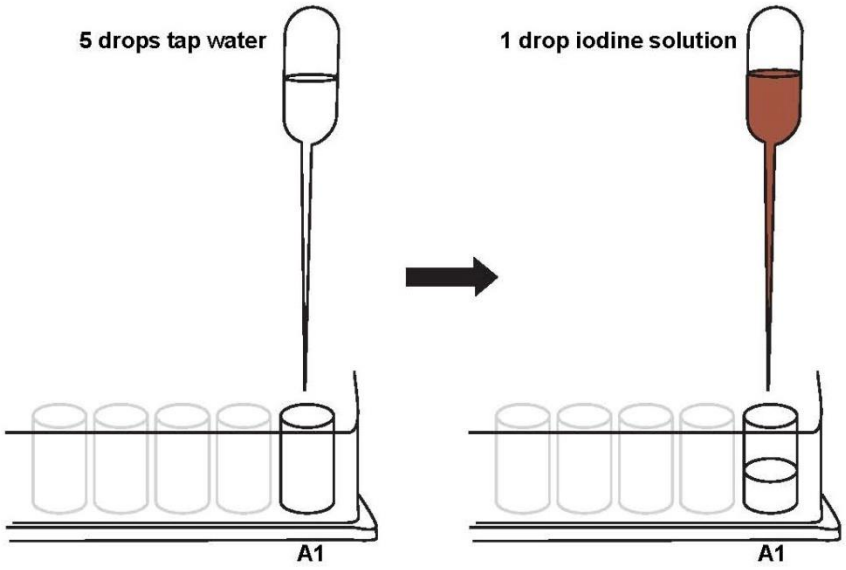
Chemicals: Starch solution [$(C_6H_{10}O_5)n(aq)$] [1%]; Iodine solution [I_2/KI(aq)] [1%]; Tap water.

NOTES

- If iodine and/or potassium iodide are not available, use the tincture of iodine obtainable from a chemist at low cost.

What to do

1. Use a propette to place 5 drops of tap water into well A1.
2. Place one drop of iodine solution from a propette into the water in well A1. (*See Question 1*)



3. With a clean propette, place 5 drops of the 1% starch solution into well A2.
4. Place one drop of iodine solution into the starch solution in well A2. (*See Question 2*)

Rinse the comboplate® and propettes with water.

QUESTIONS

Q1 What is the colour of the solution in well A1 after adding a drop of iodine solution?

Q2 What is the colour of the solution in well A2 after adding a drop of iodine solution?

Q3 How can one test for the presence of starch in food?

EXPERIMENT 14 – DOES THE FOOD WE EAT CONTAIN STARCH?

CSEC OBJECTIVE: Section B 2.5

Grade Level – 9&10

You Need

Apparatus: 1 x comboplate®; 1 x 2 ml syringe; 1 x glass rod; 6 x thin stemmed propettes; *1 x kitchen grater or sharp knife (not in the kit).

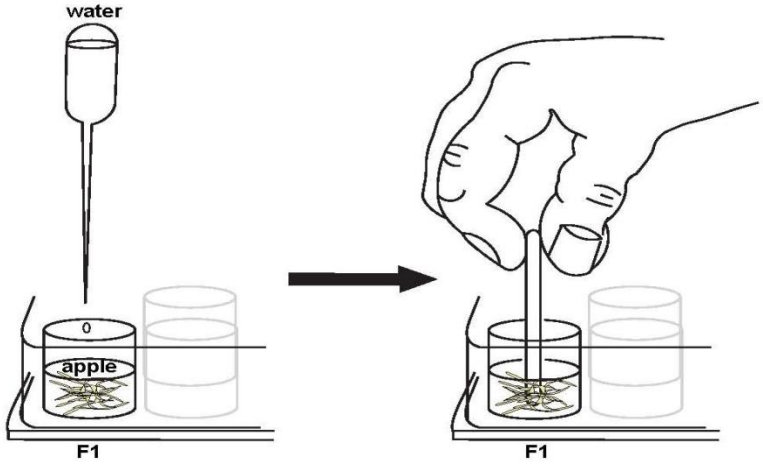
Chemicals: Iodine solution (I2/KI(aq)) [1%]; Tap water; 1 x fresh apple; 1 x fresh carrot; 1 x fresh potato; Fresh milk; Cooked white rice; Cooked white mealie meal.

NOTES

- The food items are not included in the kit.
- Any food items may be used; not necessarily those listed above.

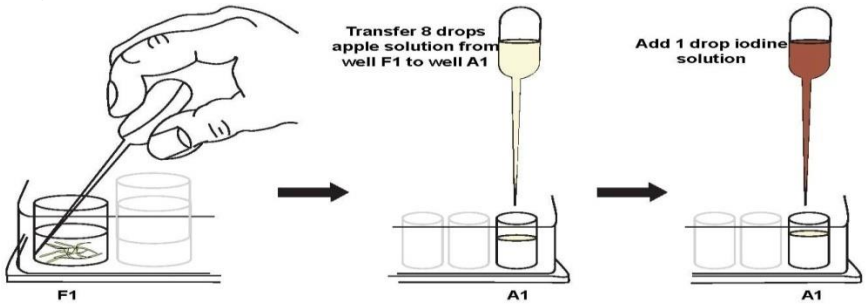
What to do

1. Finely grate a portion of each of the apple, carrot and potato. Clean the grater before grating each new food. (If a grater is not available, scrape across the flesh of each item with a sharp knife.)
2. Fill 1/3 of well F1 with the grated apple. Add water from a propette to the apple until well F1 is half full.
   Using the glass rod, grind the apple in the water.



3. Fill 1/3 of well F2 with grated carrot. Add water until the well is half full. Wipe the glass rod clean and use it to grind the carrot in the water.
4. Fill 1/3 of well F3 with grated potato. Treat the potato as you have the apple and carrot.
5. Fill 1/3 of well F4 with cooked, white rice. Rinse the glass rod and use it to break the rice into smaller pieces before adding any water.
6. Add water from a propette to the rice, until well F4 is half full. Stir the mixture with the glass rod.
7. Fill 1/3 of well F5 with cooked, white mealie meal. Add water to well F5 until it is half full.
8. Rinse the glass rod and use it to stir the mixture in well F5.

9. Using a clean propette, suck up the solution from well F1. The pieces of apple will be too large to enter the stem of the propette. Add 8 drops of the apple solution into well A1.
10. Add one drop of the iodine solution to well A1 and stir the contents of the well. (*See Question 1*)



11. With another propette, suck up all of the carrot solution from well F2. Add 8 drops of the solution into well A3. Add one drop of iodine solution and stir the contents of the well. (*See Question 1*)
12. Repeat step 11 with the potato solution from well F3, transferring this solution into well A5. (*See Question 1*)
13. Place 8 drops of fresh milk into well A7 with a clean propette. Add one drop of iodine solution. (*See Question 1*)
14. Repeat step 11 with the rice solution from well F4, adding the solution to well A9. Add 1 drop of the iodine solution to well A9. (*See Question 1*)
15. Allow the solid material in well F5 to settle. Insert the tip of a clean propette just under the surface of the solution in well F5 and suck up all of this solution.
16. Add 8 drops of the mealie meal solution into well A11. Add 1 drop of the iodine solution to well A11 and record your result in Table 1. (*See Question 1*)

Rinse the comboplate®, syringe and propettes with water.

QUESTIONS

Q1. Prepare a table like Table 1 below in your books. Record your results in Table 1.

Table

WELL	FOOD SOLUTION	COLOUR OF SOLUTION AFTER IODINE ADDED
A1		
A3		
A5		
A7		
A9		
A11		

Q2. What is the answer to the focus question?

	EXTENSION QUESTIONS Q3. Starch is a polymer of glucose. What does this statement mean? Q4. Starch molecules (polymers) can be broken down into glucose molecules (monomers) by hydrolysis, in the same way that sucrose is broken down into fructose and glucose. Using this information, choose the food/s from Table 1 above which you would eat the most of if you were going to run a long race the next day. Explain your choice. Q5. Consider the statement made above in question 4. What result would you expect in the Benedict's test if the potato, rice or maize solutions were heated with 5.5 M HCl (aq), neutralised with sodium bicarbonate, treated with Benedict's solution and then placed in a boiling water bath? Explain your answer.

EXPERIMENT 15 – EMULSION TEST FOR LIPIDS

CSEC OBJECTIVE: Section B 2.5

Grade Level – 9&10

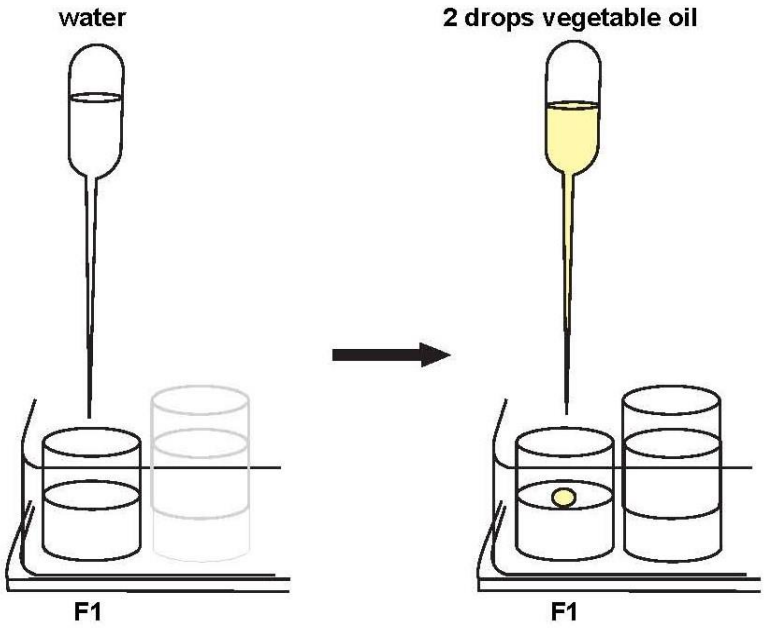
You Need

Apparatus: 1 x comboplate®; 5 x thin stemmed propettes.

Chemicals: Ethanol ($C_2H_5OH(l)$); Vegetable oil (eg. corn oil, olive oil etc.); Tap water.

What to do

1. Fill ½ of well F1 with water from a propette.
2. Add 2 drops of vegetable oil using a clean propette. (*See Question 1*)



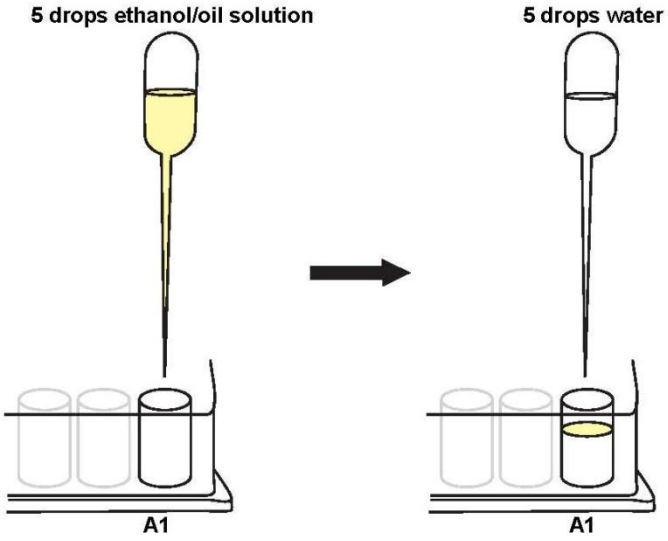
3. Stir the contents of well F1 vigorously with a plastic microspatula.
   (*See Question 2*)
4. Place 2 drops of oil into well F3. Add ethanol to well F3 from a clean propette until the well is half full.
   (*See Question 3*)



6. Suck up the ethanol/oil solution in well F3 with a clean propette and place 5 drops of

this solution into well A1.

1. Add 5 drops of water to the solution in well A1. (*See Question 4*)



Keep both the oil/water and oil/ethanol mixtures for the next experiment.

QUESTIONS

Q1. What do you observe in well F1 after adding the vegetable oil?

Q2. What do you see in well F1 after stirring?

Q3. What happens to the oil in well F3 when the ethanol is added?

Q4. What happens in well A1 after adding the water to the ethanol/oil mixture?

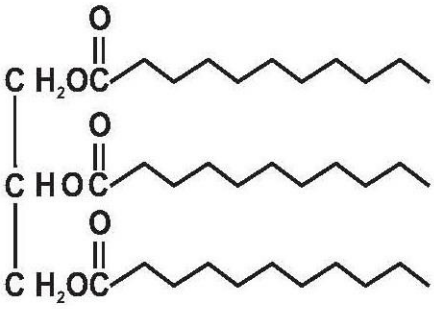
Q5. What is the general name given to the kind of cloudy liquid observed in well A1?

Q6. How can one identify lipids in food using the emulsion test?

EXTENSION QUESTION

(The following question is aimed at students with a chemistry background.)

Q7. The structure of a a complete lipid molecule is given below. Use this structure to explain your observation when oil was added to water.



a lipid molecule

EXPERIMENT 16 –GREASE SPOT TEST FOR LIPIDS

CSEC OBJECTIVE: Section B 2.5

Grade Level – 9&10

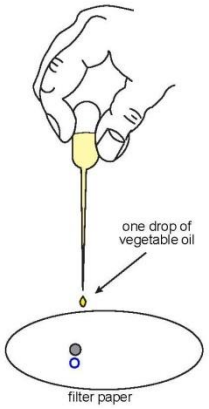
You Need

Apparatus: 1 x comboplate®; 5 x thin stemmed propettes; Filter paper or brown paper (not in the kit).

Chemicals: Ethanol/oil solution from Lipid Activity 1; Water/oil mixture from Lipid Activity 1; Ethanol (C_2H_5OH (l)); Vegetable oil (eg. corn oil, olive oil etc.); Tap water.

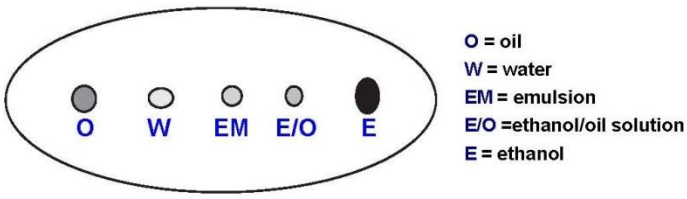
What to do

1. Place 1 drop of vegetable oil onto a piece of filter paper. Write the letter **O** on the filter paper beneath the spot with a pencil.



2. Place 1 drop of water next to the oil spot on the filter paper. Write the letter **W** on the filter paper beneath the water spot.
3. Shake the oil/water mixture in the propette so that a temporary emulsion forms inside the bulb of the propette.
4. Immediately place a drop of the emulsion on the filter paper next to the water spot. Write the letters **EM** beneath the emulsion spot.
5. Place 1 drop of the ethanol/oil solution next to the spot of the emulsion on the filter paper. Write **E/O** beneath the spot with a pencil.
6. Finally, place 1 drop of ethanol next to the ethanol/oil spot on the paper. Write the letter **E** beneath the spot with a pencil.
7. Leave the filter paper to dry. Observe the dry paper. *(See Question 1)*
8. Hold the paper up to the light. *(See Question 2)*

Rinse the comboplate® with a soap solution.



	QUESTIONS Q1. What do you see on the surface of the filter paper once it has dried? Q2. What do you notice about the oil stains on the paper when the paper is held up to the light? Q3. It was found in the emulsion test that oil dissolves in ethanol. Why, then, was an oil stain left where the ethanol/oil spot was placed on the filter paper? Q4. Explain your observations concerning the spot of the oil/water mixture. Q5. What would you have seen on the dried filter paper if the oil and water were not shaken together in the propette before placing a spot on the paper? Explain. Q6. How can the grease spot test distinguish between lipids and non-lipids in food?

EXPERIMENT 17 – DOES THE FOOD WE EAT CONTAIN LIPIDS?

CSEC OBJECTIVE: Section B 2.5

Grade Level – 9&10

You Need

Apparatus: 1 x comboplate®; 6 x thin stemmed propettes; 1 x kitchen grater or sharp knife; Filter paper or brown paper.

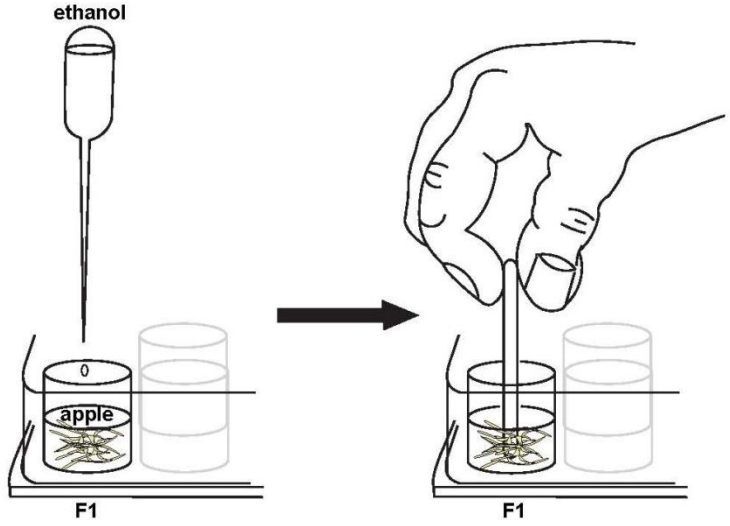
Chemicals: Ethanol (C_2H_5OH (l)); 1 x fresh apple; 1 x fresh carrot; Cooked white mealie meal; Cooked white rice; Fresh full cream milk; Tap water.

NOTE

- The food items are not included in the kit.
- The meal and rice must be cooked in plain water. No milk, sugar, salt, butter, etc. may be added.

