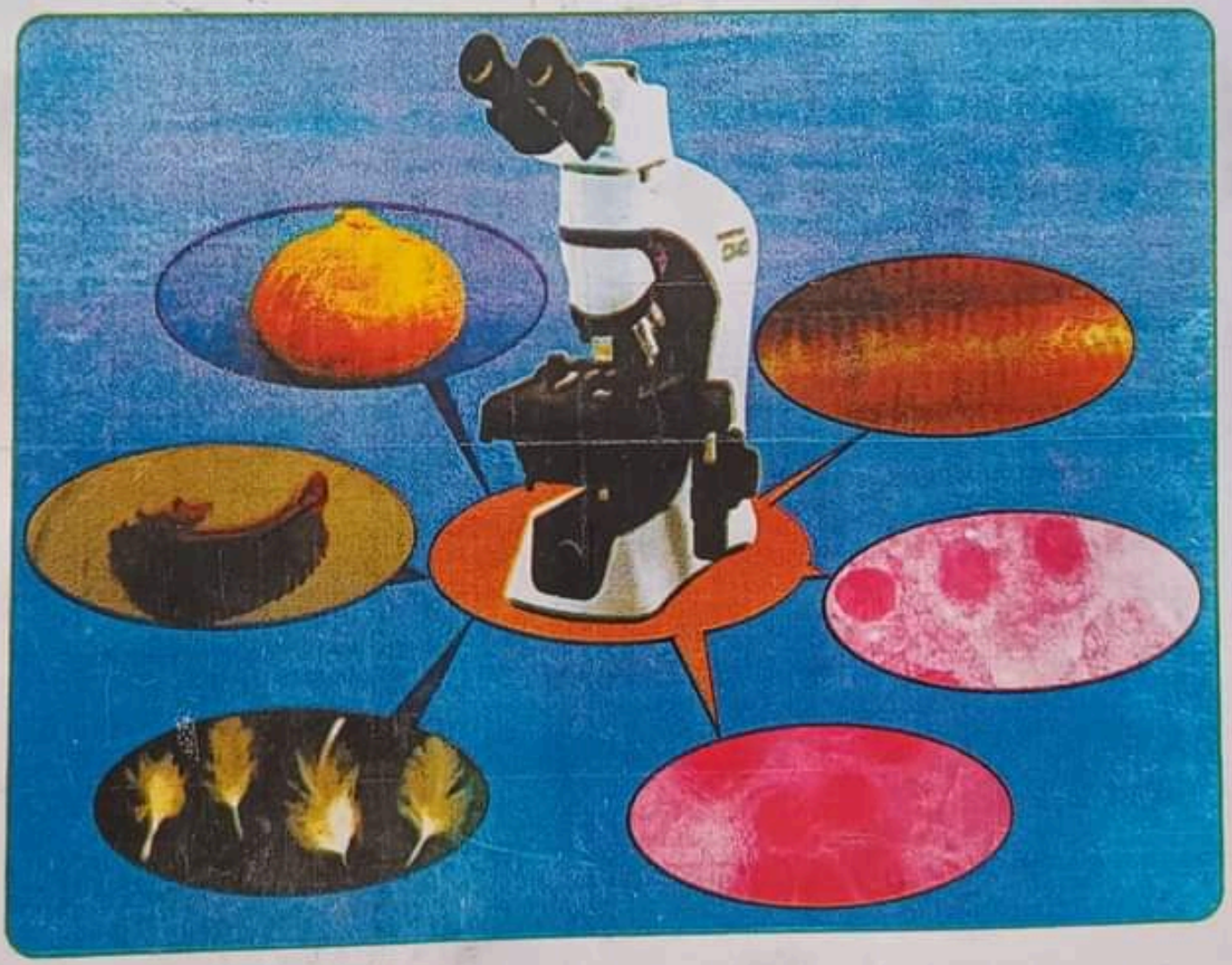
THE GOVERNMENT OF
THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF EDUCATION

PRACTICAL WORKBOOK

BIOLOGY

Grade 11



CONTENTS

PRACTICAL 1

MICROSCOPY

Activity: Preparation and measurment of specimens under the light microscope

Objective: To measure the length of very small specimens by using microscope and micrometer

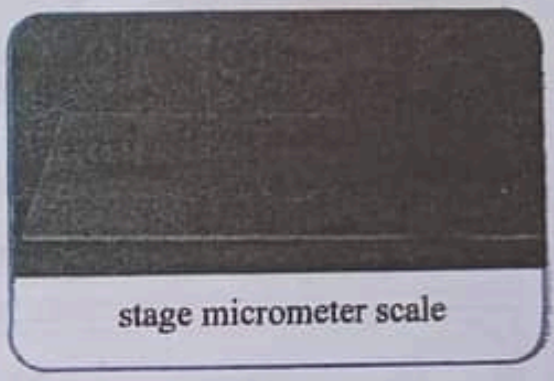
Practical outcome: (1) The students will be able to use eyepiece micrometer and microscope.
(2) The students will be able to measure the sizes of cells, tissues and small organisms.

Material required: An onion, gill filaments of fish, feathers of a chicken, stage micrometer scale, eyepiece graticule, petridish, forceps, razor blade, scissors, tooth pick, glass slide, cover slip, dropper pipette, beaker or plastic container, light microscope, distilled water, iodine solution/methylene blue, glycerol, tissue paper, notebook, pencil and pen


onion


gill filaments of fish

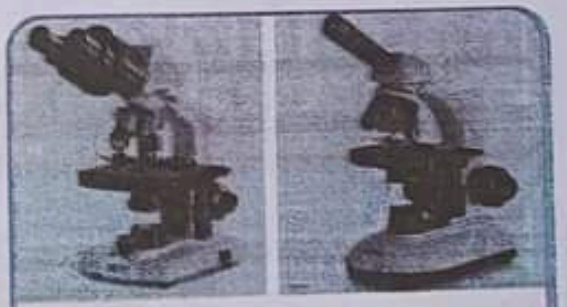

feathers of a chicken


stage micrometer scale


eyepiece graticule


petridish, forceps, razor blade, scissors, tooth pick


glass slide, cover slip, dropper pipette, beaker or plastic container


light microscope

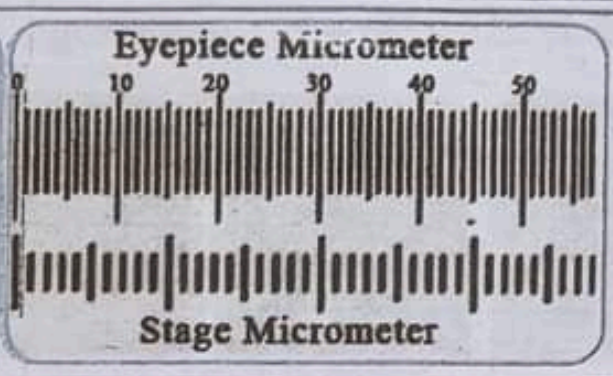
Introduction: Measuring of cells and small organisms can be carried out with an eyepiece micrometer which is a graticule on a glass disc fitted into the eyepiece of a microscope. It has a scale with 100 divisions marked on it. It is used to estimate the sizes of cells, tissues and small organisms when viewed with a microscope.

Procedure:

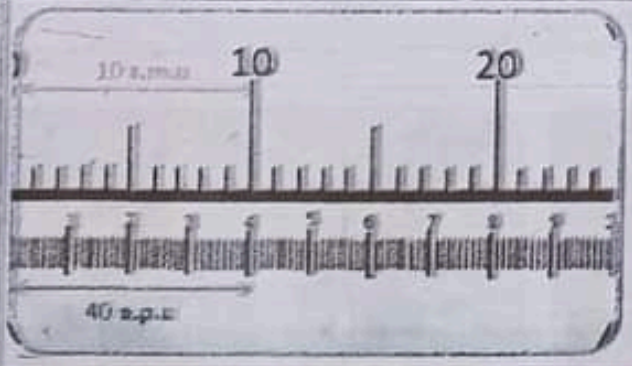
Calibration of eyepiece graticule with stage micrometer

Before measuring the specimen, the eyepiece micrometer has to be calibrated. First, a stage micrometer is placed on the stage of the microscope. A typical stage micrometer unit is 1 mm long with divisions of 0.01 mm (10 µm).

- Remove the eyepiece from the microscope and insert the eyepiece graticule. Set the objective of the microscope to 4x.



- Place the stage micrometer on the stage of the microscope.
- Superimpose the two scales on one another.
- Check the magnification of the eyepiece.



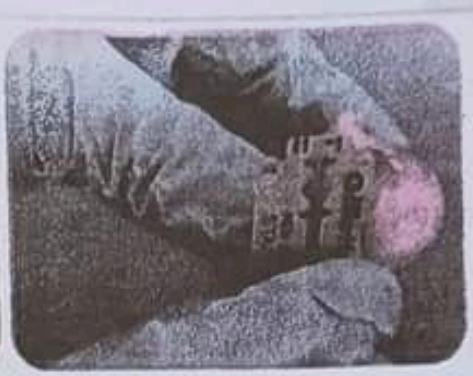
- Count the number of eyepiece micrometer units (*epu*) / stage micrometer unit (*smu*).
- In this example, 10 *smu* (10 µm x10=100 µm) overlap with (equate to) 40 *epu*.

- If your eyepiece is 10x, each eyepiece unit is 25 µm under the 4x objective.
- If your eyepiece is 1x, each eyepiece unit is 250 µm under the 4x objective.

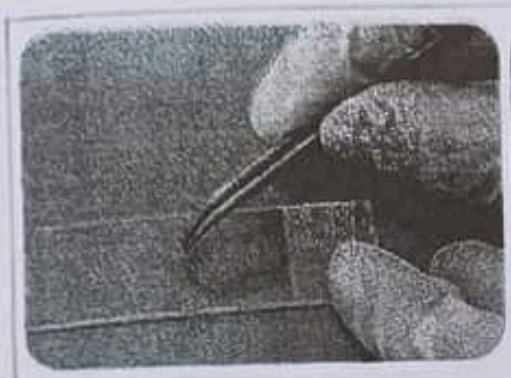
10x eyepiece + 4x objective lens = 25 µm
1x eyepiece + 4x objective lens = 250 µm

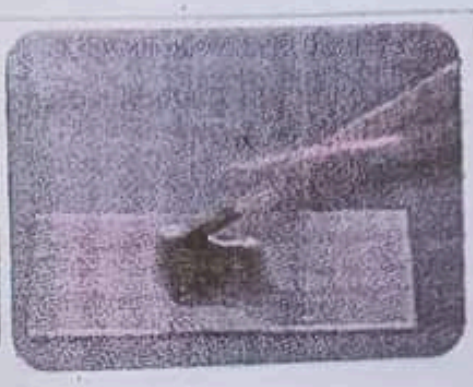
After calibrating the eyepiece micrometer, measure the following specimen.

