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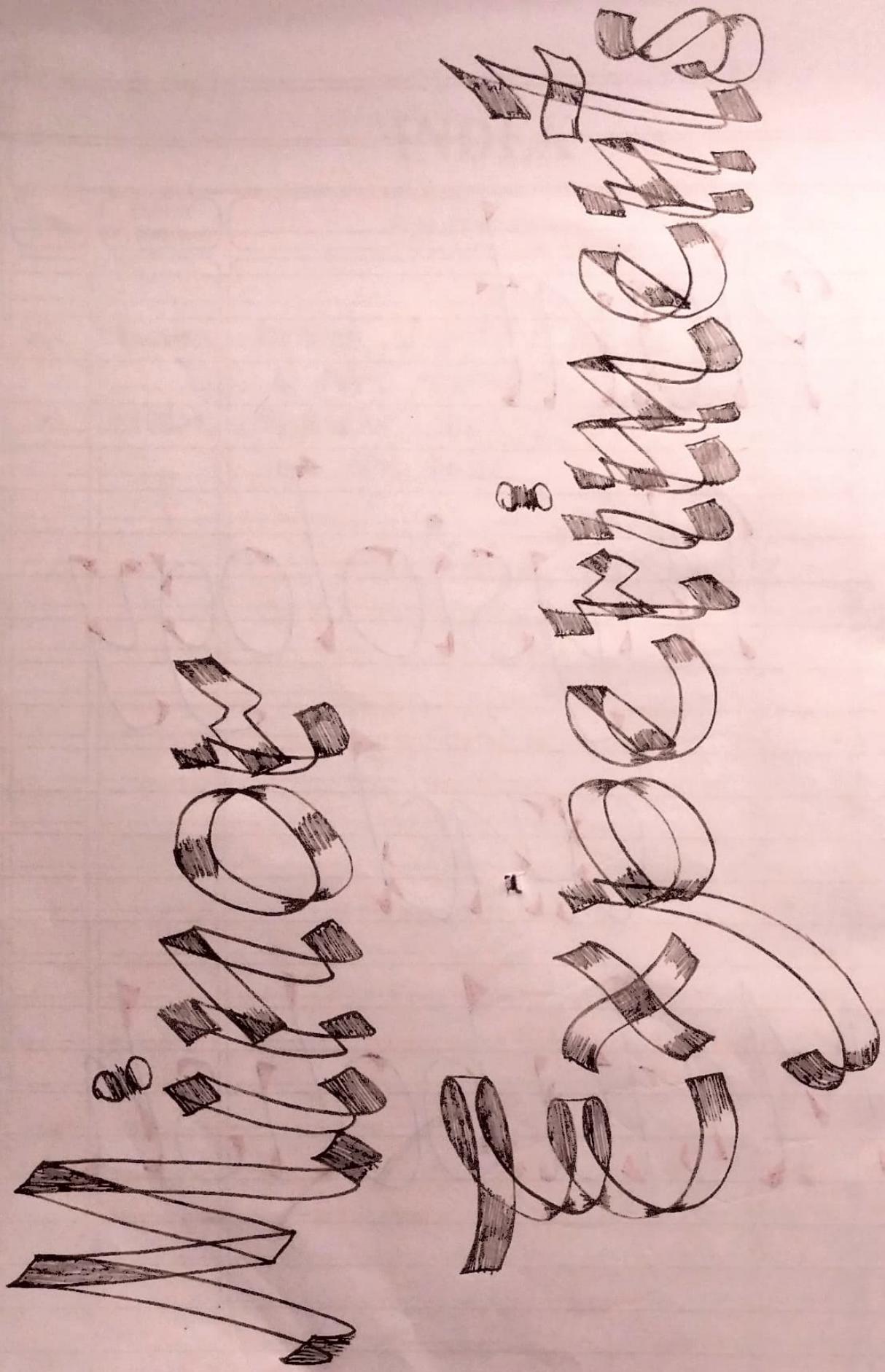
# INDEX

Plant

Physiology

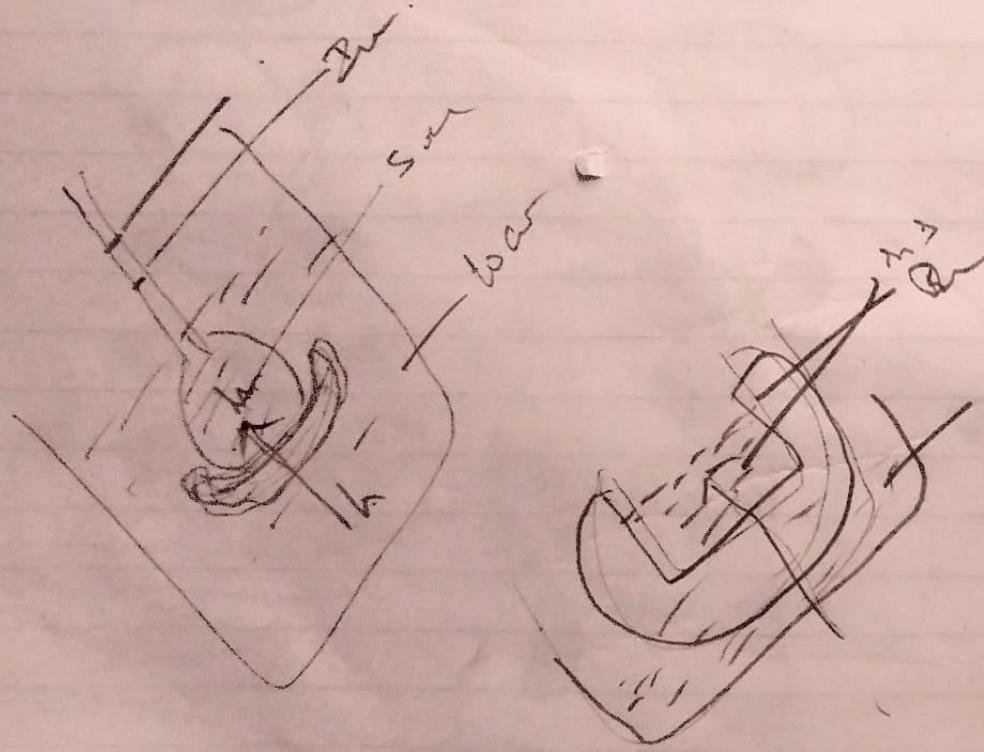
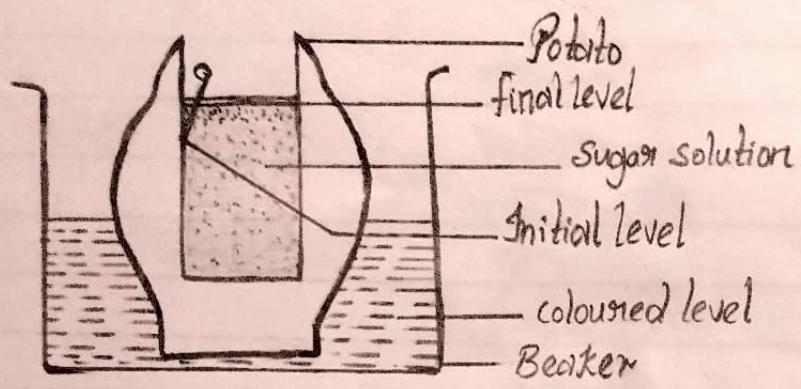
Osmo!

Metabolism





# Potato Osmoscope



# Potato Osmoscope

Aim : To demonstrate osmosis in living plant cells by potato osmometer.

Principle: Diffusion of solvent through semi permeable membrane due to difference in the water potential of adjacent cells is called osmosis.

Materials required: Potato tuber, knife, 20% sugar solution, saffronin, distilled water, Petri dish, peeler.

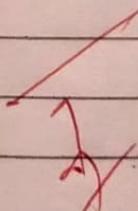
Procedure: Peel off a skin of a potato of medium (or) large sized. Make a cavity in it with water. Add 2 (or) 3 drops of saffronin. So, that the water of the petri dish becomes coloured. Fill the cavity of the potato tuber with 20% sugar solution and keep it in the petri dish containing coloured water. Mark the original level of sugar solution in it. Leave the set up for 1 hour.

Observation: After an hour, it is observed that the level of sugar solution inside the cavity of potato osmometer rises and becomes stable after certain period.