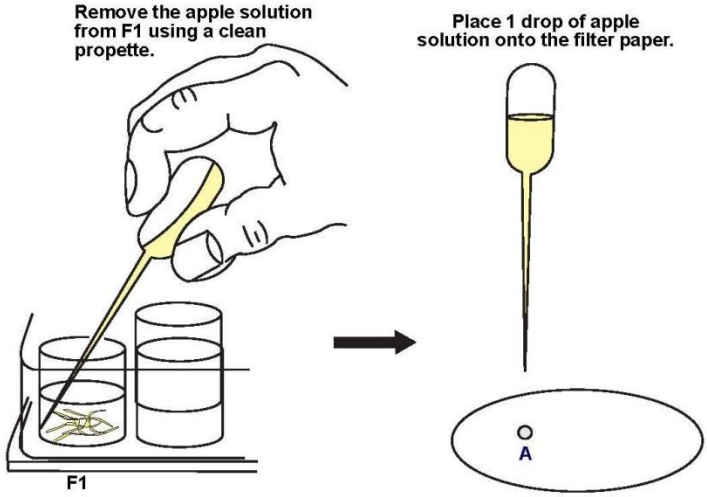
What to do

1. Use the kitchen grater to grate a portion of each of the apple and carrot. Clean the grater between each food item. (If a grater is not available, use a sharp knife to scrape across the flesh of each item.)
2. Fill 1/3 of well F1 with grated apple. Add ethanol from a clean propette to the apple in well F1 until the well is half full.
3. Grind the apple in the ethanol with a glass rod. Any food items may be used; not necessarily those listed above.

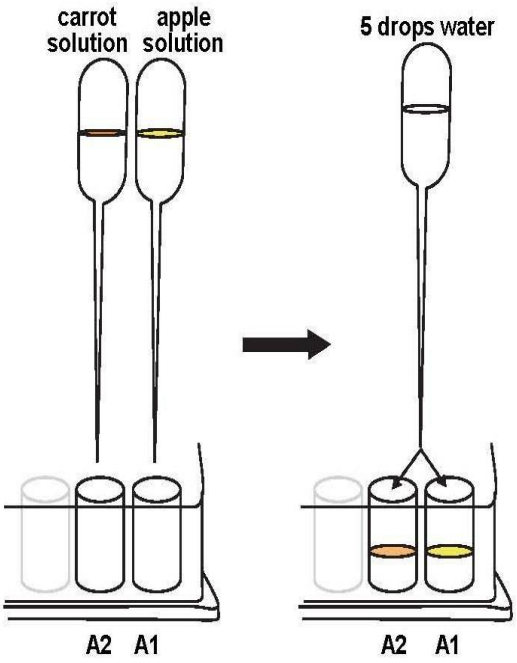


4. Fill 1/3 of well F2 with grated carrot. Add ethanol to the carrot until the well is half full. Wipe the glass rod clean and use it to grind the carrot in the ethanol.
5. Fill 1/3 of well F3 with cooked, white rice. Wipe clean the glass rod and use it to break the rice into smaller pieces before adding any ethanol.
6. Add ethanol to the rice until well F3 is half full. Stir the solution with the glass rod.
7. Fill 1/3 of well F4 with cooked, white mealie meal. Add ethanol to the meal until the well is half full.

8. Rinse the glass rod and use it to stir the mixture in well F4. (After stirring the meal should settle at the bottom of the well.)
9. Remove all of the solution from well F1 with a clean propette and place 1 drop of this solution onto a piece of filter or brown paper. Write the letter **A** under the spot.



10. Remove all of the carrot solution from well F2 with a clean propette and place 1 drop of this solution onto the filter paper next to the apple spot. Write the letter **C** under the carrot spot.
11. Repeat the above step with the rice solution in well F3 . Write the letter **R** under the rice spot.
12. Repeat the above step with the maize solution in well F4. Write the letters **MM** under the spot.
13. Using a propette, place one drop of full cream milk next to the meal on the filter/brown paper. Write the letter **M** under the milk spot.
14. Place the paper on one side and allow it to dry. While you are waiting, place 5 drops of the apple solution into well A1. Add 5 drops of water to well A1. (*See Question 1*)
15. Place 5 drops of the carrot solution into well A3. Add 5 drops of water to well A3. (*See Question 2*)
16. Repeat the emulsion test with both the rice and mealie meal solutions. (*See Question 3*)
17. Examine the dry piece of filter paper and record your results in Table 1. (*See Question 4*)



Rinse the comboplate® with a soap solution.

QUESTIONS

Q1. Does an emulsion form in well A1 when the water is added to the apple solution?

Q2. Does an emulsion form in well A3 when the water is added to the carrot solution?

Q3. Do emulsions form with rice and mealie meal?

Q4. Prepare a table like table 1 below in your books. Complete the table.

Table 1

FOOD TESTED	APPEARANCE OF PAPER AFTER DRYING

Q5. What is the answer to the focus question?

Q6. Give reasons for your answer to question 5.

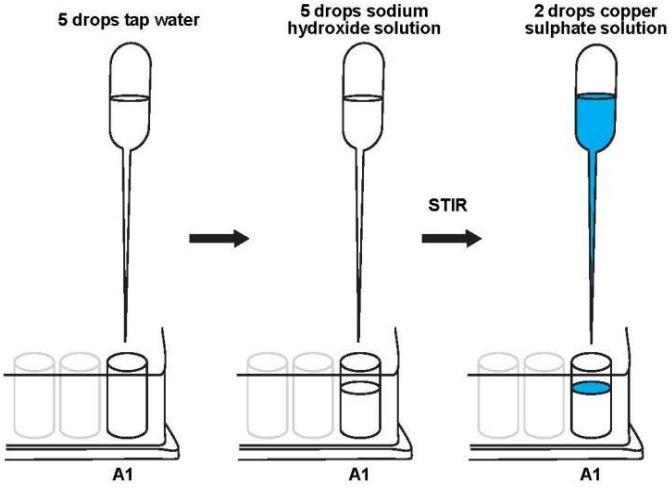
EXTENSION QUESTION

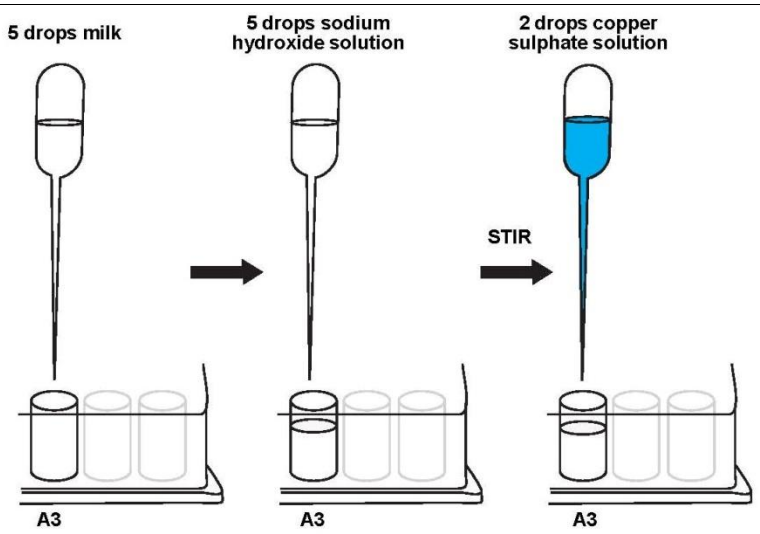
Q7. Why was the emulsion test not carried out on the milk? (Hint: what does milk look like?)

EXPERIMENT 18 – BIURET TEST FOR PROTEINS

CSEC OBJECTIVE: Section B 2.5

Grade Level – 9&10

	Introduction The Biuret test uses a dilute solution of copper(II) sulphate, which is made alkaline by the addition of sodium hydroxide. When the copper(II) ions come into contact with peptides or complete proteins, they form a complex with the nitrogen atoms in the peptide chain. The purpose of this experiment is to establish the colour of this complex as an indication of the presence of proteins in food.
	You Need **Apparatus:** 1 x comboplate®; 5 x thin stemmed propettes; 2 x plastic microspatulas. **Chemicals:** Sodium hydroxide solution (NaOH(aq)) [10%]; Copper sulphate solution ($CuSO_4$ (aq)) [1%]; Fresh milk; Tap water. **NOTE** • The food item (milk) is not included in the kit. • A dilute suspension of egg white (albumin) can be used in place of the milk as a source of protein.
	What to do 1. Using a propette, place 5 drops of water into well A1. 2. Add 5 drops of 10% sodium hydroxide solution to the water in well A1. Stir the solution with a plastic microspatula. 3. Add 2 drops of 1% copper sulphate solution with a clean propette. (*See Question 1*)  4. Place 5 drops of fresh milk into well A3. 5. Add 5 drops of 10% sodium hydroxide solution to the milk in well A3. Stir the solution with the microspatula. 6. Add 2 drops of 1% copper sulphate solution. (*See Question 2*)



7. Stir the solution in well A3 with a microspatula. (*See Question 3*)

Rinse the comboplate® and remaining equipment with water .

QUESTIONS

Q1. What do you observe in well A1 after adding the copper sulphate solution?

Q2. What do you observe in well A3 after adding the copper sulphate solution?

Q3. What happens to the solution in well A3 when it is mixed with the copper sulphate?

Q4. How can one test for the presence of proteins in food?

EXPERIMENT 19 – DOES THE FOOD WE EAT CONTAIN PROTEIN?

CSEC OBJECTIVE: Section B 2.5

Grade Level – 9&10

INTRODUCTION

The longer the peptide chain, the greater the number of peptide bonds in the chain and therefore the greater the number of complexes that will form between the copper(II) and the -NH- bonds present in the peptide chain, during the Biuret test. As a result, the complexity of the protein in a sample can be determined by the difference in the colours of the solutions. Proteins with only a few amino acids and hence few peptide bonds, are termed simple or lower proteins. Proteins with large numbers of peptide bonds are the complex or higher proteins, especially since they may also show secondary and/or tertiary structure. In the Biuret test, violet-purple indicates the higher proteins, pink indicates the lower proteins and a pale blue colour indicates that no proteins are present.

You Need

Apparatus: 1 x comboplate®; 6 x thin stemmed propettes; 2 x plastic microspatulas; 1 x glass rod; 1 x food grater or sharp knife.

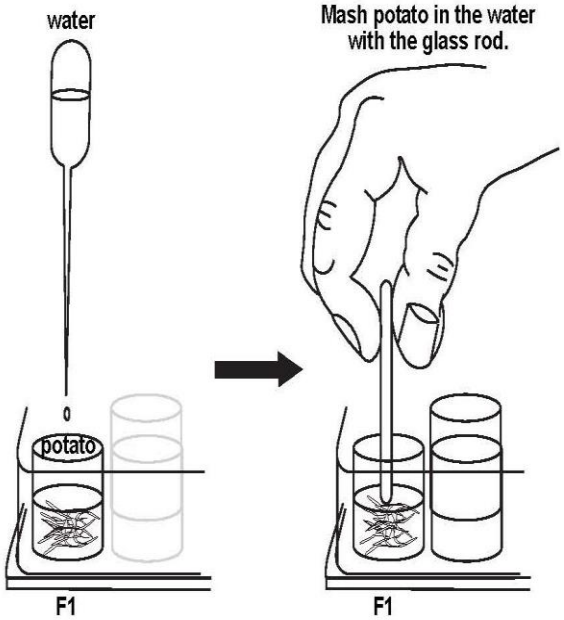
Chemicals: Sodium hydroxide solution (NaOH(aq)) [10%];
Copper sulphate solution (CuSO4(aq)) [1%]; 1 x fresh potato; 1 x fresh apple;
1 x fresh carrot; Cooked white rice; Cooked white mealie meal; Tap water.

NOTE

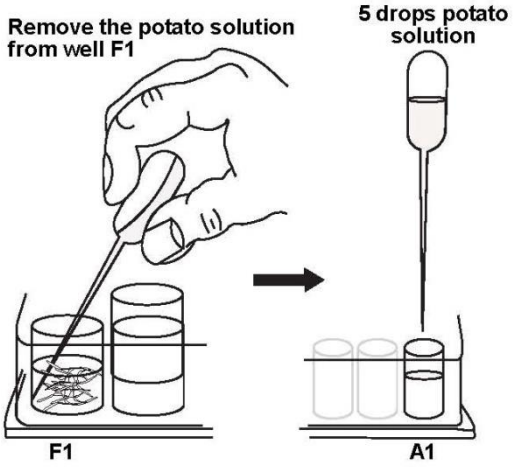
- The food items are not included in the kit.
- The meal and rice must be cooked in plain water. No milk, sugar, salt, butter, etc. may be added.
- Any food items may be used; not necessarily those listed above.

What to do

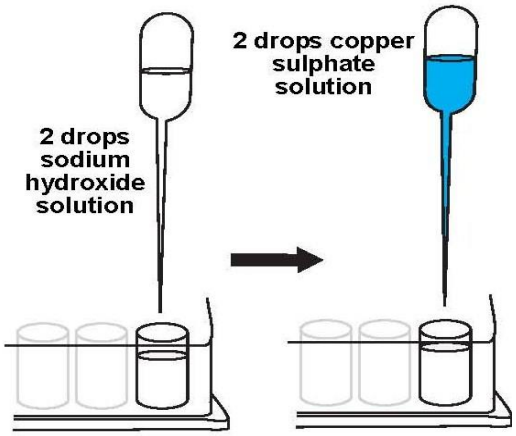
1. Use the food grater to grate a portion of each of the potato, apple and carrot. Wipe the grater clean before each new food is grated. (If a grater is not available, then scrape across the flesh of each item with a sharp knife.)
2. Fill 1/3 of well F1 with grated potato. Add water to the potato from a propette until well F1 is half full. Mash the potato in the water with the glass rod.



3. Fill 1/3 of well F2 with grated apple. Add water to the apple until well F2 is half full.
4. Wipe the glass rod and mash the apple in the water with the rod.
5. Fill 1/3 of well F3 with grated carrot. Treat the carrot in the same manner as you have the potato and apple.
6. Fill 1/3 of well F4 with cooked white rice. Rinse the glass rod and use it to break the rice into smaller pieces before adding any water.
7. Add water to the rice until well F4 is half full. Stir the mixture with the glass rod.
8. Fill 1/3 of well F5 with cooked, white mealie meal. Add water to the meal until the well is half full. Rinse the glass rod and use it to stir the meal in the water.



9. Use a clean propette to remove the Potato solution from well F1. Place 5 drops of this solution into well A1.
10. Add 2 drops of 10% sodium hydroxide solution and stir with a microspatula.
11. Add 2 drops of the 1% copper sulphate solution and stir. Record your results in Table 1 (*See Question 1*).



12. Remove the apple solution from well F2 with another propette. Place 5 drops of this solution into well A3.
13. Add 2 drops of 10% sodium hydroxide solution and stir with a microspatula.
14. Add 4 or 5 drops of 1% copper sulphate solution. Stir and record your results. (*See Question 1*)
15. Remove all of the carrot solution from well F3 and place 5 drops into well A5. Add 2 drops of 10% sodium hydroxide solution and stir with a microspatula.
16. Add 5 drops of copper sulphate solution. Stir and record your results. (*See Question 1*)
17. Repeat steps 15 - 16 with the rice solution from well F4. Place the solutions into well A7. Record your results in Table 1. (*See Question 1*)
18. The particles of mealie meal in well F5 will block the stem of a propette. Therefore, make sure that all solid material has settled in the well before attempting to remove the mealie meal solution with a propette.
19. Place 5 drops of this solution into well A9 and add 10 drops of 10% sodium hydroxide solution. Stir with a clean microspatula.
20. Add about 5 drops of the copper sulphate solution to well A9 and stir. Record your results in Table 1. (*See Question 1*)

Rinse the comboplate® and remaining equipment with water.

QUESTIONS

Q1. Prepare a table like Table 1 below in your workbooks. Record your results with the different foods tested.

Table 1

WELL	FOOD SOLUTION	COLOUR WITH COPPER SULPHATE

Q2. What is the answer to the focus question?

Q3. What does the colour of the potato solution tell you about the type of proteins present in potato?

EXTENSION QUESTION

Q4. It is often stated that rice and mealie meal contain protein. Mealie meal is a staple food in many African countries. How can the results obtained in this experiment help to explain the high incidence of Kwashiorkor (an illness related to a lack of protein in the diet) in Africa?

EXPERIMENT 20 – TESTING A LEAF FOR STARCH

CSEC OBJECTIVE: Section B 2.4

Grade Level – 9&10

You Need

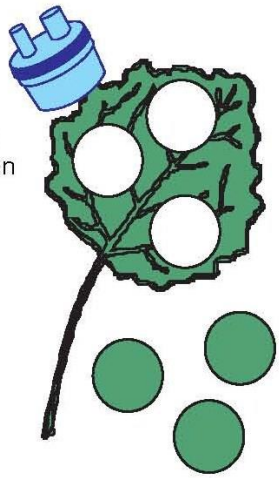
Apparatus: Comboplate®; 2 x propettes; lid 1; 2 x plastic lunch boxes; Geranium leaf; Needle.

Chemicals: I_2/KI solution (iodine solution); 70% alcohol.