Specimen 1. Membrane of onion

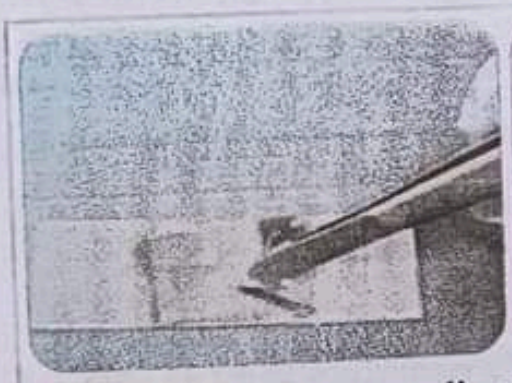


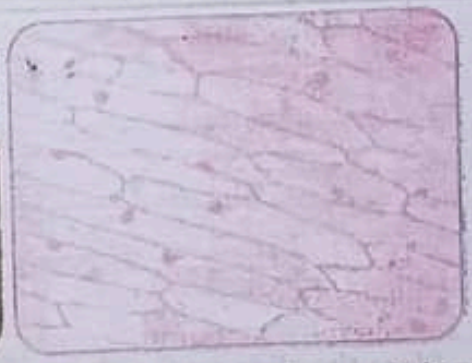
- Add a drop of water in the middle of the microscope slide using a dropper pipette.
- Tear a thin layer off the onion and place it on the glass slide.





- Using forceps, gently place the onion membrane on the glass slide.
- Add a drop of iodine solution on the onion membrane using a dropper pipette.





- Carefully place a coverslip on the membrane and press it down gently to remove air bubbles using the back of the forceps.
- Place the slide on the stage of the microscope at low power (4x objective) and focus the microscope to clearly observe the cell membrane of the onion.
- Determine the number *epu* of a cell at low power.
- This number in your the note book and convert it to the actual size of the cell.

Remember:

*1 eyepiece unit, *epu* = 250 µm if using the 1x eyepiece at low power

*1 eyepiece unit, *epu* = 25 µm if using the 10x eyepiece at low power

If the length of the cell is 4 eyepiece units at low power and under the 1x eyepiece, then:

1 eyepiece unit = 250 µm

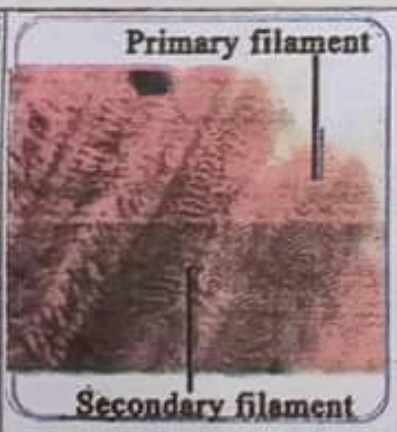
4 eyepiece units = 10 µm

Specimen 2. Gill filament of fish

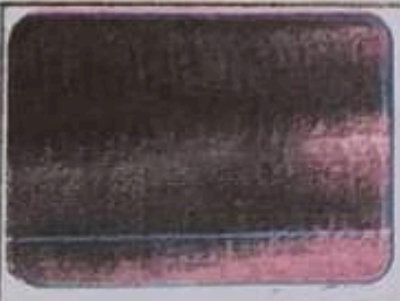
- Cut five gill filaments from the gill arch. (gills of small fish (< 7 cm) should be used); the gill arch is the bony part to which the filaments (the red "bits") are connected.

- Place the gill filaments on a glass slide.

- Add a drop of distilled water using the dropper pipette and cover with a cover slip.



- Place the slide on the stage of a microscope under 4x objective and focus the microscope to observe the specimen clearly (you will see primary and secondary filaments).

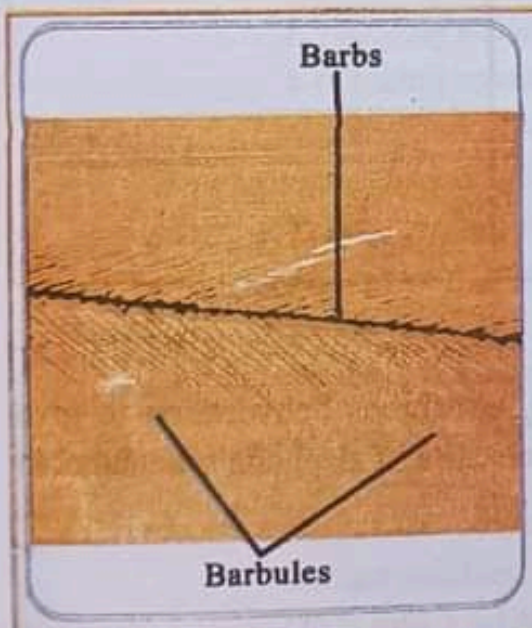


- Measure the length of primary and secondary gill filaments using an eyepiece micrometer under 4x magnification and calculate the actual length of primary and secondary gill filaments (see 'Calibration' above).

Specimen 3. Feathers

- Collect the small feathers from a chicken.

- Place a feather on a glass slide.
- Add a drop of glycerol using a dropper pipette and cover it with coverslip. (avoid adding excess amounts of glycerol, as it will turn into a sticky mess that can smudge the microscope).
- Place the slide on the stage of the microscope under 4x objective and focus the microscope to observe the specimen clearly.



- Measure the length of the feather using an eyepiece micrometer under 4x magnification and convert *epu* to the actual feather lengths.

PRACTICAL 2

CARBOHYDRATE MOLECULES

Carbohydrates are of great importance to human beings. They are major part of our diet, providing 60-70% of total energy required by the body. Chemically, carbohydrates are aldehydes and ketones of polyhydroxy alcohols. Commonly found carbohydrates are glucose, fructose, sucrose, starch etc. They are classified into monosaccharides (glucose, fructose, ribose), disaccharides (lactose, maltose, sucrose) and polysaccharides (starch, cellulose, glycogen etc.).

(a) Molisch's Test

It is a general test for carbohydrates. A positive Molisch test indicates the presence of carbohydrate in a given test solution. All carbohydrates give Molisch test positive.

Procedure of Molisch's Test

Test	Observation	Inference
Take 1 ml of carbohydrate solution in a test tube. Add 1-2 drops of 1% alcoholic α-naphthol solution to it. Mix it well and then add 2 ml concentrated H_2SO_4 from side of the test tube and observe. (Do not shake)	Violet coloured ring is obtained at the junction of the two liquids.	Carbohydrates present in the given solution.

Principle of Molisch's Test

When carbohydrate reacts with concentrated H_2SO_4 undergoes dehydration to give hydroxymethyl furfural derivative, which condenses with 2 molecules of alcoholic α-naphthol to form purple coloured complex.

(b) Iodine Test

This is a specific test for polysaccharides (e.g., starch) which adsorb iodine and form coloured complex. Starch gives blue colour while glycogen gives reddish brown colour. The most commonly available polysaccharides is starch which is a mixture of amylose and amylopectin. Starch is insoluble in cold water but forms a colloidal solution in hot water. Starch has no detectable reducing activity.

Procedure of Iodine Test

Test	Observation	Inference
Take 2 ml carbohydrate solution in a test tube, and then add 1-2 drops of dilute iodine solution to it. Mix it well and observe.	Blue or violet colour obtained	Polysaccharides present

Principle of Iodine Test

Iodine forms a coordinate complex between the helically coiled polysaccharides chain and iodine centrally located within the helix due to adsorption. The colour obtained depends upon the length of the unbranched or linear chain available for complex formation.

Activity (1) Food test for reducing sugar

Objective: To test the presence of reducing sugar in food

Practical outcome: The student will be confirm the present and absent of reducing sugars.

Material required: Benedict's solution, food sample, water bath (beaker with water, Bunsen burner, tripod, lighter), test tube, dropper, steel holder

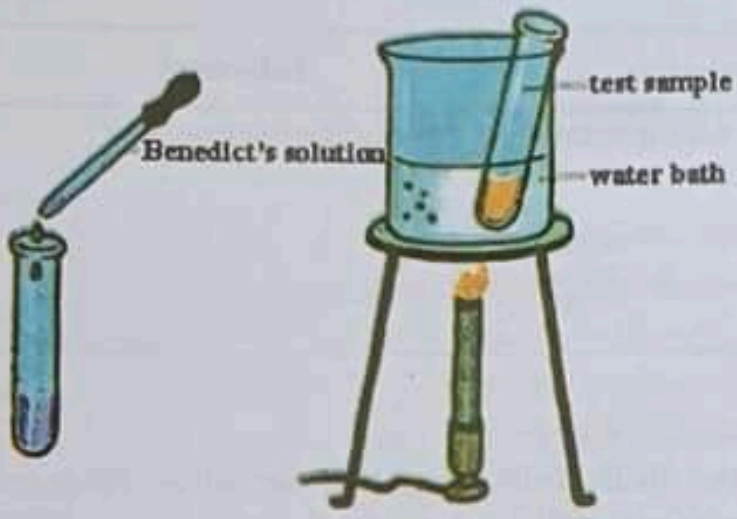
Introduction: Most of the monosaccharides and disaccharides are reducing sugars. A reducing sugar is a sugar that has a free aldehyde or ketone that can act as a reducing agent. The aldehyde group which is not attached to any other element is known as free aldehyde group. A reducing sugar can donate electrons to another molecule, which will change the color and taste of food. There are many types of reducing sugar. For example glucose found in vegetables and fruits (apple, pear), fructose found in fruits (avocado, figs) and honey, galactose found in milk (yogurt), maltose is found in barley and xylose in wood, but sucrose is a non-reducing sugar. This experiment used if a food substance contains a reducing sugar.

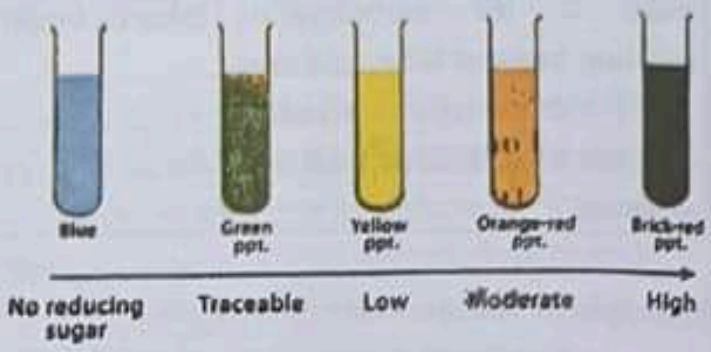
Prepare for food sample: crush the food and add the moderate distilled water Decant the suspension to remove large particles. Use the decanted liquid for the test solution.

Proceduret:

(1) Add 2 ml of the sample solution to a test tube.
(2) Add an equal volume of Benedict's solution and mix thoroughly.
(3) Place the tube in a water bath at about 90°C for about 3 minutes.
(4) Record the color change.

Observation: Solution gradually turns from blue to orange or brick red.





Observation (Final colour change)	Interpretation	Amount/qty
1. No colour change(blue)	No reducing sugar present	-
2. Green	Trace amounts of reducing sugar present	+
3. Yellow	Low amounts of reducing sugar present	++
4. Orange	Moderate amounts of reducing sugar present	+++
5. Brick-red	Large amounts of reducing sugar present	++++

Conclusion: The sample food will react with a blue liquid called Benedict's solution to give a brick red color. When the concentration of reducing sugar is low, the color of the Benedict's test may be light green or pale orange. The closer is to brick red, the more reducing sugar is present.

