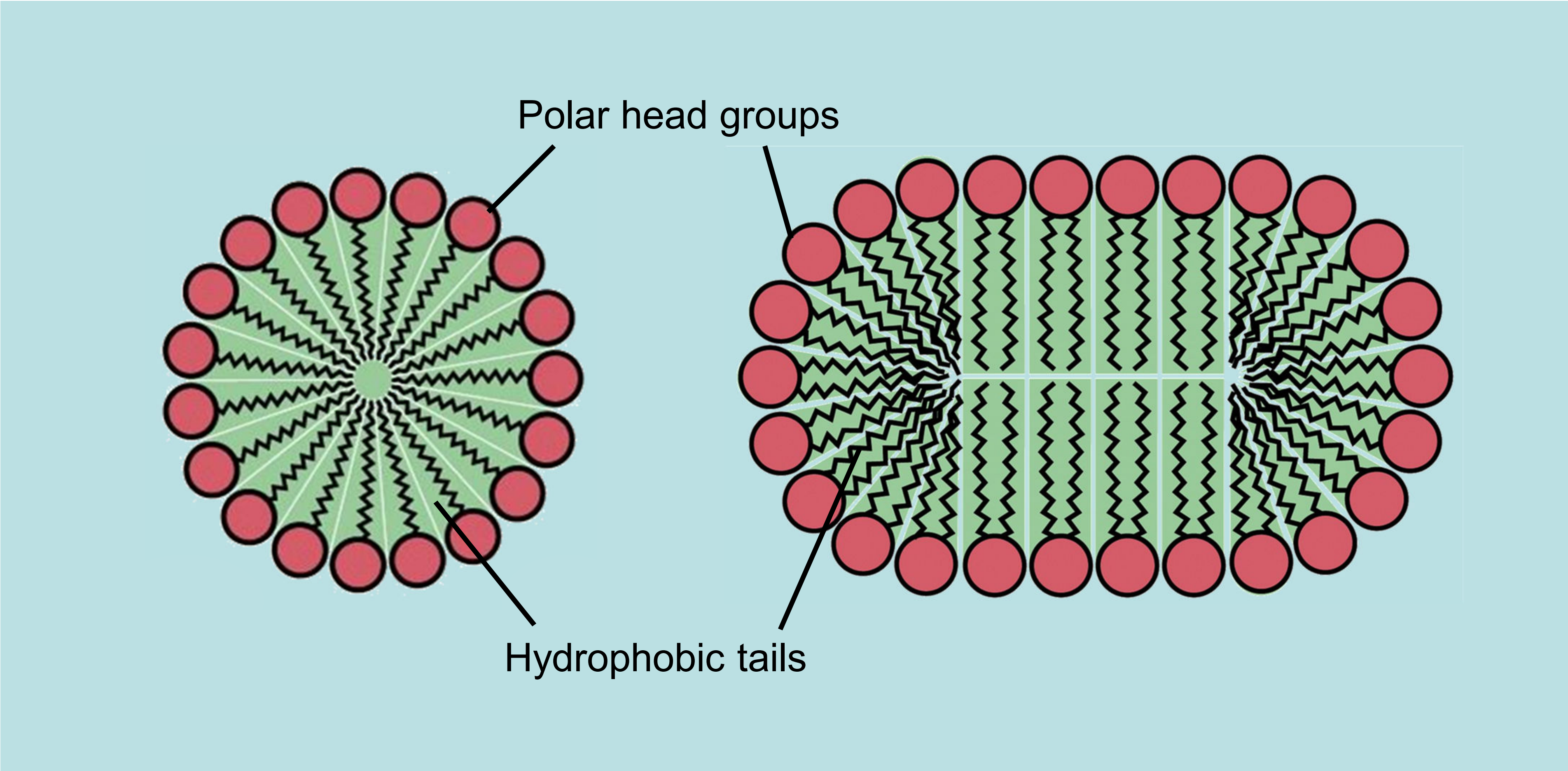
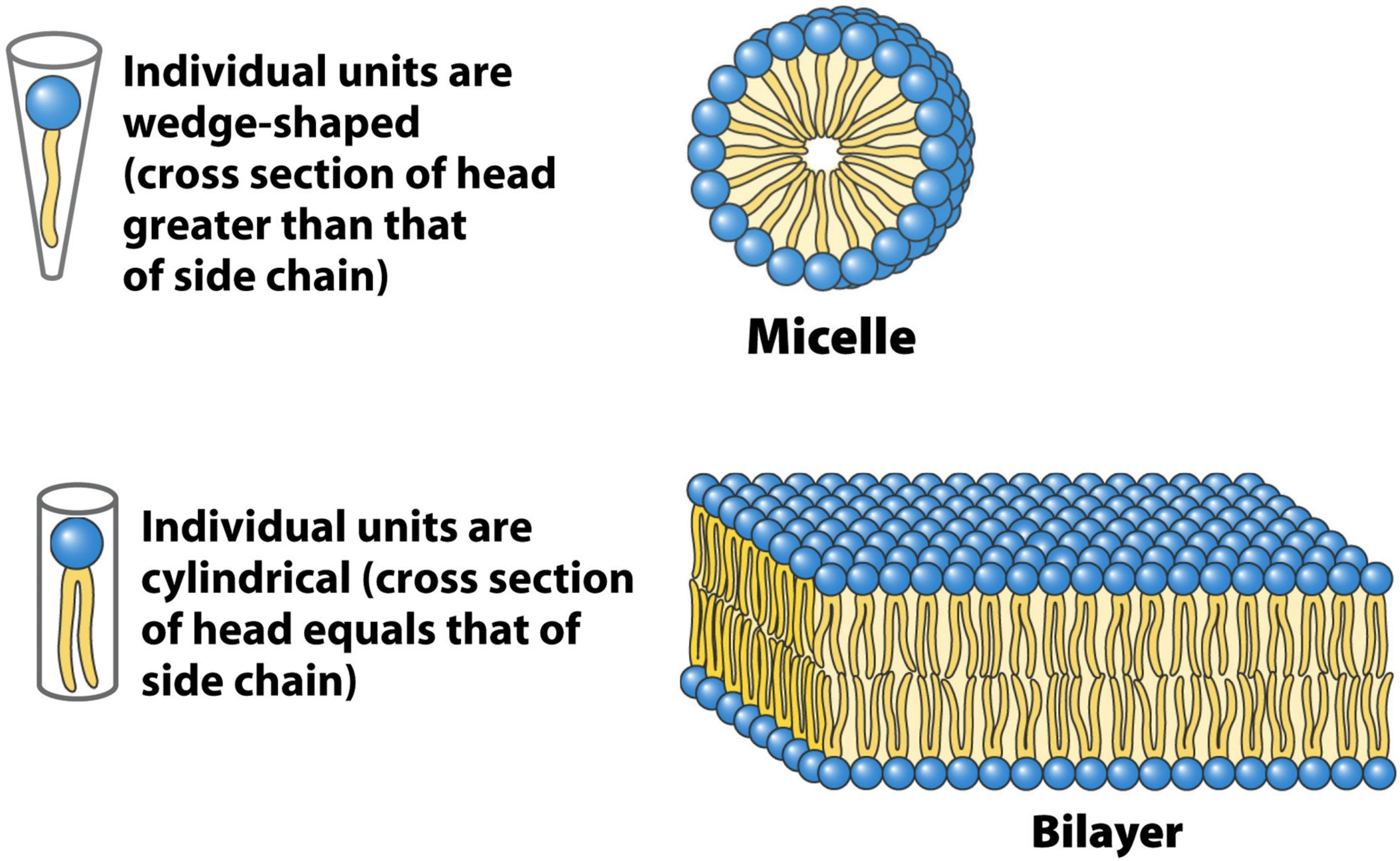
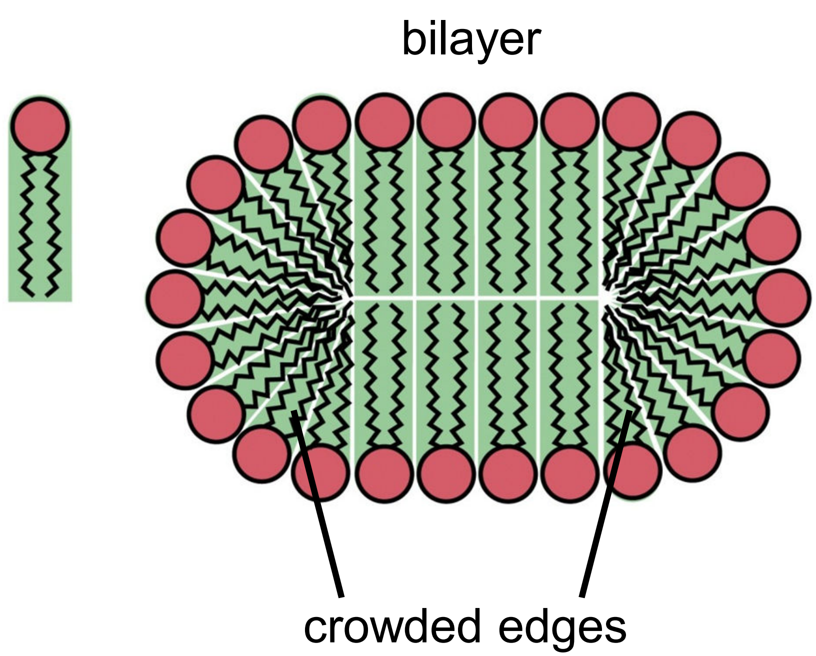
The hydrophobic effect drives the aggregation of amphiphilic lipids in water

