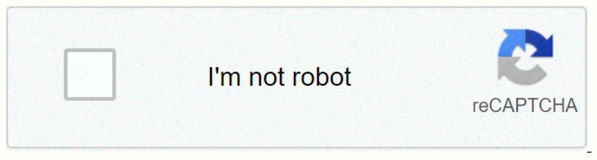

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Describe the importance of water to living things

Water has many unique qualities that are essential to maintain viable living conditions Approximately 70% of the cell's internal environment (i.e. cytoplasm) is the only substance that occurs naturally in the three states (solid, liquid, gas) on the surface of the EarthIt is necessary for the anabolic construction of organic molecules (through condensation reactions)Water is an important medium for metabolic reactions because it is essential for the neutrality of the acid base and enzymatic function Biological significance of the Water Properties by Molly Sargen figures by Daniel Total Water represents 60-75% of human body weight. A loss of only 4% of the body's total water leads to dehydration, and a 15% loss can be fatal. Similarly, a person could survive a month without food, but he wouldn't survive three days without water. This crucial dependence on water largely governs all forms of life. Clearly water is vital to survive, but what makes it so necessary? The Molecular Composition of Water Many of the roles of water in life support are due to its molecular structure and some special properties. Water is a simple molecule composed of two small and positively charged hydrogen atoms and a large negatively charged oxygen atom. When hydrogens bind to oxygen, it creates an asymmetric molecule with positive charge on one side and negative charge on the other side (Figure 1). This charge differential is called polarity and dictates how water interacts with other molecules. Figure 1: Water chemistry. Water molecules are made of two hydrogens and one oxygen. These atoms are of different sizes and charges, which creates asymmetry in the molecular structure and leads to strong bonds between water and other polar molecules, including water itself. Water is the Universal Solvent As a polar molecule, water interacts better with other polar molecules, like itself. This is due to the phenomenon in which opposite charges attract: because each individual water molecule has a negative part and a positive part, each side is attracted by molecules of the opposite charge. This attraction allows water to form relatively strong connections, called bonds, with other polar molecules around it, including other water molecules. In this case, the positive hydrogen of a water molecule will bind with the negative oxygen of the adjacent molecule, whose own hydrogens are attracted to the next oxygen, and so on (Figure 1). It is important to note that this connection causes water molecules to stick together on a property called cohesion. The cohesion of water molecules helps plants to take water into their roots. Cohesion also contributes to the high boiling point of water, which helps animals regulate body temperature. In addition, since most molecules have some electrical asymmetry, they are also polar and water molecules can form bonds and surround both their and negative regions. In the act of surrounding the polar molecules of another substance, water writhes in every corner and cracks between molecules, effectively breaking it are dissolving it. This is what happens when you put sugar crystals in water: both water and sugar are polar, allowing individual water molecules to surround individual sugar molecules, breaking sugar and dissolving it. Similar to polarity, some molecules are made of ions, or particles charged oppositely. Water breaks down these ionic molecules also interacting with the charged particles positively and negatively. This is what happens when you put salt in the water, because salt is composed of sodium ions and chloride. The water's extensive ability to dissolve a variety of molecules has earned it the designation of universal solvent, and it is this ability that makes water such an invaluable life sustaining force. On a biological level, the role of water as a solvent helps cells transport and use substances such as oxygen or nutrients. Water-based solutions, such as blood, help bring molecules to the necessary locations. Thus, the role of water as a solvent facilitates the transport of molecules such as oxygen to breathing and has a great impact on the ability of drugs to reach their targets in the body. Water supports Water of the cellular structure also has an important structural role in biology. Visually, water fills cells to help maintain shape and structure (Figure 2). Water inside many cells (including those that make up the human body) creates pressure that opposes external forces, similar to putting air in a balloon. However, even some plants, which can keep their cell structure without water, still need water to survive. Water allows everything inside cells to have the right shape at the molecular level. As the form is fundamental to biochemical processes, this is also one of the most important roles of water. Figure 2: Water impacts the cellular shape. Water creates pressure inside the cell that helps to maintain shape. In the hydrated cell (left), the water pushes out and the cell maintains a round shape. In the dehydrated cell, there is less water pushing out so that the cell becomes wrinkled. Water also contributes to the formation of membranes around cells. Each cell on Earth is surrounded by a membrane, most of which are formed by two layers of molecules called phospholipids (Figure 3). Phospholipids, such as water, have two distinct components: a polar head and a nonpolar tail. Because of this, polar heads interact with water, while non-polar tails try to avoid water and interact with each other. Seeking these favorable interactions, phospholipids spontaneously form bilayers with heads facing out in surrounding water and tails facing inwards, excluding water. The bicamador bicamador cells and selectively allows substances such as leaves and nutrients to enter and exit the cell. The interactions involved in membrane formation are strong enough for membranes to form spontaneously and are not easily interrupted. Without water, cell membranes would have no structure, and without proper membrane structure, cells would be unable to keep important molecules within the cell and harmful molecules out of the cell. Figure 3: Phospholipid bilayers. Phospholipids form bilayers surrounded by water. Polar heads face each other to interact with water and hydrophobic tails face each other inside to avoid interacting with water. In addition to influencing the overall shape of cells, water also impacts some key components of each cell: DNA and proteins. Proteins are produced as a long chain of building blocks called amino acids and need to bend into a specific shape to function properly. Water drives the bending of amino acid chains as different types of amino acids seek out and avoid interacting with water. Proteins provide structure, receive signals and catalyze chemical reactions in the cell. In this way, proteins are the working horses of cells. Ultimately, proteins drive muscle contraction, communication, nutrient digestion and many other vital functions. Without the proper form, proteins would be unable to perform these functions and a cell (let alone an entire human) could not survive. Similarly, DNA needs to be in a specific form for its instructions to be properly decoded. Proteins that read or copy DNA can only bind DNA that has a particular shape. Water molecules surround DNA in an orderly manner to support its characteristic double helix compliance. Without this form, the cells would be unable to follow the careful instructions encoded by DNA or pass the instructions to future cells, making human growth, reproduction and ultimately survival unfeasible. Chemical Reactions of Water Water are directly involved in many chemical reactions to build and break down important cell components. Photosynthesis, the process in plants that creates sugars for all life forms, requires water. Water also participates in the construction of larger molecules in cells. Molecules such as DNA and proteins are made up of repetitive units of smaller molecules. Joining these small molecules occurs through a reaction that produces water. On the other hand, water is needed for the reverse reaction that breaks down these molecules, allowing cells to obtain nutrients or reprove large pieces of molecules. In addition, water buffer cells from the dangerous effects of acids and bases. Highly acidic or basic substances, such as or hydrochloric acid, are corrosive even to the most durable materials. This is because acids and bases release excess hydrogen or absorb excess hydrogen, respectively, from surrounding materials. Losing or winning by winning hydrogen disrupts the structure of molecules. As we have learned, proteins require a specific structure to function properly, so it is important to protect them from acids and bases. Water does this by acting as an acid and a base (Figure 4). Although the chemical bonds within a water molecule are very stable, it is possible for a water molecule to give up a hydrogen and become OH–, acting as a base, or accept another hydrogen and become H3O+, acting just like an acid. This adaptability allows water to combat drastic pH changes due to acidic or basic substances in the body in a process called tamponade. Ultimately, this protects proteins and other molecules in the cell. Figure 4: Water acts as a buffer releasing or accepting hydrogen atoms. In conclusion, water is vital for life. Its versatility and adaptability help to perform important chemical reactions. Its simple molecular structure helps maintain important shapes for the internal components of cells and external membrane. No other molecule matches water when it comes to unique properties that support life. Excitingly, researchers continue to establish new water properties as additional effects of its asymmetric structure. Scientists have not yet determined the physiological impacts of these properties. It's amazing how a simple molecule is universally important for organisms with diverse needs. Molly Sargen is a first-year PhD student in the Biological and Biomedical Sciences Program at Harvard Medical School. Dan Utter is a fifth-year Doctoral student in Evolutionary and Evolutionary Biology at Harvard University. For more information: To learn more about the importance of drug solubility, see this article. Check out these articles for more information about proteins and how water impacts your fold. Learn more about phospholipids here. Learn more about water affects the structure of DNA here. Learn more about acids and bases here. Check out the unique properties of water on this page or newly discovered water properties in this article. This article is part of our special edition on water. To read more, check out our special edition homepage! Homepage!

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