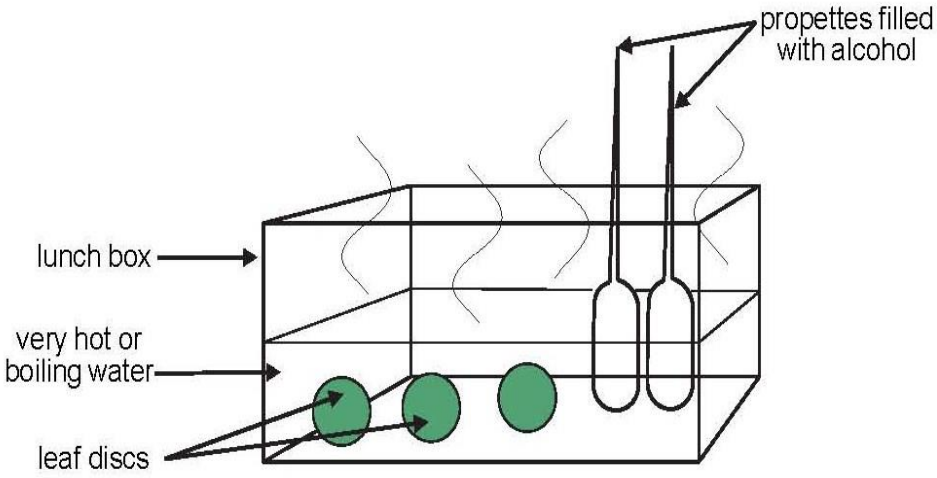
What to do

Follow the instructions as set out.

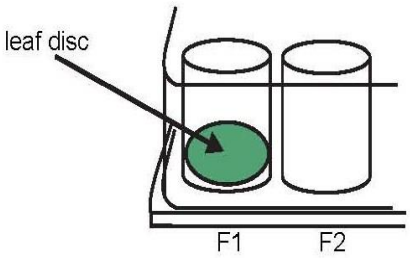
1 Use the lid to cut discs from a green geranium leaf.



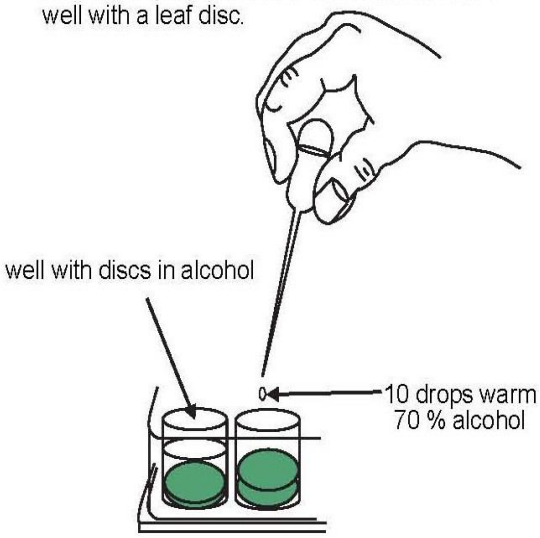
2 Place the discs in very hot water, (boiling if possible), in the lunch box for 5 minutes. In this way, the cell walls are broken down. At the same time, place the propettes, filled with alcohol, bulb down into the hot water. In this way, the alcohol is heated too.



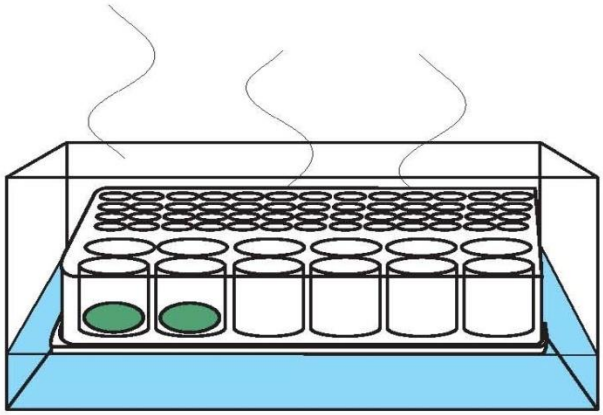
3 Use a needle to place 2 leaf discs in each of wells F1 and F2 of the comboplate®.



4 Add 10 drops of warm 70 % alcohol to each well with a leaf disc.



5 Fill the lunch box with hot water again and float the comboplate® on the water in the lunch box. (*See Questions 1, 2, 3*)



6 Use the needle to remove the leaf discs from the wells (CARE!) Place the discs in another lunch box of water at room temperature for a minute. In this way, the alcohol is rinsed from the discs.

7 Collect the chlorophyll extract from all the comboplate®s and place it in the empty lunch box in a cool place.

8 Rinse the comboplate®.

9 Use the forceps to place the leaf discs back in wells F1 and F2 of the comboplate®.

10 Use a propette to add 5 to 10 drops of I_2/KI solution (iodine solution) to each disc.

11 Observe any changes.

QUESTIONS

1. What is the colour of the alcohol after 10 minutes?
2. What is the colour of the leaf after 10 minutes?
3. What has the alcohol done to the leaf?
4. What colour did the leaf discs turn after the iodine was added?
5. What does this colour change tell you about the storage product in these leaves?

EXPERIMENT 21 – IS CHLOROPHYLL NECESSARY FOR PHOTOSYNTHESIS?

CSEC OBJECTIVE: Section B 2.4

Grade Level – 10

You Need

Apparatus: Comboplate®; 3 x propettes; lid 1 or lid 2; Plastic lunch box; Variegated leaf.

Chemicals: I_2/KI solution (iodine solution); Hot water; 70 % alcohol.

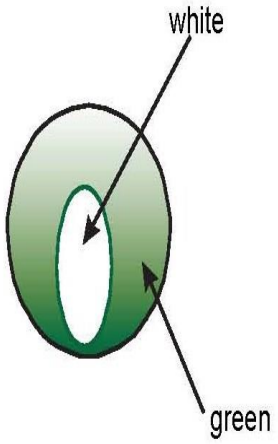
Notes

1. Use the plastic lunch box as a water bath.
2. This investigation uses a **variegated** leaf. Such a leaf has more than one colour. The type of variegated leaf you need is one which has both green and white parts in the same leaf.

What to do

Follow the instructions as set out underneath.

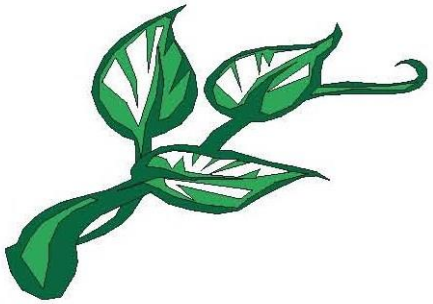
1. Pick a variegated geranium leaf around noon on a sunny day.
2. Cut discs from the leaf in the same way as you did for the first investigation.
   Ensure that you have discs which have BOTH green and white parts.
3. DRAW the discs showing the position of both the colours.
   A drawing could look something like the figure shown.



4. Soften the discs by placing them in hot water in the plastic lunch box.
5. At the same time, partly fill two propettes with alcohol and place these, bulb downwards into the hot water in the plastic lunch box.
   Doing this heats the alcohol and makes the chlorophyll extraction easier.
6. Place the discs in one or more of the F wells of the comboplate® as in previous activities.
7. Add 10 to 20 drops of warmed alcohol to each well which contains a disc. Extract the chlorophyll by allowing the discs to float in the warm alcohol. Ensure that the water in the plastic lunch box is as warm as possible.
8. When the discs have been decolorised, rinse them with water as in Photosynthesis Activity 1.
9. Rinse the comboplate® and then replace the leaf discs in the F wells of the comboplate® .
10. Use a clean propette to add a few drops of iodine solution to the leaf discs.
11. Observe any changes.

QUESTIONS

1. What was the final colour of the leaf discs which were originally green and white?
2. Make a drawing of a leaf disc which was originally both green and white.

	3. What do your results suggest about the role of chlorophyll in photosynthesis? 4. The white parts of the leaf discs had no starch. This means that there is no food for the plant in the white parts of the plant. The white parts of the leaf must get food, otherwise they would die. How do you suppose these parts get their food?
	SOMETHING TO THINK ABOUT Consider the leaves pictured alongside.  They are not variegated leaves. They are from a plant which is suffering from a deficiency of one or more essential nutrients. It may be possible to correct the problem by placing Epsom Salts on the soil around the plant and watering well. Find out why Epsom Salts could help to correct this problem.

EXPERIMENT 22 – IS LIGHT NEEDED FOR PHOTOSYNTHESIS ?

CSEC OBJECTIVE: Section B 2.4

Grade Level – 10

You Need

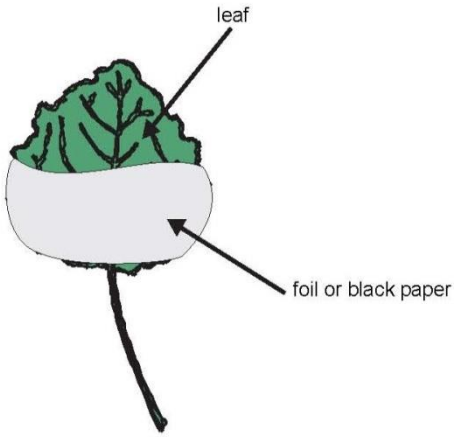
Apparatus: Comboplate®; 2 x propettes; lid 1; Plastic lunch box; Paper clips; Forceps; Geranium leaf; Aluminium foil or black paper.

Chemicals: I_2/KI solution (iodine solution); 70 % alcohol.

What to do

Follow the instructions as set out underneath.

For this investigation, you will use a leaf from a geranium plant which is growing in the garden or in a pot. The leaf remains on the plant until you are ready to do the starch test, then you remove the leaf.



1. As soon as possible after sunrise, cover part of the leaf TOP SIDE AND BOTTOM SIDE with aluminium foil or black paper.
   In this way, you are preventing light falling on the covered part of the leaf.
2. Wait for a day before doing anything else.
3. Draw the leaf accurately, marking exactly where the paper or foil covered the leaf.
4. Use lid 1 to cut discs from the leaf as in previous activities.
5. Keep discs from the covered part **separate** from discs from the uncovered parts of the leaf.
6. Test the discs for starch in the same way as you did in previous activities.
7. Tabulate your results.

QUESTIONS

1. What did the foil or black paper do?
2. What do you suppose is the link between light and photosynthesis?
3. What does the word "*photosynthesis*" mean?

EXPERIMENT 23– IS CARBON DIOXIDE NEEDED FOR PHOTOSYNTHESIS?

CSEC OBJECTIVE: Extension activity for Section B 2.4

Grade Level – 10

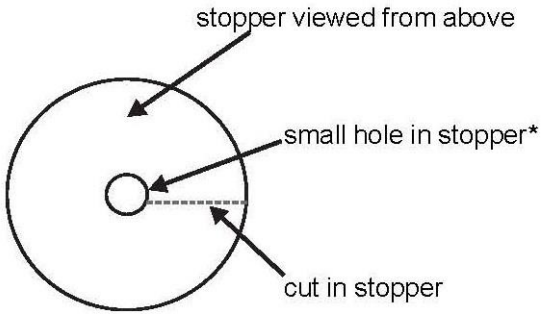
You Need

Apparatus: Comboplate®; Propettes; Large vial; Stopper to fit large vial;
Small pot plant with a few leaves*; Sharp knife.
Chemicals: I_2/KI solution (iodine solution); 70 % alcohol; Soda-lime; Petroleum jelly.
* A young seedling, recently germinated is very suitable provided the leaves ***are green*** i.e. have started photosynthesising.

What to do

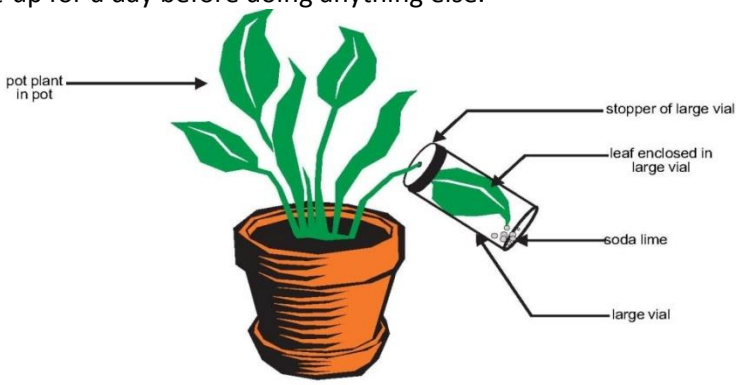
Follow the instructions as set out underneath.

1. Shake the soda lime into the large vial until the vial is one quarter full.
2. Use the knife to cut the stopper of the vial as shown below.



* the hole must be large enough for the petiole (stalk) of the leaf to fit

3. DO NOT PICK ANY LEAF OFF THE PLANT!!
4. Fit the stopper around a small leaf, sealing any gaps with petroleum jelly.
5. Place the vial with the soda lime onto the stopper as shown.
6. Seal all joints with petroleum jelly so that no air enters the jar.
7. Support the vial on any suitable and convenient item - the comboplate®, the pot, a pile of paper . . .
8. Leave the set-up for a day before doing anything else.



9. Pick the leaf which was enclosed and pick another leaf of similar size from the same

plant.

10. Test leaf discs for the presence of starch as you did in the previous investigations. Remember to keep the chlorophyll extracts in a cool place.

REMEMBER TO KEEP THE LEAF DISCS FROM THE LEAVES INSIDE THE BOTTLE AND OUTSIDE THE BOTTLE SEPARATE

11. Record your results in a table like the one below.

Leaf	**Colour after Testing with Iodine Solution**	**Conclusion**

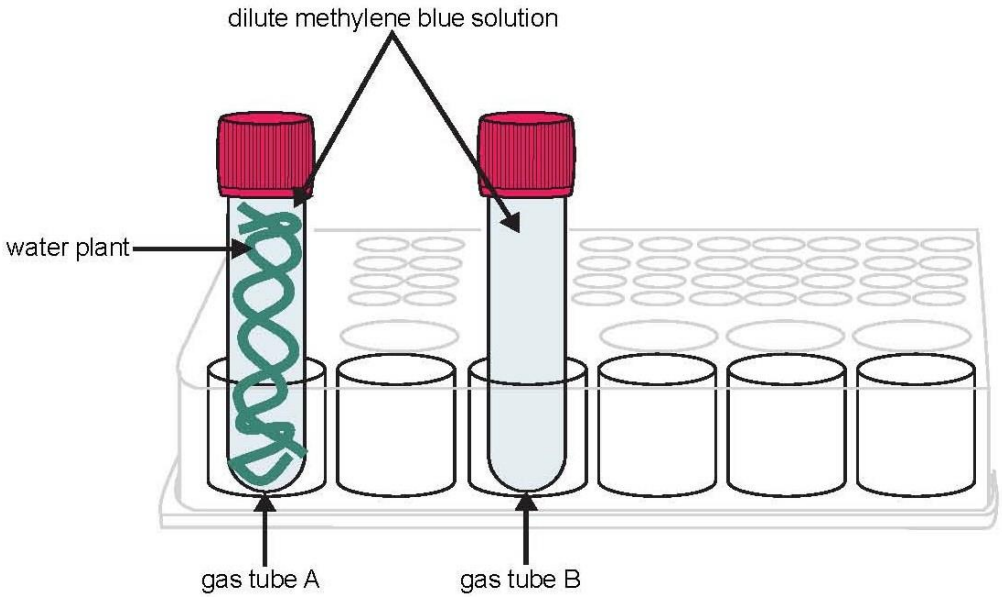
QUESTIONS

1. Did the leaf discs which did not receive carbon dioxide have any stored starch?
2. Did the leaf discs which did receive carbon dioxide have any stored starch?
3. What do these results suggest to you?
4. What elements are present in carbon dioxide?
5. What elements are present in glucose and in starch?
6. Where does the additional element come from?

EXPERIMENT 24 – IS OXYGEN RELEASED DURING PHOTOSYNTHESIS?

CSEC OBJECTIVE: Section B 2.2

Grade Level – 10

	You have already learned that light, chlorophyll and carbon dioxide are necessary for photosynthesis. In this activity, you are going to find out whether oxygen is released during photosynthesis.
	You Need **Apparatus:** Comboplate®; 2 x gas collecting tubes, A and B*; 2 x lids of gas collecting tubes*; 1 x microspatula; Water plant; Light source - such as a lamp**. **Chemicals:** Methylene blue solution (0.1% aq); Tap water; Sodium hydrogen carbonate ($NaHCO_3(s)$). * *only one provided per kit.* ** *optional but recommended; not provided in kit.*
	What to do Work in groups, sharing equipment so that each group has access to all the equipment required. 1. Fill the gas collecting tubes with water and place 3 microspatulas full of sodium hydrogen carbonate in each tube. 2. Add a few drops of methylene blue solution to each tube. Take care not to add too much methylene blue. The water should not change colour to a marked extent. 3. Place a suitable length of water plant inside tube A. Do not place any water plant in tube B. 4. Place the tubes in two of the large wells of the comboplate® and leave the apparatus in the sunlight or near a light source for several hours. 5. Observe the set up closely. (*See Question 1*) 

	QUESTIONS 1. Note what you observe in each of the tubes. 2. What can you deduce from your observations? 3. Why did we add sodium hydrogen carbonate ($NaHCO_3$) to the water? 4. What happened to the solution in tube B?

EXPERIMENT 25 – THE PRODUCTS OF COMBUSTION

CSEC OBJECTIVE: Extension of Section B 3.5

Grade Level – 10

INTRODUCTION

There are similarities and differences between respiration and combustion. In this investigation we demonstrate the products of combustion (by a burning candle).

You Need

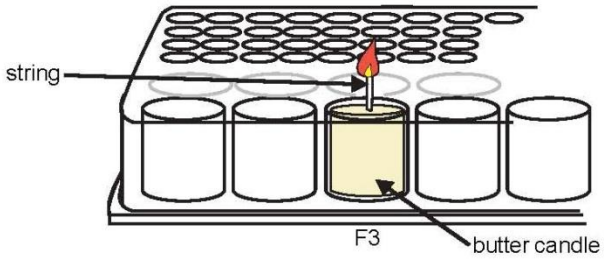
Apparatus: Comboplate®; 1 x 3 cm piece of string; 1 x propette; Matches; Vial.

