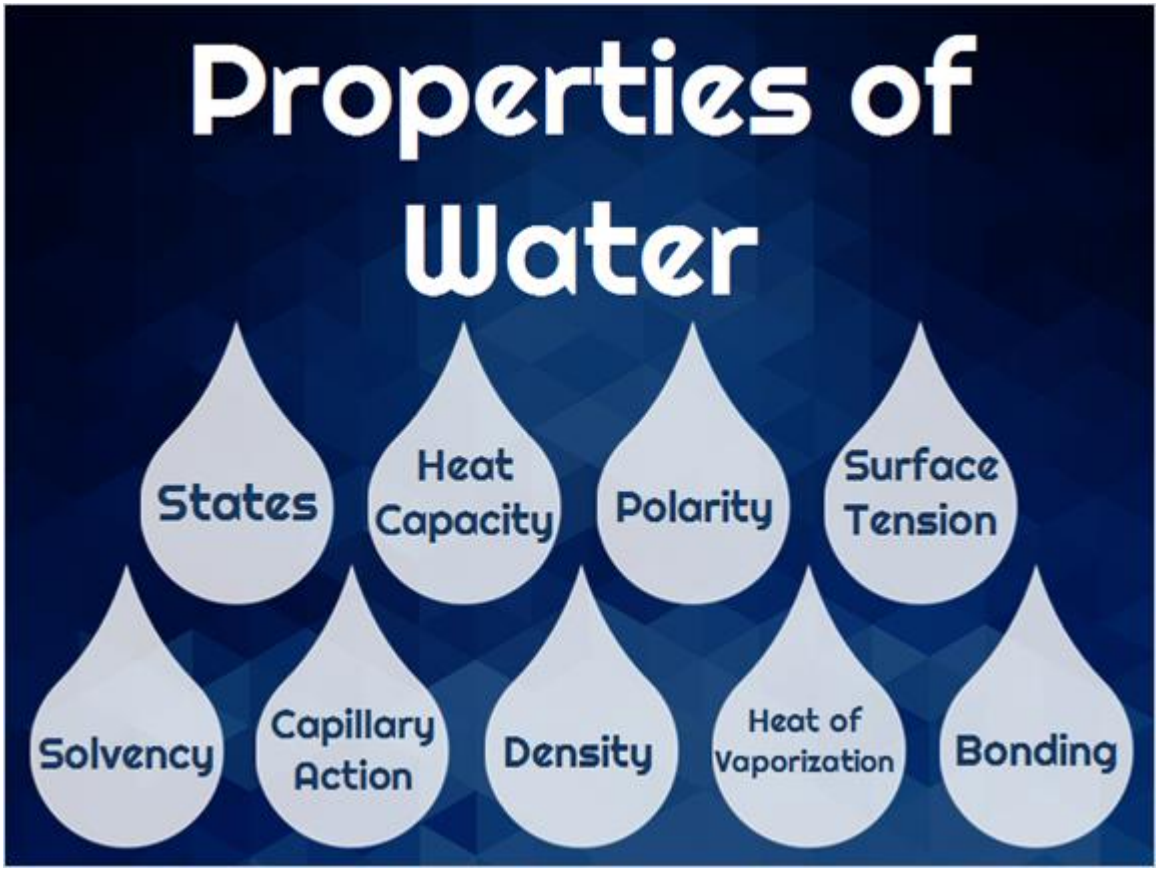
Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes

