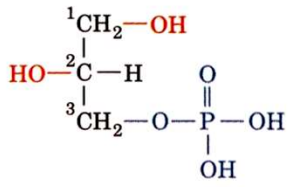
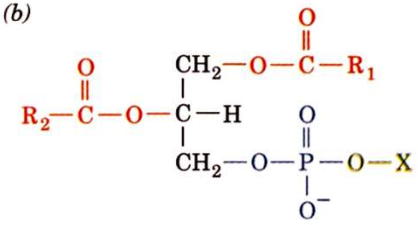
Glycerophospholipids, the Major Players

(a)



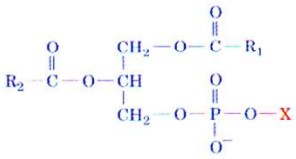
sn-Glycerol-3-phosphate

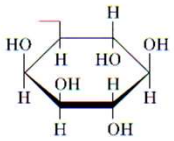
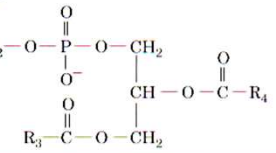
(b)



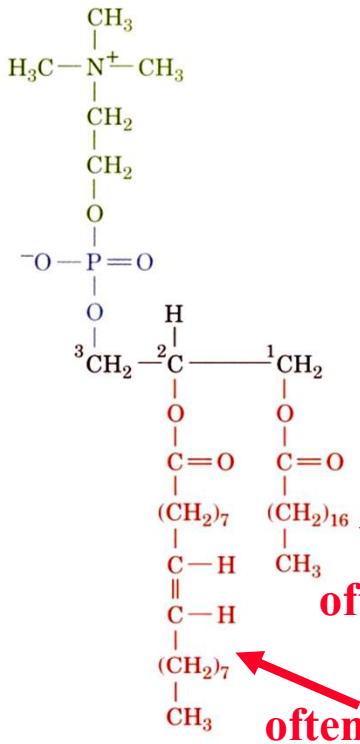
Glycerophospholipid

➢ Glycerophospholipids = phosphoglycerides are amphiphilic molecules with nonpolar aliphatic "tails" and polar phosphoryl-X "heads"

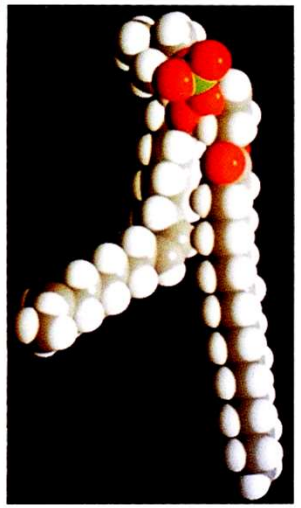


Name of X—OH	Formula of —X	Name of Phospholipid
Water	—H	Phosphatidic acid
Ethanolamine	$-CH_2CH_2NH_3^+$	Phosphatidylethanolamine
Choline	$-CH_2CH_2N(CH_3)_3^+$	Phosphatidylcholine (lecithin)
Serine	$-CH_2CH(NH_3^+)COO^-$	Phosphatidylserine
myo-Inositol		Phosphatidylinositol
Glycerol	$-CH_2CH(OH)CH_2OH$	Phosphatidylglycerol
Phosphatidylglycerol		Diphosphatidylglycerol (cardiolipin)

(a)



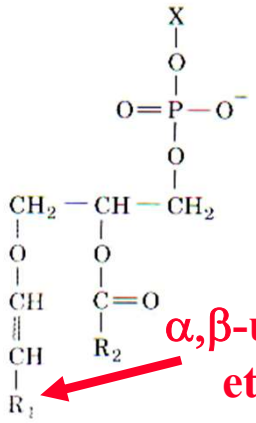
(b)



often C_{16} or C_{18} saturated

often C_{16} to C_{20} unsaturated

1-Stearoyl-2-oleoyl-3-phosphatidylcholine

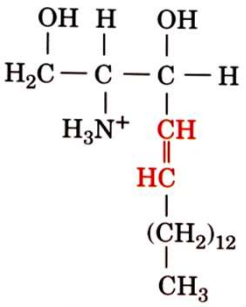


α,β-unsaturated ether (cis)

