BIOLOGY 100
SOLUTIONS TO PROBLEMS

NUCLEIC ACIDS

1. How are covalent bonds different from hydrogen bonds?

Covalent bonds are formed when two atoms share their electrons between them. When this is an equal sharing, the bond is said to be non-polar; when it is an unequal sharing, the bond is said to be polar. We see polar bonds in general biology class between H atoms and the electronegative atoms N or O. Polar bonds are the strongest bonds we study in general biology. Hydrogen bonds are the weakest bonds we study in this course. The H bond is a weak attraction between a partially positively charged Hydrogen (involved in a polar covalent bond with another atom—N or O) and a partially negatively charged atom, such as a Nitrogen or Oxygen that is involved in a polar covalent bond with another atom.

2. What does it mean when it is said that the two sugar-phosphate backbones of a double-stranded DNA molecule are anti-parallel?

The five-carbon deoxyribose has four of its carbons in a ring (denoted 1 prime (1') through 4 prime (4'), starting with the one that has the base coming off of it), and its fifth carbon (5') outside the ring—this is the one to which the phosphate of each nucleotide is attached. On one strand of a DNA molecule, the 5' carbon of each sugar (with its phosphate) is above the 3' carbon of each sugar. The other strand has just the opposite: the 3' carbon of each sugar is above the 5' carbon of each sugar (i.e., the sugars on the two strands are upside-down relative to each other.)

3. A 300 base DNA molecule could encode a protein of how many amino acids?

The longest mRNA a 300 base DNA molecule could encode is 300 bases. Each codon (codes for an amino acid) is 3 bases in length. Divide 300 by 3 bases per codon, and you get 100 codons. If you assume that each codon codes for an amino acid, then the answer is 100 amino acids. You get a "good for you!" if you realize that the last codon of the amino acid code must be a stop codon, which does not code for any amino acid. Hence, if you said the answer was 99 amino acids, you would be more correct.

4. It is estimated that the human genome contains 3 billion nucleotides (that is, the nucleus of each cell contains this number of nucleotides). A nucleotide is approximately 0.3 nm in length. If stretched out and placed end-to-end, how long is the nuclear DNA in a human cell?

3 billion nucleotides (nt) = 3×10^9 nt
3×10^9 nt x 0.3 nm/nt = 0.9×10^9 nm x 1 m / 10^9 nm = 0.9 meters long