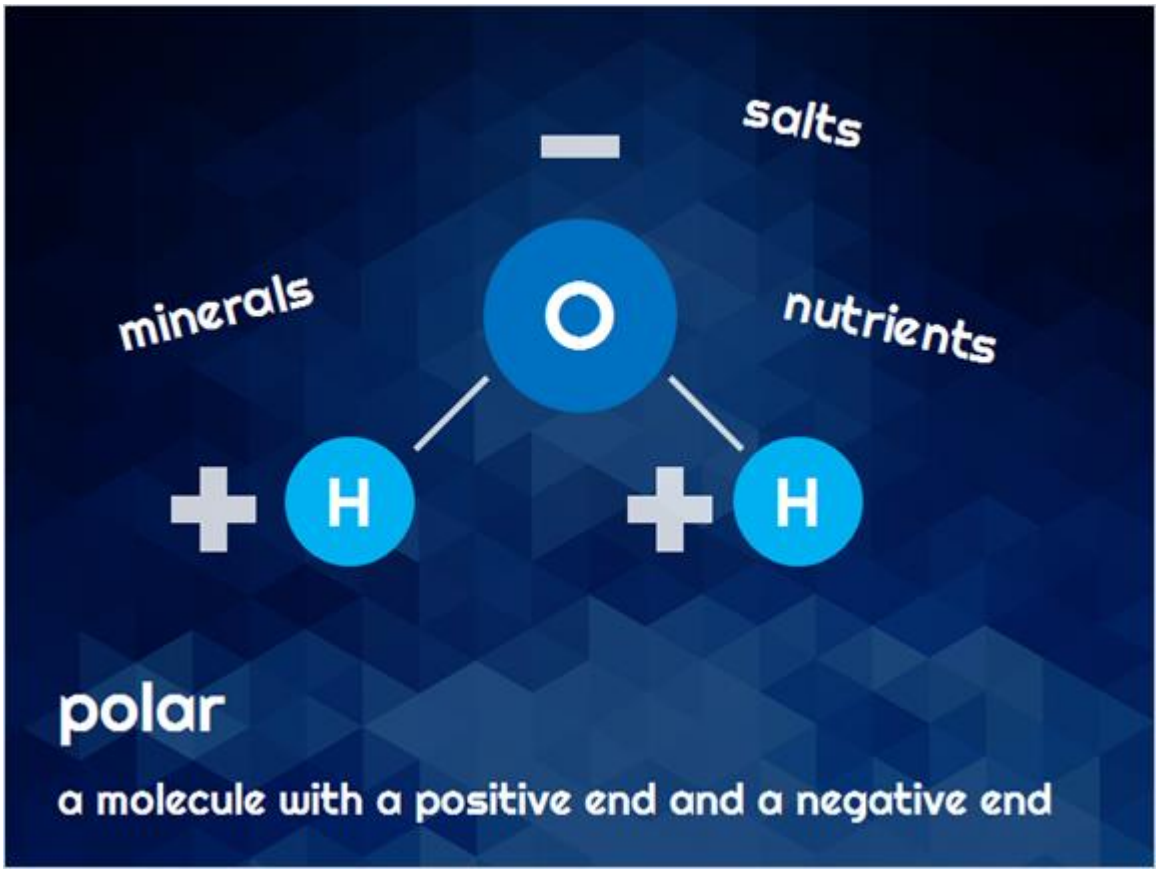


Water is the compound of life and all living things need water to survive. Without water life would cease to exist. Click ***NEXT*** to learn more about the important and varied properties of water.

Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes

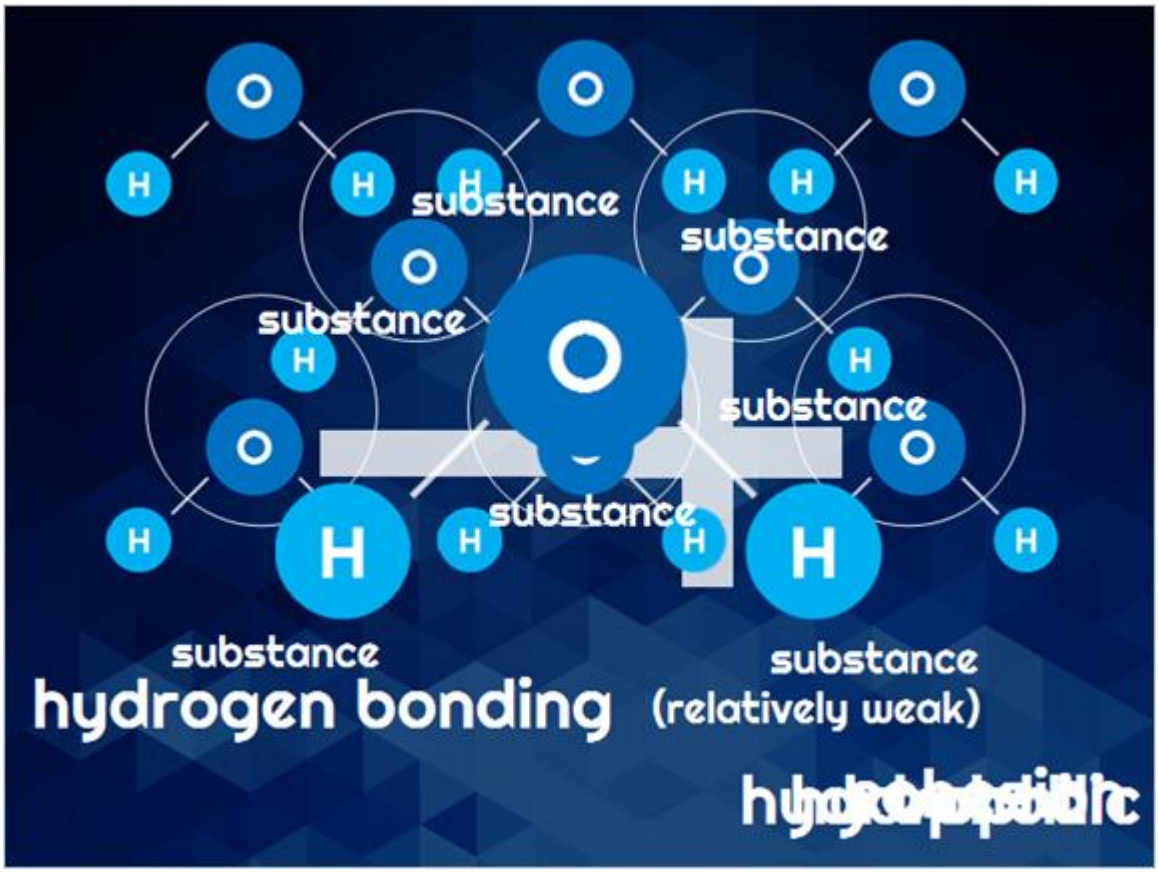
Pure water is tasteless, odorless, and colorless. Water can occur in three phases: a solid, a liquid, or a gas.

Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes



Water is made of two hydrogen atoms and one oxygen atom, and it has a bent shape. The oxygen has a slight negative charge, while the hydrogen side has a slightly positive charge; this difference in charges makes water polar, or a molecule with a positive end and a negative end. The uneven sharing of the electrons of the atoms gives the molecule a slight charge. This polarity is what enables water to easily pick up other charged molecules including important minerals, salts, and nutrients needed for life processes, as well as contaminants and harmful substances.

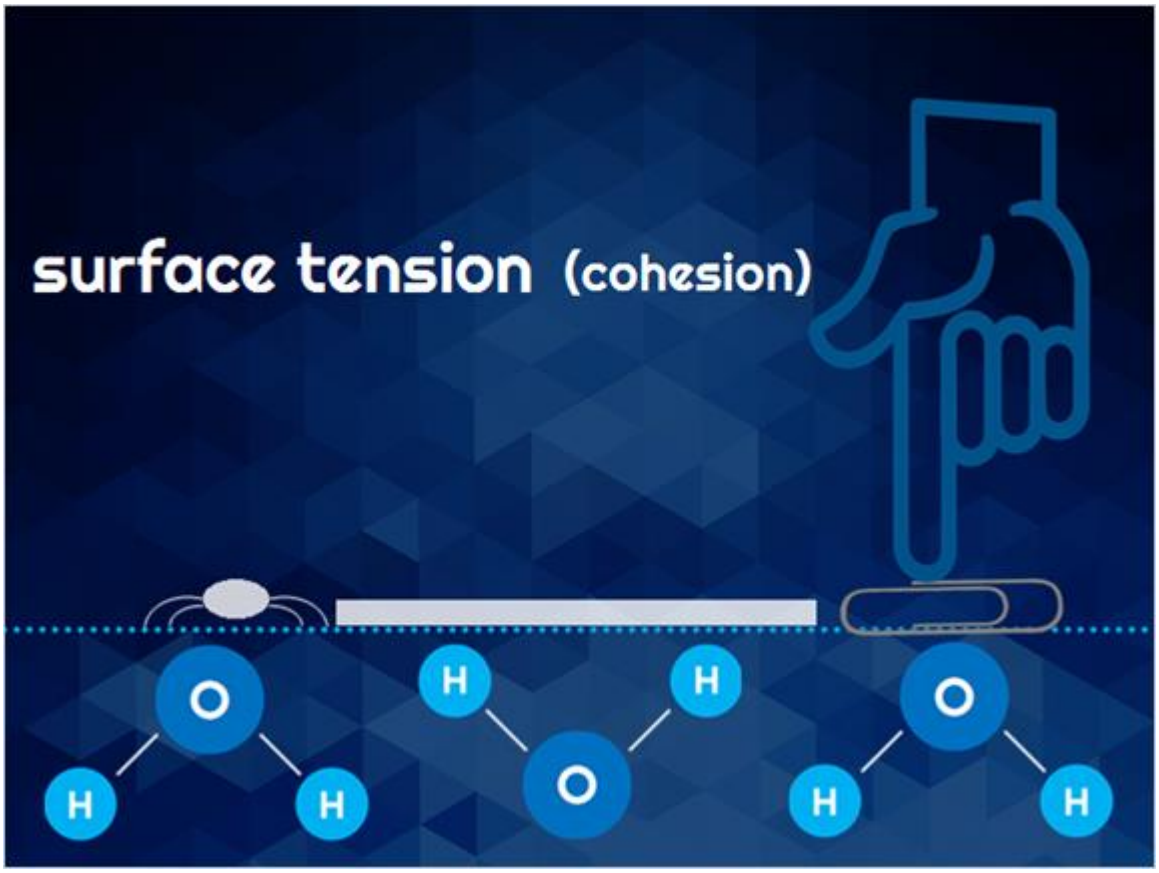
Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes