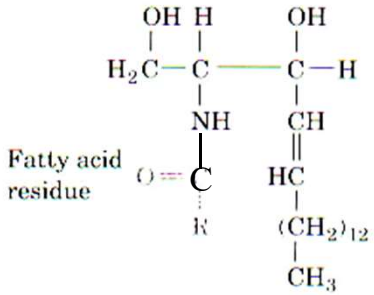
A plasmalogen

Tadpole

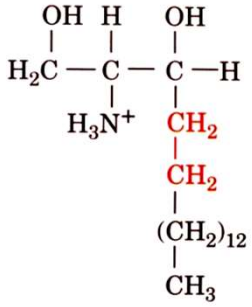
Sphingolipids, the Brainy Ones



Sphingosine



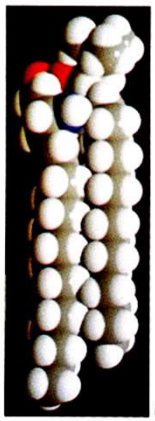
A ceramide

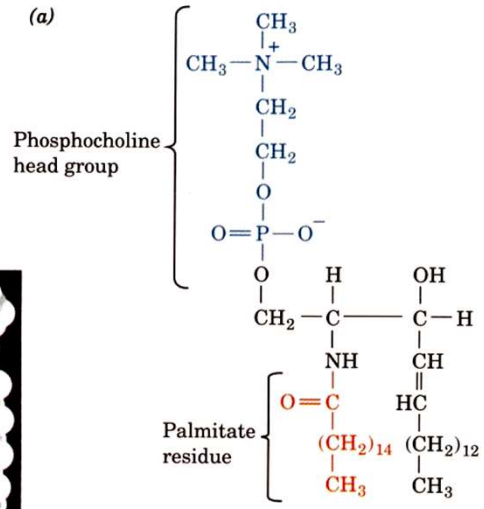


Dihydrosphingosine

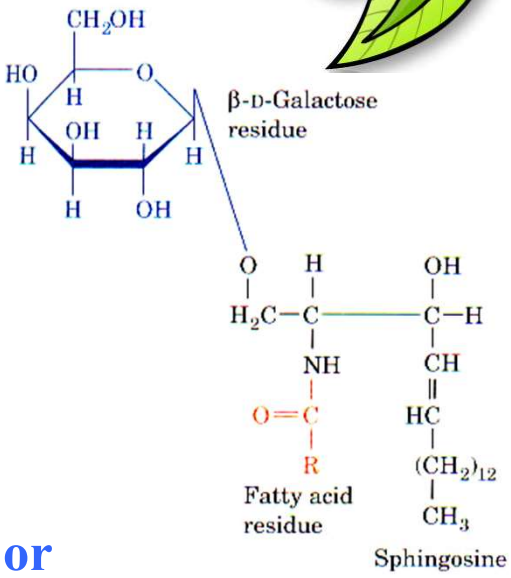
Fatty acid amide

C_{18} amino alcohols





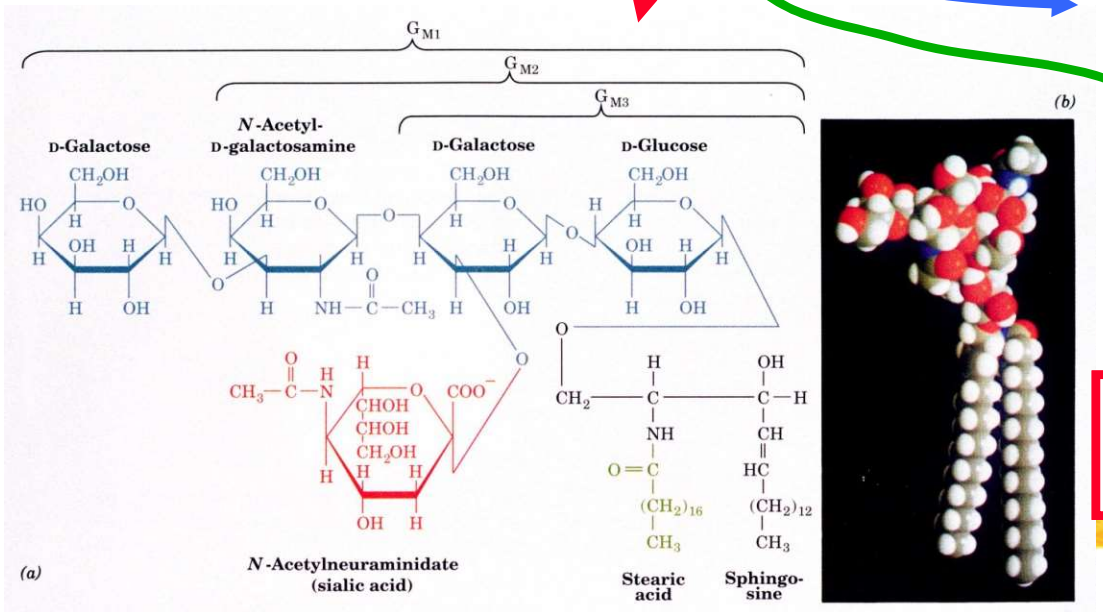
A sphingomyelin



A galactocerebroside

Phosphocholin or -ethanolamine ester (structurally similar to phospholipids)

