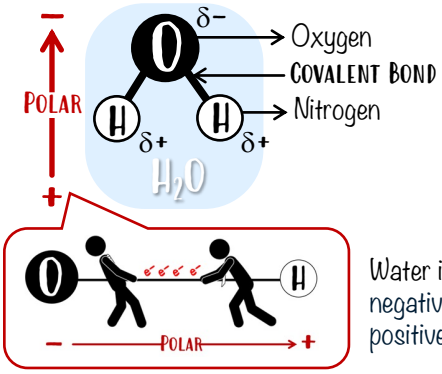
D2.3

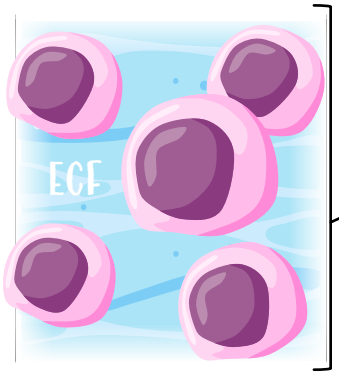
Water Potential

Introduction – what is water?

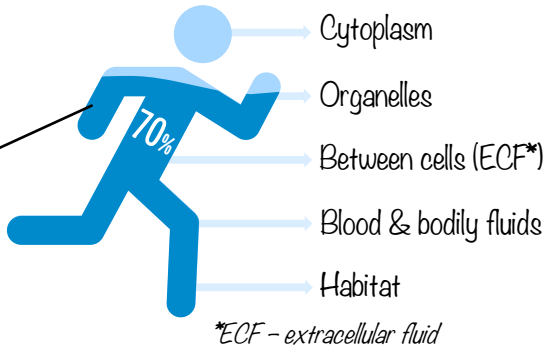
A. Structure of water



Water is a **POLAR MOLECULE** as there is a slight negative charge (δ−) near the **O** atom and a slight positive charge (δ+) near the **H** atoms.



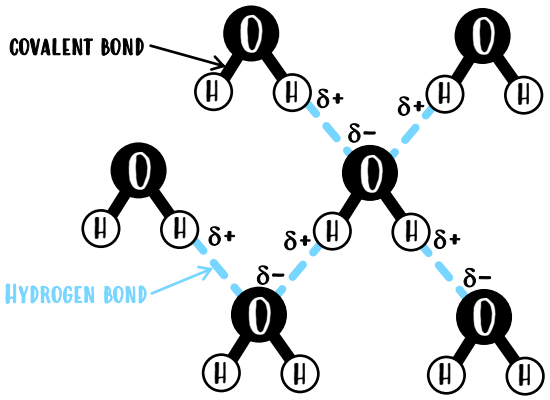
Where is water found?



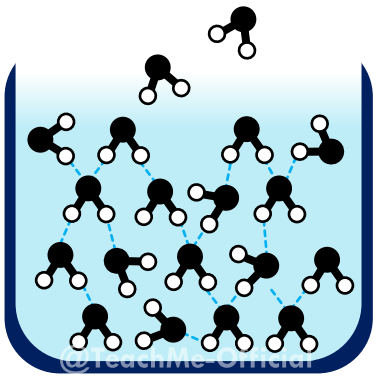
*ECF – extracellular fluid

B. Interactions between water molecules

Due to the polarity of water, the opposite slight charges between the hydrogen (**H**) and the oxygen (**O**) of another water molecule form **HYDROGEN BONDS**.



BIG BRAIN TIP!
HYdrogen bonds are **HY**ding. Weaker than covalent bonds.



In liquid state, hydrogen bonds are continually breaking, reforming and moving around.