Chemicals: Solid fat like butter or margarine; Lime water; 1 strip of anhydrous (blue) cobalt chloride paper.

What to do

Follow the instructions as set out underneath, using the diagrams to help you.

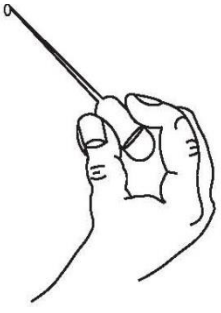
1. Shape the butter into a candle in well F3 of the comboplate®.
2. Insert the string - which acts as a wick - into the butter candle.
3. Light the wick and wait for about half a minute.



4. Hold your hand over the flame.
   What do you notice?
5. Hold a glass vial over the flame for a few seconds. Remove the vial and examine the surface.
   What do you notice?
6. Dip a strip of cobalt chloride paper into a droplet on the vial. **What do you notice?**
   What does this observation suggest to you?
7. Practise the following technique a few times.

HANGING DROP TECHNIQUE

Draw a little water into a propette. Gently squeeze the bulb so that a small drop emerges from the open end of the stem. Hold the propette as shown in the figure and keep the drop steady for as long as possible.



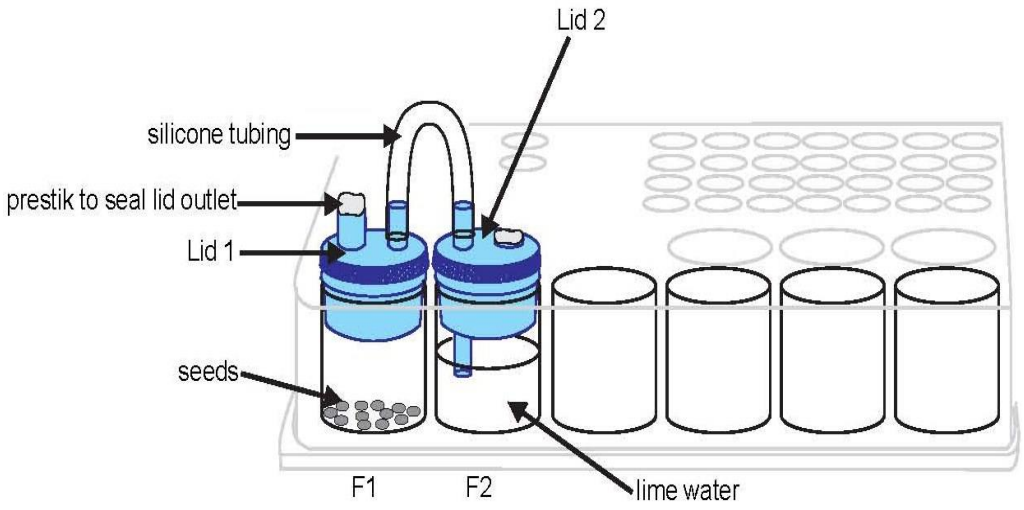
8. Use the hanging drop technique with clear lime water and hold the drop near the flame of the butter candle for a few moments. **What changes occur in the lime water?**

	What does your observation suggest to you?
	QUESTIONS 1. What substances were produced during the combustion of the butter candle? 2. What else happened? 3. What happened to the butter candle?

EXPERIMENT 26 – IS CARBON DIOXIDE RELEASED DURING RESPIRATION IN GERMINATING SEEDS?

CSEC OBJECTIVE: Section B3.5

Grade Level – 10

	As there is a lot of equipment required, work in groups; one group setting up the "experiment" and the other group setting up the "control". These must be set up at the same time.
	You Need **Apparatus:** 2 x comboplate®s; 2 x 2 ml syringes; 2 x lid 1; 2 x lid 2; *Prestik*; 2 x 50 mm lengths of silicone tubing; Germinating seeds; Dry, non-germinating seeds; Paper towel or vermiculite. **Chemicals:** Tap water; 2 ml clear lime water.
	What to do Follow the instructions as set out underneath, using the figure to help you. 1. **Experiment** Add the germinating seeds on moist paper towel or vermiculite to well F1 of one comboplate®. **Control** Add the non-germinating seeds on moist paper towel or vermiculite to well F1 of the other comboplate®. Follow steps 2 to 7 for both comboplate®s. 2. Add 2 ml clear lime water to well F2. 3. Cover well F1 with lid 1 and well F2 with lid 2. 4. Connect the outlet tubes of the lids with the silicone tubing. 5. Seal the remaining lid outlets with *prestik*. 6. Adjust the position of the lids so that there are no sharp bends or kinks in the silicone tubing.  7. Leave the set-up in a warm place for several days, observing the set up at least once

	every 24 hours. 8. Observe any changes which occur in the wells.
	QUESTIONS 1. What do you observe? a. Experiment: b. Control: 2. Why do you suppose the lime water turned milky? 3. Living organisms require fuel as a respiratory substrate. What did the seeds use as a substrate? 4. What will the seeds use as a substrate after the stored food is used up? 5. Design, without carrying out, an investigation to determine whether or not animals release carbon dioxide during respiration.

EXPERIMENT 27 – WHAT SUBSTANCES ARE FORMED DURING FERMENTATION?

CSEC OBJECTIVE: Section B 3.4 – 3.5

Grade Level – 10

INTRODUCTION

Living organisms produce carbon dioxide during respiration. Most living organisms undergo aerobic respiration, which means that they use oxygen during the process. During aerobic respiration the substrate, glucose, forms carbon dioxide and water. Some organisms, however, do not undergo aerobic respiration; they do not use oxygen and glucose is converted to other organic compounds. In certain cases, carbon dioxide is also produced. In other words, some organisms undergo anaerobic "respiration". We call anaerobic "respiration" in certain organisms **fermentation**.

During this investigation, you will examine **fermentation** by yeast.

You Need

Apparatus: 2 x comboplate®s; 2 x 2 ml syringes; 2 x lid 1; 2 x lid 2; *Prestik*;
2 x 50 mm lengths of silicone tubing.

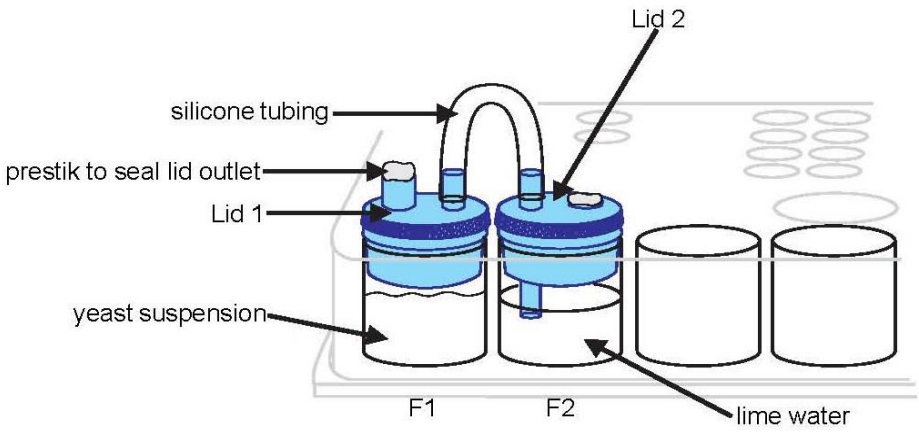
Chemicals: 1,5 ml yeast suspension in sucrose solution; 2 ml clear lime water.

What to do

Work in groups; one group being responsible for the "experiment" and the other group being responsible for
the "control".

Follow the instructions as set out underneath, using the diagram to help you.

1. Add 1,5 ml yeast suspension (experiment) or tap water (control) to well F1.
2. Add 2 ml clear lime water to well F2.
3. Cover well F1 with lid 1 and well F2 with lid 2.
4. Connect the outlet tubes of the lids with the silicone tubing
5. Seal the remaining lid outlets with prestik.
6. Adjust the position of the lids so that there are no sharp bends or kinks in the silicone tubing.



7. Leave the set-up in a warm place for 5 to 10 minutes.

	8. Observe any changes which occur in the wells.
	QUESTIONS 1. What do you observe? Experiment: Control: 2. Why do you suppose the yeast suspension became frothy? 3. How can you identify the gas? 4. What do you suppose would happen if there were no sugar in the yeast mixture? 5. Lift the lid of well F1 and smell the contents. What substance can you smell? 6. What is the formula of this substance? This compound is produced when glucose is acted on by the enzymes in yeast and in certain other organisms. We say that yeast is a ***facultative anaerobe***. This means that when oxygen is present it respires using oxygen, but is able to perform fermentation when necessary, i.e. when there is insufficient oxygen present.

EXPERIMENT 28 – IS OXYGEN USED DURING RESPIRATION?

CSEC OBJECTIVE: Section B 3.2, B 9.10

Grade Level – 10

INTRODUCTION

Most living organisms undergo aerobic respiration, which means that they use oxygen during the process.

This investigation demonstrates the use of oxygen by germinating seeds.

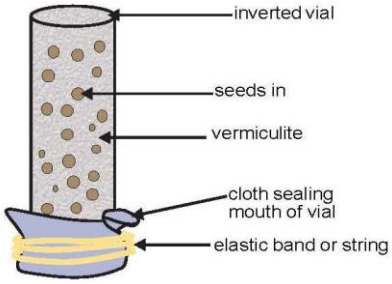
You Need

Apparatus: 1 x comboplate®; 2 x small vials; 2 pieces of fine fabric - old stockings are ideal; elastic bands or string; *Prestik*; Dry, non-germinating seeds; Germinating seeds; Vermiculite or absorbent paper.

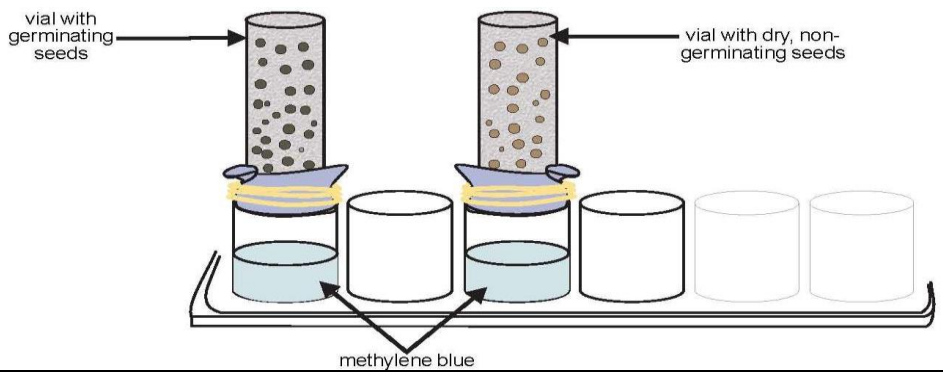
Chemicals: Methylene blue solution.

What to do

Follow the instructions as set out underneath, using the diagrams to help you.



1. Three-quarters fill one vial with germinating seeds in vermiculite and the other vial with dry, non-germinating seeds in vermiculite.
2. Tightly cover the mouth of each vial with a small piece of cloth. Secure the cloth with string or elastic band.
3. Invert the vials so that the seeds and vermiculite rest on the cloths.
4. Use a propette to half-fill wells F1 and F3 with methylene blue.
5. Place the inverted vials over the wells holding them steady with *prestik* if necessary.
6. Leave the set-up in a warm place for several days.
7. Observe and compare the growth of the seeds in the two vials.



	QUESTIONS 1. What do you observe? 2. What do your results suggest to you? 3. In this investigation, which set-up was the control?

EXPERIMENT 29 – IS ENERGY RELEASED DURING RESPIRATION ?

CSEC OBJECTIVE: Section B 3.5

Grade Level – 10

INTRODUCTION

The energy released in aerobic respiration is used by cells for many purposes. Some of these are: chemical reactions which require energy as well as growth, movement, reproduction and others.

This activity demonstrates the release of energy in the form of "heat" by living organisms.

You Need

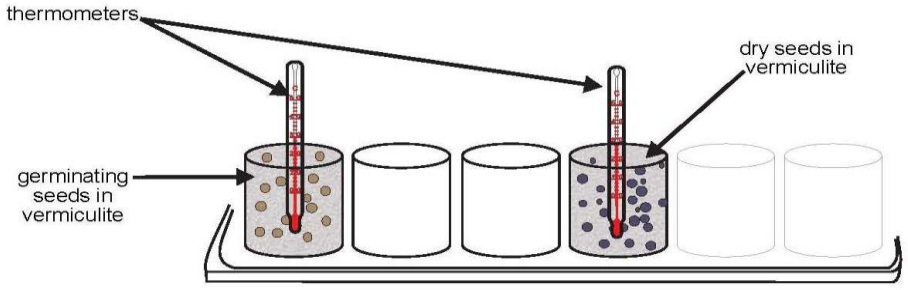
Apparatus: 1 x comboplate®; 2 x thermometers; *Prestik*; Dry, non-germinating seeds; Germinating seeds; Vermiculite or absorbent paper; Cotton wool.

Chemicals: Tap water.

What to do

Follow the instructions as set out underneath, using the diagrams to help you.

Work in groups, sharing the thermometers.



1. Fill well F1 with germinating seeds in vermiculite.
2. Fill well F4 with dry, non-germinating seeds in vermiculite.
3. Place a thermometer in each of wells F1 and F4, making sure that the bulbs are completely covered.
4. Leave the setups in a warm place, out of the sun and away from artificial heaters for a week.
5. Read the temperatures every day, at the same time of day if possible
6. Copy and complete the table on the next page into your notebook. Fill in your results. What do your findings suggest to you?

	Temperature in well F1 (^{0}C)	**Temperature in well F4 (^{0}C)**
Day 1		
Day 2		
Day 3		
etc. for a week		

	QUESTIONS 1. Which setup was the control in this investigation? 2. What else could be used as a control? 3. Why do you suppose that it is necessary to keep the setups away from the sun and artificial heaters? 4. Give another example of a temperature rise due to respiration.

EXPERIMENT 30 – DO THE RADICLES OF SEEDS ALWAYS GROW DOWNWARDS?

CSEC OBJECTIVE: Section B 7.2(i)

Grade Level – 11

You Need

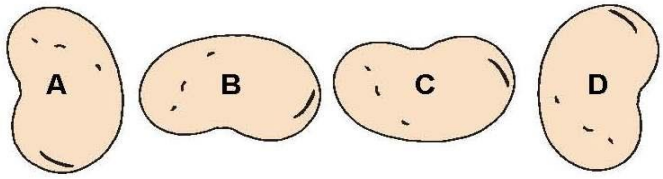
Apparatus: Comboplate®; Suitable seeds; Small plant pots; Vermiculite.

Chemicals: Tap water.

What to do

Follow the instructions as set out underneath.

1. Soak a number of seeds of the same type overnight.
2. Moisten enough vermiculite to fill 4 small plant pots.
3. Place the seeds *in different positions* in the moist vermiculite of each of the pots.



4. Leave the seeds in a warm, sheltered place for several days. Do not leave in direct sunlight and do not allow the seeds to dry out.
5. **IT IS VERY IMPORTANT TO KEEP THE VERMICULITE MOIST OR ELSE THE SEEDS WILL NOT GERMINATE**
6. Allow the seeds to germinate. Watch the behaviour of the radicles (young roots).

QUESTIONS

1. Write down what you observe when the seeds germinate.
2. What happened to the plumules (young shoots) of the seedlings?
3. Use what you have learned about tropisms to complete the following sentence about the behaviour of roots and shoots.
   Roots are _____ geotropic and negatively _____; shoots are _____ phototropic and _____ geotropic.
4. What is the advantage of tropism ***to the species***?
   [HINT]: Think of the ways in which seeds fall to the ground when they are scattered.

EXPERIMENT 31 – IN WHICH DIRECTION DO YOUNG SHOOTS GROW ?

CSEC OBJECTIVE: Section B 7.2(i)

Grade Level – 11

You Need

Apparatus: Plastic lunch box with lid; A sprouting potato*; Dark paper or aluminium foil; Scissors and tape.

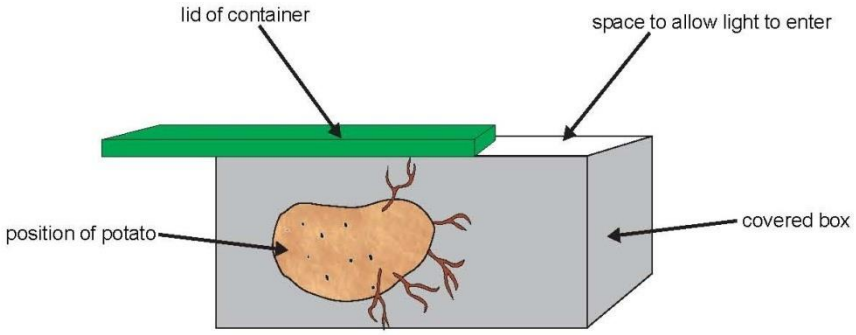
Chemicals: No special chemicals required.

* Your teacher will tell you what to do.

What to do

Follow the instructions as set out underneath.

1. Allow the potato to sprout until the shoots are about 1,5 cm to 2 cm long.
2. Place the potato at one end of the plastic container.
3. Place the lid on the container so that 6 cm is left uncovered at the end opposite the potato.
4. Cover the container with paper or foil in such a way so that light can enter the box only at the end opposite the potato.
   Refer to the diagram below.



