Chapter 12 Problems
Lipids and Cell Membranes

1. Population density. How many phospholipid molecules are there in a 1 - im 2 region of a phospholipid bilayer membrane? Assume that a phospholipid molecule occupies 70 A2 of the surface area.

4. Protein diffusion. The diffusion coefficient, \( D \), of a rigid spherical molecule is given by

\[
D = \frac{kT}{6\pi \eta r}
\]

in which \( \eta \) is the viscosity of the solvent, \( r \) is the radius of the sphere, \( k \) is the Boltzmann constant (1.38 \times 10^{-16} \text{ erg degree}^{-1}), \) and \( T \) is the absolute temperature. What is the diffusion coefficient at 37°C of a 100-kd protein in a membrane that has an effective viscosity of 1 poise (1 poise = 1 \text{ erg s}^{-1} \text{ cm}^{-3})? What is the average distance traversed by this protein in 1 \text{ ms}, 1 \text{ ms}, and 1 \text{ s}? Assume that this protein is an unhydrated, rigid sphere of density 1.35 \text{ g cm}^{-3}.

5. Cold sensitivity. Some antibiotics act as carriers that bind an ion on one side of a membrane, diffuse through the membrane, and release the ion on the other side. The conductance of a lipid-bilayer membrane containing a carrier antibiotic decreased abruptly when the temperature was lowered from 40°C to 36°C. In contrast, there was little change in conductance of the same bilayer membrane when it contained a channel-forming antibiotic. Why?

6. Melting point 1. Explain why oleic acid (18 carbons, one cis bond) has a lower melting point than stearic acid, which has the same number of carbon atoms but is saturated. How would you expect the melting point of trans-oleic acid to compare with that of cis-oleic acid? Why might most unsaturated fatty acids in phospholipids be in the cis rather than the trans conformation?

7. Melting point 2. Explain why the melting point of palmitic acid (C\(_16\)) is 6.5 degrees lower than that of stearic acid (C\(_18\)).

10. Flip-flop 2. Although proteins rarely if ever flip-flop across a membrane, the distribution of membrane lipids between the membrane leaflets is not absolute except for glycolipids. Why are glycosylated lipids less likely to flip-flop?

13. A false positive. Hydropathy plot analysis of your protein of interest reveals a single, prominent hydrophobic peak. However, you later discover that this protein is soluble and not membrane associated. Explain how the hydropathy plot may have been misleading.

Data Interpretation Problems

16. Cholesterol effects. The red curve on the following graph shows the fluidity of the fatty acids of a phospholipid bilayer as a function of temperature. The blue curve shows the fluidity in the presence of cholesterol.

(a) What is the effect of cholesterol?
(b) Why might this effect be biologically important?