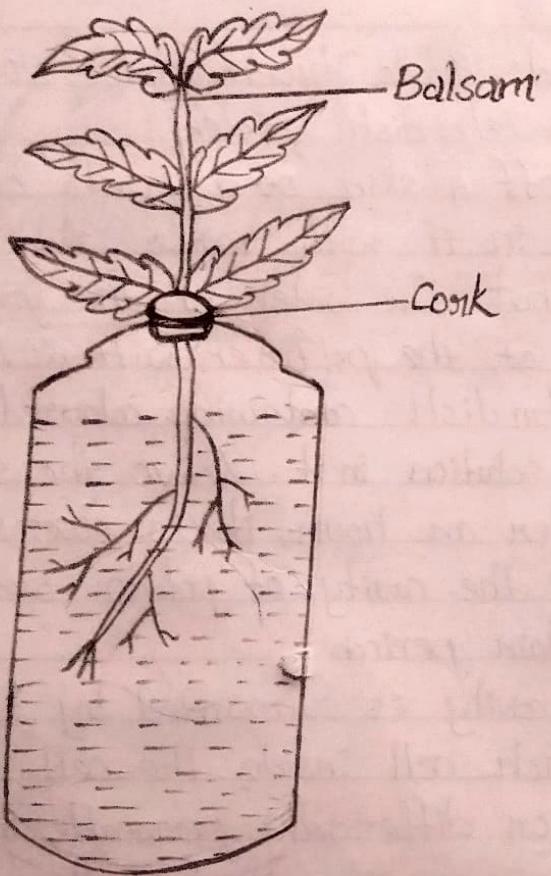
The potato cavity is surrounded by living cells. The plasma membrane of each cell inside the cell wall acts as a semi permeable membrane or differently permeable membrane.

When potato osmometer is placed in the petri dish filled with water, water diffuses into it potato tuber through cell wall.

This is the phenomenon of endosmosis, hence the initial level of sugar solution increases. This process of endosmosis continues until the hydrostatic pressure is created.



# Ascent of Sap



# Ascent of Sap

Aim: To demonstrate the movement of water through xylem in plants.

Principle: The upward movement of water against gravitation pull is called 'Ascent of sap'. This takes place in all the plants due to transpiration pull and cohesion and adhesion of water.

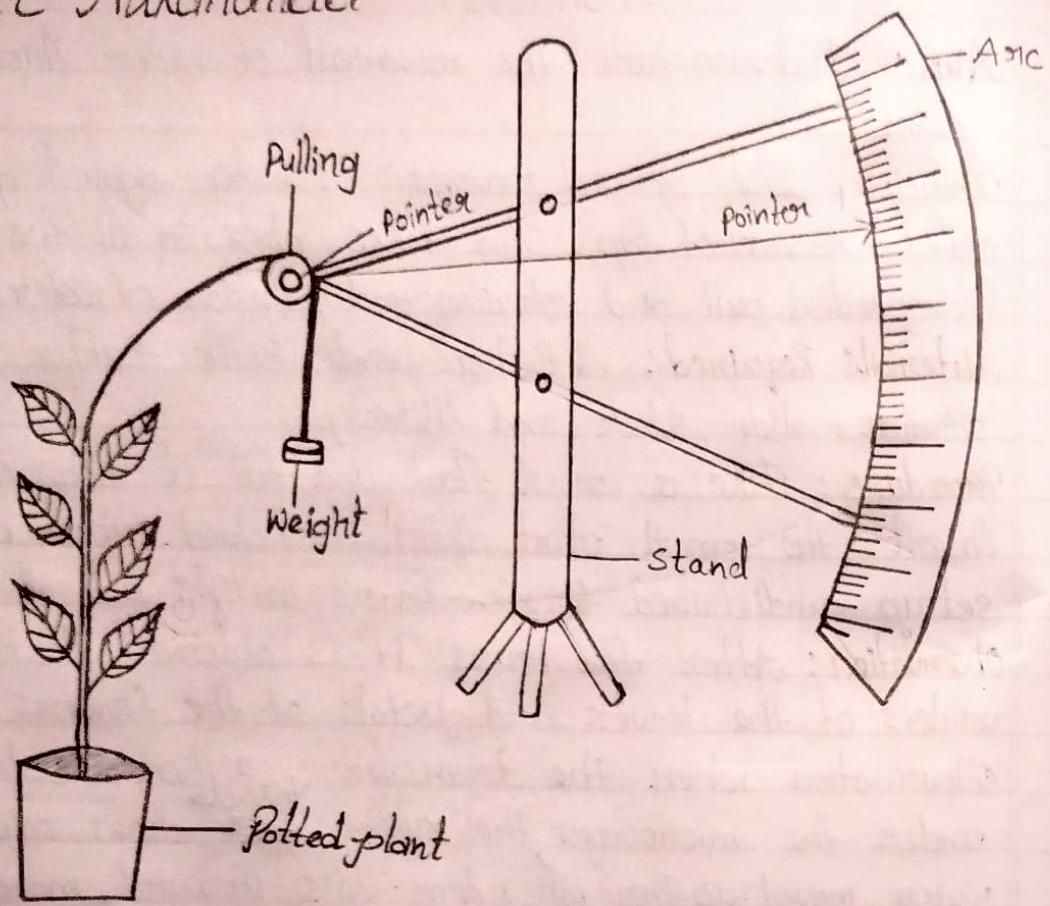
Materials Required: A Balsam plant, Bottle, Rubber cork, Eosin solution, slide, Blade and Microscope.

Procedure: Take a conical flask and fill it with eosin solution. Insert the small plant along its holded rubber cork. Leave the set up undisturbed for few hours in light and then observe.

Observation: After few hours it is observed that the veins and veinlets of the leaves and petals of the flowers shows red colourisation when the transverse <sup>vessels</sup> section of stem is observed under the microscope, the xylem ~~area~~ show colour indicating water moved up through xylem. This upward movement of water is called Ascent of sap.

2)

# Arc Auxometer



15

## Arc Auxanometer Experiment

**Aim :** To measure the growth of a plant in length by Arc Auxanometer.

**Materials Required :** Arc Auxanometer, potted plant, weight, thread.

**Procedure :** Arc Auxanometer which contains a small pulley in a arm of which is attached a long pointer sliding over a graduated arc.

One end of a thread is tied to the stem tip and another end to a weight passes over the pulley tightly. Note down the initial reading of the pointer. Keep the set up for a week.

**Observation :**

The stem grows in length, the pulley moves, and the pointer slide over the graduated arc. The distance travelled by the pointer is noted down.

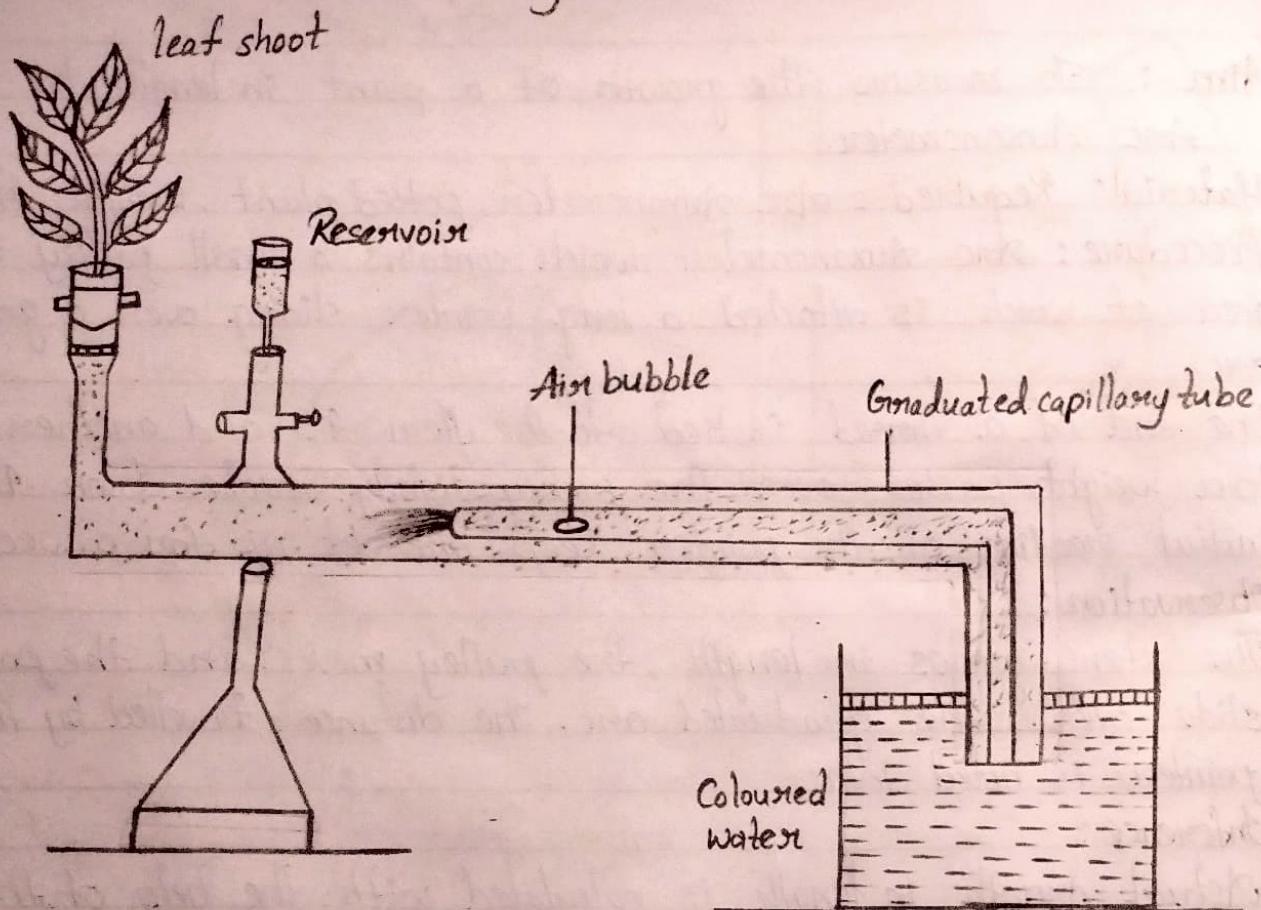
**Inference :**

Actual growth in length is calculated with the help of the formula.

$$\text{Actual growth in length} = \frac{\text{Distance travelled by pointer}}{\text{radius of the pulley}} \times \frac{\text{length of the pointer}}{\text{length of the pointer}}$$

$\cancel{2x}$

# Gianong's Photometer



# Ganong's Photometer

Aim:

To demonstrate the rate of transpiration by using Ganong's photometer.

