D2.3 Water potential

Osmolarity

The osmolarity of a solution is the total concentration of osmotically active solutes (eg. glucose, sodium ions, potassium ions). The normal osmolarity of human tissue is about 300 milliosmoles (mOsm).

- An isotonic solution has the same osmolarity as a tissue.
- A hypertonic solution has a higher osmolarity (→ water leaves the cells by osmosis).
- A hypotonic solution has a lower osmolarity (→cells take in water by osmosis)

Hypertonic and hypotonic solutions can harm human cells, so isotonic solutions are used (i.e sodium chloride). Transplants are frozen and transported in isotonic solutions.

Effects of hypertonic and hypotonic solutions on cells with a cell wall

In plant tissues, the effects of uncontrolled osmosis are moderated by the presence of an inflexible cell wall

- In hypertonic solutions, the cytoplasm will shrink (**plasmolysis**) but the cell wall will maintain a structured shape
- In hypotonic solutions, the cytoplasm will expand but be unable to rupture within the constraints of the cell wall (turgor/**turgidity**)

Higher Level

Water potential as the potential energy of water per unit volume.

It is a measure of the potential energy per unit volume. The symbol for water potential is (Ψ) and the units for measurement are kilopascals (kPa) or megapascals (MPa).

Pure water at standard atmospheric pressure and 20° has a water potential of 0kPa.

So:

→ a rise or a fall in hydrostatic pressure will change the potential energy of water. The higher the pressure, the more potential energy water has

→ When solutes dissolve, the potential energy of water is reduced. The higher the solute concentration, the less potential energy water has

Movement of water from higher to lower water potential.

Water will move from higher to lower water potential. In cells, water will move from a cell with a water potential of -200kPa to one with -300kPa.

Contributions of solute potential and pressure potential to the water potential of cells with walls.

- When solutes dissolve, the potential energy of water is reduced.
- With no solutes, the solute potential is Zero (0kPa).
- The pressure potentials are generally positive inside cells.
- A cell type in which the pressure potential is negative is onion cells

Water potential and water movements in plant tissue.

The movement of water in plant cells differs when bathed in a hypotonic solution in terms of solute and pressure potentials.

→ The more dilute the hypotonic solution, the higher the water potential.

The movement of water in plant cells bathed in a hypertonic solution in terms of solute and pressure potentials.

→ Cells will have a higher water potential than the bathing solution and there will be a net movement of water out of the tissue.