Exercise:

Test tube	Sample Tested	Final colour	Test results	If positive, (name the reducing sugar)
1.	Tap water	Clear blue	–	-
2.	Glucose solution	Dark red	+	Large amounts of reducing sugar
3.	Sucrose solution	Clear blue	–	-
4.	Starch solution	Clear blue	–	-
5.	Milk	Orange	+	Moderate amounts of reducing sugar
6.	Apple juice	Dark red	+	Large amounts of reducing sugar
7.	Potato juice	Yellow/green	+	Low/trace amounts of reducing sugar

PRACTICAL 3

PROTEIN AND LIPID MOLECULES

Activity (1) Food test for proteins

Objective: To detect the presence of proteins in food

Practical outcome: The student will be confirm the presence of proteins.

Material required: Egg albumin, 10% sodium hydroxide solution, 1% copper sulfate solution, distilled water, test tube and stir rod, dropper or pipette

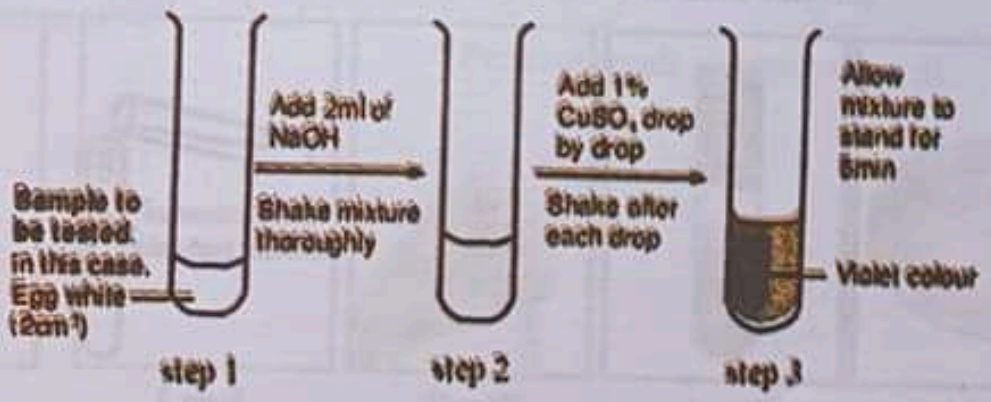
Introduction: Proteins are the most abundant organic compounds present in nature. They are present in every living organism. Life without proteins is not possible. Proteins may be present in solutions along with other biological molecules like proteins present in milk etc. Some biological fluids do not contain any proteins, for example, urine. The presence of proteins in such fluids is of biological importance. Proteins present in any solution can be easily identified by performing different biological tests.

Procedure:

(1) Place 2 ml of egg albumin into a test tube.
(2) Add about 2 ml depth of distilled water to the tube and stir to mix.
(3) Add 2 ml of 10% sodium hydroxide solution to the tube and stir.
(4) Add 5 to 6 drops of 1% copper sulfate solution and stir for two minutes.
(5) Record the colour of the solution.

Observation: It is gradually turns purple colour when mixed with protein.

Sample to be tested: in this case, Egg white (2 ml) + Distilled water (2 ml)



Activity (2) Food test for lipids

Objective: To detect the presence and absence of lipids in food sample

Practical outcome: The student will be confirm the presence and absence of lipids.

Material required: Food sample, Petri dish, test tube, dropper, spatulas, ethanol, and distilled water

Introduction: Lipids are important fats that serve different roles in the human body. The three main types of lipids are triacylglycerols (also called triglycerides), phospholipids, and sterols. Triacylglycerols make up more than 95 percent of lipids in the diet and are commonly found in fried foods, vegetable oil, butter, whole milk, cheese, cream cheese, and some meats. Naturally occurring triacylglycerols are found in many foods, including avocados, olives, corn, and nuts. Fats are lipids that are solid at room temperature, whereas oils are liquid. As with most fats, triacylglycerols do not dissolve in water. It is soluble in nonpolar solvents or organic solvent, such as chloroform/ethanol.

Prepare for food sample: Crush the food sample in the Petri dish and place two spatulas of the food sample into a test tube.

Procedure:

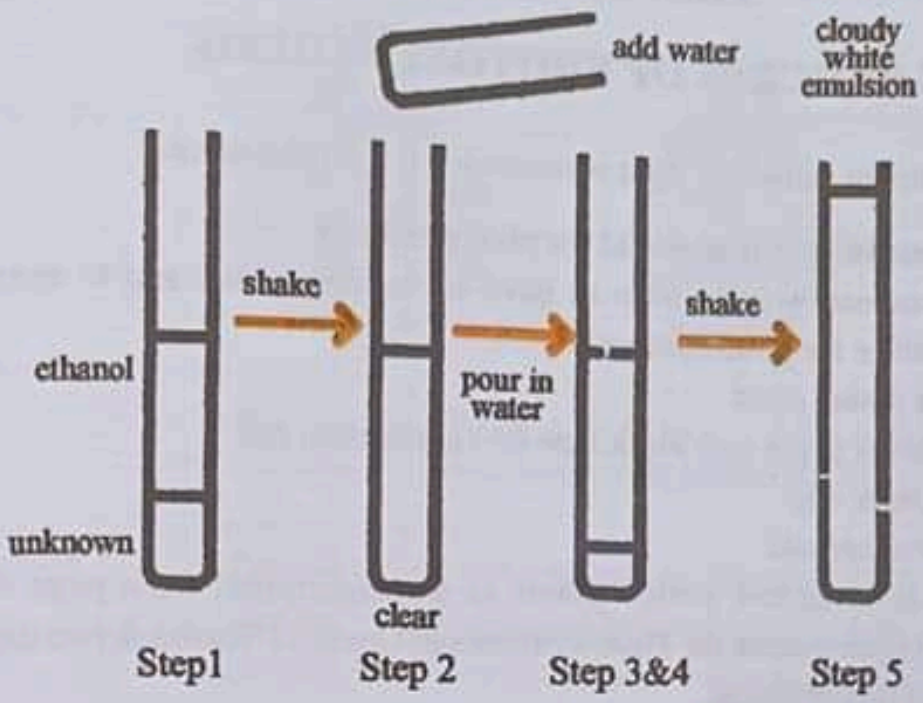
(1) Add 4 ml of ethanol to the tube and then cover the top of the tube and shake the tube vigorously.
(2) Allow the contents to settle (about 2 minutes) for the lipid to be extracted.
(3) Decant the extracted into another test tube.
(4) Pour 2 ml of distilled water into the second test tube.
(5) Record the changes of the solution.

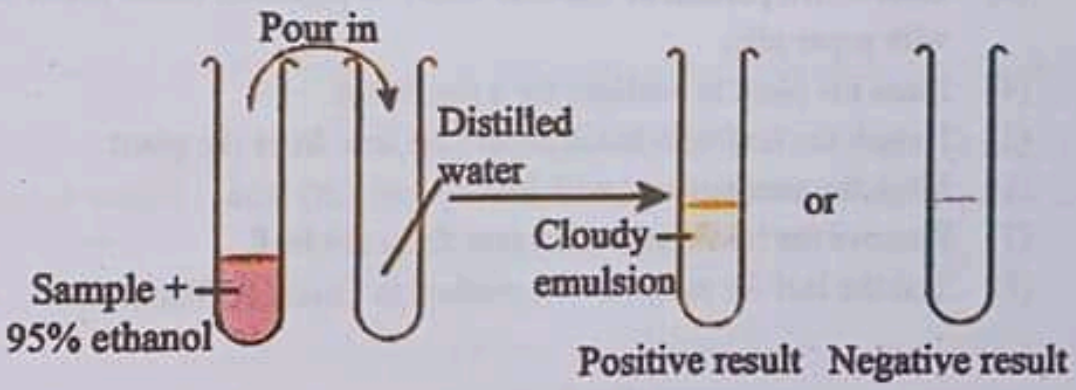
Observation:

- Solution remains colourless. No emulsion is formed. (Lipids are not present.)
- A layer of cloudy white suspension forms at the top of the solution. (Lipids are present.)

Conclusion: Lipids are non-polar organic compounds. Hence, they are soluble in organic solvents such as ethanol (alcohol), but insoluble in water.

Prepare food sample Step1 Step 2 Step 3 Step 4


add water
cloudy white emulsion
shake
shake
ethanol
pour in water
unknown
clear
Step1
Step 2
Step 3&4
Step 5


Pour in
Distilled water
Cloudy emulsion
or
Sample + 95% ethanol
Positive result
Negative result

PRACTICAL 4

THE PROCESS OF PHOTOSYNTHESIS

Experiment (1) Investigation to show that light is necessary for photosynthesis

Objective: To observe light is essential for photosynthesis

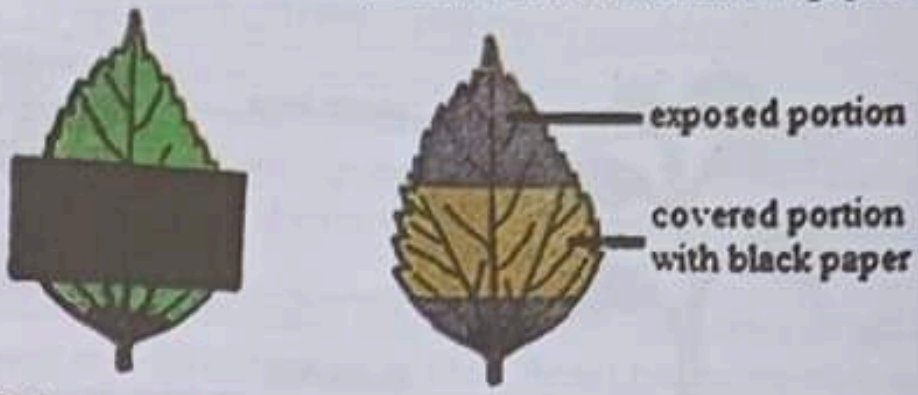
Practical outcome: The students will be able to have exploratory mind and to examine the necessities for photosynthesis.

Material required:
(1) a potted plant
(2) black paper (or) black tape (or) aluminium foil
(3) paper clip
(4) marker pen

Procedure:
(1) Destarch two potted plants as the description from page 41, 3.1.4 Requirements for Photosynthesis in Grade 11 Textbook two days ahead of this practical.
(2) Take two uniform pieces of black paper (or) tape and select a healthy leaf.
(3) Sandwich a portion of this leaf with two pieces of black paper (or) tape with paper clip.
(4) Place the plant in sunlight for a few hours.
(5) Detach the leaf with black paper (or) tape from the plant.
(6) Mark the area covered with black paper (or) tape.
(7) Remove the black paper (or) tape from the leaf.
(8) Test the leaf for starch as the method in Grade 10 Textbook.

Figure 4.1 Investigation to show light is necessary for photosynthesis

Observation: The colour of the exposed portion of the leaf turns blue-black.
The colour of the covered portion of the leaf with black paper turns brown.



Before starch test After starch test

Figure 4.2 The colours of the leaf before and after starch test

Conclusion: After starch test, the colour of the exposed area of the leaf is blue-black because photosynthesis takes place in this area.
The colour of the covered area of the leaf with black paper is brown because this area does not get the sunlight and photosynthesis does not occur in this area.
It is concluded that light is essential for photosynthesis.

Experiment (2) Investigation to show that carbon dioxide is necessary for photosynthesis

Objective: To observe carbon dioxide is essential for photosynthesis

Practical outcome: The students will be able to have exploratory mind and to examine the necessities for photosynthesis.

