ORDINARY LEVEL SECONDARY EDUCATION

STUDENT PRACTICALS WORKSHEETS

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF EDUCATION AND VOCATIONAL TARINING

Introduction:

This workbook contains practical worksheets for students on how to carry out practical activities prescribed by Tanzania Institute of Education in Biology, Chemistry and Physics ordinary level syllabi.

Practical work is an excellent and effective way of learning and reinforcing theoretical concepts in science. However, it must be remembered that practical work can be potentially hazardous and students must always be aware of this.

Each activity follows this layout:

- ✓ Aim: The objective of the experiment;
- ✓ Background Information: An introduction which gives student brief explanation to the practical activity;
- ✓ Materials: This lists the materials required for the activity;
- ✓ Procedure: An outline of steps to be followed and how to record data or observations;
- ✓ Safety Measures: Outlines procedures to reduce hazards;
- ✓ Analysis and Interpretation: Manipulation of the results obtained and discussion on its significant meaning;
- ✓ Conclusion: Students make their conclusion on practical activity;
- ✓ Questions for Discussion: These are follow-up questions which allow students to discover new possible knowledge; and
- ✓ Reflection and Self Assessment: Students state any application for which skills attained may be applied.

How to use this book

Teachers who make effective use of practical work and experiments often find that students learn better. Through practical work, teaching is enhanced and becomes more interesting both for the learner and the teacher.

This is a tool to be used by Biology, Chemistry and Physics Teachers during their lessons which involve practicals. It is expected to be used effectively to enhance learning of science by doing.

- This book consist practical activities for Biology, Chemistry and Physics subjects;
- This book will be kept by Teachers in Biology, Chemistry and Physics Departments;
- Teachers will produce copies of the practical activity and give to students one day before the lesson.

Student Report:

- Title: Write the title of practical activity
- Results: Enter the results of the practical activity obtained as requested from procedure
- Analysis: Work out on the results obtained
- Conclusion: Conclude the practical activity based on analysis
- Questions: Knowledge beyond the practical activity
- Reflection: Application of the skills and knowledge attained

Usage of locally available materials:

Science does not have to use expensive or complex resources. It can be taught in the simplest fashion using empty tins, spirit burners, a few test tubes, plastic drink bottles and materials from home. For each subject lists of locally available materials can be obtained from Teachers Practical Guide using locally available materials.

Biology Worksheets

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TESTING A LEAF FOR STARCH

Aim

To find out if starch is present in a leaf.

Background Information

All green plants have the ability to photosynthesize using chlorophyll, carbon dioxide, water and sunlight. Chlorophyll absorbs energy from the sun which breaks down water into hydrogen and oxygen. Hydrogen combines with carbon dioxide to form glucose which is immediately converted to starch. Is starch present in a leaf which has been exposed to all conditions necessary for photosynthesis?

Materials

Leaf, water, ethanol, beaker (250 ml), bunsen burner, test tube, cotton wool, white tile , dropper, forceps, iodine solution, match box, test tube holder, test tube rack, wire gauze, stopwatch and tripod stand.

Procedure

1. Light a bunsen burner. Place a tripod stand with the wire gauze on top, over the Bunsen burner flame.
2. Fill about three quarters of the beaker with water.
3. Place the beaker containing water on the burner, leave water to continue boiling until the end of the experiment.
4. Dip the whole leaf in boiling water for one to two minutes (use stopwatch/watch to read the time).
5. Fill about half of the test tube with ethanol.
6. Using forceps transfer the leaf from the boiling water into the test tube containing ethanol.
7. Cover the mouth of the test tube tightly with a piece of cotton wool.
8. Using a test tube holder, place the test tube containing the leaf and ethanol into the boiling water and leave ethanol to boil until the leaf loses its colour.
9. Using a test tube holder, remove the test tube from the water bath and place it on the test tube rack.
10. Remove the cotton wool from the mouth of the test tube.
11. Using forceps, remove the leaf from the test tube. Place on white tile. Wait for about a minute and touch it to feel whether it is hard or soft (feel its texture). Record your observations.
12. Using forceps return the leaf into the boiling water for about one minute.
13. Using forceps, remove the leaf from the boiling water, place on the white tile, wait for about one minute and feel its texture again. Record your observations.
14. Spread the leaf on a white tile and add iodine solution to cover all parts of the leaf. Record your observations.

Safety Measures

1. The leaf must be taken from a plant that has been exposed to all conditions necessary for photosynthesis to take place for not less than 4 hours.
2. Ethanol catches fire easily. Heat the test tube containing the leaf and ethanol using a water bath.

Analysis and Interpretation

1. What was the aim of dipping a leaf into boiling water (Step No.4)?
2. What was the texture of the leaf after boiling it in ethanol?

Conclusion

What conclusion can be drawn from the results obtained after adding iodine solution to the leaf?

Questions for Discussion

1. Why was the leaf boiled in ethanol?
2. Why was the leaf dipped in hot water after being removed from ethanol?
3. Why was the mouth of the test tube covered with cotton wool?

Reflection and Self Assessment

1. Give examples of organisms, other than green plants, which produce starch.
2. Would the presence of starch in a plant root, such as cassava, indicate that starch was produced in that root? Explain.
3. What is the importance of starch to human beings?
4. Which steps of the procedure were difficult and which ones were not difficult for you to follow in this experiment.

EFFECT OF CARBON DIOXIDE ON PHOTOSYNTHESIS

Aim

To investigate the effect of carbon dioxide on photosynthesis.

Background Information

There are four basic requirements for green plants to be able to manufacture their own food during photosynthesis. These are carbon dioxide, water, light and chlorophyll. Does absence of any one of them cause the plant to fail to produce starch?

Materials

Potted plant, bunsen burner, 2 flat bottomed conical flasks (250 ml), beaker (250 ml), 2 white tiles, forceps, sodium hydroxide (NaOH) solution, iodine solution, water, match box, dropper, cotton wool, 2 test tubes, test tube rack, tripod stand, wire gauze, measuring cylinder (100 ml), stopwatch/watch and test tube holder.

