Name _____

Score _____

Exam 2, BICH 440 Honors, Monday, October 25, 2004

You MUST sign the following academic integrity statement:
On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work. Signed: _____

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) The gastric (H+K+) ATPase secretes H+ to an external concentration of 0.2M from cells that have an internal pH of 7. The membrane potential is 60mV (inside negative). Assume a temperature of 37C. Ignore the energetics involved in K+ transport for this problem.

(a) What is the ΔG for transport of H+ out of the cell?

(b) Given $\Delta G^{\circ\prime}$ = -30.5 kJ/mole for ATP hydrolysis, and physiological concentrations of [ATP] = 3mM, [ADP] = 0.5mM, [Pi] = 1mM, how much ATP must be hydrolyzed per mole of H+ transported in order to make this transport reaction exergonic?

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2) (10 pts) You are trying to design a simple porin protein to facilitate transport of a monosaccharide that contains an 18-stranded antiparallel beta sheet with each beta strand joined on both ends by a tight, beta turn. Assume each beta strand is oriented perpendicular to the plane of the lipid bilayer.

(a) If the long dimension of an extended beta strand is 3.5 Angstroms per amino acid residue, approximately how many residues must exist in your designed porin protein?

(b) Would hydropathy analysis clearly demonstrate transmembrane segments of the porin protein? Why or why not?

3) (10 pts) Collagen structure

(a) Describe general characteristics of the primary, secondary, tertiary, and quaternary structures of collagen.

(b) Why is vitamin C important in stabilizing collagen structure? Draw a structure of the modified amino acid sidechain produced in the vitamin C-dependent reaction.

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4) (12 pts) On planet Zork, the genetic material is NAGNA (N-acetylgluconucleic acid). Here are some pertinent chemical characteristics of NAGNA.

i) The sugar is 2-N-acetyl-glucosamine (NAG), not 2-deoxyribose. (Hint: remember N-acetyl means the amino modification is further modified by adding an acetyl group to the nitrogen.)
ii) The phosphodiester backbone contains bis-phosphate (two phosphates) linkages between 3′-OH and 6′-OH on successive NAG residues.
iii) Nucleic acid bases as we know them are linked by beta-N-glycosidic bonds to NAG residues.

Draw the structure of a dinucleotide of NAGNA that contains a 6′-phosphate, a 3′-OH, and the sequence AC at pH 7.

5) (10 pts) Indeed, biochemistry on Zork is not normal. Whereas the sugar backbone of NAGNA is based on glucose (problem 4, above), rather than deoxyribose, the storage polysaccharides are based on ribose, rather than glucose. Zorkstarch is composed of ribose residues in beta (1 3) linkages, with branchpoints composed of alpha (1 5) linkages. Draw three residues in Zorkstarch at a branchpoint, demonstrating both types of linkages.

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6) (12 pts) (a) Back on earth now (Zork lipids are too weird) - draw the structure of the phosphoglyceride, phosphatidylethanolamine at pH 7, that contains fatty acids 18:0 and 18:2(9,12) esterified in their preferred positions. (b) Suggest two different fatty acids for this membrane lipid, one saturated and one unsaturated, that could replace those from part (a) to increase fluidity when incorporated into membranes.

7) (6 pts) Regarding the energetics of protein folding, describe two counteracting effects of entropy on this process.

8) (4 pts) Using a simple diagram, describe the structure of an immunoglobulin G molecule. Point out the location(s) of the antigen combining site(s).

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9) (6 pts) Draw the structure of alpha-D-mannose in an O-glycoprotein linkage. You need only depict the sidechain of the pertinent amino acid.

10) (4 pts) Name an example of a membrane transport protein that is involved in an antiport process. What molecules/ions are transported by this protein?

11) (5 pts) Draw the structure of palmitic acid (16:0) in a thioester linkage as it exists in a certain type of lipid-anchored membrane proteins. You need only depict the sidechain of the pertinent amino acid in the linkage.

12) (6 pts) Name three examples of glycosaminoglycans. Describe three chemical features that are shared by these molecules. (Very general characteristics such as "carbohydrate" or "polysaccharide" do not count. Dig just a little bit deeper.)