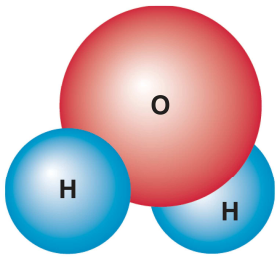
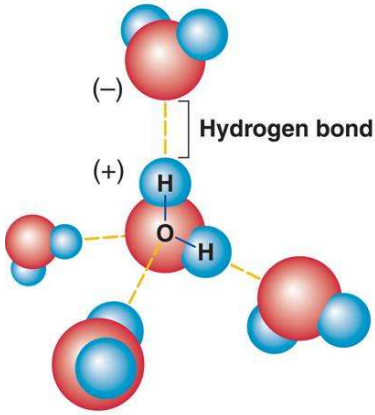
2-2 Properties of Water

The Water Molecule
Like all molecules, a water molecule is neutral.

Why are water molecules polar?
Polarity
However an oxygen atom, with 8 protons in its nucleus, has a much stronger attraction for electrons than does the hydrogen atom with a single proton.
Thus, there is a greater probability of finding the shared electrons near the oxygen atom than near the hydrogen atom.
As a result, the oxygen end of the molecule has a slight negative charge and the hydrogen end has a slight positive charge.
A water molecule is polar because there is an uneven distribution of electrons between the oxygen and hydrogen atoms.



Hydrogen Bonds
Because of their partial positive and negative charges, polar molecules can attract each other.
The attraction between the hydrogen atoms on one molecule and the oxygen atom on another water molecule is an example of a hydrogen bond.
Hydrogen bonds are not as strong as covalent or ionic bonds.
A single water molecule may be involved in as many as four hydrogen bonds at a time.
Water's ability to form multiple hydrogen bonds is responsible for many of its special properties.
Hydrogen bonds form between water molecules.



Cohesion is an attraction between molecules of the same substance.
Because of hydrogen bonding, water is extremely cohesive.
Water's cohesion causes molecules on the surface of water to be drawn inward, which is why drops of water form beads on a smooth surface.
Cohesion also explains why some insects and spiders can walk on a pond's surface.

Adhesion is an attraction between molecules of different substances.
The surface of water in a graduated cylinder dips in the center because adhesion between water molecules and glass molecules is stronger than cohesion between water molecules.
Adhesion between water and glass causes water to rise in a narrow tube against the force of gravity.
This effect is called **capillary action**.
Capillary action is one of the forces that draw water out of the roots of a plant and up into its stems and leaves.
Cohesion holds the column of water together as it rises.

Solutions and Suspensions
A **mixture** is a material composed of two or more elements or compounds that are physically mixed but not chemically combined.
Two types of mixtures can be made with water

- solutions
- suspensions

Solutions
All the components of a **solution** are evenly distributed throughout the solution.
In a salt–water solution, table salt is the **solute**—the substance that is dissolved.
Water is the **solvent**—the substance in which the solute dissolves.
Water's polarity gives it the ability to dissolve both ionic compounds and other polar molecules, such as sugar.
Water is the greatest solvent on Earth.

Suspensions
Some materials do not dissolve when placed in water.
The movement of water molecules keeps the small particles suspended.
Such mixtures of water and nondissolved material are known as **suspensions**. Eventually the particles will settle to the bottom.
Some of the most important biological fluids are both solutions and suspensions.
The blood that circulates through your body is mostly water, which contains many dissolved compounds.
Blood also contains cells and other undissolved particles that remain in suspension as the blood moves through the body.

Acids, Bases, and pH
A water molecule can react to form hydrogen and hydroxide ions.
Water is neutral because the number of positive hydrogen ions (H^+) produced is equal to the number of negative hydroxide ions (OH^-) produced.
The pH scale
Chemists devised a measurement system called the **pH** scale to indicate the concentration of H^+ ions in solution.
The pH scale ranges from 0 to 14.
At a pH of 7, the concentration of H^+ ions and OH^- ions is equal.
Pure water has a pH of 7.
Solutions with a pH below 7 are called acidic because they have more H^+ ions than OH^- ions.
The lower the pH, the greater the acidity.
Solutions with a pH above 7 are called basic because they have more OH^- ions than H^+ ions.
The higher the pH, the more basic the solution.

Acids
An **acid** is any compound that forms H^+ ions in solution.
Acidic solutions contain higher concentrations of H^+ ions than pure water and have pH values below 7.
Strong acids tend to have pH values that range from 1 to 3.
The hydrochloric acid produced by the stomach to help digest food is a strong acid.

Bases

A **base** is a compound that produces hydroxide ions (OH- ions) in solution.

Basic, or alkaline, solutions contain lower concentrations of H+ ions than pure water and have pH values above 7.

Strong bases, such as lye, tend to have pH values ranging from 11 to 14.

Buffers

The pH of the fluids within most cells in the human body must generally be kept between 6.5 and 7.5.

If the pH is lower or higher, it will affect the chemical reactions that take place within the cells.

Controlling pH is important for maintaining homeostasis.

One of the ways that the body controls pH is through dissolved compounds called buffers.

Buffers are weak acids or bases that can react with strong acids or bases to prevent sharp, sudden changes in pH.