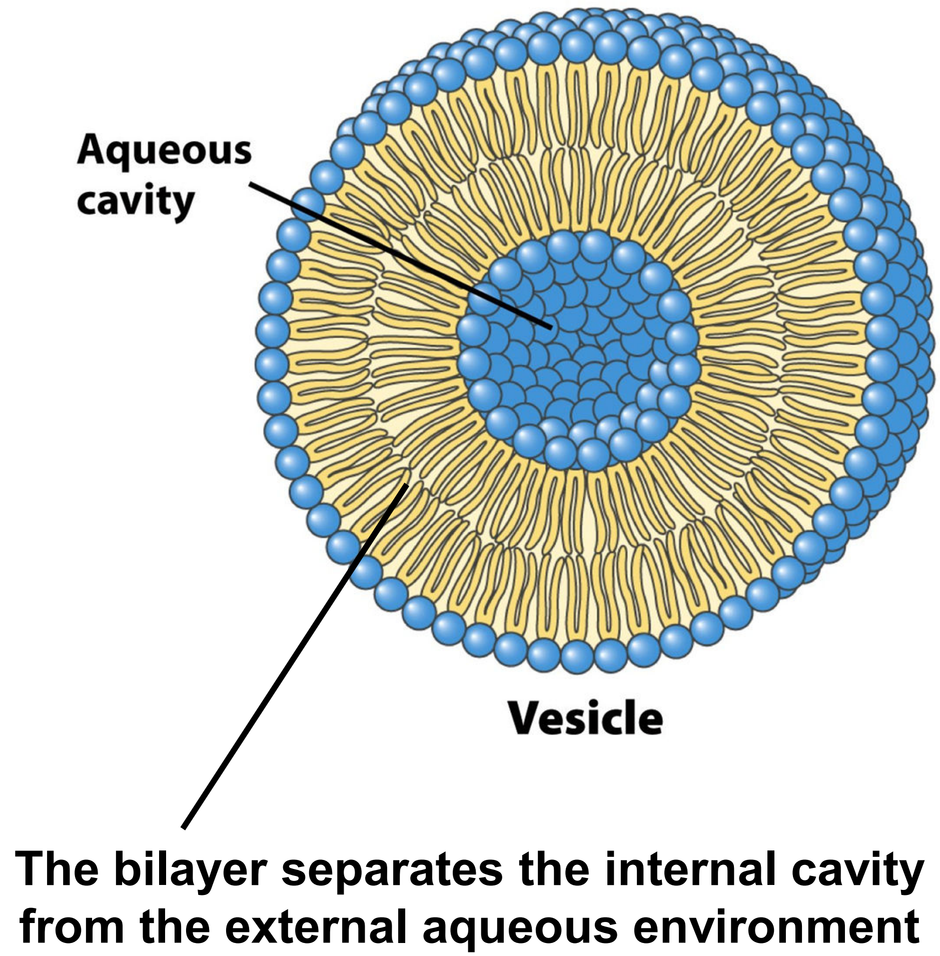


The shape of the lipid determines the structural features of the aggregate

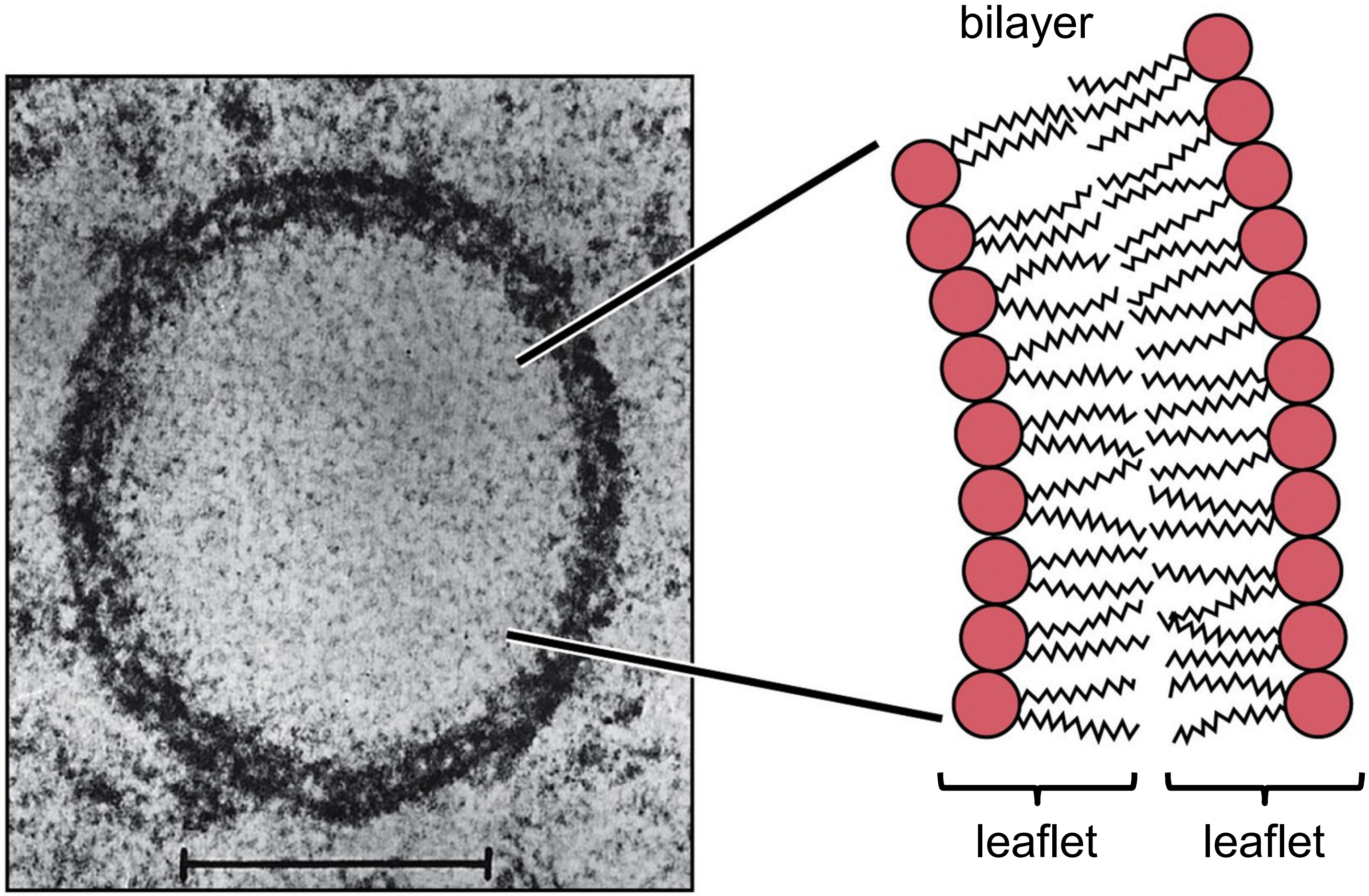


Packing at bilayer edges is crowded, so bilayers merge their edges to form vesicles