Procedure

1. Label two conical flasks A and B. Label two test tubes A and B. Label two white tiles A and B.
2. Using a measuring cylinder, put 80 ml of sodium hydroxide (NaOH) solution in conical flask A.
3. Take a potted plant. Bend one of the branches and insert the terminal leaf or leaves into conical flask A.
4. Bend another branch of the potted plant and insert the terminal leaf or leaves into conical flask B.
5. Close the mouths of both conical flasks tightly with pieces of cotton wool.
6. Expose the potted plant with its two flasks to sunlight for 6 hours. Thereafter, light the bunsen burner and place the tripod stand with the wire gauze on top over the Bunsen burner flame.
7. Fill about half of the beaker with water.
8. Place the beaker containing water on the bunsen burner and keep the water boiling until the end of the experiment.
9. Take the labeled test tubes and fill them with ethanol half way, keep them on the test tube rack.
10. Remove the cotton wool from flask A and then detach one of the leaves which were inside the flask.
11. Immerse the leaf from flask A in boiling water for about 1 to 2 minutes and then using a forceps transfer it into test tube A. Cover the test tube tightly with cotton wool.
12. Remove the cotton wool from flask B and then detach one of the leaves which were inside the flask.
13. Immerse the leaf from flask B in boiling water for about 1 to 2 minutes and then, using forceps transfer it into test tube B. Cover the test tube tightly with cotton wool.
14. Using a test tube holder, place the 2 test tubes containing the leaves and ethanol into the boiling water and leave the ethanol to boil for 1 to 2 minutes. Record your observations.

15. Using a test tube holder, remove the test tubes from the boiling water and rest them on a test tube rack.
16. Remove the cotton wool from the mouth of each test tube.
17. Using forceps remove the leaf from test tube A and put it in the boiling water for one minute.
18. Using forceps remove the leaf from boiling water and spread it on white tile A.
19. Using a dropper, add iodine solution on the leaf drop by drop until the whole leaf surface is covered by iodine solution. Record your observations.
20. Using forceps remove the leaf from test tube B and put it in the boiling water for one minute.
21. Using forceps remove the leaf from boiling water and spread the leaf on white tile B.
22. Using a dropper, add iodine solution on the leaf, drop by drop until the whole leaf surface is covered by iodine solution. Record your observations.

Safety Measures

1. Take care when using flames during the experiment.
2. Ethanol can easily catch fire, so heat the test tubes containing leaves and ethanol in a beaker containing boiling water (water bath.)
3. The potted plant must have been kept in a dark place for 24 hours.
4. Sodium hydroxide is corrosive. Avoid touching it and make sure that the leaf in beaker A does not touch the Sodium Hydroxide.

Analysis and Interpretation

1. What color changes did you observe when iodine solution was added to leaves from test tubes A and B?
2. What was the role of sodium hydroxide solution in this experiment?

Conclusion

From the results of this experiment what is the relationship between carbon dioxide and photosynthesis?

Questions for Discussion

1. Why was the potted plant kept in a dark place for 24 hours?
2. Explain why it was important to plug/cover the mouths of conical flasks with cotton wool.
3. Why was it important for the potted plant to be exposed to sunlight for 6 hours?
4. How did you know that it was carbon dioxide which prevented the production of starch in one of the test tubes? Explain.

Reflection and Self Assessment

1. Suggest an alternative chemical substance that could be used instead of sodium hydroxide.
2. Can green plants survive in absence of carbon dioxide? Explain
3. What can you do to reduce the amount of carbon dioxide in an industrial area?

EFFECT OF CHLOROPHYLL ON PHOTOSYNTHESIS

Aim

To investigate the effect of chlorophyll on photosynthesis by using a variegated leaf.

Background Information

The green color of leaves is due to the presence of a pigment called chlorophyll. Chlorophyll absorbs energy from the sunlight which is used by plant during photosynthesis. However, other plant leaves (variegated leaf) do not posses chlorophyll in some areas/portions. Do leaves or areas/portions of leaves which do not posses chlorophyll have the ability to photosynthesize?

Materials

Variegated leaf, beaker (500ml), test tube, wire gauze, cotton wool, bunsen burner, tripod stand, forceps, iodine solution, water, white tile, ethanol, test tube holder, dropper, match box.

Procedure

1. Light a bunsen burner. Place the tripod stand with the wire gauze on top, over the bunsen burner flame.
2. Fill about half of the beaker with water.
3. Place the beaker containing water on the burner and leave the water to boil until the end of the experiment.
4. Take a variegated leaf and dip the whole leaf in boiling water for one to two minutes (use stopwatch/watch to read the time).
5. Fill about half of the test tube with ethanol.
6. Using a forceps, transfer the leaf from the boiling water into a test tube containing ethanol.
7. Cover the mouth of the test tube tightly with a piece of cotton wool.
8. Place the test tube containing the leaf and ethanol into the boiling water and leave the ethanol to boil until the leaf looses color.
9. Using a test tube holder, remove the test tube from the boiling water.
10. Remove the cotton wool from the mouth of the test tube.
11. Using forceps take the leaf out of the test tube. Place it on the white tile and touch it to feel whether it is hard or soft (feel its texture). Record your observations.
12. Using forceps return the leaf into the boiling water for about 1 minute.
13. Using forceps remove it from the boiling water and feel its texture. Record your observations.
14. Spread the leaf on a white tile and add iodine solution to cover all parts of the leaf. Note down the color changes.

Safety Measures

1. Take care in using flames during this experiment.
2. Ethanol can easily catch fire, heat alcohol using a water bath.
3. The leaf must be taken from a plant that has been exposed to sunlight for not less than four hours.

Analysis and interpretation

1. Which area/portion of the leaf showed the presence of starch?
2. What does the presence or absence of the green area/portion of a leaf suggest on photosynthesis?

Conclusion

From the experiment you performed relate chlorophyll and photosynthesis.

Questions for discussion

1. Why was the leaf dipped in hot water after being removed from the ethanol?
2. What would happen if the test tube containing ethanol and leaf was not plugged with cotton wool?

Reflection and Self Assessment

1. Why was the leaf detached from the plant which had been exposed to sunlight for not less than 4 hours?
2. Why was variegated leaf used instead of a green leaf?

EFFECT OF LIGHT ON PHOTOSYNTHESIS

Aim

To find out whether light is necessary for photosynthesis.

