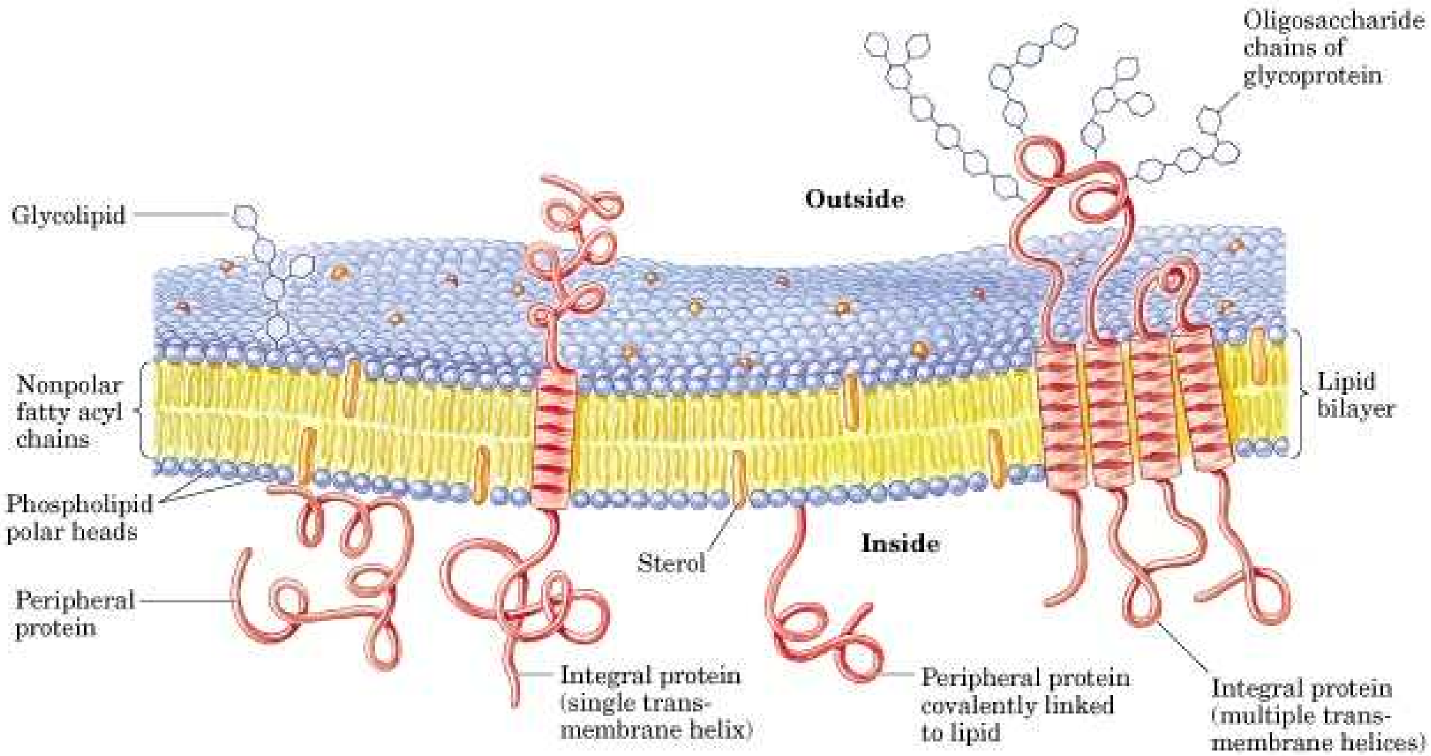
Chpt. 11

Biological Membranes and Transport



Cell membranes

are

crucial to the life of the cell

The plasma membrane encloses the cell,
defines its boundaries,
and maintains the essential differences
between the cytosol and extracellular environment

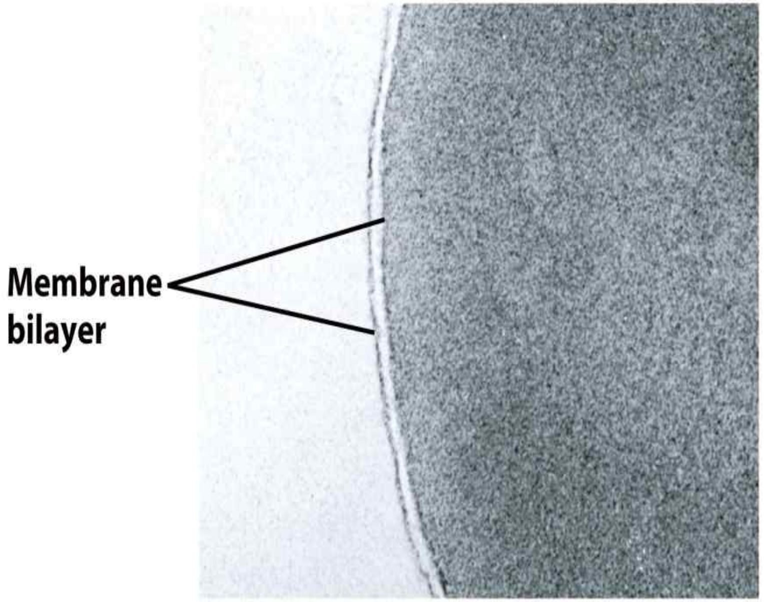
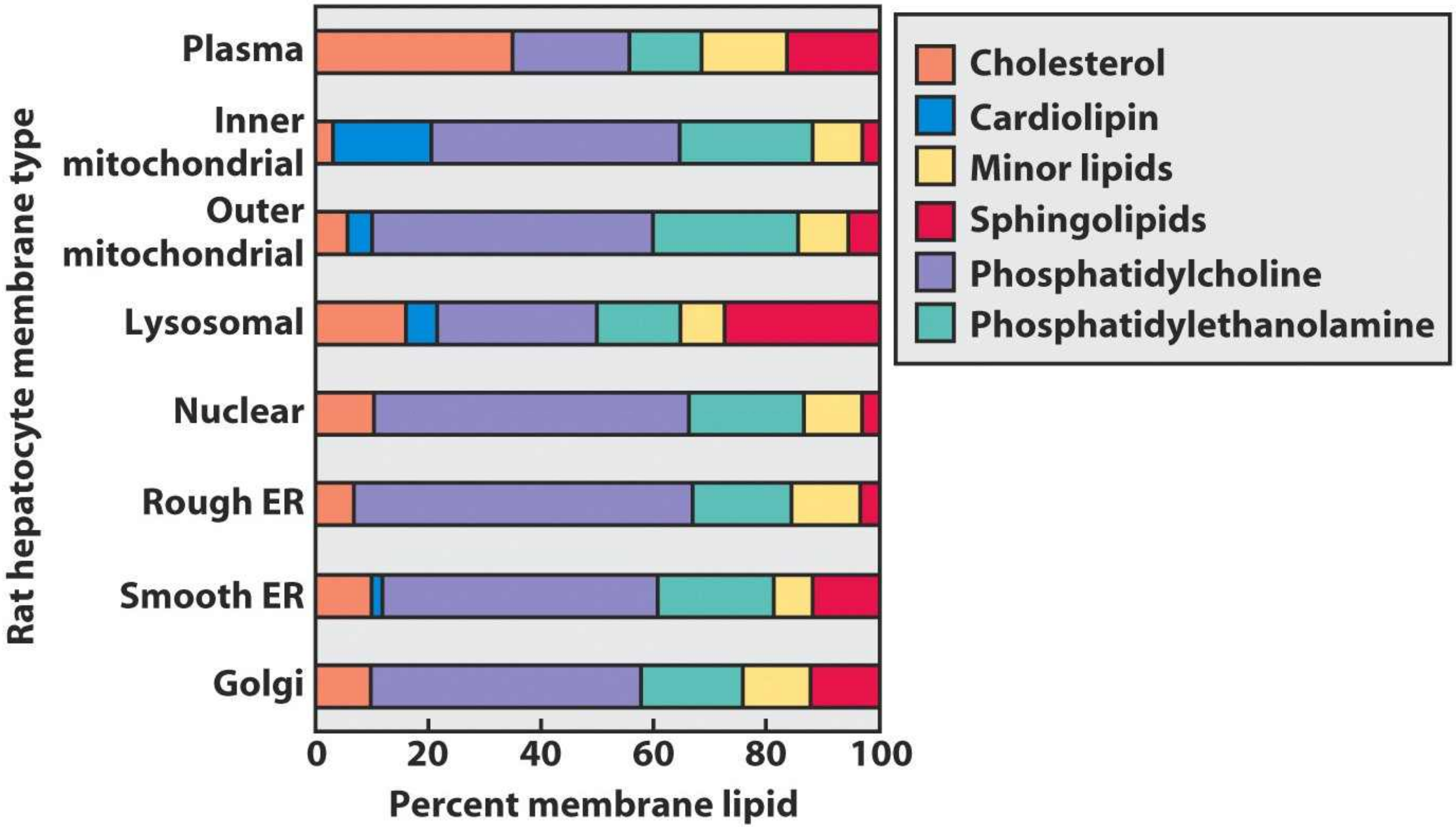