Liposomes (vesicles) are bilayer-enclosed aqueous environments



Courtesy of Walther Stoeckenius, University of California at San Francisco

Biological membranes are heterogeneous lipid bilayers with proteins

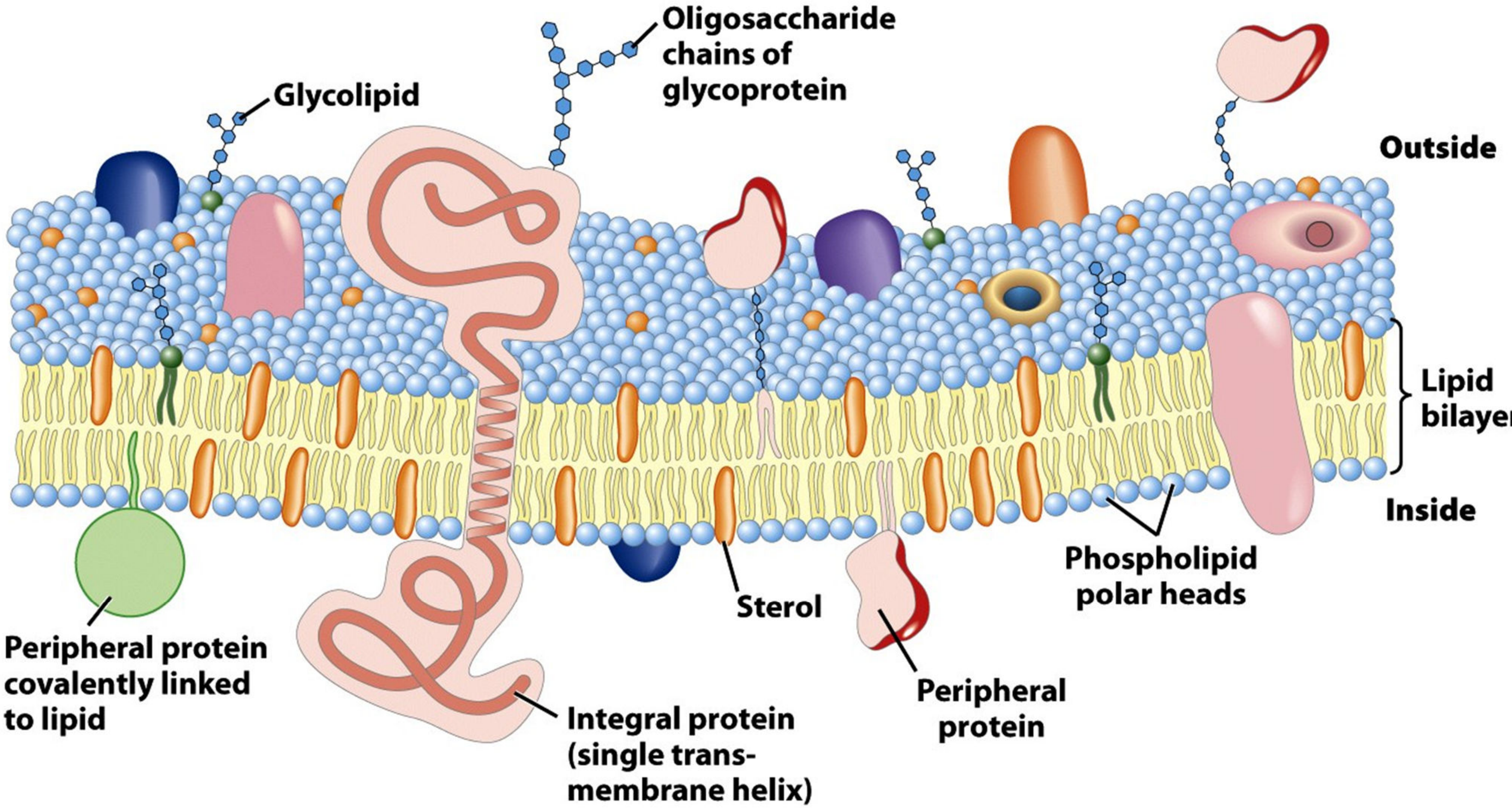


Figure 11-3
Lehninger Principles of Biochemistry, Fifth Edition

Protein and lipid content of biological membranes varies between species

TABLE 11–1 Major Components of Plasma Membranes in Various Organisms

	Components (% by weight)				
	Protein	Phospholipid	Sterol	Sterol type	Other lipids
Human myelin sheath	30	30	19	Cholesterol	Galactolipids, plasmalogens
Mouse liver	45	27	25	Cholesterol	—
Maize leaf	47	26	7	Sitosterol	Galactolipids
Yeast	52	7	4	Ergosterol	Triacylglycerols, steryl esters
Paramecium (ciliated protist)	56	40	4	Stigmasterol	—
E. coli	75	25	0	—	—

Note: Values do not add up to 100% in every case, because there are components other than protein, phospholipids, and sterol; plants, for example, have high levels of glycolipids.

Table 11-1
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Membrane lipid composition varies within a cell