Opposite electrical charges attract. Because of this, water molecules attach to each other easily. This process of "sticking together", is called hydrogen bonding. While hydrogen bonds are relatively weak compared to other types of bonds, they are strong enough to give water many unique properties. When one water molecule is attracted to another water molecule, it is called cohesion. Hydrogen bonding is why water is a liquid. Without hydrogen bonding, water would be a gas.

Substances that are attracted to water are said to be hydrophilic. These substances dissolve easily in water, or if they do not dissolve, they are able to absorb water easily. By contrast, hydrophobic substances are repelled by water. These are non-polar substances like fats and oils.

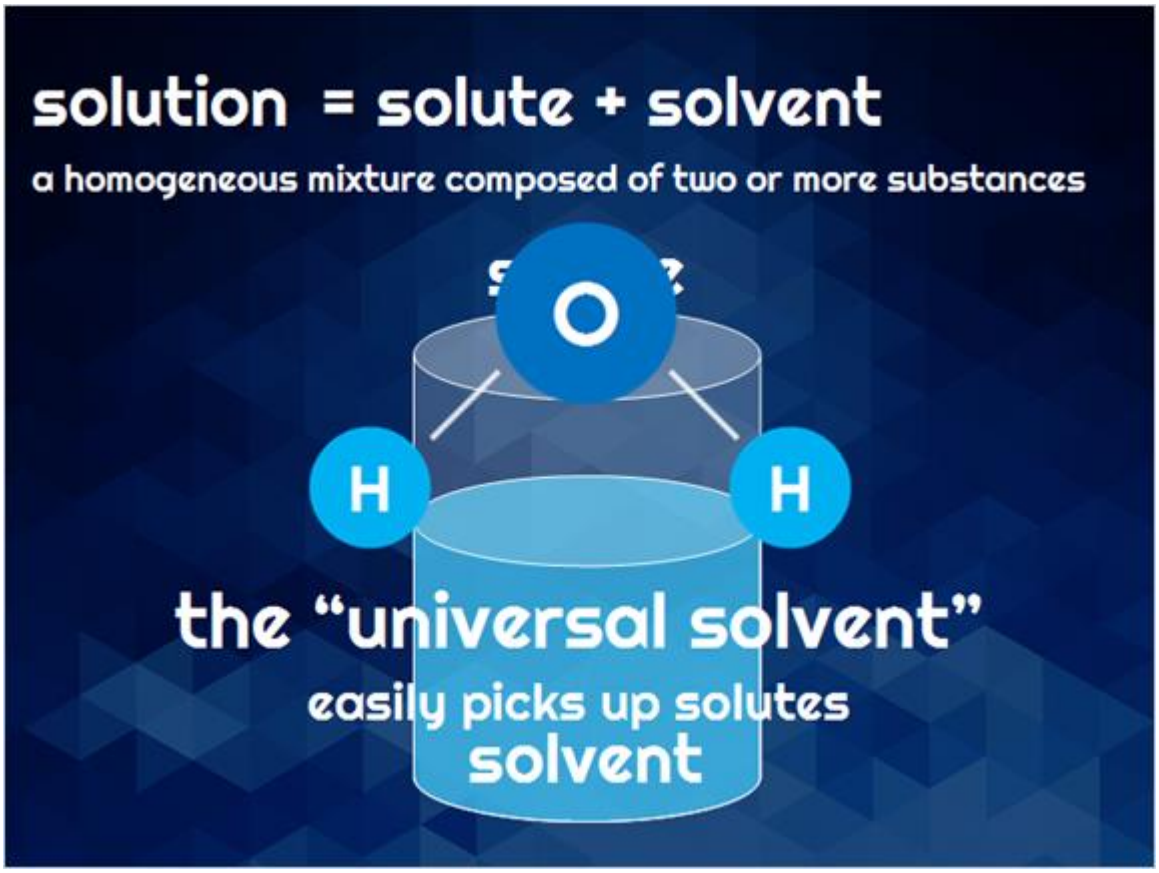
Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes



