

Chem 452 - Lecture 8

Lipids and Cell Membranes

Part 3

Question of the Day: What role do proteins play in biological membranes?

Cell Membrane Proteins

† Form vs. Function

- The membrane lipids give **form** to the cell membranes
- The membrane proteins provide the **function**

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Cell Membrane Proteins

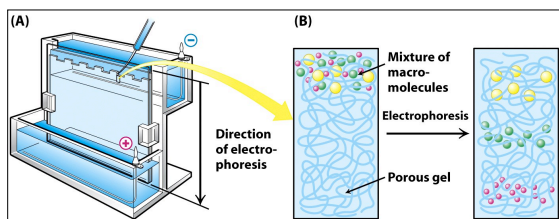
† Membrane proteins function as

- Pumps (Chapter 13)
- Channels (Chapter 13)
- Signal transducers (Chapter 14)
- Energy transducers (Chapter 18 & 19)

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Cell Membrane Proteins

- † Different membranes contain different proteins.
- They can be visualized using SDS-Polyacrylamide electrophoresis.

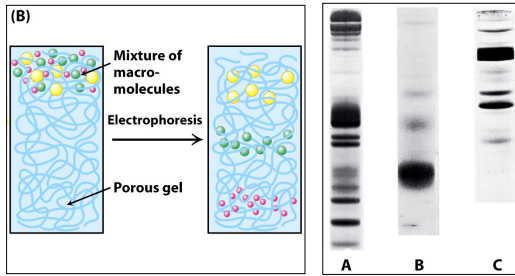


(Chapter 3, pp.71-75)

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Cell Membrane Proteins

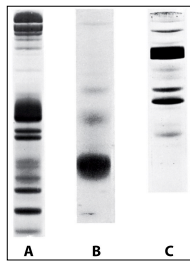
+ Different membranes contain different proteins



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Cell Membrane Proteins

+ Different membranes contain different proteins



RBC plasma membrane

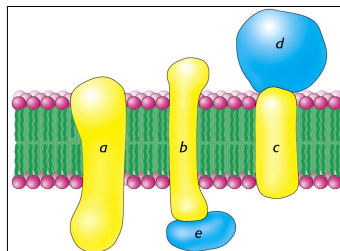
retinal rod cell
photoreceptor membrane

muscle cell sarcoplasmic
membrane

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Cell Membrane Proteins

+ Proteins can associate with membranes in different ways.



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Cell Membrane Proteins

+ Proteins can associate with membranes in different ways.

+ We will look at three different examples

- Bacteriorhodopsin (pump)
- Porin (channel)
- Prostaglandin H₂ synthase-1 (enzyme)

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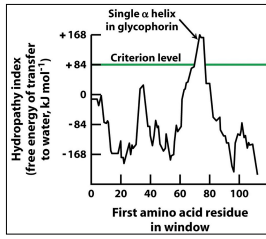
Cell Membrane Proteins

+ Hydropathy plots are used to look for membrane spanning α -helices

TABLE 12.2 Polarity scale for identifying transmembrane helices

Amino acid residue	Transfer free energy in kJ mol^{-1} (kcal mol^{-1})
Phe	15.5 (3.7)
Met	14.3 (3.4)
Ile	13.0 (3.1)
Leu	11.8 (2.8)
Val	10.9 (2.6)
Cys	8.4 (2.0)
Trp	8.0 (1.9)
Ala	6.7 (1.6)
Thr	5.0 (1.2)
Gly	4.2 (1.0)
Ser	2.5 (0.6)
Pro	-0.8 (-0.2)
Tyr	-2.9 (-0.7)
His	-12.6 (-3.0)
Gln	-17.2 (-4.1)
Asn	-20.2 (-4.8)
Glu	-24.4 (-5.8)
Lys	-37.0 (-8.8)
Asp	-38.6 (-9.2)
Arg	-51.7 (-12.3)

Source: After D. M. Engelman, T. A. Steitz, and A. Goldman. *Annu. Rev. Biophys. Chem.* 10 (1981): 321-352.
Note: The free energies are for the transfer of an amino acid residue in a helix from the membrane interior (assumed to have a dielectric constant of 2) to water.



