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BICH 440, EXAM 2, Monday, October 22, 2007, 100 points total

You MUST sign the following academic integrity statement:

On my honor, I have neither given nor received unauthorized aid on this academic work.

Signed: _____

1. Write your name on the cover page ONLY.

2. Write your student UID# on ALL pages. If you do not remember your UID#, make up a random 8 digit number. DO NOT use your social security number.

3. Write concise answers to demonstrate effectively your mastery of the subject. In order to obtain maximum credit, you need to show your work.

gas constant

R 8.315 J/mol-K

Faraday constant

F 96.5 kJ/mol-volt

1.(12 pts) Draw the structure of the glycerophospholipid, phosphatidyl ethanolamine that contains a 16:0 fatty acid and an 18:3(9,12,15) fatty acid. Show the ionization of this molecule at pH7.

2.(12 pts) Draw the structure of an N-linked glycoprotein linkage containing a disaccharide of alpha-2-N-acetyl glucose attached to the amino acid plus a galactose residue in a beta(1 → 4) linkage. For the protein part of your structure, show only the amino acid sidechain.

3.(8 pts) You are working with a membrane protein that is described by the following hydropathy plot. From this information, tell me what could be true about this protein.

4.(6 pts) A 0.2g sample of starch amylopectin was treated to quantitatively methylate free hydroxyl residues. After total hydrolysis and separation of methylated monosaccharide residues, the following amounts were found:

2,3-dimethylglucose	50 micromoles
2,3,6-trimethylglucose	1120 micromoles
2,3,4,6-tetramethylglucose	55 micromoles
1,2,3,6-tetramethylglucose	0.4 micromoles

What fraction of the total residues are reducing ends?

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



Draw the molecular structure of this cap at pH7. Do not abbreviate the phosphates.

The following hints may help you figure out this structure:

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

6.(15 pts) A pH gradient across a membrane can be used as an energy source to synthesize ATP from ADP and phosphate inside a cell (or organelle). For this problem a pH gradient of $\Delta\text{pH} = 1.0$ (interior higher by one unit) and a membrane potential of -120 mV (interior negative) exists across a plasma membrane. In addition, the following information may be useful:

[ATP] = 5 mM, [ADP] = 1 mM, [phosphate] = 2 mM, temp = 37°C

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

- (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?

7. Shorter answer questions (32 pts)

(A)(3 pts) What is unusual about the glycosyl bond conformation of bases in Z-form DNA vs. B-form DNA?

(B)(3 pts) How many base pairs in a piece of B-form DNA of length 660 Angstroms?

(C)(2 pts) Name an example of an ionophore.

(D)(2 pts) What modified amino acid is prevalent in collagen?

(E)(3 pts) Describe the carbohydrate portion of a bacterial cell wall (no structures, just words).

(F)(2 pts) How many amino acids must be present in an alpha-helical transmembrane segment?

(G)(2 pts) Name an example of a DNA intercalating agent.

(H)(4 pts) In what relative directions across a plasma membrane are the ions transported by the sodium potassium pump? In what stoichiometry? What is the energy source for this active transport?

(I)(3 pts) What is similar about the chemical structures of sphingomyelins and cerebroside? What is different?

(J)(2 pts) What would you add to a membrane preparation in order to solubilize integral membrane proteins?

(K)(4 pts) Explain why decreasing the concentration of NaCl in a solution of double-stranded DNA results in a lower melting temperature for denaturation.

(L)(2 pts) Which blood type (A, B, AB, or O) contains the simplest carbohydrate structure?