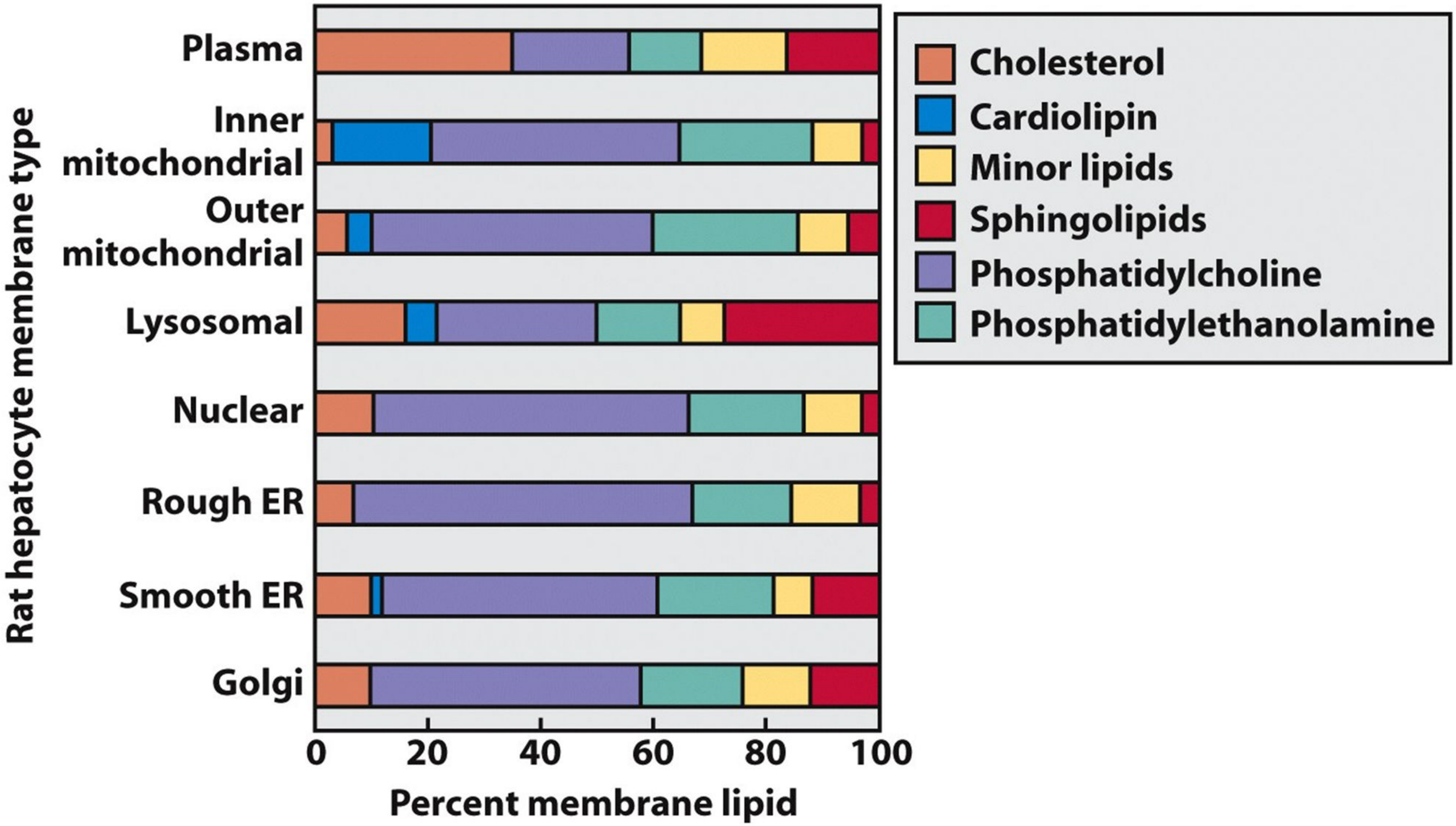

Figure 11-2
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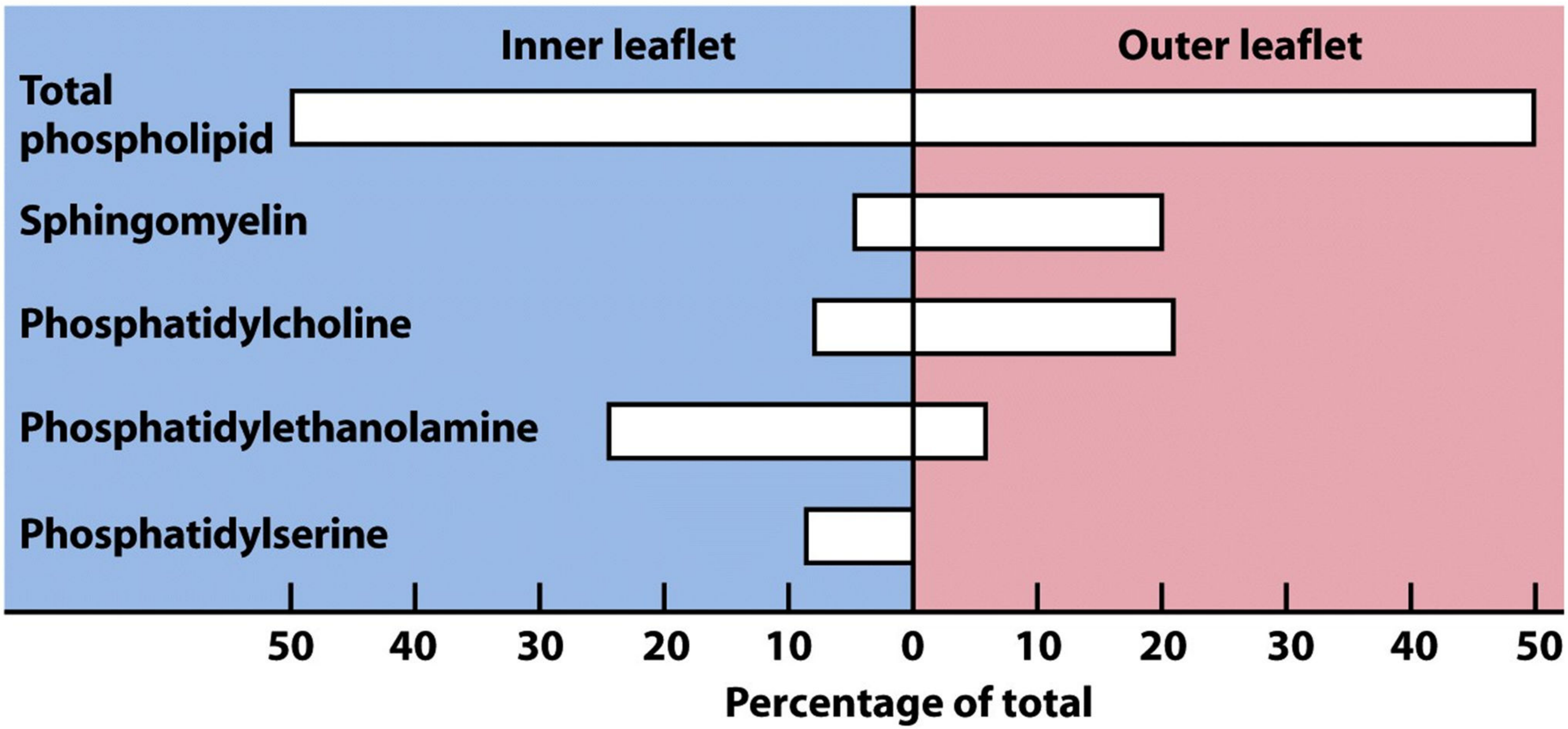
Membrane lipid composition varies between leaflets



Membrane composition even varies within each leaflet! (non-random distribution)