Background Information

Photosynthesis is a process by which green plants manufacture their own food using water and carbon dioxide in the presence of light energy from the sun and chlorophyll. Light is needed to split water molecules into hydrogen and oxygen atoms during the process. Oxygen is given out as a by-product while hydrogen combines with carbon dioxide to form glucose molecules, which unite to form starch. Is light necessary for photosynthesis?

Materials

Beaker (500 ml), test tube, white tile, 2 strips of aluminum foil, 4 clips, iodine solution, ethanol, potted plant, forceps, cotton wool, Bunsen burner, wire gauze, tripod stand, dropper, match box, test tube holder and water.

Procedure

1. Use aluminum foil and clips to cover the upper and lower surface of the middle part of one leaf of the potted plant.
2. Place the potted plant in a dark room for 24 hours.
3. Remove the potted plant from the dark area and expose it to bright sunlight for 6 hours.
4. Light the bunsen burner. Place the tripod stand with the wire gauze on top, over the bunsen burner flame.
5. Fill about three quarters of the beaker with water.
6. Place the beaker containing water on the burner and leave the water to boil until the end of the experiment.
7. Detach the covered leaf from the potted plant and remove the aluminum foil.
8. Using forceps take the detached leaf and dip the whole leaf in boiling water for one to two minutes.
9. Fill about half of the test tube with ethanol.
10. Using forceps transfer the leaf from the boiling water into the test tube containing ethanol.
11. Cover the mouth of the test tube tightly with a piece of cotton wool.
12. Using a test tube holder, place the test tube containing the leaf and ethanol into the boiling water, leave the ethanol to boil until the leaf loses its color.
13. Using a test tube holder, remove the test tube from the boiling water.
14. Remove the cotton wool from the mouth of the test tube.
15. Using forceps, take the leaf out of the test tube.
16. Using forceps return the leaf into the boiling water for about 1 minute.

17. Using forceps remove the leaf from the boiling water and spread it on a white tile.
18. Using a dropper, add iodine solution drop by drop on all parts of the leaf. Observe the color changes.

Safety Measures

1. Ethanol can easily catch fire, heat the test tube containing the leaf and ethanol in a beaker of boiling water (water bath).
2. Ethanol can evaporate easily; therefore plug/cover the test tube containing ethanol with cotton wool to prevent it from evaporating.

Analysis and Interpretation

1. Explain the color changes observed after adding iodine solution to the leaf.
2. Draw a labeled diagram of the leaf to show your observations after adding iodine solution to the leaf.

Conclusion

What can you conclude about the relationship between light and photosynthesis?

Questions for Discussion

1. Why was the potted plant kept in dark room for 24 hours?
2. Why was the leaf covered with aluminum foil?
3. Why was the potted plant with a partially covered leaf exposed to the sunlight for 6 hours?

Reflection and Self Assessment

1. What would happen if brown paper was used instead of aluminum foil?
2. What other materials could be used instead of aluminum foil?
3. From the experiment you have done, how would you advise a farmer who grows crops in the shade?

PRODUCTS OF PHOTOSYNTHESIS

Aim

To identify the gas produced during photosynthesis.

Background Information

Photosynthesis is the process by which all green plants use carbon dioxide and water in the presence of chlorophyll and light energy to produce carbohydrates and a certain gas as a by-product. The gas produced is very important for respiration and supporting life on Earth while carbohydrate is used to produce energy in living organisms. What kind of by-product gas is produced during photosynthesis?

Materials

Beaker (500 ml) , glass filter funnel, water plant, 2 glass blocks, test tube, sodium hydrogen carbonate, water, match box, spatula, glass rod and wooden splint.

Procedure

1. Place 2 glass blocks at opposite sides in the bottom of the beaker. Pour about 400 ml of water into the beaker.
2. Add one spatula full of sodium hydrogen carbonate to the beaker containing water and stir with a glass rod to mix.
3. Put the water plant into the beaker containing sodium hydrogen carbonate solution.
4. Cover the water plant with a filter funnel. The blocks should support the funnel.
5. Fill a test tube with water and invert it onto the filter funnel stem as shown in figure 1
6. Carefully take the experimental set up outside and expose it to sunlight for about six hours. Observe what is happening within the test tube.
7. After six hours, immerse a hand in the water and carefully pull up the test tube using a thumb to completely cover the mouth of the test tube before the test tube reaches the water surface.
8. Light the wooden splint.
9. Carefully remove the thumb from the test tube and insert the glowing splint into the test tube. Observe what happens to the wooden splint.

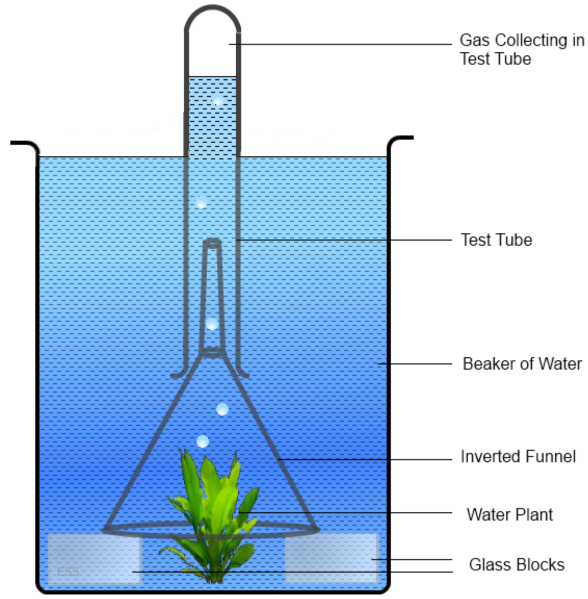

Figure 1. Collection of Gas from a Water Plant

Safety Measures

Make sure that the test tube is covered with a thumb before it reaches the surface of water.

Analysis and Interpretation

1. What happened to the wooden splint?
2. What is the name of the process that took place when the wooden splint was inserted into the test tube?
3. What was the role of baking soda in this experiment?

Conclusion

What does your observation on the glowing wooden splint indicate?

Question for Discussion

1. Why was the funnel placed on the blocks and not directly touching the bottom of the beaker?
2. What is the reason for using water plant for this experiment?