Glycophorin

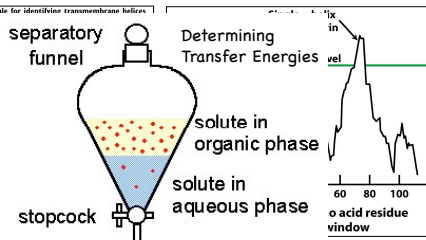
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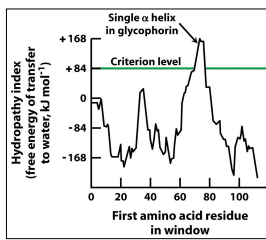
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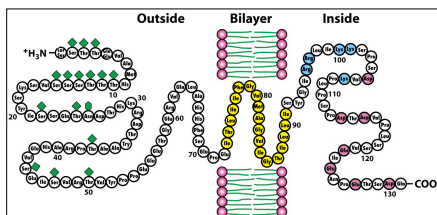
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Glycophorin

Cell Membrane Proteins

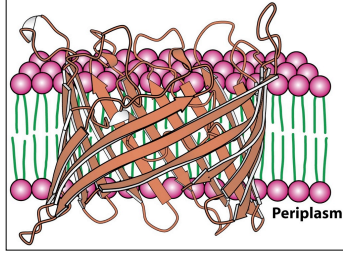
+ Hydropathy plots are used to look for membrane spanning α -helices



Glycophorin

Cell Membrane Proteins

- † Three examples of integral membrane proteins
 - Porin (Channel)



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Cell Membrane Proteins

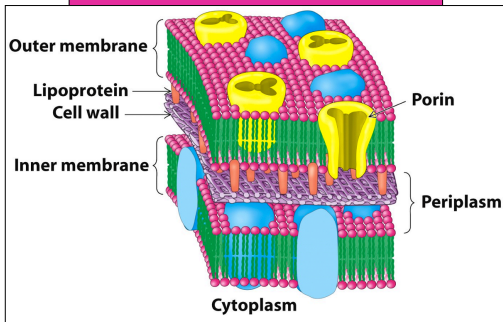
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 - Po



Membranes 13

Cell Membrane Proteins

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Membranes 13

Cell Membrane Proteins

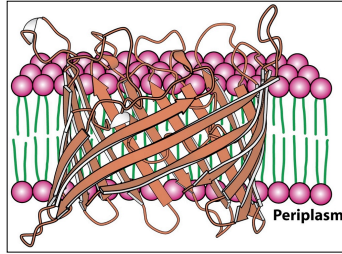
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Membranes 13

Cell Membrane Proteins

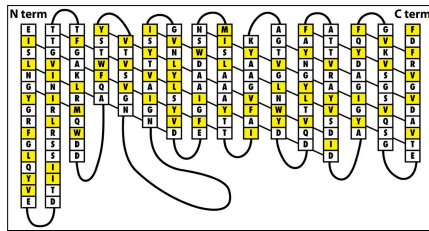
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Cell Membrane Proteins

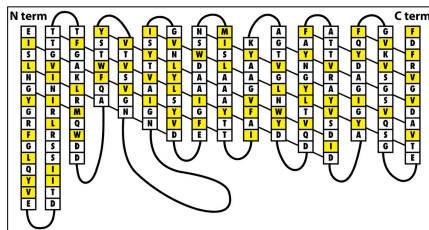
- Three examples of integral membrane proteins
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 - Sequence alternates between polar and non-polar amino acid residues



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Cell Membrane Proteins

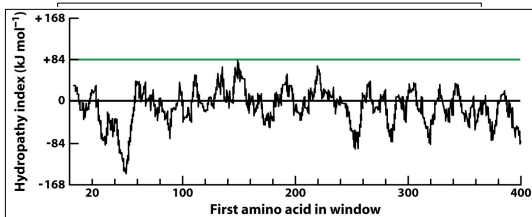
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Cell Membrane Proteins

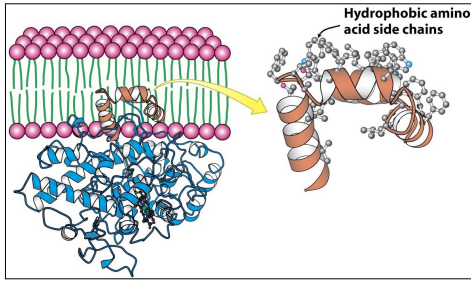
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Cell Membrane Proteins

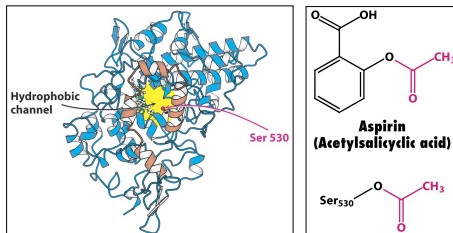
- Three examples of integral membrane proteins
 - Prostaglandin H₂ synthase-1 catalase (Enzyme)



