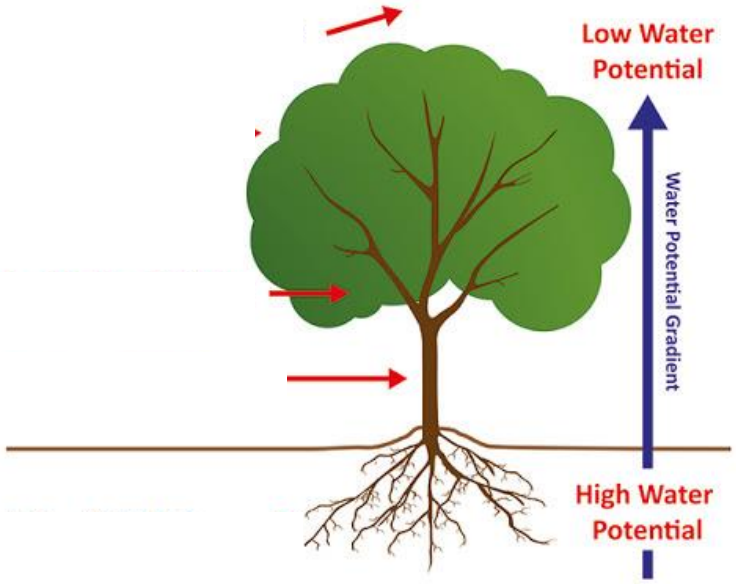
DPD AND WATER POTENTIAL



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For B.Sc. Part II (Sub.) Group C (Plant Physiology)

Lecture No. 45

DPD (Diffusion pressure deficit)

The Diffusion pressure deficit (DPD) of any solution is the difference between the diffusion pressure of the water, which is present in the solution and diffusion pressure of pure water.

or

The difference between the diffusion pressure of the solution and its pure solvent at particular temperature and pressure is called DPD.

- DPD determines the direction of osmosis and it is the power of absorption of water for the cell (Suction Pressure).
- DPD α concentration of solute
- The diffusion of water takes place from the region of lower DPD to the region of higher DPD in the process of osmosis.

Normally, osmotic pressure is greater than the turgor pressure in a cell. The difference between osmotic pressure and turgor pressure is called suction pressure or DPD.

Turgor pressure ????

When a cell is immersed in water, then water enter into the cell because osmotic pressure of the cell sap is higher. The cell content press upon the wall or develop a pressure against the cell wall, which is called turgor pressure.

✓ Turgor pressure is not applicable for free solution.

✓ This is only applicable for osmotic system of a cell.

✓The turgor pressure in encounter balanced by an equal but opposite pressure of the thick cell wall on the enclosed solution or protoplasm is known as wall pressure. It means whatever the amount of pressure exerted inner side on the cytoplasm.

✓Plant cell does not burst, when placed in pure water due to wall pressure, but an animal cell burst when placed in pure water because wall pressure is absent due to absence of cell wall. For example the consequence of endosmosis in animal cell can be demonstrated by placing RBCs of human blood in distilled water.

✓A flaccid cell has zero turgor pressure.

✓The highest value of turgor pressure is found in fully turgid cell and it is equal to the osmotic pressure. Fully turgid cell has TP = OP

✓ The value of turgor pressure is normally from zero to in between the osmotic pressure in plant cell.

✓ The value of turgor pressure is assumed as negative (-ve) during the plasmolysis of the cell.

$$TP = WP$$

✓ DPD = OP – TP

✓ The DPD of any free solution is equal to the osmotic pressure of that solution (DPD = OP).