5. Leave the setup for a few days, looking into the box once a day to observe any changes.

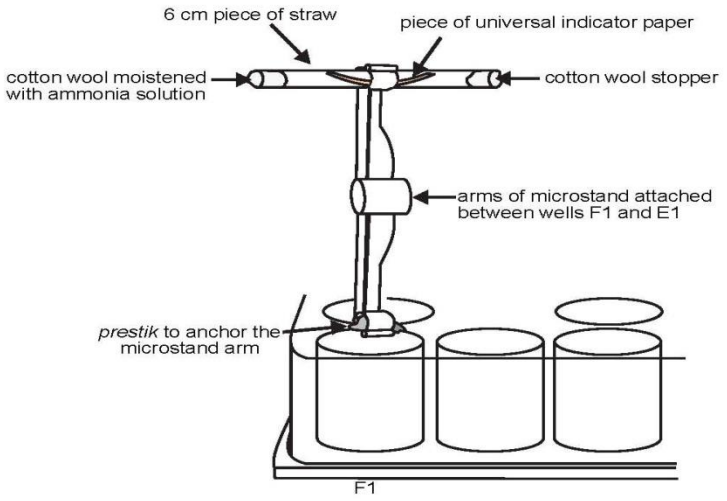
QUESTION

1. Note your observations.
2. What does your observation tell you about the behaviour of the shoots?
3. What other evidence of this phenomenon do we see in our everyday lives?

EXPERIMENT 32 – DIFFUSION IN A GAS

CSEC OBJECTIVE: Section B 1.5

Grade Level – 10

	In this activity, two microstand arms are needed. Therefore it is suggested that students work in groups to ensure that there is sufficient apparatus. Please read and follow the instructions which follow. Use the figure to help you.
	You Need **Apparatus:** Comboplate®; 1 x propette; 1 x microstand; 1 glass tube; 1 clear plastic straw (6 cm piece); Cotton wool; *Prestik*. **Chemicals:** Ammonia solution; Universal indicator paper; Tap water.
	What to Do 1. Firmly attach one microstand arm with prestik between wells F1 and E1. See diagram below.  2. Cut a strip of universal indicator paper 4 cm long and 2 - 3 mm wide and place it in the middle of the straw. 3. Use cotton wool to make a "stopper" of about 1 cm at each end of the straw. 4. Use a propette to transfer a few drops of ammonia solution to the cotton wool at each end of the straw. The cotton wool should be damp, not soaking wet. Do not let the wet cotton wool touch the universal indicator paper. 5. Carefully observe what happens to the universal indicator paper.
	QUESTIONS 1. What colour was the universal indicator paper when it was placed in the straw? 2. What happens to the indicator paper when ammonia solution is dropped onto the cotton wool? 3. What caused the colour of the universal indicator paper to change? 4. Do you think that an air current through the tube could be responsible for the change which occurred to the universal indicator paper?

EXPERIMENT 33 – MORE DIFFUSION IN A GAS

CSEC OBJECTIVE: Section B 1.5

Grade Level – 10

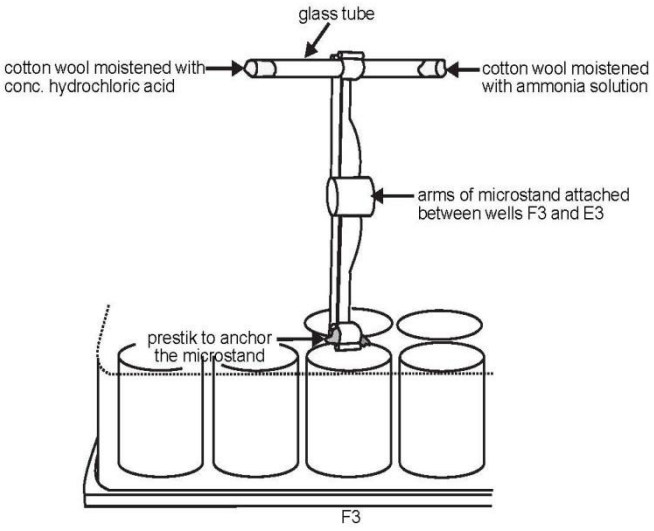
You Need

Apparatus: 1 x comboplate®; 2 x propettes; 1 x microstand; 1 glass tube; Cotton wool; *Prestik*.

Chemicals: Ammonia solution (NH3(aq)); Concentrated hydrochloric acid (HCl(aq))

What to Do

1. Firmly attach a microstand arm with prestik between wells F3 and E3.
2. Secure a glass tube into the microstand as shown in the diagram:



3. Shape a small tuft of cotton wool into a thin threadlike piece of about 1 cm long. Break it into two pieces and insert one piece into each end of the glass tube.
4. Use a clean propette to place a few drops of concentrated hydrochloric acid onto the cotton wool on the left hand side of the glass tube.
5. Use another, different, clean propette to place a few drops of ammonia solution onto the cotton wool on the right hand side in the glass tube.
6. Leave the set-up to stand for several minutes.
7. Record your observations in a table like the one below:

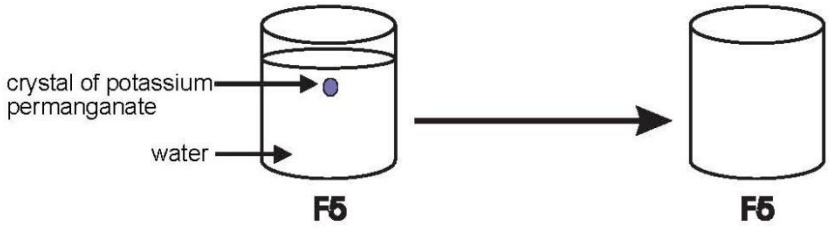
Time in Minutes	**Observation**
5	
10	
15	

	QUESTIONS 1. What happened in the glass tube? 2. What are the tiny white spots which have formed on the glass tube? 3. How did these white spots appear?

EXPERIMENT 34 – DIFFUSION IN A LIQUID

CSEC OBJECTIVE: Section B 1.5

Grade Level – 9&10

	You Need **Apparatus:** 1 x comboplate®. **Chemicals:** Potassium permanganate ($KMnO_4(s)$); Tap water.
	What to Do 1. Fill well F5 with water. 2. Drop a crystal of potassium permanganate into the water. 3. Draw your observation in a diagram like the one below: 
	QUESTIONS 1. What happened when the crystal of potassium permanganate was dropped into the water? 2. Explain your observation.

EXPERIMENT 35 – DIFFUSION IN A SOLID

CSEC OBJECTIVE: Section B 1.5

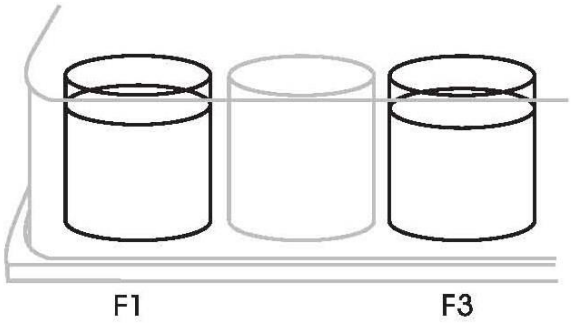
Grade Level – 9&10

You Need

Apparatus: 1 x comboplate®; Teaspoon*; Suitable container like a cup*; 1 x 2 ml syringe.
Chemicals: Potassium permanganate ($KMnO_4(s)$); Copper sulphate ($CuSO_4.5H_2O(s)$); Gelatine; Tap water.
* not provided in the kit.

What to Do

1. Add 2 teaspoons of gelatine to 50 ml of warm water in the cup and stir.
2. Use the syringe to draw up some of the gelatine mixture and fill both wells F1 and F3 to the top with the mixture.
3. Wait until the gelatine has set.
4. When the gelatine has set, add a few crystals of potassium permanganate to well F1.
5. Similarly, add a few crystals of copper sulphate to well F3.
6. Observe the setup every two minutes for 10 minutes.
7. Draw your observation in the empty wells below:



QUESTIONS

1. What did you observe in F1?
2. What did you observe in F3?
3. Why did the colours move downwards in well F1 and F3?
4. If you leave these wells to stand for another day what would happen?

EXTENSION QUESTION

Repeat the entire procedure. This time, wait for half an hour then invert (turn upside down) the comboplate® after step 5. Discuss your findings with other members of the class.

EXPERIMENT 36 – OBSERVING OSMOSIS USING DIALYSIS TUBING

CSEC OBJECTIVE: Section B 1.5

Grade Level – 10

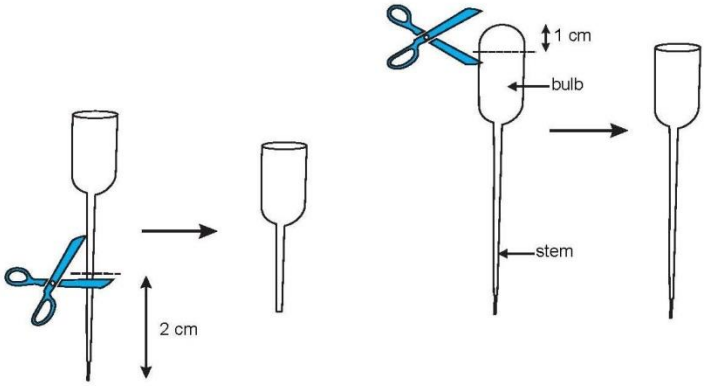
You Need

Apparatus: Comboplate®; 2 x propettes; 1 x microstand; 2 x glass vials; Scissors; 2 pieces of 8 cm square dialysis tubing; Cotton, thin string or elastic band; *Prestik* .

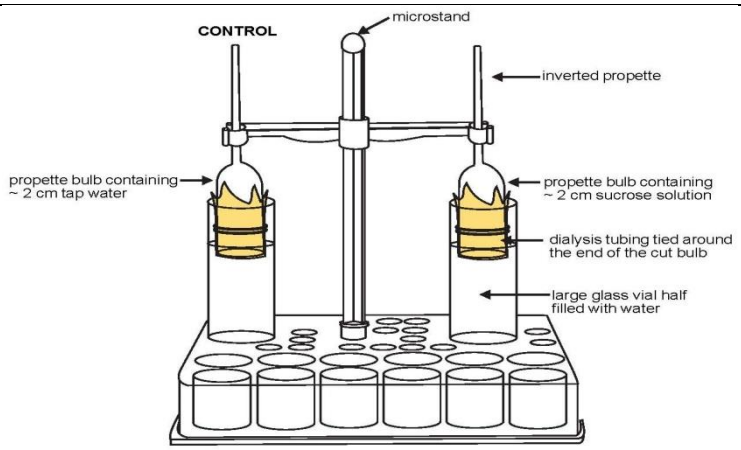
Chemicals: Sucrose solution, or orange juice, or syrup with water; Tap water.

What to Do

1. Place the microstand in well C5.
2. Half fill two large glass vials with water.
3. Secure one vial onto the comboplate® with prestik underneath the left hand arm of the microstand and another one underneath the right hand side of the microstand.
4. Cut about 1 cm off the bulbous ends of the two propettes.
5. Then cut about 2 cm off the thin end of the propettes.



6. Cut two 8cm square pieces of dialysis tubing (which has been soaked in water for (1 - 2 hours) and tie them **firmly** around the open cut ends of the propettes with a piece of string or elastic (whichever is easier).
7. Insert the thin cut end of one propette into the sucrose solution and draw up about 2 cm of sucrose solution.
8. Invert the propette containing the sucrose solution into the vial with water as shown in the diagram:



9. Secure the thin stem of the propette with prestik onto the microstand.
10. Mark the level of the sucrose solution with a marking pen and leave to stand for about an hour.
11. Do the same with the second propette but this time use tap water. This is the CONTROL.
12. Observe and note whether any change has taken place.
13. Mark any changes with the marking pen every 15 minutes and record these changes in a table like the one below.

Time (Minutes)	**Height of Solution (mm)**
15	
30	
45	
60	

QUESTIONS

1. What did you observe about the level of the water in the propette?
2. Why did the level in the stem rise?
3. Is the dialysis tubing totally permeable, selectively permeable or impermeable?
4. Do you think that the sugar molecules are able to move through the dialysis tubing? Give a reason for your answer by referring to the structure of the membrane.
5. The water molecules can / cannot move through the dialysis tubing. Which is correct?
6. Draw a graph to show how the level of the solution in the stem of the propette changes with time.

EXPERIMENT 37 – HOW DOES OSMOSIS OCCUR IN LIVING TISSUE?

CSEC OBJECTIVE: Section B 1.5

Grade Level – 10

INTRODUCTION

You have learnt that water moves by osmosis through selectively permeable membranes like dialysis tubing.

The following activity investigates osmosis in living tissue.

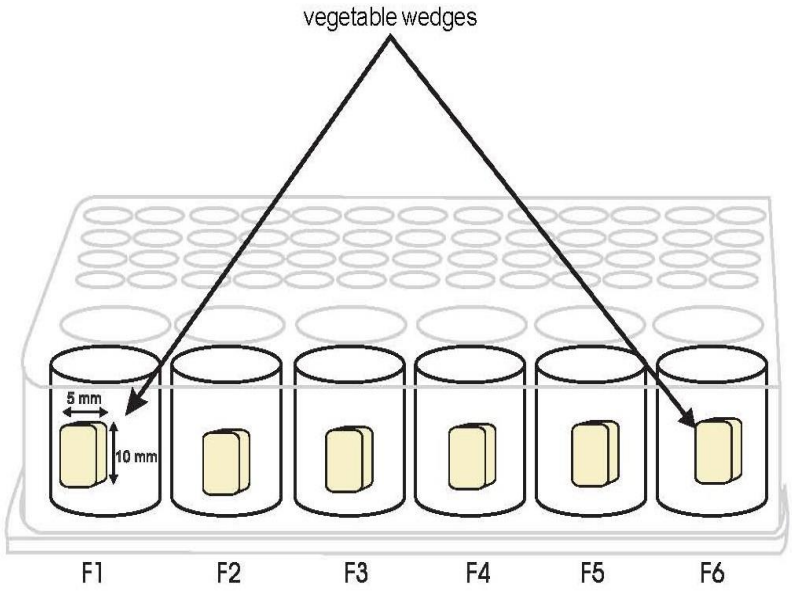
You Need

Apparatus: Comboplate®; 3 x propettes; Sharp knife; Ruler; Paper towel;
Fresh potato or other vegetable like carrot, sweet potato, turnip, parsnip;
Accurate mass meter (optional).

Chemicals: 30 % sucrose solution; 10 % sucrose solution; Tap water.

What to Do

1. Remove the skin from the potato or other vegetable and cut 6 equal-sized pieces of potato or other vegetable with the knife. The pieces should be approximately 10 mm x 5 mm x 5 mm.
2. Measure the pieces with the ruler and feel them between thumb and forefinger.
3. Place 1 potato or other vegetable piece in each of the F wells of the comboplate®.



4. Use a clean propette to fill wells F1 and F2 with tap water.
5. Use a clean propette to fill wells F3 and F4 with 10 % sucrose solution.
6. Use a clean propette to fill wells F5 and F6 with 30 % sucrose solution.
7. Leave the setup for several hours.
8. Remove the potato or other vegetable pieces and place them on the paper towel.
9. Feel the pieces again between thumb and forefinger. Note your findings.
10. Measure the pieces again with the ruler. Note your findings.

11. Record your results in a table like that below.

Potato or Other Vegetable Piece	What it Felt Like	Length in mm
F1 (tap water)	Before:	
	After:	
F2 (tap water)	Before:	
	After:	
F3 (10 % sucrose solution)	Before:	
	After:	
F4 (10 % sucrose solution)	Before:	
	After:	
F5 (30 % sucrose solution)	Before:	
	After:	
F6 (30 % sucrose solution)	Before:	
	After:	

Compare your findings with those of other groups.

QUESTIONS

1. In general, what happened to the potato or other vegetable pieces in the tap water?
2. In general, what happened to the potato or other vegetable pieces in the 10 % sucrose solution?
3. In general what happened to the potato or other vegetable pieces in the 30 % sucrose solution?
4. Try to give reasons for your findings in each case.

EXPERIMENT 38 – PATH OF WATER THROUGH THE PLANT

CSEC OBJECTIVE: Section B 4.7

Grade Level – 9&10

	INTRODUCTION You have seen that water passes into cells and tissues by osmosis. In this way, water passes into the roots of plants. The next question to ask is **"What happens to the water once it is in the root system of a plant?"** The following activity investigates the path of water through the plant.
	You Need **Apparatus:** Comboplate®; 1 x propette; Vial; Microstand; Hand lens; Young, healthy seedling between 6 cm and 10 cm tall; Blade. **Chemicals:** Tap water; Red food colouring.

What to Do

1 Remove the seedling from the soil immediately before you start the investigation.

2 Wash the soil from the roots.

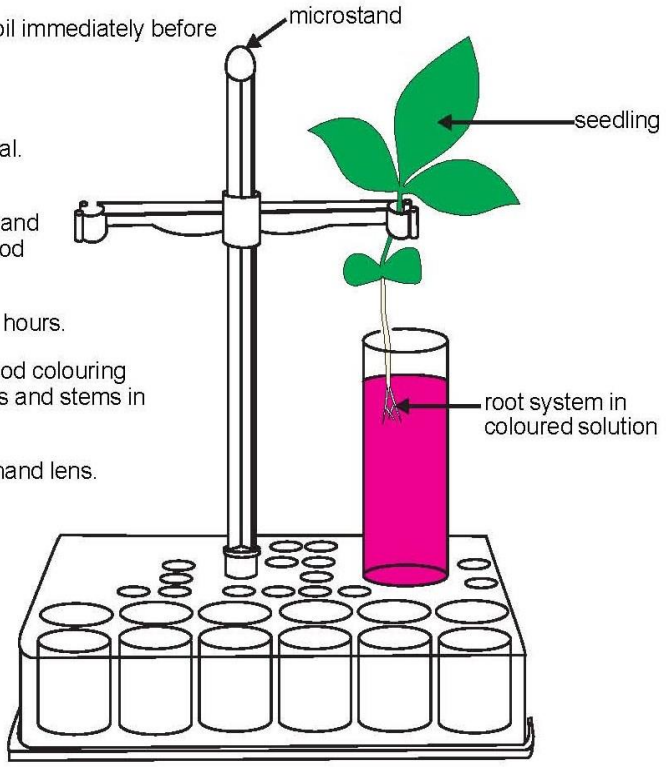
3 Place the food colouring in the vial.