Principle:

The rate of transpiration in plants is proportional to the rate of absorption of water. Therefore, the rate of absorption of water gives the rate of transpiration in plants.

This can be demonstrated by directly measuring the rate of movement of air bubble in the graduated horizontal tube of the photometer.

Materials Required: Ganong's photometer, small plant.

Procedure:

Ganong's photometer has a graduated horizontal capillary tube connected to a plant reservoir and water reservoir. The bent end is placed in the beaker as shown in the diagram.

Introduce the plant in the reservoir and see that only one air bubble is placed at one end of the tube.

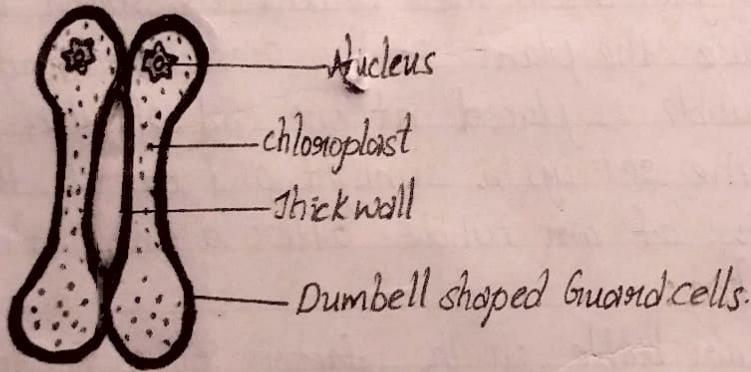
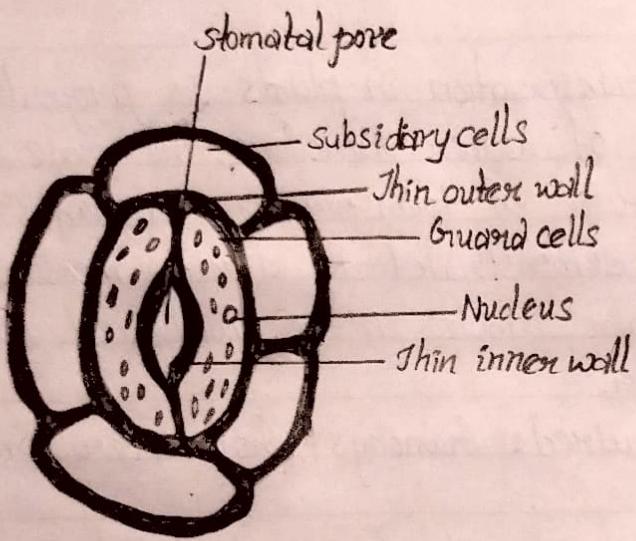
Keep the set up in sunlight and observe the initial and final positions of air bubble after a fixed interval of time.

Observation:

The air bubble on the factor influencing the air bubble moves towards the plant. The rate of movement depends on the factor influencing the rate of transpiration. By measuring the rate of air bubble, the rate of transpiration can be estimated.

2x

# Structure of Stomata



# Structure of stomata

Aim:

To study the structure of stomata in dicot and monocot leaves.

Principle:

The epidermal tissue system of leaves contain stomatal complex for exchange of gases and also for transpiration.

The transpiration is a necessary evil as it is essential for ascent of sap. The mounting of epidermis can provide information related to the structure of stomata.

Materials Required:

Dicot and Monocot leaves, slides, saffronin, cover slip and microscope.

Procedure:

Carefully peel off the epidermis from lower epidermis of the leaves slide and observe under microscope of mounting of the slide with cover slip and dye.

Observation:

The stomata is a complex made up of small opening called stoma surrounded by two guard cells. The guard cells are with inner rigid non-elastic wall and outer thin elastic wall. They contain chloroplast. They contain kidney shape in dicots and dumbbell shape in monocots. They are surrounded by subsidiary cells. The turgidity and fluidity of guard cells is responsible for opening and closing of stomata.

✓  
2x

# Mineral Deficiency Symptoms

## Nitrogen



## Phosphorus



## Boron



# Mineral Deficiency Symptoms

## Nitrogen:

- \* Yellowing of leaves
- \* first observed in older leaves and then seen in younger leaves.
- \* lower leaves fall off.
- \* Accumulation of anthocyanin leads to purplish colour in the stem and petioles.
- \* Above symptoms show the deficiency of major nutrient "Nitrogen".

## Phosphorus:

- \* Stunted growth of young plants.
- \* leaves turn dark green.
- \* Anthocyanin pigmentation is observed.
- \* Necrotic spots develop on the leaves, leaf's fall and distortion in the shape of leaf.
- \* Above symptoms shows the deficiency of major nutrient "Phosphorus".

## Boron:

- \* Death of cells in the shoot tip is observed.
- \* leaves show thick structure and curling.
- \* The root growth is stunted and flowers are not produced.
- \* Browning of internal tissue and their disintegration appear in storage roots (parts).
- \* Above symptoms show deficiency of minor nutrient "Boron".

## Molybdenum

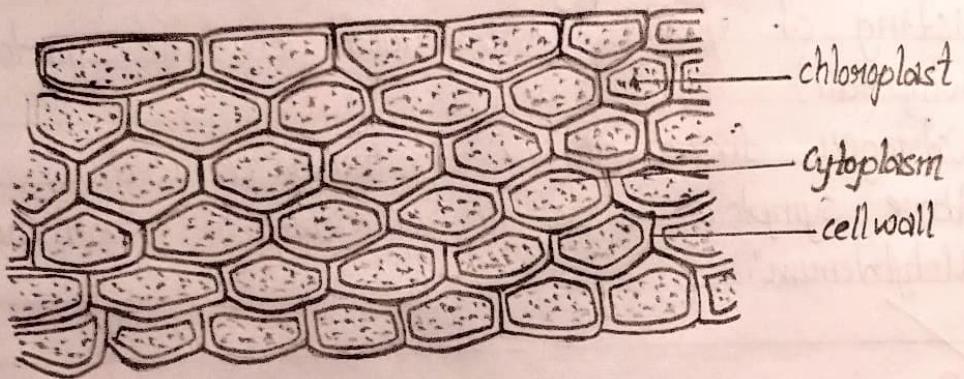


### Molybdenum:

- \* Chlorotic interveinal mottling of leaves is observed.
- \* Necrosis and infolding of leaves.
- \* Twisting of young leaves without chlorotic symptoms seen. (whip tail).
- \* Nitrogen fixing ability is much reduced.
- \* Above symptoms show the deficiency of minor nutrient "Molybdenum".

~~2X~~

# Cytoplasmic streaming in *Hydrilla* plant



# Cytoplasmic Streaming in Hydrilla

Aim:

To observe the rotation movement of cytoplasm in hydrilla leaves.

Requirements:

Hydrilla leaves, slides, cover slips, water, microscope, etc  
(use young leaves near the tip).

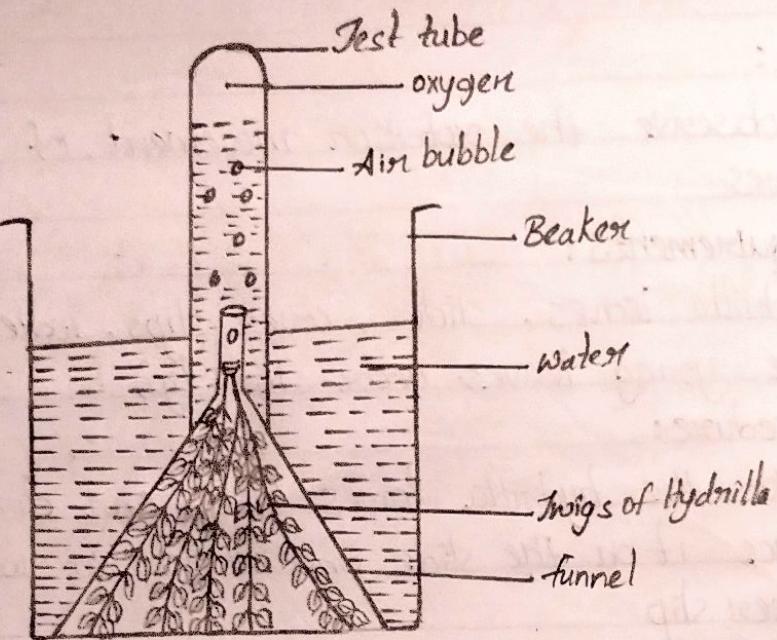
Procedure:

- \* Take the hydrilla leaves (leaf) and directly use the leaf.
- \* Place it on the slide and mount it with water with a cover slip.
- \* Observe the slide under microscope for the movement of cytoplasm in the leaf.