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Cell Membrane Proteins

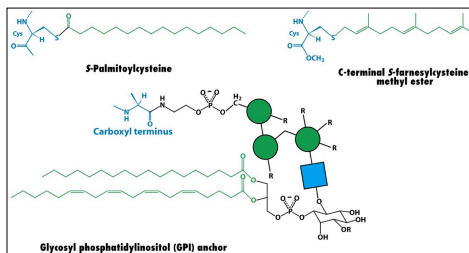
- Three examples of integral membrane proteins
 - Prostaglandin H₂ synthase-1 (Enzyme)
 - Inhibited by COX inhibitors (NSAID)



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Cell Membrane Proteins

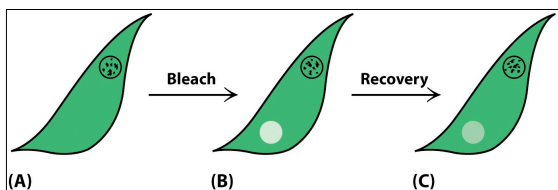
- Peripheral proteins are often have hydrophobic lipids attached to them.



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Cell Membrane Proteins

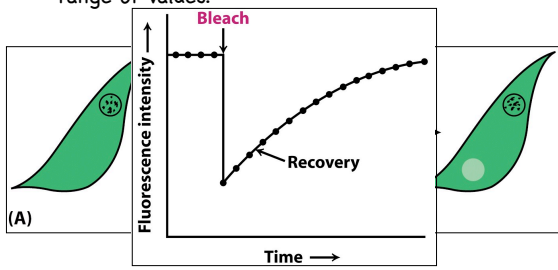
- Lateral Diffusion in membranes can have a wide range of values.



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Cell Membrane Proteins

+ Lateral Diffusion in membranes can have a wide range of values.

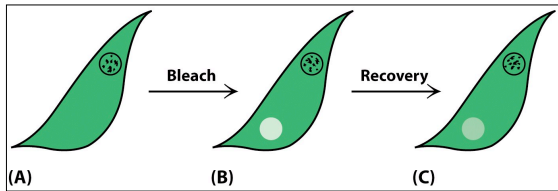


$$S = (4Dt)^{1/2}$$

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Cell Membrane Proteins

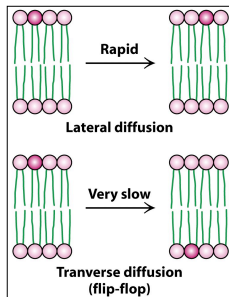
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Cell Membrane Proteins

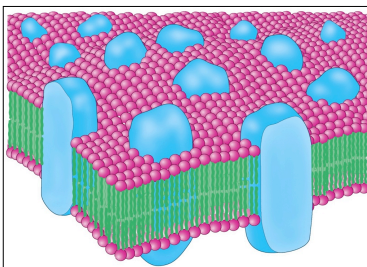
+ Transverse diffusion is very slow.



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Cell Membrane Proteins

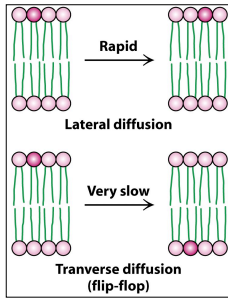
+ Fluid Mosaic Model of Singer and Nicolson (1972).



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Cell Membrane Proteins

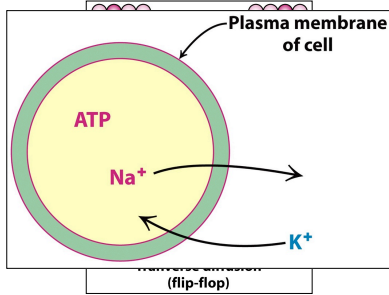
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Cell Membrane Proteins

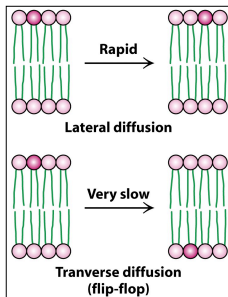
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Cell Membrane Proteins

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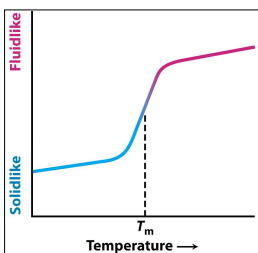


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Cell Membrane Proteins

+ Membrane fluidity is modulated by

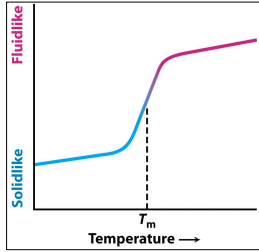
- Fatty acid composition
- Cholesterol (animals)



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Cell Membrane Proteins

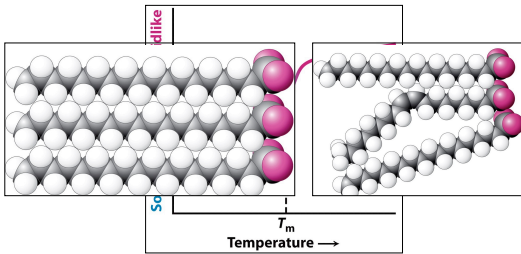
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Cell Membrane Proteins