TABLE 11–1 Major Components of Plasma Membranes in Various Organisms

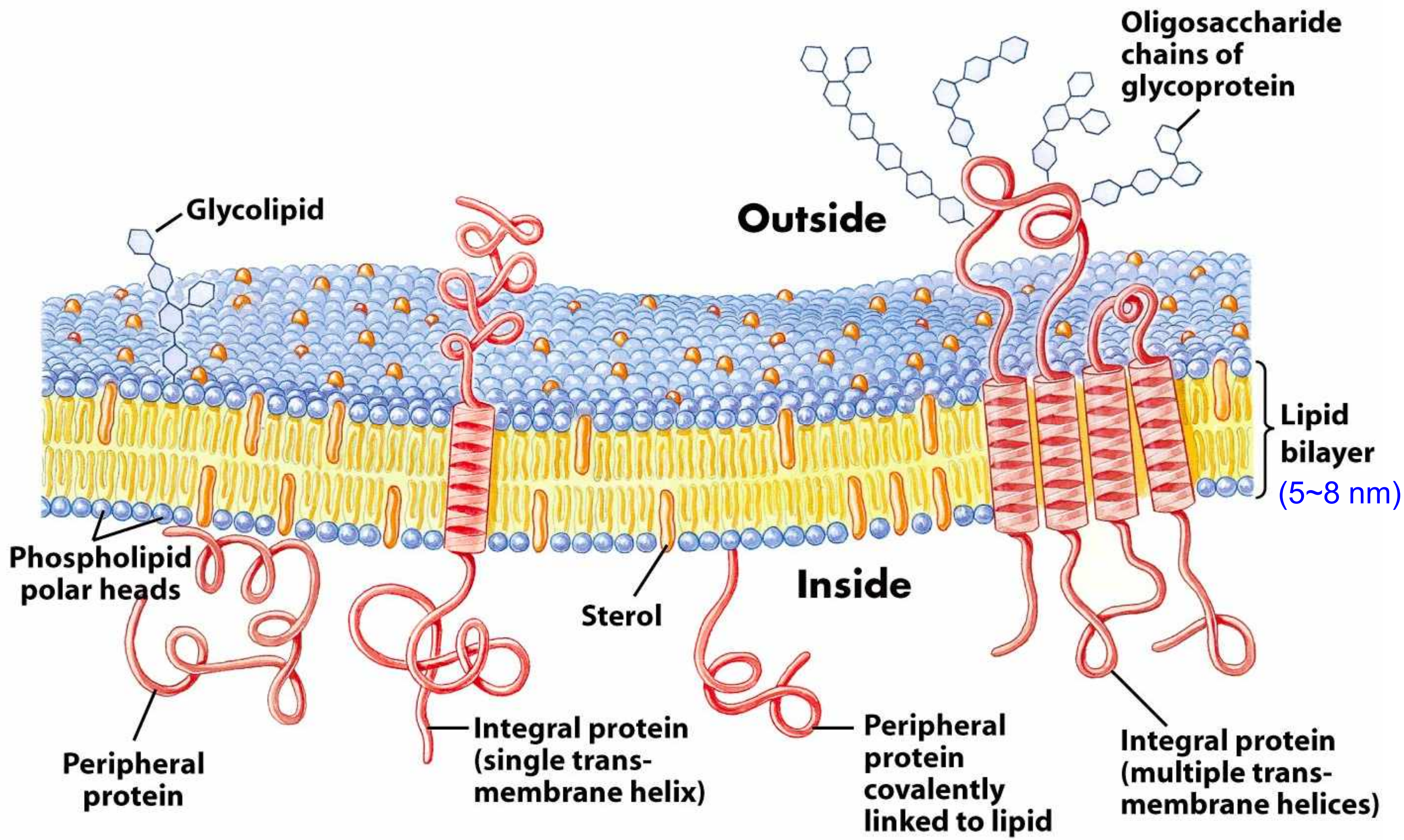
	Components (% by weight)				
	Protein	*Phospholipid*	*Sterol*	*Sterol type*	*Other lipids*
Human myelin sheath	30	30	19	Cholesterol	Galactolipids, plasmalogens
Mouse liver	45	27	25	Cholesterol	–
Maize leaf	47	26	7	Sitosterol	Galactolipids
Yeast	52	7	4	Ergosterol	Triacylglycerols, steryl esters
Paramecium (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.

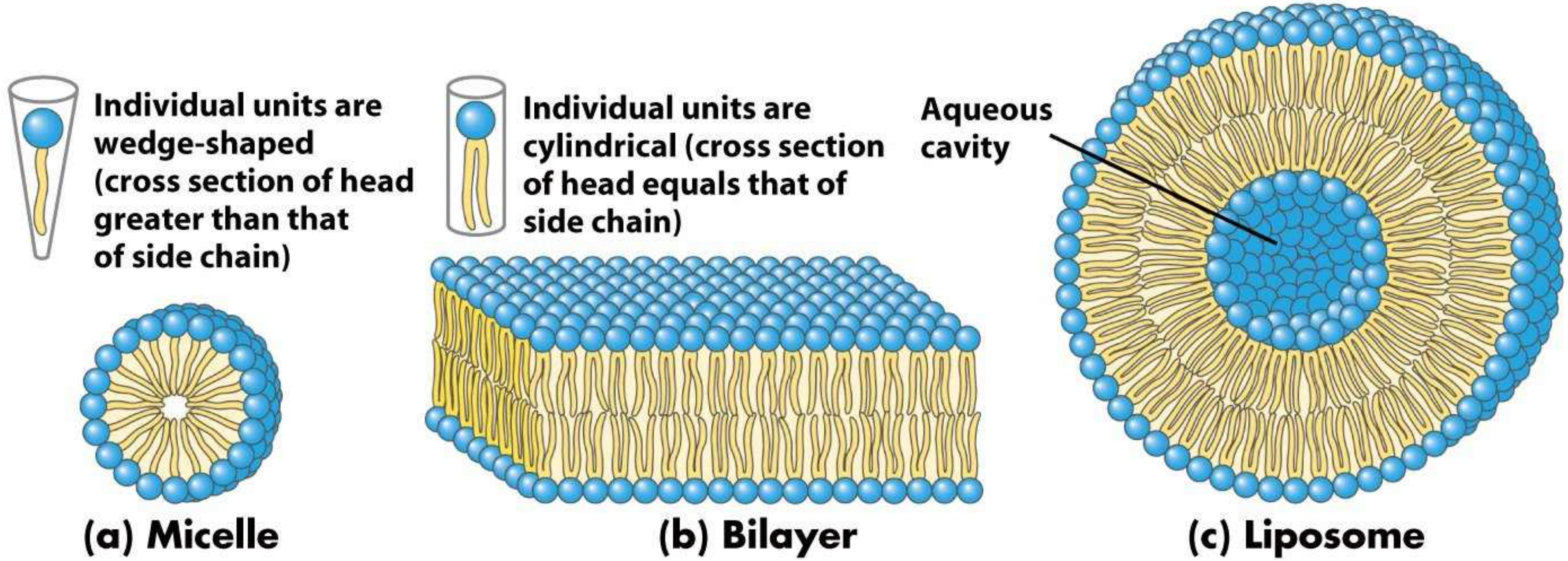
Lipid composition of the biological membranes