Material required:
(1) two potted plants
(2) sodium hydrogen carbonate ($NaHCO_3$) and sodium hydroxide (NaOH)
(3) two transparent plastic bags
(4) two beakers
(5) marker pen

Procedure:
(1) Destarch two potted plants as the description from page 42, 3.1.4 Requirements for Photosynthesis in Grade 11 Textbook two days ahead of this practical.
(2) Add sodium hydrogen carbonate in one beaker and sodium hydroxide in another.
(3) Take place the beaker with $NaHCO_3$ in one potted plant and the beaker with NaOH in another one.
(4) Seal these two potted plants with transparent plastic bags.
(5) Place these plants in sunlight for a few hours.
(6) Detach a leaf from each plant and mark for $NaHCO_3$ and NaOH.

(7) Test the leaves for starch as the method in Grade 10 Textbook.

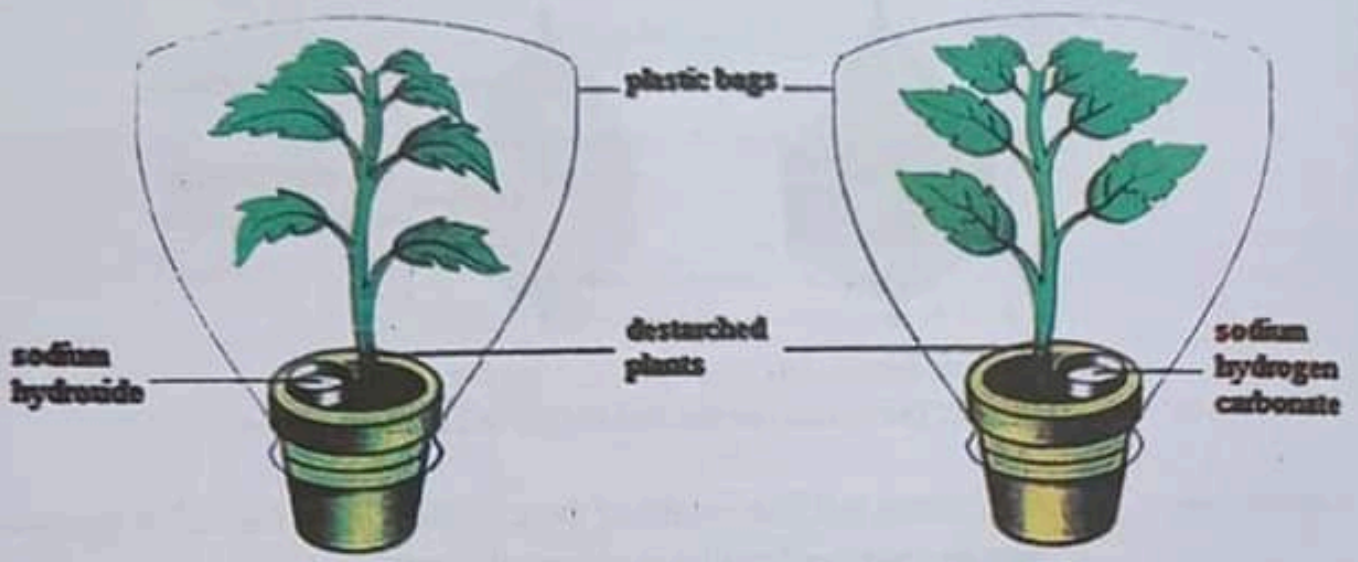
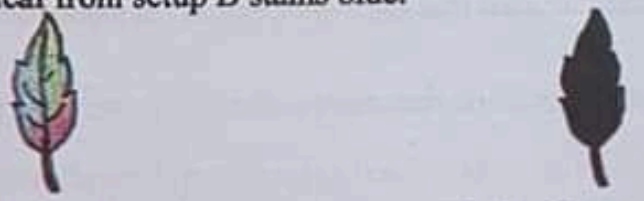


Figure 4.3 Investigation to show carbon dioxide is necessary for photosynthesis

Observation: The leaf from setup A stains brown.
The leaf from setup B stains blue.



The leaf from setup A The leaf from setup B

Figure 4.4 The colours of the leaves from setup A and setup B after starch test

Conclusion: The leaf from setup A stains brown due to starch is absent because sodium hydroxide absorbs carbon dioxide.
The leaf from setup B stains blue due to starch is present because sodium hydrogen carbonate causes carbon dioxide enrich atmosphere.
It is concluded that carbon dioxide is essential for photosynthesis.

PRACTICAL 5

THE PROCESS OF RESPIRATION

Experiment (1) Demonstrate the carbon dioxide is released during respiration

Objective: To show experimentally that carbon dioxide is released during respiration.

Practical outcome: The student will observe the CO_2 is produced by germinating seeds during respiration.

Material required: Conical flask, U-shaped delivery tube (tube bent twice at right angles), cotton wool or moist blotting paper, water, thread, beaker, test tube, rubber cork with one hole, 20% freshly prepared KOH solution, vaseline, soaked gram seeds

Introduction: Respiration is a catabolic process which involves the breakdown of food or complex organic molecules into simpler products, with the release of energy. This process can take place either in the presence of oxygen (aerobic respiration) or in its absence (anaerobic respiration).

The overall reaction mechanism of aerobic respiration involves the oxidation of carbohydrate and the subsequent production of CO_2, H_2O and energy.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + \text{Energy}$

Procedure:

(1) Take the conical flask and place some germinating gram or pea seeds in it.

(2) Insert the shorter end of the glass tube through the hole in the cork and fix it on the conical flask.

(3) Before fixing the cork, hang a test tube containing KOH solution inside the conical flask with the help of a thread.

(4) Take coloured water in the beaker and keep the longer end of the glass tube dipped inside it.

(5) Make the conical flask airtight by applying Vaseline on its rim.

(6) Note the initial level of water in the tube.

(7) Observe and note the rise in the water level after an hour, without disturbing the apparatus.

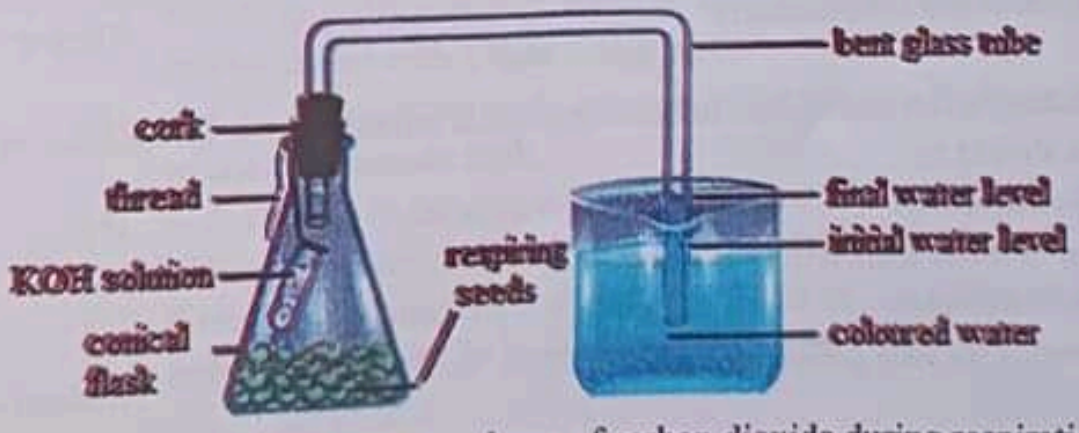


Figure 5.1 Demonstration of the release of carbon dioxide during respiration

Observation: ----------

Conclusion: ----------

Precautions:

1. Germinating seeds should be kept moist.
2. All connections of the set-up should be air-tight.
3. Freshly prepared KOH solution should be used.
4. Keep one end of U-shaped delivery tube in conical flask and the other end immersed in water of the beaker.
5. The test tube containing KOH should be hung carefully.

Exercises

Multiple choices

1. The material used to make connections of the set-up air-tight is
   (a) vaseline
   (b) oil
   (c) wax
   (d) glue

   Answer: ----------

2. Name the cell components required for completion of aerobic respiration in a cell.
   (a) Chloroplast and nucleus
   (b) Ribosomes and ER
   (c) Golgi body and lysosomes
   (d) Cytoplasm and mitochondria

   Answer: ----------

3. Before setting up an experiment to show that seeds release carbon dioxide during respiration, the seeds should be
   (a) dried completely
   (b) boiled to make them soft
   (c) soaked in vinegar
   (d) kept moist till they germinate

   Answer: ----------

4. In plants, when the rate of photosynthesis equals the rate of respiration, it is called
   (a) boiling point
   (b) transpiration
   (c) compensation point
   (d) freezing point

   Answer: ————————

5. Which of the following precautions are to be taken for a successful run of the experiment to show that carbon dioxide is given out during respiration?
   A. Cork should be airtight.
   B. Seeds in the flask should be totally dry.
   C. A small tube with freshly prepared KOH solution should be placed in the flask.
   D. The end of the delivery tube should be above water level.
   The correct answer is
   (a) A and B
   (b) A and C
   (c) A, B and C
   (d) A, B and D

   Answer: ————————

Experiment (2) Demonstrate the release of heat energy during respiration

Objective: To observe light is essential for photosynthesis

Practical outcome: The student will obsérve heat is liberate during respiration in germinating seeds.

Material required: 2 thermos flasks, 2 thermometers, 2 rubber stoppers, 2 beakers with seeds like beans or peas

Introduction: Respiration is the process of releasing energy from digested food-therefore respiration is an exothermic process. Respiration transfers energy that cell needs to function fully.

Procedure:

(1) Take 2 beakers with seeds. To one of the beakers add water and allow seeds soak for the whole night.
(2) On the next day morning, take two wide mouthed thermos flasks which can be closed with a tight fitting cork.
(3) Put the germinating seeds into one of the thermos flasks and dry seeds in another thermos flask.
(4) Make a hole in the cork and insert a thermometer into cork and see the bulb of the thermometer is in the midst of the seeds.
(5) Record the temperature in both the flasks at every two or three hour intervals for about 24 hours.