4 Support the aerial parts of the seedling in an arm of the microstand and submerge the roots in the food colouring as shown alongside.

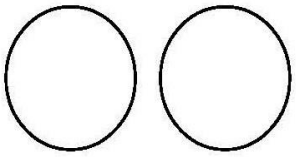
5 Allow the setup to stand for 1 - 3 hours.

6 Remove the seedling from the food colouring and use the blade to cut the roots and stems in transverse section.

7 Examine the sections using the hand lens.



8 Copy the circles below, draw what you see and mark with a coloured pen or pencil the areas where you can see the red food colouring.



Use a reference book to identify the tissues if you do not know their names.

QUESTIONS

1. In what tissue did you observe the red food colouring?
2. What can you conclude from this observation?

EXTENSION ACTIVITIES

1. Repeat the procedure with other plants which have variegated (for example, green and white) leaves and observe the leaf veins after a few hours.
2. Repeat the procedure with pale-coloured flowers and observe changes which occur in the petals.

EXPERIMENT 39 – DOES THE ROOT SYSTEM OF A PLANT PUSH WATER UP THE STEM?

CSEC OBJECTIVE: Section B 4.7

Grade Level – 9&10

INTRODUCTION

You have seen that water is carried in the xylem of plants from the roots to the stems and to other aerial parts.

This activity investigates how water passes upwards in plants.

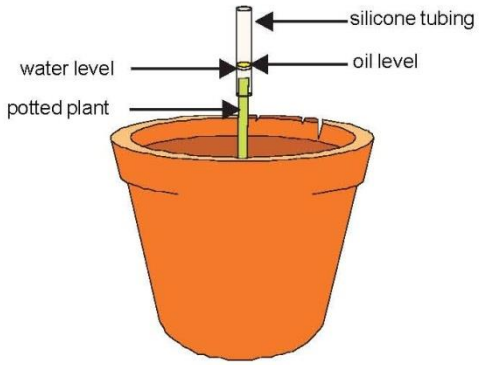
You Need

Apparatus: Small, young potted plant; Silicone tubing (2 cm length); 2 x propettes; Blade.

Chemicals: Tap water; Oil.

What to Do

1. Select a plant with a stem that will fit into the silicone tube.
2. Ensure that the plant has been well watered for a few days.
3. Use the blade to cut off the top of the plant about 2 cm above soil level. Discard the top of the plant.
4. Push one end of the silicone tube over the cut stem.
5. Use a propette to put water into the silicone tube until the water is just visible.
6. Use another propette to add a few drops of oil on the water in the tube.
7. Mark the level of the water in the tube.
8. Water the potted plant 2 or 3 times over the next 24 hours.
9. Observe any changes.



QUESTIONS

1. Why do you suppose we placed oil over the water in the tube?
2. What did you observe about the level of water in the tube above the stem?
3. Where did this water come from?
4. Do you think the water level rose because of transpiration?
5. What system of the plant caused the water level to rise?

EXPERIMENT 40 – IS WATER LOST THROUGH THE AERIAL PARTS OF A PLANT?

CSEC OBJECTIVE: Section B 4.7

Grade Level – 9&10

INTRODUCTION

You have already learned that water passes into plants via the root system and is transported in the xylem throughout the plant. This activity investigates which parts of plants release water.

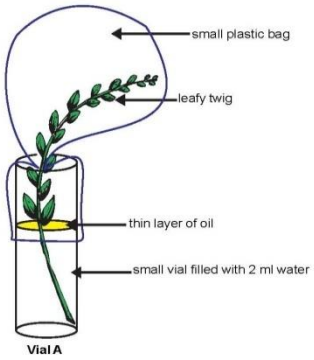
You Need

Apparatus: Comboplate®; 3 vials (A, B and C); A small leafy twig; A small leafless twig; A small flower on a stalk; propettes; 1 x 2 ml syringe; 3 small plastic bags; Elastic bands.

Chemicals: Tap water; Anhydrous (blue) cobalt chloride paper.

What to Do

1. Use the syringe to place 2 ml water in each of the vials.
2. Place the plant parts in the vials as follows:
   - A leafy twig;
   - a. B leafless twig;
   - b. C flower on stalk
3. Use a clean propette to place a thin layer of oil on the water in each of the vials.
4. Cover vials A, B and C with the plastic bags and secure these with elastic as shown below.
5. Place the vials in wells F1, F3 and F5 of the comboplate®.



Vial A

6. Leave the setup for several hours, or overnight.
7. Remove the plastic bags from the vials and estimate which bag contains the most, second most and least liquid. Record your estimations.
8. Test the liquid in each one with cobalt chloride paper. Record your findings.

QUESTIONS

1. What was the purpose of the oil on the surface of the water?
2. Which plant part lost the most, second most and least liquid?
3. What happened to the blue cobalt chloride paper when you used it to test the liquids in each of the plastic bags?
4. What liquid did the plant parts lose?
5. Summarise all your findings in one or two sentences.

EXPERIMENT 41 – INVESTIGATING HOW THE LEAVES OF PLANTS LOSE WATER

CSEC OBJECTIVE: Section B 4.7

Grade Level – 9&10

You Need

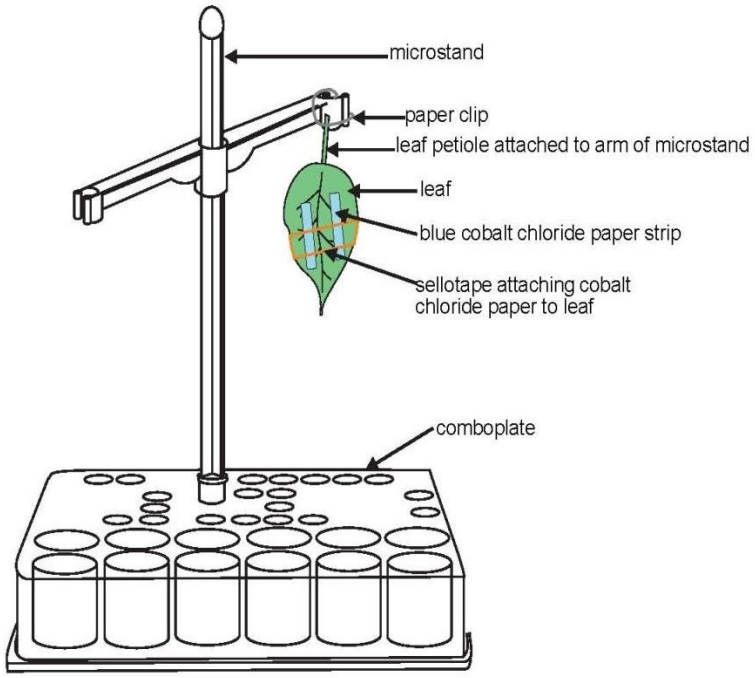
Apparatus: Comboplate®; Microstand; Leaf of plant (with petiole); Paper clip; Sellotape - width 10 mm; Hand lens.

Chemicals: Vaseline; Anhydrous (blue) cobalt chloride paper.

What to Do

Each student group should use a different leaf. In this way, comparisons can be made later.

1. Set up the comboplate® with a microstand in one of the small wells.
2. Select a suitable leaf.
3. Place small strips of cobalt chloride paper onto both dorsal (top) and ventral (bottom) sides of the leaf with the sellotape.
4. Attach the petiole of the leaf to an arm of the microstand as shown.



5. Leave to stand in a shady position. Examine the setup every five minutes and note any changes.
6. Examine one or two leaves with the hand lens. Draw what you see.

QUESTIONS

1. Was there any change in the colour of the cobalt chloride paper on any side of the leaves?
2. What does this observation suggest?

3. Do leaves lose water from both surfaces, from the upper surface, from the lower surface?
4. 4. Record your results in a table like that below.

LEAF	SIDE	TIME	Colour of Cobalt Chloride Paper
LEAF A	Dorsal		
	Ventral		
LEAF B	Dorsal		
	Ventral		
LEAF C	Dorsal		
	Ventral		

EXPERIMENT 42 – LOSS OF LIQUID WATER FROM PLANTS

CSEC OBJECTIVE: Extension of Section B 4.7

Grade Level – 9&10

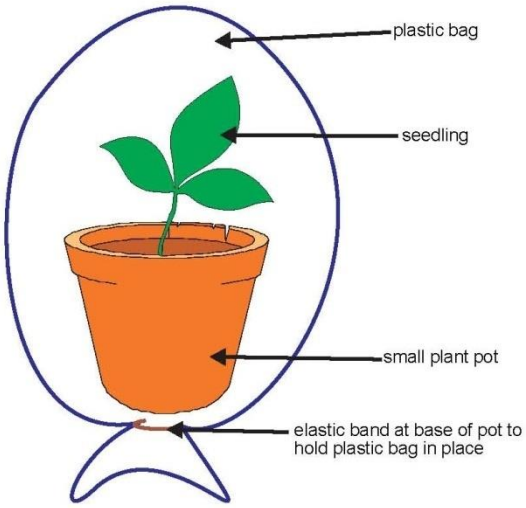
You Need

Apparatus: Seedlings of three different plant species e.g. mealie, lentil, radish, already planted in pots; 3 small plant pots; Plastic bags large enough to cover the pots with the seedlings; Elastic bands.

Chemicals: Tap water.

What to Do

1. Ensure that the seedlings are well watered for a few days and that the soil or vermiculite is kept moist.
2. Cover the seedlings with the plastic bag held in place by an elastic band around the base of the pot.



NOTE: ***Steps 1 and 2 (above) create very humid conditions around the leaves.***

3. Observe the seedlings over the next day or two.

QUESTIONS

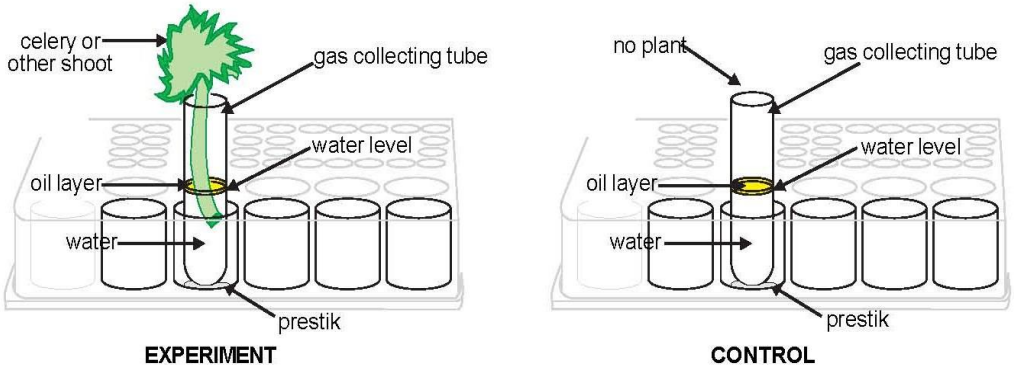
1. What can be seen along the margins of the leaves?
2. What process has taken place?
3. Under which environmental conditions would this process take place in plants?
4. Why would guttation occur under these conditions?

EXPERIMENT 43 – LOSS OF WATER FROM PLANTS UNDER VARIOUS ENVIRONMENTAL CONDITIONS

CSEC OBJECTIVE: Section B 4.8

Grade Level – 10&12

	INTRODUCTION You have already learned that transpiration is the evaporation of water from plant surfaces, particularly from the stomata on leaves. The quantity of water that plants lose in this way depends on both internal and external factors.
	You Need **Apparatus:** Comboplate®; *Prestik*; Gas collecting tube; Propette; 2 ml syringe; China marker or felt-tipped pen; Plastic bag; String or elastic bands; Small stalks of celery or other leafy twig. **Chemicals:** Tap water; Cooking oil. *NB The plants which you select must be of the same type (species) and must be as similar as possible. That is, they should have equal numbers of leaves, be of the same age and so on in order to make meaningful comparisons.*
	What to Do A. As duplicate equipment is needed, work in groups so that each group has access to all the requirements. In this way, each group can take responsibility for a plant under different conditions. Half of the groups should have set-ups without plants. These setups serve as the controls. B. It is advisable to prepare the setups as early as possible in the day, as nightfall alters the environmental conditions. C. Follow the instructions underneath. 1. Use *prestik* to secure the gas collecting tube (open end up) in an F well of the comboplate®. 2. Use the syringe to add 3 ml tap water to the gas collecting tube. 3. Place the celery stalk in the water. 4. Use the propette to put a THIN layer of oil (about 6 drops) on the water. 5. Mark the level of the water in the tube. 6. Repeat the entire procedure without the plant.



7. Place the paired setups (one with plant; one without plant) under different environmental conditions; each **pair** to **one** set of conditions.

Examples include:

- a cool windy area,
- a cool still area,
- a hot windy area,
- a hot still area,
- a humid area,
- a sunny area,
- a shady area.

Plastic bags may also be placed over the gas collecting tubes to simulate humid conditions.

8. Leave the setups for several hours.
9. Examine the water levels of each setup and record your results in a table like that underneath.

Condition	**Final Water Level**	
Windy	No plant	- 1 mm
	Plant	
Sunny	No plant	
	Plant	
Dark	No plant	
	Plant	

QUESTIONS

1. Which plant or plants lost the most water?
2. Which plant or plants lost the least water?
3. Was any water lost from the control setups?

EXPERIMENT 44 – FLOWERING PLANTS - SEED STRUCTURE

CSEC OBJECTIVE: Section B 9.9 (Optional Activity Section B 2.5, 4.11)

Grade Level – 10/ 11

INFORMATION

Flowering plants, known as **angiosperms**, are very widely spread on Earth. Flowers carry the reproductive structures of these plants. Flowering plants are classified into two groups, monocotyledons and dicotyledons - depending on the structure of the seeds of these plants. There are also differences between various other parts of the plants in these groups. In this series of activities, you will examine the parts of flowering plants.

You will also learn to recognise whether the plant is a monocotyledon or a dicotyledon.

You Need

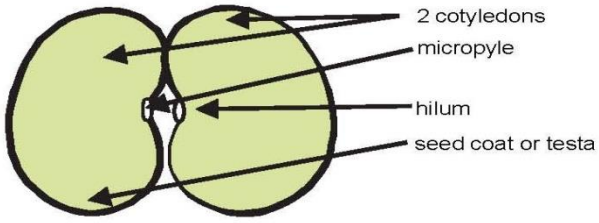
- Plastic lunch box with lid
- Forceps
- Hand lens
- Potting soil *
- Seeds of plants*
- Paper towel
- Petri dish

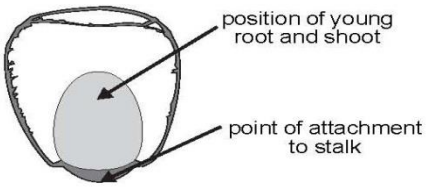
* To be obtained from your teacher

What to do

Stage 1 - The seed

1. Obtain a bean seed or a peanut and a maize or wheat seed.
2. Use the diagrams below to help you identify the external parts of the seeds.





3. Gently break open the bean or peanut. You will see that it can be broken into two similar "halves".
   These two "halves" are the reason for the term **Di**cotyledon; **Di** means **two**.
4. Try to break the maize or wheat seed (grain) into two parts in the same way.
   Is it possible to break these seeds into two?
   For this reason, these types of plants are called **Mono**cotyledons; **Mono** means **one**.

Internal Structure of the Seed

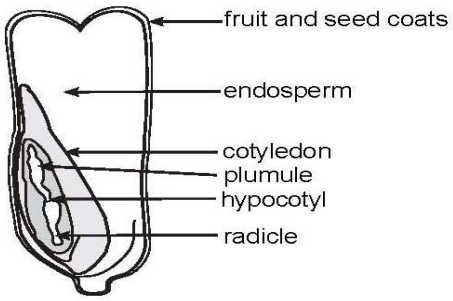
Obtain seeds which have been soaked for 24 hours.

Complete the following exercise for each of the seeds which you examine.

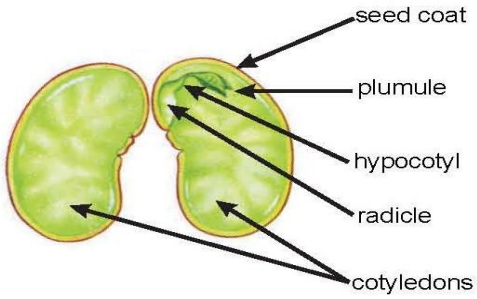
1. In what ways is the soaked seed different from a dry seed?
   HINT: Compare size, shape, texture.

Remove the seed coat and examine the inside of the seed. You will observe a small embryo inside the seed.
Use the diagrams below to identify the following parts of the seeds which you will study.

Internal Structure of Maize Grain



Internal Structure of Bean Seed



Use a biology dictionary or other text as well as your own knowledge and insight to help you complete the following question.