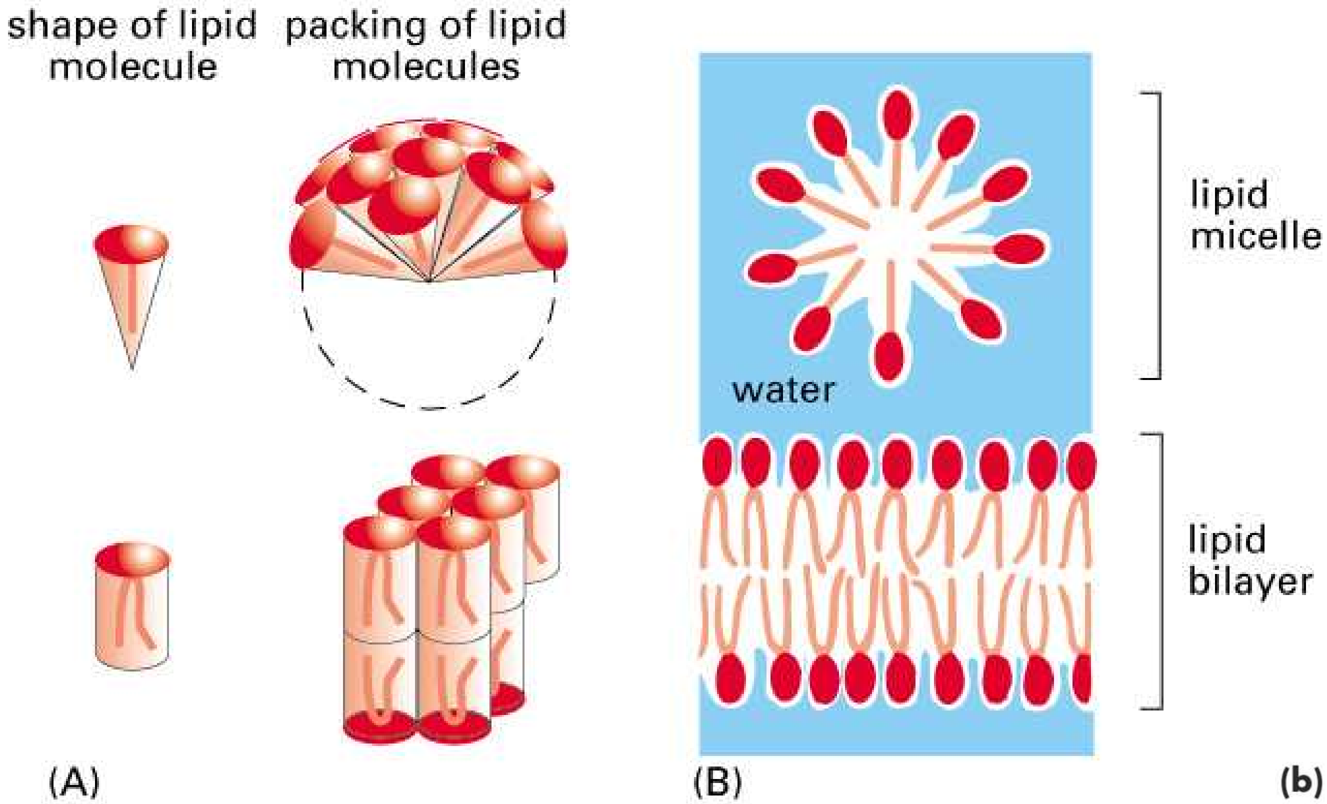


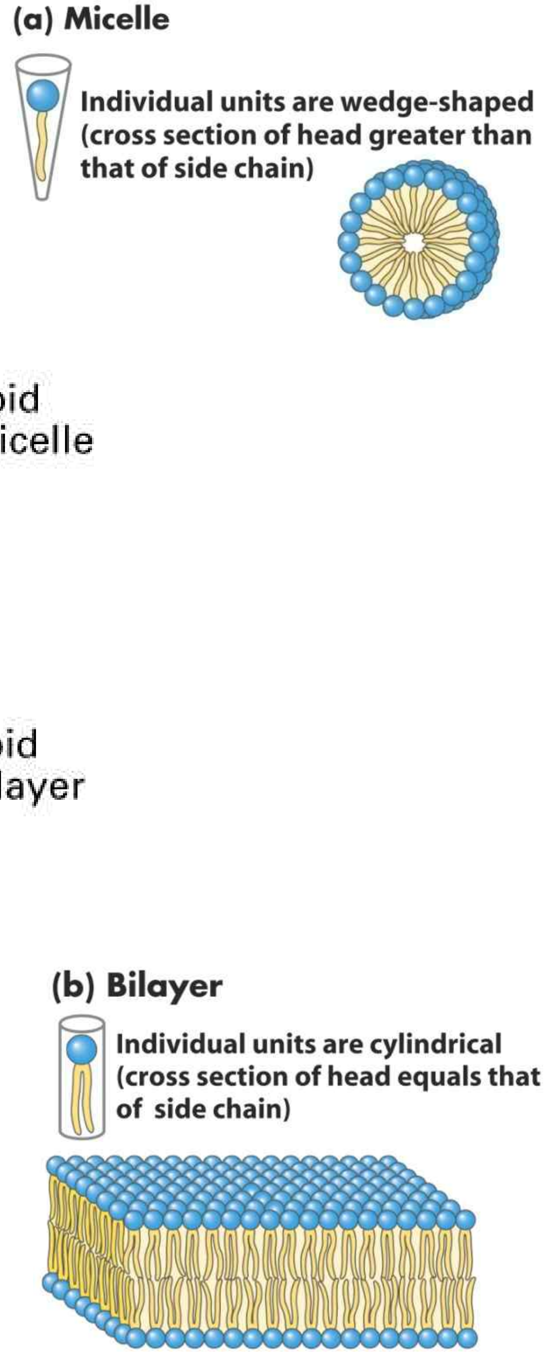
Fluid mosaic model for membrane structure

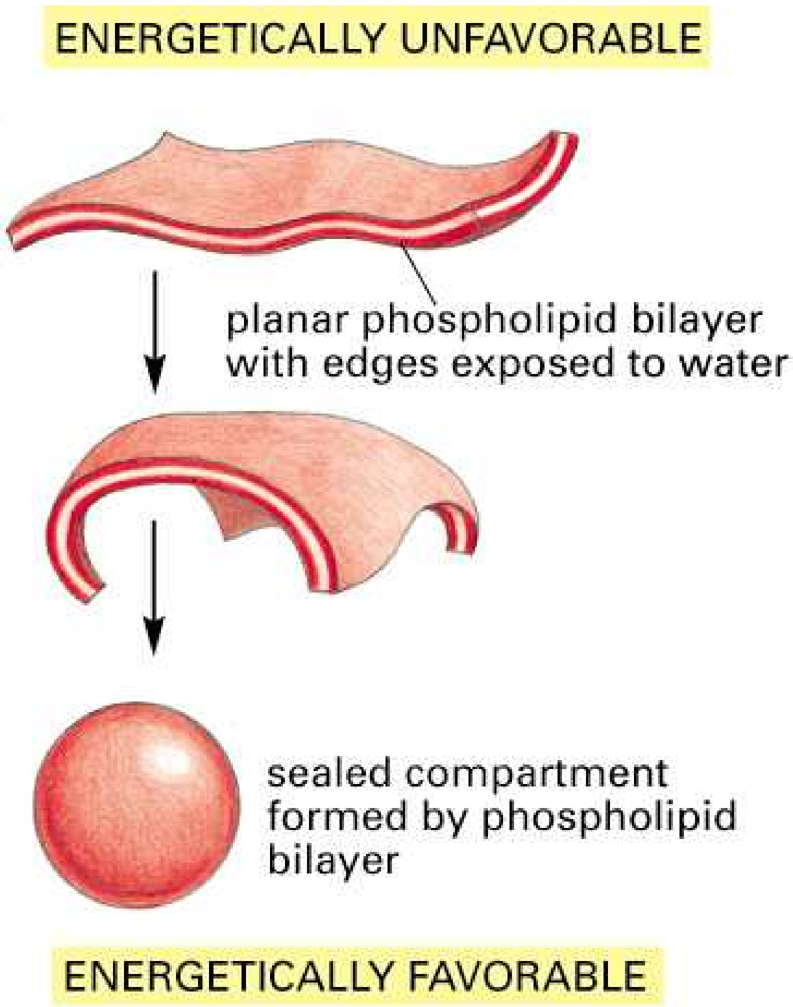


Amphipathic lipid aggreagates that forn in water




shape of lipid molecule
packing of lipid molecules
lipid micelle
water
lipid bilayer
(A)
(B)


(a) Micelle
Individual units are wedge-shaped (cross section of head greater than that of side chain)
(b) Bilayer
Individual units are cylindrical (cross section of head equals that of side chain)