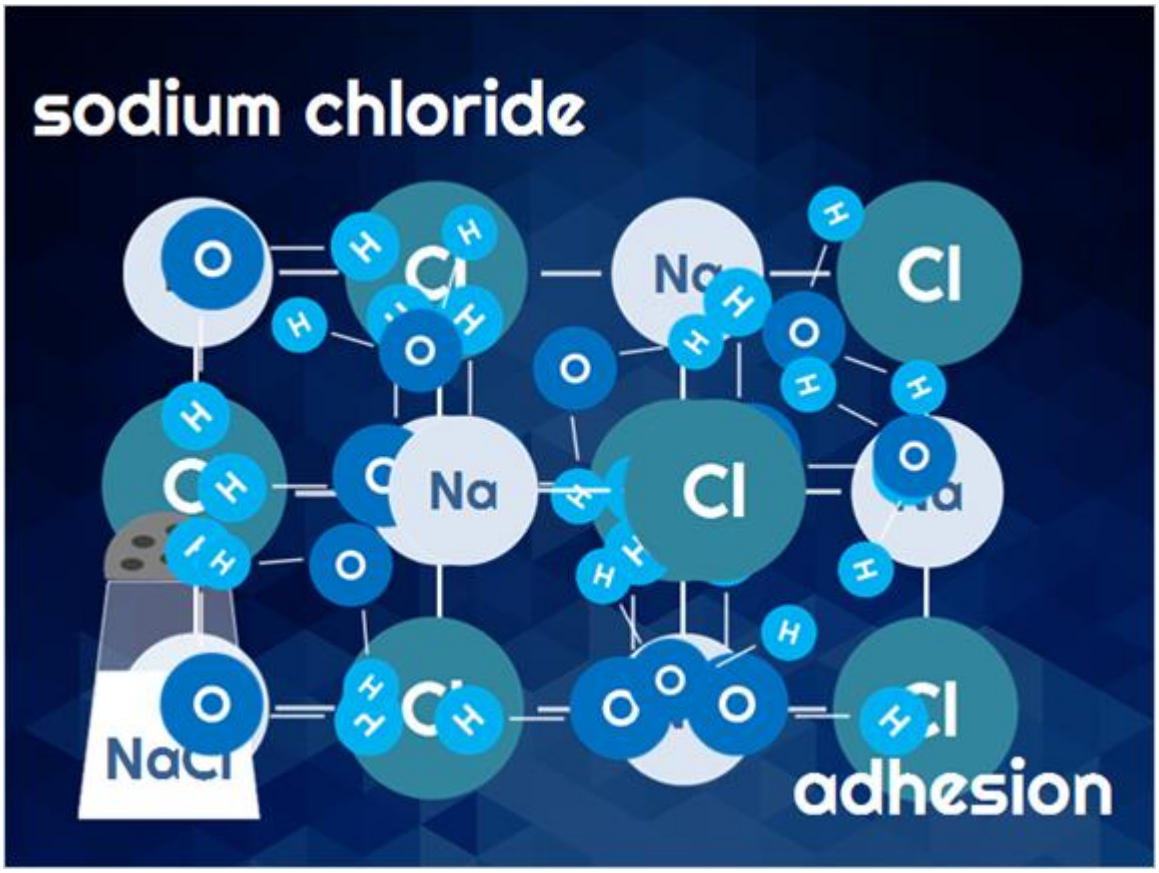
Because water molecules attract to one another by hydrogen bonding, it experiences surface tension, which is an example of cohesion. The molecules link together and form a “skin” on the water’s surface. Although this “skin” can hold objects with a greater density such as a paper clip, surface tension can be impacted by several factors. As the surface area of an object increases, it can have a larger impact on the surface tension of water. That is why some objects with a small surface area can appear to float on water. Some small insects, such as the water strider, can walk on water because their weight is not enough to penetrate the surface. A paper clip can sink into the water by applying force with your finger. This breaks the hydrogen bonds in the water which are considered weak bonds.

If you have ever “belly-flopped” into a pool, you know that water does not feel like a liquid when you hit it with a large portion of your body. This is because of water’s surface tension.

