Biology 5357

Chemistry & Physics of Biomolecules

Examination #3

Membranes, Membrane Proteins
& Glycobiology Module

December 7, 2018

Name: _____

Question 1. (8 points) Name the eight major types of lipid structures in biological membranes. Give an example of each.

Question 2. (3 points) Describe three ways that archaeal lipids can be chemically different from lipids in eubacterial membranes.

Question 3. (10 points; A-E, 2 points each) Consider the CMC for detergent amphiphiles:

(A) What is the major driving force for micelle formation?

(B) What values of the critical packing parameter lead to the formation of spherical micelles?

(C) What happens to the CMC when the hydrophobic chain length of the amphiphile is increased?

(D) What happens to CMC of an anionic detergent when the salt concentration is increased?

(E) Consider the detergent CHAPS with a CMC of 10 mM. At 35 mM, what is the concentration of CHAPS monomers in solution?

Question 4. (8 points; A-D, 2 points each) Consider the main bilayer phase transition:

(A) What are the molecular changes that occur during the main bilayer phase transition?

(B) Draw a graph that describes the trend of T_m as a function of acyl chain length.

(C) Draw a graph that describes the trend of T_m as a function of number of double bonds in the acyl chains.

(D) Which T_m is higher? PC with 16:0, 18:1 cis-9 chains or PC with 16:0, 18:1 trans-9 chains?

Question 5. (4 points) List four different types of solvation methods (*i.e.*, structures) used for the biochemical study of purified membrane proteins.

Question 6. (6 points) Describe the three different types of passive transport across biological membranes. Give a specific example for each.

Question 7. (4 points) Describe the two different types of active transport that are used in biological membranes. Give a specific example for each.

Question 8. (4 points; A & B, 2 points each) Consider a cell that has the following intracellular and extracellular ion concentrations. Note, there are other ions in the system that are not included here and can be ignored:

$[Na^+]_i = 20$ mM	$[Na^+]_o = 150$ mM
$[K^+]_i = 140$ mM	$[K^+]_o = 10$ mM
$[Cl^-]_i = 40$ mM	$[Cl^-]_o = 40$ mM

(A) Write down the Nernst equation for calculating the equilibrium potential across the membrane.

(B) In this cell, there is a single type of ion channel that is open at rest and it is selectively permeable for chloride. What is the resting membrane potential?

Question 9. (6 points) The equation for the whole-cell current through a single type of ion channel is:

$$I = N \cdot P_O \cdot \gamma \cdot (V_m - E_{rev})$$

Describe the meaning of the following terms: N, P_O, γ, V_m, E_{rev} and $(V_m - E_{rev})$.

Question 10. (3 points; A-C, 1 point each) In the "Cl^- dump" assay, proteoliposomes containing the functional CLC Cl^-/H^+ antiporter are prepared with 300 mM Cl^- on the inside, and the outside solution is exchanged into 1 mM Cl^-.

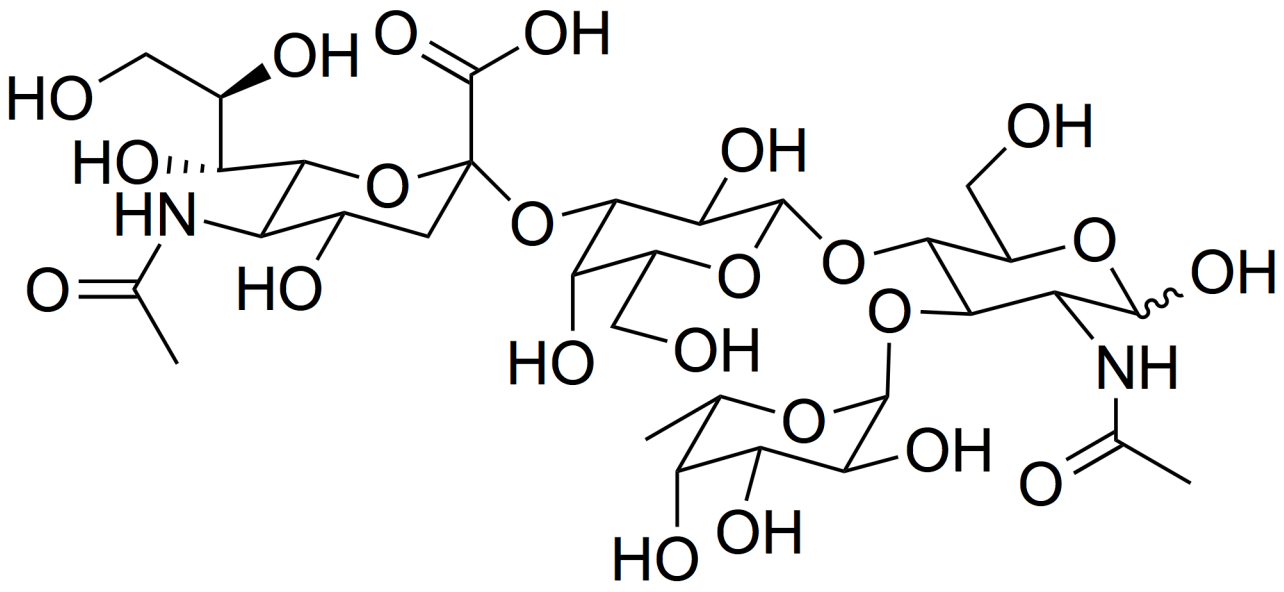
(A) Upon exchange into the low chloride solution there is a large concentration gradient, but no net movement of chloride out of the vesicles. Why?

