

## UNIT II

# The World of the Living

### Experiment 23

#### AIM

To prepare temporary mounts of leaf peels to observe stomata and to differentiate between dicot and monocot stomata.

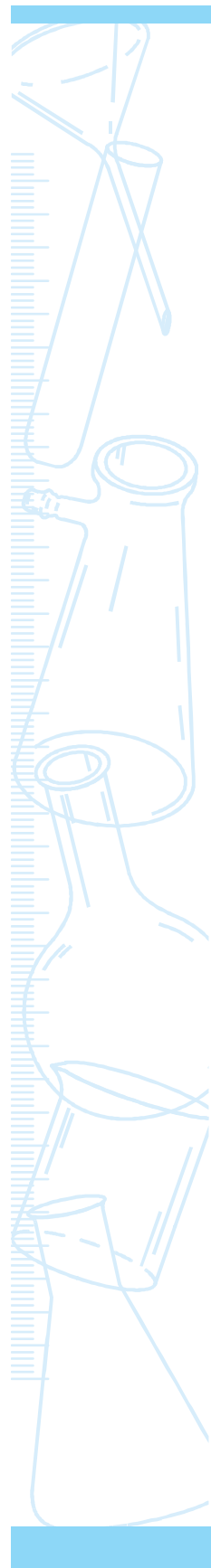
#### THEORY

In plants, physiological processes such as respiration and photosynthesis involve exchange of gases between plant tissues and the external atmosphere. This occurs through minute microscopic pores called stomata (singular; stoma) present in the leaf. Stoma is an elliptical pore with two kidney shaped guard cells on either side. The guard cells have thin outer and thick inner walls. When guard cells are turgid, the stoma opens and it closes when the guard cells are flaccid.

The number, distribution and type of stomata varies in different plants. Within a plant, the number and distribution may vary between the upper and lower surfaces of leaf. However, the type of stomata remains the same in a particular plant species. Stomata are either absent or non-functional in submerged aquatic plants. In this experiment we shall prepare the temporary mounts of leaf peels of dicot and monocot plants to observe their stomata.

#### MATERIALS REQUIRED

Fresh leaves of a dicot plant (such as *Petunia*, *Dianthus*, *Solanum*) and a monocot plant (such as lily, maize, grass), compound microscope, slide, cover slip, needle, brush, a piece of blotting paper, and a razor blade.



## PROCEDURE

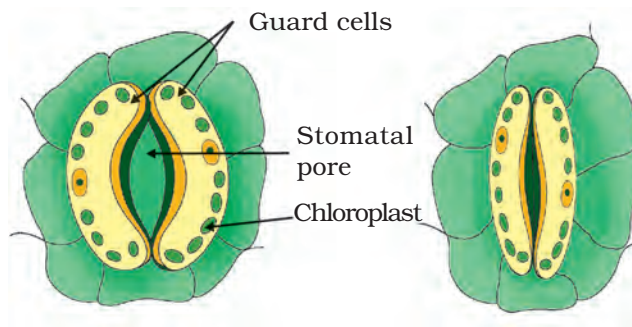


1. Remove a peel from the lower surface of a dicot leaf. This can be easily done by folding or tearing the leaf and pulling out the thin membranous transparent peel. Leaf peels can also be obtained by carefully scratching the leaf surface with a razor blade.
2. Mount the peel on a slide in a drop of water and place a cover slip on it. Avoid air bubbles. Blot the excess water from the slide.
3. Focus the peel under the low power of compound microscope and observe the stomata, guard cells and epidermal cells.
4. Count the number of stomata, and epidermal cells in the field of microscope without disturbing the slide.
5. Observe and identify the contents of guard cells under high power.
6. Move the slide and again count the number of stomata and epidermal cells. Record your observations.
7. Calculate the average number of stomata and epidermal cells in the field of the microscope.
8. Draw the diagram of a stoma and label its parts.
9. Repeat the process with peels removed from a monocot leaf. Record your observations.
10. Following the same procedure, study the stomata of other dicot and monocot plants.

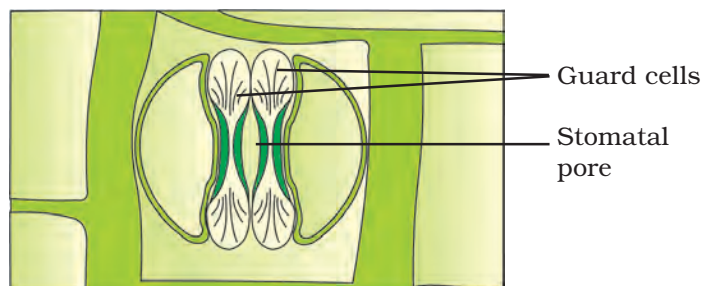
## OBSERVATIONS



Sl. No.	Observation	Dicot	Monocot
1.	Number of stomata in the microscopic field		
2.	Number of epidermal cells in the microscopic field		
3.	Shape of guard cells (bean seed shaped or dumbbell shaped)		
4.	Number of chloroplasts in each guard cell		



**Fig. 23.1** : (a) An open dicot stoma; and (b) closed dicot stoma



**Fig. 23.2 :** An open monocot stoma (grass)

## RESULTS AND DISCUSSION



Based on the observation compare the characteristic of the dicot and monocot stomata and draw your own conclusion.

### NOTE FOR THE TEACHER

- It is found that number, size, and distribution of stomata vary in different plants. In general, the stomata are lesser on the upper surface as compared to that on the lower surface of leaf.
- Fewer stomata on the upper surface prevent excessive loss of water due to transpiration as this surface is directly exposed to sunlight.
- In aquatic plants stomata are either absent or non-functional. Stomata are absent in roots also.
- This experiment can be extended as a project by taking leaves of different plants. This will help students to have a fair idea about the variations in shape, number, size and distribution of stomata on two surfaces of leaves of different plants. Stomatal index can be calculated by using the formula

$$\text{Stomatal index} = \frac{S}{E} \times 100\%$$

Here  $S$  and  $E$  are the numbers of stomata and epidermal cells respectively per microscopic field.

### QUESTIONS

- What is the function of guard cells in stomata?
- Why is the number of stomata greater on the lower surface of a leaf?
- Why are stomata absent in roots?
- What is the shape of guard cells in stoma of grass leaf?
- Do guard cells have rigid or elastic walls? Justify your answer.

## Experiment 24

### AIM

To show that light is essential for photosynthesis.

### THEORY

Photosynthesis is the process by which green plants synthesize carbohydrates by using carbon dioxide ( $\text{CO}_2$ ), water, sunlight and chlorophylls present in the leaves. Light is one of the essential requirements for photosynthesis. The energy contained in solar radiation is absorbed by the photosynthetic pigments and is converted into utilizable chemical energy during photosynthesis.

### MATERIALS REQUIRED

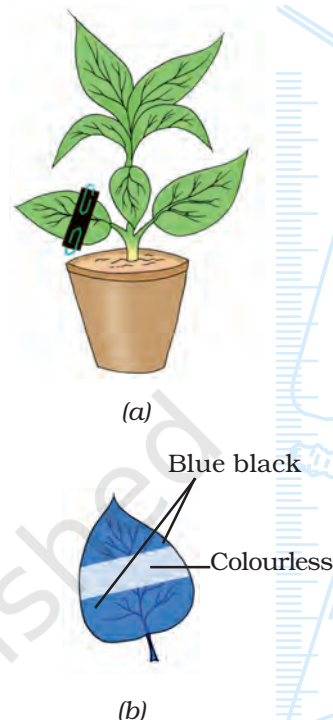


De-starched potted plant (balsam, *Amaranthus*, *Tecoma* or any plant with thin herbaceous broad leaves), thick black paper strips, paper clips, alcohol, iodine solution, a beaker (250 mL), a burner (or a spirit lamp), a tripod stand, a wire gauge, a boiling tube, forceps, and a petridish.

### PROCEDURE

1. Take a de-starched plant (from the list given above). Using strips of thick black paper and paper clips, cover a part of an intact leaf of the plant as shown in Fig. 24.1(a). You may cover several leaves of the same plant with black strips and clips.

- Place the set-up in bright sunlight for about two hours.
- Take about 150 mL water in a beaker and boil it.
- Pluck the experimental leaves from the potted plant and remove the black paper strips from them. Keep these leaves in boiling water for some time till the leaves become soft. Stop heating the water. Remove the beaker from the tripod stand. Allow it to cool to about 60 °C.
- Transfer the leaves to a boiling tube containing alcohol.
- Place the boiling tube (containing experimental leaves in alcohol) in the beaker containing hot water at about 60 °C. Keep the boiling tube in the beaker till the leaves become colourless.
- Take some iodine solution in a petri dish.
- Wash the leaves in water and dip them in iodine solution in petri dish.
- After about five minutes, remove the leaves from iodine solution, wash them with water and observe the colours of the exposed part and unexposed (covered with black paper) part of the leaf [Fig. 24.1(b)].



