

DNA Structure Activity

Problem 10: Review of the Features of the Watson-Crick Model for DNA Structure

Components of DNA

DNA is a polymer. The monomer units of DNA are nucleotides, and the polymer is known as a "polynucleotide." Each nucleotide consists of a 5-carbon sugar (deoxyribose), a nitrogen containing base attached to the sugar, and a phosphate group. There are four different types of nucleotides found in DNA, differing only in the nitrogenous base. The four nucleotides are given one letter abbreviations as shorthand for the four bases.

- A is for adenine
- G is for guanine
- C is for cytosine
- T is for thymine

DNA Bases

Adenine and guanine are purines. Purines are the larger of the two types of bases found in DNA. The 9 atoms that make up the fused rings (5 carbon, 4 nitrogen) are numbered 1-9. All ring atoms lie in the same plane. Cytosine and thymine are pyrimidines. The 6 atoms (4 carbon, 2 nitrogen) are numbered 1-6. Like purines, all pyrimidine ring atoms lie in the same plane.

Deoxyribose Sugar

The deoxyribose sugar of the DNA backbone has 5 carbons and 3 oxygens. The carbon atoms are numbered 1', 2', 3', 4', and 5' to distinguish from the numbering of the atoms of the purine and pyrimidine rings. The hydroxyl groups on the 5'- and 3'- carbons link to the phosphate groups to form the DNA backbone. Deoxyribose lacks an hydroxyl group at the 2'-position when compared to ribose, the sugar component of RNA.

Nucleosides and Nucleotides

A nucleoside is one of the four DNA bases covalently attached to the C1' position of a sugar. The sugar in deoxynucleosides is 2'-deoxyribose. The sugar in ribonucleosides is ribose. Nucleosides differ from nucleotides in that they lack phosphate groups. The four different nucleosides of DNA are deoxyadenosine (dA), deoxyguanosine (dG), deoxycytosine (dC), and (deoxy)thymidine (dT, or T). In dA and dG, there is an "N-glycoside" bond between the sugar C1' and N9 of the purine. A nucleotide is a nucleoside with one or more phosphate groups covalently attached to the 3'- and/or 5'-hydroxyl group(s).

DNA Backbone

The DNA backbone is a polymer with an alternating sugar-phosphate sequence. The deoxyribose sugars are joined at both the 3'-hydroxyl and 5'-

hydroxyl groups to phosphate groups in ester links, also known as "phosphodiester" bonds.

DNA Double Helix

DNA is a normally double stranded macromolecule. Two polynucleotide chains, held together by weak thermodynamic forces, form a DNA molecule.

Features of the DNA Double Helix

- Two DNA strands form a helical spiral, winding around a helix axis in a right-handed spiral.
- The two polynucleotide chains run in opposite directions.
- The sugar-phosphate backbones of the two DNA strands wind around the helix axis like the railing of a spiral staircase.
- The bases of the individual nucleotides are on the inside of the helix, stacked on top of each other like the steps of a spiral staircase.

Base Pairs

Within the DNA double helix, A forms 2 hydrogen bonds with T on the opposite strand, and G forms 3 hydrogen bonds with C on the opposite strand. dA-dT and dG-dC base pairs are the same length, and occupy the same space within a DNA double helix. Therefore the DNA molecule has a uniform diameter. dA-dT and dG-dC base pairs can occur in any order within DNA molecules

DNA Helix Axis

The helix axis is most apparent from a view directly down the axis. The sugar-phosphate backbone is on the outside of the helix where the polar phosphate groups (red and yellow atoms) can interact with the polar environment. The nitrogen (blue atoms) containing bases are inside, stacking perpendicular to the helix axis.

◀ PROBLEM 10		ANSWER	
DNA STRUCTURE ACTIVITY	BIOCHEMISTRY	VOCABULARY	THE BIOLOGY PROJECT

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