Lipid bilayer:
- self-sealing properties
- fluidity

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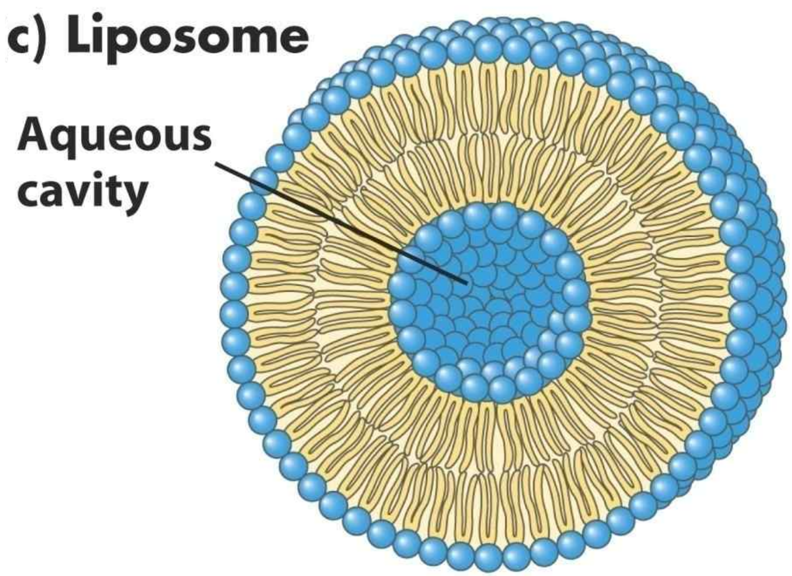
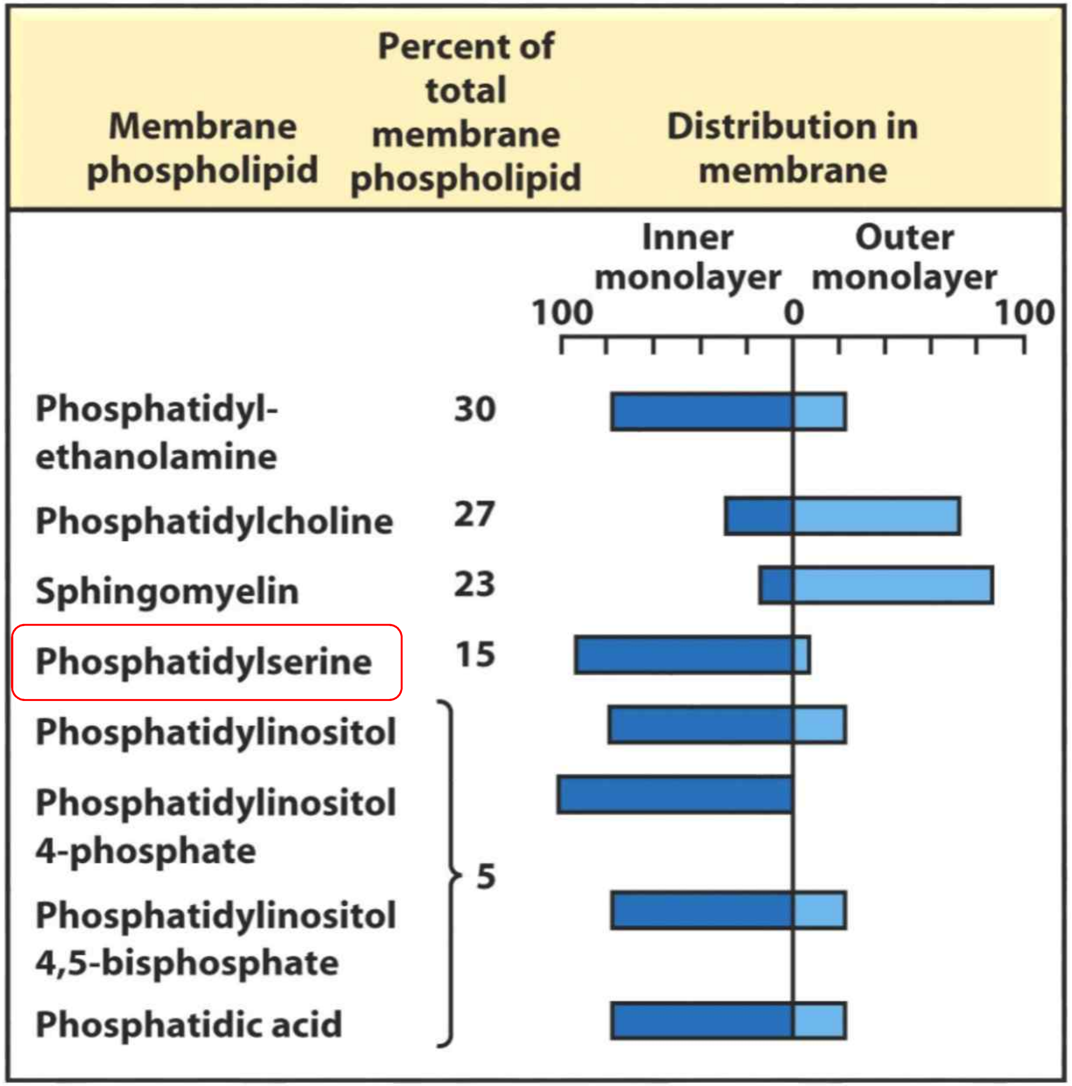
ideal str. for cell memb.



Asymmetric distribution of phospholipids

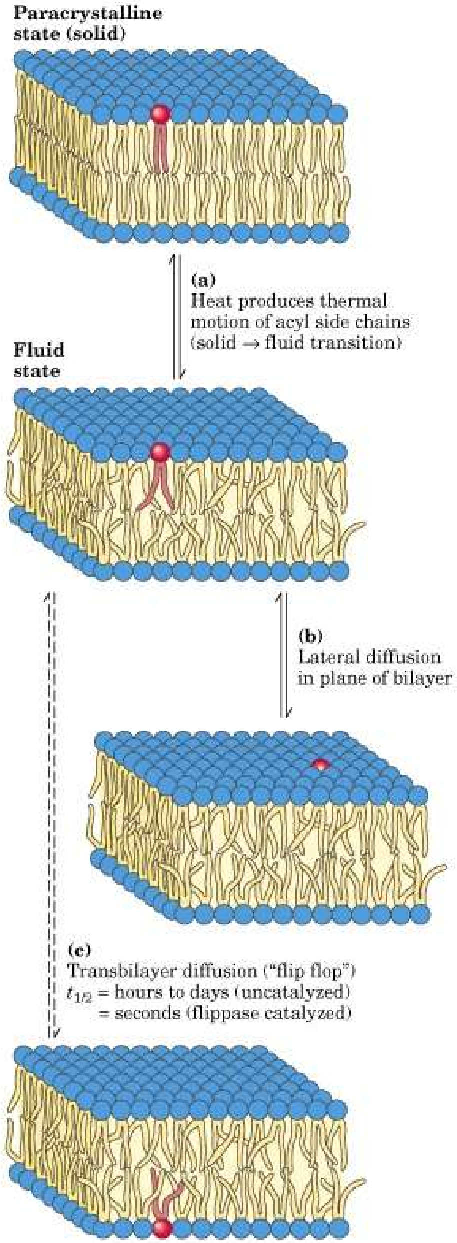


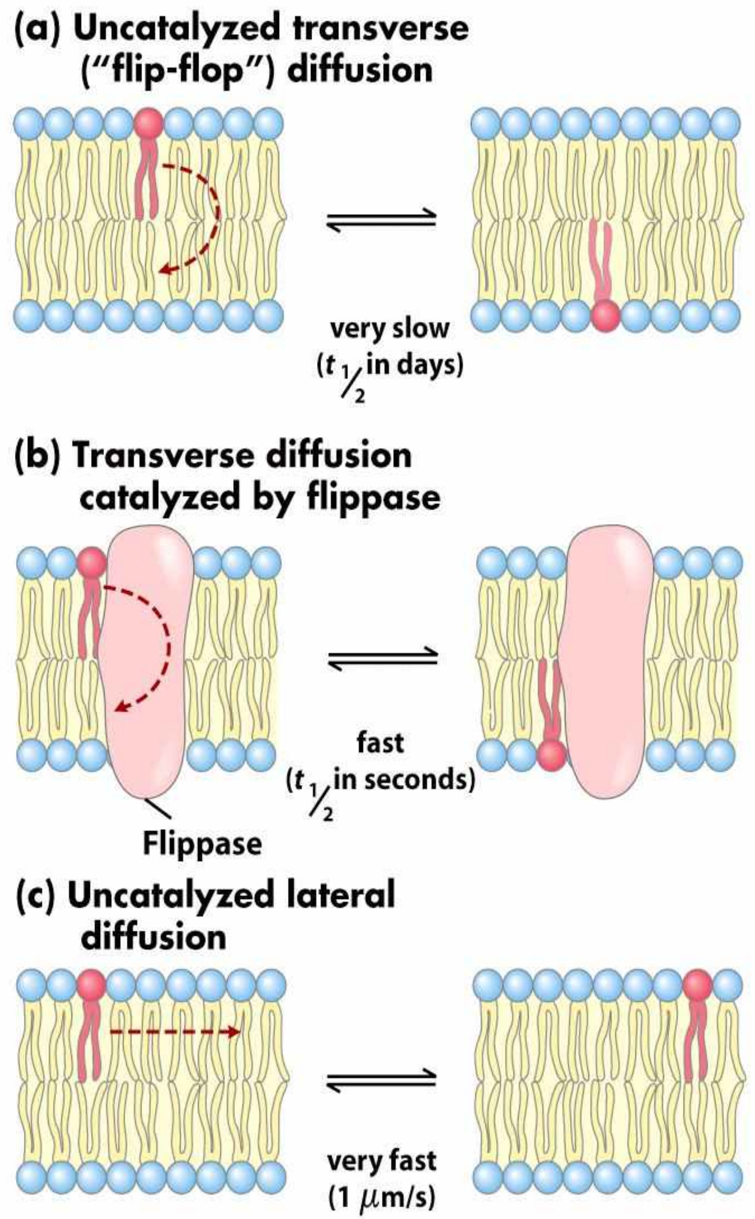
determined by treating the intact cells with phospholipase C

Lipid asymmetry is functionally important. Many cytosolic proteins bind to specific lipid head groups.