Reflection and Self Assessment

1. During this experiment, did you experience any challenge(s)? If so, how did you overcome the challenge(s)?
2. Is the gas produced used by the plant in any activity?
3. Propose an experimental set up that would also test if a land plant produces the same gas as a by-product.

FOOD TEST FOR STARCH

Aim
To determine if starch is present in maize flour.

Background Information
Starch is common in many food stuffs. The function of starch in the human body is to provide energy. How can you know that certain food stuff contains starch?

Materials
Bunsen burner, tripod stand, wire gauze, match box, beaker (250 ml), test tube, test tube holder, dropper, iodine solution, 2g maize flour, water, measuring cylinder (10 ml), stopwatch/watch and test tube rack.

Procedure
1. Light a bunsen burner and place a tripod stand with the wire gauze on top, over the bunsen burner flame.
2. Fill a beaker about three quarters full of water.
3. Place the beaker containing water on the bunsen burner and leave water to continue boiling.
4. Take about 2 g of maize flour and place it into a test tube.
5. Using measuring cylinder, measure 2 ml of cold water and pour it into the test tube containing maize flour. Shake the mixture well.
6. Using a test tube holder, place the test tube containing the mixture into the water bath. Continue shaking the test tube on water bath for about 5 minutes.
7. Using a test tube holder, remove the test tube from the water bath, place it on the test tube rack and allow the mixture to cool.
8. Using a dropper, add two drops of iodine solution into a test tube containing the mixture. Shake the mixture and record your observations.

Safety Measures
While heating the mixture, face the test tube mouth away from yourself and others.

Analysis and Interpretation
What was the color change when iodine solution was added to the mixture?

Conclusion
Relate the color observed after adding iodine solution to the mixture and starch.

Questions for Discussion

1. Why was the mixture boiled?
2. Why was it necessary to shake the mixture well after adding iodine solution?

Reflection and Self Assessment

1. Using the knowledge you have gained from this experiment, describe the procedure to test for the presence of starch in a cassava root.
2. Mention three types of foods, other than maize, that contain starch.
3. In the human body, what enzymes are associated with the breakdown of starch?

FOOD TEST FOR REDUCING SUGARS

Aim

To determine if reducing sugars are present in an onion bulb.

Background Information

A reducing sugar is a simple sugar which is a basic unit of more complex carbohydrates like starch and cellulose. Reducing sugars are a source of energy for the human body. What indicates the presence of reducing sugar in particular food stuff?

Materials

Bunsen burner, tripod stand, wire gauze, match box, beakers (250 ml), beaker (100 ml), test tube, test tube holder, dropper, Benedict's solution, filter paper, water, onion bulb, scalpel, mortar, pestle, measuring cylinder (10 ml), white tile, stopwatch/watch and test tube rack.

Procedure

1. Light the bunsen burner and place a tripod stand with the wire gauze on top, over the bunsen burner flame.
2. Fill a beaker (250 ml) about three quarters full of water.
3. Place the beaker containing water on the bunsen burner and leave water to boil.
4. Take and peel the onion bulb to get white fleshy leaves and place it on a white tile.
5. Cut an onion bulb in one half using a scalpel and slice one half of the onion bulb into small pieces.
6. Place the onion bulb pieces into a mortar and grind thoroughly with a pestle.
7. Using a measuring cylinder, measure about 20 ml of cold water and pour it into the mortar containing ground onion and mix gently.
8. Place a filter paper into a clean beaker (100 ml) and pour grounded solution, wait for 5 minutes to filter and obtain an onion solution.
9. Take the beaker containing the onion solution, measure 2 ml of onion solution and pour it into a clean test tube.
10. Using a dropper, add an equal amount (2 ml) of Benedict's solution to the test tube containing the onion solution.
11. Using a test tube holder, dip the test tube containing onion solution and Benedict's solution in the boiling water bath to boil the mixture for three to five minutes. Observe and record the color changes.
12. Using a test tube holder, remove the test tube from the boiling water bath and turn off the bunsen burner.

Safety Measures

During heating of solutions, face the test tube away from yourself and others.

Analysis and Interpretation

Write the sequence of color changes observed when the onion solution was heated with Benedict's solution.

Conclusion

What is the relationship between the final color observed and reducing sugar?

Questions for Discussion

1. Why did Benedict's solution change from its original color to the final color observed?
2. Why should the ground mixture be filtered?
3. Why are some sugars called reducing sugars?

Reflection and Self Assessment

1. What are the advantages of understanding which food stuff contain reducing sugars?
2. Mention two types of food stuff, other than onion, which contain reducing sugar.

FOOD TEST FOR NON-REDUCING SUGARS

Aim

To determine if non-reducing sugars are present in sugarcane.

Background Information

A non- reducing sugar is a complex sugar made of chains of two or more reducing sugars. Non-reducing sugars are an energy source for the human body. What indicates the presence of non-reducing sugar in particular food stuffs?

Materials

Bunsen burner, tripod stand, wire gauze, match box, 1 beaker (250 ml), 1 beaker (100 ml), test tube, test tube holder, dropper, Benedict's solution, water, sugarcane, dilute Hydrochloric acid, dilute sodium hydroxide, knife, measuring cylinder (10 ml), stopwatch/watch, sieve, mortar and pestle.

Procedure

1. Light the bunsen burner and place a tripod stand with the wire gauze on top, over the bunsen burner flame.
2. Fill a beaker (250 ml) about three quarters full of water.
3. Place the beaker containing water on the bunsen burner and leave water to boil.
4. Using a knife, peel a piece of fresh sugar cane and cut it into small pieces in the mortar.
5. Crush the pieces using a mortar and pestle until you get fine fibers.
6. Using a measuring cylinder, measure 10 ml of water and add to the mortar containing the ground sugarcane. Squeeze and sieve into a beaker (100 ml) to obtain sugar cane solution.
7. Using a measuring cylinder, measure 2 ml of sugarcane solution and pour into a clean test tube.
8. Using a dropper, add about 3-5 drops of dilute hydrochloric acid to the test tube containing sugarcane solution.
9. Using a test tube holder, place the test tube containing sugarcane solution and dilute hydrochloric acid into the boiling water bath for about 2 minutes.
10. Using a test tube holder, remove the test tube from the boiling water and let it cool for about 3 minutes.
11. Using a dropper, add about 2 ml of dilute sodium hydroxide in the cooled test tube containing sugarcane solution and dilute hydrochloric acid.
12. Using a dropper, add equal amounts (2 ml) of Benedict's solution to the test tube containing sugarcane solution, dilute hydrochloric acid and sodium hydroxide.
13. Using a test tube holder, place the test tube containing sugarcane solution, dilute hydrochloric acid, dilute sodium hydroxide and Benedict's solution into the boiling water bath for about 5 minutes. Observe and record the color changes.