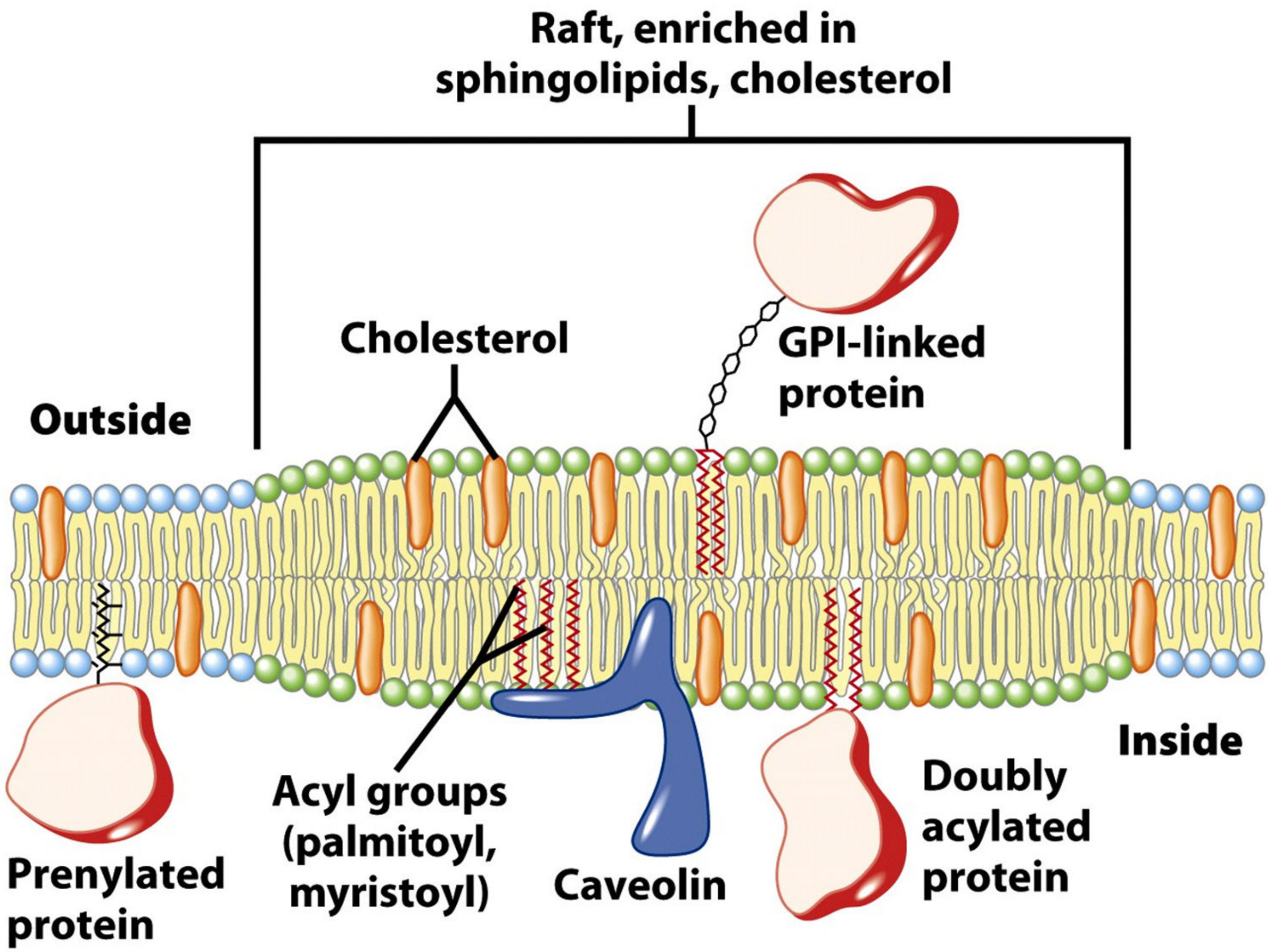


Figure 11-20a
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Membrane microdomain (raft)

Atomic force microscopy reveals the presence of membrane microdomains (rafts)

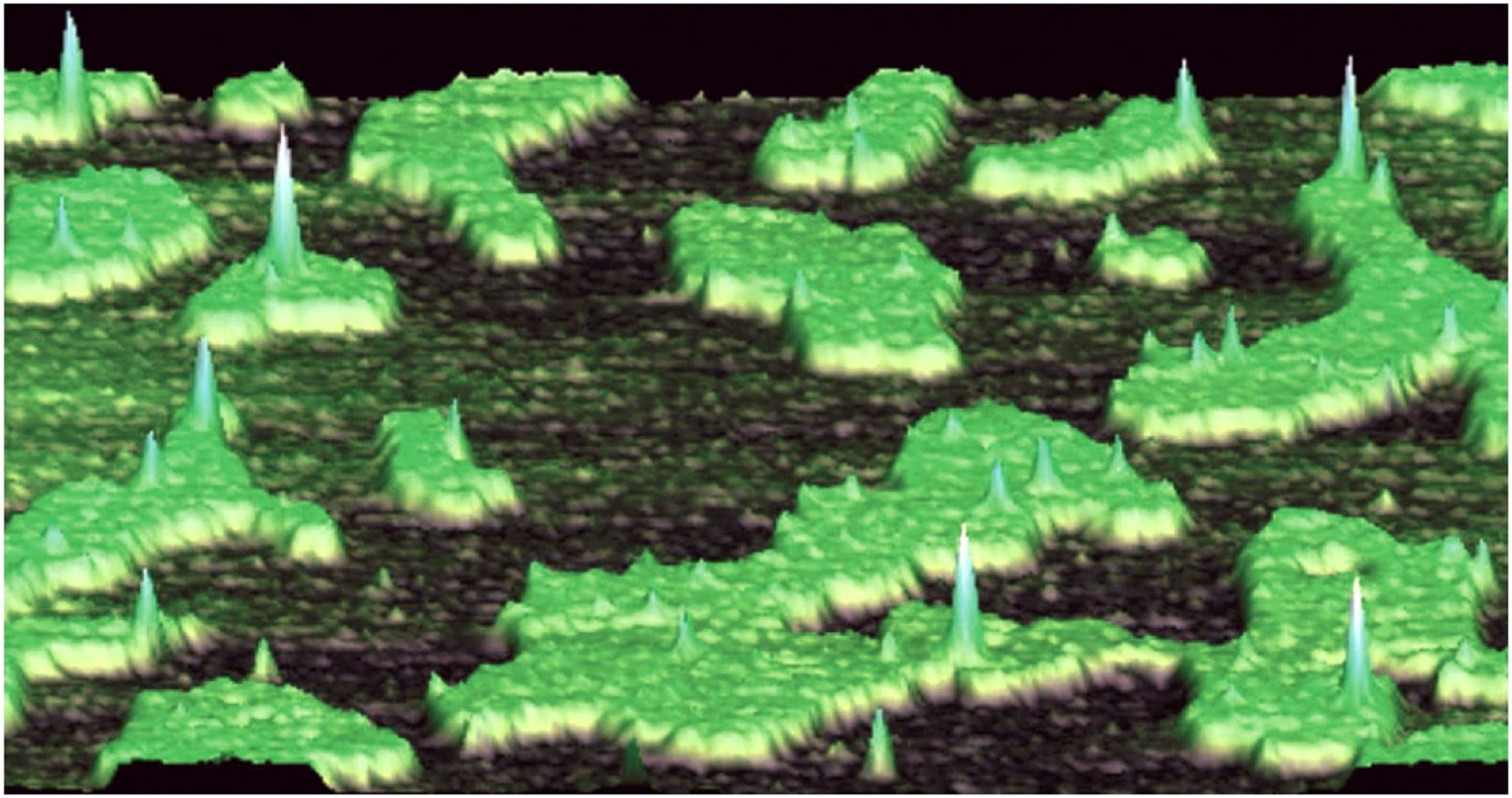

Figure 11-20b
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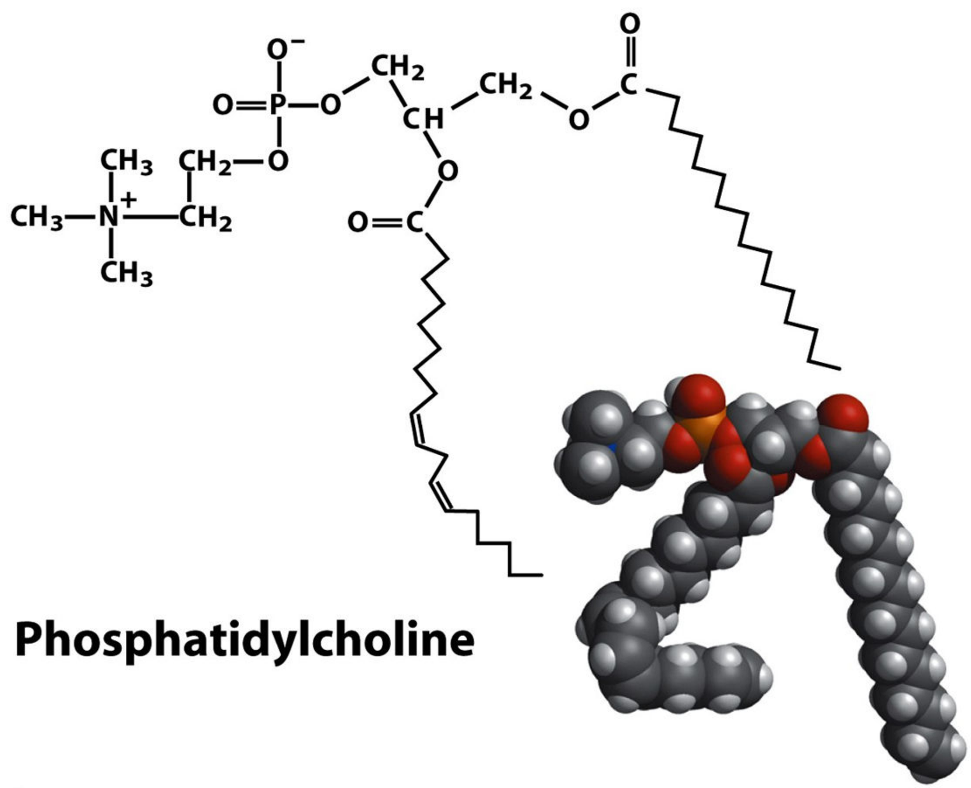
Different lipid composition leads to different properties of the membrane, like fluidity



