

### Exam #3: Carbs & Fats Edition – Let's Get Cooking!

1. \_\_\_\_\_ 15 pts
  2. \_\_\_\_\_ 10 pts
  3. \_\_\_\_\_ 15 pts
  4. \_\_\_\_\_ 10 pts
  5. \_\_\_\_\_ 20 pts
  6. \_\_\_\_\_ 30 pts
- 100 pts

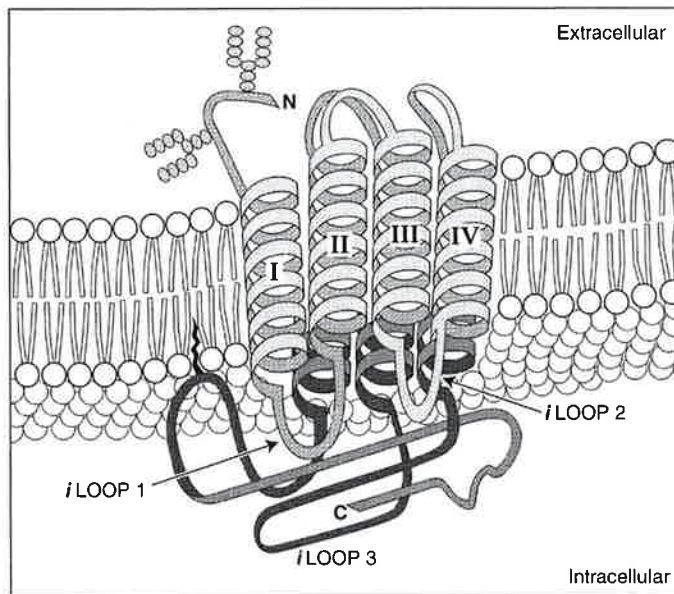
"I love science, and it pains me to think that so many are terrified of the subject or feel that choosing science means you cannot also choose compassion, or the arts, or be awed by nature. Science is not meant to cure us of mystery, but to reinvent and reinvigorate it."

Robert Sapolsky  
*Why Zebras Dont Get Ulcers* p. xii

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Note: In several places a category of lipid called phosphatidylcholine is mentioned. Choline is  $\text{HO}(\text{CH}_2)_2\text{N}^+(\text{CH}_3)_3$

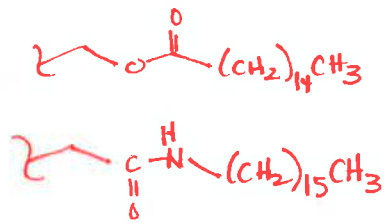
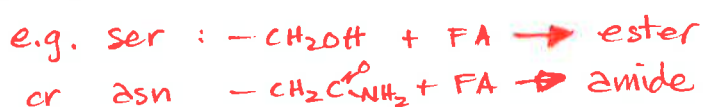
1. (15 points). Consider the following cartoon diagram.



5 pts (a) What do the gray ovals on the extracellular side represent? *carbohydrates*

5 pts (b) What does the black lightning flash in the membrane represent? *lipid - fatty acid*

5 pts (c) Give an amino acid residue and a corresponding functional group that would be suitable for connecting the black lightning to the protein.



2. (10 points). The table below gives the composition of several important cooking fats.

fat	saturated FA	monounsaturated FA	polyunsaturated FA
olive oil	14%	74%	11%
soybean oil	16%	23%	58%
butter	51%	21%	3%

Assume that you cook with these fats, that you digest the fats, and they enter your normal metabolic pathways.

5 pts (a) Which fat is likely to have the greatest negative impact on your health? Why?  
*butter: rich in sat. fats, this makes membranes less fluid*

5 pts (b) Which fat will have the greatest antioxidant capacity? Why?  
*soybean oil: high in PUFA's, which have diallylic sites between alkenes that absorb ROS by reacting with them.*