Water as a solvent

Water is known as a "**universal solvent**"

Terminology

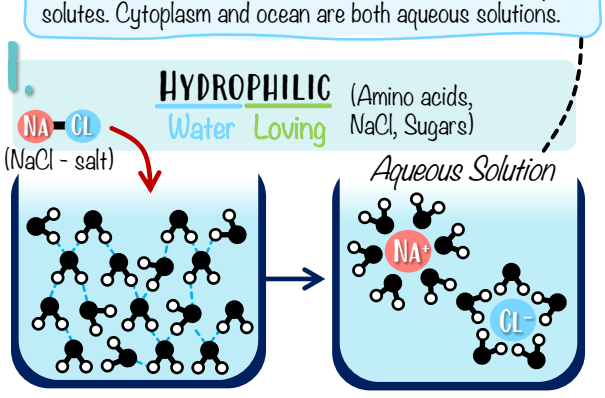
SOLUTE (salt)
The substance to be dissolved in a solvent.

SOLVENT (water)
The substance that will dissolve other substances (solute).

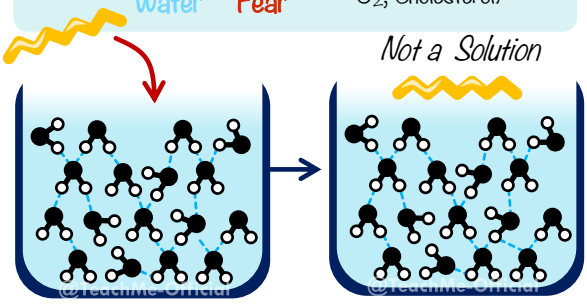
SOLUTION (salty water)
This is mixture formed when the solute has been dissolved by the solvent.

We refer to solutions as aqueous solutions if water is the solvent no matter what mixture of substances makes up the solutes. Cytoplasm and ocean are both aqueous solutions.

I. **HYDROPHILIC** Water Loving (Amino acids, NaCl, Sugars)



II. **HYDROPHOBIC** Water Fear (Lipids, Proteins, CO_2, O_2, Cholesterol)



BIG BRAIN TIP!
"Like dissolves like"
"Polar dissolves Polar"

I. The particles of a solute separate from each other
II. The water particles separate from each other
III. The separated solute and water particles combine to make a solution

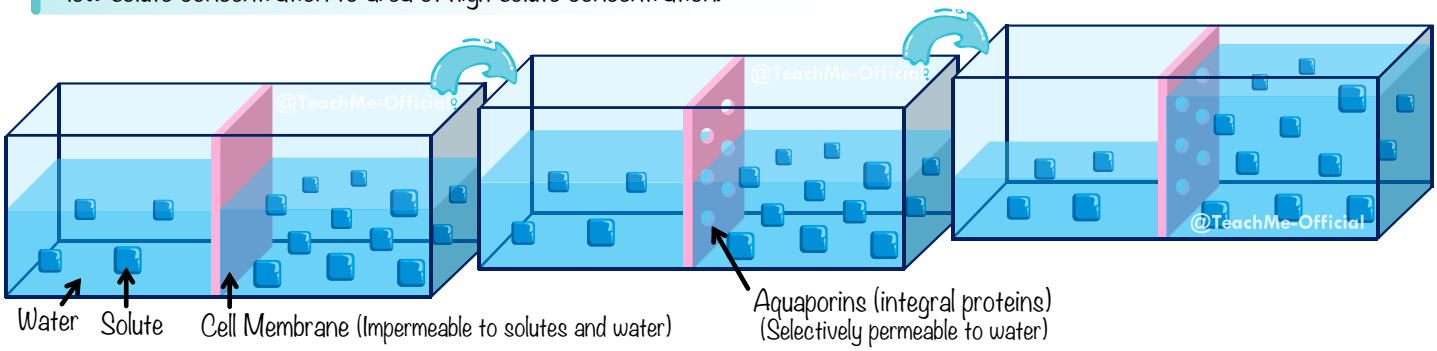
Solvation (hydration) is the interaction of a solvent with a dissolved solute.