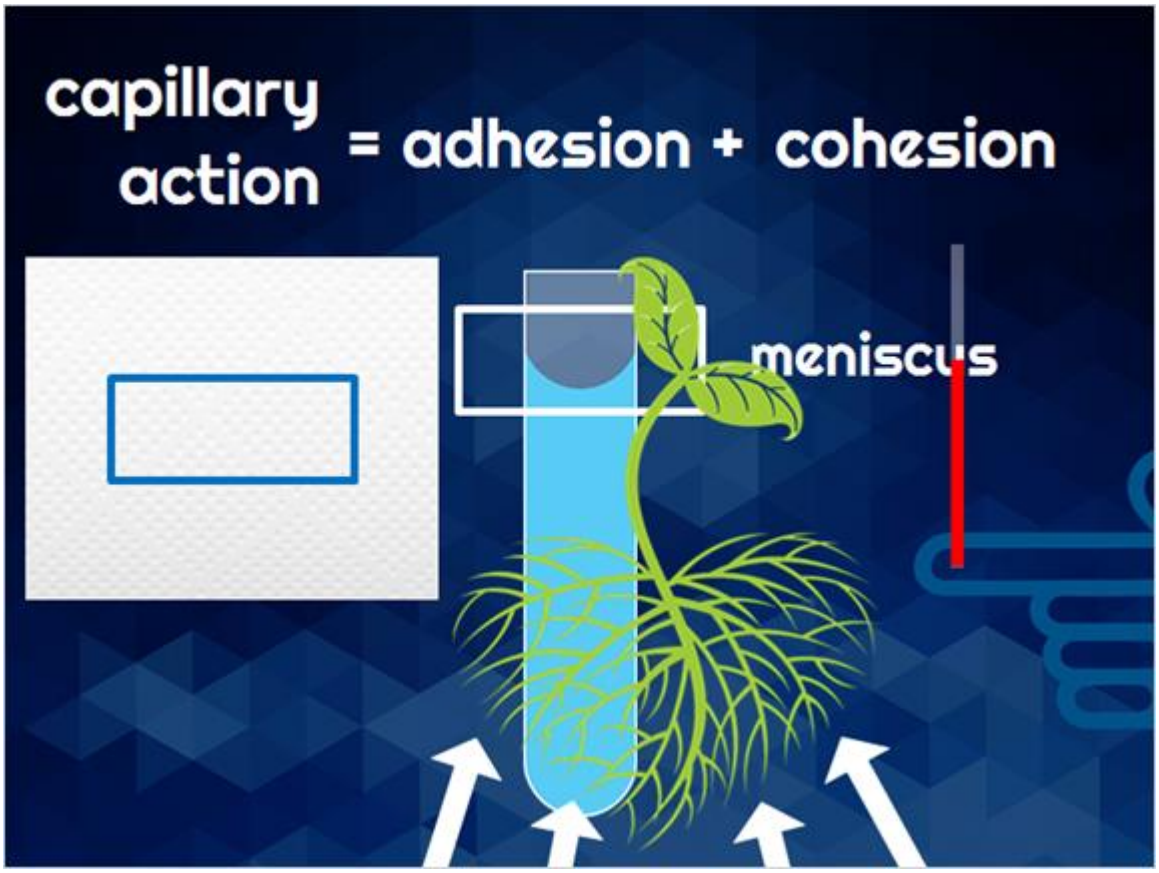
Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes



A solution is a homogeneous mixture composed of two or more substances. In such a mixture, a solute is dissolved in another substance, known as the solvent. Water is known as the universal solvent because it easily picks up solutes and other polar substances to make solutions. Some of the solutes are beneficial and some are harmful. Harmful solutes are called contaminants. Water is able to dissolve many substances, like salts and other ions that are important for use by living things.



Common table salt, also called sodium chloride, is a solute that is easily dissolved in water. Sodium chloride is a substance that contains alternating sodium and chlorine ions. When table salt is added to water, the partial charges on the water molecule are attracted to the positive sodium and negative chlorine ions. The water molecules work their way into the crystal structure and between the individual ions, surrounding them and slowly dissolving the salt. The negative oxygen ends of water molecules will surround the positive sodium ions; the positive hydrogen ends will surround the negative chlorine ions. When a water molecule is attracted to another substance, like sodium chloride, it is called adhesion.



Capillary action is the result of adhesion and cohesion. Adhesion of water to the walls of a vessel, like a glass test tube, will cause an upward force on the liquid at the edges and result in a meniscus which turns upward. The surface tension acts to hold the surface intact, so instead of just the edges moving upward, the whole liquid surface is dragged upward.

A familiar example of capillary action is the tendency of a dry paper towel to absorb a liquid by drawing it into the narrow openings between the fibers. Other examples include a finger prick blood test and the transport of fluids, such as water, within a plant. Plants use capillary action every day to survive. It is how they pull water up from their roots to use for photosynthesis. The "tube" plants have are called xylem.