2. Match the word in column A with the phrase in column B by writing out the word with the correct phrase next to it.

A WORD	**B PHRASE**
1 coleoptile	a the root of the embryo
2 radicle	b stored food for the developing embryo
3 endosperm	c the portion of the seedling stem below the cotyledon/s
4 hypocotyl	d the shoot of the embryo
5 plumule	e protective covering of plumule

QUESTIONS

1. How do the embryos obtain food?

Testing Seeds for the Presence of Stored Food (Starch) - *Optional Activity*

1. Place a drop of iodine on each soaked seed from which the seed coat was removed.

Questions

1. What do you see?
2. Which seeds seem to store the most starch?

EXPERIMENT 45 – OBSERVING GERMINATION

CSEC OBJECTIVE: Section B 9.10

Grade Level – 10

Stage 2 - Germination of the Seed

You Need

- Small planting pot*
- Potting soil*
- Seeds*
- Tap water

* Your teacher will provide these

What to do

A Preparation

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

1. Place the potting soil in a small planting pot so that the pot is about half full.
2. Plant the seeds in the soil about 3 cm apart.
3. In your notebook, draw a table like the one below, leaving space for at least 14 days. Observe and record the germination and growth of the young plant.

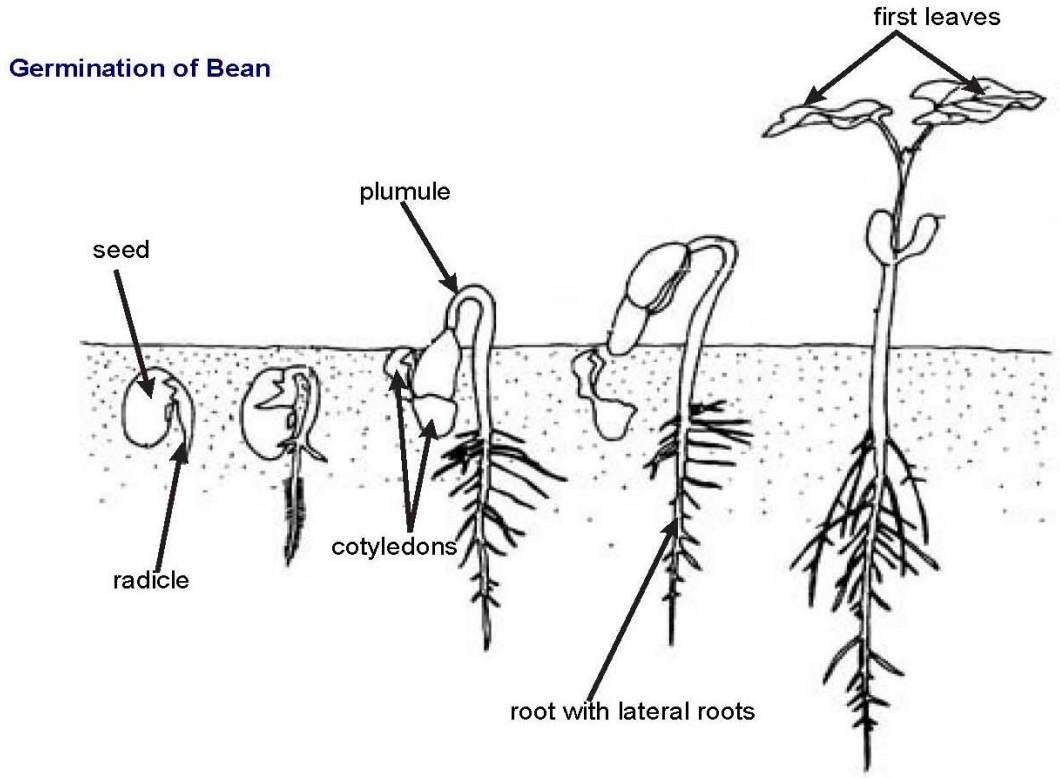
DAY	OBSERVATION	
	RADICLE	PLUMULE
1	none visible	none visible
2		
3		
etc....		
10	**example:** 3 cm long	
etc....		

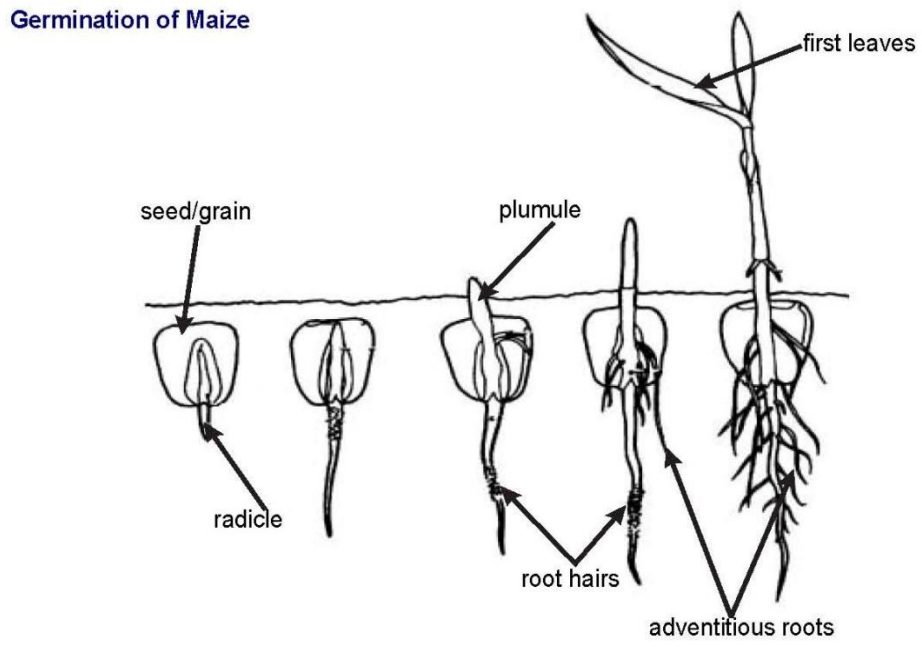
4. Sprinkle water on the seeds and the soil EVERY DAY for about 2 weeks. (Growth rate depends on temperature so the time is not exact.)
5. Leave the small planting pot in a sheltered area.

B Observation

After about two weeks, carefully remove a seedling (young plant) from the soil and place it on damp newspaper.

1. Use the diagrams below to identify the named structures on your seedling. Your seedling will probably be at an early stage of development.
2. Obtain a larger planting pot from your teacher and plant the seedling in the pot with fresh potting soil OR plant the seedling in the soil outside. Take care not to damage the roots.

	Continue examining the seedling at regular intervals in order to identify additional structures as they develop. 3. Copy the diagrams below. Use coloured pencils to show each part of the embryo (radicle and plumule) at first. Use the same colour for each structure in the later stages. 4. Look after your seedling and the plant which it later becomes. You will need it to continue the following parts of this series of activities (to come).
	



EXPERIMENT 46 –VEGETATIVE STRUCTURES OF ANGIOSPERMS

CSEC OBJECTIVE: Section A 1.1, B 4.5, 4.6, 4.9

Grade Level – 10/11

Stage 3 - The adult plant
A External Structure
You Need
The plant which has germinated and grown, about 15 cm tall; Damp newspaper.

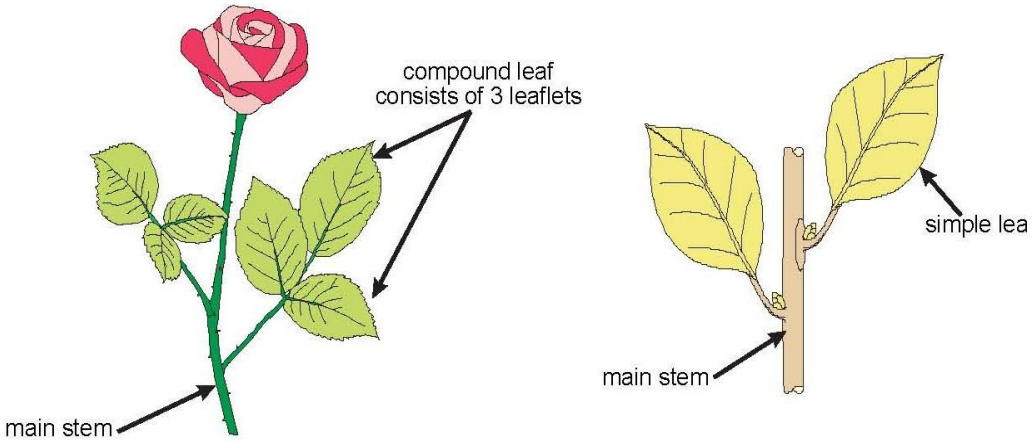
What to do
Turn over the container or carefully uproot the plant. Wash excess soil from the roots if necessary and place the plant on damp newspaper. Answer questions 1 to 7 for both the monocotyledon and the dicotyledon.

1. The roots anchor the plant in the ground. Examine the roots carefully. Does there appear to be one main root from which smaller roots arise or are there roots of approximately equal size? In other words does the plant have a tap root or does it have adventitious roots?
2. Is the stem branched or unbranched?
3. Are the leaves long and thin or are they another shape? If they are another shape choose a descriptive word for the leaf from the list in the box below or write your own word which best describes the leaf.

Some descriptive words for the shape of a leaf

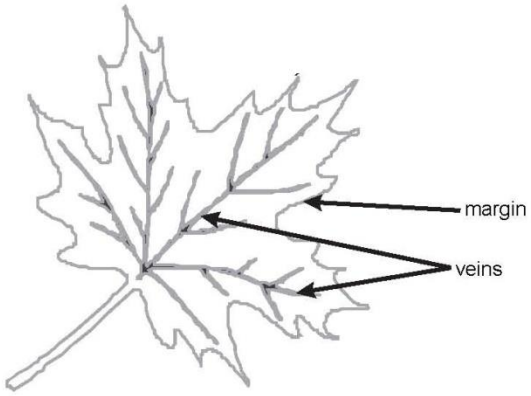
round, oval, square, heart-shaped, oblong, egg-shaped, pointy etc.

4. Are the leaves simple or compound? Use the figure below to help you decide.



5. Does the base of the leaf wrap around the stem or not?
6. Examine the margin (edge) of the leaf. Is the edge smooth or not?
7. Look at the veins of the leaf. Do the veins run parallel to each other or do they branch out and form a network?

Draw and label a leaf of your plant in your note book. Use the example below as a guide.



Remember to answer the questions on vegetative structure for both monocotyledons and dicotyledons.

B Internal Structure (*Optional*)

The following section is to be used in conjunction with a light microscope.

The microscopic structure of roots and stems

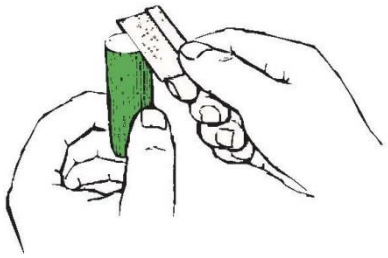
The procedure for preparing the sections is identical in each case. Preparing a section of a leaf is very difficult, due to the nature of leaf tissue (very soft).

You Need

Light microscope, Pieces of monocotyledon and dicotyledon root and stem, Glass slides, Coverslips, Safe blade or scalpel, Propette, Tap water.

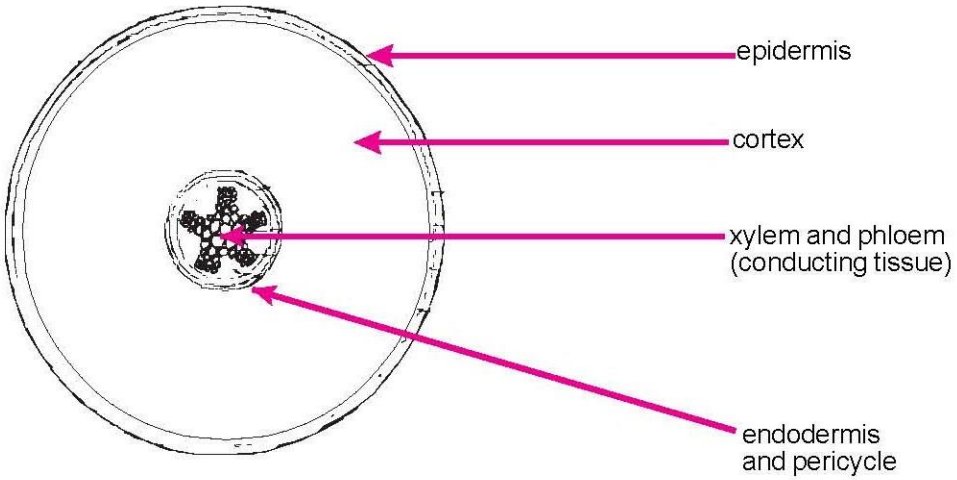
What to do

1. Half-fill a shallow dish with tap water.
2. Rinse the safe blade with tap water.
3. Hold the material (e.g. dicotyledon stem) between thumb and forefinger.
4. Hold the safe blade at a slight angle and CAREFULLY cut thin sections of the material. The sections **need not** be complete; i.e. they **need not** be whole circles.



5. Allow the sections to fall into the water.
6. Cut as many sections as possible, to practise your technique.
   Note: Thin sections should look slightly transparent.
7. Select 3 to 4 of the thinnest sections and mount them in water on a glass slide.
8. If you have any difficulty covering the section with a coverslip, your sections are **too thick**. Practise until you cut thinner sections.
   When you have mastered the technique of cutting thin sections, you can stain your sections with iodine solution. The stain will help you to see the tissues more clearly.
9. Draw (sketch) what you see.
10. Repeat the procedure for the different plant sections you wish to examine.

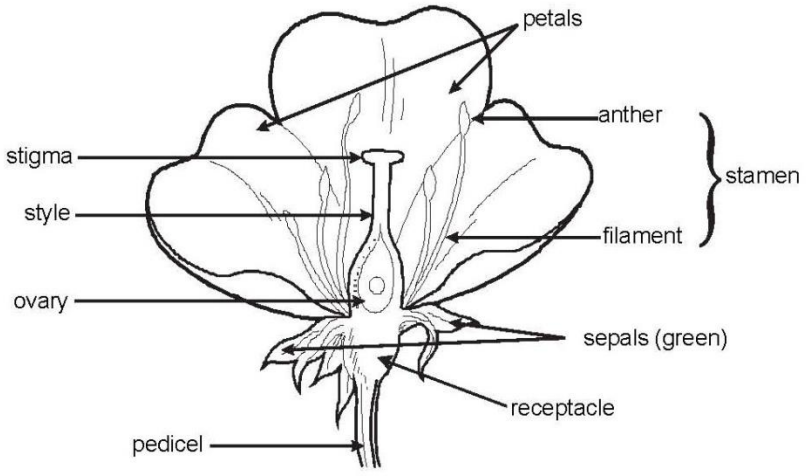
Example of a young root of a dicotyledon



EXPERIMENT 47 – STRUCTURE OF ANGIOSPERM FLOWERS

CSEC OBJECTIVE: Section B 9.6

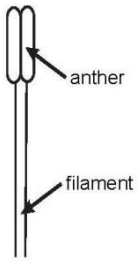
Grade Level – 10

	Stage 4 - Structure of the flower **A External Structure** **(This section must be completed for both the monocotyledon and the dicotyledon.)**
	You Need • A selection of flowers; from the plant which you have grown as well as other flowers • Hand lens • Forceps • Needle* • Sharp knife* * Your teacher will provide these
	What to do 1. Observe the plant and watch for the production of flowers. When several flowers are visible, pick a mature flower. Your teacher will also provide some flowers for comparison. 2. Cut a flower in half lengthwise. 3. Use the hand lens and the needle to examine the flowers. Refer to the diagram below and identify the main parts of the flower /s which you have in front of you.  The stamens together form the male part of the flower (androecium). The ovary, style and stigma together form the female part of the flower (gynoecium).
	OBSERVATION QUESTIONS a) Are there distinct sepals and petals? b) Are the parts of the flower in multiples of three or not? c) Are the petals joined to each other or are they free? d) Are the sepals joined to each other or are they free?

e) Does the flower have both male and female parts?

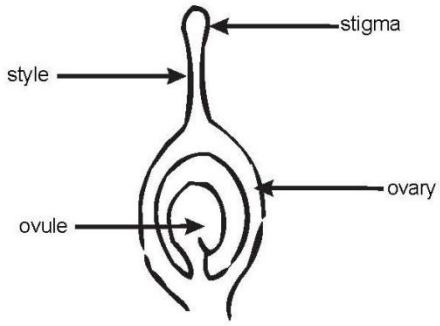
4. Carefully remove one stamen from the flower. View the stamen using the hand lens and make a clear drawing of it in your notebook. See the example below.

A Stamen



Similarly, remove the gynoecium and make a clear drawing of it in your notebook. See the example below.

A Pistil



B Internal Structure (*Optional*)

The following section is to be used in conjunction with a light microscope.

Examining the Reproductive Structures of Some Angiosperms

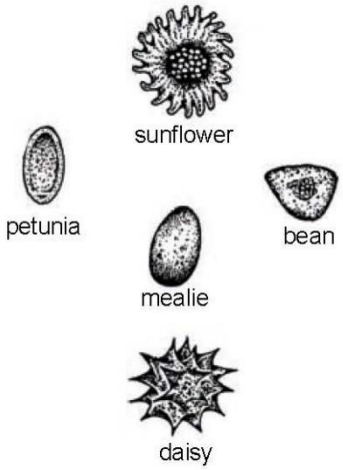
You Need

Light microscope; Dissecting needle; Several anthers; preferably from different types of flowers; Some mature anthers with loose pollen and some young anthers; Several ovaries, also from different types of flowers; Glass slides; Coverslips; Safe blade or scalpel*; Propette; Tap water.

What to do

The Androecium

1. Use the propette to add a few drops of water to the slide.
2. Shake pollen from one type of plant onto the slide.
3. Place the coverslip ***gently*** over the pollen.
4. Repeat the procedure with pollen from different types of plants.
5. Draw what you see.