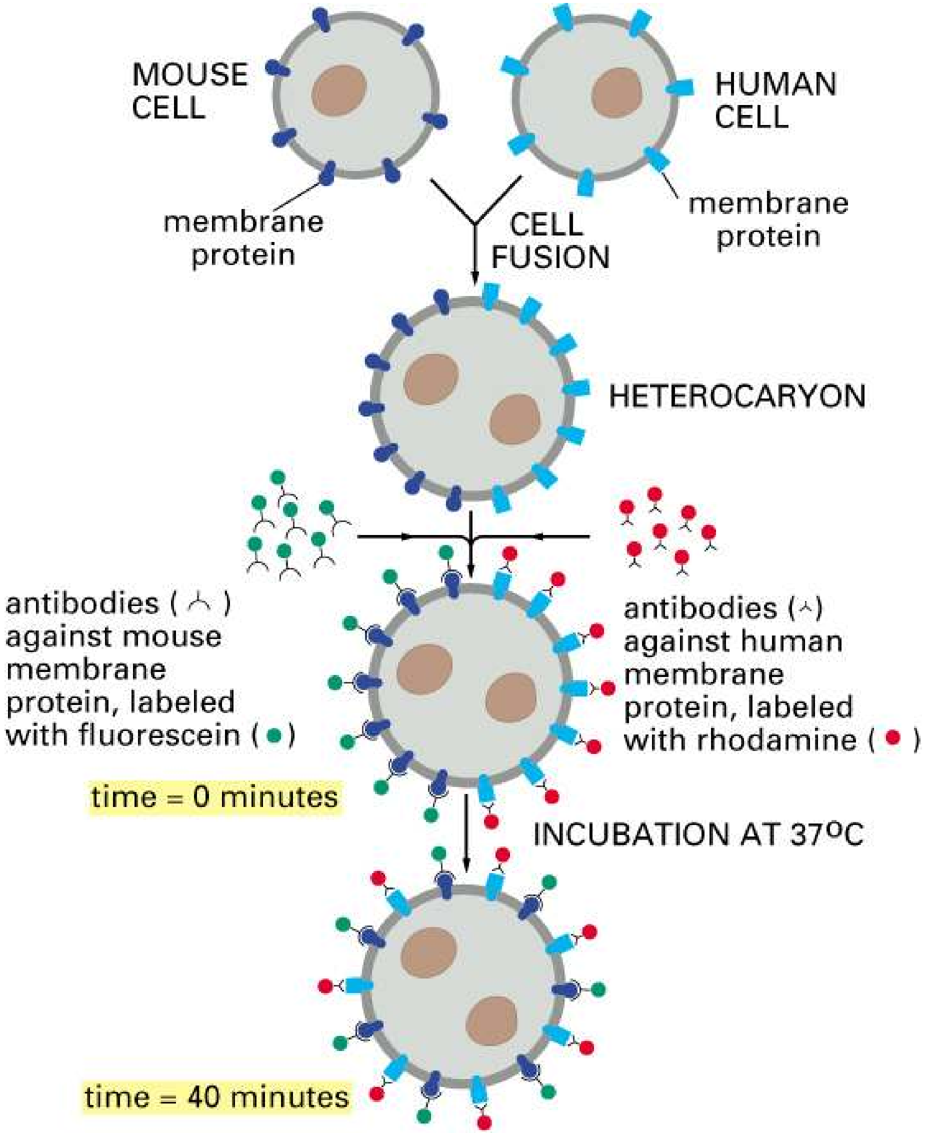
Motion of membrane lipids

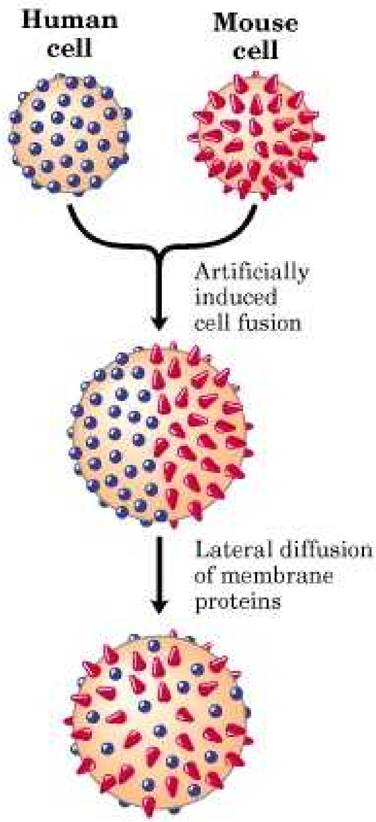
Transition
temperature



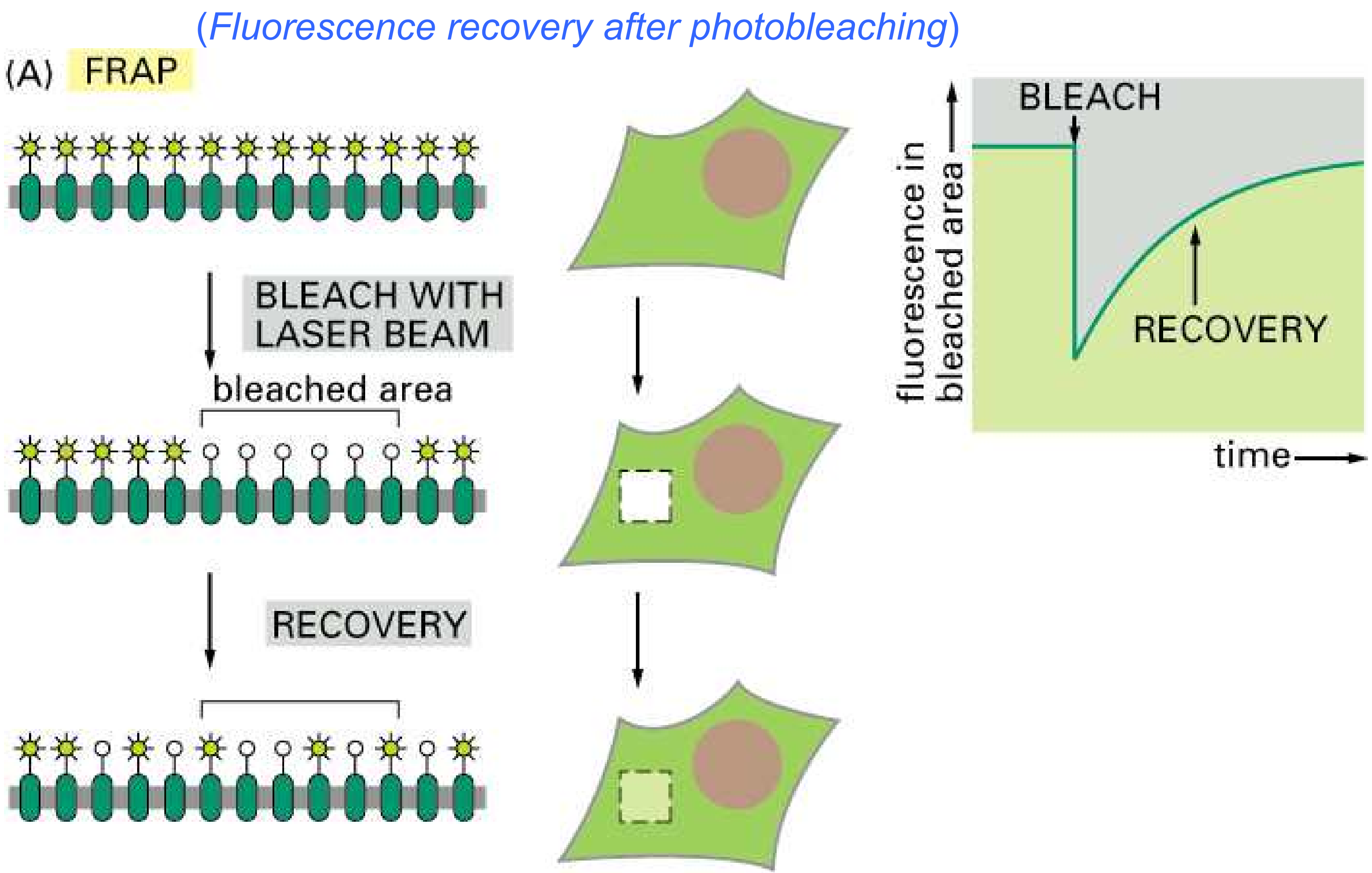


The mixing of plasma memb. proteins on mouse-human hybrid cells (lateral diffusion)

