**Problem Set 2** (**Due: January 30th**)

1. Explain why an ether is less likely to be hydrolyzed than an ester. The best answer would include an image and discussion of the transition state for each.

2. Consider the reaction: $CH_3C(O)OCH_2CH_3$ (l) + $H_2O$ (l) ⇌ $CH_3COOH$ (l) + $CH_3CH_2OH$ (g)
   a. Draw a skeletal structure of the products and reactants.
   b. Based on what you observe, predict the sign of $\Delta S$ and explain your reasoning.
   c. Using this link, calculate the change in entropy for this reaction. Note that these compounds are named ethyl acetate, water, acetic acid, and ethanol, respectively.
   d. Is this reaction spontaneous at all temperatures?
      i. If not, is it spontaneous at high temperatures or low temperatures?
      ii. Calculate the temperature where the reaction becomes spontaneous. Report your answer in °C.
   e. Show a reaction pathway that minimizes the activation energy. Make sure to include all steps and show the flow of electrons.

3. Using the three step reaction mechanism for a hydrolysis reaction we discussed in class, clearly show why a C-C bond in a ketone is not likely to be hydrolyzed. Use acetone ($CH_3C(O)CH_3$) as your reactant.

4. Draw phosphatidylcholine made with 22:4n-6 and 16:0.

5. How many water molecules are needed to completely hydrolyze the phospholipid in problem 4?

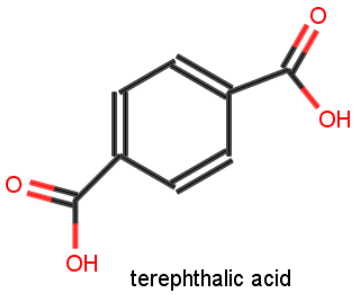
6. Consider the compound below. Identify all bonds that are susceptible to hydrolysis using the chemical pathway we emphasized in class.


7. For each pair, determine which would be more likely to increase membrane fluidity.
   a. 18:0 vs. 16:0
   b. 18:1n-9 vs. 18:0
   c. 18:1n-9 vs. 18:1n-3
   d. 1 mM cholesterol vs. 10 mM cholesterol
   e. 25 °C vs. 100 °C

8. From the list of fatty acids below, determine which is most likely to be an essential fatty acid.

   16:0 18:1n-6 20:3n-6 16:1n-7

9. In addition to being at the heart of biological macromolecules (DNA, RNA, proteins, lipids), condensation reactions are also a central part of many industrial processes. For example, plastic bottles used for soft drinks or bottled water are composed of polyethylene terephthalate (PET), a recyclable polyester. This polymer is made by repeated condensation reactions between ethylene glycol and terephthalic acid.
    a. Show the product of condensation of the two molecules below.



terephthalic acid

ethylene glycol

    b. Clearly explain how the molecule you drew above can continue to reaction with more ethylene glycol and terepthalic acid.
    c. For PET to be a good polymer for soft drink bottles, it needs to be resistant to water and acid. Examine the structure you drew above and explain why it is resistant to each of these.

10. The formation of a lipid bilayer seems like it should be characterized by $\Delta S < 0$; indeed, phospholipids are organized into a bilayer that is very ordered. However, entropy is the major contributor to this spontaneous process. Explain this seemingly counterintuitive observation.

11. What is the partition coefficient and why is it important?

12. Aspirin has a log P of 1.19.
    a. If 10 mM aspirin is added to a mixture of water and octane, calculate the concentration of aspirin that would be dissolved in water once an equilibrium is established.

    b. If 500 μM aspirin is removed from the aqueous phase by reaction with an enzyme, determine the concentration of aspirin in both phases when equilibrium has been reestablished.