2.2 WATER

TOPIC CONNECTIONS
- 4.3 Carbon cycling
- 4.4 Climate change

Recall that atoms want to have their outer valence shells full and will bond with other atoms to do so. Oxygen would like to take on 2 more electrons, and hydrogen atoms would like to gain 1 electron. By hydrogen and oxygen sharing their electrons with each other (covalently bonding), water molecules complete their outer valence shells and become more stable. Covalent bonds form among the two hydrogen atoms and the oxygen atom (H₂O). Although these atoms are sharing electrons, oxygen pulls the electrons in the covalent bond closer to its nucleus (centre of the atom), forcing the electrons farther away from the hydrogen nuclei. When electrons are shared unequally, a molecule is polar. In water molecules, the oxygen atom takes on a slightly negative charge and the hydrogen atoms take on slightly positive charges due to oxygen having a greater attraction for the shared electrons. (See Figure 2.2.) Be prepared to draw and label two bonded water molecules, including the internal bonds, the hydrogen bonds, the charges on the atoms and the polarity of the molecules.

![Figure 2.2. Water molecule](image)

The polarity of water leads to the formation of hydrogen bonds between water molecules. Hydrogen bonds form due to an attraction between a slightly positive hydrogen atom in one polar molecule and a slightly negative oxygen atom in another polar molecule. Hydrogen bonding is an important feature of water molecules that gives water many unique properties that are important to living organisms. (See Figure 2.3.)

![Figure 2.3. Cohesive forces in water molecules](image)

**REMEMBER**
Water is not the only molecule that has hydrogen bonding. The formation of the DNA double helix involves hydrogen bonding as well.
Properties of Water

Water exhibits thermal, cohesive and solvent properties that are due to the hydrogen bonds that form among water molecules. Hydrogen bonds are individually weak. Collectively, though, they can be quite strong. Although they are not as strong as covalent bonds, hydrogen bonds resist breaking. The strong attraction among water molecules gives water many unique properties.

The attraction of water molecules to each other is called **cohesion**. The attraction of water molecules to other surfaces is called **adhesion**. Both adhesion and cohesion are due to the formation of hydrogen bonds. Adhesion and cohesion give water the properties that are important to living organisms. (Refer to Table 2.4.)

<table>
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<tr>
<th>Characteristic</th>
<th>Property</th>
<th>Importance to Living Organisms</th>
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| **High specific heat:** Water resists temperature changes. | Thermal | Organisms can maintain stable body temperatures in varied climates for a period of time.  
Aquatic environments can maintain fairly stable temperatures to support multiple life-forms. |
| **Cohesion:** Water attracts other water molecules. | Cohesive | **Transpirational pull:** Water passively moves from the roots to the leaves of plants, supplying the entire organism with water. As one molecule evaporates from the leaves, another is pulled into the roots, thereby forcing the entire water column upwards. |
| **Universal solvent:** Water can dissolve many substances. The polarity of water allows it to dissolve both positively and negatively charged substances (ions, polar molecules). | Solvent | Water dissolves polar substances and ions in order for them to be easily transported into the tissues of living organisms.  
Since water can dissolve many substances, it is the site of many metabolic processes. |
| **High heat of vaporization:** Water absorbs a lot of heat when it changes from a liquid state of matter to a gaseous state of matter. | Thermal | **Evaporative cooling:** Since heat is lost from the body when water evaporates, sweating is an efficient method of cooling. Evaporation of water also helps cool plant tissues. |