

# Plant Physiology

## Water Relation.

1. What is transpiration? What are the types of transpiration? Explain the factors affecting the rate of transpiration.

(1+3.5+3.5)marks.

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- Def<sup>n</sup>: Process of loss of water from the internal tissue of the living plants in the form of water vapour through the aerial parts such as leaves, stem, etc.

Types of transpiration:

i. Stomatal transpiration:

- Loss of water in the form of water vapour from the stomata of plants.
- About 90-97% of total transpiration.
- Directly proportional to the number of stomata.
- Unequal transpiration takes place through dorsiventral leaf.
- Equal transpiration takes place through isobilateral leaf.

## ii. Cuticular transpiration:

- Loss of water vapour through the cuticle present in epidermal tissue of leaf and stem.
- About 3-10% of total transpiration.

- Takes place throughout day and night.
- Main process of transpiration in xerophytes.
- Inversely proportional to the thickness of cuticle.
- In case of herbaceous plant it may go up to 50% of total transpiration.

### iii. Lenticular transpiration:

- Loss of water in the form of water vapour from lenticels present in the bark of plants.
- About 0-1% of total transpiration.
- Opens during whole day and night.

#### iv. Bark transpiration:

- Loss of water vapour through bark of the woody stem.
- Occurs continuously during day and night but in very small amount.

### Factors affecting the rate of transpiration:

#### A. External factors:

##### a. Light:

- Increases the rate of transpiration within a certain physiological range with the rise in temperature between  $0^{\circ}\text{C}$  and  $30^{\circ}\text{C}$ .

### b. Temperature:

- Increases the rate of transpiration within a certain physiological range with the rise in temperature between  $0^{\circ}\text{C}$  and  $30^{\circ}\text{C}$ .

### c. Humidity:

- Rate of transpiration decreases with increase in relative humidity.

### d. Wind:

- Slow blowing wind increases the rate of transpiration by removing moist air and winds of high velocity reduce the rate of transpiration by inducing the closure of stomata.

e. Atmospheric pressure:

- Lowering of atmospheric pressure increases the rate of transpiration on hills.

- Plants growing in higher altitudes shows higher rate of transpiration because of low atmospheric pressure.

B. Internal factors:

a. Root-shoot ratio:

- Greater the root-shoot ratio, greater will be the rate of transpiration.

b. Leaf orientation:

- Horizontally, oriented leaves

generally transpire more than vertically oriented leaves as they receive more light.

### c. Leaf area:

- Rate of transpiration increases with the increase in transpiring area.

### d. Leaf structure:

- Structure of leaves like thick cuticle, coating of wax, suberin, reduced number of stomata, sunken stomata, etc. reduce transpiration.

2. What is transpiration? Discuss the process of transpiration by bell jar method. (4 marks)

-Def<sup>n</sup>: Process of loss of excess water from aerial plant parts (leaf, stem) in the form of water vapour.

Demonstrate the process of transpiration of Bell jar-method:

Requirements:

Apparatus: A bell jar, glass plate, plastic, thread.

Chemicals: Vaseline or grease.

Materials: A fresh and healthy potted plant.

## Theory:

- Transpiration is a process of loss of excess water in the form of water vapour from the internal tissues of plants through the aerial parts such as the stomata of leaves and green stems, barks and lenticels.