(B) Valinomycin is often used to initiate transport. What does valinomycin do?

(C) What should the counter cation be in order to observe transport with valinomycin? What should the intra- and extra-liposomal counter cation concentrations be set to?

Question 11. (4 points) Compare and contrast the two different types of membrane proteins synthesis/folding.

Question 12. (20 points; A-E, 4 points each) Shown below is the "sialyl Lewis x" tetrasaccharide, which is often at the terminus of *O*-linked glycans at the cell surface.



(A) What monosaccharides are present in sialyl Lewis x? Label them on the figure.

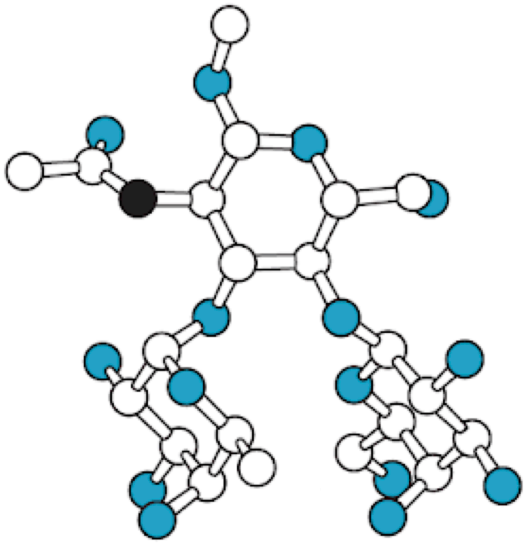
(B) Indicate on the structure the location of the reducing end of sialyl Lewis x.

(C) Mark the glycosidic linkages on the structure, and label each linkage as α or β.

(D) Write the full name of this tetrasaccharide. Use standard abbreviations for the monosaccharides such as Gal for galactose, *etc.*, and numbers, α/β and bonds to indicate linkages and connect the structure. (Example: lactose is Galβ1-4Glc)

(E) Sialyl Lewis x is frequently overexpressed on both *N*- and *O*-linked glycans of cancer cells. What effect might this have on the disease process?

Question 13. (4 points) Below is structure of a trisaccharide conformation from the crystal structure of glycan bound to a selectin-like mutant of mannose binding protein A (PDB: 2KMB). For the lower two rings, label each face as either A or B, and explain the nature of the sugar-sugar packing interaction between these rings.



Question 14. (5 points) Briefly summarize the similarities and differences in the attachment and processing of *N*-linked and *O*-linked glycans.

Question 15. (6 points; A & B, 3 points each) Briefly explain the utility of each of the following protocols in the analysis of glycan structure.

(A) Permethylation, followed by hydrolysis, and subsequent acetylation.

(B) Cleavage with hydrazine or a protein *N*-glycosidase, followed by labelling with 2-aminobenzamide.

Question 16. (5 points) Discuss the thermodynamics of the formation and cleavage of glycosidic bonds. Why are GDP-sugars and UDP-sugars used biosynthetically during creation of glycosyl linkages?