**Fig 24.1 :** (a) A de-starched potted plant with part of a leaf covered with black paper strips on either side; (b) An experimental leaf after treatment with iodine

## OBSERVATIONS



After iodine treatment, colour of covered portion of leaf is \_\_\_\_\_ ; and the colour of the exposed portion of leaf is \_\_\_\_\_ .

## RESULTS AND DISCUSSION



Based on the results obtained, give reasons for the appearance of blue colour in the exposed parts of leaf and non-appearance of blue colour in the parts of leaf covered by black paper.

## PRECAUTIONS



- Alcohol is highly inflammable and hence it should not be heated directly on the flame.
- Satisfactory results will not be obtained if the plant is not completely de-starched.

## NOTE FOR THE TEACHER

- It is advised to select a herbaceous plant with thin, broad leaves. Thick, mucilaginous and fleshy leaves should be avoided.
- Keep a potted plant in darkness for about forty eight hours for de-starching the leaves. A de-starched plant must be provided to students for performing this experiment.
- The boiling point of alcohol is about 78 °C. If the test tube containing the leaves in alcohol is either heated directly or dipped in the boiling water, the alcohol will immediately evaporate without being much in contact with the leaves. It is therefore important to heat the test tube containing alcohol and leaves in a water bath (a beaker containing hot water at about 60 °C, in this case).
- The exposed part (to the sunlight) of the leaf turns blue on treatment with iodine whereas the covered part does not turn blue. The standard test for starch is treatment with iodine. Appearance of blue-black colour confirms the presence of starch.

## QUESTIONS

- What is meant by de-starching? Why do plants get de-starched when kept in continuous darkness for about forty eight hours?
- Will you get the same result if you perform the experiment without de-starching the plant? Give reason.
- Why do we warm the leaves in alcohol?
- Arrange the following steps in correct sequence:
  - (i) de-starching the plant;
  - (ii) treatment with iodine;
  - (iii) attaching black paper strips to the leaf;
  - (iv) keeping the set-up in sunlight;
- Why do we keep the experimental plant in bright sunlight?
- Can this experiment be performed with a de-starched leaf detached from the plant? Give reasons.

## Experiment 25

### AIM

To show that carbon dioxide is essential for photosynthesis.

### THEORY

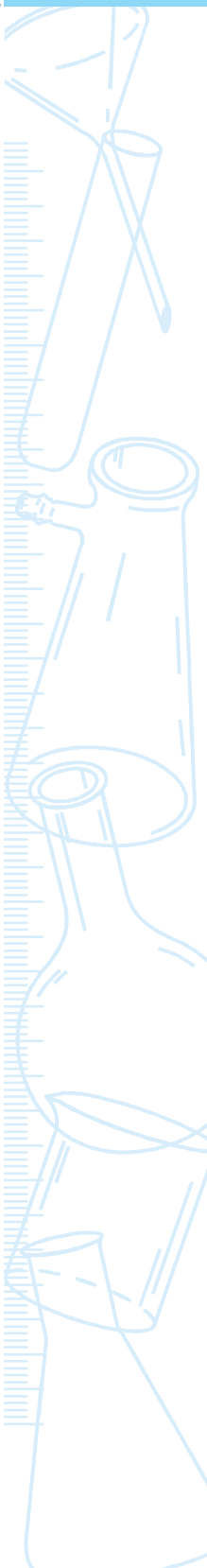
Plants are known as autotrophs as they synthesize or produce their own food (carbohydrate) by the process of photosynthesis. Besides light and water, carbon dioxide ( $\text{CO}_2$ ) is essential for this process. Carbon dioxide is taken up from the atmosphere through the stomata present in the leaves. During photosynthesis, carbon dioxide is reduced to form carbohydrates (glucose). If any one of the raw materials is not available, photosynthesis will not occur.

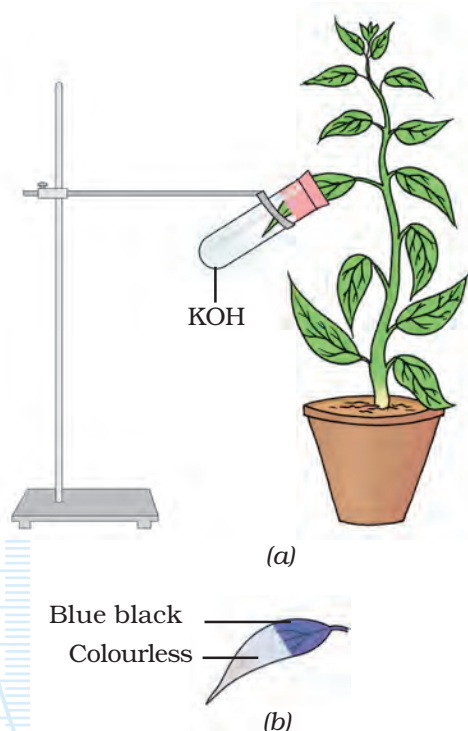
### MATERIALS REQUIRED

A de-starched herbaceous long leaved potted plant (such as *Tecoma*, balsam, *Amaranthus* or *Salvia*), two boiling tubes, a split cork, KOH solution (caustic potash), alcohol, iodine solution, petroleum jelly, beakers, a petridish, forceps, a burner (or a spirit lamp), a tripod stand, a wire gauge, and a laboratory stand with a clamp.

### PROCEDURE

1. Take a de-starched potted plant (from the list given above).
2. Fill one-fifth of the boiling tube with KOH solution.





**Fig. 25.1 :** A de-starched potted plant with part of a leaf in a boiling tube with KOH solution; (b) An experimental leaf after treatment with iodine

3. Insert one half of an intact leaf of the de-starched plant into the boiling tube through a split cork as shown in Fig. 25.1. Ensure that the leaf does not touch the solution.
4. Fix the tube to the stand with a clamp. Make the boiling tube air tight by applying a thin smear of petroleum jelly.
5. Keep the set up in bright sunlight for about one and half hours.
6. Take about 150 mL water in a beaker and boil it.
7. Detach the experimental leaf from the parent potted plant and boil it in water in a beaker for some time. Stop heating the water. Remove the beaker from the tripod stand. Allow it to cool to about 60 °C.
7. Transfer the leaf to alcohol taken in another boiling tube.
8. Place the boiling tube (containing experimental leaf in alcohol) in the beaker containing hot water. The leaf will also become warm. Keep the boiling tube in the beaker till the leaf become colourless.
9. Take some iodine solution in a petri dish.
10. Wash the leaf in water and dip it in iodine solution in the petri dish.
11. After about five minutes, remove the leaf from the iodine solution, wash it with water and observe (Fig. 25.2).

## OBSERVATIONS



After iodine treatment, colour of leaf portion that was inside the boiling tube (and not exposed to air) is \_\_\_\_\_ ; and the colour of leaf portion that was exposed to air is \_\_\_\_\_ .

## RESULTS AND DISCUSSION



Based on the results, reason out why only a part of the leaf turns blue or blue-black after treatment with iodine.



## PRECAUTIONS



- Care must be taken while handling KOH and alcohol.
- While setting up the experiment, insert the leaf carefully through the split cork. Do not damage it.
- Experimental set-up must be air-tight.
- Alcohol is highly inflammable and hence it should not be heated directly on the flame.
- Leaf should not touch the KOH solution.
- Satisfactory results will not be obtained if the plant is not completely de-starched.

## NOTE FOR THE TEACHER

- Keep a potted plant in darkness for about forty eight hours for de-starching the leaves. A de-starched plant must be provided to students for performing this experiment.
- The boiling point of alcohol is about 78 °C. If the test tube containing the leaves in alcohol is either heated directly or dipped in the boiling water, the alcohol will immediately evaporate without being much in contact with the leaves. It is therefore important to heat the test tube containing alcohol and leaves in a water bath (a beaker containing hot water at about 60 °C, in this case).

## QUESTIONS

- Why do we de-starch the leaves before the experiment?
- What is the role of KOH in the experiment? Can you suggest any other substance that can be used in place of KOH?
- How does the carbon dioxide gas enter the leaves?
- If carbon dioxide gas is essential for photosynthesis, do you think that plants growing in places with high CO<sub>2</sub> concentration have an advantage over plants growing in less polluted areas?

## Experiment 26

### AIM

To study the liberation of carbon dioxide gas during aerobic respiration.