Observation:

Cytoplasm show rotation movement. This is due to the streaming movement of cytoplasm.

2X



S.No	Intensity of light	No. of oxygen bubbles per minute
1.	low	19
2.	High	25

# Effect of Intensity of light on Photosynthesis

**Aim:** To study the effect of intensity of light on the rate of photosynthesis.

**Principle:** Photosynthesis is the anabolic pathway which converts solar energy into chemical energy. It requires sunlight, water, carbon dioxide and chlorophyll. In the presence of all the factors higher plants perform photosynthesis and releases oxygen. The rate of photosynthesis is proportional to the rate of evolution of oxygen.

**Materials required:**

Hydrilla plant, Beaker, funnel, test-tube, water and slide.

**Procedure:**

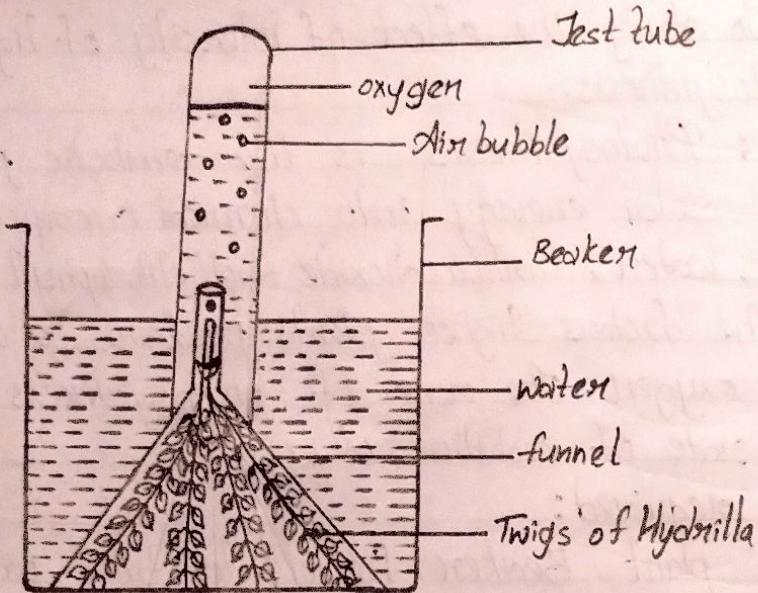
Take few twigs of hydrilla plant and insert the cut ends into the funnel. Place the funnel in the beaker containing water in inverted position as shown in the diagram. Take a test tube fill with water and invert it on the funnel in such a way that no air bubbles enter into it.

Keep the set up in shade and count the number of air bubbles produced in one minute time. Now transfer the set up in to sunlight and again count the number of bubbles produced per minute. Tabulate the values and draw the conclusion.

**Observation :**

The rate of photosynthesis maintain in high intensity of light as the number of air bubble produced in one minute is more in high intensity than in low intensity.

2x



S.NO	Rate of $\text{CO}_2$	No of oxygen bubbles per minute
1.	Normal water	25
2.	$\text{CO}_2$ enriched water	30

# Effect of Carbon dioxide on Photosynthesis

Aim : To study the effect of carbon dioxide on the rate of photosynthesis.

Principle : Photosynthesis is the anabolic pathway which converts solar energy in to chemical energy. It requires sunlight, water, carbon dioxide and chlorophyll. In the presence of all the factors higher plants perform photosynthesis and releases oxygen. The rate of photosynthesis is proportional to rate of evolution of oxygen.

Materials Required : Hydrilla plant. Beaker, funnel, test tube, water, slide and sodium bicarbonate.

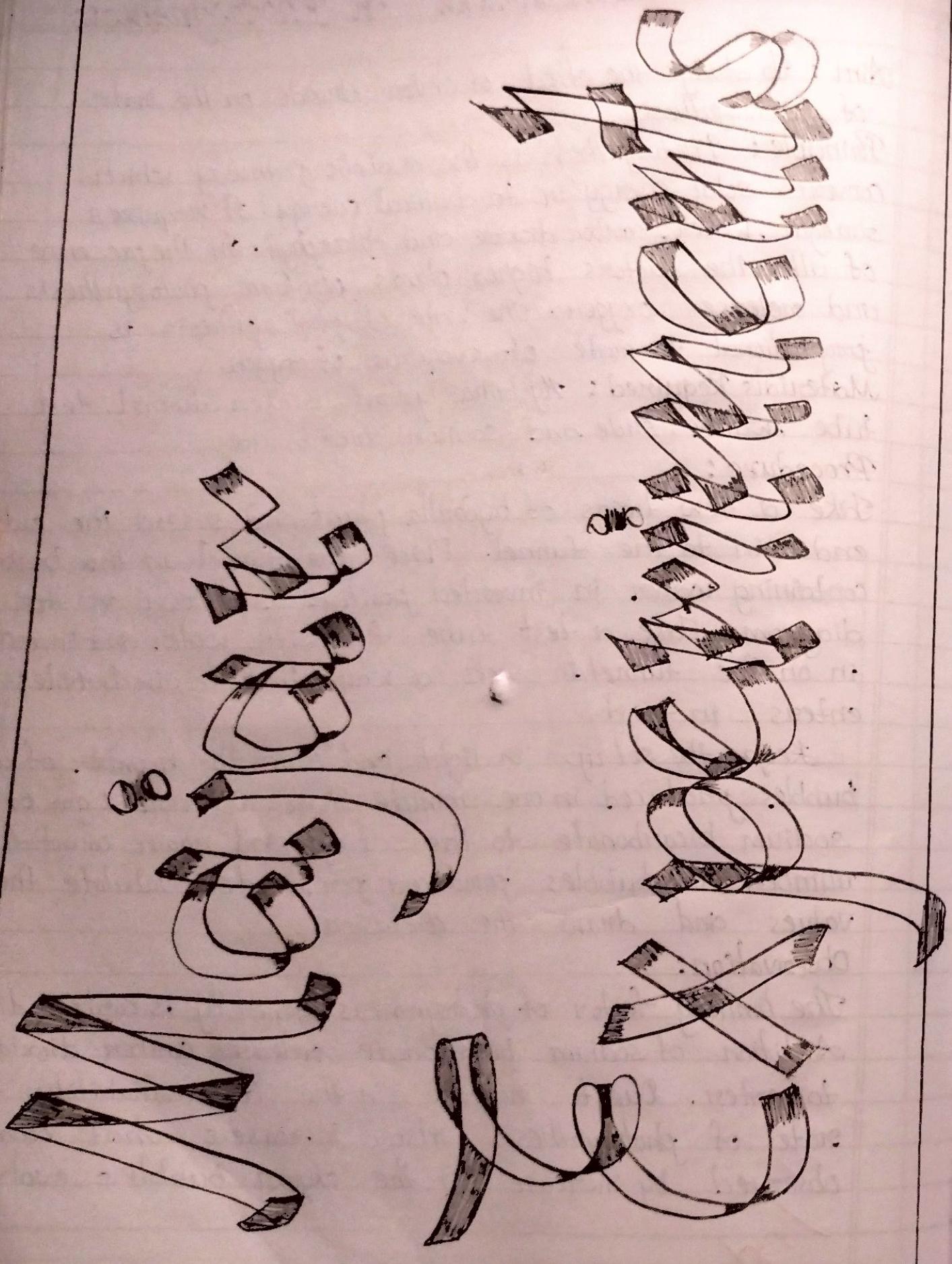
Procedure :