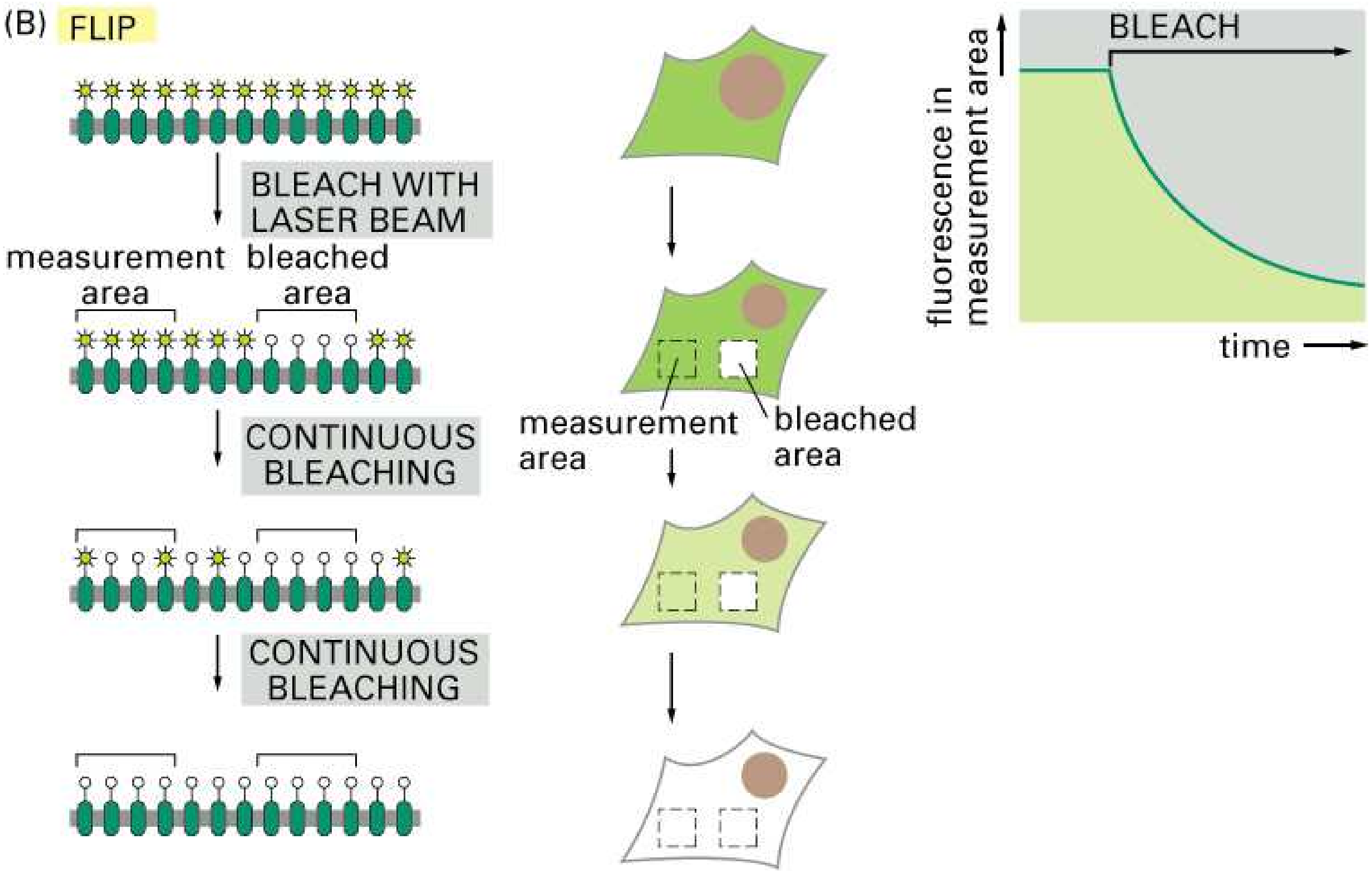




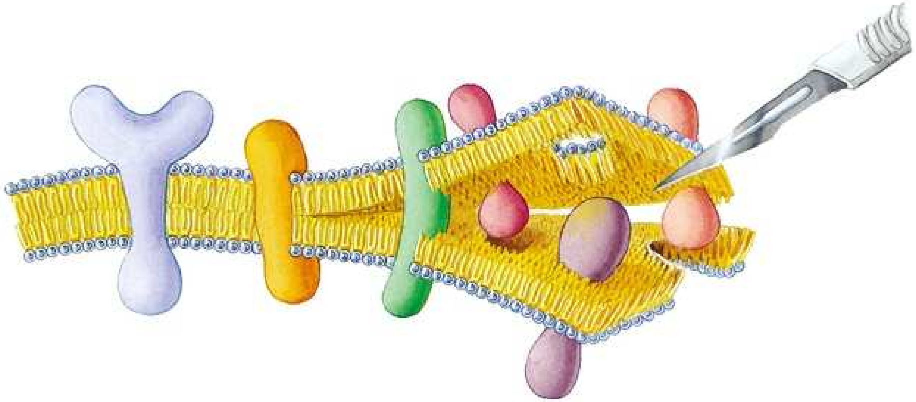
Measuring the rate of lateral diffusion of a membrane proteins

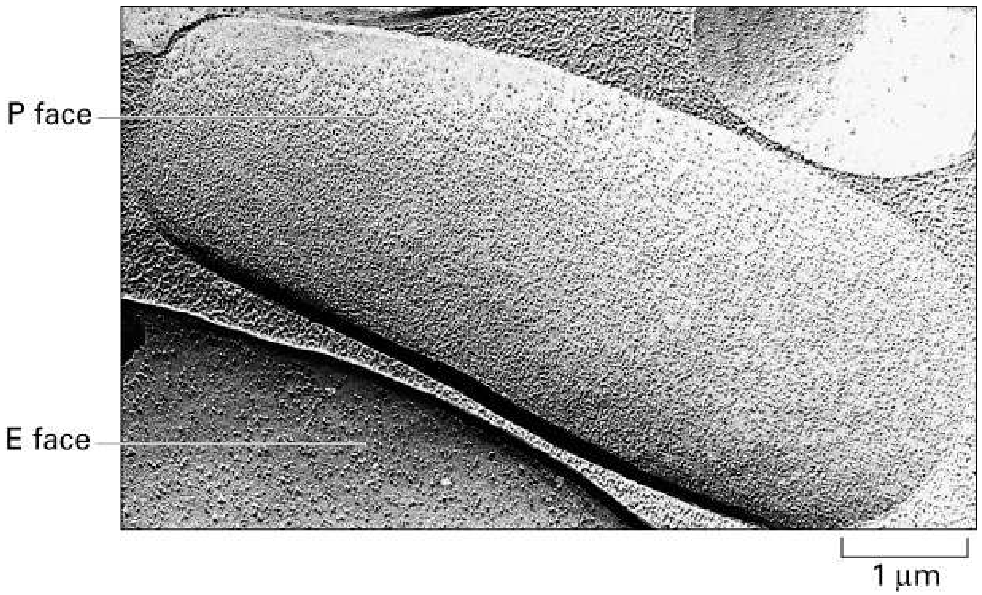


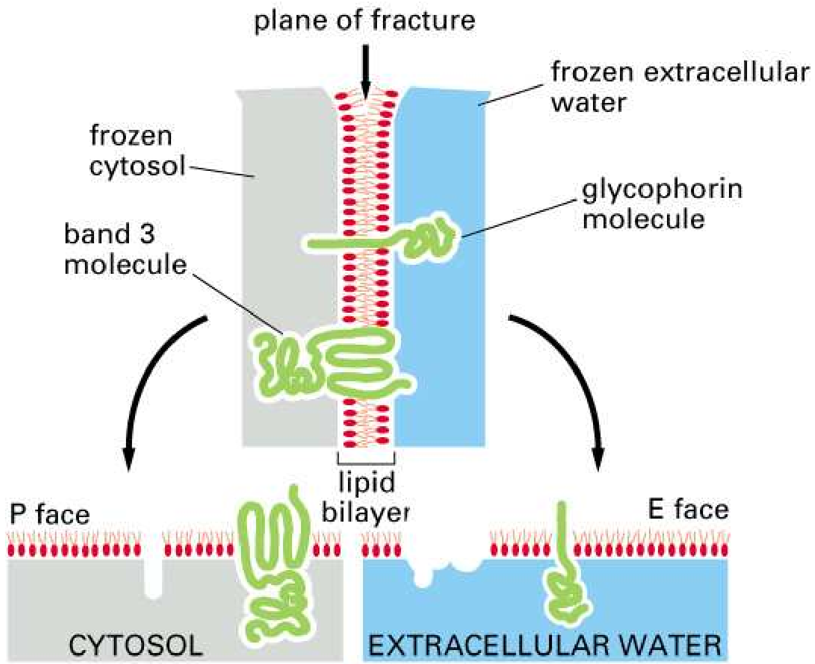
(*Fluorescence loss in photobleaching*)