### THEORY

Respiration is a catabolic process wherein food is oxidized to release energy for various life processes. It is of two types, namely (i) aerobic respiration that takes place in the presence of oxygen, and (ii) anaerobic respiration that takes place in the absence of oxygen. In aerobic respiration the breakdown of food (glucose) leads to the release of carbon dioxide gas, water and energy in the form of adenosine triphosphate (ATP). Most organisms that we see around us undergo aerobic respiration. Yeast and certain microorganisms and cells of skeletal muscles in our body undergo anaerobic respiration. In this experiment, we shall study the liberation of carbon dioxide gas during an aerobic respiration, using two different methods.

*Note:* Here, two methods are suggested to study the liberation of carbon dioxide gas. Teachers may suggest any one of these depending on the facilities available in the school laboratory.

### METHOD 1

### MATERIALS REQUIRED



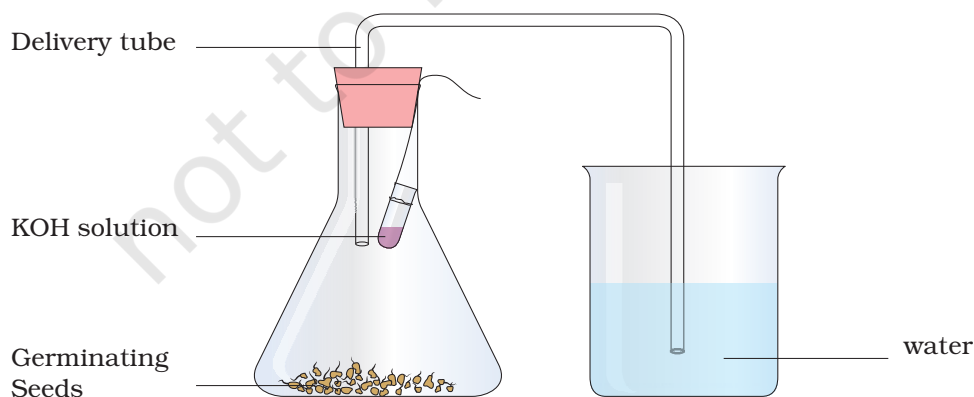
Germinating gram seeds, KOH solution, petroleum jelly, a conical flask

(100 mL), a beaker (250 mL), a single-bore cork, a clean delivery (bent) tube, a small test tube, a piece of thread, and a measuring scale.

## PROCEDURE



1. Take about forty germinating seeds in a conical flask.
2. Fix the cork to the mouth of the conical flask and with the help of a thread, suspend the tube containing KOH solution (as shown in Fig. 26.1).
3. Insert one end of a clean delivery tube in the conical flask through the cork. Dip the other end of the delivery tube in a beaker filled with water as shown in Fig. 26.1. There will be a rise of water level inside the delivery tube at the end dipped in the water due to capillary action. Mark the position of water level in the tube. This is the initial reading ( $h_1$ ) of water level in the delivery tube. (Mark the initial position of water level on the delivery tube with a sketch pen.)
4. Make the conical flask air-tight by applying a thin smear of petroleum jelly so that the gas evolved during the process of respiration by the germinating seeds does not leak out.
5. Keep this set-up undisturbed for about forty five minutes in the bright sunlight.
6. Do you find any change in the water level inside the delivery tube after forty five minutes? Does it increase? Note and record the final water level ( $h_2$ ) in the delivery tube. (Mark the final level of water in the delivery tube with a sketch pen.)
7. You have drawn lines on the delivery tube for recording the initial and final water levels in it. As a matter of courtesy to those using this tube later, please clean the tube.



**Fig. 26.1 :** Production of carbon dioxide gas during respiration in a conical flask

## OBSERVATIONS



- Observe the position of water level inside the delivery tube in the beginning of the experiment and at the end of the experiment (The duration of experiment is the time during which the experimental set-up is placed in bright sunlight).
- Record the change in water level in the delivery tube.

## RESULTS AND DISCUSSION



Analyse the experimental results and give reasons for the results obtained.

## PRECAUTIONS



- Ensure that the experimental set-up is air-tight.
- KOH is corrosive. Handle it carefully.

## NOTE FOR THE TEACHER

- KOH solution kept in the test tube inside the air-tight conical flask absorbs the evolved carbon dioxide released by germinating seeds thereby creating a partial vacuum in the conical flask. So an equal volume of water rises up in the tube. This indicates that the germinating seeds are actively respiring and evolving carbon dioxide gas during the process of respiration.
- This experiment can also be performed using flower buds.

## QUESTIONS

- What is the role of KOH in this experiment?
- When we say that plants and animals respire, where exactly is the process occurring?
- Why do we use germinating seeds in this experiment?

## METHOD 2

## MATERIALS REQUIRED



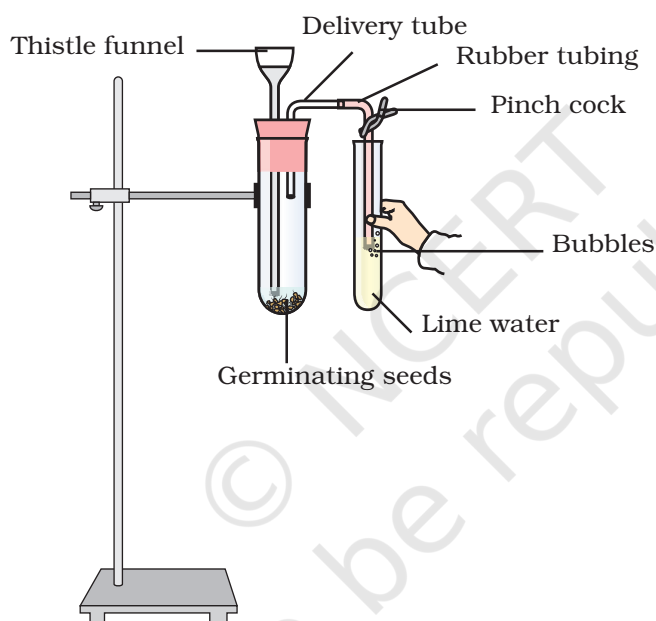
Germinating gram seeds, phenol red indicator, petroleum jelly, a thistle

funnel, a delivery tube, rubber tubing, boiling tube, a test tube, a two-bore rubber cork, a pinch cock and a stand with clamp,

## PROCEDURE



1. Place about twenty germinating seeds in a boiling tube containing some water in it.
2. Fit a two-bore rubber cork to the mouth of the boiling tube. Make the set up air-tight by applying a thin smear of petroleum jelly so that the gas evolved during the process of respiration by the germinating seeds does not leak out.
3. Fix a thistle funnel through one of the bores in the cork (Fig. 26.2). The lower end of thistle funnel must dip in water.



**Fig. 26.2 :** Production of carbon dioxide gas during respiration

4. Pass a delivery tube through the second bore of the cork. Attach a rubber tubing to the delivery tube, fold it backwards and fix a pinch cock. Using a clamp, fix the boiling tube to a stand, as shown in Fig. 26.2.
5. Place the set-up in bright sunlight for about one hour.
6. Take about 1 mL of water in a test tube (1 drop of water has a volume of nearly 0.1 mL). Add two drops of phenol red indicator to it and shake. Note the colour.
7. Dip the free end of rubber tubing into the test tube containing phenol red indicator solution and release the pinch cock.

8. Pour a few mL of water through the thistle funnel into the boiling tube containing germinating gram seeds.
9. Observe bubbles of a gas emerging from the rubber tube dipped in the phenol red indicator solution. Shake the test tube vigorously and note the change in the colour of indicator. Record your observations.

## OBSERVATIONS



Colour of dilute phenol red indicator in the beginning of experiment is \_\_\_\_\_. After keeping the boiling tube in bright sunlight for about an hour and on passing the evolved gas from the boiling tube through the indicator, the colour of phenol red indicator changes to \_\_\_\_\_.

## RESULTS AND DISCUSSION



With the knowledge of reaction of carbon dioxide gas with phenol red indicator solution interpret the observations.

## PRECAUTIONS



- Take sufficient number of germinating seeds.
- Keep the set up in bright sunlight.
- Apparatus must be air-tight. Check all joints and apply petroleum jelly so that the evolved gas does not escape from the boiling tube.

## NOTE FOR THE TEACHER

- Phenol red is a very sensitive indicator. Initially when diluted with water it is pink in colour. After carbon dioxide gas is passed through it, its colour turns to pale yellow. Phenol red is pink in neutral and alkaline medium. However its colour is pale yellow in acidic medium.
- In place of phenol red indicator, lime water [ $\text{Ca}(\text{OH})_2$  (aq.)] can also be used. Lime water is a colourless solution. It becomes milky when carbon dioxide gas is passed through it (this is due to the formation of calcium carbonate), However on passing excess of carbon dioxide gas through the lime water, calcium hydrogencarbonate is formed. It is soluble in water and forms a colourless solution.