14. Using a test tube holder, remove the test tube from the boiling water bath and turn off the bunsen burner.

Safety Measures

Do not taste any food stuffs

Analysis and Interpretation

1. What is the role of dilute hydrochloric acid in this experiment?
2. What is the role of dilute sodium hydroxide in this experiment?
3. What does the color change you have observed indicate?

Conclusion

What is the relationship between the final color observed and non-reducing sugar?

Questions for Discussion

1. How can you prove that sugarcane contains non-reducing sugar?
2. Why did you boil the mixture after adding dilute hydrochloric acid?

Reflection and Self Assessment

1. Mention two types of food stuffs, other than sugarcane, which contain non-reducing sugar.
2. What is the difference between reducing and non- reducing sugar?
3. Why it is not advised to test for non-reducing sugar before testing for a reducing sugar?

FOOD TEST FOR PROTEIN

Aim
To determine if protein is present in egg albumin.

Background Information
Protein is a food substance which is present in both plants and animals. Protein is used by the human body for growth and repair of damaged areas. How can you test for protein in food stuff?

Materials
Egg, 2 beakers (250 ml), 2 test tubes, sodium hydroxide, 1% copper (II) sulphate, dropper, forceps, measuring cylinder (10 ml), water and glass rod.

Procedure
1. Take one egg and use the forceps to break the shell to create a small hole in one end.
2. Through the hole pour out the egg white (albumin) into a beaker.
3. Using a measuring cylinder, measure 50 ml of water and add to the egg white then mix gently using a glass rod.
4. Using a measuring cylinder, measure 4 ml of the egg white solution and pour it into a clean test tube.
5. Using a measuring cylinder, measure 2 ml of sodium hydroxide and pour it into the test tube containing egg white solution and shake the mixture well.
6. Using a dropper, add 1% copper (II) sulphate solution drop wise to the test tube containing egg white and sodium hydroxide solution. Shake the mixture well until you observe a color change. Record the observations.
7. Using a measuring cylinder, measure 4 ml of egg white solution and pour it into another clean test tube.
8. Using a dropper, add 1% of copper (II) sulphate solution drop wise to the test tube containing egg white solution and shake the mixture well until you observe a colour change.
9. Using a measuring cylinder, measure 2 ml of sodium hydroxide and pour it into the test tube containing egg white solution and copper (II) sulphate. Shake the mixture well and record the observations.

Safety Measures
Do not taste any food stuff.

Analysis and Interpretation
1. What is the role of sodium hydroxide in this experiment?
2. What is the importance of adding water to egg white before testing?

3. What is the importance of stirring the egg white mixture very gently?

Conclusion

What is the relationship between the colors observed and protein?

Questions for Discussion

1. Why is egg albumin used to test for protein rather than the egg yolk?
2. How were the results affected by the order you added the sodium hydroxide and the 1% copper (II) sulphate?

Reflection and Self Assessment

1. How can you use the knowledge gained from this experiment to better care for pregnant women and children?
2. Mention three types of food stuff, other than egg, that contain protein.
3. Can protein be used as a source of energy? Explain.
4. In the human body, what enzyme is associated with the breakdown of protein?

FOOD TEST FOR LIPIDS

Aim

To determine if lipids are present in groundnuts.

Background Information

Lipids are organic food substances consisting of carbon, hydrogen and oxygen, similar to the structure of carbohydrates. However lipids contain much less oxygen in relation to carbon and hydrogen than carbohydrates. There are two forms of lipids which are fats and oils. Fats are solid at room temperature while oils are liquid at room temperature. How can the presence of fats and oils be tested in food stuff?

Materials

Dropper, 2 test tubes, test tube rack, filter paper, Sudan (III) solution, groundnut solution, beaker (100 ml), measuring cylinder (10 mL), sieve, stopwatch/watch, lukewarm water, and mortar and pestle.

Procedure

This experiment consists of three alternative procedures to determine the presence of fats or oils in groundnuts called alternative A and B.

1. Grind the groundnuts using a mortar and pestle.
2. Using a measuring cylinder, measure 10 ml of lukewarm water to the mortar and mix thoroughly.
3. Filter the solution into a 100 ml beaker using filter paper.

Alternative A

1. Using a measuring cylinder, measure 2 ml of groundnut solution and put it into a clean test tube.
2. Using a dropper, add 2 drops of Sudan (III) solution to the test tube containing groundnut solution.
3. Shake the mixture well and place it on a test tube rack to allow it to settle for about 2 minutes. Record your observation.

Alternative B

1. Take a filter paper and lay it flat on the laboratory bench.
2. Using a dropper, put 3 drops of groundnut solution to the paper.
3. Let the solution dry on the paper.
4. Hold the paper vertically up against the light and look through the paper, record your observations.

Safety Measures

1. Do not taste the food stuff.

Analysis and Interpretation

1. What did you observe when Sudan (III) solution was added to the groundnut solution?
2. What did you observe when you placed the filter paper against the light?

Conclusion

What do you conclude from the results of this experiment?

Questions for Discussion

1. Why is it important to allow the mixture of groundnut solution and Sudan (III) solution to settle when testing for fats and oils?

Reflection and Self Assessment

1. Mention three food stuffs, other than groundnuts, that contain fats or oils.
2. Explain the effects of eating too much food containing fats and oils.
3. In the human body, what enzyme is associated with the breakdown of fats and oils?

OSMOSIS

Aim

To investigate osmosis in a living tissue.

