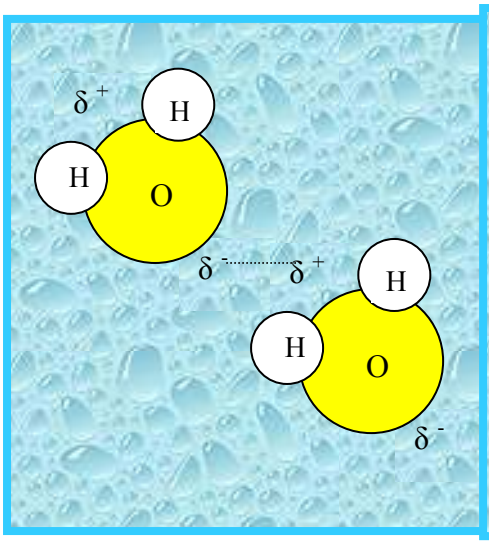
Chemistry and biochemistry of water and its effect on pond ecology

Teachers Notes

Water is one of the smallest and lightest of molecules with a unique collection of properties.

Life in aquatic habitats has many advantages over life on land, but there are also a range of problems that come with living in such habitats.

Water is essential to life on earth and much of the credit lies in the hydrogen bonding that exists between water molecules.



Each hydrogen atom is covalently bound to the oxygen through which electrons are shared, but the distribution of electrons throughout the molecule means that there is a slight polarity with the hydrogen areas being more positive and the remaining electron rich oxygen being more negative.

This polarity gives rise to the solvent properties of water and also enables the hydrogen bonding which results in the remaining properties of water.

These unique properties make *liquid* water the cornerstone of life on earth. Creating habitats for flora and fauna to live in whilst contributing a minimum 60% of all living biomass on the plant

Property		Explanation	Keywords
Cohesion and adhesion	**Formation of droplets**	Molecules of water are attracted to each other as a result of hydrogen bonding, in the case of water this means that up to 15% of water molecules in a glass of water are hydrogen bonded to their neighbours at any one time. This pulls the water molecules closer together than would other wise be expected and makes them "sticky" In cohesion, water molecules stick to each other, where as in adhesion the water molecules are sticking with other surfaces It causes rain drops to form and makes it possible for humans to drink through straws and in tall plants helps water move through the xylem tissues through transpiration	Hydrogen bonding Sticky Transpiration
	Surface tension	Hydrogen bonding infers that a water molecule is pulled equally towards all its adjacent neighbours but, at the surface of water, these molecules can only be pulled left, right and down. The pulling of the water molecules downwards means that a	Pond skater

		more solid surface is created, known as surface tension. Some aquatic invertebrates like the Pond Skater are able to make use of this surface tension and with additional physiological adaptations "walk" on water.	
Solvent	**Dissolved gases**	The transfer of oxygen and carbon dioxide in and out of all organisms as part of respiration. The greatest challenge for aquatic organisms is gaseous exchange. Gases like oxygen and carbon dioxide will dissolve in water meaning that some animals do not need to breathe air in order to respire but they must still be able to absorb oxygen and excrete carbon dioxide. There is always less oxygen in water than there would be in air and this makes animals very sensitive to factors that affect the rate at which oxygen might be dissolved in water. These include factors such as temperature, and organic content. Aquatic fauna have developed a wide range of strategies to increase the oxygen they can absorb	Respiration Dissolved gases
	Inorganic ions and nutrients	Pure water contains no nutrients and as such would be a very poor habitat for organisms. However water is an excellent solvent and never occurs in its pure form in the environment. The solvent properties of water are due to the polarity of the Hydrogen and oxygen molecules Inorganic ions dissolved in water mean that phytoplankton can photosynthesise forming the basis of an aquatic food web. Issues can be caused however by the ease of which such ions are dissolved in terms of pollutants from farming and industrial processes	Polarity Photosynthesis Pollutants
	Flotation	Because living things are mostly made up of water, in humans this is around 60-70%, they float very easily in water. Many aquatic organisms develop strategies to allow them to alter their ability to float and swim by having changeable air sacs within body cavities	Air sac
Density	**Ice formation**	Unlike all other liquids, the molecules in solid water are actually further apart than they are in liquid water. This makes ice less dense than liquid water and therefore ice will float on water. In winter this means that ponds freeze from the top down and ice even acts as an insulating layer protecting the water beneath from further freezing. Organisms can survive over winter without freezing. Without this feature there would be no life in water in temperate and polar regions	Ice as insulation
	Viscosity	Water is actually at its most dense at 4^0C, and therefore it's most viscous. In winter, ponds are less likely to freeze but it does	Streamlining

		cause problems for the animals that have to swim through it. Most aquatic organisms have developed streamlined bodies to reduce the effect.	
Temperature buffer	**Specific heat capacity**	Specific heat capacity refers to the amount of energy required to increase the temperature of 1Kg of water by 1^0C. In the case of water this is 4.2 Kj and is significantly higher than would be expected and higher than most other liquids. In summer months this means that water must absorb a great deal of energy in the form of heat from the sun in order for the temperature to increase. Since most bodies of water are large enough not to be significantly effected by the heat from the sun, water provides an almost constant temperature for the plants and animals living there	Kj
	Latent heat of vaporisation	In summer small water bodies like ponds are at risk of drying out but again, the amount of energy required to vaporise or evaporate water is so high that the impact is less than would otherwise be expected. Making it rare for water bodies to dry up and so depriving organisms of their habitat.	
	Heat of fusion	As summer turns to winter, water that is already colder than the surrounding land should be at risk of freezing, however, the energy water must now loose in order to freeze is so high that the water temperature again remains roughly constant, as winter deepens in fact it could be higher than surrounding land.	