

The water molecule is a polar molecule
with a *negative* and a *positive* side.

(O attracts electrons more strongly than H, causing the O to take on a *partial* negative charge and the H atoms to take on *partial* positive charges)

Fig. 2.12

A *hydrogen bond* can be formed by the electrical attraction of a partially-positive H atom to a partially-negative atom in another molecule.

After Fig. 2.15

Four properties of water key to supporting life on Earth are based on the ability of water to form hydrogen bonds

1. Cohesion
2. Moderation of temperature
3. Insulation of bodies of water by floating ice
4. The solvent of life

Again, all this results from the polarity of water molecules!

And all this is due to the hydrogen bond!

1. *Cohesion* among water molecules

Hydrogen bonding holds water molecules together

Fig. 3.5 Liquid water

Cohesion among water molecules provides a stretchable, compressible liquid.

Example 1: Pulling water up trees

Fig. 3.3

Example 2: Water strider walks on water

Fig. 3.4

2. Moderation of temperature

Example: Coastal areas have a mild climate because water resists temperature changes

It takes a lot of energy to increase the temperature of water because hydrogen bonds must be broken first before the water molecules can move faster (= increase in temperature).

Fig. 3.5

The ability of water to resist temperature changes means that the earth can absorb a lot of solar energy without much change in temperature. This prevents extreme swings in temperature and improves the stability of the Earth's environment.

A habitable planet!

Moderation of *body* temperature

Hydrogen bonds must be broken for water molecules to leave the liquid as water vapor.

For every water molecule that leaves, the remaining liquid gets cooler. This is how water loss (sweating or transpiration) cools many living organisms and keeps them from overheating.

3. *Insulation of Water Bodies by Ice*

Euphausiid shrimp

Fig. 3.5

Ice is less dense than liquid water

Once again, due to hydrogen bonding!

Fig. 3.5

4. *Water is the solvent of life!*

Water molecules form *hydration shells* around the polar components of salts. Water dissolves salts like table salt = NaCl (sodium chloride).

Fig. 3.6

Large molecules like proteins are also dissolved in the water solution of living cells.

Fig. 3.7

Many protein surfaces are polar or charged.

Hydration by water is essential to the proper functioning of proteins, and thus to life. If a cell dries out, it ceases to function and, for most lifeforms, dies.

Two more terms: *hydrophobic* (“water-fearing”) and *hydrophilic* (“water-loving”)

Hydrophilic = “water-loving” compounds, with charged or polar regions that attract water molecules, that mix readily with water

Hydrophobic = “water-fearing” compounds, without polarity and without attraction for polar water molecules, that do not mix with water

Fig. 3.7