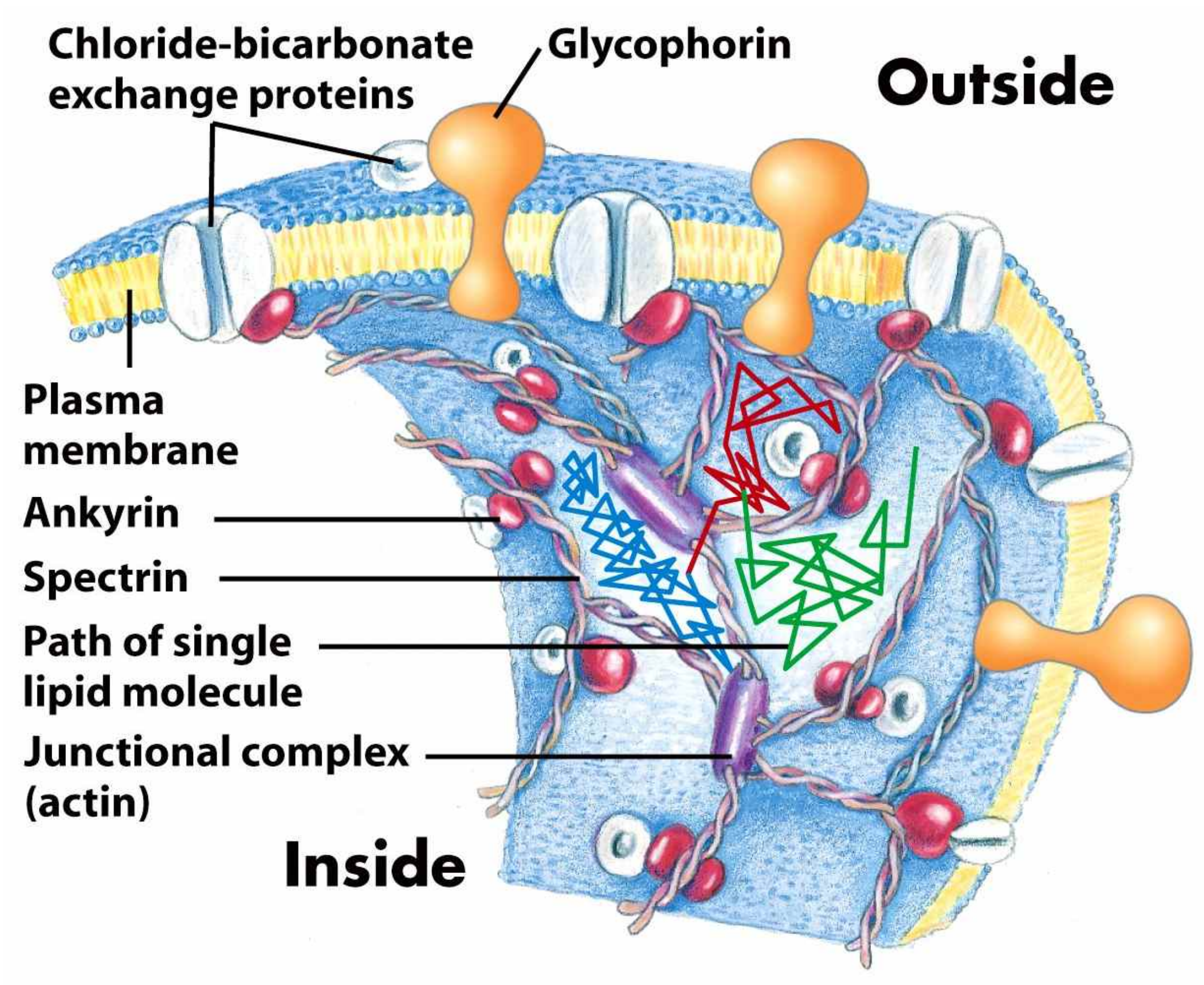
Freeze-fracture technique







Restricted motion of the erythrocyte chloride-bicarbonate exchanger



Membrane proteins

perform most of the specific functions of memb.
the amounts and types of proteins in a memb. are highly variable

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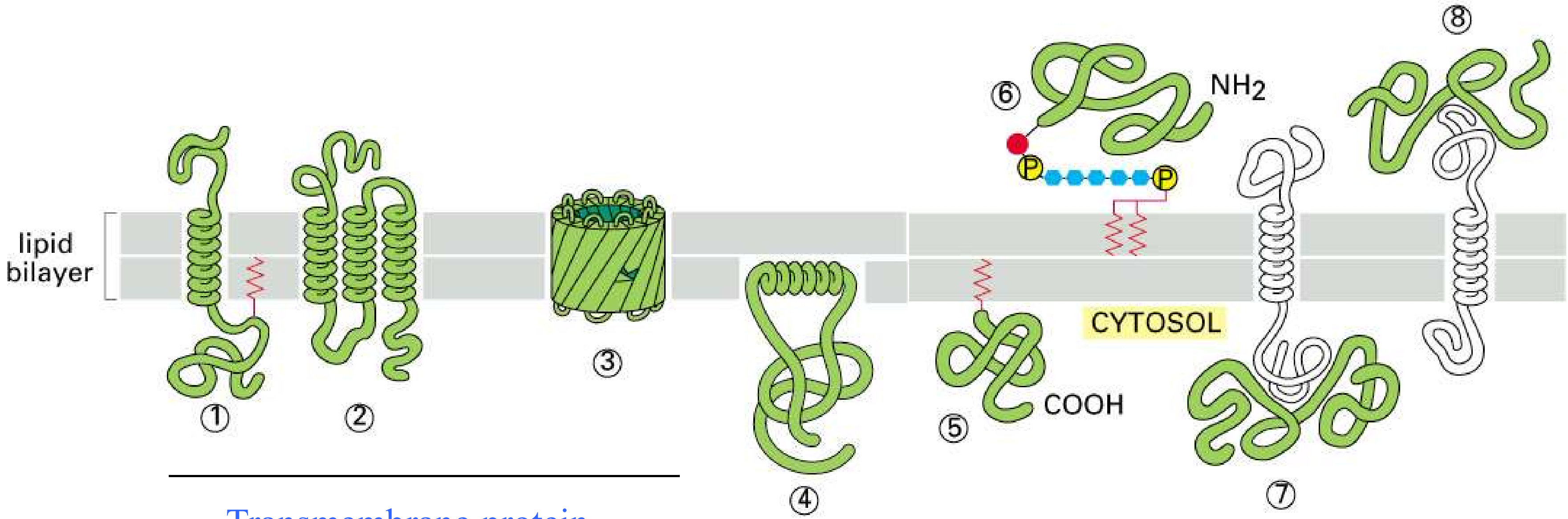
Typical plasma memb.: ~ 50% of its mass
Nerve cell axon: less than ~ 25% of memb. mass
Mitochondria inner memb.: ~ 75%

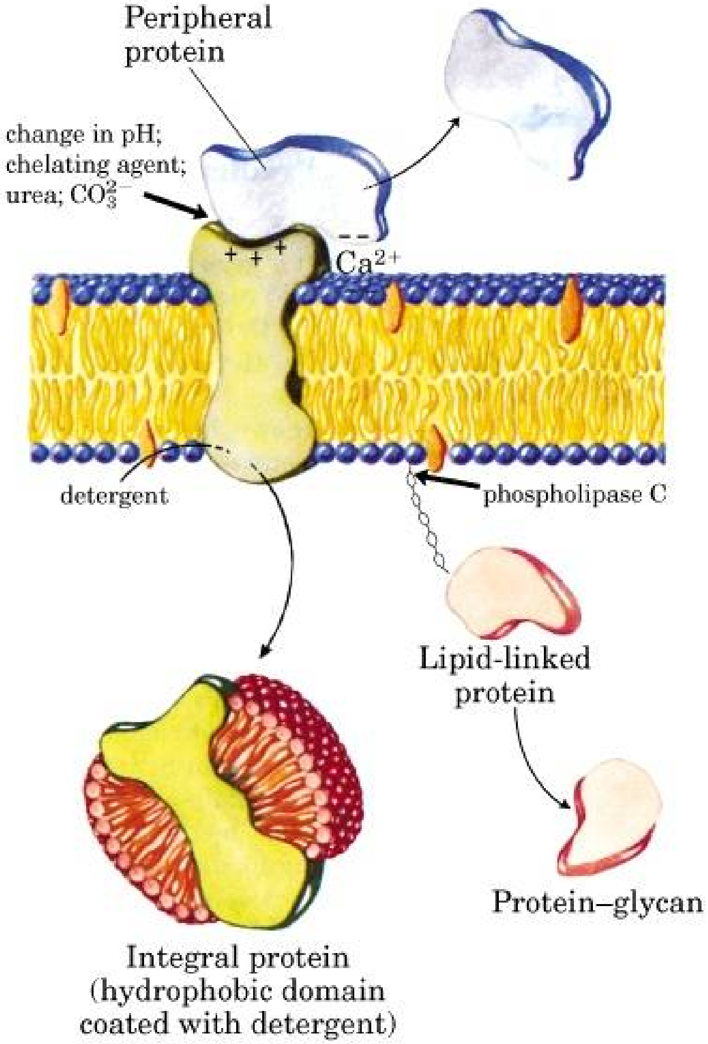
Peripheral membrane protein
Integral membrane protein
Lipid-anchored membrane protein