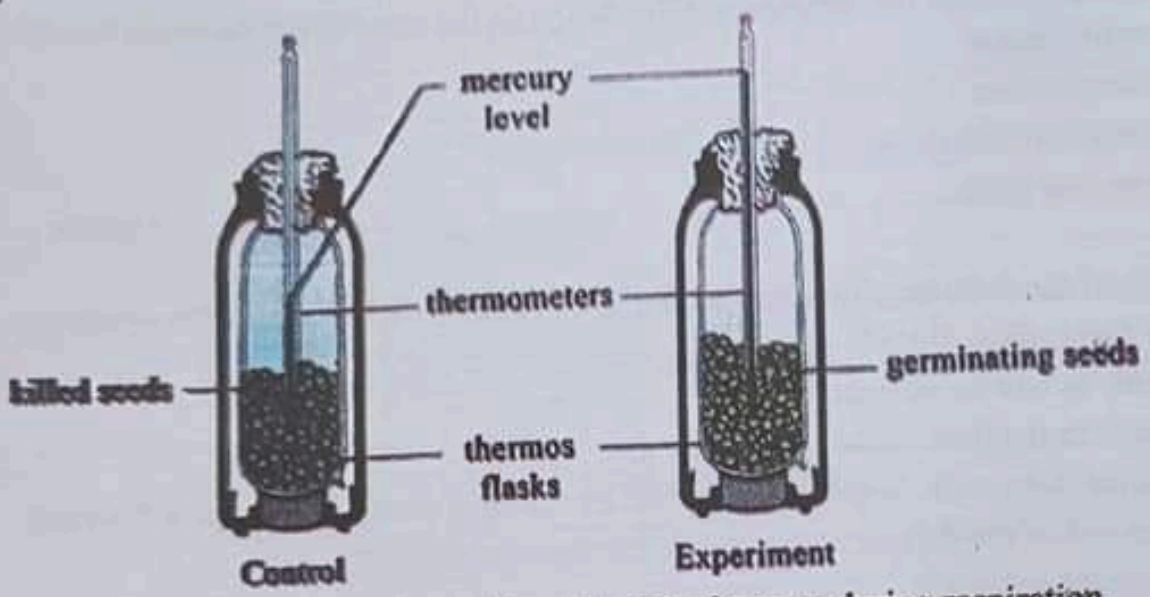


Figure 5.2 Demonstration of the released of energy during respiration

Observation: _____

_____

_____

Conclusion: _____

_____

_____

Exercises

Multiple choices

1. The role of oxygen in cellular respiration is:
   (a) to form CO_2
   (b) to liberate energy from hydrogen storage
   (c) to change pyruvate to acetyl CoA
   (d) to accept hydrogen and form water

   Answer: _____

2. The materials form in anaerobic respiration are
   (a) CO_2 and water
   (b) CO_2 and alcohol
   (c) CO_2 and formaldehyde
   (d) CO_2 and haemoglobin

   Answer: _____

3. Alcohol is produce during the process of
   (a) photosynthesis
   (b) acrobic respiration
   (c) combustion
   (d) fermentation

   Answer: ----------

4. The energy liberated during respiration is stored in the form of
   (a) heat
   (b) ADP
   (c) ATP
   (d) NADP

   Answer: ----------

5. Mitochondria is the storage house for:
   (a) NADH
   (b) ADP
   (c) ATP
   (d) Citric acid

   Answer: ----------

Experiment (3) Demonstrate the carbon dioxide is released during respiration

Objective: To show experimentally that carbon dioxide is released during respiration

Practical outcome: The student will observe carbon dioxide is liberated during exhalation.

Material required: 3 test tubes, water, calcium hydroxide (limewater)

Procedure:
(1) Add 10 ml of lime water to test tubes.
(2) Bubble room air through one test tube for one minute using a straw and observe and record the results.
(3) With the other test tube, bubble exhaled air through the solution for 1 minute. Try to bubble the air through the same rate that you did with the first test tube. After 1 minute record your results.

Result: Carbon dioxide will turn lime water (calcium hydroxide) cloudy.

Test for Carbon dioxide

Figure 5.3 Carbon dioxide turns limewater cloudy

Exercises

Multiple choices

1. Energy is released during
   (a) Internal respiration
   (b) External respiration
   (c) Cell respiration
   (d) Breathing

   Answer: ----------

2. Respiration is a
   (a) Physical process
   (b) Chemical process
   (c) Biochemical process
   (d) Physico-chemical process

   Answer: ----------

3. Which of the following statements is not correct about cellar respiration?
   (a) Energy is released
   (b) Occurs in all living forms
   (c) Oxygen is used and CO_2, is liberated
   (d) Haemoglobin is always needed in all forms

   Answer: ----------

4. During respiration, yeast produces
   (a) Heat and energy
   (b) Ethyl alcohol and energy
   (c) Alcohol, carbon dioxide and energy
   (d) Water, carbon dioxide and energy

   Answer: ----------

5. Carbon dioxide turns lime water ——— during respiration.
   (a) Milky
   (b) Opaque
   (c) Darker
   (d) None of the above

   Answer: ----------

PRACTICAL 6

THE CARBON DIOXIDE CONTENT IN INHALED AND EXHALED AIR

Activity Investigation of carbon dioxide content in inhaled and exhaled air

Objective: To compare the carbon dioxide content in inhaled and exhaled air

Practical outcome:
(1) Students will be able to recognize the composition of carbon dioxide contamination in their exhaled air.
(2) The students will be able to interpret and evaluate the result of the experiment.
(3) The students will be able to use laboratory apparatus and materials.

Material required: Two test tubes, teaspoon, dropping pipette, glass or plastic straw,1000 ml beaker or plastic container, clear limewater solution (calcium hydroxide), corks, rubber tubing or silicon pipe

test tube, teaspoon, dropping pipette, straw

beaker

clear limewater solution (calcium hydroxide)

Caution: The rubber tubing must be sterilized or washed well prior to use. Please neither blow strongly into the limewater nor strongly suck up the limewater when doing this experiment – instead, just breathe gently into the solution., just breathe gently. Wear eye protection since carbon dioxide is harmful to your eyes.

Introduction: Air that is breathed in and air that is breathed out has different amounts of gases in it due to exchanges that take place in the alveoli of the lungs. Atmospheric air contains around 20 – 21% oxygen, of which we only absorb around 4 – 5%. The air that is exhaled contains around 16% oxygen. The normal carbon dioxide content of air is around 0.04%. As carbon dioxide diffuses into the alveoli from the blood, we exhale air containing around 4% carbon dioxide (Table 1). The air, we breathe out contains more water vapour than when the air we inhale, and the temperature of exhaled air is higher than that of the inhaled air. The following experiment will be performed to demonstrate changes in the content of carbon dioxide in air as we inhaled and exhale.

Table 1. Composition of gases in inhaled and exhaled air

Gas	Inhaled air	Exhaled air
Oxygen	21%	16%
Carbon Dioxide	0.04%	4%
Nitrogen	78%	78%

Procedure: Limewater indicator solution can be used for this experiment as follows:

Preparation of limewater

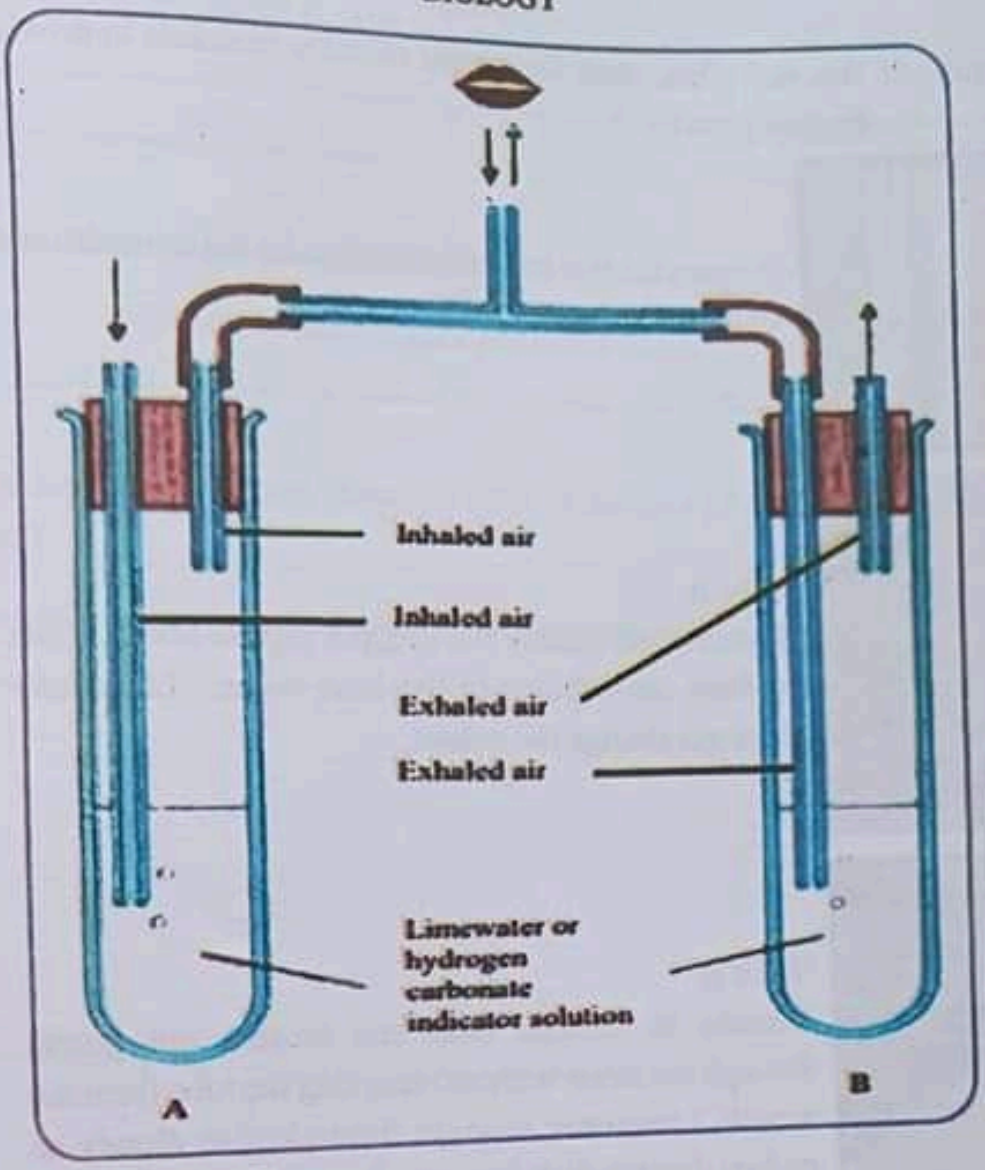
Put 1 teaspoon of calcium hydroxide (traditionally called slaked lime) in a clean glass beaker or plastic container, up to 1 liter in size.

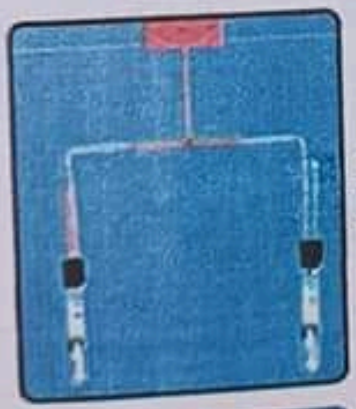
Fill the jar with 500 ml of distilled or tap water and stir the solution vigorously for 1-2 minutes to dissolve the slaked lime into water.
Let it stand for 6 - 10 hours for sedimentation.

Pour the clear solution of limewater to the another container or bottle and store. Be careful not to stir up the sediment again.
(If necessary, filter the lime water using filter paper or coffee filter to obtain a clear solution of limewater.)

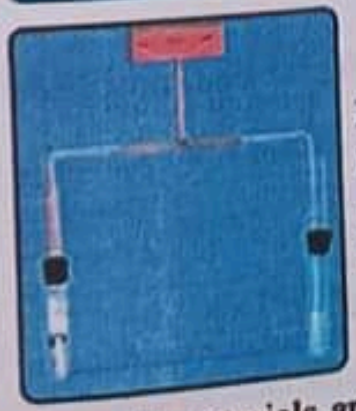
Preparation of test tube:

1. Set up the apparatus as in the diagram.
2. Both tubes contain the same level of limewater.
   (The length of glass or rubber tubing is important. The 'T'- shaped joint should be connected to long delivery tubing dipped into limewater at one side and to short delivery tubing at the other, and vice versa, as indicated in the figure below.)