Water Potential

Remember the concept of **OSMOSIS** we learnt back in section **B2.1**

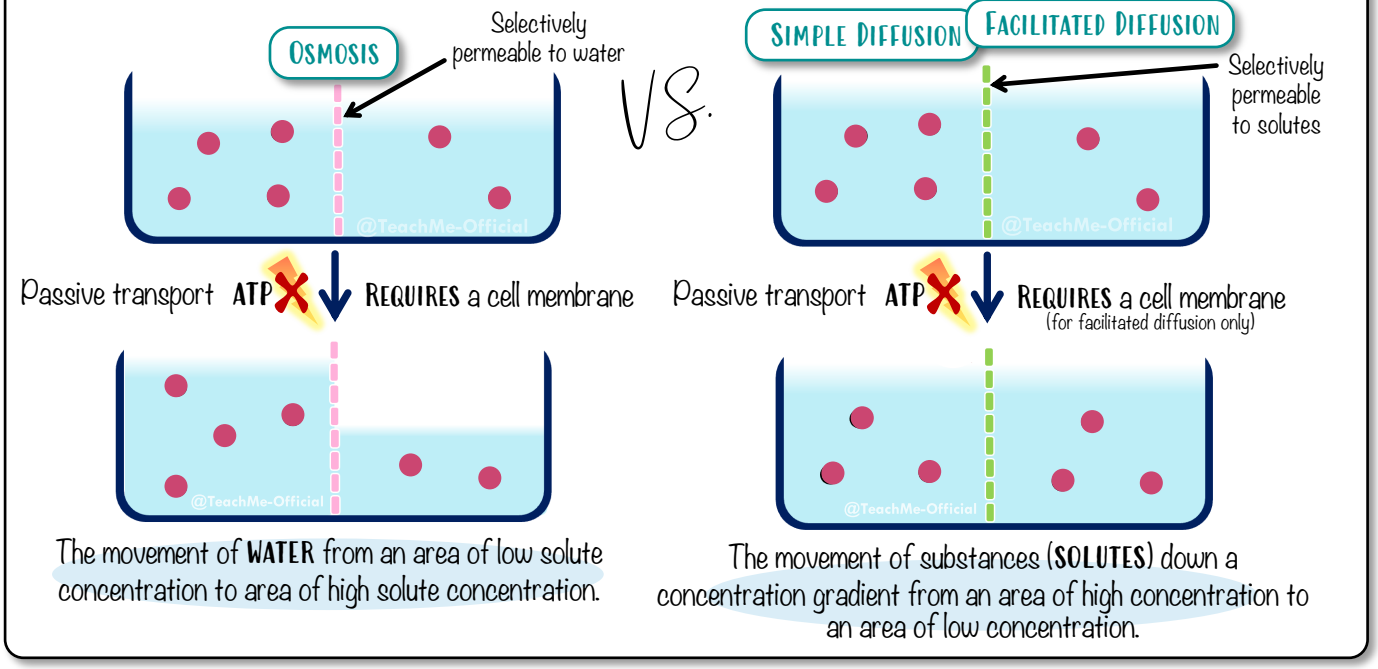
OSMOSIS The movement of **WATER** from an area of low solute concentration to area of high solute concentration.

Water is hydrophilic (polar) and can't pass through the hydrophobic layers of the cell membrane, it therefore requires a "hydrophilic tunnel" – aquaporins, to pass through.



WATER POTENTIAL The measure of the potential energy (potential movement – tendency of movement) of water in a particular environment or system in comparison to pure water. More in **HL**.

OSMOSIS and **SIMPLE & FACILITATED DIFFUSION** are all types of **PASSIVE TRANSPORT**... So *what* differentiates them?



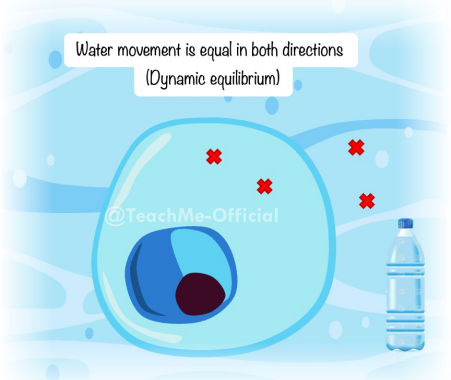
The movement of **WATER** from an area of low solute concentration to area of high solute concentration.

The movement of substances (**SOLUTES**) down a concentration gradient from an area of high concentration to an area of low concentration.