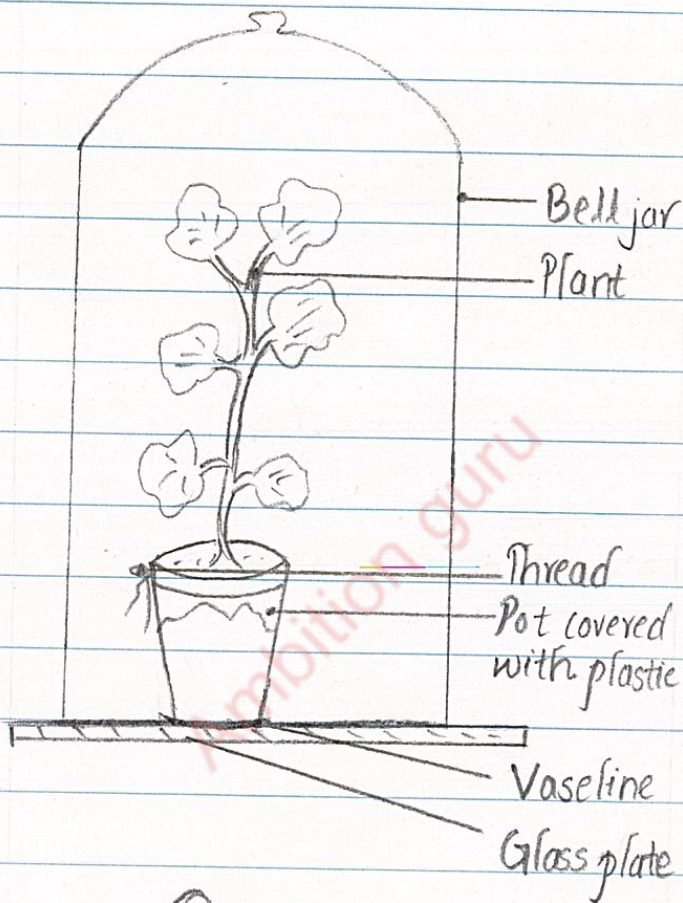
## Procedure

- Select a fresh healthy well watered potted plant.
- Cover the soil surface of the pot properly with a sheet of plastic.
- Tie it around the neck of pot by a thread to prevent direct evaporation of water from soil surface.

- Keep the plotted plant on a glass plate and cover with a dry and clean bell jar.

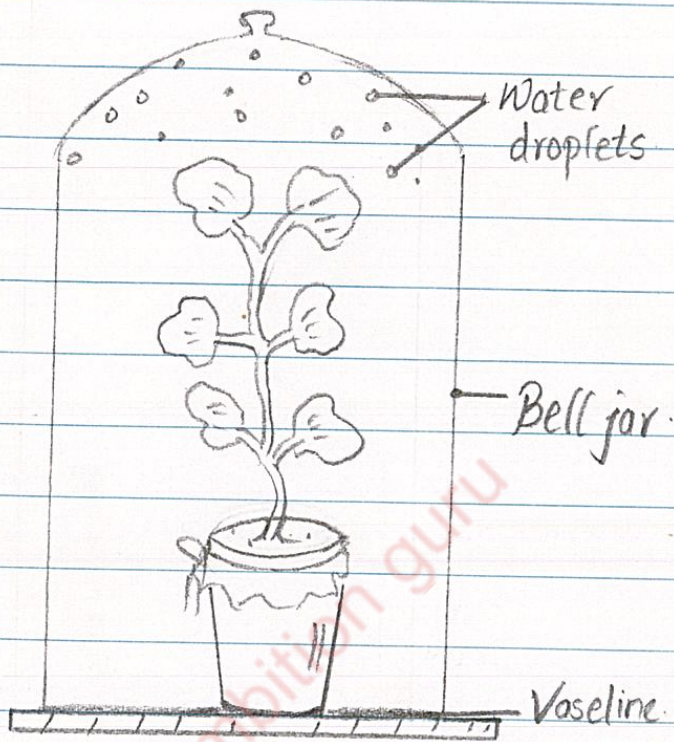
- Apply vaseline or grease on the edges of the bell jar to prevent the entry of moisture from outside.

- Expose the experimental set up in sunlight for few hours without any disturbance.



(a)

At the beginning of experiment.



(b)

At the end of experiment:

Fig: Demonstration of process of transpiration by using Bell-jar

## Observation:

- After some time, the droplets of water vapour appear on the inner surface of the bell jar.