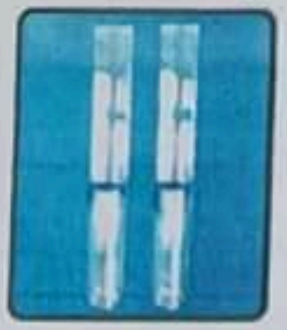
Breathe in and out gently through the rubber tubing without removing the tube from the mouth.



Do not breathe too hard. Keep in-/exhaling until the liquid in one of the tubes changes colour. Limewater changes from clear to cloudy as carbon dioxide dissolves into it.

If not all materials are available to assemble the apparatus for this experiment, the following, simpler procedure can be adopted.

Materials required: Two test tubes, clear limewater solution (calcium hydroxide), plastic straw, dropper pipette.



Prepare the two test tubes containing the same amount of clear limewater.

Tube A

Squeeze and release the dropper pipette several time to form air bubbles in the lime water. Limewater does not change the colour.

Tube B

Breathe in through nose and breathe out gently through the straw without removing the tube from the mouth. Limewater changes from clear to cloudy as carbon dioxide dissolves into it.

Questions:

1. In which tube did bubbles appear when you breathed out? Explain why.

_____

_____

2. Why are the lengths of glass or rubber tubing not the same for inhaled and exhaled tubes?

_____

_____

3. In which tube did bubbles appear when you breathed in? Explain why.

_____

_____

4. What happened to the liquid in tube A?

---

5. What happened to the liquid in tube B?

---

6. What do your results tell you about the relative amount of carbon dioxide in inhaled air and exhaled air?

PRACTICAL 7

HOMEOSTASIS

Activity Demonstration of homeostasis in the human body

Objective: To learn how homeostasis occurs in human body

Practical outcome: (1) Students will be able to explain the working mechanism of homeostasis in the human body.

(2) Students will be able to generate an appropriate suitable table and the graph from the given data.

(3) Students will be able to read and interpret the data from the graph and make an appropriate conclusions from the data.

Material required: students, fingertip pulse oximeter, clinical thermometer (digital or analog), stopwatch or timer in mobile phone

Fingertip Pulse Oximeter or heart rate (pulse rate) measure by hand

Clinical thermometer (digital or analog)

Stopwatch or timer on mobile phone

Introduction: This experiment on homeostasis is an important activity that helps the students to understand better the vital workings of involuntary body systems. Through different experiments, students can observe how the respiratory system, the cardiovascular system and the endocrine system work together to maintain homeostasis.

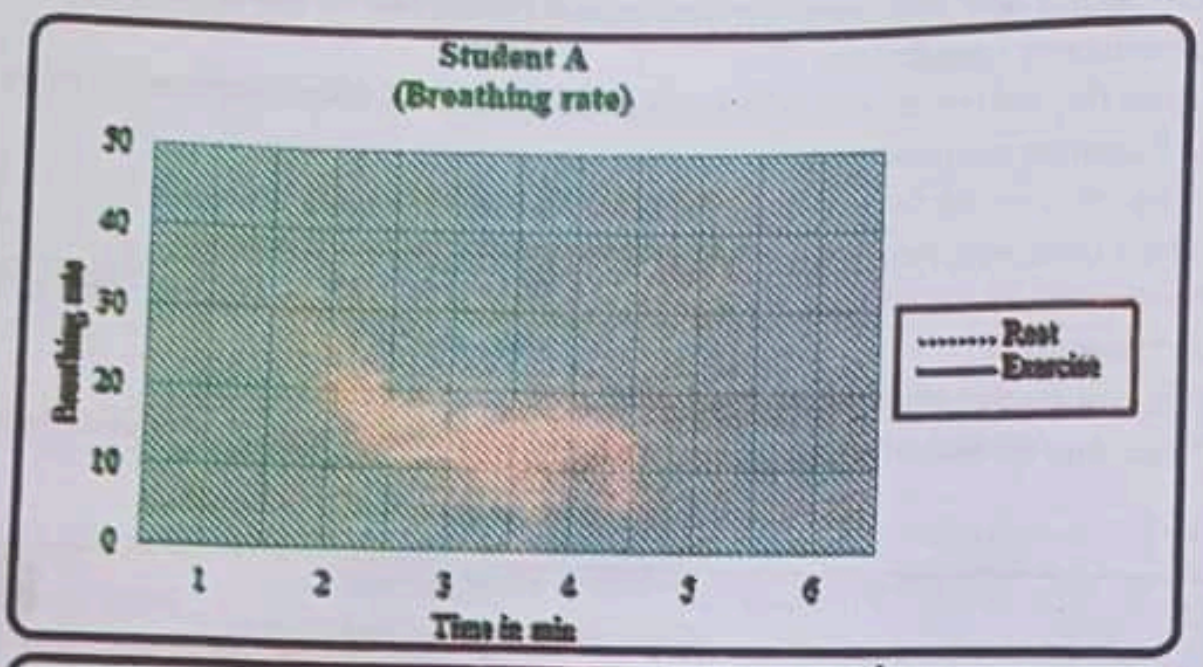
Procedure:

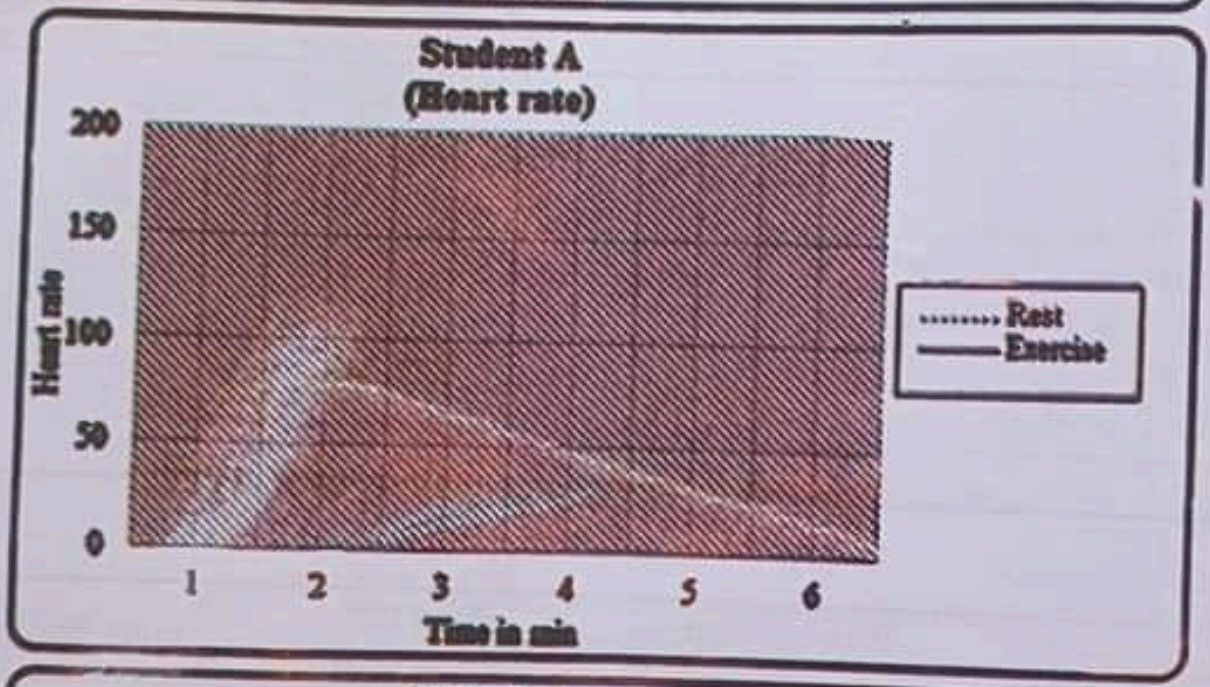
- Pair up two students.
- Count the breathing rate of student A in resting position for one minute and record this as the number of times air is breathed in and out.
- Record the pulse rate and body temperature.
- Repeat this step (recording of breathing rate, pulse rate, body temperature) every minute for 5 minutes continuously.
- Student A should then exercise vigorously, for example by doing jumping jacks or climbing stairs for 5 minutes.

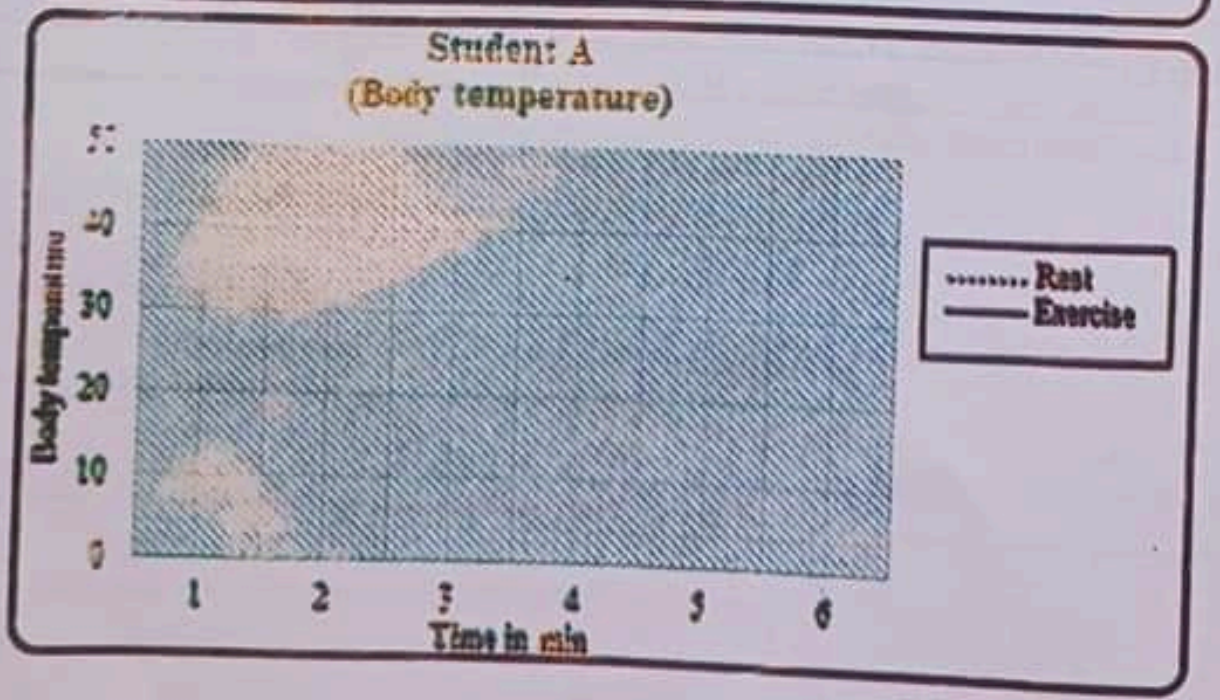
- Immediately after exercising, determine the breathing rate for one minute, record the pulse rate and body temperature.
- Repeat this step (recording of breathing rate, pulse rate, body temperature) every minute for 5 minutes continuously.
- Repeat the process for student B.
- Fill the table with the results of both students A and B.
- Plot the line graphs of the results using the given axes (Dotted line for "Rest", Solid line for "Exercise").
- Compare the two lines in the graph.
  (Note: Any student who is not fit to doing exercise can participate as record keeper)