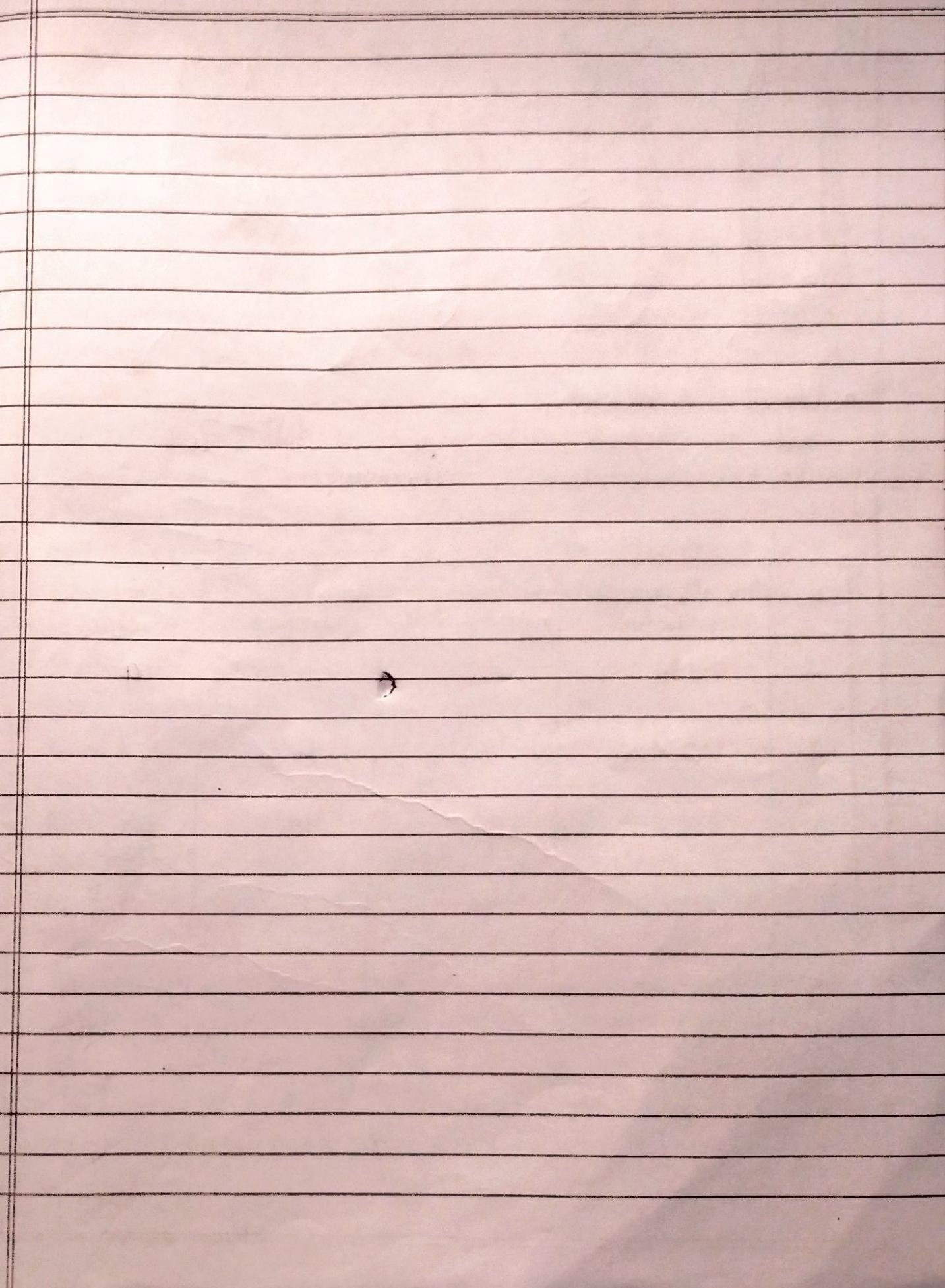
Take a few twigs of hydrilla plant and insert the cut ends in to the funnel. Place the funnel in the beaker containing water in inverted position as shown in the diagram. Take a test tube fill with water and invert it on the funnel in such a way that no air bubbles enters in to it.

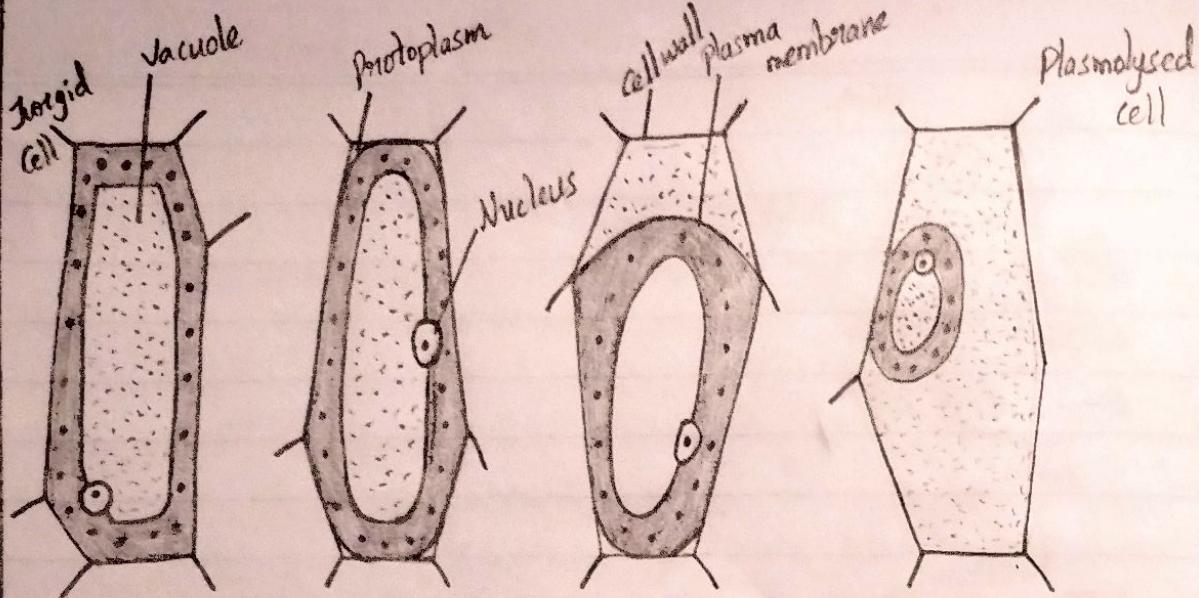
Keep the set up in light and count the number of air bubbles produced in one minute time. Now add 1 gm of sodium bicarbonate to the set up and again count the number of bubbles produced per minute. Tabulate the values and draw the conclusion.

Observation :

The limiting factor of photosynthesis generally is carbon dioxide. Addition of sodium bicarbonate releases carbon dioxide in to water. Due to increase in the  $\text{CO}_2$  availability, the rate of photosynthesis also increases that can be observed by increase in the oxygen bubbles evolved.







a. Normal cell

b. cell with incipient plasmolysis

c. Concentration of cytoplasm

d. Plasmolysed cell.

S.NO	Cone of sugar sol <sup>n</sup> dilute water	cell under microscope field	No. of cells plasmolysed	% of cells plasmolysed
1.	0.1M	42	02	09
2.	0.2M	46	12	26
3.	0.3M	38	19	50
4.	0.4M	45	32	71
*				
5.	0.5M	40	37	92

$$\begin{aligned}
 \Psi_s &= -CRT \\
 &= -(0.3 \times 0.0831 \times 273 + 27^\circ\text{C}) \\
 &= -74.79 \text{ bars.}
 \end{aligned}$$

# Determination of osmotic Potential of Plant cell

Sop by plasmolysis method using Rheo discolour on Tradescantia leaves

Aim:

To measure the osmotic potential of the cell sap by incipient plasmolysis method by using given Rheo discolour leaf.

Principle:

The osmotic potential is referred to as potential ability of a solution, exerting a pressure when kept in a condition of osmosis. The osmotic potential is dependent on the concentration of solute. Higher the concentration of solute lower the osmotic potential. Under given conditions osmotic potential can be calculated by the equation  $\Psi_s = -CRT$  where C is concentration of solution used when fifty percent of cells are plasmolysed, R is gas constant whose value is 0.0831 and T is the temperature at which the (Absolute temperature) (273) + t°C, where t is the room temperature at which experiment is conducted.

Materials Required:

watchglass, 100ml beaker, slides, microscope, cover slip, sharp blade, Rheo discolour leaves and 1M sucrose solution.

Procedure:

Prepare 1M sucrose stock solution by dissolving 34.23g of sucrose in 100ml of water. From the standard solution prepare 0.1M, 0.2M, 0.3M, 0.4M and 0.5M solution as follows.

Add 9ml of water to 1ml of stock to get 0.1M concentration.

Add 8ml of water to 2ml of stock to get 0.2M concentration.

Add 7ml of water to 3ml of stock to get 0.3M concentration.

Add 6ml of water to 4ml of stock to get 0.4M concentration.

Add 5ml of water to 5ml of stock to get 0.5M concentration.



