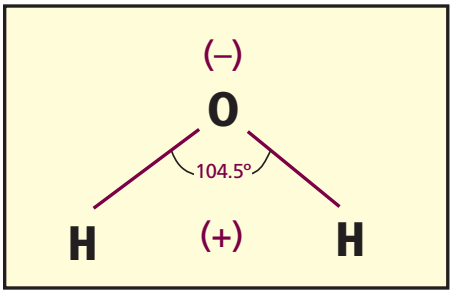
Water and Life

Water is essential for life on Earth. Up to 60% of the mass of the human body is water, and for some organisms this figure can be as high as 90%. Liquid water is so important for life on Earth that scientists searching for evidence of life on Mars and other planets begin by looking for evidence of this unique substance.

Why is water so important? For one thing, it is liquid over a range of temperatures. The biochemical reactions necessary for life can only take place in a liquid environment, where molecules can move and interact with each other. But that isn't all. Water has several unusual properties that distinguish it from other liquids. These properties stem from its unique chemistry.



The structure of a water molecule is shown on the right. In water, two hydrogen atoms bond to an oxygen atom. These bonds are covalent, which means that the oxygen and hydrogen share electrons. But in water, the sharing is unequal, because the electrons participating in the bond are more closely attracted to oxygen than to hydrogen. The hydrogen atoms in a water molecule tend to make an obtuse angle with the oxygen atom. This nonlinear shape results in a molecule with a partially negative side near the oxygen and a partially positive side near the hydrogen. These partial charges are shown in parentheses on the diagram below. Molecules with negative and positive sides are called **polar molecules**.

Each partially negative oxygen atom in a water molecule is attracted to the partially negative hydrogen of several other nearby water molecules. These forces of attraction are called hydrogen bonds. Hydrogen bonds are weaker than covalent bonds, so they don't form a rigid structure, but they are strong enough to affect the properties of water.

- Water has a higher boiling point than similar liquids. Hydrogen bonds hold hydrogen molecules together, so it takes a higher temperature for them to boil.

- Water is cohesive, which means it holds together more than most liquids. This affects its ability to transport substances in body fluids, such as blood, and in plants.

- Water is an excellent solvent. Because it is polar, it can dissolve many common substances, such as salt and sugar. Water is a major component of the cytoplasm in cells, where it acts as a solvent for the many chemical reactions of metabolism, and in the fluid outside cells, where it transports nutrients to and wastes from the

cells. However, water does not dissolve lipids, because lipids are nonpolar. The insolubility of lipids in water is responsible for the ability of cell membranes to separate the watery inside of the cell from its environment.

Water has several other unique properties. It's the only substance that exists on earth as solid, liquid, and gas. It has a high heat capacity, which means that it doesn't rapidly freeze or boil away when the temperature varies. This keeps water liquid over a wide temperature range.

Unlike other solids, ice, the solid state of water, is less dense than water in the liquid state. As a result, ice floats. The surface layer of ice provides some insulation to bodies of water such as lakes, allowing fish and other aquatic organisms to survive in the liquid water beneath the ice. If ice sank, ice on the surface would continue to freeze and sink until lakes and ponds were filled with solid ice, killing the fish and other organisms.

For more about the amazing properties of water, check the following links:

http://www.amnh.org/exhibitions/water/?section=blueplanet
http://www.pbs.org/wgbh/nova/evolution/liquid-of-life.html