WEEK 1 PROBLEMS

Problems From Chapter 1

1.1 In the early years of the twentieth century, why did many biologists and biochemists believe that proteins were probably the genetic material?

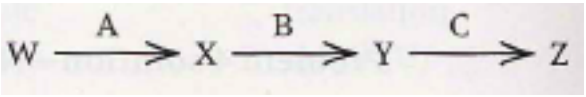
1.2 When the base composition of a DNA sample from *Micrococcus luteus* was determined, 37.5 percent of the bases were found to be cytosine. The DNA of this organism is known to be double-stranded. What is the percentage of adenine in this DNA?

1.3 DNA extracted from a certain virus has the following base composition: 20 percent adenine, 40 percent thymine, 25 percent guanine, and 15 percent cytosine. How would you interpret this result in terms of the structure of the viral DNA?

1.4 duplex DNA molecule contains 642 occurrences of the dinucleotide 5'-GT-3' in one or the other of the paired strands. What other dinucleotide is also present exactly 642 times?

1.5 Shown here is the terminal part of a metabolic pathway in a bacterium in which a substrate metabolite (small molecule) W is converted into a final product metabolite Z through a sequence of three steps catalyzed by the enzymes- A, B, and C. Each of the enzymes is the product of a different gene.

Which metabolites would be expected to be missing, and which present in excess, in cells that are mutant for:
(a) Enzyme A?
(b) Enzyme B?
(c) Enzyme C?



1.6 A mutation isolated in the bacterium discussed· in Problem 19 affects one of the enzymes in the pathway shown, but it is not known which step (A, B, or C) is blocked. The final product Z of the pathway is essential for growth. When mutant cells are placed in cultures lacking Z, they cannot grow. If Z is added to the medium, they grow. Experiments are carried out to determine whether any of the intermediates can substitute for Z in supporting growth. It is found that mutant cells can grow in the presence of Y but not in the presence of W or X. Deduce from these data what step in the pathway is blocked in the mutant.

1.7 The DNA content of an organism contains 50% GC basepairs. On average, how frequently would you expect to find the sequence 5´ATGG3´?

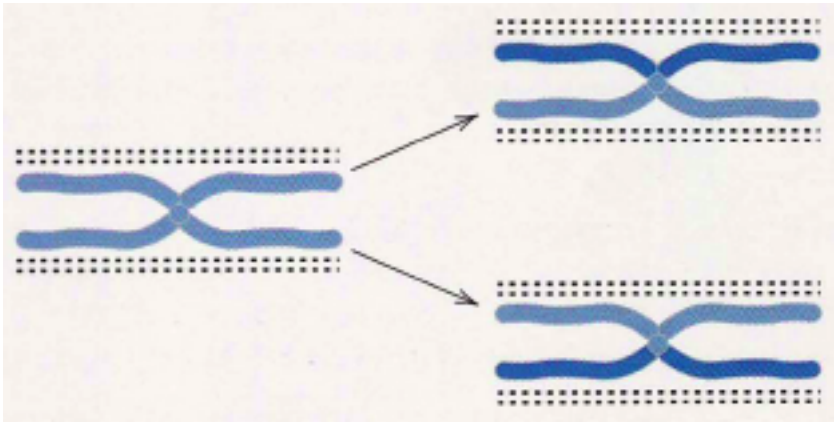
Problems From Chapter 6

6.1 The haploid genome of the wall cress, *Arabidapsis thaliana,* contains 100 Mb and has 10 chromosomes. Estimate the time of replication, assuming that there is only one origin of replication (exactly in the middle) for each chromosome, that replication is bidirectional, and that the rate of DNA synthesis is 1000 nucleotide pairs per second (typical of bacterial cells).

6.2 Specify the function or enzymatic activity of the following enzymes or enzyme complexes that participate in DNA replication: primosome, gyrase, DNA ligase, polymerase I (Pol I), and polymerase III (Pol III).

6.3 For the fluorescent color coding A = green, T = red, G = black, and C = purple, read the DNA sequence in each of the accompanying gel diagrams. How does the sequence in gel A differ from that in gel B?

6.4 The first evidence for semiconservative replication of DNA in eukaryotes made use of an artificial nucleotide of thymidine called bromodeoxyuridine (BUdR), in which the methyl group in thymine is replaced with an atom of bromine. When chromatids whose DNA contains BudR are stained with certain fluorescent dyes, the chromatids with one strand labeled and one unlabeled fluoresce very brightly (light blue in the accompanying illustration), whereas those with both strands labeled fluoresce dully (dark blue). The illustration depicts the fluorescence patterns of chromosomes in mitotic metaphase after one and two rounds of DNA replication in the presence of BUdR, and the dotted lines represent the DNA strands in the DNA duplex present in each chromatid. Depict the BUdR labeling of each chromatid by (1) making the line solid if the strand is fully labeled with BUdR or (2) leaving it dashed if it is half labeled with BUdR.



6.5 The human genome contains 3 billion nucleotide pairs, and estimates suggest that it contains 50,000 genes. If all genes are evenly spaced throughout the genome, on average, how many nucleotides would there be from the beginning of one gene to the beginning of the next gene?