2.11 Water Potential

The movement of water between cells and the effects of water potential on plant cells

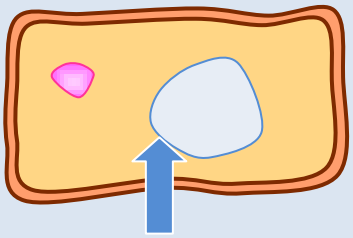
The term **water potential** (ψ) refers to the measure of the tendency of water molecules to diffuse from one place to another. For a more detailed introduction into water potential and to read about its effect on animal and plant cells, see 1.8 Movement Across Cell Membranes.

Water molecules always move from a region of high water potential (less negative) to an area of lower water potential (more negative). Pure water has a water potential of zero – this means that the water potential cannot get any higher, because the scale for water potential (measured in kilopascals – **kPa**) is negative. Because pure water has such a high water potential, it has a very high tendency to lose water to its surroundings, as they will have a lower water potential.

In a plant cell, the cytoplasm contains salts and sugars (solutes) that will reduce its water potential. This is because having the solutes lowers the number of "free" water molecules in the cytoplasm. Therefore, all plant cells always have a negative water potential.

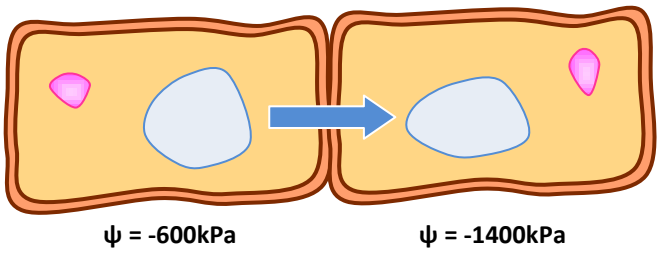
If you place a plant cell in *pure water*, it will take up water molecules by osmosis because the water potential of the cell is lower than that of the water surrounding it. However, it will not continue to absorb water until it bursts, because it has a strong cellulose cell wall. Once the cell has taken as much water as it is going to, it is **turgid**. The water inside starts to exert pressure on the cell wall, called **pressure potential** (also ψ). As this pressure potential builds up, the intake of water slows down.

When a plant cell is places in a solution with a very low water potential, for example a concentrated salt solution, it will *lose* water via osmosis. This is because the solution has a much lower water potential than the cell, so the water molecules move out of the cell. The cytoplasm and vacuole begin to shrink and shrivel. Eventually, the cytoplasm stops pushing against the cell wall and is called **incipient plasmolysis**. If the water loss continues, the plasma membrane will lose contact with the cell wall too. This is **plasmolysis**.



▲ The water potential of the cell is negative, but the pure water surrounding it is zero (the highest possible water potential), so water molecules move into the cell

▼ The cell on the left has a higher water potential because its value is *less negative*, so water molecules move from it into the cell on the right which has a lower water potential (it has a higher negative value)



The table below shows relative water potentials and where they may be found:

Highest water potential 0kPa	Pure water	No solute dissolved
Lower water potential -10kPa	Dilute solution	Small amount of solute dissolved
Very low water potential -500kPa	Concentrated solution	Large amount of solute dissolved