*Preparation of lime water:* Shake about 5 g of calcium hydroxide,  $\text{Ca}(\text{OH})_2$  in 100 mL water. Allow it to stand for 24 hours. Decant the supernatant liquid and use it for the tests. Always use freshly prepared lime water.

## QUESTIONS

- Why germinating seeds or flower buds are ideal materials for this experiment?
  - Why is the experimental set-up kept in sun-light?
  - Why do we pour water into the boiling tube containing germinating seeds through a thistle funnel?
  - What is the gas that reacts with the phenol red indicator (or with the lime water)?
  - How do germinating seeds respire - aerobically or anaerobically? Analyse.
  - Drop a NaOH (or KOH) pellet into the pale yellow phenol red indicator and observe? Reason out the cause of the change.
  - Arrange the following steps in correct sequence for this experiment:
    - (i) the colour of phenol red indicator (or lime water) changes;
    - (ii) remove the pinch-cock attached to the rubber tubing;
    - (iii) take a few germinating seeds in the boiling tube;
    - (iv) place the set-up in bright sunlight.
- (a) i, ii, iii, iv; (b) iii, iv, ii, i; (c) iv, ii, iii, i; and (d) iii, ii, iv, i.

## Experiment 27

### AIM

To study the liberation of carbon dioxide gas during fermentation.

### THEORY

Living organisms obtain their energy from the food material by the process of cellular respiration. Most of the organisms are aerobic wherein, oxygen is used to break-down glucose completely into carbon dioxide and water, and simultaneously releasing energy in the process. Some organisms like yeast and certain bacteria can respire in the absence of oxygen by a process called anaerobic respiration. During this process, glucose is converted to ethanol and carbon dioxide, and energy is released. This process of respiration in some microorganisms under anaerobic conditions is called fermentation. In this experiment we shall study the process of fermentation and the liberation of carbon dioxide gas.

### MATERIALS REQUIRED

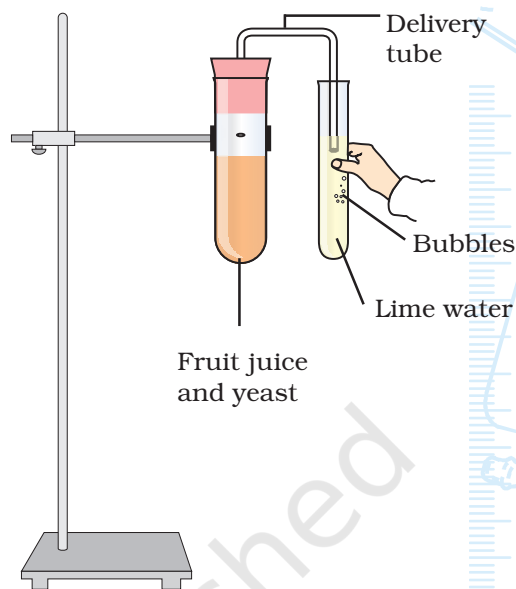


Any fruit juice (or sugar solution), powdered granules of baker's yeast, freshly prepared lime water, petroleum jelly, two test tubes, a single-bore cork, a delivery tube, a dropper, a beaker (250 mL), and a laboratory stand with a clamp,



## PROCEDURE

1. Fill a test tube completely with a fruit juice (or sugar solution).
2. Dissolve the powdered granules of baker's yeast in water in another test tube. Using a dropper, add about twenty drops (2 mL) of this suspension in the test tube filled with the fruit juice. Smell the liquid mixture and record its smell.
3. Fix a cork in the mouth of this completely filled test tube. While fitting cork, some fruit juice may spill over. Make the test tube air-tight by applying a thin smear of petroleum jelly.
4. Insert a delivery tube through the single-bore cork in this completely filled test tube through the cork (Fig. 27.1).
5. Clamp the test tube to a laboratory stand.
6. Dip the other end of the delivery tube in the freshly prepared lime water kept in a beaker, as shown in Fig. 27.1.
7. Keep the set-up undisturbed in bright sunlight for about sixty minutes.
8. Do you see any gas bubbles passing through the lime water? Does it turn milky? Record your observations.
9. Note and record the smell of the fruit juice mixture in the test tube at the end of the experiment.



**Fig. 27.1 :** Set-up to study liberation of carbon dioxide gas during fermentation

## OBSERVATIONS



Smell of the fruit juice mixture at the beginning of experiment is \_\_\_\_\_, while at the end of experiment (that is after keeping the set-up in bright sunlight for about sixty minutes) is \_\_\_\_\_.

Gas bubbles passing through the lime water are observed during the experiment and the lime water turns \_\_\_\_\_.

## RESULTS AND DISCUSSION



Observe the change in smell of the fruit juice mixture after keeping it in bright sunlight. What does it show? Analyse the results and comment on the anaerobic nature of the set experiment and formation of ethanol and carbon dioxide.



## PRECAUTIONS

- Apparatus must be airtight to provide anaerobic conditions.
- Use only freshly prepared lime water.

## APPLICATIONS

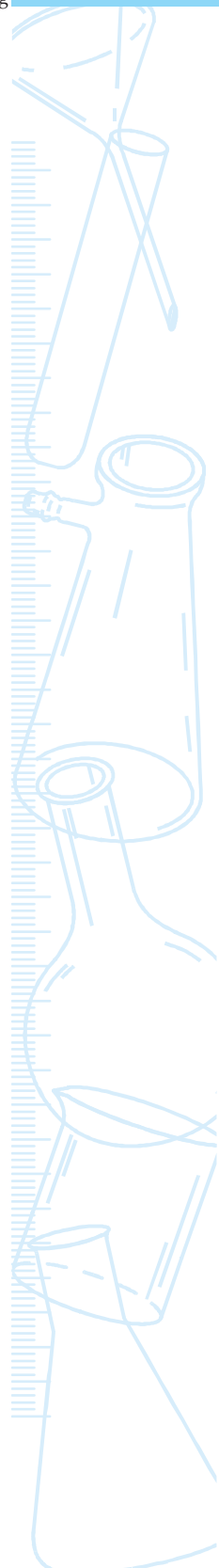
- Fermentation has intense industrial applications. Breweries, baking industries and pharmaceutical industries make use of this process extensively.

## NOTE FOR THE TEACHER

- During the experiment, fermentation has taken place under anaerobic conditions in which glucose in the fruit juice (or sugar solution) is broken down into ethanol and carbon dioxide. Lime water  $[\text{Ca}(\text{OH})_2 \text{ (aq.)}]$  is a colourless solution. It becomes milky when carbon dioxide gas is passed through it. This is due to the formation of calcium carbonate. However, on passing excess of carbon dioxide gas through the lime water, calcium hydrogencarbonate is formed. It is soluble in water and forms a colourless solution.  
*Preparation of lime water:* Stir about 5 g of calcium hydroxide,  $\text{Ca}(\text{OH})_2$ , with 100 mL water. Allow it to stand for 24 hours. Decant the supernatant liquid and use it for the tests. Always use freshly prepared limewater.
- The liberation of carbon dioxide may also be verified by dipping the delivery tube in freshly prepared KOH solution (in place of lime water). The carbon dioxide gas released in the fermentation process of fruit juice (or sugar solution) is absorbed by the KOH solution. A partial vacuum is produced inside the delivery tube and the level of KOH solution in the delivery tube rises.
- The liberation of carbon dioxide may also be verified by dipping the delivery tube in a test tube containing phenol red indicator solution. On passing the carbon dioxide gas through it, the pink indicator turns into pale yellow.
- Fermentation is not always limited to anaerobic organisms. For example, even in the presence of abundant oxygen, yeast cells prefer fermentation rather than oxidative phosphorylation, as long as sugars are readily available for consumption. Sugars are the common substrates for fermentation, and most common fermentation products are ethanol and lactic acid.

## QUESTIONS

- Why do we take a fruit juice (or a sugar solution) for this experiment? Can we use any other food material in place of fruit juice or sugar solution?
- How does the lime water turn milky in this experiment?
- What are the industrial products that are manufactured by the process of fermentation?
- What are the end products of fermentation?
- Which by-product of the fermentation process is useful in baking industry?
- Which by-product of fermentation is useful in brewing industry?



## Experiment 28

### AIM

To study the action of salivary amylase on starch solution.

### THEORY

The human digestive system consists of an alimentary canal and its associated glands, namely salivary glands, gastric glands, liver, pancreas and intestinal glands. These glands secrete various digestive enzymes which hydrolyze complex molecules of food into simpler molecules that are absorbed into the blood. Saliva is one of the digestive juices secreted by salivary glands present in the mouth cavity. It contains an enzyme called salivary amylase (ptyalin) that acts on starch and converts it into simpler sugars.