Phosphatidylcholine

Figure 10-14 part 1
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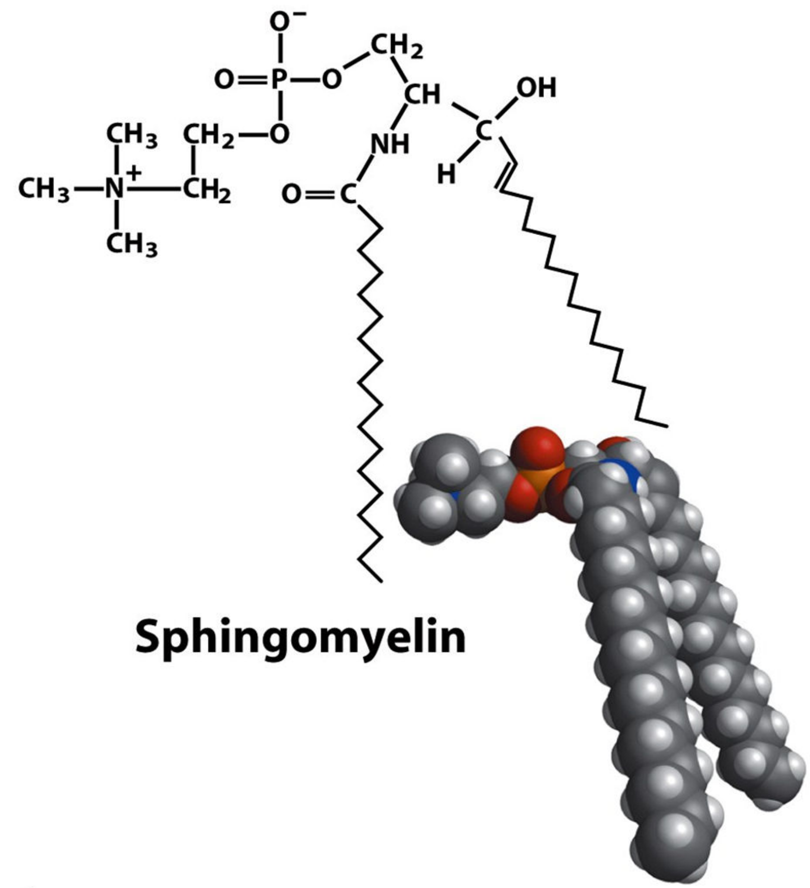

Sphingomyelin

Figure 10-14 part 2
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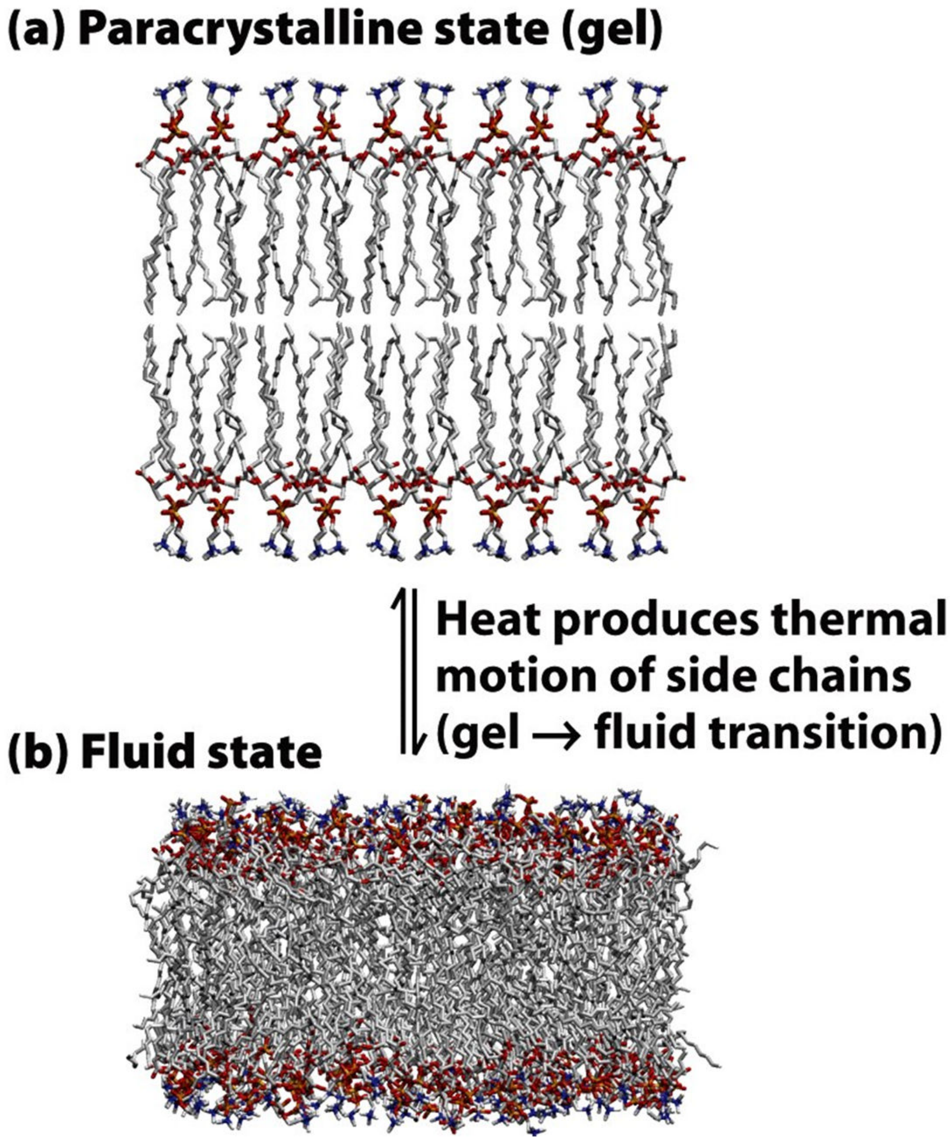
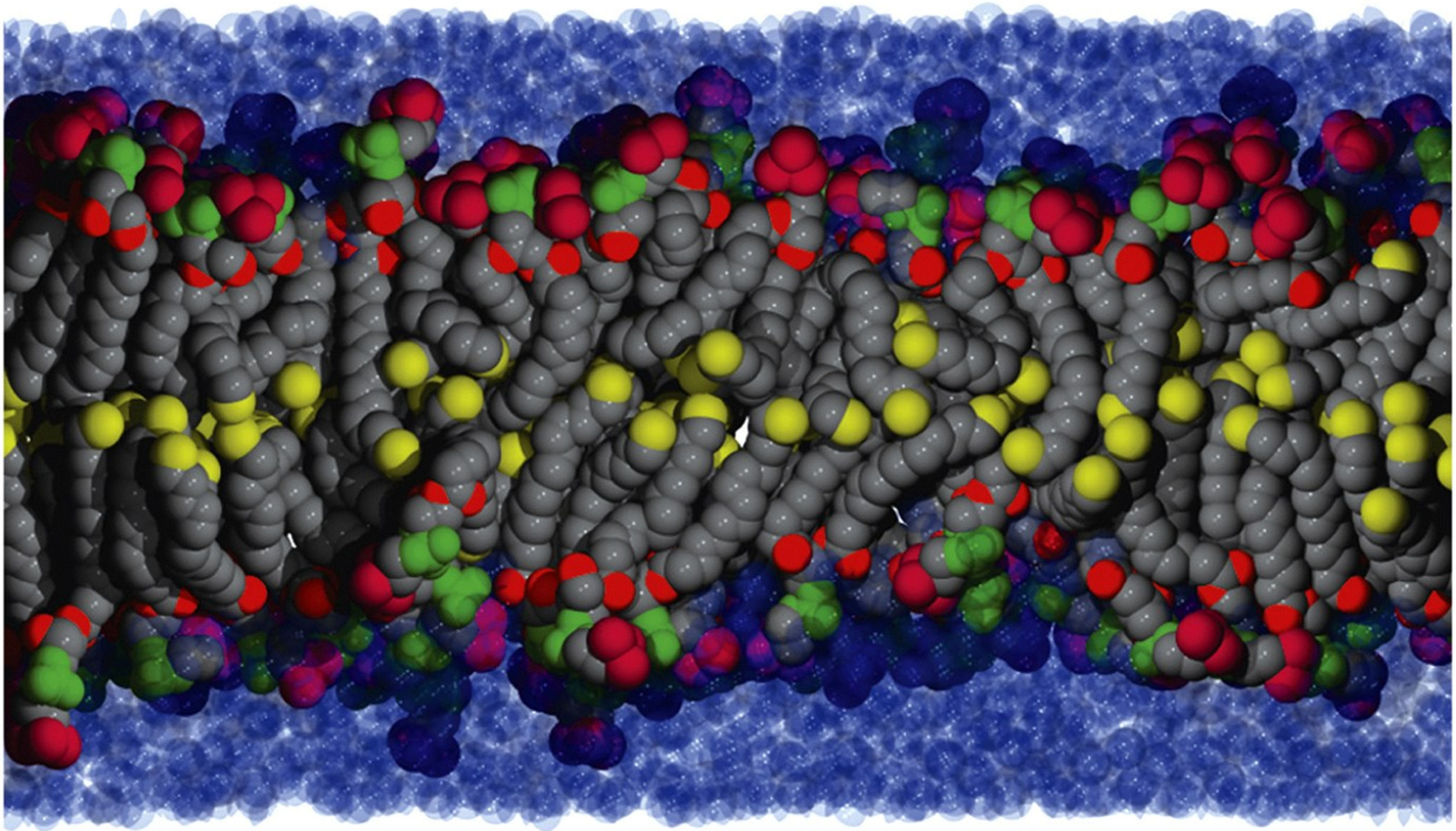
Temperature also affects bilayer fluidity



