

Secondary structure of DNA

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The basic secondary structure of nucleic acids is a helix of two chains or two sections of the same chain, which is twisted into a shape resembling a hairpin.

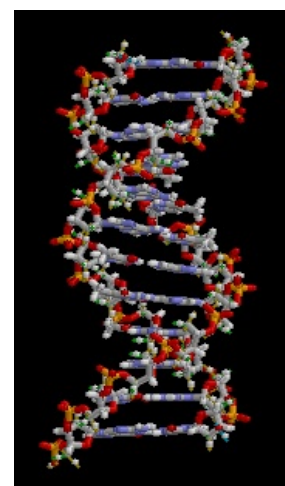
History of the discovery of the structure of DNA

The legendary discovery of the DNA **double helix**, proposed by James Watson and Francis Crick in 1953, began the modern phase of the development of biology and biochemistry. The aforementioned Nobel Prize winners came from Chargaff's findings on the ratio of bases in DNA; the amount of adenine in a DNA molecule is equal to the amount of thymine, and the amount of guanine is equal to the amount of cytosine. It follows that the ratio between purine and pyrimidine bases is **1:1**. Another important basis for the assembly of the DNA model was provided by photographs of the diffraction of X-rays passing through a crystal of pure DNA, taken by Rosalind Franklin and Maurice Wilkins. They showed a double periodicity of the density of atoms: 0.34 nm and 3.4 nm.

Custom secondary structure

Basic properties

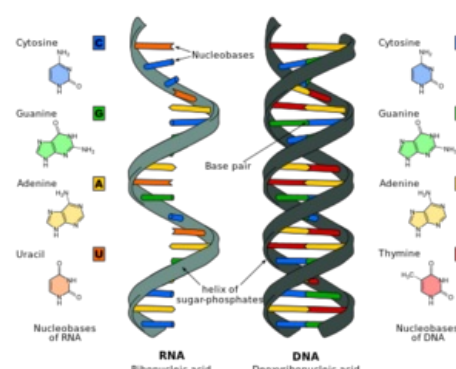
Both strands of the DNA double helix wind **clockwise** around the axis (if the thumb of the right hand follows the direction, the strands wind in the direction of the other fingers). The pentose phosphate backbones of both chains rotate along the outer surface of the double helix (helix), while the bases face its axis. In accordance with Chargaff's rules, adenine pairs **with two hydrogen bonds with thymine (A=T)** and **guanine with three hydrogen bonds with cytosine**. The condition is the necessary tautomeric form of the bases. Bases and chains that pair in this way are called **complementary**. In contrast, chains that are identical or very similar in nucleotide order and have the same polarity are called **homologous**.



spatial structure of DNA

Other properties

In the Watson-Crick model of DNA, the faces of the bases are perpendicular to the axis of the double helix and form the steps of a sort of "spiral staircase". They are 0.34 nm apart. Adjacent base pairs bind through hydrophobic interactions, which strengthens the binding of the DNA strands. One revolution of the double helix contains ten base pairs, so it measures 3.4 nm (the periodicity of the density of atoms according to X-ray diffraction!). The diameter of the double helix is 2 nm. On the surface of the helix there are two longitudinally winding grooves, one shallow, the other deep. In the deeper of them, there are conditions for the binding of proteins to specific sequences of bases. The phosphates at the edges of the grooves are at pH dissociated around 7, so they can bind to the basic amino acids of proteins with their negative charges. The described spatial arrangement is possible because a purine base is always paired with a pyrimidine base, so that the distances of both C1 are almost the same for all pairs. Another condition for the described arrangement of DNA is the opposite polarity of the phosphodiester bonds of both chains. We say they are **antiparallel**. In one direction the direction of the bonds is 5'-3' and in the other 3'-5'.



Difference between DNA and RNA structure

Conformation of DNA

Basic conformation

The DNA described by Watson and Crick is in the so-called **B-form**, when the conformation of deoxyribose is **2'-endo**. This means that while the 4 atoms of the deoxyfuranose ring are in a plane, the C2' carbon protrudes in the same direction as C5'.

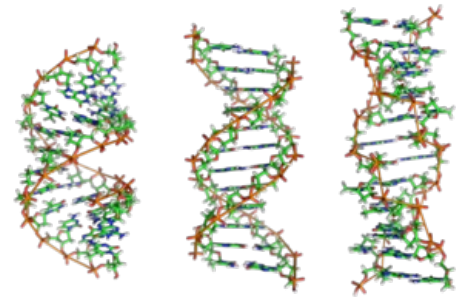
Other conformations

The DNA double helix exists in other conformations. **In form A** , the double helix is also right-handed, but it contains 11 base pairs in one turn, their surfaces are not perpendicular to the axis of the helix, and the major groove is covered by phosphates (and therefore difficult for proteins to access). This time the deoxyribose is **in the 3'-endo conformation** . **A left-handed** DNA double helix, the so-called **Z-form** , has also been described . Here, the chains do not wrap smoothly like in right-handed helices, they go "here and there", "zig-zag". One turn contains 12 base pairs. Z-DNA has only one groove with a high density of negative charges. It has been described *in vitro* , it is assumed to exist *in vivo* in certain regions of DNA.

Links

related articles

- The structure of nucleic acids
- Basic components of nucleic acids
- Primary structure of nucleic acids
- Cleavage of nucleic acid by hydrolysis
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Different conformations of the DNA double helix. A,B,Z forms

Other chapters from the book **ŠTÍPEK, S.: Brief biochemistry of the preservation and expression of genetic information**

Resources

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- ŠTÍPEK, Stanislav. *Brief biochemistry : Storage and expression of genetic information*. 1st edition. Medprint, 1998. 92 pp. pp. 14–17. ISBN 80-902036-2-0 .

Category:Biochemistry Category:Molecular biology Category:Genetics