When placing a cell in an environment with different tonicities (solute levels), osmosis causes cellular strutcural changes.

ISOTONIC Environment Tonicity

ISO = EQUAL CONCENTRATION COMPARED TO CELL



HYPOTONIC

HYPO = LOW CONCENTRATION COMPARED TO CELL

HYPERTONIC

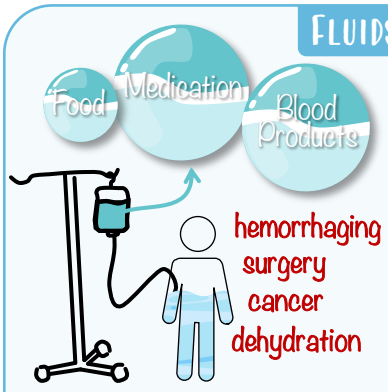
HYPER = HIGH CONCENTRATION COMPARED TO CELL

Water Potential

Uses of Isotonic Solutions

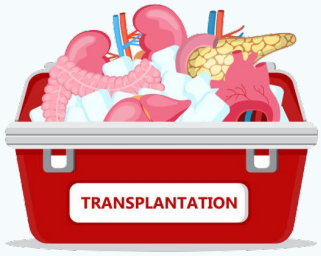
They are used to maintain the balance between **ICF** [Intracellular Fluid (inside cells)] and **ECF** [Extracellular Fluid (outside cells)].

Fluids



Different IV* solutions concentrations used for different medical conditions. Most are isotonic to prevent excess water movement in or out of the body cells.

Transplantation



Organs are stored in an isotonic solution when being transported to prevent damage to the donor organ.

Contact Lens Solution

Contact lens solution is isotonic to match the natural salinity of tear fluid and prevent eye irritation and discomfort

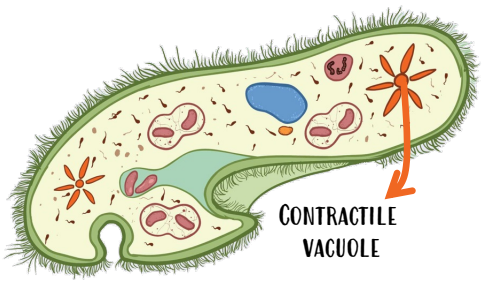
*IV - IntraVenous

Adaptations

To prevent harmful swelling and shrinkage of cells

A. In Paramecium

Aquatic single-celled animal

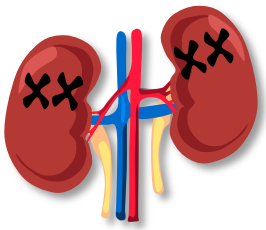


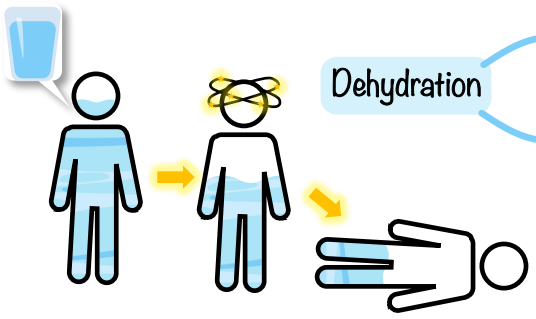
The paramecium contains an organelle: the **CONTRACTILE VACUOLE**, which collects excess water from the interior of the cell and periodically empties it into the surrounding environment. This mechanism prevents the cell from swelling even when it is placed in a hypotonic environment.

B. In Mammals

The kidney

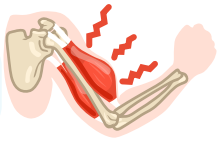
The **KIDNEY** is the main organ responsible for the balance of water in the body. A disfunction in the proper functioning of the kidney could lead to **DEHYDRATION**. **CELL SHRINKAGE** is a result of dehydration, it causes the feeling of thirst, light headedness and fainting. The lack of water in the body will also cause build-up waste to accumulate, muscle cramping and organ disfunction.