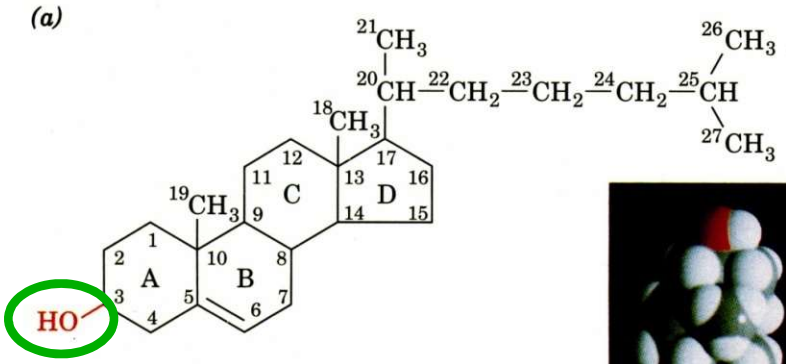
Head group = one sugar



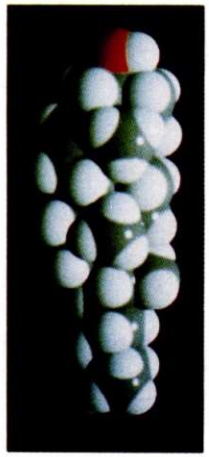
Most complex sphingoglycolipids

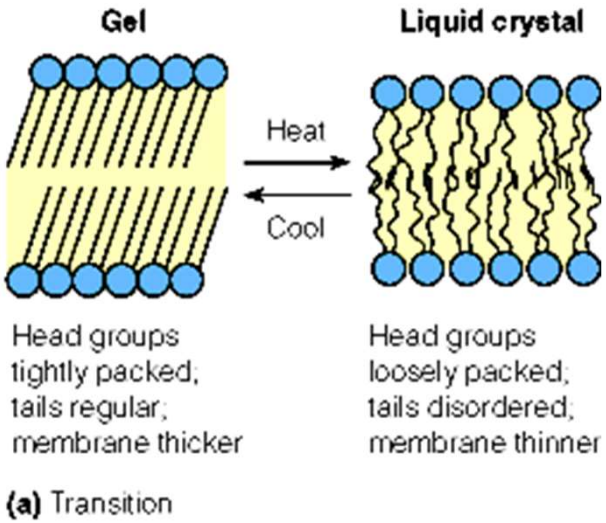
6% of brain lipids; cell-cell recognition