At physiological temperatures, membrane bilayers are (and must be) quite fluid



Courtesy of Richard Pastor and Richard Venable, NIH, Bethesda, Maryland

E. coli can change its lipid composition to achieve ideal fluidity of its membrane

TABLE 11–2 **Fatty Acid Composition of *E. coli* Cells Cultured at Different Temperatures**

	Percentage of total fatty acids*			
	10 °C	20 °C	30 °C	40 °C
Myristic acid (14:0)	4	4	4	8
Palmitic acid (16:0)	18	25	29	48
Palmitoleic acid (16:1)	26	24	23	9
Oleic acid (18:1)	38	34	30	12
Hydroxymyristic acid	13	10	10	8
Ratio of unsaturated to saturated†	2.9	2.0	1.6	0.38

Source: Data from Marr, A.G. & Ingraham, J.L. (1962) Effect of temperature on the composition of fatty acids in *Escherichia coli*. *J. Bacteriol.* **84**, 1260.

*The exact fatty acid composition depends not only on growth temperature but on growth stage and growth medium composition.

†Ratios calculated as the total percentage of 16:1 plus 18:1 divided by the total percentage of 14:0 plus 16:0. Hydroxymyristic acid was omitted from this calculation.

Lipids diffuse readily within one leaflet of the bilayer, but not between leaflets

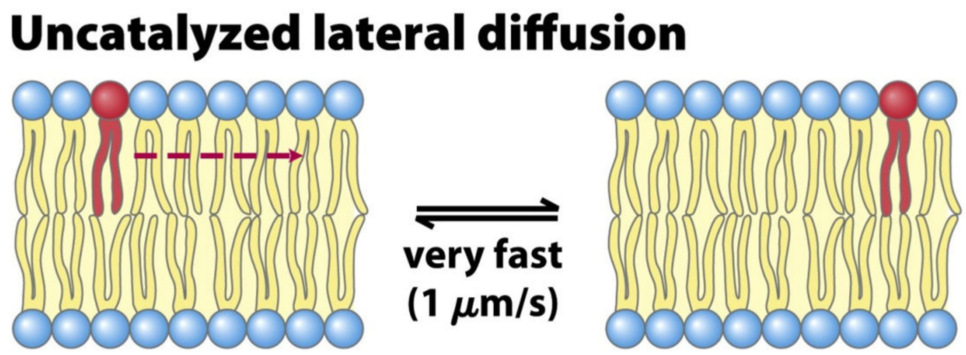


Figure 11-16b
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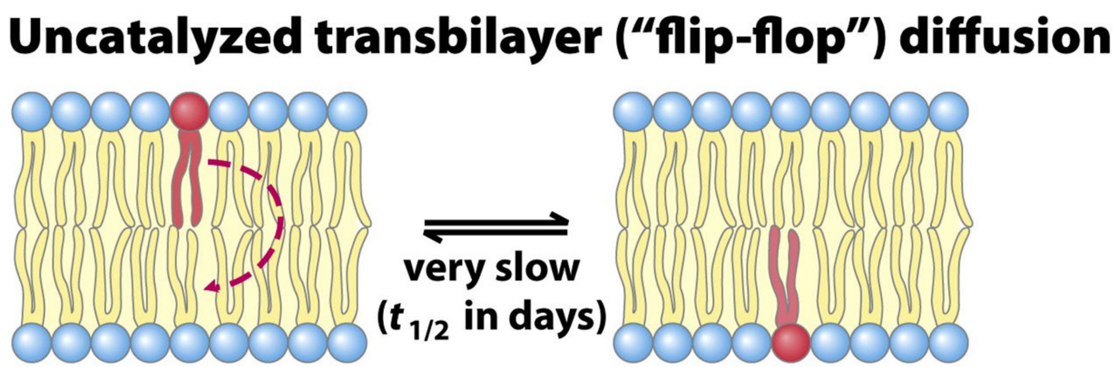

