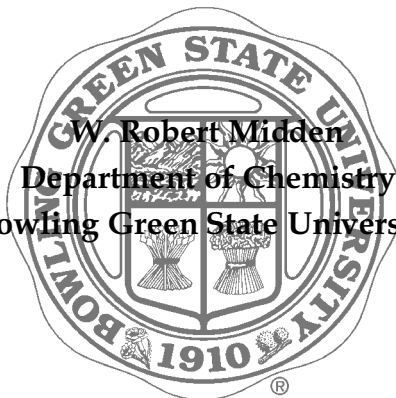


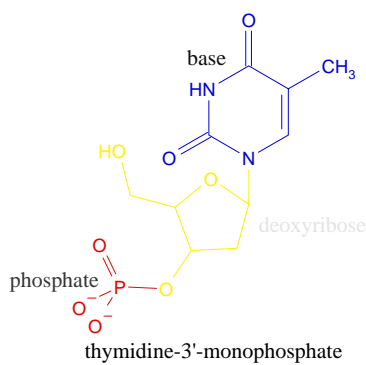
The Structure of DNA

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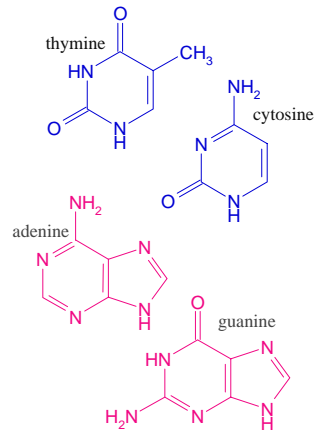
What is the molecular structure of a nucleotide?



- A nucleotide in DNA, consists of:
- a pyrimidine or purine base
- deoxyribose
- phosphate.

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What are the bases found in DNA?



- Only four different bases are commonly found in DNA in large amounts.
- Two are based on the pyrimidine ring.
 - thymine
 - cytosine
 - some DNA contains 5-methylcytosine or uracil
- Two are based on the purine ring.
 - adenine
 - guanine

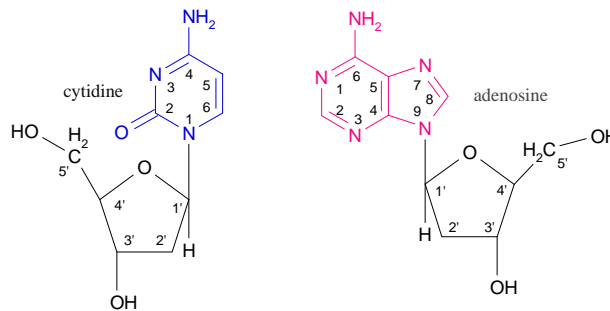
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DNA Structure

The Connection of the Sugar to the Base



- 2-Deoxyribose is a five carbon sugar that is missing the OH at C-2.
- The C-1 of deoxyribose is connected to N-1 of pyrimidines and N-9 of purines.

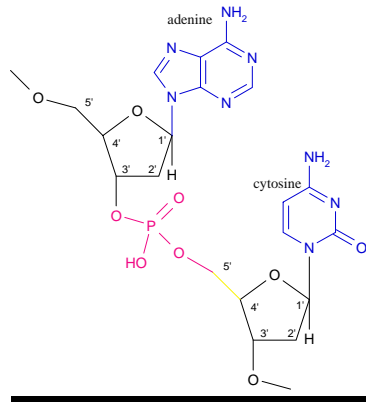
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DNA Structure

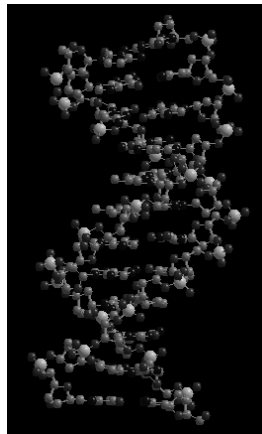
How are nucleotides linked in DNA?



- The 5'-O of one nucleotide is linked via a phosphate group to the 3'-O of the next nucleotide.

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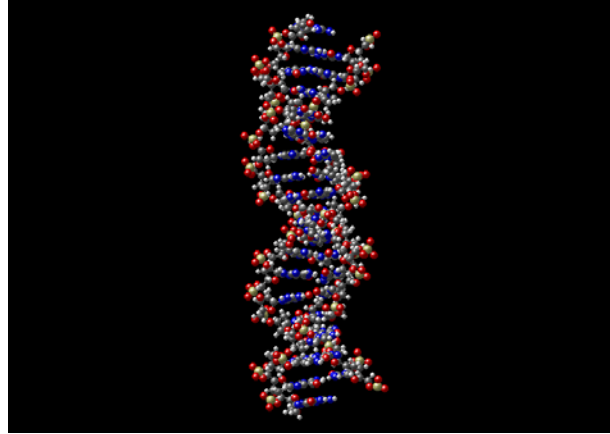
The Double Helix



- DNA is found in cells as a pair of long strands of nucleotides wrapped around each other in a spiral or helical shape
- The two strands associate by hydrogen bonding between the bases.
- The bases are aligned parallel to each other, one "stacked" on top of another.

