Name _____

Score _____

Exam 2, BICH 440 Honors, Friday, November 7, 2003

Write your name on each page. Write concise answers to demonstrate effectively your mastery of the subject. **Show your work in order to receive maximum credit** where applicable.

gas constant R 8.315 J/mol-K
Faraday constant F 96.5 kJ/mol-volt

1) (10 pts) Calculate the approximate concentration (in molarity AND mg/ml) for the amount of DNA nucleotides in a human somatic cell nucleus (i.e., if all the genomic DNA was hydrolyzed to single nucleotides). Assume the **haploid** content of the human genome to be 3 billion base pairs and the **diameter** of the nucleus to be 20 micrometers (spherical shape).

2) (8 pts) In one sentence describe the major accomplishment of each of the following biochemists that has been covered so far in this course.

(A) Kary Mullis

(B) Walter Gilbert

(C) Aaron Klug

(D) Erwin Chargaff

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3) (11 pts) Given the following sequence of single-stranded RNA. Answer the questions below.

5′-GGAUAAUCAUUUGCAAUUGCAGGCUGGCCCUGCUUUAACAAGUUAA-3′

(A) Write the sequence of a 15 nucleotide DNA that would form the most stable hybrid with this RNA sequence. Make sure you denote the polarity of this oligonucleotide.

(B) Using the 15 nt. oligonucleotide from part (A) as a primer for cDNA synthesis from the RNA strand using reverse transcriptase, write the sequence of DNA produced from the primer when only the nucleotides ddGTP, dTTP, dATP and dCTP are added to the reaction. Show polarity.

(C) What potential problem might exist when using the primer in (A) as a probe for hybridization to this RNA sequence (Hint: Carefully consider the sequence of the 15 nt. oligonucleotide.)

4) (15 pts) (A) Draw the structures of the 2′-deoxyribonucleosides, deoxycytidine and deoxyguanosine, when they are engaged in a Watson-Crick base pair. Clearly indicate the hydrogen bonds using dotted lines.

(B) The pKa for the N-1 proton on the guanine base is 9.4. In alkaline conditions, say pH 10, will the stability of the base-pair that you drew in part (A) be altered? Explain why or why not.

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5) (10 pts) Given the structure of sphingosine below, draw the structure of a cerebroside composed of oleic acid (18:1□9) and □-D-galactose.

6) (10 pts) A disaccharide known as □,□-trehalose is a nonreducing sugar that contains two D-glucopyranose residues. Based on this information, draw its structure.

7) (10 pts) Draw the structure of a cholesteryl ester containing palmitic acid (16:0).

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8) (9 pts) Within a segment of supercoiled DNA, 200 base-pairs is converted from the B-form to the Z-form, WITHOUT breaking the phosphodiester backbone. Assume that the DNA is entirely double-stranded in both states. What are the **changes** in the following values (remember to keep track of the sign (+ or -))?

(A) the twisting number (T):

(B) the linking number (L):

(C) the writhing number (W) (supercoiling):

9) (8 pts) Calculate the mass ratio of protein:DNA in a nucleosome CORE particle. The molecular weights of histones are: H1: 21,000; H2A: 14,000; H2B: 14,000; H3: 15,000; H4: 11,000

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10) (9 pts) The resting membrane potential of a cell is –60 mV (inside more negative). If the free energy change for the transport of Na+ from the inside to the outside is 12.6 kJ/mole, and the [Na+] inside the cell is 10 mM, what is [Na+] outside the cell? (Temp = 37 °C)