The Structure of DNA

The Chemical Composition of DNA

- by the 1860s, Miescher discovered that nuclein, was slightly acidic and contained large amounts of phosphorous and nitrogen
- by the 1920s, it was discovered that DNA consisted of three main components: **deoxyribose sugar**, a **phosphate group** that is negatively charged, and a **nitrogenous base**
- four nitrogenous bases exist in DNA – adenine (A), guanine (G), cytosine (C), and thymine (T)
- Figure 2, p. 210 illustrates the four nitrogenous bases
- DNA is a polymer of nucleotide monomers
- each monomer consists of a deoxyribose sugar (five-carbon cyclic ring structure) attached to a phosphate group and a nitrogenous base
- Figure 3, p. 211 illustrates the five-carbon deoxyribose sugar, where each carbon is numbered clockwise
- the first four of the five carbon atoms, together with an oxygen atom, form a five-membered ring, and the fifth carbon atom extends out from the ring
- the first carbon is referred to as the “1 prime” carbon, the second is referred to as the “2 prime”, etc.
- a deoxyribose sugar has a hydroxyl group on the 3’ carbon, and a hydrogen atom on the 2’ carbon
- the nitrogenous base is attached to the 1’ carbon through a **glycosyl bond** and the phosphate group is attached to the 5’ carbon by an ester bond
- Figure 9, p. 214 illustrates these connections

The Physical Structure of the DNA Molecule

- Watson and Crick’s model consists of two **antiparallel** strands of nucleotides (see Figure 8, p. 214)
- the bases of one strand are paired with bases of the complimentary strand
- the bases face inward toward each other, such that a pyrimidine is always paired with a purine
- A is always paired with T, and C is always paired with G
- hydrogen bonds form between the base pairs such that two form between A and T, and three form between C and G
- single hydrogen bonds are generally weak, however, since all of the base pairs running along the sugar-phosphate backbone of the entire structure are held together by H-bonds, their collective strength is high
- this helps to maintain the stability of the entire molecule which is of extreme importance to the life of an organism
- one complete helical turn is made every 10 nucleotides

- the sugar-phosphate backbone adds to the stability of the molecule as well, as it supports the base position and maintains their position in the sequence
- the two strands run antiparallel – one strand runs in the 5' to 3' direction, while the other strand runs in the 3' to 5' direction
- the 3' end terminates with a hydroxyl group of the deoxyribose sugar, and the 5' end terminates with the phosphate group (see Figure 9, p. 214)
- this means that every DNA molecule has an intrinsic directionality – for example, the sequence of bases is indicated in the following way:

  5' – ATGCCGTTA – 3'

  3' – TACGGCAAT – 5'

- by convention, only the 5' to 3' strand is written, since the complimentary strand can be deduced from the pairing nature of the bases

Homework: 1-9, p. 216

For an excellent tutorial demonstrating the structure of DNA, click on http://www.dnaftb.org/dnaftb/