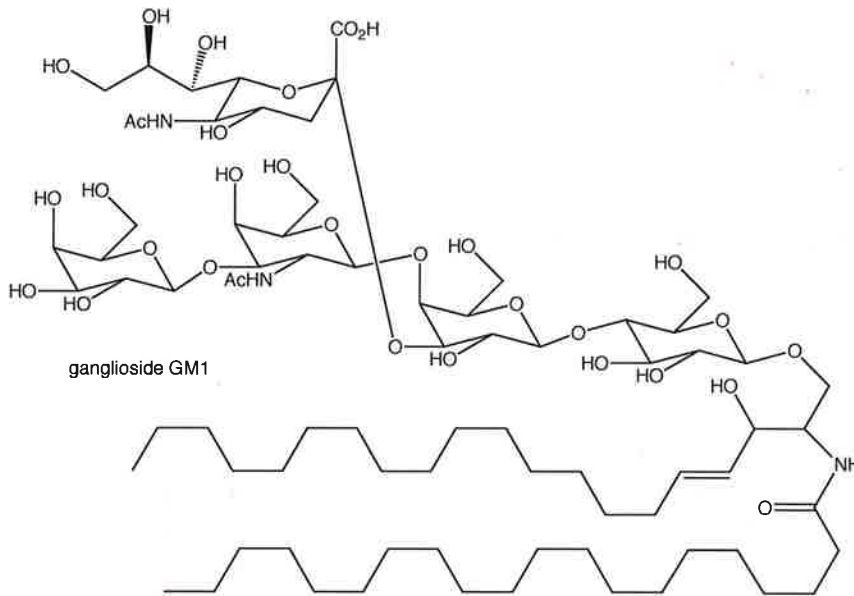
3. (15 points). Give 2 cellular functions for lipids and 3 cellular functions for carbohydrates. For each function, give the name of a molecule or substance which is involved with that function as an example. Make sure your answers are distinct things and not different examples of nearly the same thing.

3pts each

lipid 1: } possible themes: formation of membranes  
energy storage  
lipid 2: } pigments  
hormones/steroids

carb 1: } possible themes: energy (raw, & storage)  
carb 2: } structure (e.g. peptidoglycan, cellulose=wood)  
cell-cell signalling  
carb 3: } blood types etc  
nutrition  
nutritional fiber/indigestible

4. (10 points). Gangliosides have been implicated in numerous diseases. A typical ganglioside is shown below.



5pts

(a) Categorize this lipid at a high level, such as "phosphatidylcholine" or "triacylglycerol." Be as specific as possible.

glycoceramide

5pts

(b) Gangliosides readily form lipid rafts. Concisely explain how the structure makes this possible.

The sugar portion would be just outside the lipid bilayer. Since the sugars are rich in -OH groups, one can expect that the sugar groups can hydrogen bond to each other. That should cause multiple gangliosides to associate into a raft.

5. (20 points). Gram-positive bacteria have teichoic acid on their outer membrane/cell wall assembly, shown at right. Identify each of the following structural features or give a short answer as appropriate. If a requested feature is not present, write NP.

(a) Circle the portion of the molecule that would be located within the membrane.

(b) Circle an example of a phosphodiester.

(c) Give the letter of a deoxy sugar.

B & G

(d) Give the type of linkage between B and A.

$\beta$  1-3

(e) Are any of the sugars in this molecule reducing sugars? If so, give the letter(s).

NP - no hemi-acetals

(f) Is ring D from the D- or L- stereochemical series?

D

(g) Give the letter of a sugar with an  $\alpha$  anomeric carbon.

