

The hydrogen bond



The Hydrogen Bond is one of the most important components of existence and vitality. It occurs in many biological structures, such as DNA and protein which are the "building blocks" of life. But perhaps the simplest system to understand the importance of hydrogen bonds is water. In liquid water and solid ice, the hydrogen bond is simply the chemical bond that exists between H₂O molecules and keeps them together. Although relatively weak, hydrogen bonds are so numerous in water that they play a large role in determining their properties.

The nature of the hydrogen bond in addition to some other factors, such as the disordered arrangement of hydrogen in water imparts unusual properties to H₂O that have made conditions favorable for life on Earth. For example, it takes a relatively large amount of heat to raise water temperature one degree. This enables the world's water bodies to store enormous amounts of heat, producing a moderating effect on the world's climate, and it makes it difficult for marine organisms to destabilize the temperature of the ocean environment even as their metabolic processes produce enormous amounts of waste heat.

One of the most important noncovalent interaction within molecules is the hydrogen bond, a dipole formed when a hydrogen atom covalently bonded to an electronegative atom is shared with a second electronegative atom (typically an oxygen, nitrogen or fluorine atom), such that the proton may be approached very closely by an unshared pair of electrons. Hydrogen bonds play a significant role in the unusual thermodynamic properties of water and ice, and the DNA double-helical and protein α -helical and β -structure conformations are extensively hydrogen bonded.

Hydrogen Bonds can be formed between different molecules (Intermolecular)

<https://assignbuster.com/the-hydrogen-bond/>

or between the different parts of the same molecule (Intramolecular). Since there are a large number of hydrogen donors and acceptors in biological systems, hydrogen bonds play an indispensable role in maintaining the structure of biological molecules.

Hydrogen bonding in proteins:

The three dimensional structure of a protein is often dependent on an intricate network of H- bonds that can occur between a variety of atoms, involving atoms on two different amino acid side chains, atoms on amino acid side chains and water molecules at the protein surface

Regions in a protein molecule in which amino acids are arranged into specific, regular spiral or folded structures are called secondary structure.

There are two forms of secondary structure, the alpha helix and the beta pleated sheet. Each of these structures is stabilized by hydrogen bonds between atoms of the amino acid backbones which are the same as atoms involved in peptide bond formation. Although individual hydrogen bonds are weak, the combination of many hydrogen bonds makes the secondary structure rather stable.

Hydrogen bonding in DNA:

The pairing of bases in DNA occurs due to the hydrogen bonding which involves hydrogen donor and acceptor groups in purine and pyrimidine bases.

Guanine and cytosine form three hydrogen bonds whereas adenosine and thymine form only two hydrogen bonds.

Thus, it is seen that Intramolecular hydrogen bonds play an important role in maintaining the structure of biological materials, such as secondary (coiled) and tertiary (folded) structures of proteins and the double helix of DNA

Bibliography:

Andrezej Hendrich's notes, viewed May 11, 2006 Strong Hydrogen Bonds in Chemistry and Biology: CL Perrin, JB Nielson - Annu Rev Phys Chem, 1997 - physchem. annualreviews. org

E. D. Isaacs, A. Shukla, P. M. Platzman, D. R. Hamann, B. Barbiellini and Tulk, Phys. Rev. Lett. 82, 600 (1999).

E. D. Isaacs, A. Shukla, P. M. Platzman, D. R. Hamann, B. Barbiellini and Tulk, J. Phys. Chem. Solids 61, 403 (2000).

A. Shukla, B. Barbiellini, T. Buslaps and P. Suortti, Zeitschrift fur Physikalische Chemie, 215, 315-1321 (2001).

B. Barbiellini and A. Shukla, Phys. Rev. B 66, 235101 (2002) (preprint cond-mat/0210316).