The Importance of Hydrogen Bonds in DNA

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Introduction

Many people have a basic understanding of why DNA is important to them, but not many know about what is important DNA. Simple but important forces, called hydrogen bonds, help it to perform its tasks and maintain its stability.

What is a Hydrogen Bond?

A hydrogen bond is a bond that forms when a hydrogen atom from one polar molecule becomes electrically attracted to an electronegative atom, such as an oxygen or nitrogen atom, in another polar molecule. They are represented in diagrams by dashed or dotted lines to distinguish them from covalent bonds.[1]

![Diagram of hydrogen bonds](http://example.com/hydrogen_bonds_diagram.png)

The strength of a hydrogen bond is only a small fraction of the energy required to break a covalent bond. Collectively, however, many hydrogen bonds add up to a strong force that helps maintain the three-dimensional structure of a molecule. This is particularly true in deoxyribonucleic acid (DNA).

What Role Do Hydrogen Bonds Play in DNA?

Francis Crick and James Watson first realized in 1953 that hydrogen bonds were responsible for interlocking the two strands of DNA, thus supporting their speculations on the experimental X-ray work of Maurice Wilkins and Rosalind Franklin.[2]

A distinguishing feature of base pairing is its specificity! An adenine base in one strand forms two hydrogen bonds with a thymine base in the opposite strand, or a guanine base forms three hydrogen bonds with a cytosine. This keeps the width of the double helix relatively constant.

![Diagram of DNA structure](http://example.com/dna_structure_diagram.png)

The structure of DNA suggests that it can be copied in a process called DNA replication. During this process, the original DNA strands are used as templates for synthesizing new DNA strands.

How Do Hydrogen Bonds Aid in DNA Replication?

![Diagram of DNA replication](http://example.com/dna_replication_diagram.png)

The enzyme DNA helicase binds to one of the DNA strands and uses energy from ATP hydrolysis to unwind the strand and break apart (denature) the hydrogen bonds between the nucleotide bases, unzipping the DNA. Another enzyme DNA polymerase later attaches free nucleotides to the unzipped strand and hydrogen bonds can form again between the opposite strands.[8]

The weakness of the hydrogen bonds is important for the process and the stability of the hydrogen bonds between A and T or between G and C prevent permanent mistakes from happening.

Mutations in DNA

One important property of hydrogen bonding is that when heated, the bond denatures and becomes non-functional.

- A physical application of this occurs under exposure to UV radiation. With prolonged exposure to this radiation, heat causes enough energy for the hydrogen bonds to lose stability in DNA, which prevents the DNA from properly functioning and coding for proteins. It can cause mutations if duplication is in progress.[7]

- A chemical application occurs in gene mutations. These mutations can cause two basic types of changes to a gene: the base sequence within a gene can be changed or a single nucleotide is replaced with a different nucleotide. This is also commonly caused by chemical mutagens or radiation. Because of the weakness of the hydrogen bonds between the base pairs in complementary DNA, DNA strands can break and base shifting can occur.[8]

Conclusion

Hydrogen bonds, although weak in force, are very important in structure and function of DNA. This is the blueprint that stores the information needed to construct the components of cells in the body. Without these weak hydrogen bonds, DNA replication cannot occur and complementary strands of DNA would not form its double helical structure.

Because of the significance of hydrogen bonds, scientists are able to amplify DNA and closely study its properties and behaviors. With the genetic code technique, there is potential for scientists to discover diseases in the future. That alone would improve the quality of life on a global level.

References

5. Allen S. Misalignment. [Website](http://example.com/alignment_website.html) (April 2011)