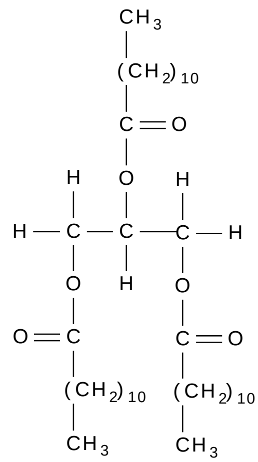
Chemistry 2000 Spring 2006 problem solutions: Biochemistry

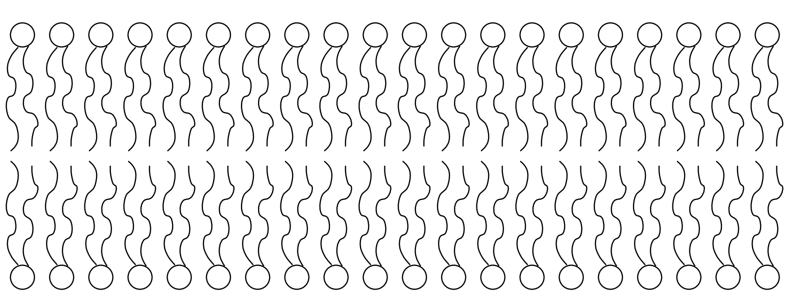
1. $C_4H_8O_4 + C_5H_{10}O_5 \rightarrow C_9H_{16}O_8 + H_2O$
2. A lipid is a biochemical compound which is soluble in nonpolar solvents.
3.



   Note that the fatty acid chains were drawn in this alternating arrangement only for convenience in drawing the structure. In this kind of crude structural diagram, the orientation doesn't matter.

4. A biological membrane is largely made up of a phospholipid bilayer. Since a picture is worth a thousand words, here's mine:

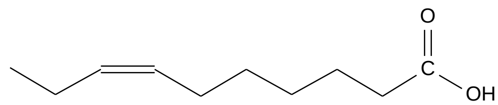
   outside



   inside

   The circles represent the polar head groups of the phospholipids while the squiggly lines represent the nonpolar tails. In addition to the phospholipids, membranes also contain proteins which play specific functional roles.

5.



I'm using the organic chemistry convention that there's a carbon at every corner with an appropriate number of hydrogen atoms attached. I didn't specify any particular fatty acid, so the number of carbon atoms in the nonpolar tail is variable. There are a few key things you should try to get right in your diagram:

- There has to be a carboxylic acid group (COOH) at one end.
- An omega-3 fatty acid has a double bond between the third and fourth carbons atoms from the methyl end.
- I didn't specifically ask for this, but it's a nice touch to draw the double bond in the natural cis conformation.

6. **Primary:** sequence of amino acids

   Secondary: local organization into (e.g.) α helices or β sheets

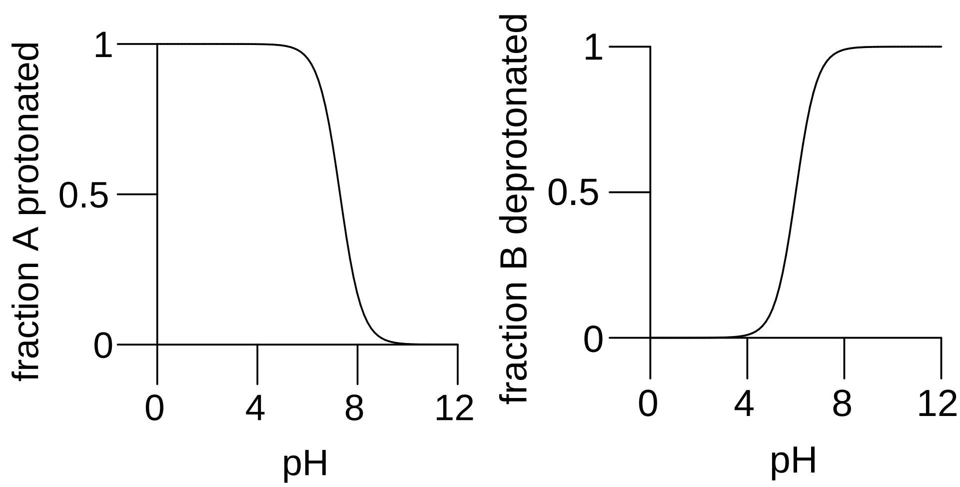
   Tertiary: large-scale folding of a single peptide

   Quaternary: association of several peptides into a single functional protein complex

7. It's a redox half-reaction:

$$\text{-S-H} + \text{H-S-} \rightarrow \text{-S-S-} + 2\text{H}^+ + 2\text{e}^-$$

8. Many of the amino acids have side-chains which have acidic or basic properties. In order for an enzyme to function, we generally need some of the amino acids to be protonated and some deprotonated. To simplify our discussion, suppose that there are just two such amino acids, A and B, the first of which needs to be protonated and the other not. Further suppose that $pK_{a(A)} > pK_{a(B)}$. The distribution curves for the two amino acids have the following appearance:



(I drew these pictures using $pK_{a(A)} = 7.30$ and $pK_{a(B)} = 6.00$. Note that there is only a narrow range, from about pH 6.00 to pH 7.30, where both amino acids are in the correct state. This is the range where the enzyme will function. Note that we can in fact show the expected profile of the enzyme activity curve by multiplying the two distributions together: