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Topic: Water as biological Solvent

Water as biological Solvent

Introduction:

A **solvent** is simply a substance that can dissolve other molecules and compounds, which are known as **solutes.**

A homogeneous mixture of solvent and solute is called a **solution**, and much of life's chemistry takes place in **aqueous solutions**, or solutions with water as the solvent.

Because of its **polarity and ability to form hydrogen bonds,** water makes an excellent solvent, meaning that it can dissolve many different kinds of molecules. Most of the chemical reactions important to life take place in a watery environment inside of cells, and water's capacity to dissolve a wide variety of molecules is key in allowing these chemical reactions to take place.

The Biological Significance of Water:

From a Biological point of view, water is important for a number of reasons: As a **metabolite**: Water is involved in many (bio) chemical reactions inside cells metabolism.

For example, the chemical reactions of condensation and hydrolysis involve the removal and addition of water and water is essential for the light-dependent reactions of photosynthesis.

As a **solvent**: many biological and inorganic chemicals dissolve in water, and can be transported and react with other chemicals within cells (and in laboratory test-tubes).

Substances that dissolve in water are called *hydrophilic* ("water-liking").In contrast; substances that do not dissolve in water are called hydrophobic ("water-hating").

These can form structures like the cell membrane and internal cellular membranes which keep water-soluble chemicals in compartments within the cell.

A number of unusual physical properties are a direct consequence of cohesion between water molecules due to hydrogen bonds formed between -H and -O- of different water molecules.

Water has a particularly **high heat capacity** - higher than any other common substance. This is the amount of heat (usually expressed in calories, kilocalories, or joules) needed to raise the temperature by one degree (usually expressed in Celsius or Kelvin).

Specific heat takes mass into account. The specific heat of water is 1 calorie/gram °C = 4.186 joule/gram °C,This makes water useful for storing heat energy, and stabilises temperature within bodies of water (ponds, lakes, seas) as well as the bodies of animals.

Water has a large **latent heat of vaporisation**. This permits efficient cooling by means of sweating.

Water shows **cohesive properties**. This allows long columns of water to be formed and drawn up in the vascular tissue of trees (and smaller plants). It is also responsible for surface tension where water meets air - an important feature for small pond insects, and in the functioning of lungs.

In addition water is unusual in that its solid form - **ice** - has a **lower density** than the liquid form, so it floats. It forms an insulating layer at the top of ponds and lakes, with water beneath at an even 4 °C.

Solvent properties of water:

Because of its ability to dissolve a wide range of solutes, water is sometimes called the "universal solvent."

Generally speaking, water is good at dissolving ions and polar molecules, but poor at dissolving non-polar molecules. (A **polar** molecule is one that's neutral, or uncharged, but has an asymmetric internal distribution of charge, leading to partially positive and partially negative regions.)

Water interacts differently with charged and polar substances than with nonpolar substances because of the polarity of its own molecules. Water molecules are polar, with partial positive charges on the hydrogens, a partial negative charge on the oxygen, and a bent overall structure.

The unequal charge distribution in a water molecule reflects the greater electronegativity, or electron-greediness, of oxygen relative to hydrogen: the shared electrons of the O-H bonds spend more time with the O atom than with the Hs.

Because of its polarity, water can form electrostatic interactions (charge-based attractions) with other polar molecules and ions. The polar molecules and ions interact with the partially Water molecules forming hydration shells around Na+ and Cl- ions.

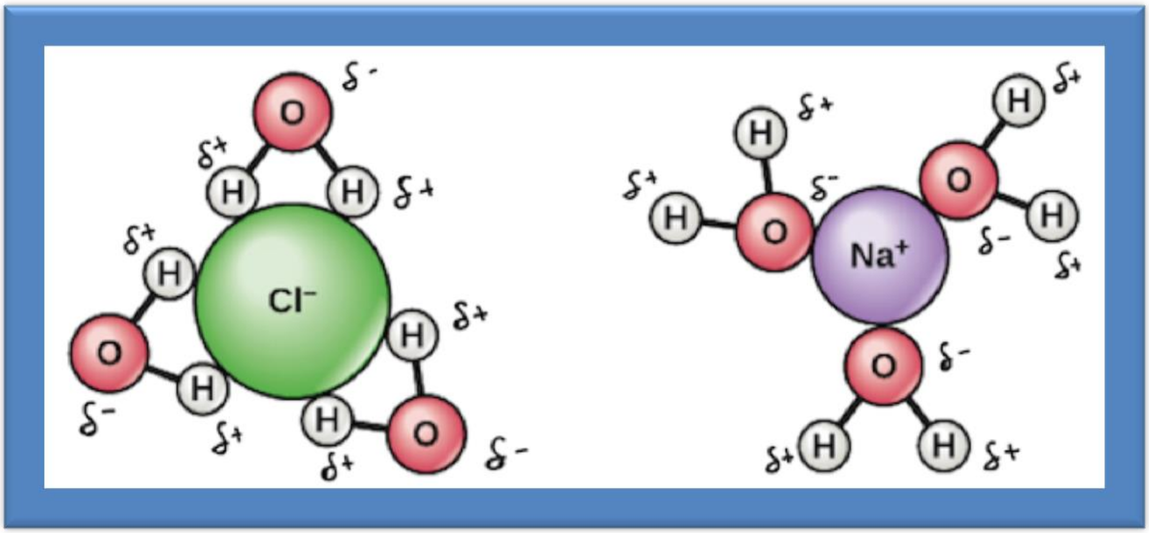

Fig: Dissociation of NaCl in water

The partially positive ends of the water molecules are attracted to the negative Cl- ion, while the partially negative ends of the water molecules are attracted to the positive Na+ ion.

If you stir table salt into water, the crystal lattice of NaCl will begin to dissociate into Na^++start superscript, plus, end superscript and Cl^-−start superscript, minus, end superscript ions. (**Dissociation** is just a name for the process in which a compound or molecule breaks apart to form ions.)

Water molecules form hydration shells around the ions: positively charged Na^++start superscript, plus, end superscript ions are surrounded by partial negative charges from the oxygen ends of the water molecules, while negatively charged Cl^-−start superscript, minus, end superscript ions are surrounded by partial positive charges from the hydrogen ends.

As the process continues, all of the ions in the table salt crystals are surrounded by hydration shells and dispersed in solution.

Non-polar molecules, like fats and oils, don't interact with water or form hydration shells. These molecules don't have regions of partial positive or partial negative charge, so they aren't electrostatically attracted to water molecules.

Thus, rather than dissolving, non-polar substances (such as oils) stay separate and form layers or droplets when added to water.