MCB 110
Spring 2003

Midterm
February 24, 2003

Name _____ ID # _____

You are given 5 questions below. Answer only 4 of them. If you answer all 5, only the first 4 answers will be graded.

1. We have seen a number of examples of a nucleophilic attack in which the reaction was highly energetically favorable. For example, the incorporation of deoxyribonucleotides by a DNA polymerase. List five (5) distinct examples of a nucleophilic attack in which the free energy change (ΔG) is close to zero such that the equilibrium constant for the reaction is near one. In these cases, the reaction is energetically neutral, or nearly so. In each case, state briefly in chemical terms why ΔG is near zero and what is the physiological advantage of a ΔG near zero.

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2. Compare and contrast the mechanisms for maintaining the fidelity of DNA replication and protein synthesis. Give the steps involved in each where errors can occur and how they are corrected.

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3. Repetition of sub-gene-sized DNA sequences is important in many cellular processes. Name five (5) distinct examples of such repetitions in DNA sequences. Make sure that the examples are different. For example, you cannot say that Tn1, Tn3, Tn5, Tn7, and Tn10 cause a direct repeat of a short sequence in the target DNA that flanks the transposon and count that as five separate examples. (You also cannot use target sequence repeats around transposons as an example now). Indicate whether the repeat is direct, inverse, or can be either. In one sentence for each example, indicate the function of the repeat sequence. Where possible, state why the function would be different or impossible if the repeat had a different orientation or if there was a single copy of the sequence.

   Extra Credit: What is the probable consequence for the secondary structure of an mRNA encoded by a gene containing an inverted repeat?

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4. Consider a bifunctional alkylating agent of the general structure $Cl(CH_2)_nCl$ that attacks DNA. This agent can have the following consequences:

   (A) It can add to a base, B, to give the product
   $Cl(CH_2)_nCl$ -B. This is a monoadduct. In cases (B)-(E), a diadduct is formed.

   (B) It can add to two bases in the same strand of the double helix, B_{W1} and B_{W2}, to give
   B_{W1}-$(CH_2)_n$-B_{W2}

   (C) It can add to bases in the complementary strands of the double helix, B_W and B_C, to give
   B_W-$(CH_2)_n$-B_C

   (D) It can add to bases on different chromosomes in random positions, B_I and B_{II}, to give
   B_I-$(CH_2)_n$-B_{II}

   (E) It can add to the same base at the exact same positions in homologous chromosome, B_M and B_D, to give
   B_M-$(CH_2)_n$-B_D

   In each case, indicate which repair processes would likely be important in repair of the damage. Give your reasoning.