## Conclusion:

- Water vapour released by the aerial part of the plant later condenses to form water droplets in the inner wall of bell jar.
- No possibility of entry of water vapour from the soil surface or from the outside.
- Aerial parts of the plants release water in the form of water vapour by process of transpiration.

## Precautions:

- Plants must be fresh, healthy and well watered.
- Bell jar must be clean and dry.
- Setup must be exposed to sunlight.
- Soil surfaces of potted plant must be covered properly with plastic paper.

3. Describe the experiment to show the process of osmosis by using egg membrane or by potato osmoscope.  
(4 marks)

-To demonstrate the process of osmosis by using potato osmoscope.

Requirements:

Apparatus: Beaker, scalpel, pins.

Chemicals: Sugar solution, water.

Materials: A large healthy potato tuber,

Theory:

-When two solutions having different concentration are separated by semi-permeable membrane, solvent molecules move from its higher water potential to its lower water potential until the development of equilibrium condition.

## Procedure:

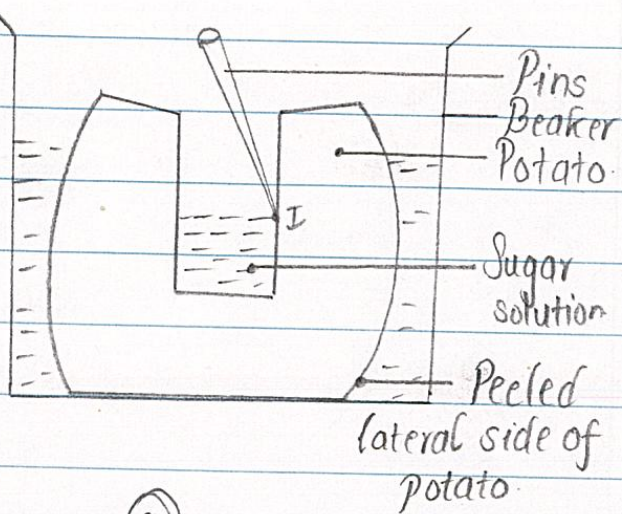
- Select a large sized healthy potato tuber.
- Peel off its skin and cut its base to make it flat.
- Make a deep hollow cup like cavity in the potato tuber using a scalpel almost upto the bottom.
- Pour concentrated sugar solution upto half of the potato cavity.
- Mark the initial level of sugar solution as 'I' by fixing a pin in the wall of potato cavity.
- Keep potato tuber having concentrated sugar solution in

a beaker containing water.

- Leave the experimental set up for few hours without any disturbance.

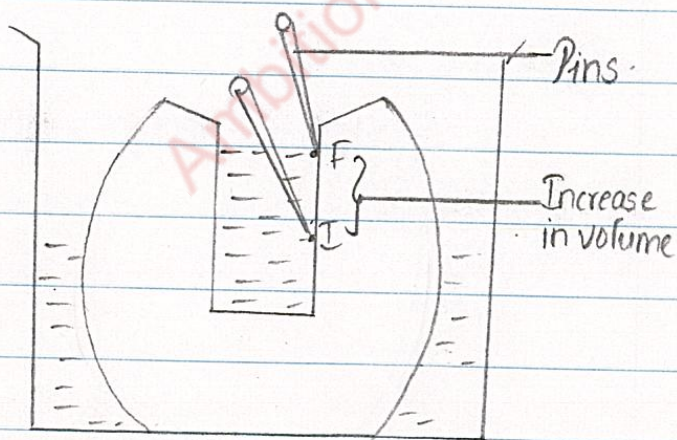
Observation:

- After sometime, the level of sugar solution in the potato cavity rises up from the initial marked level (I) to a certain height which marks as a final level (F) by fixing a second pin to the inner wall of potato cavity.



(a)

At the beginning of experiment.



(b)

At the end of experiment.

Fig: Demonstration of osmosis by using potato osmoscope.