A/G/F

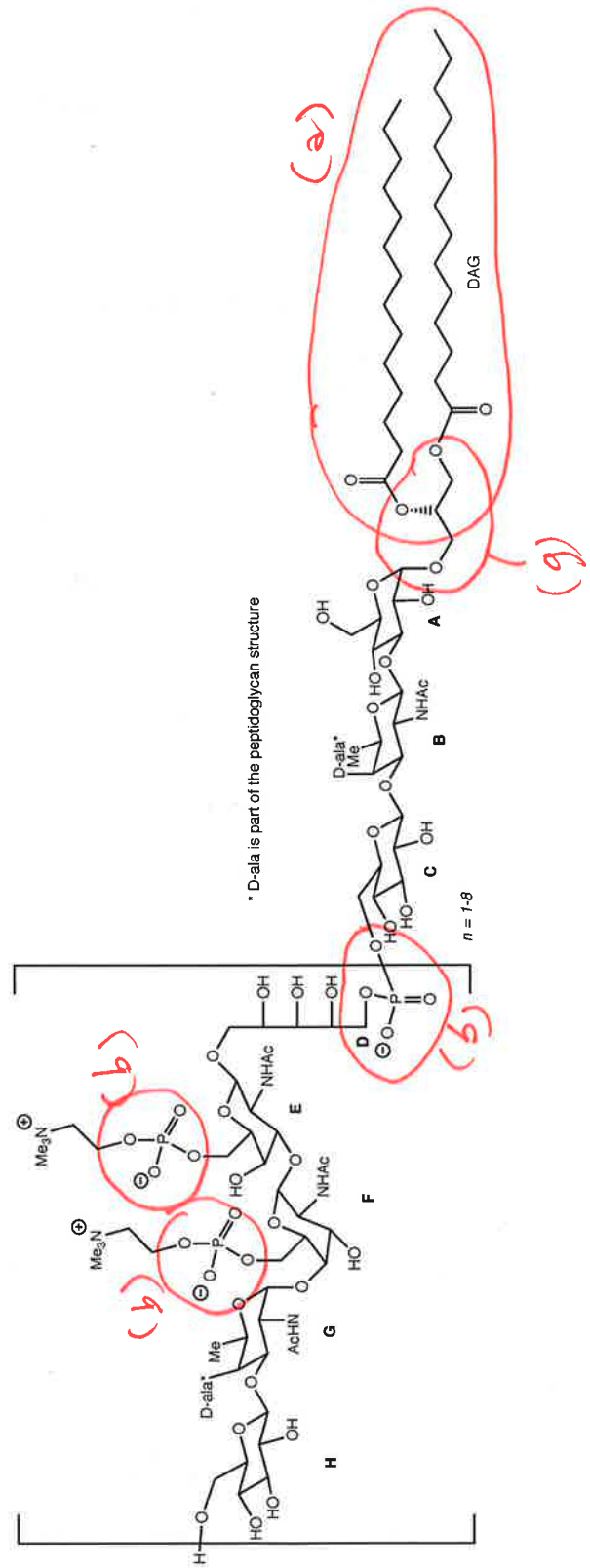
(h) Ignoring any differences in the nature of the attached groups, what stereochemical term describes the relationship between E and H?

epimers or diastereomers  
at C4

(i) At several places teichoic acid has a connection to the peptidoglycan layer. What is the significance of this?

crosslinking leads to increased strength

(j) Circle an example of glycerol embedded in the structure.

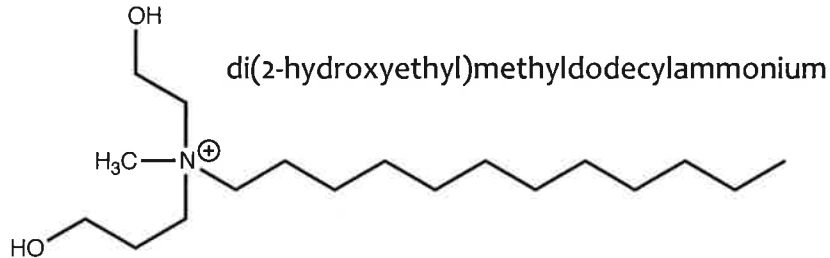


2 pts each

6. (30 points). Chose and answer 3 of the following questions. Keep your answers concise and to the point. Rambling or "brain-dumps" will be marked down. Space to answer the questions is given below.

10 pts  
each

- (a) Flip-flop of lipids from one side of a membrane to the other is a slow process, but it does occur. Would the rate of flip-flopping be greater for phosphatidylcholine or cholesterol? Explain.
- (b) The following compound was found to leach out of typical lab plasticware.<sup>1</sup> Based upon its structure, is this compound likely to pose a problem when working with cells? Explain.



- (c) Triacylglycerols and phospholipids both contain esterified fatty acids, but only one can form micelles. Which one is it, and why is the other one not able to form micelles? Explain.
- (d) Oil & vinegar salad dressing is generally composed of soybean or corn oil (both triacylglycerols), and vinegar, an aqueous solution of acetic acid (along with some spices). Commercial salad dressings often contain lecithin, which is the common name for phosphatidylcholine. Why would this compound be added to oil and vinegar dressing? Explain.
- (e) Draw the structure of a phosphatidylcholine composed of 16:0 and 18:2( $\Delta^{9,12}$ ) fatty acids.

Answers:

option \_\_\_\_\_

(a) PC has a (+) & (-) charge in its headgroup and charges will not like to transit the non-polar membrane interior. Cholesterol has no charges. Cholesterol should flip more often.

option \_\_\_\_\_

(b) It should be a big problem, as it is a classic detergent that would disrupt membranes.

option \_\_\_\_\_

(c) Only phospholipids can form micelles because they have the classic non-polar tail + polar head structure. Triglycerols have no such structure.

(d) PC has detergent/emulsifier properties & would be expected to keep H<sub>2</sub>O + oil in a bit more harmonic state.

<sup>1</sup>Science vol. 322 pg 917 (7 Nov 2008)

(e)