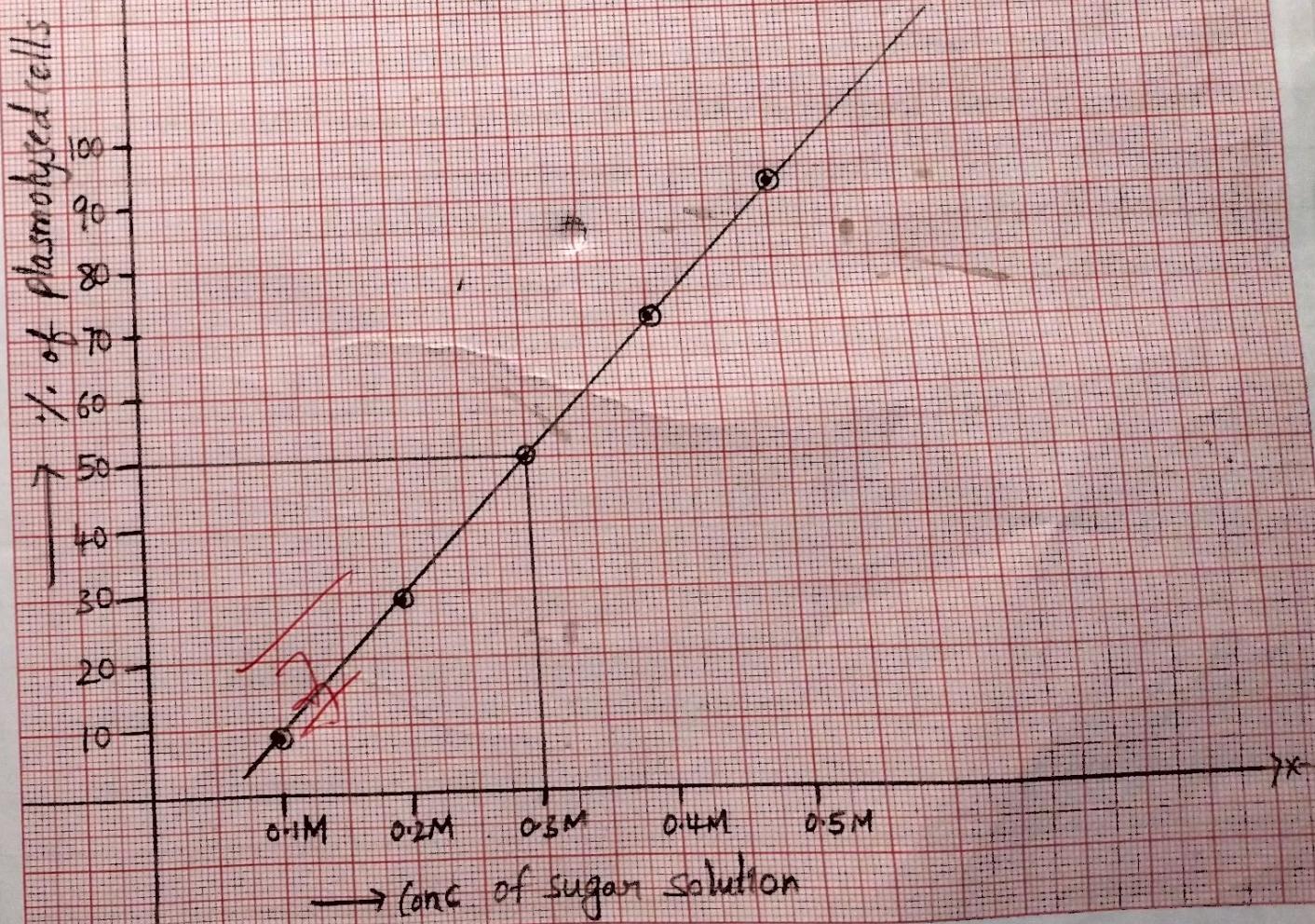
Determination of osmotic Potential of plant cell sap by  
Plasmolysis method using *Phenolphthalein* on *Tradescantia*  
Leaves.

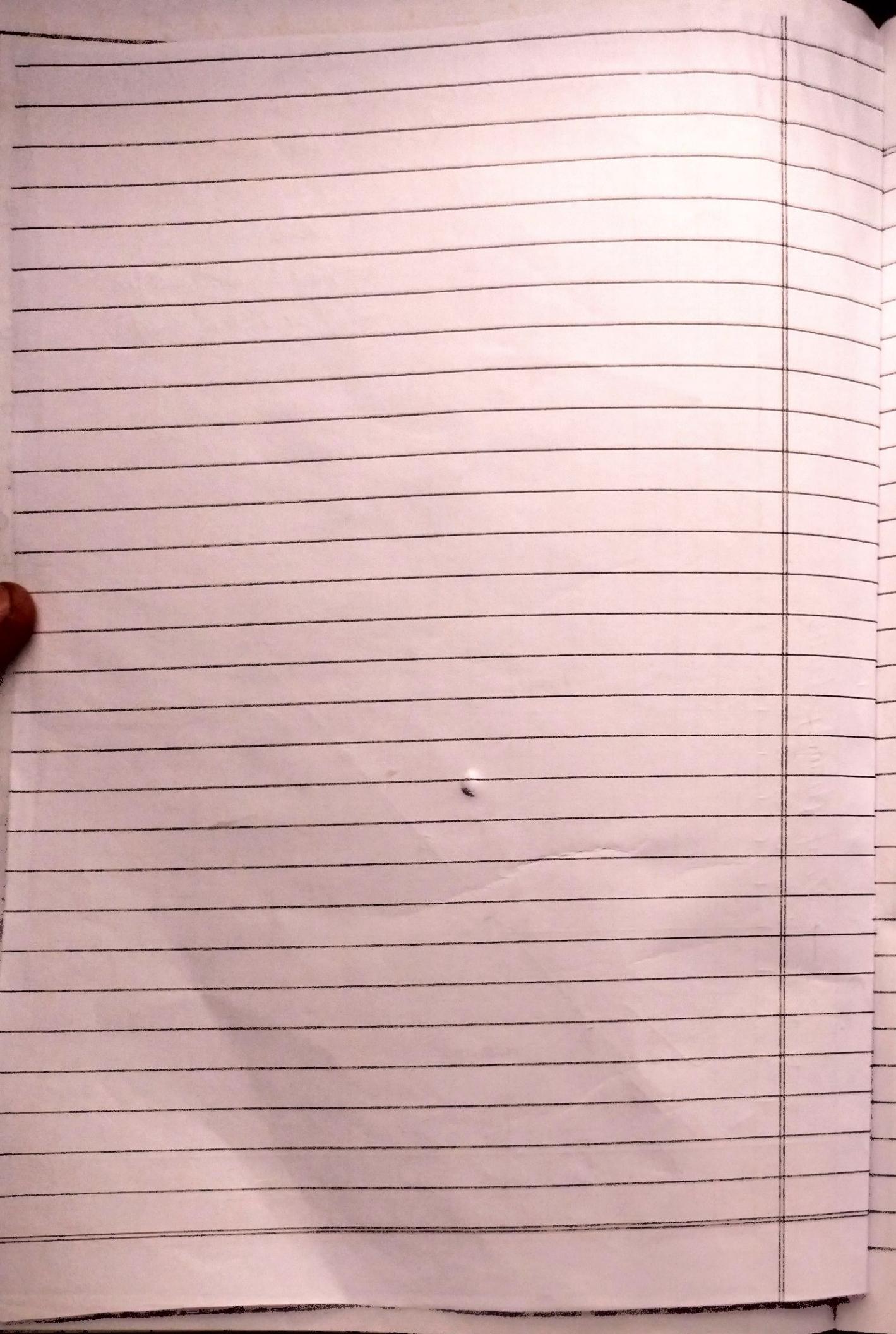
y-axis

Scale

$$x\text{-axis} = 1 \text{ unit} = 0.1 \text{ M}$$

$$y\text{-axis} = 1 \text{ unit} = 10\%$$





6

Take watch glasses and few ml of different molar concentration and label them. Now take out the epidermal peel from the lower epidermis of rheo leaf and transfer them into watch glasses. Incubate for 30 minutes and then mount the peel with the same molar concentration from which it is taken and observe under microscope and calculate the percentage of cells plasmolysed from the table.

Plot a graph by taking concentration on x-axis and percentage of cells plasmolysed on y-axis from the graph obtain the concentration 'c' of sugar solution at which 50% of cells were plasmolysed. Calculate the osmotic potential by using the formula  $\Psi_s = -CRT = -(Cx0.0831 \times 273 + t^\circ C)$

The osmotic potential of Rhei discolor leaf is -74.79 bars

Observation:

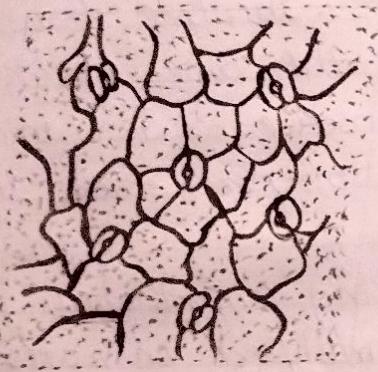
Percentage of plasmolysed cells increases with increase in the concentration.

Calculation:

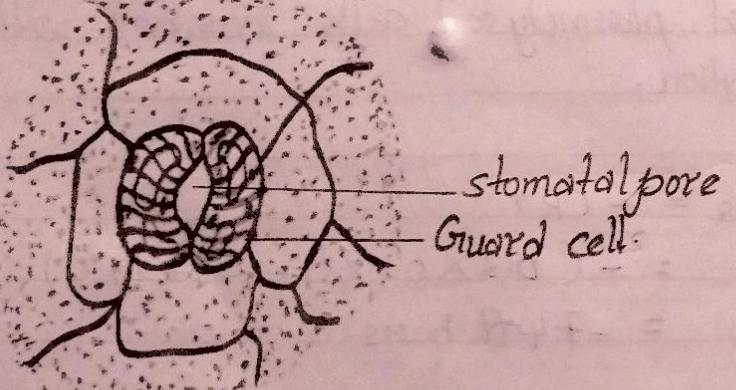
$$\begin{aligned}\Psi_s &= -CRT \\ &= -(0.3 \times 0.0831 \times 273 + 27^\circ C) \\ &= -74.79 \text{ bars.}\end{aligned}$$

✓  
2x

## Stomatal Index



stomata Magnified



$$\text{Stomatal Index} = \frac{\text{No of stomata}}{\text{No. of epidermal cells + stomata}}$$

where, no of stomata = 6

No. of epidermal cells = 28

$$= \frac{6}{28+6} = \frac{6}{34} \times 100$$

$$= 17.6\%$$

## Determination of Stomatal Index

Stomatal index is the measurement of the surface density of stomata. This parameter has been found useful in comparing leaves of different plant varieties as it plays very important role in photosynthesis and transpiration.

