Molecular Biology Through Discovery
Problem Set 1: Strategies of Life, Protein

Part I: Strategies of Life

1.1. Which of the following are hydrophobic? Hydrophilic? Amphipathic?

A. vinegar	D. sugar
B. skin	E. wax
C. tooth paste	F. rabid dogs

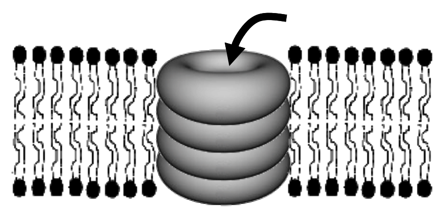
(The following problems require drawing. You might use Paint, PowerPoint or similar, or you can draw something and scan it somehow. Establish your own graphical conventions or – why not? – use those that appear in the Notes.).

1.2. Consider that at an air-water interface, amphipathic molecules expose their hydrophobic surface to air. Draw a picture of what a soap bubble might look like at the molecular level, using a long-sticked popsicle to represent a molecule of soap.

1.3. Some potent antiseptics are amphipathic molecules consisting of a long chain alkane on one end and a positively charged ammonium group on the other. Here's* an example. How do you suppose they fit into a membrane? Draw a picture, labeled with approximate dimensions (in nanometers†) of the membrane and the antiseptic. At the scale of your model, how big would a cell be?

1.4. Phospholipase A2 is an enzyme commonly found in snake venom that acts by cutting off one of the two fatty acids on phospholipids. Draw a picture that shows how extensive action of the enzyme might detrimentally affect the structure of a cell membrane.

Part II: Proteins



1.5. Some antibiotics form rings that stack and create a pore through the membrane. Consider a cyclic polypeptide antibiotic in which each ring is composed one instance of each of the four amino acids: serine, glycine, threonine, and alanine. If the atoms of the backbone are approximated by touching spheres of about 0.2 nanometers in diameter,† estimate the circumference of the pore (presume it to be a circle) and the diameter of the largest molecule that could fit through it. Approximate the circumference (π·diameter) to be 3·diameter. (Show work)

1.6. Before you cook an egg, the egg "white" is not at all white: it's clear. After you cook the egg, the "white" is white, because the large amount of globular protein has denatured (i.e., unfolded), and as a consequence, the protein has precipitated. Why should unfolding globular protein that are normally soluble in water cause them to stick to each other (which is what "precipitate" means)?

1.7. Lactate dehydrogenase (the last enzyme in human anaerobic glycolysis) is a soluble, multimeric protein. If you were to try to fold a single linear polypeptide chain of lactate dehydrogenase, you would find it impossible to do so without leaving a large number of hydrophobic amino acids exposed to water. Explain.

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* http:// www.drugstore.com/lysol-all-purpose-cleaner-lemon-breeze/qxp190350

† How big are nanometers? Try visiting Scale of the Universe.

1.8. When we considered the article by Dorothy Wrinch [Wrinch DM (1936). Protoplasma 25:550-569], we blipped over a section beginning on p.555 that concerned itself with protein structure. Let's go back to that.

8a. Does the description of protein structure that begins Section 6 accord with your current understanding of proteins? How?

8b. At the bottom of p.555 Wrinch begins a discussion of "di-amino acids". What are the amino acids she's referring to?

8c. She makes a claim in this same discussion that the chromosome should be rich in basic amino acids. As it happens, she was right. Why?

Extra – in case you have the time and inclination

1.9. Make a set of 20 different graphical symbols representing the 20 amino acids. You may use colors, shapes, fill style, etc, but no letters or numbers. The symbols should be organized so that they are ***easy to write*** and ***easy to remember*** and that if two amino acids share some important characteristics then their symbols also are similar in some respect (but not identical).