#### 4. Differentiate between osmosis and diffusion. (4 marks.)

Osmosis	Diffusion
i) Movement of solvent (water) molecules from its region of lower concentration through semipermeable membrane until equilibrium.	i) Movement of molecules from the region of higher concentration to the region of lower concentration until equilibrium.
ii) Involves the movement of solvent molecules only.	ii) Diffusing molecules may be solids, liquids or gases.

iii) Semi-permeable membrane is required.

iii) Semi-permeable membrane is not required.

iv) Influenced by turgor of hydr

iv) Not influenced by the pressure other than diffusion pressure.

5. Describe an experiment to show the rate of transpiration by Ganong's potometer. (4 marks).

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

**Requirements:**

**Apparatus:** Ganong's potometer, a beaker, cork with a hole, dropper.

**Chemicals:** Grease or Vaseline.

**Materials:** A healthy leafy twig.

**Theory:**

- Loss of water in the form of water vapour from the internal tissues of living plants through the aerial parts such as the leaves, green stems, bark and lenticels is called transpiration.

**Procedure:**

- Fill Ganong's potometer completely with water.

- Cut a short soft leafy twig under water to avoid the blockage of continuous water column in the xylem.
- Fix it into the wide mouthed end of the potometer through a hole in the cork.
- Make the apparatus air tight by applying Vaseline or grease on the edge between the cork and mouthed end of potometer.
- Dip the distal bend tube of apparatus into a beaker containing water.
- Insert an air bubble through the distal end by a dropper and adjust it at zero mark in horizontal graduated tube.

-Expose the whole set up to sunlight for few hours.