**Aim:** To determine the stomatal index of given Tridax or Jecoma leaves.

**Procedure:** Select a mature Tridax or Jecoma leaf. Apply a thin layer of either gum or nail polish to the lower surface of the leaf and leave it for 10 minutes for drying. After complete drying peel the gum or nail polish layer carefully with the help of forceps without damaging the layer. Mount the peeled layer with a drop of diluted saffranin and a drop of glycerine on a clean glass slide using coverglass and observe under a microscope.

**Observation:**

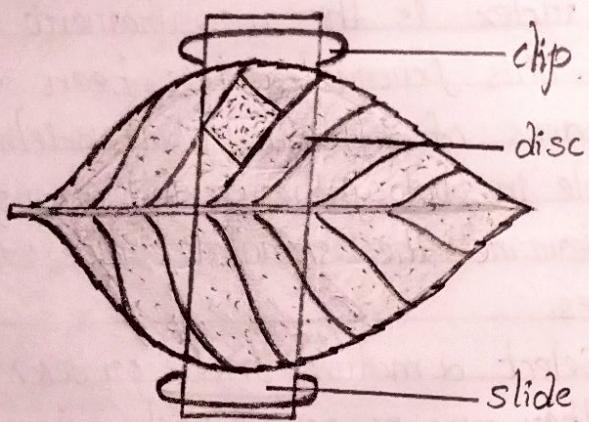
Number of stomata present in unit area of leaf may be seen under microscope field count the number of stomata as well as number of epidermal cells in a given unit area and calculate the stomatal index using the following formula.

$$\text{Stomatal Index} = \frac{\text{Stomatal density} \times 100}{\text{Stomatal density} + \text{epidermal cell density}}$$

**Result:** The stomatal index of the given leaf is 17.6 %.

2x

# Cobalt Chloride Paper Method



S.No	Plant	Time taken for colour change of discs	
		Lower surface	Upper Surface
1.	Bougainvillea	15 mins	25 mins



# Determination of Rate of Transpiration

## Using Cobalt Chloride Paper Method

**Aim:** To determine the state of transpiration by using cobalt chloride paper.

**Principle:** Dry cobalt chloride paper strips are blue in colour but when they absorb water they become pink. This property can be used to determine the time taken for complete colour change which is proportional to the state of transpiration.

**Materials required:** fresh plants in natural habitat, cobalt chloride soaked filter paper stripe, slides, gemclips, rubber bands, stopwatch, desiccators.

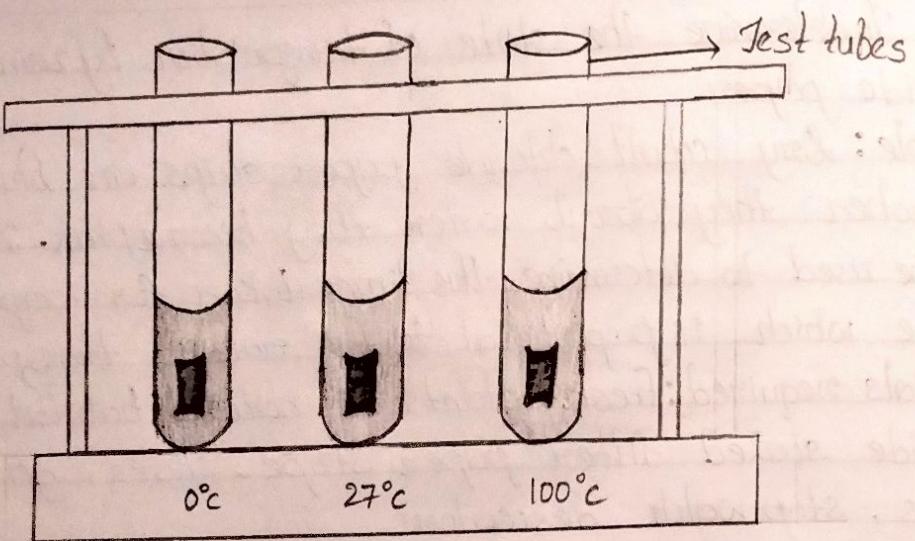
**Procedure:** Take the filter paper and cut small pieces of  $1\text{cm}^2$  size. Dip the paper discs in cobalt chloride solution for 2 minutes and dry them in hot air oven. store them in desiccators containing calcium chloride. Now place the discs on both upper and lower epidermal layers of plants and close them with slides and clips or rubber bands. Note the time taken for the complete colour change from blue to pink and tabulate the values.

**Observation:**

Plants in natural habitats participate in transpiration during day time. During transpiration released with water vapour is absorbed by the disc and change its colour. The time taken indicates the state as well as abundance of stomata. It is observed that the rate of transpiration is more on lower surface than the rate of transpiration on upper surface indicating the unisostomatus condition in plants. The time also depends on wind velocity, light intensity etc.

✓  
2X

# Membrane Integrity.



S.No	Temperature	O.D Values
1.	0°C	0.15
2.	27°C	0.33
3.	100°C	0.60

# Effect of Temperature on Membrane Integrity

**Aim:** To observe the effect of temperature on membrane integrity using beet root cylinder.

**Principle:** The living membrane of cells is selectively permeable. The membrane contains proteins and lipids which are sensitive to temperature. When temperature increases the integrity of the membrane alters leading to the leakage of cell's contents. Beet root cells contain anthocyanin pigment which is leaked out during high temperature. The colour concentration is directly proportional to the effect of temperature.

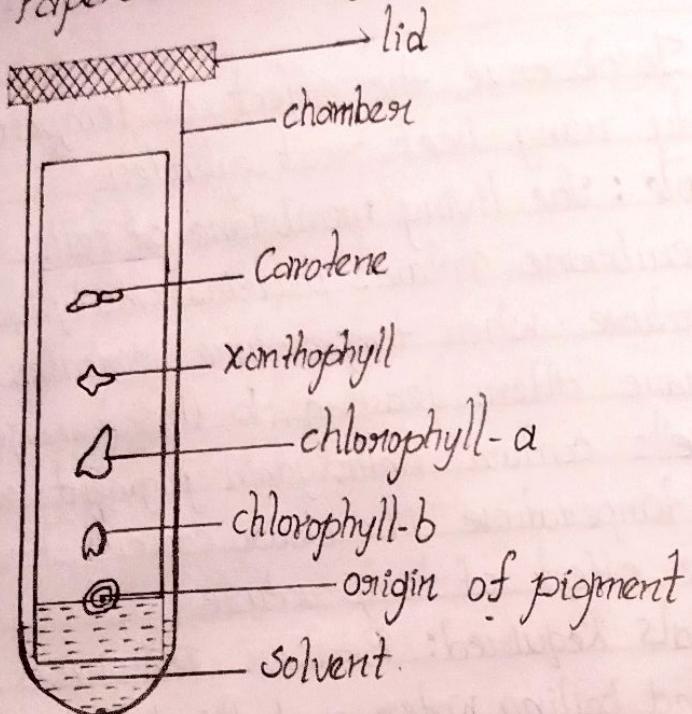
**Materials Required:** Beakers, Test tubes, Beet root, cork bores, ice and boiling water and third tube and obtain cylinders at room temperature.

**Procedure:** Take the beet root tuber and obtain cylinders of beet root having 1cm height with the help of cork bores and blade. Take three test tubes with 2ml of water in each and add one cylinder to each of the three tubes. Incubate tube at 0°C, another at 100°C in boiling water and the third tube at room temperature (27°C) for ten minutes. Now measure the OD values of solution in each tube at 500nm with spectrophotometer and note the values in the table.

**Observation:** The intensity of colour increases with the temperature as the temperature affects the membrane integrity. High OD values in test tube at 100°C confirms that the high temperature ~~disturbs~~ the membrane and increases the permeability.

Ans

# Paper Chromatography



S.NO	Pigment	Rf
1.	chlorophyll - b	$\frac{2}{10} = 0.2$
2.	chlorophyll - a	$\frac{25}{10} = 0.25$
3.	xanthophyll	$\frac{45}{10} = 0.45$
4.	carotene	$\frac{75}{10} = 0.75$

# Separation of chlorophyll Pigments by Paper Chromatography

**Aim:** To separate the chloroplast pigments by paper chromatography.

**Principle:** Chromatography is a common separating method based on the partial coefficient of solutes. In this method pigment content is fixed in stationary phase and a mobile phase is seen to separate them.

**Materials Required:** Iodium leaves, chromatography paper (Whatman No. 1), mortar and pestle, beakers, capillary tube, chamber, pencil, sand, distilled water, acetone and petroleum ether.

**Procedure:** Cut the chromatography paper into sheets of suitable size and draw a pencil line 1cm above the all end. Prepare the leaf extract by filtering the ground mixture of leaf, acetone and pinch of calcium carbonate and sand. Apply it to the paper on the marked line with capillary tube.