Dehydration

- Cell shrinkage* → Thirst → Light headedness and fainting
- Blood flow diminished to body (only to important organs – heart, brain)
  - → Muscle cramping and organ problems
  - → Build-up waste products in the body



*Loss of water causes extracellular fluid to become hypertonic, water then leaves the cells, causing cell shrinkage.

Water Potential

Try for yourself!

Consider three scenarios (A, B and C) and answer the following questions (I, II and III) for each.

A. Raisins in pure water. 

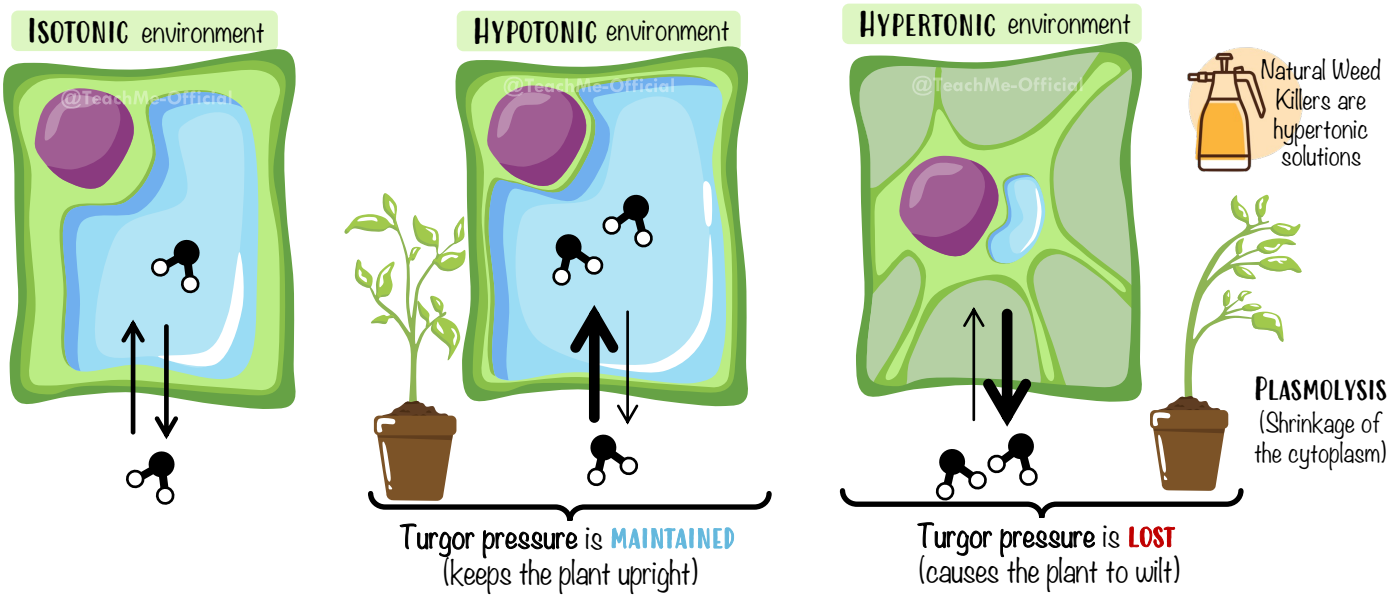
B. Human red blood cells in a solution with a high solute concentration. 

C. Gargling with saltwater to relieve a sore throat. 

I. What term best describes the external cell environment?
II. Which way does the water move and why?
III. What is the result of osmosis?

Osmosis in Plant Cells [with cell wall]

Most plant cells are **HYPERTONIC** relative to their **environment**. Therefor water tends to move inwards (high hydrostatic pressure) leading to a **HIGH TURGOR PRESSURE** (pressure exerted against a boundary in a confined space). This pressure is important in helping plants maintain shape and remain upright.



ANSWERS: **A.** I. Hypotonic, II. Moves into the raisin, III. Swelling of raisin - **B.** I. Hypertonic, II. Moves out of the red blood cell, III. Shrinking of red blood cell – **C.** I. Hypertonic, II. Moves out of the throat cells, III. Shrinking of throat cells.

notes