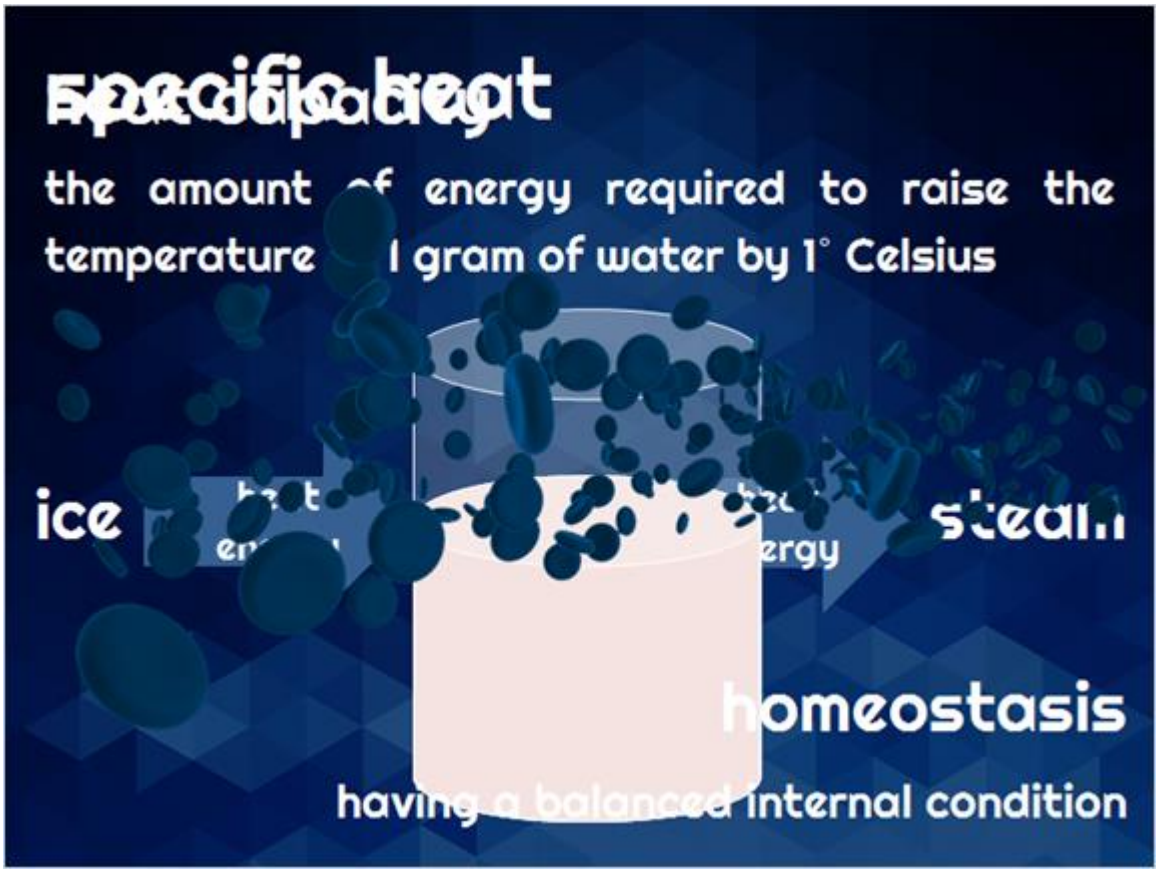
Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes

If you have ever carried a bucket full of water, you know it is heavy. However, if you try to fill the same bucket with rocks, you would find it much harder to carry. Rocks weigh more for their size than water. If you filled the same bucket with wood chips, it would be easier to carry than either the water or the rocks.

Another way to see the difference between rocks, water, and wood is to drop a rock and a piece of wood into the water. The rock sinks. The wood floats. This demonstrates that rocks have a higher density than water, and wood has a lower density than water. Density is the amount of mass packed into a given volume, or how tightly something is packed into a particular space.

Most solids are denser than liquids of the same compound. However, solid water is less dense than liquid water. We know this to be true because when we place ice cubes into a glass of water, the ice floats. When water freezes, it freezes from the top to the bottom allowing the ice to float on top. As a result, plants and animals are able to live at the bottom of ponds, lakes, and other bodies of water even when the top layer is frozen.