Cholesterol, the Unruly One

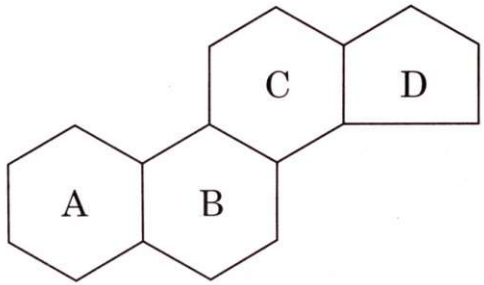


Cholesterol



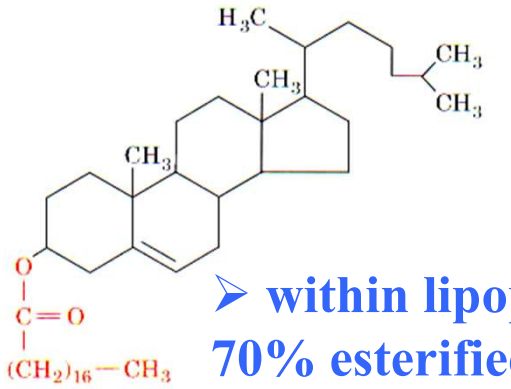


- major component of animal plasma membranes
- weakly amphiphilic



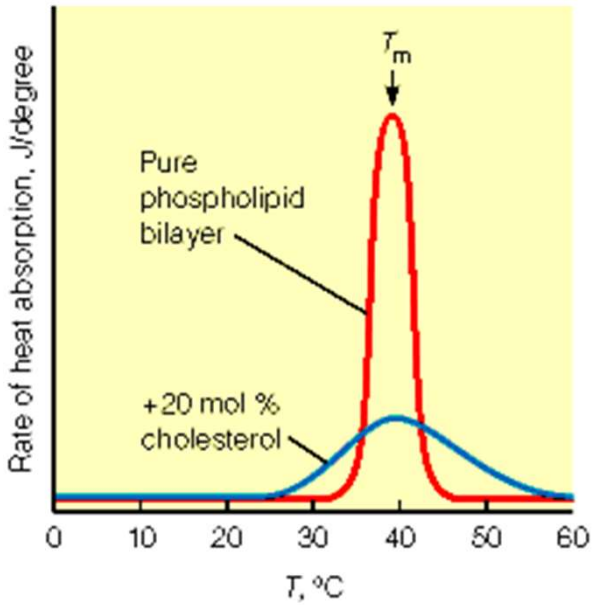
Cyclopentanoperhydrophenanthrene

- rigid fused ring system



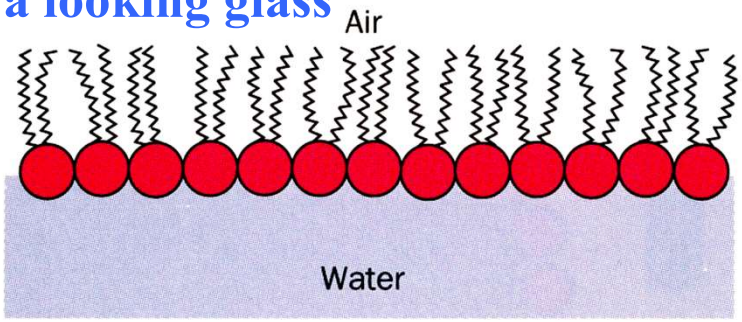
Cholesteryl stearate

- within lipoproteins in blood plasma: 70% esterified to fatty acids for transport



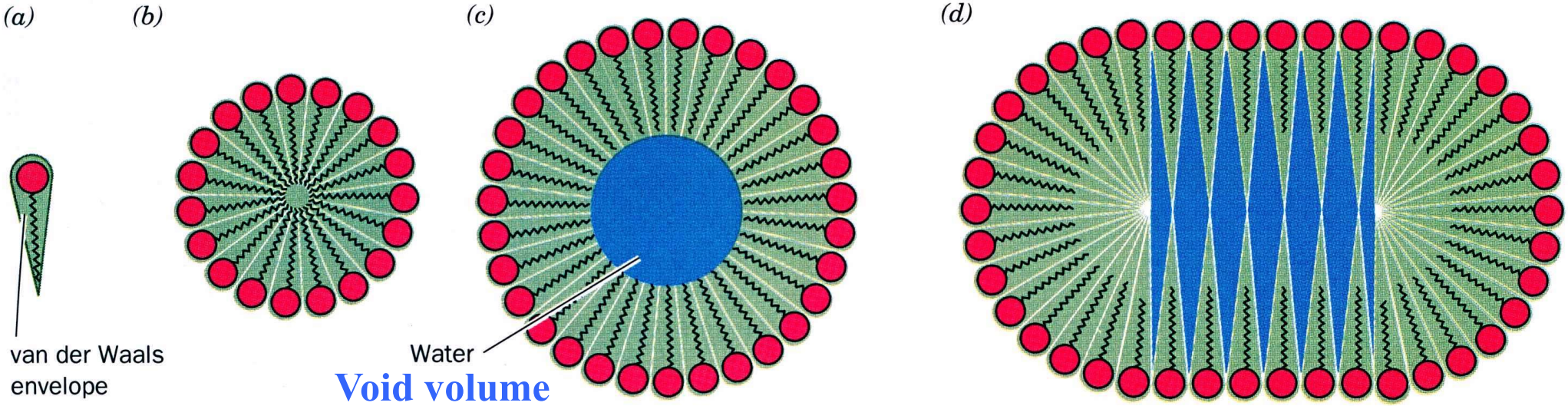
The "Magical" Properties of Lipids

➢ **Benjamin Franklin (1774): A drop of olive oil calms waves on a pond to become "smooth as a looking glass"**



Reduction in water's high surface tension

Single-tailed lipids/detergents form small (several 100 molecules containing) micelles:

