Membrane Structure and Composition

11.1 THE COMPOSITION AND ARCHITECTURE OF MEMBRANES

Each Type Of Membrane Has Characteristic Lipids And Proteins
All Biological Membranes Share Some Fundamental Properties
A Lipid Bilayer Is The Basic Structural Element Of Membranes
Three types of Membrane Proteins Differ in their Association with the Membrane
Peripheral Membrane Proteins Are Easily Solubilized
Integral Proteins Are Held In The Membrane By Hydrophobic Interactions With Lipids
The Topology Of An Integral Membrane Protein Can Be Predicted From Its Sequence
Covalently Attached Lipids Anchor Some Proteins

(5th ed.)
11.1.1 Each Type Of Membrane Has Characteristic Lipids And Proteins p. 372
11.1.2 All Biological Membranes Share Some Fundamental Properties p. 373
11.1.3 A Lipid Bilayer Is The Basic Structural Element Of Membranes p. 374
11.1.4 Three Types of Membrane Proteins Differ in their Association with the Membrane p. 375
11.1.5 Many Membrane Proteins Span The Lipid Bilayer p. 375
11.1.6 Integral Proteins Are Held In The Membrane By Hydrophobic Interactions With Lipids p. 376
11.1.7 The Topology Of An Integral Membrane Protein Can Be Predicted From Its Sequence p. 378
11.1.8 Covalently Attached Lipids Anchor Some Proteins p. 379

11.2 MEMBRANE DYNAMICS

Acyl Groups In The Bilayer Are Ordered To Varying Degrees p. 381
Transbilayer Movement Of Lipids Requires Catalysis p. 381
Lipids And Proteins Diffuse Laterally In The Bilayer p. 383
Sphingolipids And Cholesterol Cluster Together in Membrane Rafts p. 384
Membrane Curvature and Fusion are Central To Many Biological Processes p. 387
Integral Proteins of the Plasma Membrane are Involved in Surface Adhesion, Signaling and other Cellular processes p. 388

Suggested Problems from Chapter 11 (both editions): #2, 3, 4, 5, 6, 13
11.1 THE COMPOSITION AND ARCHITECTURE OF MEMBRANES

You will not be required to re-learn the specific names of specific lipids. i.e. palmitic, stearic etc.

Plasma membranes are typically composed of 50% lipid; 50% protein (approx.)

The lipid composition of eubacterial and eukaryotic plasma membranes is very similar, while that of archaebacterial membranes is distinct. Nevertheless, membranes of all three groups have similar structural and functional properties.

The major membrane lipids of eubacteria and eukaryotes are amphoteric glycerophospholipids [fatty acids esterified to glycerol phosphate]. The fatty acids are generally unbranched, and have an even number of carbon atoms. The degree of unsaturation is variable and is an important aspect of thermal adaptation (see below).

You are not responsible for knowing each of the specific categories og membrane protein (Type I-VI) in Fig. 11-8.

PROTEIN: (membrane proteins can be as much as 20% of total cell protein)

solute transport proteins and "permeases"
electron transport proteins such as cytochromes
proton translocating ATPase
photosynthetic reaction centers
enzymes for cell wall biosynthesis
genome attachment and replication

11.2 MEMBRANE DYNAMICS

Lipid bilayer membranes exhibit a temperature-dependant phase transition. For proper membrane function the membrane must maintain the Liquid Crystal (more fluid) state.

<table>
<thead>
<tr>
<th>COLDER</th>
<th>WARMER</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Paracrystalline Gel&quot; (phospholipids form static hexagonally ordered array)</td>
<td>Phase Transition (Liquid-Ordered State)</td>
</tr>
<tr>
<td>Activity of membrane proteins is impaired by loss of lateral mobility and/or failure to properly insert in membrane.</td>
<td>&quot;Melting Temp.&quot; (Tm)</td>
</tr>
<tr>
<td></td>
<td>Liquid (Disordered) Crystal</td>
</tr>
<tr>
<td></td>
<td>(&quot;Fluid Mosaic&quot;)</td>
</tr>
<tr>
<td></td>
<td>Protein function normal.</td>
</tr>
</tbody>
</table>

The cis double bonds in unsaturated fatty acids makes them "kinky". This reduces the hydrophobic interactions of adjacent lipid molecules in a monolayer, preventing close packing and thereby and increasing membrane fluidity. trans double bonds have little effect on fluidity.
**Homeoviscous Adaptation** is a response that maintains constant membrane fluidity at different temperatures by altering the relative proportions of saturated vs. unsaturated fatty acids used to synthesize phospholipids.

**Homeoviscous Adaptation in E. coli**

Fatty acid composition of plasma membrane as % total fatty acids

See also Table 11-2

<table>
<thead>
<tr>
<th></th>
<th>10°C</th>
<th>43°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>C16 saturated (palmitic)</td>
<td>18 %</td>
<td>48 %</td>
</tr>
<tr>
<td>C16 cis-9-unsat. (palmitoleic)</td>
<td>26 %</td>
<td>10 %</td>
</tr>
<tr>
<td>C18 cis-11-unsat. (cis-vaccinic)</td>
<td>38 %</td>
<td>12 %</td>
</tr>
</tbody>
</table>

Flippase vs Floppase vs Scramblase