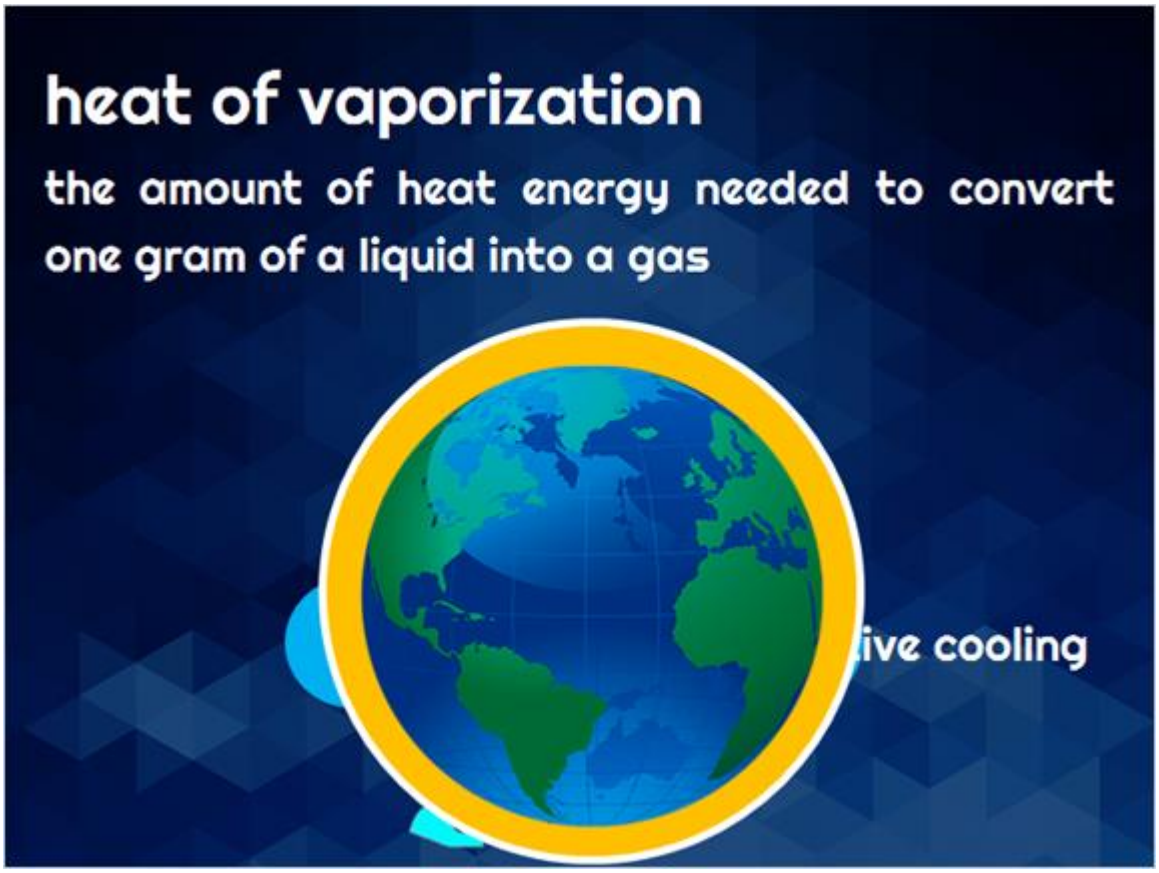
Module 2: Biochemistry
Topic 1 Content: Properties of Water Notes



The hydrogen bonds between water molecules are also responsible for another property of water - its heat capacity. A great deal of heat energy is required to change water's phase, or state, from solid ice to liquid or from liquid to gas, or steam. Water has an extraordinarily high heat capacity, or specific heat, to absorb energy. Specific heat is measured as the amount of energy required to raise the temperature of 1 gram of water by 1 degree Celsius.

A lot of energy is needed to break apart the hydrogen bonds between water molecules. This makes it more difficult to heat up water quickly. However, when water does heat up, it retains heat longer.

High heat capacity also helps maintain homeostasis in cells. Homeostasis is the condition of having a balanced internal condition. Without a high heat capacity, water would heat up very easily in cells and evaporate, causing our cells to shrivel up and die. In addition, because water is a part of the blood, heat is distributed among the tissues in the body.



Another property of water that helps humans maintain homeostasis is the heat of vaporization. When liquid water has absorbed enough energy to break all of the hydrogen bonds, it changes from a liquid to a gas. The heat of vaporization is the amount of heat energy needed to convert one gram of a liquid into a gas. When the water evaporates, it removes heat with it. This is how sweating helps you to cool down. When you sweat, and the sweat evaporates from your skin it also removes heat. This is a process known as evaporative cooling.

Water helps to moderate Earth's temperature, keeping the Earth at a temperature that is conducive to life. Water vapor that is evaporated remains in the atmosphere, and the vapor holds the heat that is radiated from the Earth's surface, thereby insulating the Earth. Large bodies can also store absorb heat from air that is warmer than the body of water.