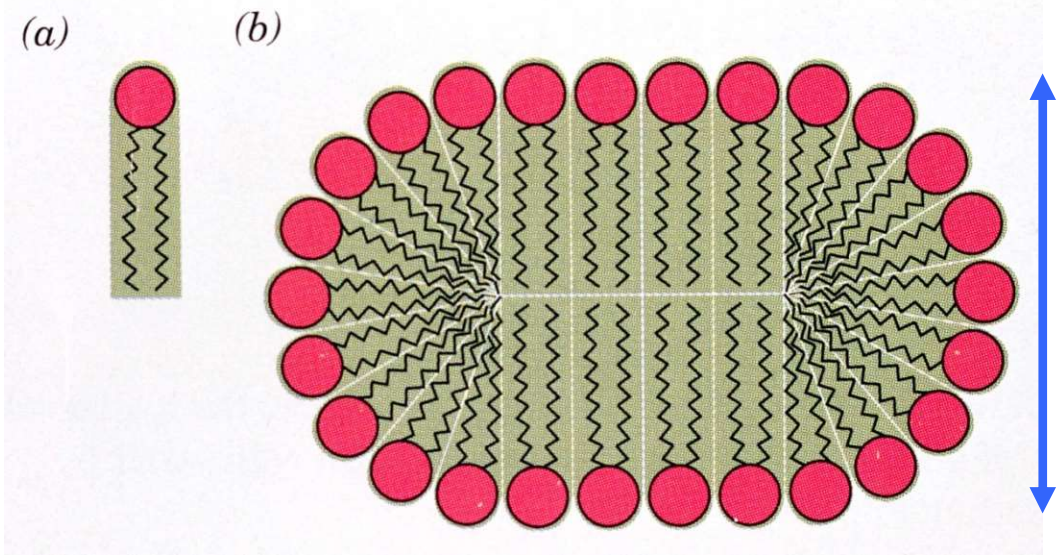


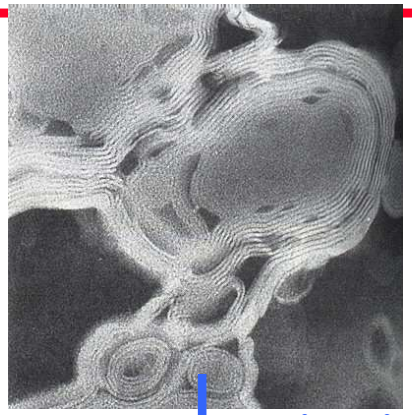
Void volume ⇒ unfavorable!

Good at emulsifying!

Lipid Bilayers Work Their Magic in and Around Cells

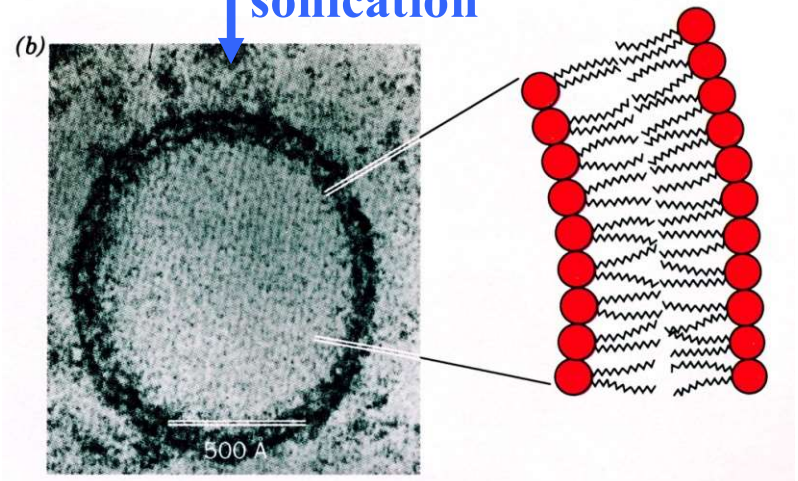
Double-tailed lipids = phospholipids and sphingolipids form disklike micelles ⇒ lipid bilayers of membranes!



