Module 9 / Double Helix Structure

Describe the major characteristics of the B-DNA double helix

Building the Double Helix

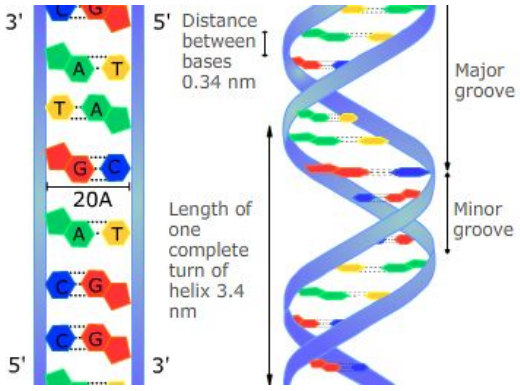
As described in the previous section, the hybridization of DNA and RNA results in the formation of:

- Double stranded DNA or RNA with
- Antiparallel orientation (5' to 3' against 3' to 5') with
- Uniform distance between the strands due to pairing of a purine with a pyrimidine (A with T (or U) and G with C).

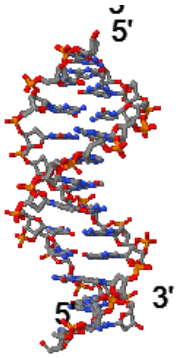
This representation of the ladder of a double stranded DNA is illustrated in the figure below on the left side. However, this secondary structure spontaneously forms a double helical coiled structure that is depicted on the right hand side of the figure below. This structure has several distinct features that characterize the dominant structure called B-DNA.

Instructions: The base-paired ladder shown on the left coils into a double helix which is represented by either a 2D image (middle) or a 3D Jmol (right). Use the buttons to explore the various features of the DNA Structure.

Representations of Double Stranded DNA: From the Ladder to the Double Helix



DNA Structure (B-helix)



JSmol

Flash Player needed! Please click here to install Flash Player.

Use the interactive 3D Jmol image to explore these features of the double helix:.

- The two helical polynucleotide chains are coiled around a common axis

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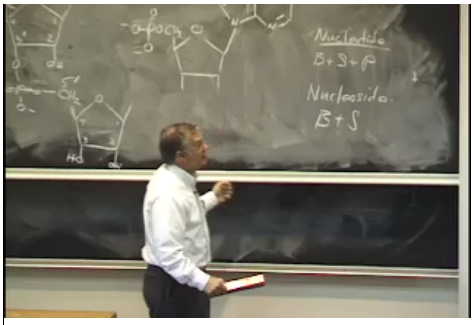
- The phosphate and ribose groups are on the outside
- The bases are directed toward the inside of the helix, and stack on the central helical axis.
- The planes of the bases are perpendicular to the axis of the helix
- The diameter of the helix is uniform and is 20 Angstroms
- The bases are stacked and separated by a uniform distance of 3.4 Angstroms.

The following link is a video in which Dr. Brown explains how DNA and RNA are constructed from the backbones and bases.

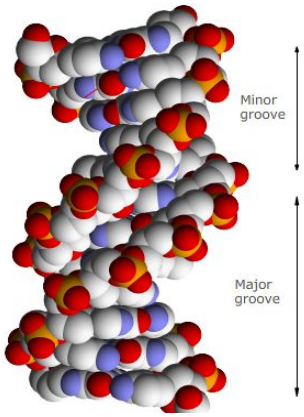


0:00

DNA has Grooves

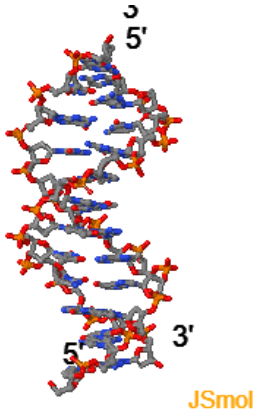
A predominate feature of the DNA double helix is the presence of grooves, or indentations, on the side of the helix. This grooves expose the edges of the basepairs, The grooves are called the major groove and the minor groove. Both grooves are deep and expose the edges of the bases to the external environment, making them accessible for protein binding. The minor groove is quite narrow (approximately 12 Angstroms across) and while the edges of the bases may be accessible to solvent and small molecules, they are generally not accessible to larger molecules. The major groove on the other hand is quite wide (approximately 22 Angstroms across) and is sufficiently wide to accommodate a protein alpha helix. Below is a side view of the B-DNA structure using a space filled model (left) next to a 3D Jmol image that will allow you to highlight each groove and determine which atoms from each basepair project into the groove. The nature of the atoms that are exposed in the grooves of the structure are important for the ability of proteins to recognize specific sequences of DNA. Discrimination of the different sequences must be made by having access to the bases inside the structure since the backbone structure is common to all sequences of DNA

Side View of B-DNA Helix

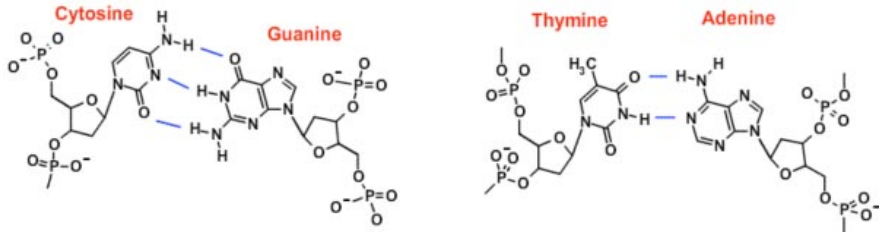


This space filled model of the B-DNA shows the major and minor grooves resulting from the formation of the double helix.

DNA Structure (B-helix)



Bases pairs inside double helix



Use the buttons on the above Jmol to see the location of a C-G and a T-A basepair in the double helix.

did I get this

By close examination of the figures and manipulation of the model, which atoms on the base pairs would be accessible in the major groove of B-DNA?

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