### MATERIALS REQUIRED

1% starch solution, 1% iodine solution, saliva, distilled water, three test tubes, test tube stand, a measuring cylinder (10 mL), a dropper, a glass rod, a glazed tile (or two petri dishes), a spatula (or spoon), and surgical cotton,

### PROCEDURE

1. Rinse your mouth with fresh water. Using a spatula or spoon, collect some saliva from the mouth cavity. Filter the saliva through a cotton swab and take 1 mL of it in a test tube. Add 10 mL distilled water to it.

- Label this test tube as saliva solution. Keep it in the test tube stand.
- Take 2 mL of 1% starch solution in each of two test tubes. Label the test tubes as A and B. Keep both test tubes in the test tube stand.
  - Add 1 mL diluted saliva to test tube B. Shake thoroughly. Do not add anything to test tube A.
  - After about five minutes using a dropper, take five drops of solution from test tube A on a glazed tile (or in a petri dish) and add two drops of 1% iodine solution. Mix the two with a glass rod. Observe the colour of the mixture and record your observation. Wash the glass rod after mixing.
  - At a distance away from the place where the above mixture (step 4) is kept on the glazed tile (or on a separate petri dish), place five drops from test tube B. Add two drops of 1% iodine solution to it. Mix the two with the glass rod and observe the colour of this mixture and record your observation. Wash the glass rod after mixing.
  - Repeat steps 4 and 5, after five, ten, fifteen and twenty minutes.

## OBSERVATIONS



Solution	Colour after adding iodine solution			
	5 min	10 min	15 min	20 min
Test tube A solution				
Test tube B solution				

## RESULTS AND DISCUSSION



Based on observations, reason out the results obtained for test tube A and test tube B solutions.

## PRECAUTIONS



- Rinse your mouth with water before collecting saliva.
- Saliva should be filtered through moistened cotton swab before use.
- Wash the glass rod every time after use.

## NOTE FOR THE TEACHER

- Iodine is an indicator that turns starch into blue-black colour. In test tube A starch was not hydrolysed since amylase was not present. In tube B amylase broke down starch into simpler carbohydrates.

Since no starch is available in tube B after some time, it does not turn blue-black with iodine solution.

- Iodine crystals are insoluble in water but soluble in potassium iodide solution.

## QUESTIONS

- Name the enzyme present in saliva.
- What is the role of iodine solution in the experiment?
- What is an enzyme?
- What is the substance formed when iodine reacts with starch.
- Name the substrate and enzyme in this experiment.
- Why does chewing food thoroughly in our mouth helps the digestive process?
- Which one of the following is an indicator in the experiment?  
(i) starch solution; (ii) amylase; (iii) saliva; (iv) iodine solution.

## Experiment 29

### AIM

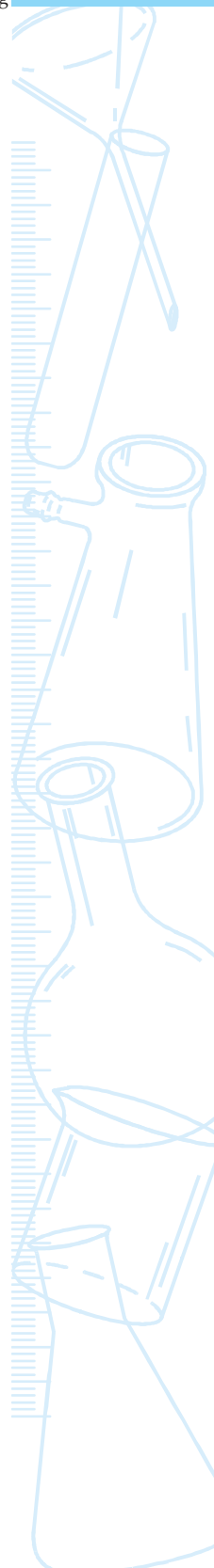
To determine the mass percentage of water imbibed by raisins.

### THEORY

Imbibition is a special type of diffusion in which movement of water takes place due to difference in water molecule concentration between the adsorbant and the imbibant. For imbibition to occur an adsorbent is required. For example, the dry plant or dry seeds (adsorbent) when placed in water increase enormously in volume. Water molecule concentration difference between the adsorbent and the liquid imbibed is essential for imbibition. In addition, for any adsorbent to imbibe any liquid, affinity between the adsorbent and the imbibent is necessary. For example, the cellulose material of dry wood (adsorbent) has strong affinity for water (imbibent). This results in swelling of wood when kept in water. The rate of imbibition varies with the variations in temperature.

In this experiment we shall study the phenomenon of imbibition using dry raisins. Water molecules enter the dry raisins as a result of which they swell. The difference in mass between swollen and dry raisins gives the amount of water absorbed by the raisins. When expressed in terms of percentage, it is called mass percentage of water imbibed by raisins.

$$\text{Mass \% of water imbibed} = \frac{\text{mass of the water absorbed by the raisins}}{\text{initial mass of the raisins}} \times 100$$



## MATERIALS REQUIRED



A handful of raisins, a beaker (50 mL), a thermometer, physical balance with weight box, a pair of forceps and a piece of blotting paper.

## PROCEDURE



1. Select about twenty dry and clean raisins of approximately uniform size.
2. Weigh them using a physical balance and note their mass ( $m_1$ ).
3. Keep the raisins for about an hour in sufficient water taken in a beaker. (It is expected that the raisins would be completely swollen within an hour.)
4. Note the temperature ( $\theta$ ) of water in the beaker.
5. Using forceps, remove the swollen raisins from the beaker; gently roll them on a blotting paper to remove the water sticking to their surface.
6. Weigh the swollen raisins to find their final mass ( $m_2$ ).

## OBSERVATIONS AND CALCULATIONS



Temperature of water,  $\theta =$  \_\_\_\_\_  $^{\circ}\text{C}$  = \_\_\_\_\_ K  
 Initial mass of the twenty dry raisins,  $m_1$  = \_\_\_\_\_ g  
 Final mass of the swollen raisins,  $m_2$  = \_\_\_\_\_ g  
 Mass of the water absorbed by the raisins, ( $m_2 - m_1$ ) = \_\_\_\_\_ g.

or

Mass % of water imbibed =  $\frac{\text{mass of the water absorbed by the raisins}}{\text{initial mass of the raisins}} \times 100$

$$\text{Mass \% of water imbibed} = \frac{m_2 - m_1}{m_1} \times 100$$

$$= \text{_____} .$$

## RESULTS AND DISCUSSION



The mass percent of water absorbed by the raisins at temperature \_\_\_\_\_ K is \_\_\_\_\_ %.

Analyse the reasons of water imbibed by the raisins.



## PRECAUTIONS



- Ensure that the raisins are dipped in water completely.
- Remove the raisins from the beaker only after ensuring that the raisins are completely swollen. Care should be taken while taking the raisins out from the beaker while using forceps. The forceps must not pierce into the raisins.
- Before weighing the swollen raisins, they should be properly dried with the help of blotting paper.

## NOTE FOR THE TEACHER

- In this study, adsorption is the process of formation of a layer of a liquid on a solid.
- In place of raisins, dry gram seeds may also be used. However, these may require more time for complete swelling.
- The mechanism by which the water enters the raisins or seeds is also called imbibition.

## QUESTIONS

- Will a piece of iron also swell when it is kept in water? Justify your answer.
- Have you experienced difficulty in closing wooden doors or windows during rainy seasons? Give a suitable explanation.
- Suggest an experiment by which the swollen raisins can be shrunk again.
- In some plants seed coats are very hard and thick. How do they break before seeds germinate.
- What will happen to the shape of a grape when it is placed in a viscous sugar solution?
- What is the effect of temperature on rate of imbibition?

## Experiment 30

### AIM

To study the phenomenon of phototropism and geotropism in plants.

### THEORY

Plant and its parts respond to various environmental stimuli like light, water, gravitational force, day-night changes, certain chemicals etc. All such responses are collectively called plant movements. Two of the most common responses are phototropism and geotropism. Phototropism refers to the response of plants to sunlight and geotropism refers to their response to gravitational force. Stems and aerial parts of plants grow towards the source of light; hence they are said to be positively (+ve) phototropic and concurrently also negatively (-ve) geotropic. Roots on the other hand grow away from light [negative (-ve) phototropism] and towards the gravitational force hence they exhibit positive (+ve) geotropism.

