B.Sc. Botany (Sub.) II
Group: C
Topic: Diffusion Pressure Deficit

Dr. Sanjeev Kumar Vidyarthi
Department of Botany
Dr. L.K.V.D. College, Tajpur

Diffusion Pressure Deficit (Suction Pressure)

Meyer defines diffusion pressure as “that physical property of a substance which is responsible for its diffusion whenever other prevailing conditions permit the occurrence of this process”. Diffusion pressure has also defined as a function of the free energy of a substance. The term may be applied to both solute and solvent of a solution. Under ideal conditions the diffusion pressure of the solute is an expression of the driving force with which its molecules diffuse into pure solvent.

According to Meyer (1945) the diffusion pressure deficit of water (DPD) in a solution, is the amount by which its diffusion pressure is less than that of pure water at the same temperature and atmospheric conditions. For cells in the plants where the diffusion pressure of water external to the cells may be above or below that of water at atmospheric pressure, the DPD of water in a cell due to solute should be defined as the amount by which its diffusion pressure is less than that of pure water under the same external pressure. This DPD may not correspond to the DPD of water in the cell referred to pure water at atmospheric pressure. For example, the DPD of water in the xylem vessels and tracheids of plants may be lowered to a greater extent by transpiration pull than by the solutes dissolved in it.

Diffusion Pressure Deficit directly proportional to the concentration of the solution:

In case of plants the cell sap is a watery solution of many inorganic and organic sub-stances; i.e., its pure solvent is water. If these cells are placed in pure water the water will enter into the cells due to higher DPD of the cell sap or water deficit.

In other words, the DPD of the cell sap or the cells is a measure of the ability of the cells to absorb water and hence it is often called as the Suction Pressure (SP). It is related with osmotic pressure (OP) and turgor pressure (TP) of cell sap and also the wall pressure (WP) as follows:

DPD (SP) = SP – WP

But (WP) = TP

Therefore, DPD (SP) = OP – TP

Due to the entry of the water the osmotic pressure of the cell sap decreases while its turgor pressure is increased so much so that in a fully turgid cell turgor pressure equals the osmotic pressure-

OP = TP (in fully turgid cell)

Hence, DPD (SP) = O (zero)

On the other hand, the removal of water from the cell sap (ex-osmosis) results in an increase of its OP and decrease of the turgor pressure so much so that in fully plasmolysed cells the value of turgor pressure becomes zero.

TP = OP (in fully plasmolysed cell) and hence, SP = OP

In case, the cell is placed in a hypotonic solution instead of pure water, the suction pressure of the cell sap will be-

SP = (OP – OP) – TP

Where OP, is the osmotic pressure of outer hypotonic solution.

Thus it is quite obvious that the DPD or SP in case of plant cells is not directly proportional to their osmotic pressure or the concentration of the cell sap but depends both on OP and TP Higher osmotic pressure of the cell sap is usually accompanied by lower turgor pressure so that its DPD or SP is greater and water enters into it. But, sometimes it is possible that two cells are in contact with each other one having higher osmotic pressure and also higher turgor pressure than the other cell and still it's does not draw water. It is because of its lower Diffusion Pressure Deficit (DPD) or suction pressure (SP), no matter its OP is higher.

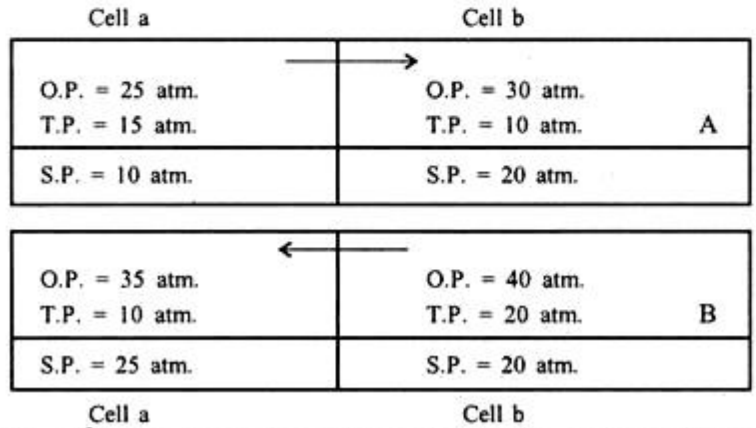

Fig. Entry of water into the cell depends on D.P.D. or Suction Pressure and not on O.P. only.

Determination of Diffusion Pressure Deficit:

A number of cylinders of tissues (2 or 3 cm. long) are cut from a large sized potato tuber or beet root etc. with the help of the cork-borer after the skin of the potato tuber etc. has been removed. The cylinders of tissue are weighed and placed in different test tubes containing sugar solution of varying but known concentrations (e.g. 0.50 M, 0.45 M, 0.40 M and so on). The test tubes (each of which contains one cylinder of tissue) are plugged.

After about 24 hours, the cylinders of tissue are taken out of the sugar solutions from the test tubes, dried with filter paper, and again weighed. The sugar solution in which the weight of the cylinder of tissue does not change is noted. DPD or the Suction Pressure of the tissue will be equal to the osmotic pressure of this sugar solution which can be known from any standard table by using Vant's Hoff equation:

$OP = C\ i\ R\ T$

Where,

C = Concentration of solution expressed as molality (mol. per kg of water).

i = the activity coefficient (for non-electrolytes such as sugars it is 1; for electrolytes such as NaCl it varies with their concentration).

R = gas constant.

T = absolute temperature (K) = °C + 273.