Biological Membranes and Transport

All Membranes are Different

Phospholipids Are a Major Component of Biological Membranes

Amphipathic- hydrophilic and hydrophobic regions

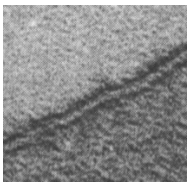
Possible arrangements

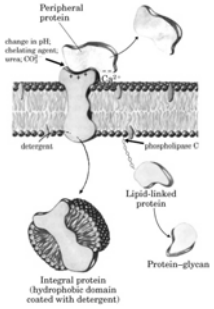
- monolayer
- micelle
- bilayer

General Form of a Membrane

Fig. 12-11 Lehninger POB 3rd Ed.

- Phospholipid bilayer ~7.5 nm thick
  Contains *integral* and *peripheral* proteins

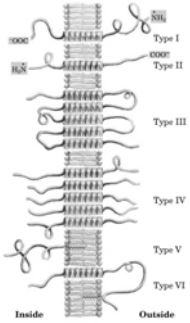




Integral Protein Orientation

Fig. 12-14 Lehninger POB 3rd Ed.

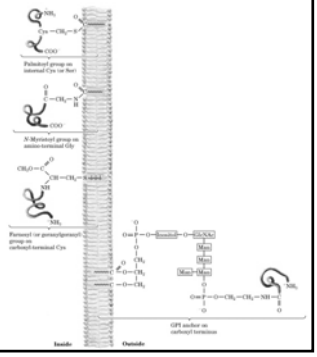
- Peripheral proteins- extracted by high salt, e.g.
- Integral proteins- extracted by detergent only, form *liposomes*



Lipid Anchors

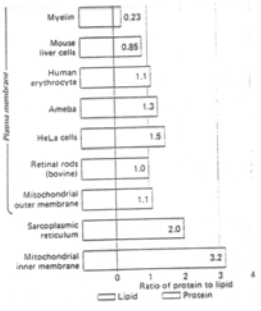
Fig. 12-13 Lehninger POB 3rd Ed.

- Fatty acid
- Farnesyl (C15) or Geranylgeranyl (C20) CAAX
- GPI



Ratio of Protein:Lipid

- 1:1 as a rule of thumb



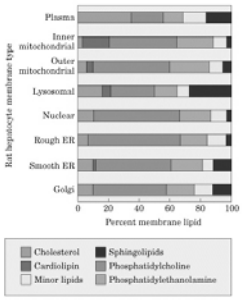
Proteins of Membranes

- Depends on what membrane (compartment)
- "Marker enzymes"
  - Plasma membrane: Na^+K^+ATPase
  - ER: G6Pase
  - OMM (outer mitochondrial membrane):
  - IMS (intermembrane space):
  - IMM (inner mitochondrial membrane): SDH
  - Matrix: citrate synthase
  - Golgi:
  - etc.

Lipids of Membranes

Fig. 12-2 Lehninger POB 3rd Ed.

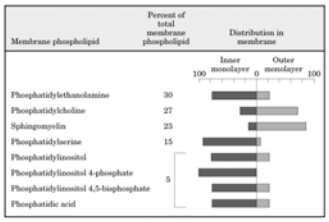
- Depends on what membrane
- PC and PE predominate (55-75%)



Lipids of Membranes

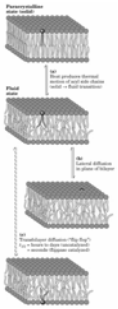
Fig. 12-5 Lehninger POB 3rd Ed.

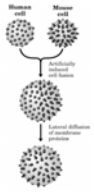
- Depends on what membrane
- PC and PE predominate (55-70%)
- Curved: assymetric



Singer's Fluid Mosaic Model

Fig. 12-6, 12-7 Lehninger POB 3rd Ed.





Lateral fluidity of lipid and protein is constant and rapid
"flip-flop" is rare and slow
Membrane fusion is constant

Membrane Fusion is Constant

Membranes are self-sealing
Endocytosis/Exocytosis annexins, clathrin
ER, Golgi budding, endosomes, etc
inversion

Membranes are Assymetric

Curved: different lipids in each "leaflet"
Recognition: glycolipids are on outside
Signal transduction: PI inside
Signal transduction: Proteins inside

Membranes Change

- Environment example
- Diet high in cholesterol
- Drug resistance

Table 12–2

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.

†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.

Membrane Transport

1. Diffusion

-down concentration gradient

-no energy

-extremely slow

Membrane Transport

Fig. 12-23 Lehninger POB 3rd Ed.

2. Facilitated Diffusion

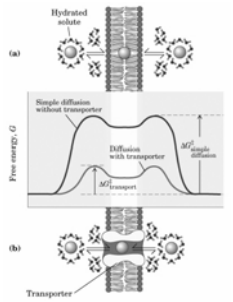
-down concentration gradient

-no energy

-not as slow

-protein mediated: 12 membrane-spanning passes

-protein mediated: enzyme similarities



Membrane Transport

Fig. 12-30a Lehninger POB 3rd Ed.

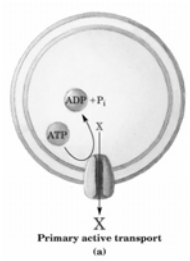
3. Primary Active transport

-protein mediated

-up concentration gradient

- transport protein uses energy

-fast



Membrane Transport

Fig. 12-30 Lehninger POB 3rd Ed.

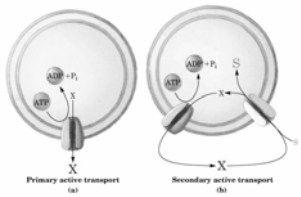
4. Secondary Active Transport

-protein mediated

-up concentration gradient

-uses energy, but not by transport protein itself

-fast

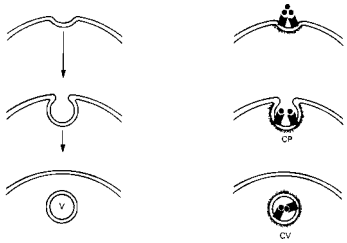


Membrane Transport

Fig. 43-21 Harpers 24th Ed.

5. Endocytosis

6. RME



Membrane Transport

Fig. 12-42 Lehninger POB 3rd Ed.

7. Channels are kinetically similar to facilitated diffusion

Receptors

Fig. 13-11 Lehninger POB 3rd Ed.

Single transmembrane spanning

Serpentine (7) transmembrane spanning