Background Information

In living things, osmosis is concerned with the movement of water. Water moves from a region where the solute is less concentrated to a region where the solute is more concentrated. Water moves from the soil into the root hair when the salts in the root hair make the water less abundant than in the soil. Thus, the osmotic potential in this case is higher in the root hair than in the soil. The root hair cell is also said to have a higher osmotic pressure than the soil. Osmosis can only take place between two regions of different concentration which are separated by selective permeable membrane.

Materials

Three (3) large Irish potatoes, 4 beakers (500 ml), table salt, scalpel, water, dropper, bunsen burner, tripod stand, wire gauze, match box, spoon, spatula, masking tape, marker pen, stopwatch/watch, measuring cylinder (10 ml), and petri dish.

Procedure

1. Label four (4) beakers A, B, C and D with masking tape and a marker pen.
2. Using a scalpel, slice off two opposite sides of each of the three potatoes.
3. Scoop out the central portion of one sliced side of each potato using a scalpel to make a shallow hole.
4. Light the bunsen burner. Place the tripod stand with the wire gauze on top, over the Bunsen burner flame.
5. Fill about half of beaker D with water and put one of the potatoes.
6. Place beaker D, containing water and potato, on the burner and boil it for about 10 minutes.
7. Using a spoon remove the potato from the beaker, place it in a Petri dish and leave it to cool.
8. Turn off the bunsen burner and wash beaker D.
9. Put about 200 ml of water into each of the three beakers.
10. Place one of the un-boiled potatoes into beaker A and the other into beaker C. Place the boiled potato into beaker B and mark the level of water in each beaker.
11. Using a measuring cylinder, measure 10 ml of water and pour it into beaker D then dissolve three spatulas full of table salt. Mix the solution with a glass rod.
12. Using a measuring cylinder, measure 4 ml of the salt solution and add to the hole of the potatoes in beaker A and B.

13. Leave the experiment for six hours. Observe and record the level of water in the beaker and in the potato holes.

Safety Measures

1. Make sure that the potato is not over-boiled.
2. When creating the shallow holes in the potatoes, try to remove identical volumes from each of the potatoes.

Analysis and Interpretation

1. What do the changes noted in this experiment mean?
2. Considering the solutions in the potato holes and that in the beakers, which one had a higher osmotic pressure?
3. What was the role of setup C in this experiment?
4. In which potato did the solution level increase?

Conclusion

1. What conclusion can be made from this experiment based on the changes in the solution/water level?
2. From this experiment what is the most important condition for osmosis to occur?

Questions for Discussion

1. Why was one of the potatoes boiled?
2. What would happen if concentrated sugar solution was placed in beakers A and B and distilled water was placed in the holes of the potatoes in these two beakers?

Reflection and Self Assessment

1. What are the three ways in which osmosis is important to plants?
2. Explain what would happen if the farmer applied fertilizer to the crops during a dry period.

MEASUREMENT OF PULSE RATE

Aim

To determine the pulse rate by taking the pulse at the wrist.

Background Information

Pulse rate is the number of heart beats per minute. Pulse rate can be felt at the wrist and any area where arteries are close to the surface of the skin. At rest an adult human heart beats an average of 72 times per minute. However this can increase or decrease due to physical activity, emotional states or health factors. The ability to determine the pulse rate is useful in medical sciences and detecting the presence of illness in the body. It is also useful to indicate the level of physical fitness. Is your pulse rate above or below that of an average adult at rest?

Materials

Stop watch/watch

Procedure

1. Ask your fellow student to rest calmly and quietly for 10 minutes.
2. Ask your fellow student to turn the palm of his/her left hand upward.
3. Place the index and middle fingers of your right hand on the wrist of your fellow's hand approximately 2 cm below the palm.
4. While pressing your fingers down move them slightly to locate exact point where the pulse is (Observe Figure 2 below).
5. Using your left hand observe the pulse for one minute, start the stop watch and at the same time count the number of beats. Record your count and observations.
6. Ask your fellow student run to 50 meters away and then run 50 meters to return back to the experiment site.
7. Once your fellow student returns, let your fellow student turn the palm of his/her left hand upward again.
8. Place the index and middle fingers of your right hand on the wrist of your fellow's hand approximately 2 cm below the palm.
9. While pressing your fingers down move them slightly to locate exact point where the pulse is.
10. Start the stop watch, observe the pulse for one minute and count the number of beats. Record your count and observations.

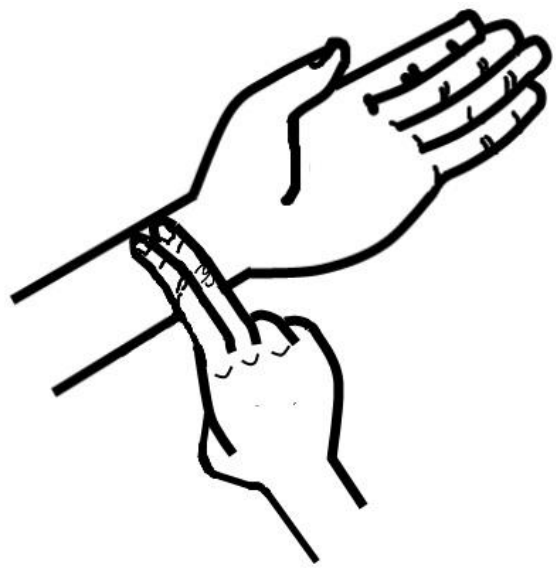

Figure 2. Demonstration of how to measure wrist pulse

Safety Measures

The thumb should not be used for measuring another person's heart beat because it also has strong pulse which may interfere with correct perception of the target pulse.

Analysis and Interpretation

What is the difference between the pulse rate before and after exercise?

Conclusion

What is the difference between your pulse rate at rest and that of an average adult human?

Questions for Discussion

1. Why did you use index and middle fingers to detect the pulse?
2. Why was it easier to feel the pulse rate after exercise?

Reflection and Self Assessment

1. What is the importance of taking a pulse rate?
2. How does the pulse rate relate to the blood pressure?
3. Why did the pulse rate increases after exercise?
4. What other parts of the body can be used to feel the pulse rate?

EFFECT OF WATER ON ROOT GROWTH

Aim
To investigate the growth movement of plant roots in response to water as a stimulus.