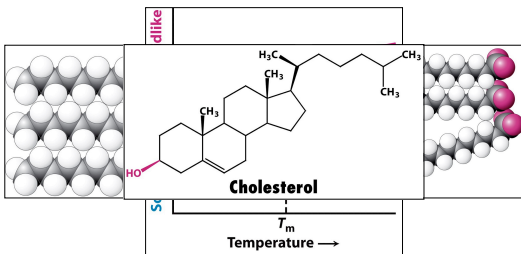
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Cell Membrane Proteins

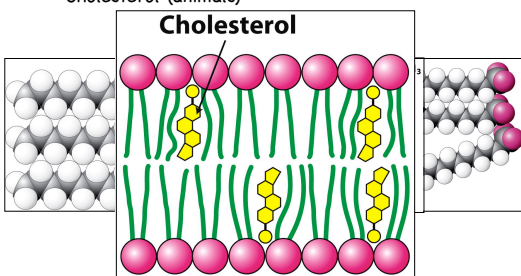
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Cell Membrane Proteins

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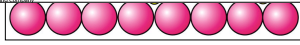
Cell Membrane Proteins

- Membrane fluidity is modulated by
 - Fatty acid composition
 - Cholesterol (animals)

Cholesterol
 Table 12.3 The melting temperature of phosphatidylcholine containing different pairs of identical fatty acid chains

Number of carbons	Number of double bonds	Fatty acid		T_m (°C)
		Common name	Systematic name	
22	0	Behenate	<i>n</i> -Docosanoate	75
18	0	Stearate	<i>n</i> -Octadecanoate	58
16	0	Palmitate	<i>n</i> -Hexadecanoate	41
14	0	Myristate	<i>n</i> -Tetradecanoate	24
18	1	Oleate	<i>cis</i> - Δ^9 -Octadecenoate	-22

Table 12.3
 Biochemistry, Seventh Edition
 © 2004 W. H. Freeman and Company

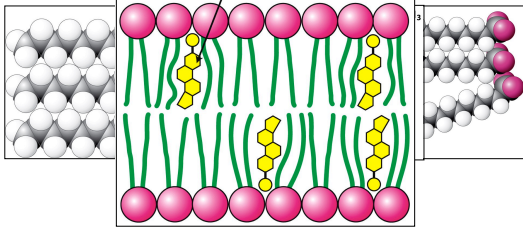


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Cell Membrane Proteins

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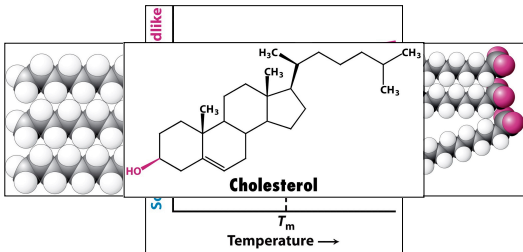
Cholesterol



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Cell Membrane Proteins

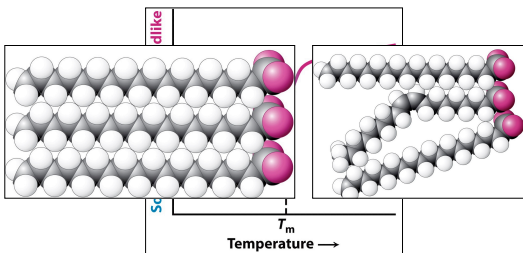
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Cell Membrane Proteins

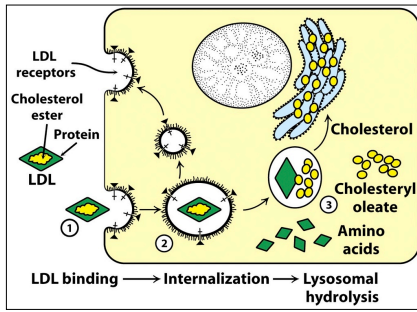
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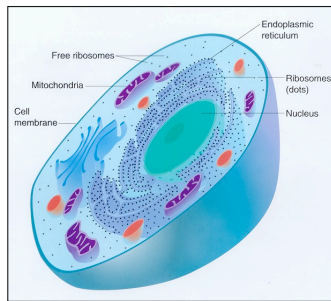
+ Eukaryotic cells



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Cell Membrane Proteins

+ Eukaryotic cells



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Next up

+ Unit V, Lecture 9 - Membrane Channels and Pumps. (Chapter 13)

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