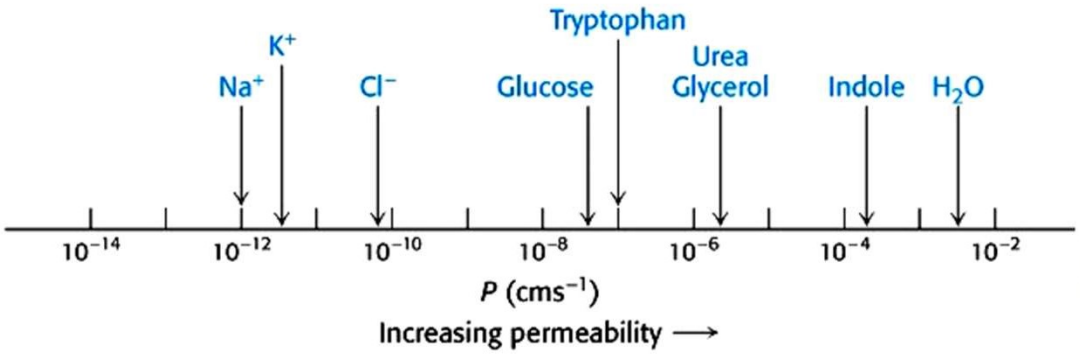


Multilamellar phospholipid vesicle

sonication



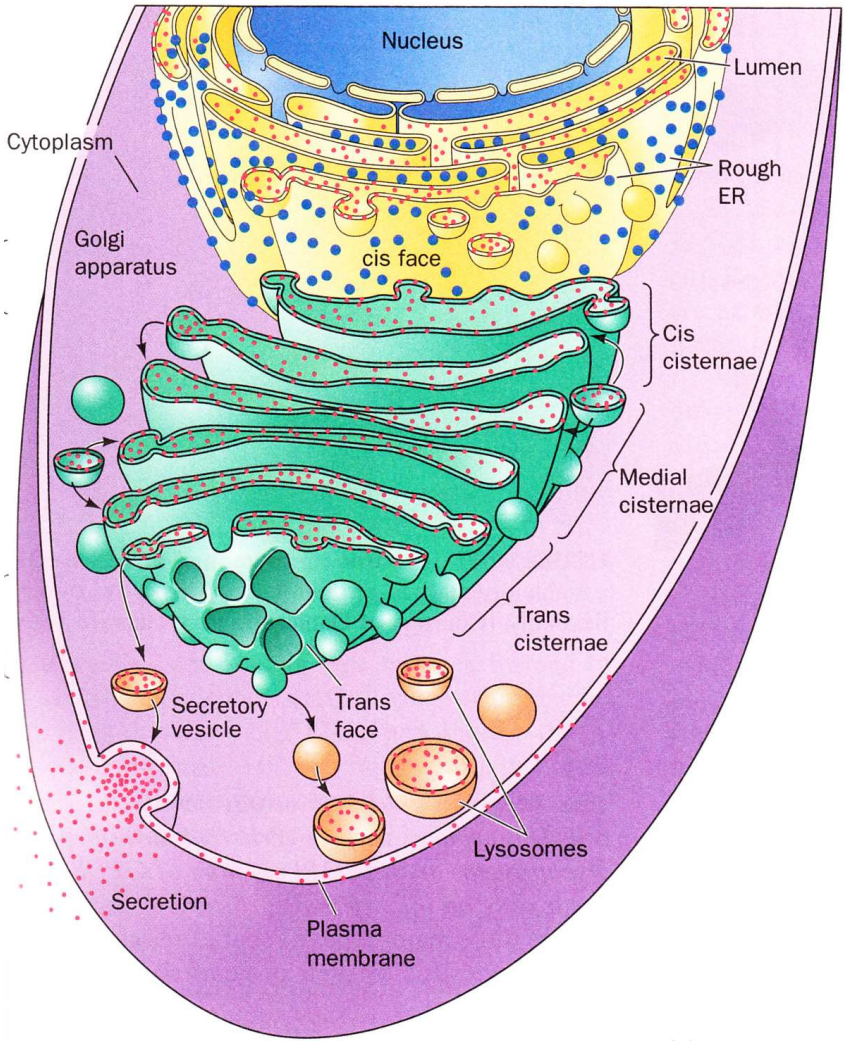
Lipid bilayers are highly impermeable to ions and polar molecules



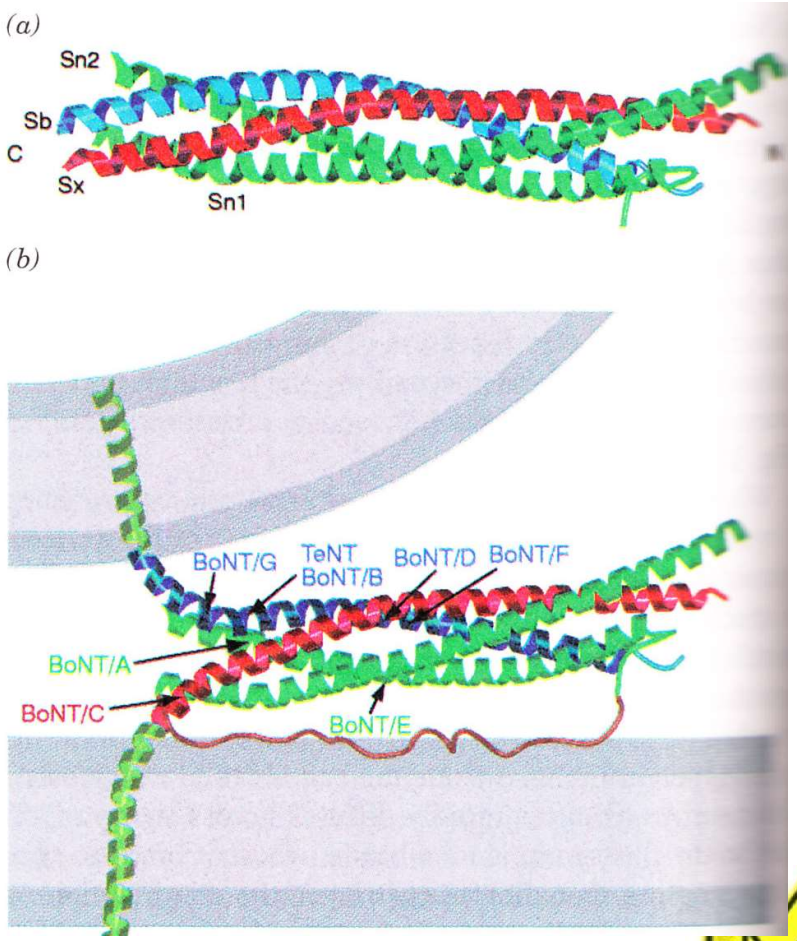
Liposome = closed, self-sealing, solvent-filled single-layer vesicle