Prepare the solvent by mixing acetone and petroleum ether in 1:9 ratio and add it to the chromatography chamber and close with lid for saturation. Now open the lid, place the paper into the chamber in such a way that the spot is above the solvent level. close the lid and allow the solvent to move to the other end.

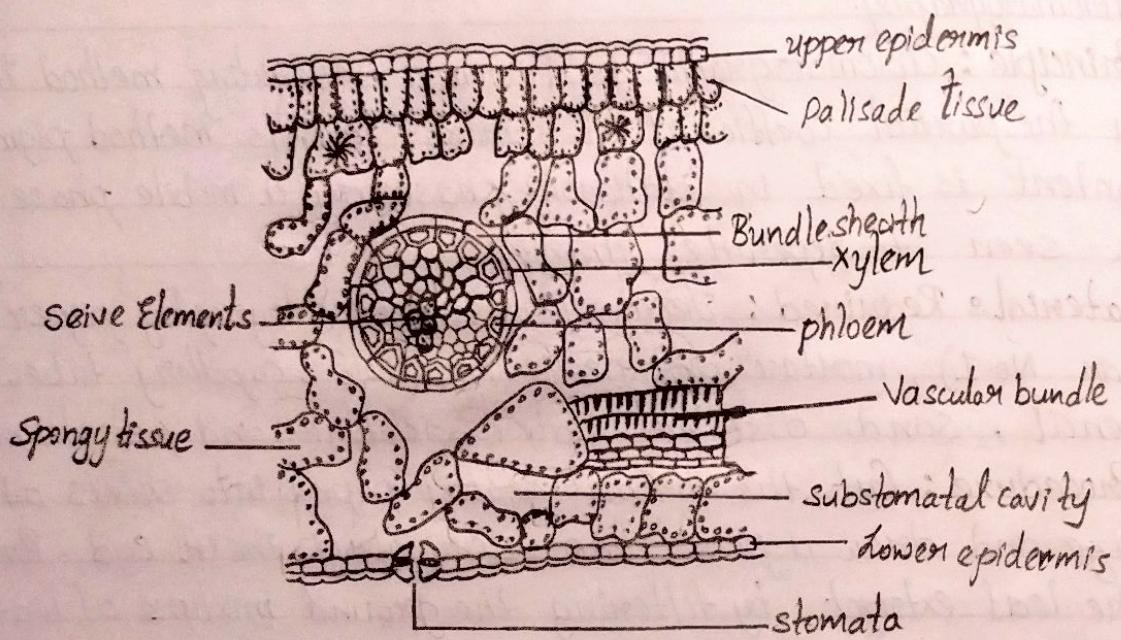
**Observation:**

After an hour all pigments will be separated in the sequence from bottom to top as chlorophyll-b, chlorophyll-a, xanthophylls, carotene. The chlorophyll-b is yellowish green, chlorophyll-a is bluish green, xanthophylls is yellow and carotene is orange. The distance moved by pigments is estimated and R<sub>f</sub> values are calculated by using the formula,

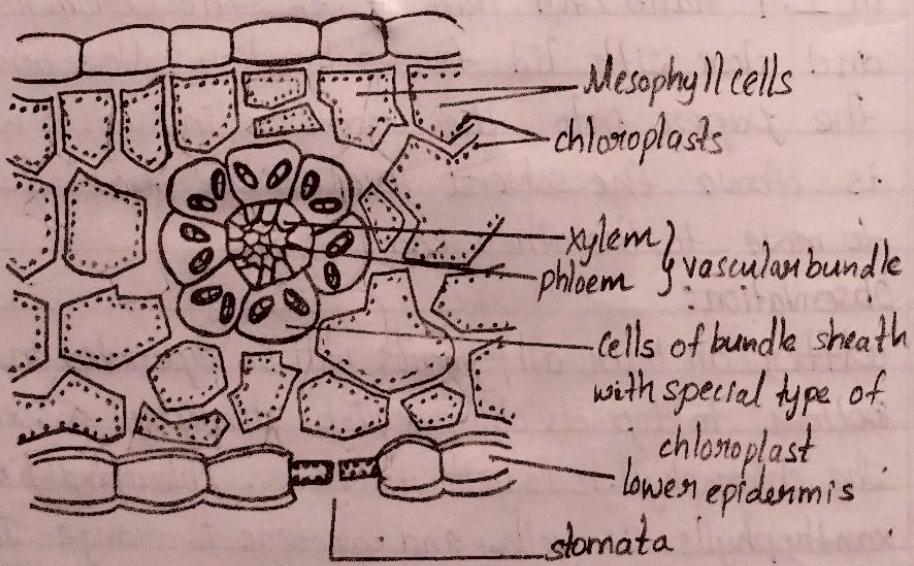
$$R_f = \frac{\text{distance travelled by pigment from origin}}{\text{distance travelled by solvent}}$$

28

## $C_3$ Leaf



## $C_4$ Leaf



# Comparative Anatomy of C<sub>3</sub>, C<sub>4</sub>, CAM Leaves.

Aim:

To compare leaf anatomy of C<sub>3</sub>, C<sub>4</sub> and CAM plants.

Requirements:

Compound microscope, glass slide, cover slips, saffranin, blade, glycerine.

Plant materials:

Fresh leaves of C<sub>3</sub>, C<sub>4</sub> and CAM plants.

Principle:

C<sub>3</sub> plants are the plants in which the Calvin cycle regulates normally and the first formed stable product is phosphoglyceraldehyde (PGA with 3 carbon atoms). The first formed product is an

Procedure:

Take fresh and healthy leaves of CAM [Bryophyllum], C<sub>3</sub> [Tridax] and C<sub>4</sub> [corn] and wash with water. Take the fine transverse sections of leaves with a sharp blade. Treat the sections with saffranin and a drop of glycerine and mount on a glass slide with a cover slip. Then observe under the microscope.

Observation: Following anatomical characters are observed from the given leaf materials.

Material A:-

\* Mesophyll is differentiated into the palisade and the spongy layer.

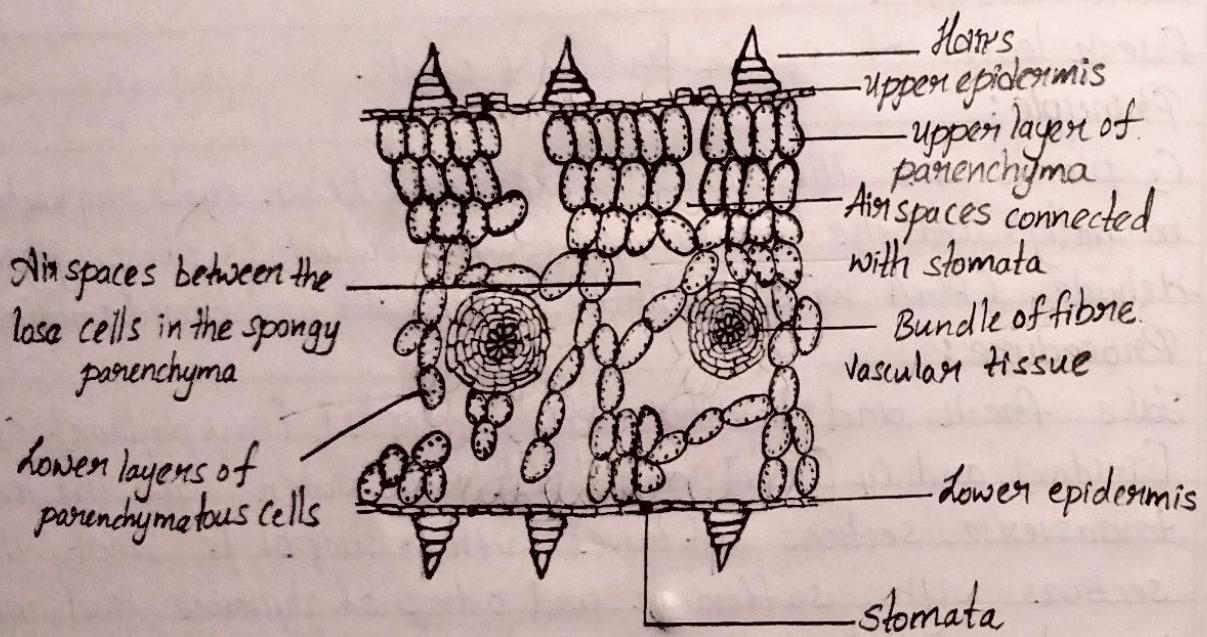
\* Bundle sheath cells are absent. Kranz anatomy is not present.

Material B:-

\* Mesophyll is not differentiated.

\* Bundle sheath cells, Kranz anatomy and chloroplasts dimorphism is observed.

## CAM Leaf



### Material C :-

- ★ Mesophyll is thick and cells are characterized by large vacuoles.
- ★ Leaf succulence is observed.
- ★ Thick cuticle and sunken stomata are observed

### Result :-

Material A -  $C_3$  leaf anatomy.

Material B -  $C_4$  leaf anatomy.

Material C - CAM leaf anatomy.

✓  
dx