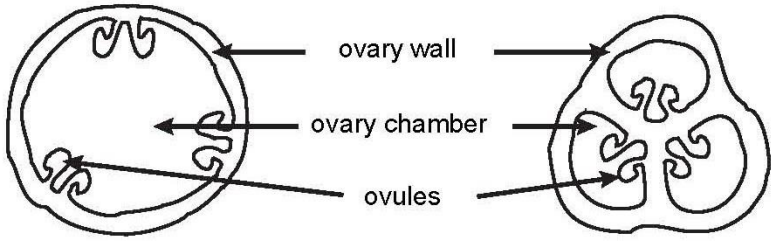
Examples of different pollen grains

Pollen grains are very small and you will not see detail. You should, however, see shape, size and colour differences between pollens of different flowers.

The gynoecium

1. Use a blade to cut thin transverse sections of the ovary of a flower. Choose a flower which is quite old and where the petals have fallen off.
2. Mount the sections in water on a slide.
3. Examine these using the light microscope.
4. Identify the ovary chambers with little ovules inside. Ovules ripen into seeds after some time.
5. Repeat the procedure with several different flowers.
6. Draw what you see.

Example of ovule



EXPERIMENT 48 – WHAT IS THE STRUCTURE OF A FREE-LIVING FLATWORM?

CSEC OBJECTIVE: Section A 1.1

Grade Level – 10

INFORMATION

You have already learned that planarians belong to a class of free-living (i.e. non parasitic) predators and scavengers that feed on a variety of other animals. Planarians are aquatic, living in fresh water where they hide under rocks.

You Need

- Plastic lunch box if you maintain your own colony*
- Forceps
- Hand lens
- Petri dish
- Propette
- Stones
- Pond water (NOT tap water)
- Planarians

* The teacher can decide whether to have a single colony or more than one colony.

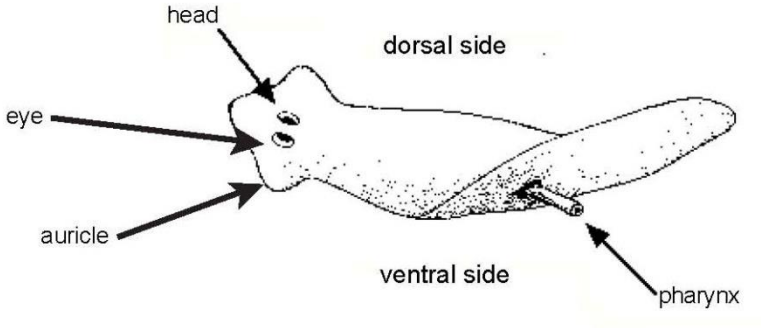
What to do

Follow the instructions below.

When you are ready to begin the study, remove a planarian from the water. It may be attached to a rock or stone. If so, leave it attached and use the propette filled with pond water to keep it moist. Place the planarian and rock in a petri dish and use a hand lens to view it.

The water must be changed regularly.

On the planarian you are studying, find the structures indicated in the figure below.



Observe the planarian with the hand lens and answer the following questions.

1. What is the length and the width of the planarian?
2. What colour is the planarian?
3. Does it have a definite front (anterior end) and rear (posterior end)?
4. Does the planarian move in a specific direction all the time?
5. How do you think the planarian receives information about its surroundings?
6. Locate the ventral (under) side of the planarian and identify the pharynx. This is a long tube to which the mouth is attached. Collect some food from your teacher. Place the

food in the container with the planarian and observe it feeding. You must be patient - keep observing the planarian over a period of time. Once you have seen it feeding, describe what you see.

7. Consider the following report.

Plenty of planarians?

A biologist placed a single planarian in an aquarium, making sure there was enough food for the planarian. Some time later, two smaller planarians were seen and there was no sign of the original planarian.

Where do you think the two planarians came from?

8. What do you think happened to the original planarian?
9. Devise an investigation which could test your ideas. Write down the steps of the method for your investigation.

EXPERIMENT 49 – WHAT IS THE STRUCTURE OF AN EARTHWORM?

CSEC OBJECTIVE: Section A 1.1

Grade Level – 10

INFORMATION

You may have learned that earthworms live in moist areas. They burrow all the time and feed on decaying vegetation. They are segmented worms with a through gut and a closed circulatory system. In this series of activities, it will be your responsibility to ensure that their environment does not dry out.

You Need

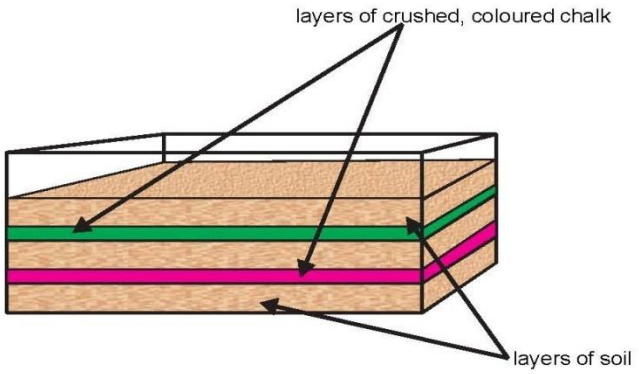
- Plastic lunch box
- Propette
- Forceps
- Hand lens
- Crushed chalk
- Old leaves
- Petri dish
- Tap water
- Earthworms*

* Your teacher will tell you whether or not to maintain your own earthworm colony.

What to do

Stage 1 Setting up an earthworm environment

1. Place a layer of damp soil at the bottom of the lunch box.
2. Sprinkle a thin layer of chalk on top of this layer.
3. On top of this chalk layer, place another layer of damp soil and then another layer of chalk of a different colour.
4. Finally place a layer of soil on the top. Use the diagram below to help you.



5. Place several dead (but not dried out) leaves on the top soil layer.
6. Place three or four earthworms on the top soil layer and leave them for a day. Examine the environment of the earthworms every day and observe any changes in the soil and the chalk layers. DO NOT FORGET TO KEEP THE SOIL MOIST - NOT

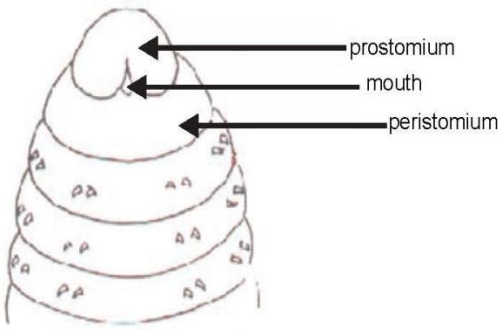
WATERLOGGED.

Stage 2 The structure of an earthworm

1. Take one earthworm from the lunch box and place it in a moistened petri dish with about a teaspoon of soil. Observe the earthworm's structure and behaviour. ***Use the propette filled with water to keep the earthworm moist.***
2. Is there a clear front (anterior) end and rear (posterior) end?
3. Are there visible sense organs?
4. Is the earthworm asymmetrical, radially symmetrical or bilaterally symmetrical?
5. Is the body flat or rounded?
6. Hold the worm in the palm of one hand. Feel the body along the dorsal, lateral and ventral surfaces.
   What do you feel?
7. Does the body appear to be composed of a single unit or of several units?
8. Count the number of segments in the earthworm's body. Compare your answer with the answer of other groups. Is the number of segments always the same?
9. Now examine the earthworm with a hand lens and locate the bristles (setae, chaetae). Where on the body are they situated?
10. How many bristles are on each segment?
11. The earthworm lives in soil. Of what value are the bristles to the earthworm when it burrows? To help you answer this question, find out if the earthworm moves easily on glass or on a clean petri dish.
12. Observe the earthworms moving in their environment (i.e. moist soil in the lunch box). Describe their locomotion using the words in the box to help you.

contract, relax, thicker, thinner, anterior, posterior, circular muscles, longitudinal muscles

13. Keep the earthworm moist and observe the dorsal blood vessel.
    a. In which direction does the blood flow?
    b. Time the pulse rate per minute.
14. Observe the anterior end of the earthworm. Find the structures illustrated.

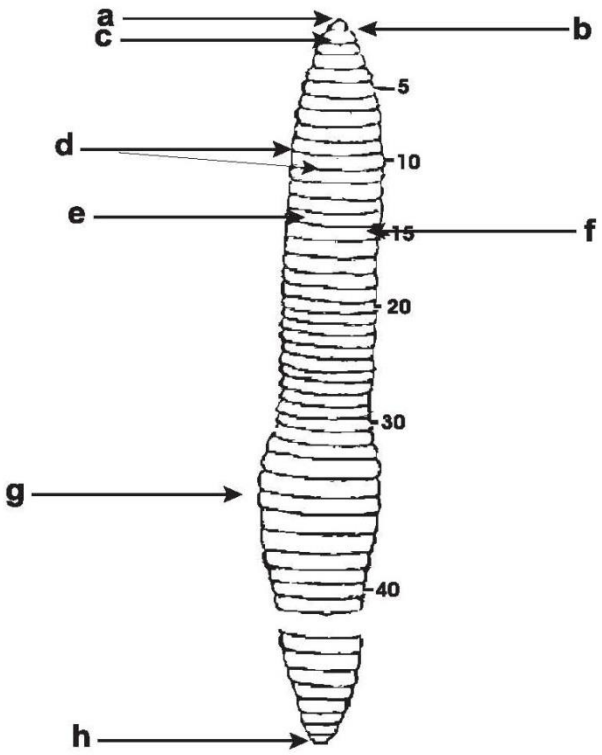


Use the hand lens to look carefully along the length of the earthworm. Find the little holes or pores on most segments. What do you suppose is their function? To help you answer this question, think about the characteristics of life - nutrition, movement . . . and so on.

If the earthworms are mature, you will notice a swollen region between segments 32 to

37. This is the clitellum. It plays a major role in reproduction.

15. Replace the earthworms in the lunch box. Discuss how their behaviour is related to the fertility of the soil OR discuss the reasons why gardeners like earthworms.



16. The drawing above shows a ventral view of the body of an earthworm.
    a. List the letters a to h in your notebook. Beside each of these, write the appropriate label from the box below.

List of structures found on earthworm

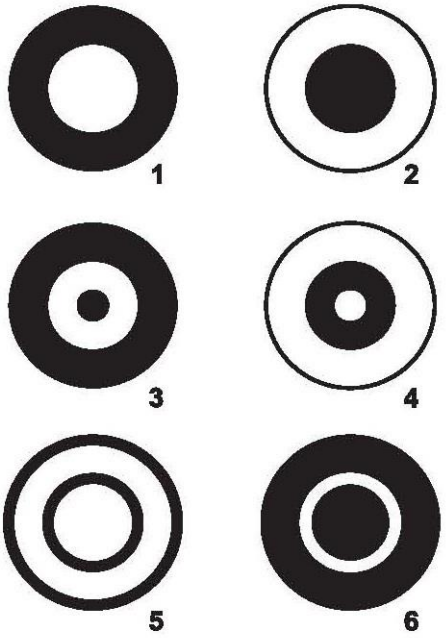
mouth	prostomium	peristomium	dorsal pore
chaetae	segments	last segment	anus
female reproductive opening		male reproductive opening	
clitellum	openings of spermathecae		

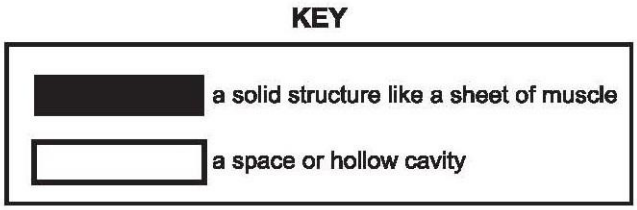
    b. List the structures which can be seen only in dorsal view.

17. Read the following description of the body structure of an earthworm.

The earthworm is covered by a thin cuticle which helps prevent desiccation or drying out. Beneath the cuticle is the epidermis followed by the circular and longitudinal muscle layers. The hollow, through-gut runs centrally through the coelom (body cavity). The enteron, gut-cavity, is surrounded by layers of muscles.

The sketches below are representations of possible transverse sections through a number of worm-like animals. Which of them do you think best represents the earthworm?





EXPERIMENT 50 –WHAT IS THE STRUCTURE OF AN INSECT (LOCUST)?

CSEC OBJECTIVE: Section A 1.1

Grade Level – 10

INFORMATION

Locusts are insects which undergo several moults before they reach adulthood. In other words, they undergo an incomplete metamorphosis. The juvenile stages of the locust are called **hoppers or instars**. The first hopper or instar hatches from the egg and when the fifth hopper or instar moults, the final, adult stage is reached. One or more colonies of locust hoppers (or grasshoppers, cockroaches or crickets) has been established in your classroom.

INTRODUCTION

Examine the colony every day. Look out for the shed skins of the hoppers. Use the information below to help you identify the hopper stages.

The 5th instar is easier to study than is the adult, because it cannot yet fly. The wings are not fully developed at this stage.

Hopper or Instar stage	Characteristics
1st and 2nd instar stages are very small and it is difficult to observe any distinguishing features.	
3rd Instar	wing buds point down
4th Instar	wing buds point up
5th Instar	wings half the length of the body
Adult	wings longer than body

Replace the grass every day and remove any dead hoppers, old food and other waste.

Introductory Questions

1. Locusts are usually found in dry areas. Examine the locusts in the colony and list all the ways you can see how these animals are adapted to dry conditions.
2. Why do you suppose the juveniles are called "hoppers"?
3. In history, we hear and read of "locust plagues". Why are swarms of locusts a plague, do you think?
4. Consider a small swarm of ten million adult individuals. Each locust has a mass of three grams. They feed for two days. What mass of green material is consumed in this time?

When you observe a locust in detail:

You Need

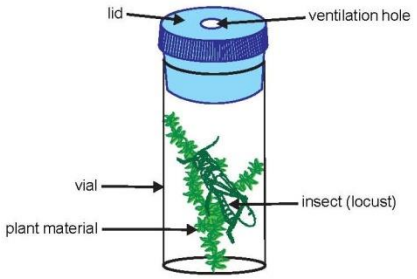
- Forceps
- Hand lens
- Petri dish
- Paper towel
- Locusts*

- Large vial
- Fresh grass
- Water
- Twig

* To be obtained from your teacher

What to do

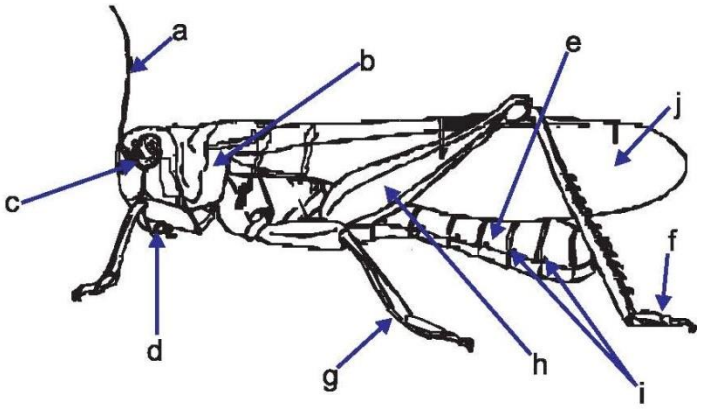
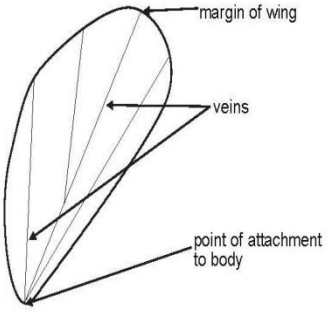
Set up the vial with a single insect inside as shown below. Examine the insect in the vial to observe its structure.



To answer some of the questions on its behaviour, you will have to examine the locusts in the colony. Put the locust back in the colony when you have finished studying it.

Observe one adult locust in detail. Answer the following questions.

1. Does the locust have an exoskeleton?
2. Find out from a suitable text the name of the substance of which it is composed?
3. Into how many parts is the body divided?
4. Is the body segmented?
5. How many appendages are there?
6. From which body part do they arise?
7. List the sense organs of the locust and note where they are located, how many there are and their function.
8. Locusts can hear. How do you think they can do this?
9. Watch the locust feeding. Which structures do they use when they feed?
10. How is undigested food eliminated?
11. Along the sides of the body are several holes or pores. Watch them. What do you think they are there for?
12. Watch a locust walking. Describe how they use their legs. Observe carefully and note which legs on either side are used simultaneously (at the same time).
13. You will notice that the hind legs are different from the others. What do you think is the function of the hind legs?
14. Identify the following structures on an adult locust. If you do not know the meanings of the terms, refer to a biology dictionary or other text.

	✓ head ✓ antennae ✓ compound eye ✓ simple eye ✓ mouthparts ✓ pronotum ✓ thorax ✓ legs especially hind jumping ✓ leg ✓ fore wing ✓ hind wing ✓ spiracles ✓ abdomen ✓ sternum ✓ tergum ✓ foot Refer to the diagram below. In your notebook, write the letters a to j underneath one another. Beside each letter, write the correct label. 
	Stage 2 Examining insect parts using a light microscope - *Optional Activity* **You need** • Light microscope • Dissecting needle • Forceps • A few dead insects • Glass slides • Coverslips • Dropper/propette • Tap water
	What to do 1. Use the forceps to remove a wing from the dead insect. 2. Mount the wing on a glass slide. 3. Use the propette to add a few drops of water to the slide; enough to cover the wing. This step can be left out if the body part is fairly large. 4. Place the coverslip gently over the material on the slide. 5. Focus the light microscope on the slide. 6. Identify wing margin, veins, point of attachment to body of insect.  Repeat the process with the legs of a few insects and with the body parts of different insects. In this way you can find out more about the ways in which insects are modified for different ways of life (jumping, swimming, hopping, digging). Some whole, small insects, like fleas, can be viewed using the light microscope.