Water’s life-supporting properties essay sample

Without water, the life forms we see on Earth could not possibly exist. This simple combination of three atoms—one oxygen, two hydrogen—acts in complex ways that can turn a barren, dusty planet into a thriving biological community (Tanacredi & Loret, 2000). The role of water in supporting life is an essential one on Earth and probably elsewhere, given the unusual properties of water compared with other potentially abundant compounds.

Its dipolarity, high boiling point and heat of vaporization and, for ice, melting temperature; its expansion on freezing; and its solvent properties make it an ideal medium for life (Mottl, Glazer, Kaiser, & Meech, 2007). Solvent and Metabolic Properties Water is vital both as a solvent in which many of the body’s solutes dissolve and as an essential part of many metabolic processes within the body. Metabolism is the sum total of biochemical reactions occurring in living organisms by which energy is made available to the organism and consists of anabolism and catabolism (Bortman et al, 2003).

In anabolism, water is removed from molecules (through energy requiring enzymatic chemical reactions) in order to grow larger molecules (e. g. starches, triglycerides and proteins for storage of fuels and information). In catabolism, water is used to break bonds in order to generate smaller molecules (e. g. glucose, fatty acids and amino acids to be used for fuels for energy use or other purposes) (Mulrew, 1998) . Water is thus essential and central to these metabolic processes.

Specific Heat The specific heat capacity of a substance is the energy required to change the temperature of 1 gram of material by 1? C. It is a measure of how much heat a substance can store. The high specific heat

capacity of water is due to the gradual breaking of hydrogen bonds with increasing temperature. This attribute gives water its high boiling point and heat of vaporization properties. Biologically, the high specific heat of water is advantageous as it allows the temperature of an organism to be buffered against rapid changes with alterations in the environment (Mulrew, 1998).

Dielectric Properties Since water molecules are polarized, they have a dipole moment (placing them in an electric field would produce a torque about their center of mass) (Mulrew, 1998). Water molecules will tend to align themselves when an electric field is applied with their positive aspects toward the negative side of the field and their negative aspects toward the positive side of the field. In a random orientation, the electric fields produced by the charge separation on the water molecules would cancel, but in this coordinated alignment, the electric fields of the water molecules tend to combine and oppose an external electric field.

The degree to which a substance does this is called its dielectric constant. Water has a high dielectric constant which allows it to act as a solvent for ionic compounds such as sodium chloride and potassium chloride. All biological cells require ionic gradients to be maintained, thus water is an admirable solvent for this purpose. Neutrality of pH Water is also central to acid-base neutrality and enzyme function with its pH value of 7. Acids have pH values less than 7 while bases have values greater than 7.

For example, stomach acid is useful to digestion but has a corrosive effect on the esophagus during reflux. Neutralization is accomplished by ingesting a base such as aluminum hydroxide to produce the neutral molecules water

and the salt aluminum chloride. Human biochemistry that involves enzymes usually performs optimally around a biologically neutral pH of 7. 4 (Mulrew, 1998) and water plays a central role in achieving this pH condition. Molecular structure

A number of observable properties of water result from its molecular structure, meaning not only the atoms that make up water, but also the shape of the water molecule. The bonds between the one oxygen and two hydrogen atoms do not form a straight line but form an angle like a wide V. This shape gives the molecule a positive electric charge on one side and a negative electric charge on the other. This charge gives water the properties of adhesion, the tendency to stick to certain other substances and cohesion, the tendency to stick to itself (Tanacredi et al, 2006).

Immiscibility with non-polar liquids Liquids that have no polarization (no partial separation of charges like there are on the water molecule) have a very low solubility in water (Mulrew, 1998). An oil-vinegar salad dressing is a good example of what happens when you try to mix the two. The non-polar molecules would have to break the hydrogen bonds between water molecules in order to fit in between them, thus mixing is energetically unfavorable. This effect is what allows the “ hydrophobic” bonds to form in aqueous solutions—the primary stabilizing factor for all biological membranes (Mulrew, 1998).

Water has other life-supporting properties which are beneficial especially to plant life. Its high tensile strength supports water columns in large trees and its capillary rise property is used by plants to bring water from the group up

to the leaves (Mulrew, 1998). As Felix Franks of University of Cambridge said, “ Water is the magic ingredient that turns lifeless powders on laboratory shelves into living things. Without water it’s all just chemistry. Add water and you get biology” (cited in Matthews, 2006).

Reference

http://www. ucalgary. ca/~kmuldrew/cryo_course/cryo_chap3_1. html