Background Information
Plants or plant parts grow toward various stimuli. The growth movement of a part of a plant toward water is termed as hydrotropism. Roots show positive hydrotropism while shoots show negative hydrotropism. How do roots show positive hydrotropism?

Materials
Wooden box 15 x 15 x 15 (cm) with a perforated base and 2 transparent glass or hard plastic sides, 2 wooden boxes 15 x 15 x 15 (cm), dry soil or saw dust, eight germinated pea seedlings, porous pot, water, Anhydrous Calcium Chloride ($CaCl_2$), wire mesh, sand and cotton wool.

Procedure
This experiment involves three separate experimental set ups, labeled A, B and C.

Experimental Set Up A
1. Take a wooden box with dimensions of about 15 x 15 x 15 (cm) with two sides fixed with transparent glass or hard transparent plastic material, a perforated base and an open top. Fill the box with dry soil or dry saw dust to the top.
2. In the center of the box, make a small hole in the soil or saw dust and place a porous pot. Fill the pot to the brim (top) with water.
3. Remove some of the soil or saw dust near each of the transparent sides and place one germinating pea seedling in each hole. The seedlings should be visible from outside the box. Cover the holes with soil or saw dust. The only source of moisture should be the pot in the center of the box.
4. Leave the set up for 3-4 days. Thereafter, make observations and carefully dig up the seedlings so as not to damage the roots. Record your observations.

Experimental Set up B
1. Take a wooden box with dimensions about 15 x 15 x 15 (cm) and with an open top. Fill the bottom with Anhydrous Calcium Chloride ($CaCl_2$) crystals to a depth of 2cm.
2. Inside the box put a piece of wire mesh so that it slants from the top to the bottom.
3. Place three germinating pea seedlings on the wire mesh at equal distances, making sure their roots penetrate the wire mesh and extend toward the $CaCl_2$ crystals.

4. Soak enough cotton wool in water and use it to surround the germinating seeds completely leaving the shoot to extend above the cotton wool.
5. Leave the set up for 3-4 days. Thereafter, carefully remove the wire mesh. Record your observations.

Experimental Set up C

1. Take a wooden box with dimensions about 15 x 15 x 15 (cm) and with an open top and fill it with 1 kg of sand. Add 500 ml of water to the sand in the box and mix thoroughly.
2. On top of the box place a piece of wire mesh.
3. On the wire mesh place three germinating pea seedlings at equal distance apart. Making sure the roots penetrate the wire mesh.
4. Soak enough cotton wool in water and use it to surround the germinating seeds completely leaving the shoot to extend above the cotton wool.
5. Leave the set up for 3-4 days. Thereafter, carefully remove the wire mesh. Record your observations.

Safety Measures

Keep all experimental set ups away from rain or any other source of moisture.

Analysis and Interpretation

1. What was the role of porous pot in this experiment?
2. What was the role of Anhydrous Calcium Chloride in this experiment?
3. What was the stimulus present in each experiment?

Conclusion

1. Describe the direction of growth of each root with respect to water source.
2. What is the biological term given to the growth movement which was investigated in this experiment?

Questions for Discussion

1. In Experimental Set up C, why did the roots not grow toward the cotton wool?
2. Why were germinating seeds used for this experiment instead of seeds which have not yet germinated?

Self Assessment and Reflection

1. If rain falls on the ground, why don't roots grow toward the ground surface?
2. What is the importance of hydrotropism to plant growth?

DETERMINATION OF BODY TEMPERATURE OF HOMEIOTHERMIC AND POIKILOTHERMIC ANIMALS

Aim

To compare the body temperature of homeiothermic and poikilothermic animals under different environmental temperatures.

Background Information

All animals are capable of regulating their body temperature to keep it within a certain range depending on their nature and their environment. In some animals their body temperature fluctuates with environmental changes in temperature, such animals are called poikilotherms. In other animals their body temperature remains relatively constant despite the changes in the environmental temperature, such animals are called homeiotherms. How do the body temperatures of poikilothermic and homeiothermic animals differ when subjected to different temperature conditions?

Materials

Laboratory thermometer, 2 animal cages, blunt forceps/ wooden stick, gloves, small towel, methylated spirit, stopwatch/watch and frog/toad and guinea pig/rat/mouse.

Procedure

1. Use a laboratory thermometer to measure and record the temperature of the room.
2. Put on the protective gloves and take a frog/toad from a cage.
3. Using a small towel, hold a frog/toad securely.
4. Carefully open the buccal cavity of the frog/toad using blunt forceps or small wooden stick.
5. Carefully insert the thermometer into the buccal cavity of the frog/toad and hold it in position for 5 minutes. Record the temperature on the thermometer while it is inside the buccal cavity.
6. Remove the thermometer from the buccal cavity and clean it together with the forceps using methylated spirit.
7. Remove the guinea pig/rat/mouse from the cage.
8. Using a small towel, hold a guinea pig/rat/mouse securely.
9. Carefully open the mouth of the guinea pig/rat/mouse with the help of blunt forceps or small wooden stick.
10. Carefully insert the thermometer into the mouth of the guinea pig/rat/mouse and hold it in position for 5 minutes. Record the temperature on the thermometer while it is inside the mouth.
11. Remove the thermometer from the mouth and clean it together with the forceps using methylated spirit.
12. Return the animals to their cages and expose them to the sunlight during the afternoon for one hour.

13. Remove the frog/toad from the cage.
14. Carefully open the buccal cavity of the frog/toad with the help of blunt forceps or small wooden stick.
15. Carefully insert the thermometer into the buccal cavity of the frog/toad and hold it in position for 5 minutes. Record the temperature on the thermometer while it is inside the buccal cavity.
16. Remove the thermometer from the buccal cavity and clean it together using methylated spirit.
17. Takeout the guinea pig/rat/mouse from the cage.
18. Carefully open the mouth of the guinea pig/rat/mouse with the help of a blunt forceps or small piece of wooden stick.
19. Carefully insert the thermometer into the mouth of the guinea pig/rat/mouse and hold it in position for 5 minutes. Record the temperature on the thermometer while it is inside the mouth.
20. Remove the thermometer from the mouth, clean it together with the forceps using the methylated spirit, then return the animals to their cages.