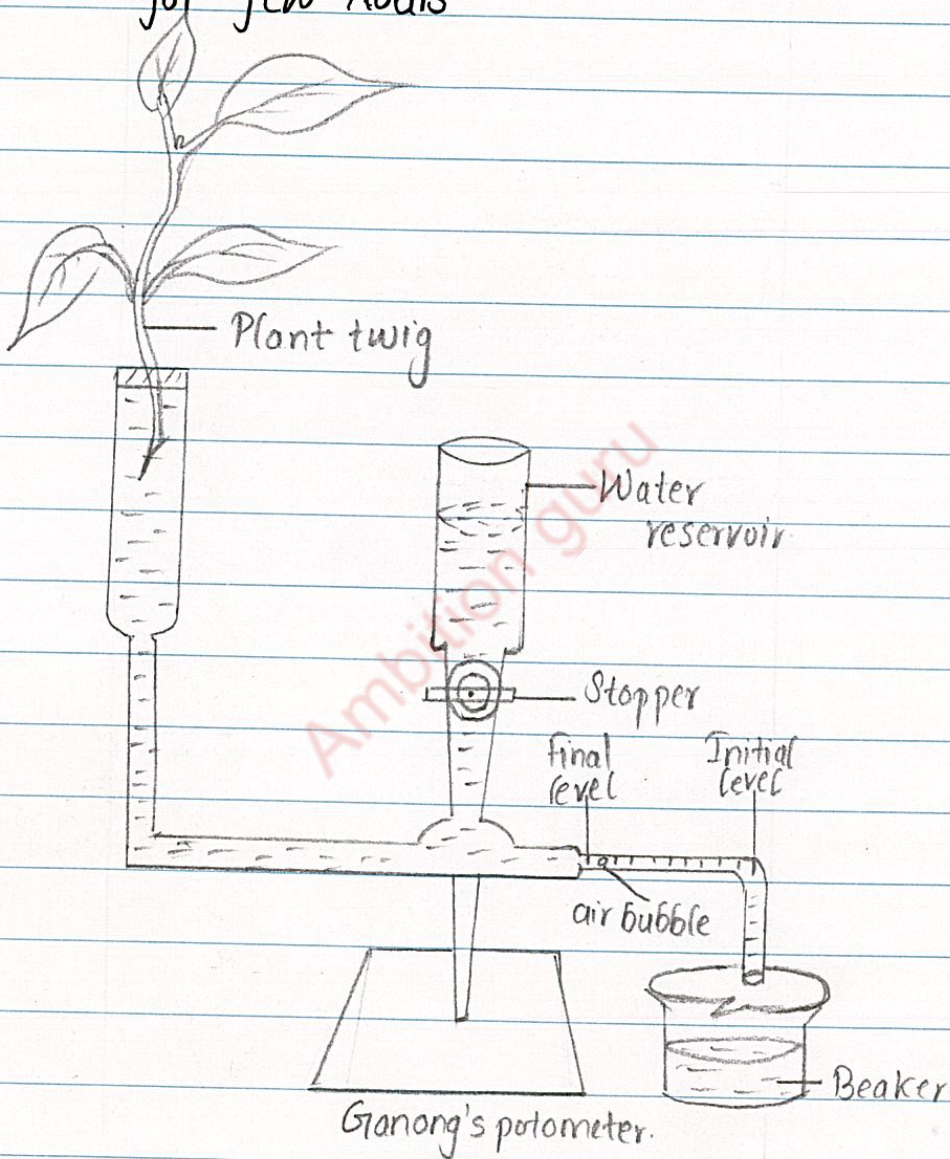


Fig: Demonstration of transpiration using Granong's Potometer.

## Observation:

- After few hours of experiment, air bubble slowly moves towards the plant through the horizontal tube of potometer.

## Conclusion:

- During the process of transpiration, water is lost from the aerial parts of plant in the form of water vapour which creates a suction pressure.
- Suction pressure helps in absorption of water from horizontal tube of potometer.
- Amount of water transpired by the twig is approximately equal to the amount of water absorbed from the beaker.

## Precautions:

- Edge between the cork and mouth of potometer must be sealed by using Vaseline or grease.
- Only one air bubble must be entered in the horizontal capillary tube.
- Set up must be exposed to the sunlight.
- Set up must not be disturbed after setting.

6. Demonstrate the ascent of sap through xylem. (4 marks)

To demonstrate the path of ascent of sap by simple method.

Requirements:

Apparatus: Beaker, stand, clamp, blade, slide, cover slip, knife, microscope.

Chemicals: Water, eosin solution.

Materials: A healthy herbaceous plant with white flowers.

Theory:

- Ascent of sap is the process of upward movement of sap from roots to the top of the plant

parts through the continuous pathway of tracheids and vessels of xylem.

### Procedure:

- Take a healthy fresh herbaceous plant with a white flowers.
- Cut its twig under water with a knife to avoid the blockage of continuous water column in the xylem.
- Keep the twig into beaker containing water.
- Colour the water with few drops of eosin to observe the water movement.
- Fix the twig vertical position by using a stand and clamps.

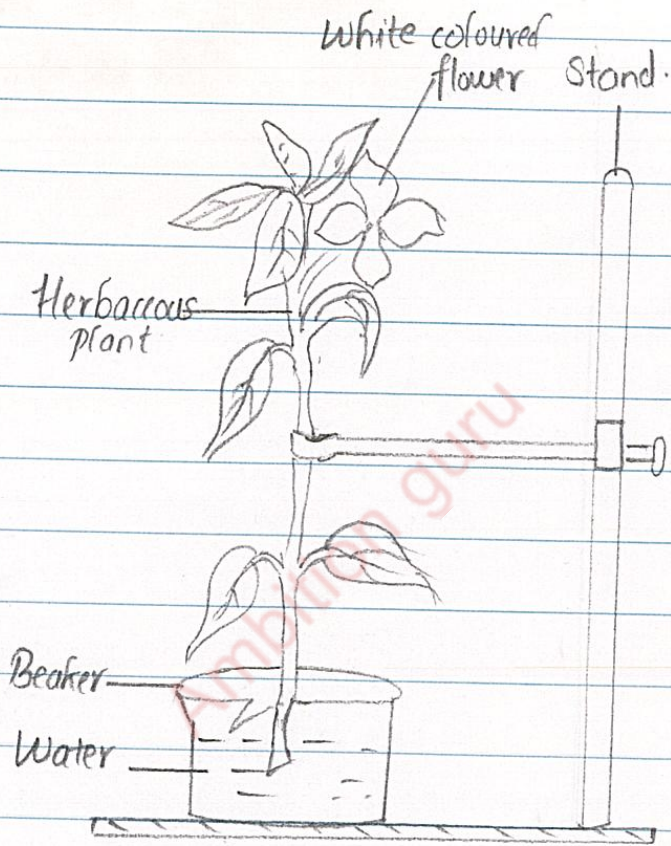
- Leave the experimental set up for few hours without any disturbance.