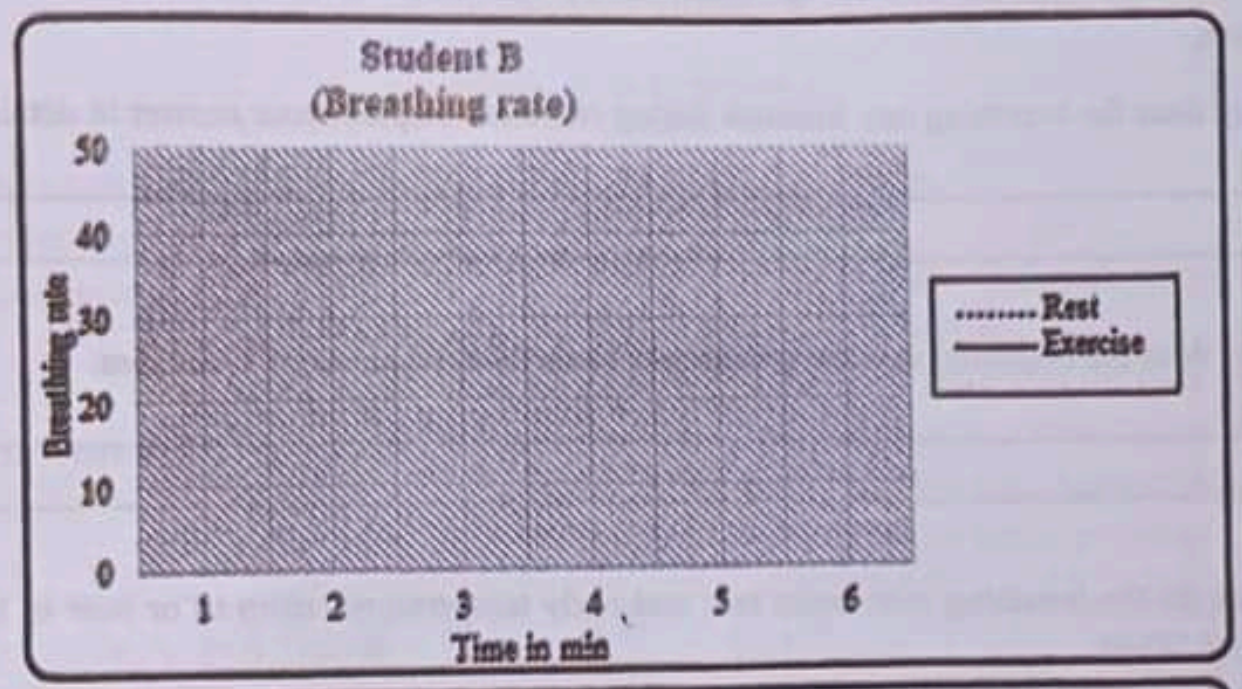
Rest position	Breathing rate (respiratory rate)		Heart rate (pulse rate)		Body temperature	
	A	B	A	B	A	B
1						
2						
3						
4						
5						

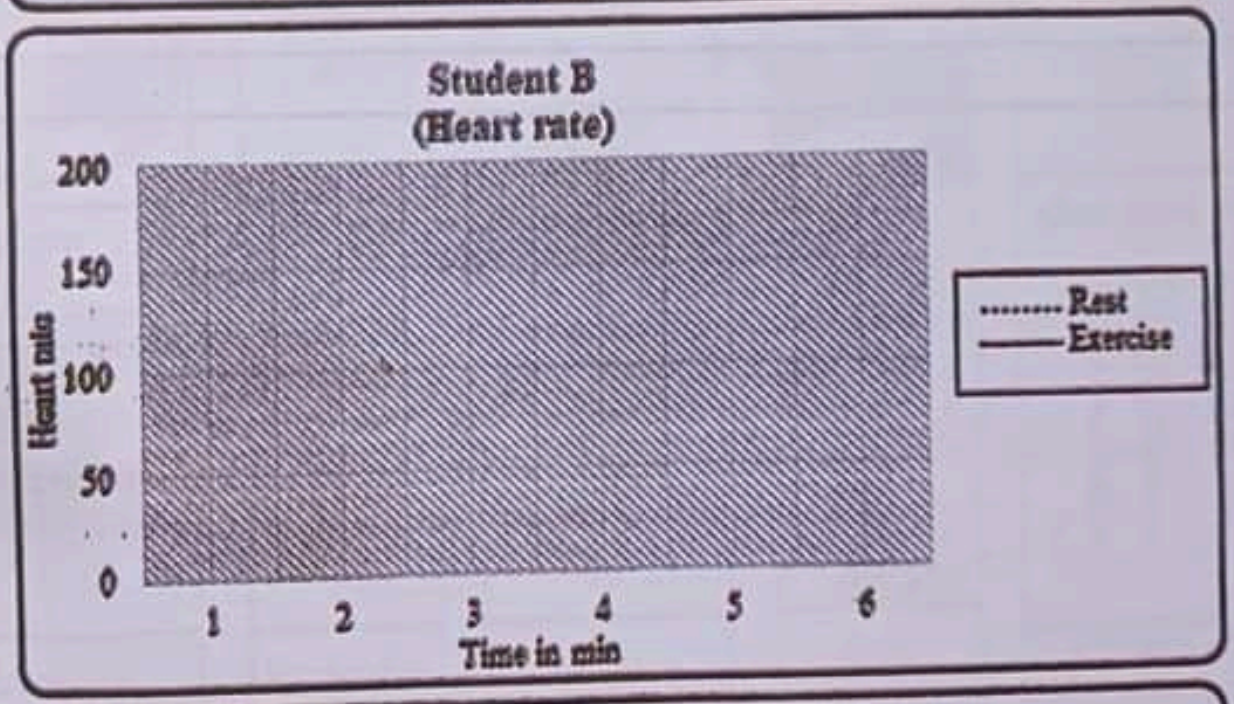
After 5 min of exercise	Breathing rate (respiratory rate)		Heart rate (pulse rate)		Body temperature	
	A	B	A	B	A	B
1						
2						
3						
4						
5						

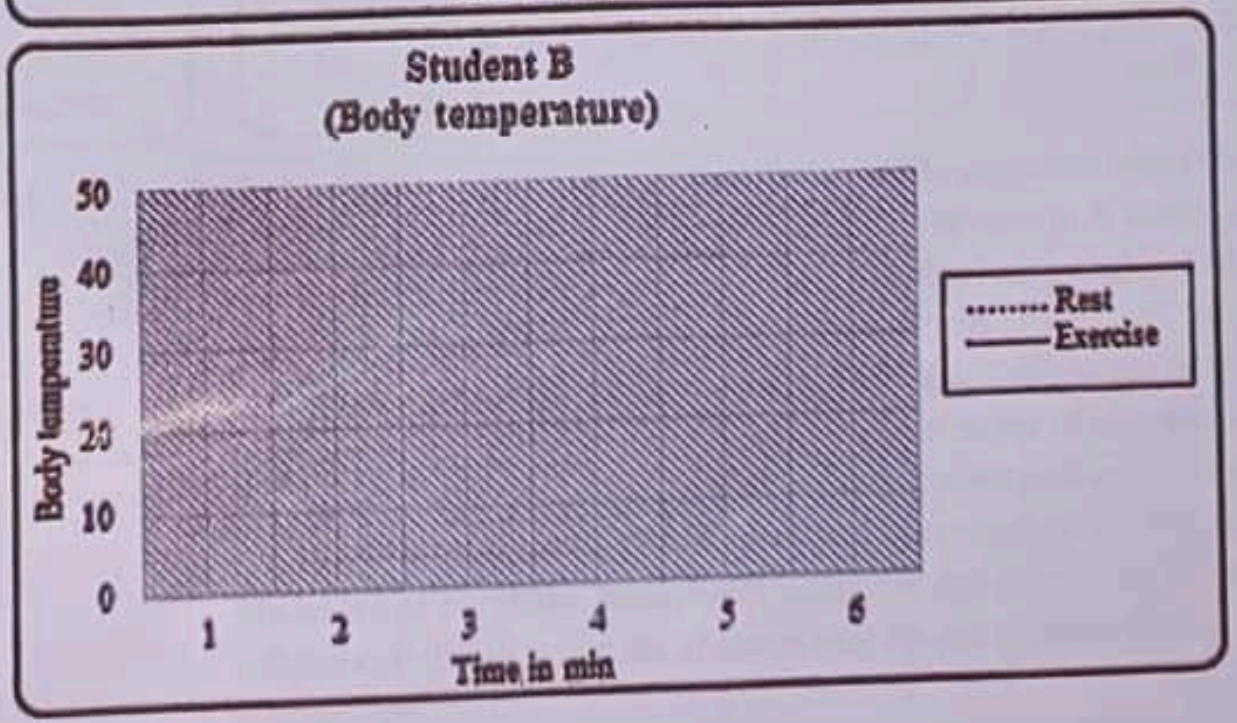

Student A
(Breathing rate)
Breathing rate
0
10
20
30
40
50
1
2
3
4
5
6
Time in min
Rest
Exercise


Student A
(Heart rate)
Heart rate
0
50
100
150
200
1
2
3
4
5
6
Time in min
Rest
Exercise


Student A
(Body temperature)
Body temperature
0
10
20
30
40
50
1
2
3
4
5
6
Time in min
Rest
Exercise


Student B
(Breathing rate)
Breathing rate
50
40
30
20
10
0
1
2
3
4
5
6
Time in min
Rest
Exercise


Student B
(Heart rate)
Heart rate
200
150
100
50
0
1
2
3
4
5
6
Time in min
Rest
Exercise


Student B
(Body temperature)
Body temperature
50
40
30
20
10
0
1
2
3
4
5
6
Time in min
Rest
Exercise

Questions:

1. Why does the breathing rate increase during exercise? Explain your answer in detail.

2. Why does the breathing rate not return to 'normal' as soon as exercise finishes.

3. When do the breathing rate, heart rate and body temperature return to or near to baseline levels? Why?

PRACTICAL 8

CELL DIVISION

Activity: Observe the stages of mitosis in root tip cells of onion

Objective: To outline the process and stages of mitosis

Practical outcome: (1) Students will be able to recognize the different stages of mitosis associated with cell division in onion root tip.

(2) Students will be able to use laboratory apparatus for slide preparation.

Material required: Onion, 1M HCl, acetocarmine, water, glass slide, coverslip, spirit lamp and matches or gas lighter, immersion oil, beaker, dropper pipette, light microscope, scissors, forceps, tooth pick, razor blade, petridish


onion


1M HCl


acetocarmine


water

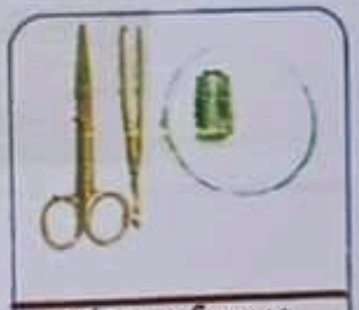

glass slide, coverslip


spirit lamp, matches / gas lighter


immersion oil


beaker, dropper pipette


light microscope


scissors, forceps, tooth pick, razor blade, petridish

Caution: Hydrochloric acid (HCl) is an acid that is highly corrosive when concentrated. Always handle it with care to prevent harm or injury. A chemical-resistant apron, chemical-resistant gloves and chemical splash goggles should be worn when handling HCl to protect your eyes and skin.