Membranes Profoundly Determine How Our Human Cells Work

- **Compartmentalization**



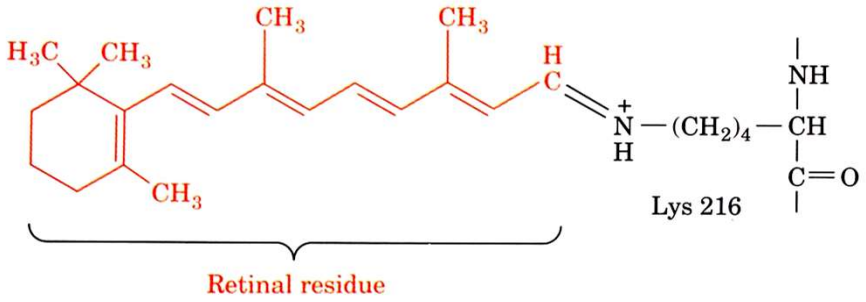
- **Membrane fusion through SNARE-SNAP complexes**

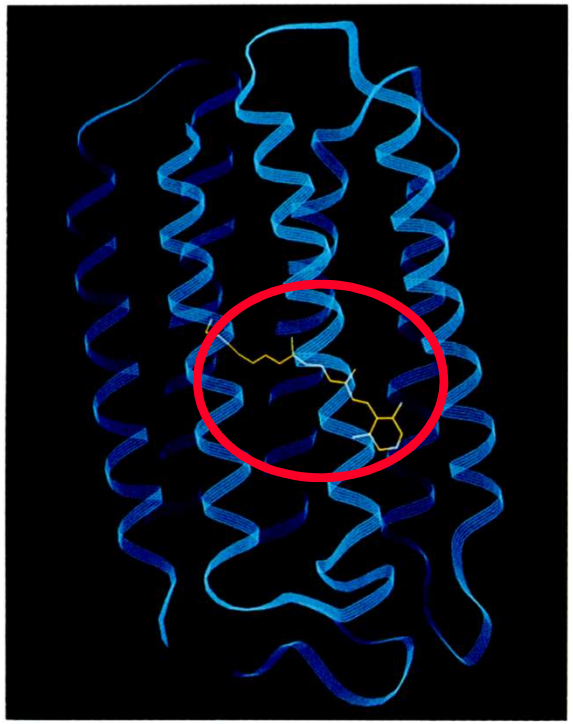


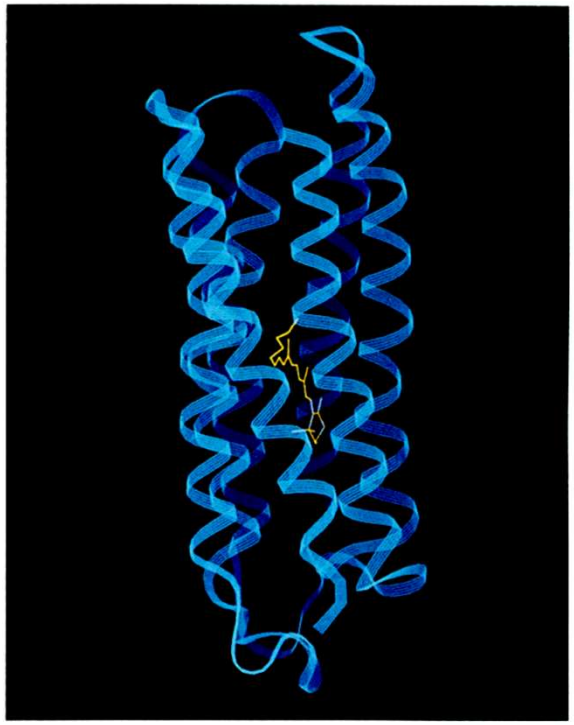
https://www.youtube.com/watch?v=0KRB6fmqvnc
https://www.youtube.com/watch?v=B_zD3NxSsD8
http://www.youtube.com/watch?v=KxTYyNEbVU4