### MATERIALS REQUIRED



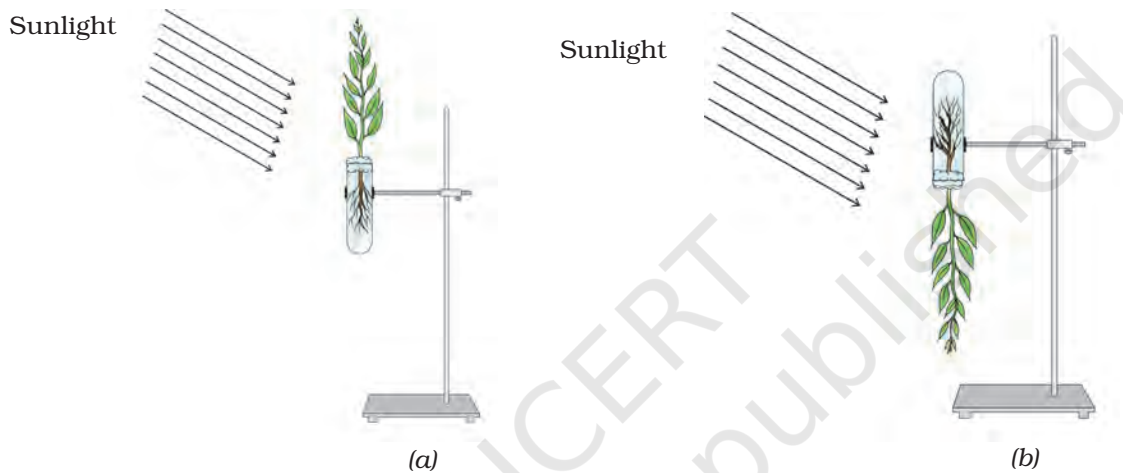
Two tender undamaged and un-branched plants with roots and leaves (such as seedlings of green gram), two boiling tubes, two laboratory stands with clamps, cotton, and adhesive tape.

### PROCEDURE



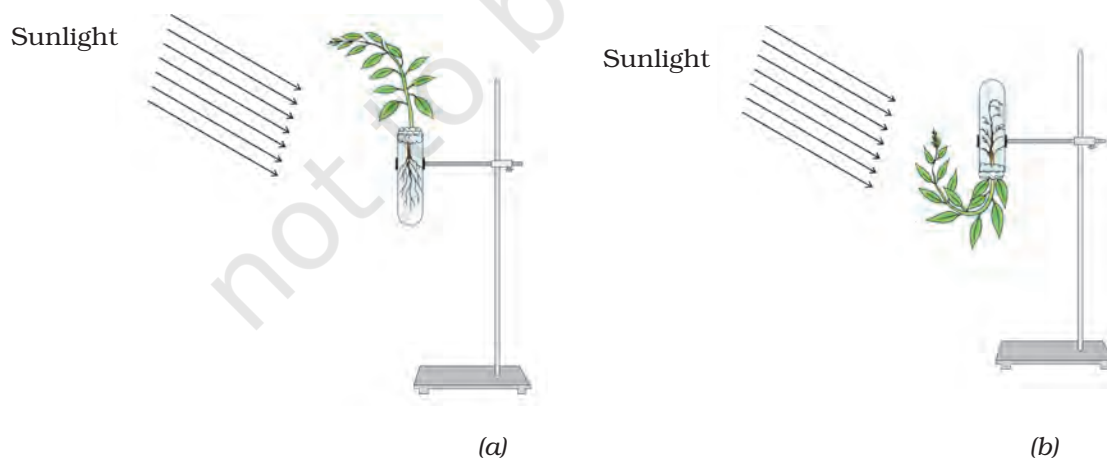
1. Take water in two test tubes to about two-third of their heights. Mark these test tubes as A and B.

2. Insert one plant into each test tube and introduce cotton swabs in such a way that roots dip in water and the stem with leaves project out of the test tube.
3. Seal the mouth of two test tubes using additional cotton and adhesive tape such that no water trickles out of the test tube even when they are inverted.
4. Fix tube A vertically upright in a laboratory stand as shown in Fig. 30.1(a). Fix the other test tube B upside down in another laboratory stand, as shown in Fig. 30.1(b). Ensure that the water in second tube does not trickle down.



**Fig. 30.1 :** The two plants in the beginning of the experiment on day 1

5. Place the two laboratory stands near a window such that direct sunlight falls on the two plants.



**Fig. 30.2 :** The two plants at the end of the experiment on day 4 (say)

6. Observe the plants in each test tube on day 2, day 3, and day 4. Record your observations. Note the direction of growth of stem and primary root. Indicate the features having +ve (or -ve) phototropism and +ve (or -ve) geotropism.

## OBSERVATIONS



	Day 1	Day 2	Day 3	Day 4
Plant in test tube A:				
Stem				
Root				
Plant in test tube B:				
Stem				
Root				

## RESULTS AND DISCUSSION



- Based on the observations recorded for plants in test tubes A and B, reason out the responses of stem and root in the experiment.

## PRECAUTIONS



- Select tender, un-branched herbs.
- Ensure that the roots of plants dip in water.

## NOTE FOR THE TEACHER

- The stem in test tube A grows vertically upwards and bends towards the light. The stem in test tube B shows a curvature and bends upwards towards the light and away from the gravitational force, thus showing +ve phototropism and -ve geotropism. Roots in both the test tubes grow downwards thus exhibiting positive geotropism. Roots in test tube B curve and grow towards the gravitational force thus exhibiting +ve geotropism.
- Experiment can also be set up with germinating seedlings of grams. Gram seedlings (20 -30) can be grown in a pot or in a small vessel and placed near a window. The young seedlings curve towards the direction of light.
- While it is easy to observe the response of stems, it is rather difficult to observe the response of roots.

## QUESTIONS

- Can a plant part be both +vely phototropic and +vely geotropic?
- What is the response of rhizome of ginger to light stimulus?
- Look at a banyan tree. Structures hang from aerial branches and grow towards the soil. Should we call these structures stem branches or roots? Explore.
- In what way does +ve geotropic response of roots help plants?

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## Experiment 31

### AIM

To study binary fission in *Amoeba* or *Paramecium* and budding in yeast or *Hydra*.

### THEORY

Binary fission and budding are forms of asexual reproduction in lower organisms, like bacteria, unicellular protozoans, and a few other animals. In binary fission, the parent cell divides into two daughter cells by amitosis and each daughter cell grows into an adult. The division of nucleus is called amitosis because the stages of a typical mitotic division are not observed in these cells. Budding is commonly seen in yeast and *Hydra*. *Hydra* is a tiny freshwater organism which produces young ones from its body laterally. Yeast is a unicellular organism which produces a chain of cells attached to the parent cell.

### MATERIALS REQUIRED



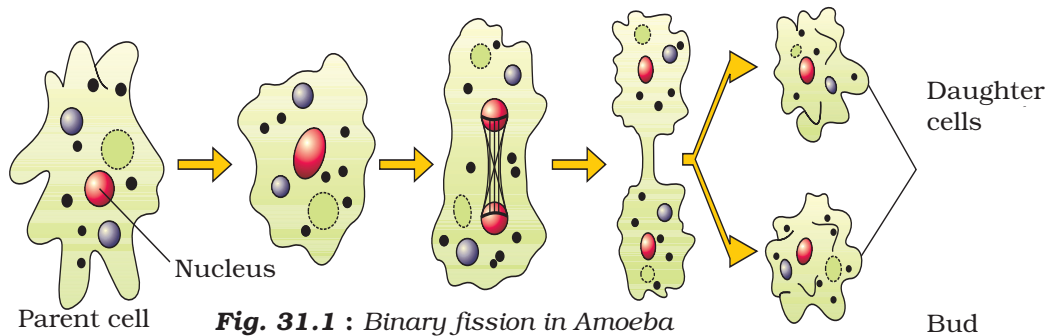
A compound microscope, permanent slides of binary fission in *Amoeba* or *Paramecium*; budding in yeast or *Hydra*; charts of binary fission and budding.

### PROCEDURE

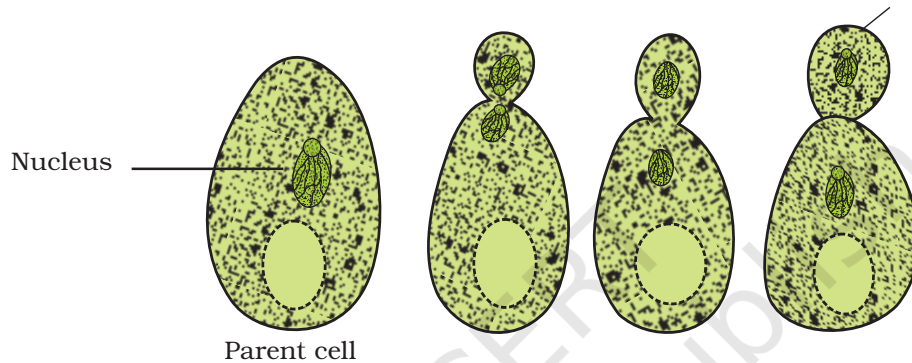


1. Focus the slide under high power of compound microscope.
2. Observe the stages in binary fission and budding (Figs. 31.1 and 31.2).