Safety Measures

This experiment may be stressful to animals which may cause them to bite you. Take care when handling them and do not use excessive force when performing this experiment.

Analysis and Interpretation

1. From your observations, explain how the temperatures of the two animals varied from one environment to another?
2. Using your observations, which animal is poikilothermic and which is homeiothermic?

Conclusion

Based on the results of this experiment, what conclusion can you make concerning the relationship of body temperatures of the frog/toad and guinea pig/rat/mouse with respect to environmental conditions?

Questions for Discussion

1. Why was the temperature measured from the mouth and not from other parts of the body?
2. Why was a towel used to hold the animals?

Reflection and Self Assessment

1. Mention two other animals which are poikilothermic and two which are homeiothermic.
2. How does a human being behave when subjected to a very cold environment for a prolonged period?
3. What factors may influence the change of body temperature of homeiothermic animals?
4. How do poikilotherms overcome overheating or overcooling?

5. What are the advantages of being homeiothermic and poikilothermic?

EXTERNAL CONDITIONS NECESSARY FOR SEED GERMINATION

Aim
To determine the external conditions necessary for seed germination.

Background Information
The development of a seed into a seedling is called germination. The ability of a seed to germinate depends on both internal and external factors. When internal conditions are met, a seed is considered to be viable. However, viable seeds cannot germinate in absence of certain external conditions. What conditions are necessary for a viable seed to germinate?

Materials
Four (4) beakers (250 ml), 12 viable seeds, measuring cylinder (100 ml), beaker containing boiled water, beaker containing un-boiled water, oil, cotton wool, masking tape, marker pen and refrigerator (freezer).

Procedure
1. Label four 250 ml beakers A, B C and D with masking tape and a marker pen.
2. In beaker A place enough dry cotton wool to cover the bottom of the beaker. On top of the dry cotton wool place three viable seeds.
3. In beaker B place enough dry cotton wool to cover the bottom of the beaker and add about 125 ml of cooled, previously boiled water. On top of the cotton wool place three viable seeds. Add about 40 ml of oil to cover the surface of water.
4. Soak some cotton wool in un-boiled water.
5. Place enough wet cotton wool into beaker C to cover the bottom of the beaker. On top of the wet cotton wool place three viable seeds.
6. Soak some cotton wool in un-boiled water.
7. Place enough wet cotton wool into beaker D to cover the bottom of the beaker. On top of the wet cotton wool place three viable seeds. Then place beaker D into a refrigerator (freezer).
8. Leave all experimental set ups for 3-4 days. Thereafter, record observations from beakers A, B, C, and D.

Analysis and Interpretation
1. What happened to the seeds kept in beakers A, B, C and D after 3-4 days?
2. What factors, necessary for germination, were present in the beaker or beakers in which germination took place?
3. What were the factors which prevent germination in other beakers?
4. What is the role of cotton wool in this experiment?

Conclusion

What factors are necessary for viable seeds to germinate?

Questions for Discussion

1. Why was boiled water used?
2. Why was oil used?
3. Why was beaker D placed into a refrigerator (freezer)?

Reflection and Self Assessment

1. How would a seed be affected if one of the factors necessary for germination was present in excess?
2. What would happen to a fish placed in a beaker contained water covered with oil on its surface?

EXAMINATION OF GROWTH REGIONS IN FLOWERING PLANTS

Aim
To examine growth regions in the young root of a bean seedling.

Background Information
Growth is an irreversible increase in body size and weight. In multicellular organisms, growth is brought about by an increase in number and size of cells. As the number of cells increases, groups of them become specialized tissues with a specific function. Tissues will further develop to become distinct organs with a specific function. Young plants exhibit localized growth, which is mainly apical. This means that in plants growth is mainly confined to the tips of young roots and shoots. How can growth regions in a young root be examined?

Materials
Bean seedling, pin, cork, conical flask (250 ml), ruler, water and marker pen.

Procedure
1. Take a fresh germinating bean seed that has a young root of about 2 cm long.
2. Using a ruler and a marker pen, make marks on the young root from the terminal tip to the area near the seed at intervals of 2 mm.
3. Fill the conical flask about three quarters full of water.
4. Pin the bean seed to the underside of a cork so that the young root hangs downward.
5. Put the cork into the mouth of the conical flask with the young root pointing toward the bottom of the flask (Figure 3).
6. After 3 days remove the cork from the flask and unpin the seed from the cork.
7. Examine the changes in length by observing the distances between the markings. Record your observations.

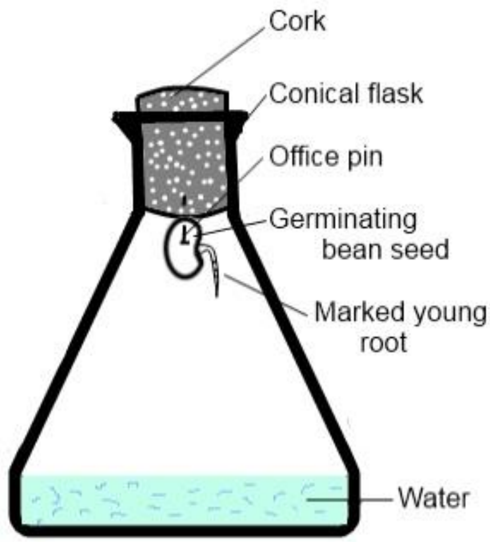

Figure 3. Examination of growth regions

Safety Measures

- Be careful when putting marks on the young root and when attaching it to the cork, because it is very delicate.
- Care should be taken on pining the seedling to the cork so as to avoid destroying the embryo.

Analysis and Discussion

1. What changes did you observe regarding the growth of the young root?
2. Draw and label the seedling with its markings before and after the experiment.
3. Compare the intervals of the markings on the young root at the beginning and at the end.

Conclusion

1. Which region of the young root showed the greatest increase in length? Explain.
2. Which region of the young root showed the smallest increase in length? Explain.

Question for Discussion

1. Why was the young root of the seedling marked before it was attached to the cork?
2. Why did you fill the conical flask with water before it was closed with a cork?

Reflection and Self Assessment

1. What would happen if the tip of the young root was cut?
2. What hormone(s) caused the results observed during this experiment?