

## Lecture 4: Introduction to Lipids

### Question 1:

Which of the following statements are TRUE, and which are FALSE? Please explain why.

- a) The amphipathic nature of phospholipids allows them to form bilayers spontaneously in aqueous environments, driven exclusively by hydrogen bonding between head groups.
- b) Fatty acids with cis double bonds introduce bends in the hydrocarbon chain, which increase membrane fluidity.
- c) A high partition coefficient (P or logP) indicates that the compound is more hydrophilic and dissolves better in water.
- d) Eicosatetraenoic acid (written as 20:4  $\Delta^{5,8,11,14}$ ) has 20 carbons and 4 double bonds at positions 5-6, 8-9, 11-12, and 14-15.
- e) Sphingolipids are built on a glycerol backbone, similar to glycerophospholipids.
- f) In phosphatidylinositol, the inositol head group is connected to the phosphate by a glycosidic bond.
- g) Glycerophospholipids give a net negative charge to most biological membranes.

## Question 2:

a) Draw a structure of a triacylglycerol lipid formed from glycerol and three fatty acids:

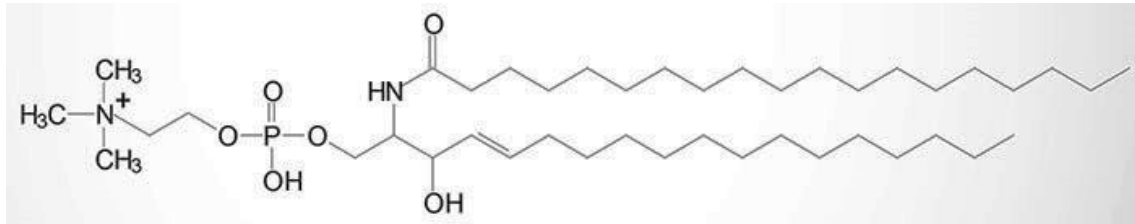
- Fatty Acid 1: (18 : 1  $\Delta^9$ )
- Fatty Acid 2: (18 : 0)
- Fatty Acid 3: (18 : 2  $\Delta^{9,12}$ )

Indicate the position of the double bonds and glycerol moieties.

b) Draw a structure of glycerophospholipid formed from Fatty Acid 1 and Fatty Acid 2, and note the position of the phosphate group. The head group can be indicated with an "X" (no need to specify which one it is).

### Question 3:

Examine the membrane lipid pictured below and answer the following questions.



- Is this lipid classified as a phospholipid or a glycolipid? How can you tell?
- Is this lipid considered a sphingolipid or a glycerophospholipid? How can you tell?
- What fatty acid chains are used in this lipid? Are they saturated or unsaturated? What kind of bond links the fatty acids to the headgroup?

#### Question 4:

The melting points of a series of 18-carbon fatty acids are:

- Stearic acid (18 : 0) = 69.6 °C
- Oleic acid (18 : 1  $\Delta^9$ ) = 13.4 °C
- Linoleic acid (18 : 2  $\Delta^{9,12}$ ) = -5 °C
- Linolenic acid (18 : 3  $\Delta^{9,12,15}$ ) = - 11C.

a) What structural aspect of these 18-carbon fatty acids can be correlated with the melting point?

b) List all possible triacylglycerols that can be constructed from glycerol, palmitic acid (16 : 0), and oleic acid (18 : 1  $\Delta^9$ ). Rank them in order of increasing melting point

### **Question 5:**

Lipid bilayers forming between two water phases have the following important property: they produce bi-dimensional sheets where their edges seal to form liposomes.

- a. What lipid-specific properties account for this behaviour?
- b. What is the consequence of this property on biological membranes?

### Question 6:

Assume the following octanol–water partition coefficients (logP) for the three biomolecules of different hydrophobicity:

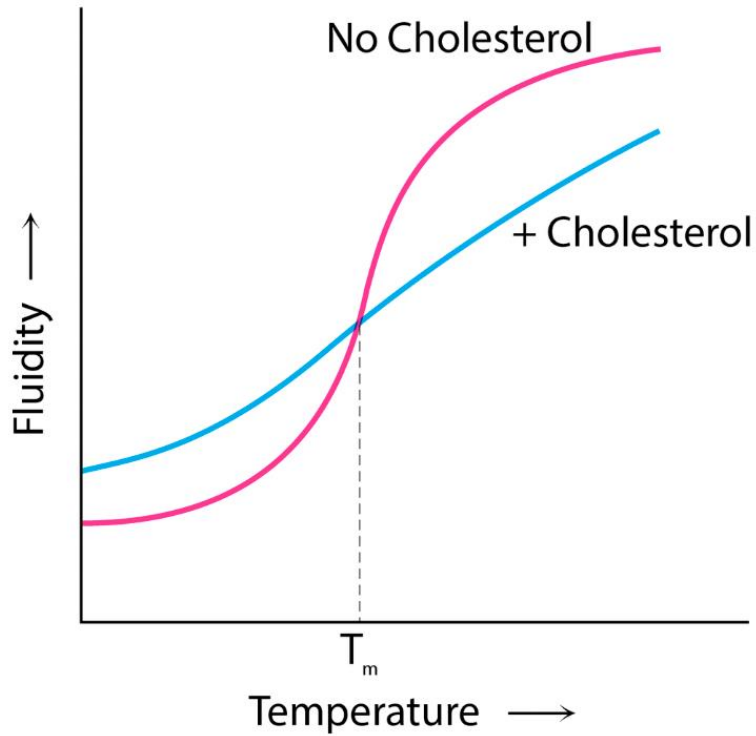
- Cholesterol: logP = 8.86
- Dodecanoic acid (lauric acid, 12:0): logP = 4.00
- Glucose: logP = -3.24

You start with **10 mmol** of each biomolecule, and dissolve it into a solution that consists of **0.5L of water** and **0.5L of octanol** (=1L total), mix and let equilibrate. Using the logP values from above, can you calculate what will the final concentrations of each molecule be in water and octanol phases once the equilibrium has been reached. HINT: Don't forget to correct for the volume change.



### Question 8:

The red curve below shows the fluidity of fatty acids in the phospholipid bilayer as a function of temperature, with  $T_m$  indicating the melting point of the membrane. The blue curve shows the same dependence in the presence of cholesterol.



- What is the effect of cholesterol based on this graph? How does it influence the membrane fluidity?
- Why might this effect be biologically important?