(1) **DPD of normal cell**

$$DPD = OP - TP$$

(2) **DPD for fully turgid cell :**

When a cell is placed in pure water or hypotonic solution then water enter into the cell, results turgor pressure develop in the cell. The cell starts swelling due to the turgor pressure. Simultaneously, concentration of cell sap decreases due to continuous inflow of water. Therefore OP is goes on decreasing and T.P. increase due to this, when value of TP will be equal to the OP then DPD will be zero.0

(3) **DPD for flaccid cell**

If, cell is in flaccid state then

$$TP \text{ or } WP = O$$

$$\text{Therefore, } DPD = OP$$

If a flaccid cell placed in water then water enters into cell because DPD of the cell sap is higher.

(4) DPD for plasmolysed cell

Sometimes the value of turgor pressure is negative as in plasmolysed cell. In this state

$$DPD = OP - TP$$

$$[TP = -Ve]$$

$$DPD = OP - [- TP] = OP + TP$$

So that the DPD of the plasmolysed cell is greater than osmotic pressure

✓Demand of water = Plasmolysed cell > Flaccid cell > Partially turgid cell > Fully turgid cell.

When the osmotic pressure and turgor pressure will be equal, then the DPD will be zero. Water will not enter in this type of cell and cell become fully turgid.

✓ But, when turgor pressure is lesser than the osmotic pressure, in normal cell then value of DPD will exist definitely in the cell and water would enters inside the cell.

Water Potential

✓All living things, including plants, require a continuous input of free energy to maintain and repair their highly organized structures, as well as to grow and reproduce.

✓ Processes such as biochemical reactions, solute accumulation, and long-distance transport are all driven by an input of free energy into the plant.

✓ The **chemical potential of water is a quantitative expression** of the free energy associated with water. In thermodynamics, free energy represents the potential for performing work.

✓ Note that chemical potential is a relative quantity: It is expressed as the difference between the potential of a substance in a given state and the potential of the same substance in a standard state.

✓ **water potential** is defined as the chemical potential of water divided by the partial molal volume of water (the volume of 1 mol of water)

✓ Water potential is a measure of the free energy of water per unit volume (J m–3).

✓These units are equivalent to pressure units such as the pascal, which is the common measurement unit for water potential.

Three major factors contribute to cell water potential

✓ The major factors influencing the water potential in plants are *concentration*, *pressure*, and *gravity.*

✓ Water potential is symbolized by ψ_w.

$$\psi w = \psi s + \psi p + \psi g$$

✓ The terms ψs, ψp, and ψg denote the effects of solutes, pressure, and gravity, respectively, on the free energy of water.

Solute Potential : The term ψs, called the solute potential or the osmotic potential, represents the effect of dissolved solutes on water potential.

✓ Solutes reduce the free energy of water by diluting the water.

✓ This is primarily an entropy effect; that is, the mixing of solutes and water increases the disorder of the system and thereby lowers free energy.

✓This means that the osmotic potential is independent of the specific nature of the solute.

✓ Dissolved solutes reduce the water potential of a solution relative to the reference state of pure water.

Pressure: The term ψ_p is the hydrostatic pressure of the solution.

✓ Positive pressures raise the water potential; negative pressures reduce it.

✓Sometimes ψ_p is called pressure potential.

✓ The positive hydrostatic pressure within cells is the pressure referred to as turgor pressure.

✓The value of ψ_p can also be negative, as is the case in the xylem and in the walls between cells, where a tension, or negative hydrostatic pressure, can develop.

✓ Thus the value of $\boldsymbol{\psi}_p$ for pure water in an open beaker is 0 Mpa.

Gravity: Gravity causes water to move downward unless the force of gravity is opposed by an equal and opposite force.

✓ The term ψ_g depends on the height (h) of the water above the reference-state water, the density of water (rw), and the acceleration due to gravity (g).

✓ When dealing with water transport at the cell level, the gravitational component (ψg) is generally omitted because it is negligible compared to the osmotic potential and the hydrostatic pressure.

Water always move from higher water potential towards the lower water potential.

Water potential in the plant: Cell growth, photosynthesis, and crop productivity are all strongly influenced by water potential and its components. Like the body temperature of humans, water potential is a good overall indicator of plant health.

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Thank You!!!