

Name _____

I.D. _____

Score _____

Exam 2, BICH 440, Section 500, Monday, October 28, 2002

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. (15 pts) Eukaryotic messenger RNAs are "capped" at their 5' ends with an unusual structure that can be abbreviated:

7-MeGpppAp...

I'll give you the following hints to help you with the structure.

- a) The guanine base is methylated at position 7.
- b) The guanosine and adenosine ribonucleosides are linked together with a triphosphate chain using 5' carbons on each.
- c) The phosphate "to the right" of the A is on the 3' carbon.
- d) The atom that is methylated on guanine then carries a positive charge.

Draw the molecular structure of this "cap" (at pH 7). Do not "abbreviate" the phosphates.

5. (15 pts) At the cellular membrane of some bacteria, oxidation-reduction reactions within the membrane generate a pH gradient of $\Delta\text{pH} = 1.0$ (interior higher by one unit) and a membrane potential of -120mV (interior negative). This “proton-motive” force can be used to synthesize ATP from ADP and phosphate inside the cell. Here is some more information that may be useful as you solve the problems below:

temp. = 37°C

[ATP] = 5 mM

[ADP] = 1 mM

[phosphate] = 2 mM

for ATP hydrolysis, $\Delta G^\circ = -30.5\text{ kJ/mole}$

(other constants given on pg. 1)

- (a) How much free energy is made available by the pH gradient and membrane potential for the transport of protons INTO the cell?
- (b) As the protons are transported into the cell, ATP synthesis can be coupled to this process by the enzyme ATP synthase. At 100% efficiency, under the conditions listed above, how many protons must be transported to synthesize one molecule of ATP?

6. (12 pts) Draw the structures of the products of phosphatidylserine hydrolysis catalyzed by phospholipase D at pH 7. This phosphoglyceride molecule contains 18:0 and 18:2(9,12) fatty acids.

7. (37 pts) Short answer

- (a) (4 pts) Which blood group carbohydrate-containing structure is the smallest and not antigenic?

An individual homozygous for this blood group antigen can accept blood from what other types?

- (b) (2 pts) A b-specific nuclease catalyzes the hydrolysis of pApGpCpTp between the C and T residues. Write the products of this cleavage reaction using the same nomenclature.

- (c) (2 pts) What two amino acid residues are somewhat more likely to be part of a tight beta turn in a protein structure?

- (d) (5 pts) Briefly describe what is meant by conformational entropy in the folding of a protein. Is this favorable or unfavorable for the direction of protein folding? What other entropy-related interaction tends to counteract the above as proteins fold in aqueous solution?

- (e) (4 pts) Per molecule of ATP hydrolyzed by the sodium-potassium pump, how many molecules of each ion are transported and in what direction(s) across the plasma membrane?
- (f) (2 pts) Approximately how many nucleotides are there in a RNA of molecular weight 40,000?
- (g) (2 pts) Starting with a circular, double-stranded DNA molecule of 5100 base-pairs, how many fragments would you expect to find after hydrolysis catalyzed by a restriction enzyme that recognizes a sequence of 4 base-pairs (assuming completely random sequence of the plasmid)?
- (h) (2 pts) What is the common name for the enzyme that catalyzes the cleavage of the heteropolysaccharide in bacterial cell walls?
- (i) (2 pts) What is the difference in structure between a cerebroside and a ganglioside? (a few words only; do not draw structures)
- (j) (3 pts) Name three steroid hormones.
- (k) (3 pts) Briefly explain why the curve describing the rate of membrane transport vs. concentration of the molecule being transported is hyperbolic when carried out by facilitated diffusion.
- (l) (2 pts) What is the wavelength commonly used to detect and quantitate nucleic acids by spectrophotometry?
- (m) (2 pts) What amino acid sidechain is involved in the lipid linkage for prenylated proteins (lipid-linked proteins containing poly-isoprene groups)?
- (n) (2 pts) What two amino acid sidechains are involved in O-linkages of glycoproteins?