Introduction: Mitosis refers to a type of cell division. The parent cell produces two identical diploid daughter cells that contain the same number of chromosomes as the parent cell. During mitosis, the chromosomes undergo a series of changes that are readily identifiable and that represent the progression of mitosis through the stages of prophase, metaphase, anaphase and telophase. In this practical, mitosis cell division in cells of onion root tip can be observed under the light microscope.

Procedure:

Preparation of 1M HCl

- Add 8.8 ml of Hydrochloric acid (HCl) into 100 ml of distilled water (DW).

Preparation of acetocarmine stain

- Add 45 ml of acetic acid into 55 ml of distilled water (DW).
- Heat the solution to boil.
- Add 1g of carmine and continue heating for 10 minutes while stirring.
- Cool the solution.
- Filter the solution to remove any precipitates.

Preparation of onion root tip

The root cap region contains cells that cover and protect the underlying growth region as the root pushes through the soil. The region of cell division (mitosis region or growth zone) where cells are actively dividing but not increasing significantly in length. In the region of cell elongation, cells are increasing in length, but not dividing. Therefore, the growth zone is selected for slide preparation of this practical.

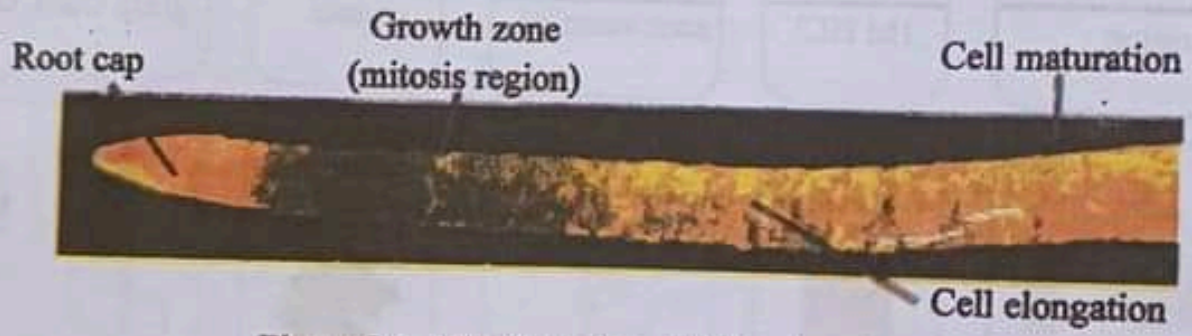


Figure 8.1 Mitosis region of onion root tip

- Place the onion on the lid of a beaker or bottle using a toothpick.
- Fill the beaker with tap water (only the lower surface of the onion should come in contact with water).
- Let the onion rest on water for 3-4 days (only the lower surface should be in contact with water).
- After 3-4 days, roots will emerge from the base of the stem of the onion.

- Cut about 1 cm of fresh onion roots from the mitosis region and keep them in water.

- Place 5 ml of 1 M HCl in a petridish and gently warm using sprit lamp.
- (Caution: Concentrated HCl cannot be used.)

- Pour warm 1 MHCl on to the onion roots and wait for 10 - 15 minutes. (Cellulose walls of plant cells are broken down by the treatment.)

- After 10 - 15 minutes, wash the root tip with water 3 to 4 times.

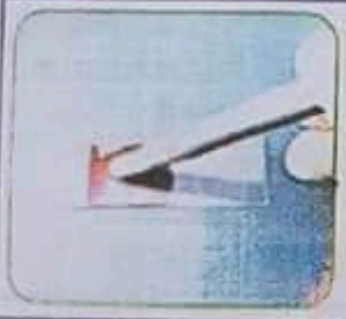
- Take the root tip from water and place it on the glass slide.

- Grind the root tip into pieces by using forceps.

Staining the root tip

- Put a drop of acetocarmine stain on the root and wait until the white root tip turns red.

- Gently place a cover slip over the fragmented root, avoid introducing bubbles between the slide and the coverslip.

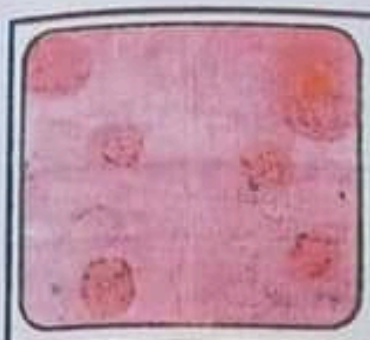


- Using the blunt end of the forceps, gently press the cover slip until the root tips are uniformly squashed between the slide and cover slip. (Squashed preparations appear faint cloudy pink and almost colourless.)

- The root tip preparation can be readily viewed under a light microscope using 1000x magnification (place a drop of immersion oil on the top of your cover slip when you use the100x lens).
- Slowly rotate your 100x oil objective lens into place and adjust the fine focus until you obtain a clear image.
- Stages of mitosis can be observed under the microscope.

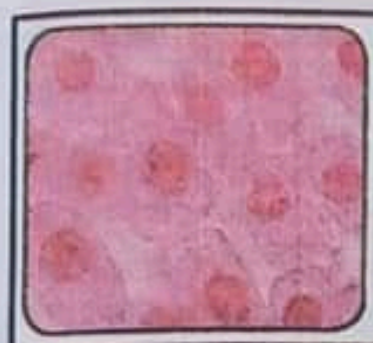
Prophase

- Chromosomal condensation is initiated, giving the nucleus a 'grainy' appearance.
- The nucleus is still visible, further chromosomal condensation results in chromosomes, resembling thick ropes which begin to assemble into chromatids and centromeres.



Metaphase

- Chromosomes align along the equatorial plate.



Anaphase

- Chromosomes with separated sister chromatids begin to move away from the equatorial plate, towards opposite poles.
- Sister chromatids reach the opposite poles in equal numbers.

Telophase

- Chromosomal decondensation commences.
- Chromosomes almost fully decondense to pose as the original chromatin.
- Chromosomes are no longer individually recognizable but instead, form a chromatin network.
- The nuclear membrane and nucleolus reappear.
- The cell plate begins to form.

Questions:

1. Which part of the onion root tip is the best region to study mitosis? Why?

---

2. Why is HCl used in the root tip squash?

---

3. Other than an onion, can you suggest any other raw plants for the study of mitosis? Why?

Why is the acetocarmine stain used in this experiment?

Draw a cell showing each stage of mitosis in cells of the onion root tip.

Prophase	Metaphase	Anaphase	Telophase

PRACTICAL 9

PATTERNS OF INHERITANCE

Activity: Conducting theoretical backcrosses, codominant, multiple alleles and dihybrid crosses

Objective: To distinguish the characters and traits in backcrosses, to conduct test crosses, and to conduct crosses that involve genotypes with codominant and /or multiple alleles

Practical outcome: (1) Students will be able to predict the genotypes and phenotypes of F_1 and F_2 offsprings.

(2) Students will be able to solve basic genetic problems.

Backcross

1. Heterozygous black (Bb) guinea pigs are mated to homozygous recessive (bb) white guinea pigs. Predict the genotypic and phenotypic ratios expected from backcrossing the black F_1 progeny to (a) the black parent, and (b) the white parent.

Codominant cross

2. Yellow coat color in guinea pigs is produced by the homozygous genotype C^YC^Y, a cream coat color by the heterozygous genotype C^YC^W, and a white coat color by the homozygous genotype C^WC^W. What genotypic and phenotypic ratios are mating between two cream-colored individuals likely to produce?
3. Hair shape in human is a codominant characteristic. Straight hair and curly hair are codominam alleles and the heterozygous individual has wavy hair. Hla Hla and Mya Mya both have wavy hair. Deduce the probabilities that their children will have straight hair, curly hair or wavy hair.

Multiple alleles

4. A child has blood group O. If the father has blood group A and the mother has blood group B, then what is the blood group genotype of the parents and what are the possible genotypes of their offsprings?
5. There are four blood groups in the human population: A, B, AB and O. Both I^A and I^B are dominant over i ($I^A = I^B > i$). What would be the phenotypes of the offspring if the parents have the following blood groups?
   (i) $I^AI^A \times I^Ai$ (ii) $I^Ai \times I^Ai$ (iii) $I^Ai \times I^Bi$ (iv) $I^AI^B \times I^Ai$, (v) $I^AI^B \times ii$

Dihybrid cross

6. Describe the cross between a homozygous tall, round-seeded pea plant and a dwarf, wrinkled-seeded pea plant. What will be the types of progenies in the F_2 generation of this cross and in what proportion will it be? (tall, round-seed dominant over dwarf, wrinkled-seed.)

PRACTICAL 10

INVESTIGATING FOOD CHAIN AND FOOD WEB

Activity: Identify the producers, consumers such as herbivores, and carnivores

Objective: To understand the food chain, pyramids of numbers and food web.

Practical outcome: The students will be able to know the ecosystem and its components.

Material required: Note book, pencil or ball pen, hand lens, camera (if possible)

Introduction: Producers make their own food by photosynthesis using light energy. Consumers cannot produce their own food, so they need to eat other organisms to get energy. Herbivores only consume on plants while carnivores on other animals.

Procedure:

(1) Make a list of the organisms which can be found in your school campus. (Refer the appendix provided below, if necessary.)

(2) Sort out the organisms into producers, herbivores and carnivores.

(3) Record them in the table with respective columns.

Activity:

A. Construct the food chain by using the recorded organisms.

B. Construct the pyramid of numbers by referring the food chain that you have done.

Appendix

Plants	Insects	Birds	Reptiles/ others animal
Algae	Butterfly	Crow	Lizard
Moss	Spiders	Sparrow	Snake
Mushroom	Ants	Hawk	Turtle
Grass	Mosquito	Robin	Rat
Ferns	Grasshopper	Owl	Frog
Daisy	Beetle	Swan	Dog
Roses bushes	Worm	Ostrich	Cow
Corns	Louse	Parrot	Squirrel

Exercise

1. Construct a Food web using the following animals. This ecosystem represents a farm area. The corn is the main source of food for many of the herbivores in the area. You do not have to draw

REFERENCES

O – LEVEL BIOLOGY LEARNING THROUGH DIAGRAMS, New Edition 2012, Singapore Asia Publishers Pte Ltd

https://www.livestrong.com/article/386795-the-definition-of-reducing-sugars/

https://sciencing.com/test-reducing-sugars-5529759.html

https://en.wikipedia.org/wiki/Reducing_sugar

https://microbiologyinfo.com/benedicts-test-principle-composition-preparation-procedure-and-result-interpretation/

https://biology-igcse.weebly.com/food-test-4---biuret-test-for-proteins.html

https://microbenotes.com/biuret-test-for-protein/

https://byjus.com/biology/test-for-protein/

https://biology-igcse.weebly.com/-food-test-3---emulsion-ethanol-test-for-fats.html

https://med.libretexts.org/(4.2 what are lipids?- medicine Libre Texts)

https://www.youtube.com/watch?v=aWuOkbtymBY

https://www.youtube.com/watch?qN-RFvhgu-3

https://www.youtube.com/watch?v=9DbPRjgnPpQ

https://www.youtube.com/watch?v=2ggn4KhF1oE

https://www.youtube.com/watch?v=nc80Ile1ETI

https://www.youtube.com/watch?v=FZJAa-ZayrM

https://www.youtube.com/watch?v=EsT3w7L4suo

https://www.youtube.com/watch?v=5-ur7bWqlDQ