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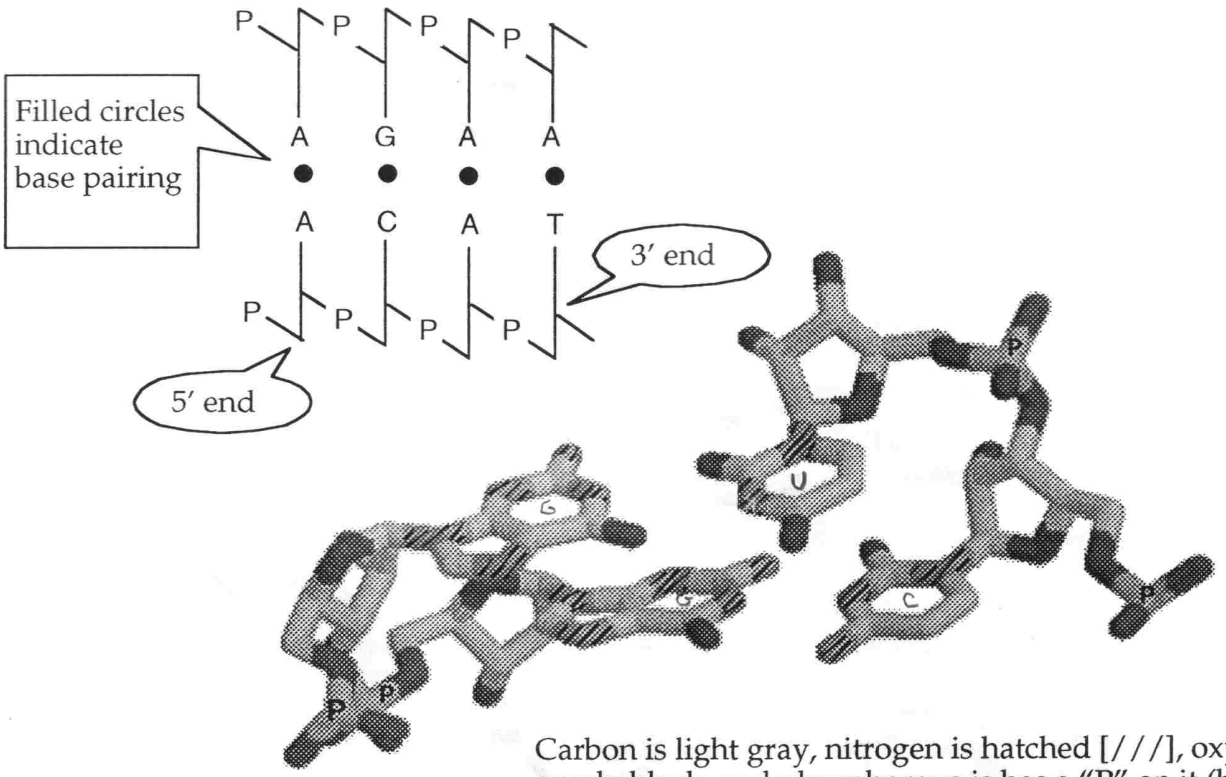
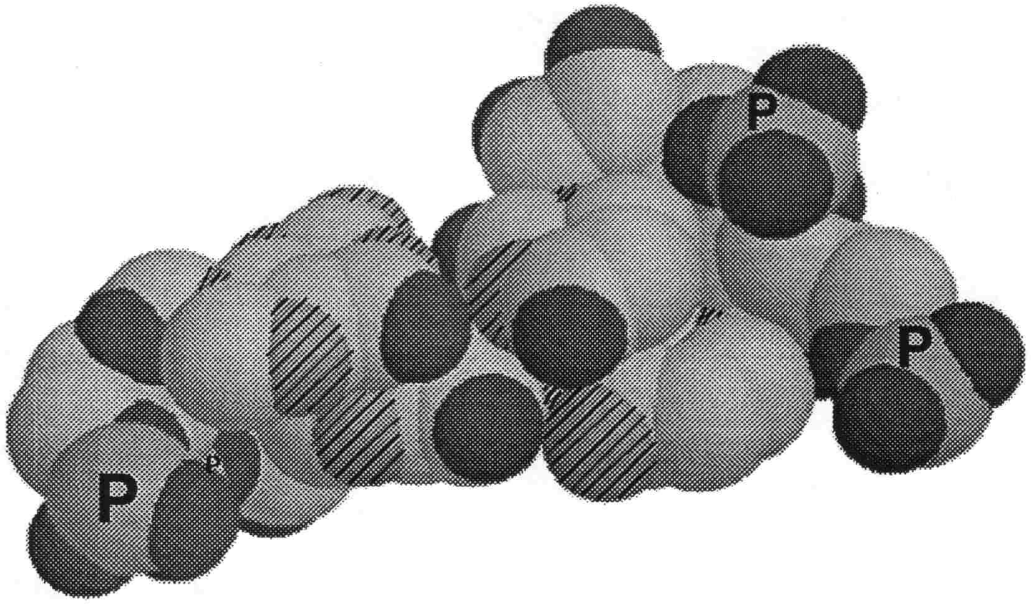
5. Shown below is a single view of a portion of a nucleic acid molecule, but in stick figure and space filling formats. H's are not idicated. Write out the nucleotide sequence and indicate polarity and base pairing. Is it RNA or DNA? Just use a shorthand for nucleotide sequences; e.g., (and this is a completely wrong answer):



Carbon is light gray, nitrogen is hatched [///], oxygen is nearly black, and phosphorous is has a "P" on it (hydrogens are not shown).



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