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The DNA Double Helix



click the molecule to start rotation, click again to stop, double click to restart

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Supercoiling

- Each strand of DNA often consists of millions of nucleotides.
 - a typical mammalian cell nucleus only a couple μm in diameter contains DNA that has a total length of about 3 cm.
- To fit such a long strand into the nucleus of a cell, the DNA must be packed very tightly.
- This tight packing is accomplished in part by “supercoiling.”

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What is supercoiling?

- Supercoiling involves additional twisting of the DNA double helix that causes it to coil up on itself, much as a rubber band does when it is twisted excessively.

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Levels of DNA Structure

- Similar to proteins, there are three levels of structure in nucleic acids
- Primary: the order or sequence of the bases
- Secondary: local repeating structure
- Tertiary: overall conformation

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How is DNA primary structure determined?

- There are two common methods for determining DNA primary structure, i.e., the base sequence.
- Both methods are only able to provide the base sequence directly for a piece of DNA about 120-150 bases long.
- Longer sequences are determined by sequencing overlapping pieces.
- One method uses DNA polymerase with dideoxynucleotides.
- The other uses chemical reagents.

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Dideoxy Sequencing

- In dideoxy sequencing, the DNA is divided into four samples.
- DNA polymerase and a mixture of the four nucleotide triphosphates is added to each sample.
- A small amount of a different dideoxynucleotide triphosphate is added to each of the samples.

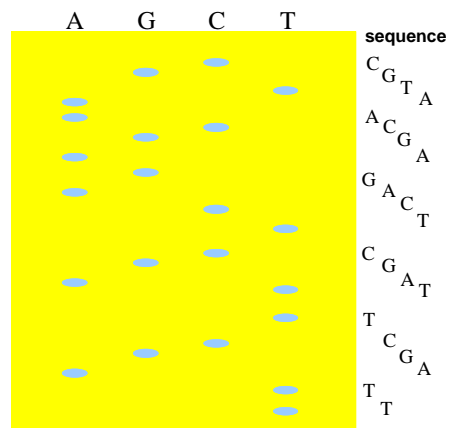
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How the Sequence is Determined

- The dideoxynucleotide causes DNA synthesis to stop at the point where it is incorporated into the growing DNA strand.
- The position of the bands in electrophoresis analysis reveals the sequence of the bases.

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Gel Electrophoresis



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Maxam-Gilbert DNA Sequencing

- The Maxam-Gilbert method of DNA sequencing uses a set of chemicals that break the DNA phosphodeoxyribose backbone at specific bases.

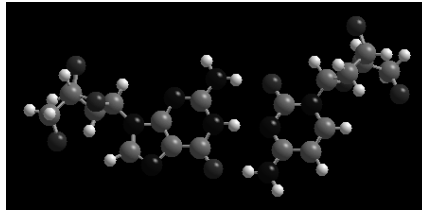
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How it is Done

- The DNA to be sequenced is divided into four samples.
- Each sample is treated with a reagent that breaks the DNA strand at a specific base...
- and then analyzed in parallel lanes on an electrophoresis gel.
- Positions of the bands on the gel reveal the sequence of the bases.

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Nucleic Acid Secondary Structure



- The secondary structure of DNA (and RNA) is determined by the hydrogen bonding patterns.
- Hydrogen bonding patterns in nucleic acids are very specific.
- Guanine H-bonds best to cytosine.
- Adenine H-bonds best to thymine (uracil in RNA).

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Nucleic Acid Tertiary Structure

- The overall conformation of DNA is designated with letters such as A, B, D or Z.
- B-DNA is the most common DNA conformation and was the first discovered.
- Z-DNA is the most different. It corresponds to a left-handed helix whereas most other common conformations are right-handed helices.

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Questions For Discussion

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Nucleotide Structure

Draw the molecular structure of a typical DNA nucleotide and indicate which part is the base, deoxyribose and phosphate. Which points participate in hydrogen bonding between bases?

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DNA Base Structures

What are the molecular structures of the four bases commonly found in DNA?

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RNA Bases

Which base is found in RNA instead of thymine?

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Uracil vs Thymine

How does uracil differ from thymine?

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Connecting a Base to a Sugar

How are the bases connected to deoxyribose, by
what type of bond between which atoms?

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Numbering The Rings

What numbers are assigned to each of the atoms in pyrimidines, purines and deoxyribose?

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Linking Nucleotides

What is the molecular structure of the linkage between nucleotides in a single strand of DNA?

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The Double Helix

Describe the structure of a DNA double helix: how many strands are involved, in what shape these are strands arranged, the arrangement of the bases and what two types of interactions account for the association of the strands.

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Supercoiling

What is supercoiling and why is it important to the function of DNA inside cells?

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DNA Primary Structure

What is DNA primary structure and how is it determined experimentally?

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Nucleic Acid Secondary Structure

What types of intermolecular interactions determine DNA and RNA secondary structure?

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Base Pairing

Which bases form "Watson-Crick" pairs?

Indicate which parts of the molecules participate in hydrogen-bonding.

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DNA Conformation

What is the most common conformation of DNA?

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B-DNA vs Z-DNA

What is the difference in the conformation of B-DNA and Z-DNA?

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