3. Draw diagrams of the stages in binary fission and budding.



**Fig. 31.1 :** Binary fission in Amoeba



**Fig. 31.2 :** Budding in yeast

## NOTE FOR THE TEACHER

- Charts may be used to reinforce the knowledge about different stages in binary fission and budding.
- A few points pertaining to binary fission and budding are given as follows:
  - (a) Binary fission in *Amoeba* or *Paramecium*
    - (i) *Amoeba* is irregular in outline and possesses a nucleus.
    - (ii) *Paramecium* is also a unicellular organism but its shape is like a slipper.
    - (iii) While viewing the permanent slide under high power, it is advised to locate and demonstrate the stages of binary fission.
  - (b) Budding in yeast or *Hydra*
    - (i) Yeast cells are spherical or oval in shape.
    - (ii) While viewing the permanent slide under high power, it is advised to locate and demonstrate the stages of budding and chain of buds.
    - (iii) In *Hydra*, buds appear laterally from the parent organism.

## QUESTIONS

- Which type of cell division is involved in binary fission?
- How many daughter cells are formed in binary fission?
- Why binary fission and budding are included under asexual reproduction?
- Are binary fission and budding faster processes of reproduction when compared to sexual reproduction. Justify.

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## Experiment 32

### AIM

To study vegetative propagation in potato, *Bryophyllum* and an aquatic plant.

### THEORY

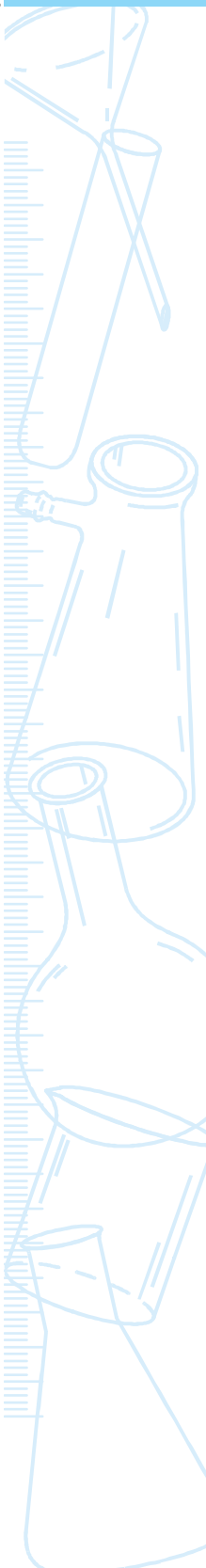
Although majority of flowering plants reproduce sexually by the production of flowers, some angiosperms reproduce by asexual methods also. Such plants produce offspring from the vegetative parts like roots, rhizome, stem and leaves. This method of reproduction is called vegetative propagation. Common examples of plants exhibiting vegetative propagation are potato, *Bryophyllum*, *Chrysanthemum* etc. and aquatic plants like *Hydrilla*, *Eichhornia*, *Pistia* etc. Horticulturists use this method for propagation of ornamentals like *Hibiscus*, rose, *Chrysanthemum*, jasmine etc.

### MATERIALS REQUIRED

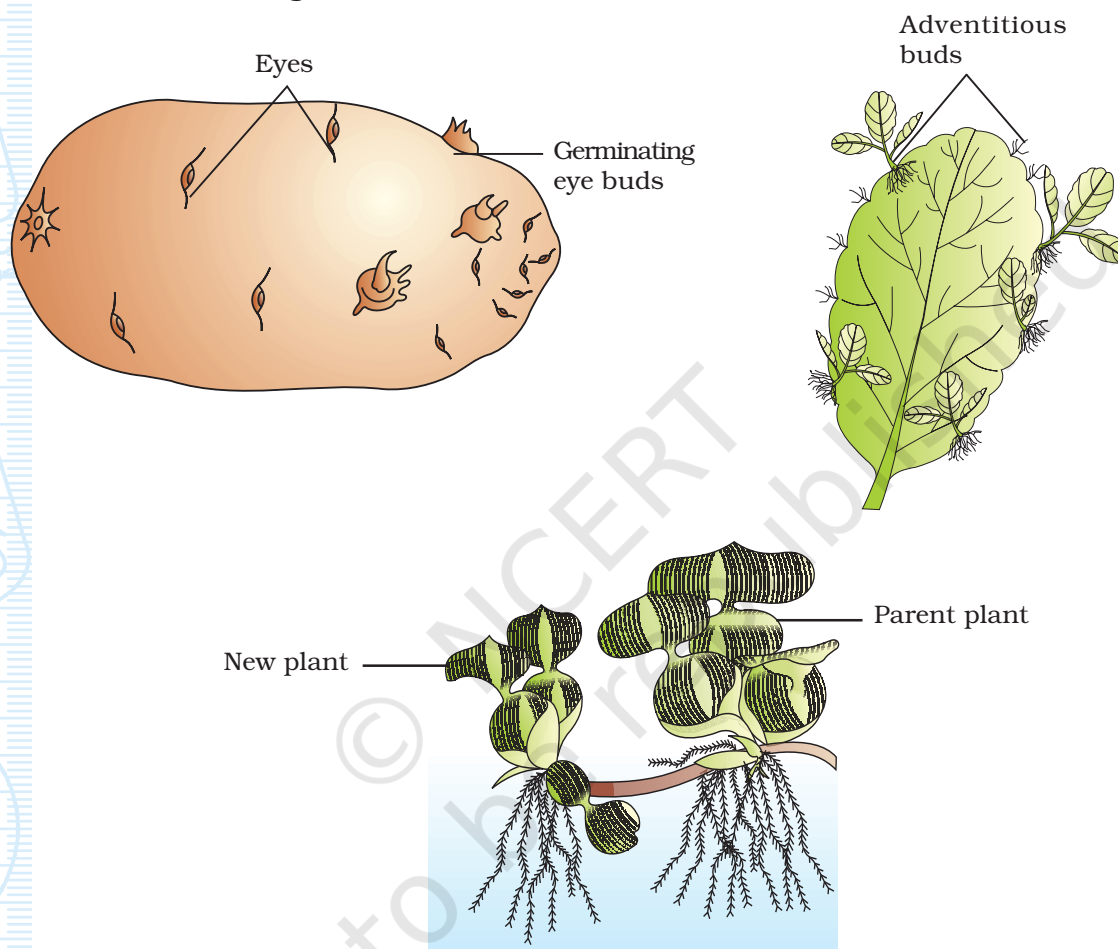
Two old tubers of potato (one with shoots and another without shoots), a few mature leaves of *Bryophyllum* with young adventitious buds, aquatic plant like *Eichhornia* or *Pistia*, a hand lens (magnifying lens).

### PROCEDURE

1. Examine a potato tuber carefully [Fig. 32.1(a)]. You will observe small pits or 'eyes' are actually the nodes of the stem.



2. With the help of hand lens (magnifying lens), observe each 'eye'. You will find a small adventitious bud in each eye.
3. Observe the origin of shoots from the surface of tuber. Draw sketches of a tuber without shoots and another with shoots.
4. Observe the lamina of Bryophyllum leaf, particularly the leaf margins [Fig. 32.1(b)].



**Fig. 32.1** : Vegetative propagation in (a) potato; (b) Bryophyllum; and (c) an aquatic plant

5. Tiny plants will be seen arising some notches in the margin.
6. Draw a diagram of Bryophyllum leaf with tiny plants attached to its margins.
7. Carefully observe the aquatic plant [Fig. 32.1(c)].
8. Note the formation of a new plant and the region of attachment of both plants.
9. Draw a diagram of the aquatic plant depicting the exact origin of the young plants.

## OBSERVATIONS



The surface of potato tuber has several \_\_\_\_\_. New shoots arise from the \_\_\_\_\_. Potato tuber represents a modified \_\_\_\_\_.

The margins of Bryophyllum leaves are \_\_\_\_\_ and they bear \_\_\_\_\_. Leaf is the \_\_\_\_\_ part of a plant.

In aquatic plant, new plant arises from the portion of parent plant.