Membrane Protein Example: *Halobacterium halobium* Bacteriorhodopsin

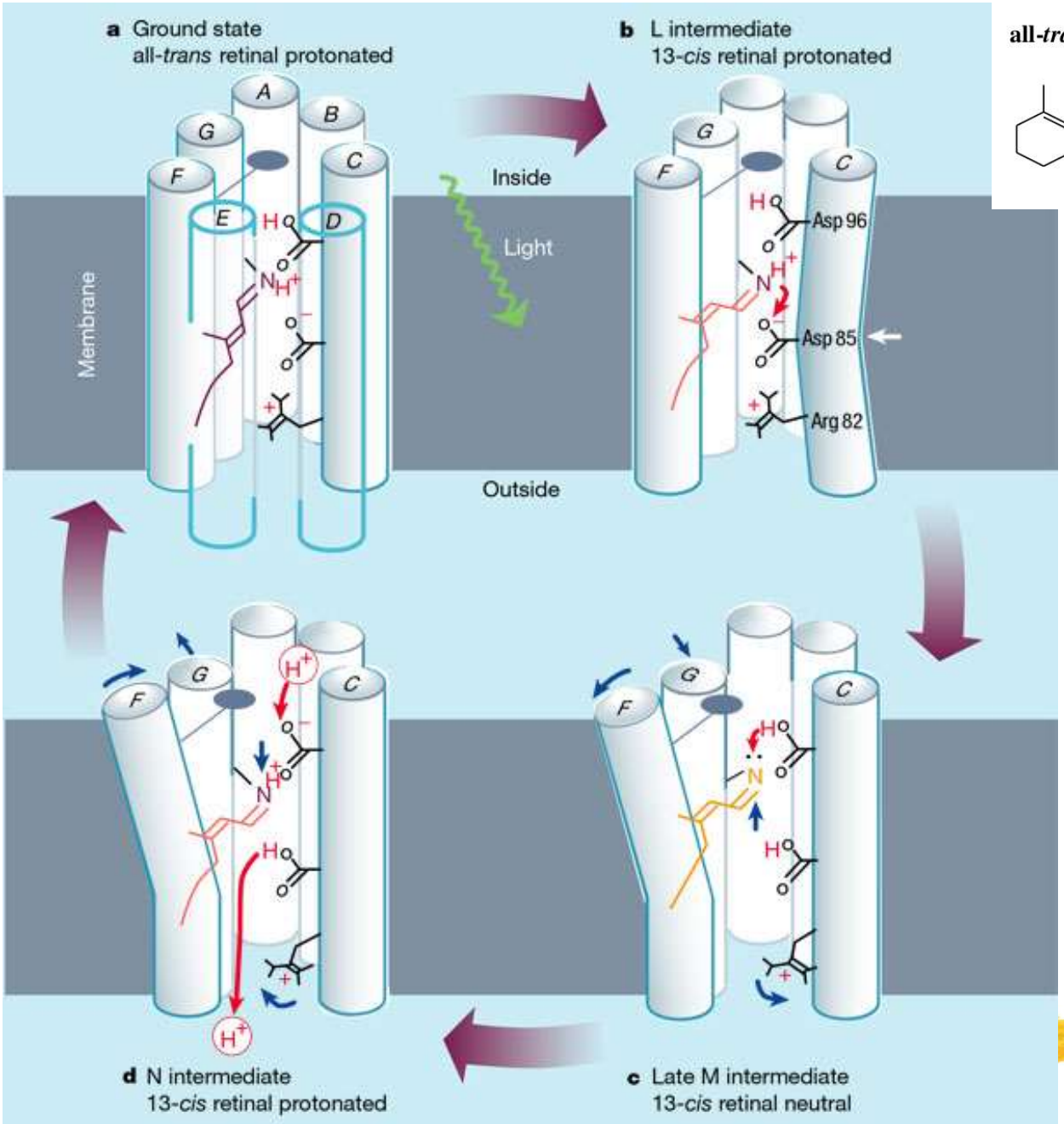
- Extreme halophile - non-viable below 2 M NaCl (seawater has only 0.6 M NaCl!)
- At low [O_2] cell membrane develops 0.5-μm wide patches of purple membrane with bacteriorhodopsin as the only component ⇒ light-driven proton pump

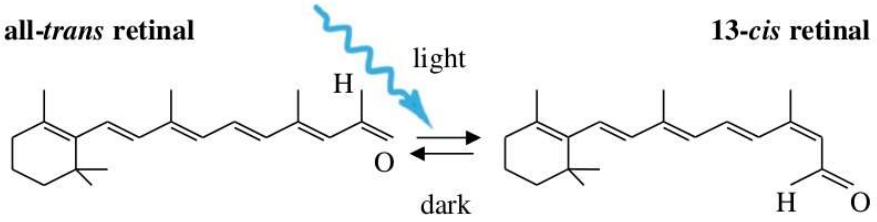






Bacteriorhodopsin : How it Works In the Membrane





Vision in our eyes works similarly:

- **Rods and cones are photoreceptor cells with rhodopsin, composed of a protein (opsin) and retinal**
- **Trans→Cis isomerization drives a cyclic cascade that amplifies the signal, generating a nerve cell impulse (Na^+, Ca^{2+} influx channel closed)**