ASCENT OF SAP

B.Sc.Botany-Sem-4

Paper2-unit 1

Compiled BY-

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Ascent of Sap -The ascent of sap in plants may be defined as "a process which determines the movement of water and nutrient solution from roots to the leaves in plant against the force of gravity."

The path way of movement of water-The upward translocation (movement) of water usually takes place through the xylem. This was first reported by Malpighi (1671) when he completed his ringing experiment. In this experiment he found that the epidermis, cortex, pericycles, endodermis cambium, phloem, pith etc are not directly related to the water ascending process except xylem vessels and now this view is agreed by all the scientists because the xylem vessels have the right cross-sectional area to permit upward movement of the large quantity of water.

It is a process the upward movement of water takes place against gravitational force. In lower and small plants, however it may be due to root pressure or by some other means, but in very tall plants like Eucalyptus, etc. this problem is quite complicated. Many theories have been put forward to account for the ascent of sap to such a great heights. The main important theories for ascent of sap are as follows:-

1. **Root pressure theory:** Some physiologists believe that the root pressure developed in xylem vesssels pushes up water to leaves and branches in herbs and lower shrubs Specially in conditions which are favourable both for low transpiration and low absorption of water from soil. It has generally been assumed that exudation of cut stems and branches is due to the action of the cells in the roots. This

theory may be applied to small herbaceous plants but it is not possible in taller plants.

2.Physical force theories:

(a)Capillary force theory-According to this theory xylem vessels and trachieds occur in the form of thin capillaries.Thus the xylem capillaries exert a capillary force which helps in ascent of sap. This theory can be applied in case of small plants but ascent of sap is not possible in case of tall plants.
(b) Atmospheric pressure theory- According to this theory the ascent of sap on plants takes place due to the atmospheric pressure. But this is also not true in tall plant because due to atmospheric pressure the water can rise upto the height of 33 feet or 10 meters.

(c) Imbibition force- This theory was proposed by Sachs (1878-79). According to this theory, the water moves moves upward in stem entirely in the walls of xylem elements by the process of imbibition. According to this theory the water does not rise through cavities of xylem vessels. The supporters of this theory observed the rise of imbibition force upto 1000 atmospheres and tried to explain the phenomenon in tall trees but the opponents of this view blocked the xylem vessels cavaties by paraffin and showed that as a result of blocking, rise of sap does not occur, thus this imbibition theory was discarded.

(d) Cohesive force Or Cohesion of water theory Or Dixon's theory- Dixon and Jolly (1895) proposed transpiration pull" or cohesion of water theory of ascent of sap in plants.
(a) There occurs a strong force of attraction between water molecules.
(b) The force of attraction (cohesion) is responsible for the tensile strength of water column in the xylem vessels.

(c) The loss of water from the leaves is responsible for a transpirationpull .
(d) The column of water from the roots to the leaves does not break at any point and is continuous.
(e) Xylem vessels nearly act as reservoirs for the rise of water and mineral salts.
Due to these observations, physiologists believed that a strong cohesive force forms a long and continuous column of water from roots to leaves without any air bubble in the passage, the transpiration pull helps in the process and thus the water rises to a great height. Now a days, inspite of the fact that this theory has several weak points like presence of air bubble in the xylem of several plants, presence of dissolved gas in sap etc, the Dixon's Cohesion of water theory perfectly agrees with the known facts of the mechanism ascent of sap in plants.

3. **Vital theories** The supporter of vital theories believe that the water conduction (ascent of sap) is carried by the activity of living cells. Xylem vessels and trachieds through which longitudinal movement of water occurs, are nonliving but they are always in intimate contact with living cells which apply motive power for the ascent of water. This power comes from the living cells which is supposed as vital activity. Godlewski (1884) and Sir J. C. Bose (1923) are the pioneer advocates of this theory.

   Godlewski (1884) said that the upward movement of water in plant is the result of periodic changes in the osmotic pressure of the living cells specially the ray cells of the Xylem. The water movements was due to the contraction and expansion of wood ray cells and alternate increase and decrease in the osmotic respiration mechanism of the cells. Jones (1917) supported this idea but Strasburger(1923) discarded this idea as he

demonstrated the rise of picric acid in Xylem vessels which is a poison and kills the living cells.

Sir J.C. Bose noticed the pulsatory movements in the cells of endodermis with the help of galvanometric direction of the needle and proposed the pulsatory movement theory. The living cells with this pulsatory activities work like the pumps, when a particular cell contracts the cell sap is pumped in the next higher cell and the process of ascent of sap continues from one cell to another and so on.

References-

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