Figure 11-16a
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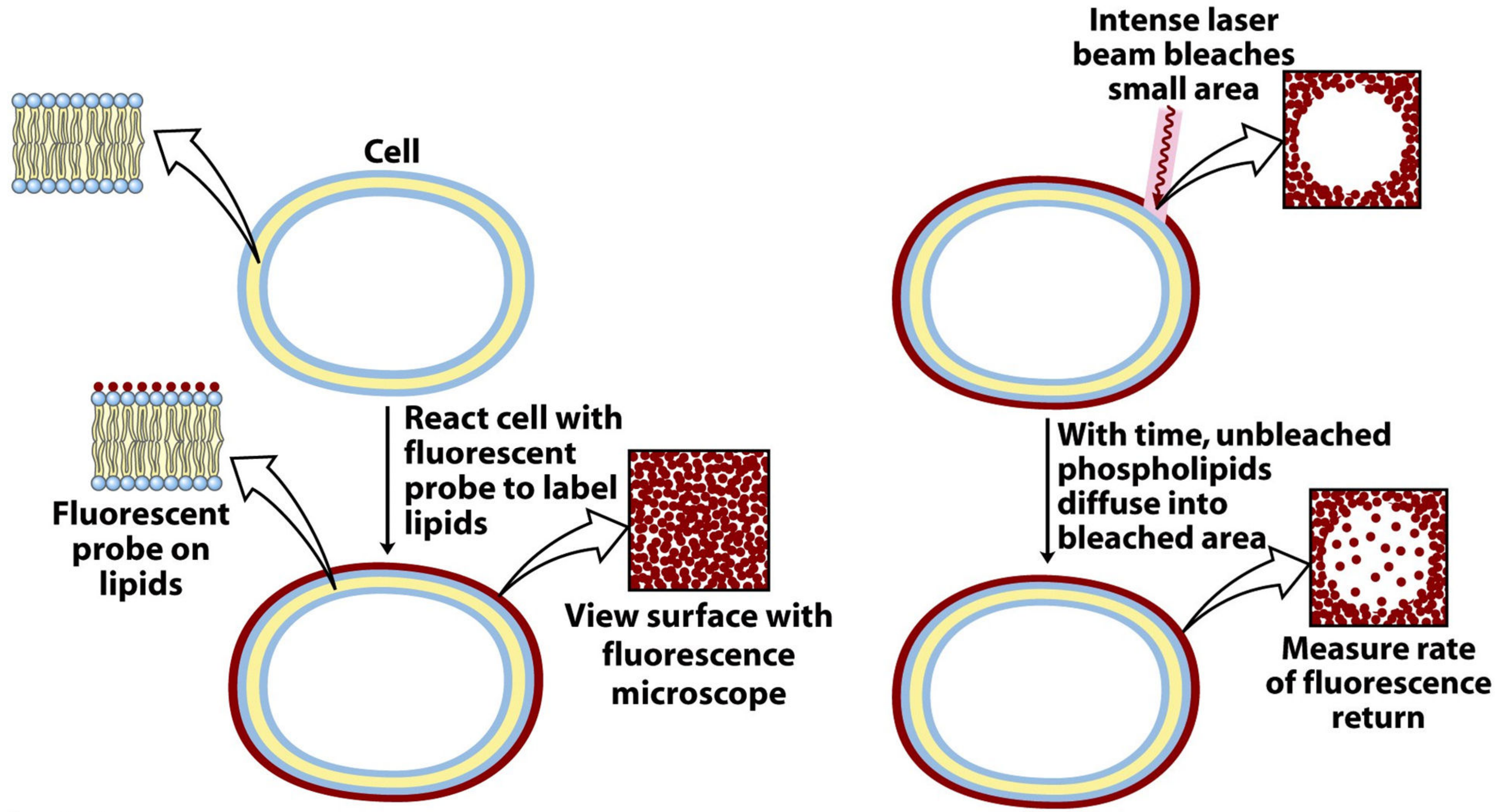
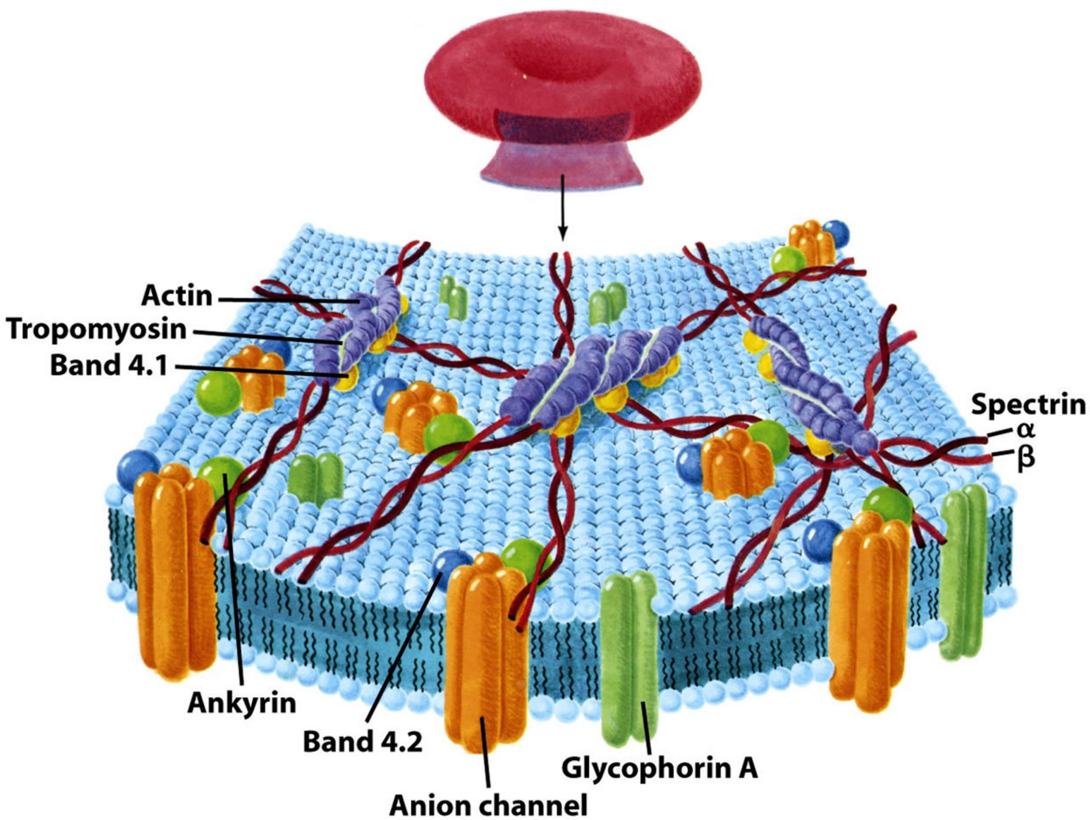
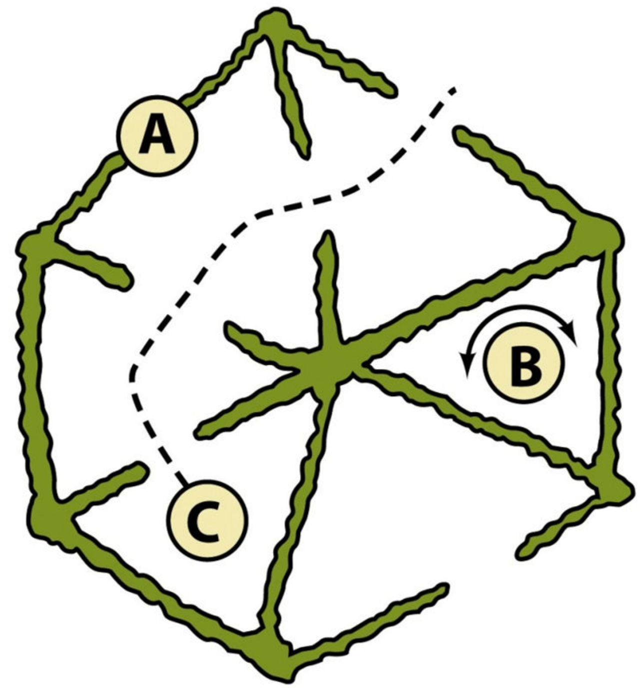
Biological membranes are ‘fluid mosaics’ – proteins and lipids diffuse laterally



Photobleaching allows measurement of diffusion rates in the membrane

The membrane ‘skeleton,’ which shapes the cell, limits movement of proteins and lipids





The ‘fencing-in’ and diffusion of lipids can be observed using fluorescent microscopy