### Observation:

- After some time, the veins of leaf and white petals appear to red in colour.

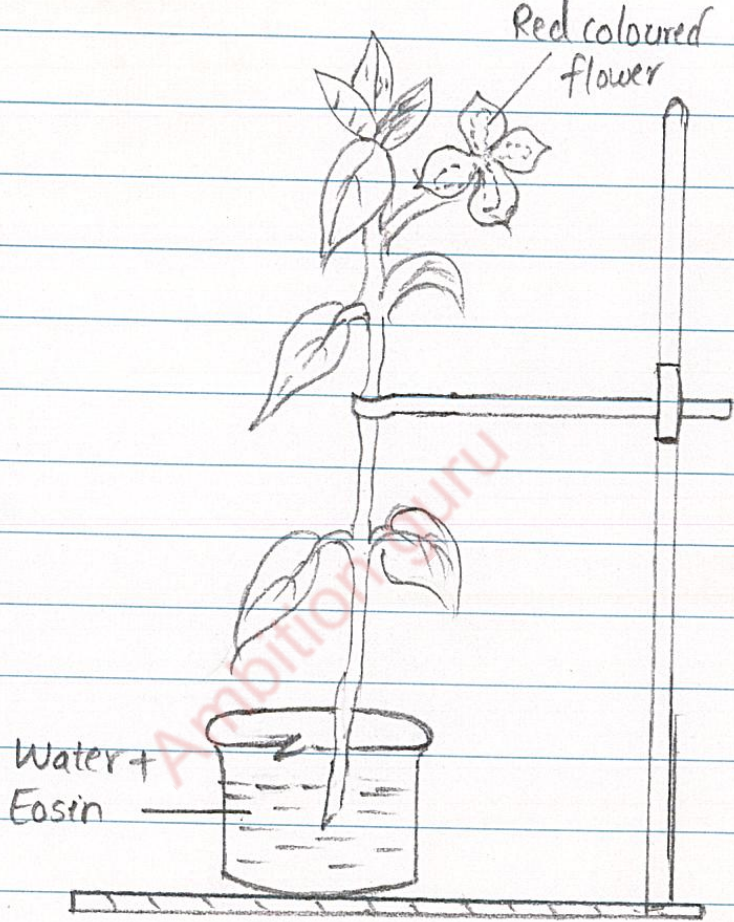
- T.S. of stem of twig is cut and observed under microscope by preparing a temporary slide of section of stem.

- Vessels and tracheids in xylem tissues are seen red.



@

At the beginning of the experiment.



At the end of experiment.

Fig: Demonstration of the path of ascent of sap

## Conclusion:

- Leaves of twig remain fresh and turgid because of continuous transport of water.
- Colour part of section of stem indicates the movement of water and minerals through vessels and tracheids of xylem.
- Experiment concludes that the path of the ascent of sap is only due to conducting elements of xylem.

## Precautions:

- Plant must be fresh and healthy with white flowers.
- Twig must be kept in the vertical position by using clamps and stand.

- Colour changes of the petals of flower must be observed properly.

- Experimental set up must not be disturbed after setting.