## DISCUSSION

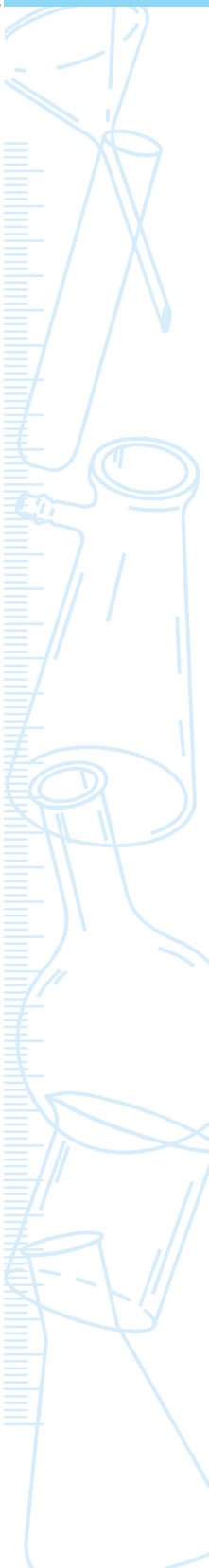
Analyse the origin of new plants in the three materials observed. Give reasons why this method of propagation is called vegetative propagation.

### NOTE FOR THE TEACHER

- In the present exercise, three examples are explained to understand vegetative propagation. The ability of certain plants like the ornamental plants, fruit bearing plants and plants used as vegetables to propagate vegetatively has been exploited by horticulturists, floriculturists and agriculturists.
- The most common method of reproduction in floating aquatic plants is the vegetative method. From the base of the condensed stem lateral shoots called offsets are formed. New plants arise from these offsets. This is how in a very short period of time aquatic plants multiply rapidly and cover the surface of the entire water body.
- This activity may also be considered as a project work.

## QUESTIONS

- Both potato tuber and radish are underground organs. Why is the former called a stem but later called a root?
- Can a vegetatively produced plant be called a clone? Analyse.
- Find out the method of propagation in banana, sugarcane, and ginger.



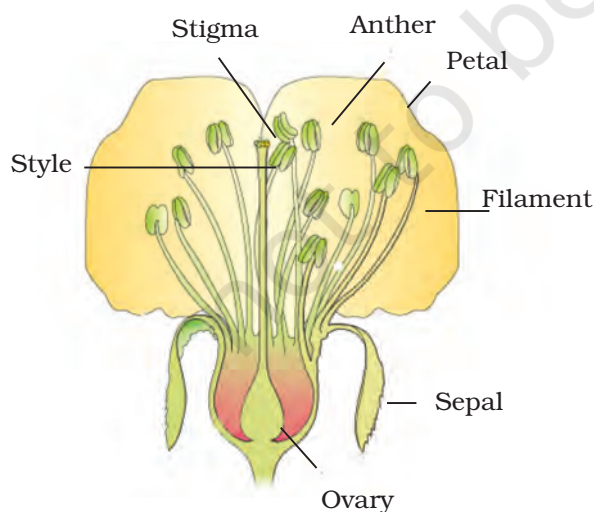
## Experiment 33

### AIM

To study the parts of a flower and their role in sexual reproduction.

### THEORY

Flower is a sexual reproductive part of angiosperms. A typical flower consists of four parts, namely sepals, petals, stamens and carpels. Collectively, sepals and petals constitute *Calyx* and *Corolla*, respectively. Likewise, stamens and carpels (or pistil) constitute *androecium* and *gynoecium*, respectively. Calyx and corolla are called accessory parts of the flower while androecium and gynoecium are called the reproductive parts. Stamens are the male reproductive organs where pollen grains are formed and carpels are the female reproductive parts, which enclose the ovules.



**Fig. 33.1 :** Longitudinal section of a flower

All floral parts are inserted on the thalamus which is a flattened or knob like structure of the stalk of flower (pedicel). Floral parts are present in successive whorls, sepals form the outer most whorl followed by petals, stamens and carpels.

Flowers show lot of variation in their shape, size, colour, number of sepals, petals,

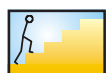
stamens and carpels. Various scientific terms are used to describe the structure of a flower. A short list of terms is provided here. The students are required to understand the definition of these terms before describing a flower.

## MATERIALS REQUIRED



Flowers of china rose, *Datura*, mustard, *Petunia* or *Dianthus*, charts of transverse sections of anther and ovary, permanent slides of the flowers chosen, dissection microscope, beaker, forceps, needle, slides, razor blade, and cover slips.

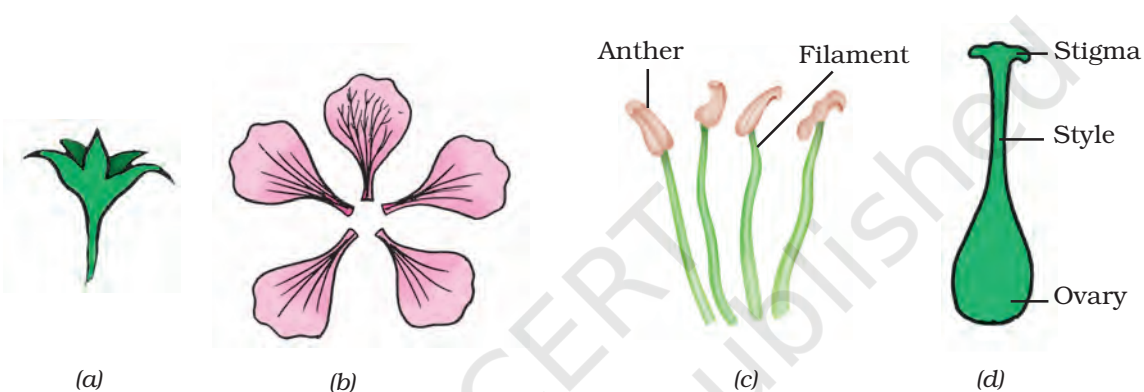
## PROCEDURE



- To prevent drying of flowers, keep the twigs in a beaker containing water.
- Examine the position of flower on the twig. Determine whether it is axillary or terminal; solitary or an inflorescence.
- Study the following characters of the flower and record the features:
  - Flower *pedicellate* (with stalk) or *sessile* (without stalk).
  - Complete – a flower with sepals, petals, stamens and carpels.  
Incomplete – a flower which lacks one or more floral whorls.
  - Unisexual – a flower with only stamens or carpels.  
bisexual – a flower with both stamens and carpels.
  - Sepals (calyx), Fig. 33.2(a): They form the outer whorl of the flower. They are small, green leaf like structures. In some flowers sepals may be coloured. Count the number of sepals; observe their colour; find out whether the sepals are free (polyseplous) or fused (gamoseplous).
  - Petals (*corolla*), Fig. 33.2(b): Count the number of petals; observe their colour and shape; find out whether petals are free (polypetalous) or fused (gamopetalous).
  - Stamens (*Androecium*), Fig. 33.2(c): Mount one stamen on the stage of the dissecting microscope and observe its various parts such as a stalk (short or long) called the filament, and a terminal bi-lobed anther.
  - Pistil (Gynoecium), Fig. 33.2(d): Mount the pistil on the stage of the dissecting microscope and observe its various parts such as the basal swollen portion (ovary), a *style* and a flattened tip, the *stigma*. Inside the ovary are one or more ovules attached to a flattened cellular cushion known as *placenta*.
- Cut a cross section of the anther. Mount the section in a drop of water taken on a slide. Observe it under the dissecting microscope.

Locate pollen grains in the slide and the cavities in anther called pollen sacs.

5. Cut a cross section of ovary, mount the section in a drop of water taken on a slide. Observe it under the dissection microscope. Count the number of chambers (locules) and locate ovules.
6. Draw diagrams of a flower showing sepal, petal, stamen and pistil.
7. Observe the permanent slides of transverse sections of anther and ovary. Identify different parts using the charts provided. Draw their diagrams in your notebook.



**Fig. 33.2 :** (a) Sepals (calyx); (b) Petals (corolla); (c) Stamens (Androecium); and (d) Pistil (Gynoecium)

## OBSERVATIONS



**Table 1**

Flower	Observations
Solitary or inflorescence	
Axillary or terminal	
Pedicellate or sessile	
Complete or incomplete	
Unisexual or bisexual	

**Table 2**

	Number	Colour	Free/fused
Sepals			
Petals			
Stamens			
Pistil			

## NOTE FOR THE TEACHER

- The purpose of this experiment is to observe the flower as a sexual reproductive part. Hence taxonomic description is kept minimum.
- Emphasis should be more on the stamen and pistil, their parts and the role in sexual reproduction.
- It is advised to show pollen grains and ovules to the students by making temporary mounts of these materials. Their role in sexual reproduction may also be discussed.
- If fruits and seeds are available, a seed can be cut open and its embryo may be mounted on a slide and demonstrated.

## QUESTIONS

- Does a plant produce as many fruits as the number of flowers it produces?
- Why does a flower produce thousands of pollen grains but only a few ovules?
- What is the function of coloured petals in a flower?
- Why are stamens and pistil called the essential parts of a flower?