

## ➤ BIOLOGICAL IMPORTANCE OF WATER

- Water is the mother liquor of all forms of life.
- It is the vital essence miracle of Nature and the great sustainer of life.
- The essentiality of water is a continuous reminder of the aqueous origin of life.
- It was the solvent water that the chemical reactions of biological processes evolved.
- All the aspects of cell structure and function are adapted to the physical and chemical properties of water.
- No other substance on earth is as abundant as water.
- The bodies of living organisms contain 70-90% water.

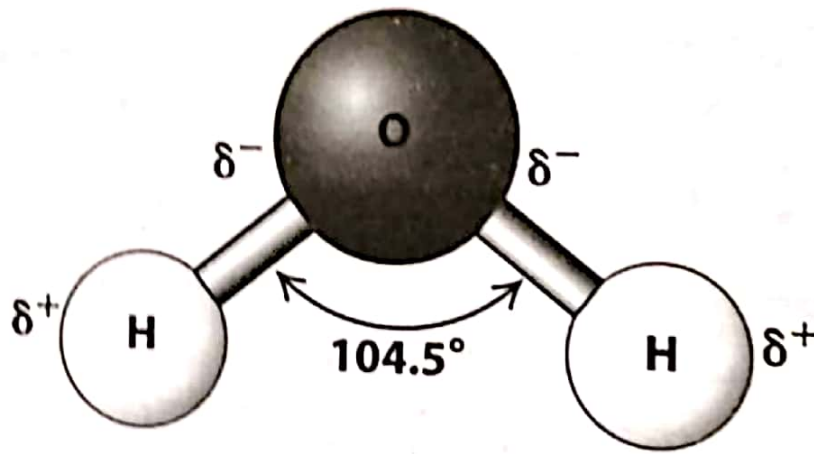
Following are the biological importance of water

### 1. Polarity of Water

Water's composition (two parts hydrogen to one part oxygen) was discovered by the scientist Henry Cavendish (1731-1810) in about 1781.

Knowing the electro negativity, two atoms allows one to predict whether a bond between them will be covalent or ionic.

Molecules that have uneven distributions of electric charge are said to be polar. When a polar molecule, such as water come close to an ion or to another polar molecule, its negative pole (oxygen) are attracted toward the other molecule's positive pole and its, positive pole toward negative pole. Water molecules are bonded to one another through hydrogen bonds. Hydrogen bonds are weaker than covalent bonds the hydrogen bonds in water have bond energy (the energy required to break a bond) of only about 20 KJ/mole as compared to 460KJ/mole for the covalent O-H bond but they still cause water molecules to remain attached together.



### 2. Universal Solvent

Water is a solvent for a great number of molecules which ionized solutions in water. It may thus, be called a Universal solvent which facilitates chemical reactions both outside and within biological systems.

When Sodium chloride (NaCl) is put in water, the electronegative ends of water molecules are attracted to the Sodium ions (Na<sup>+</sup>) and electropositive ends (H<sup>+</sup>) of water are attracted to the chloride (Cl<sup>-</sup>) ions.

As a result sodium and chloride ions separate and dissolve in water. Like this water molecules also dissolve all minerals and salts present in soil, which are then absorbed by plants roots.

### 3. Cohesive and Adhesive nature of water

Cohesive force = Intra-molecular force

Adhesive force = inter-molecular force

Due to hydrogen bonds in water molecules, are attached to one another (cohesive force) and also attached to the wall of a container (adhesive Force).

It is due to the cohesive and adhesive property of water molecules that water molecules raise about 100 meters above the ground in Red wood tree (Tallest Plant)

#### 4. High surface tension

Like a stretched membrane the surface of a liquid tends to contract as much as possible. This phenomenon is called surface tension. Water has the highest surface tension (72.8).

It is the reason that water rises to unusually high levels in narrow capillary tubes.

Surface tension has great significance in physiology of living organisms.

#### 5. High Specific heat and high heat of vaporization due to hydrogen bonds in water molecules

- i. It has high heat capacity and high heat of vaporization.
- ii. It causes water molecules to remain liquid rather than change to ice or steam.
- iii. Without hydrogen bonds water would boil at  $-80^{\circ}\text{C}$  and would freeze at  $-100^{\circ}\text{C}$ .
- iv. In such conditions life for living organisms would become impossible.

**Heat Capacity:** The amount of heat energy required to raise the temperature of one gram of water by one degree Celsius.

#### Explanation:

Due to high heat capacity, water molecules absorb or release large quantity of heat with little change in temperature. The reason is that, temperature of water rises and falls more slowly as compared to other liquids. In this way, water has a role to maintain the internal body temperature constant and protect it from rapid temperature changes.

**Heat of Vaporization:** The amount of heat required to convert one gram of water into vapour form at its boiling point.

- i. Water molecules has high heat of vaporization
- ii. This property in water molecules help living organisms, e.g. animals get rid of excess body heat during sweating.
- iii. Plants get rid of excess of heat through transpiration.

#### 6. Water expands at low temperature OR Expansion on freezing

Most substances decrease in volume (and hence increase in density) as their temperature increase. But water expands when temperature falls below  $4^{\circ}\text{C}$ .

In fact, water just above the freezing point is heavier than water at the freezing point. Therefore, it moves towards the bottom, freezing begins at the surface and bottom is last to freeze. Organisms living at the bottoms of fresh water lakes are, hence protected from freezing.

It is concluded that:

- i. Almost all substances contract on cooling, water expands. If water could contract on cooling, it would have become heavier and would have sunk.
- ii. When the temperature of water is raised above  $0^{\circ}\text{C}$ , its volume decreases up to  $4^{\circ}\text{C}$  and thereafter increases. Water thus has minimum volume and hence the maximum density of 1 at  $4^{\circ}\text{C}$ .
- iii. While all substances increase in volume when they are melted, the volume of ice decreases when melted.
- iv. Frozen water (ice) is less dense than liquid water and this is the reason that ice floats in liquid water.