Membrane proteins associates with the lipid bilayer

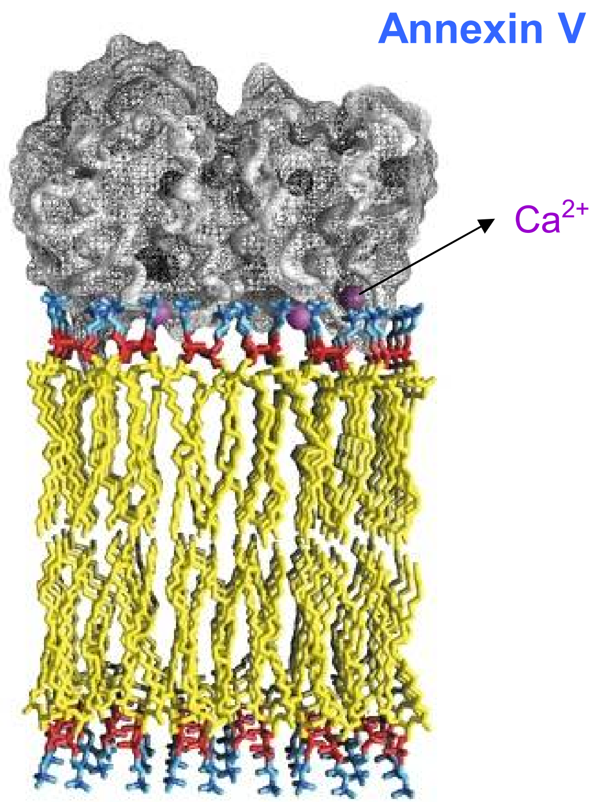


Transmembrane protein

Peripheral and integral proteins

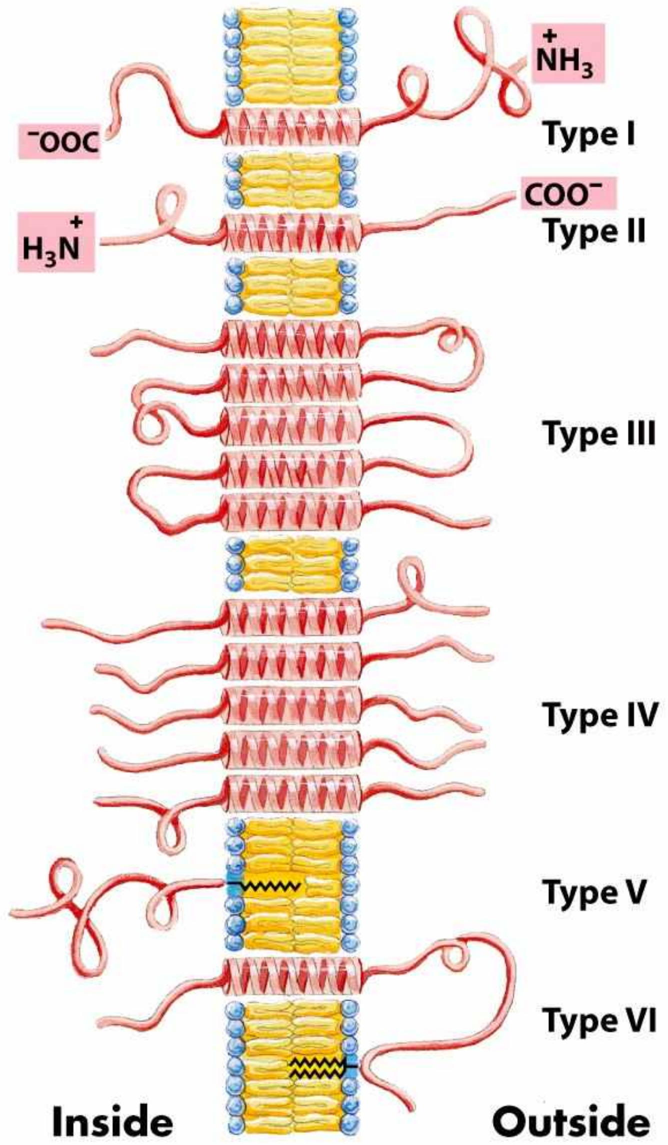


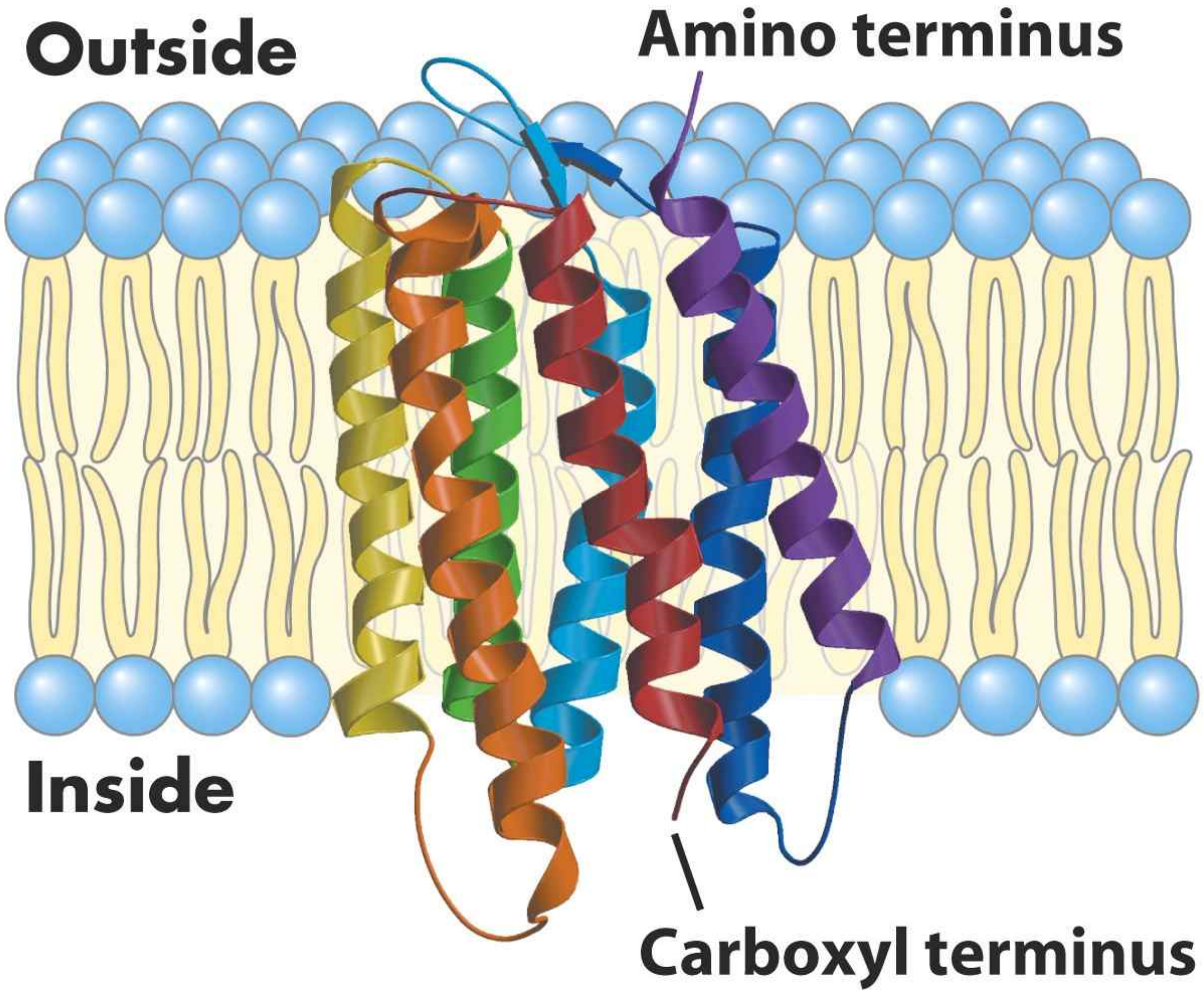
Calcium-dependent
(negative charged) phospholipid
binding protein



** propidium iodide (PI)*

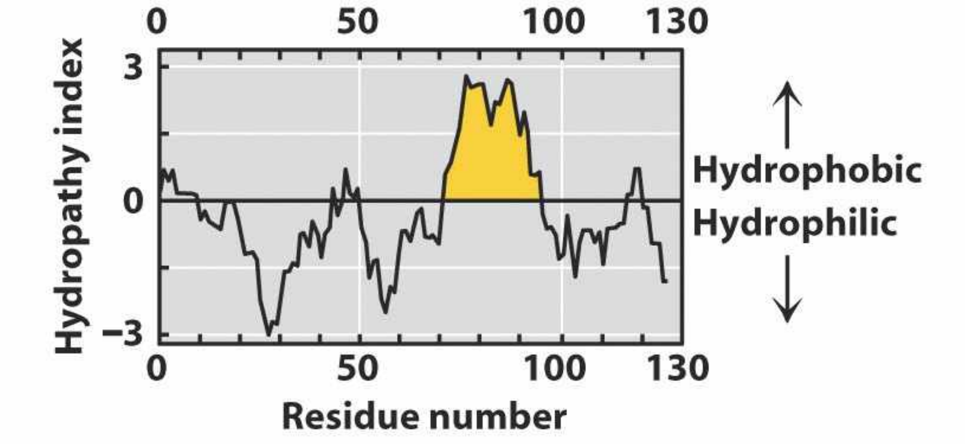
Integral membrane proteins



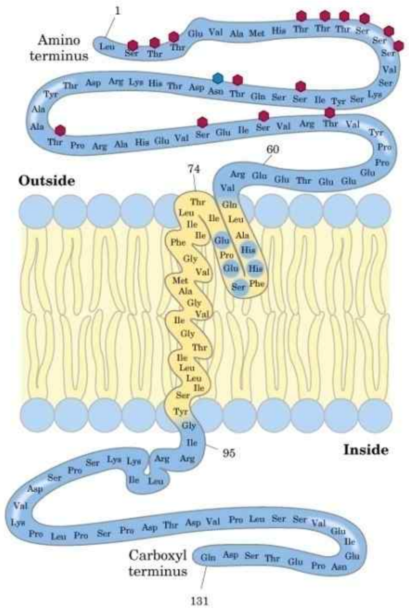


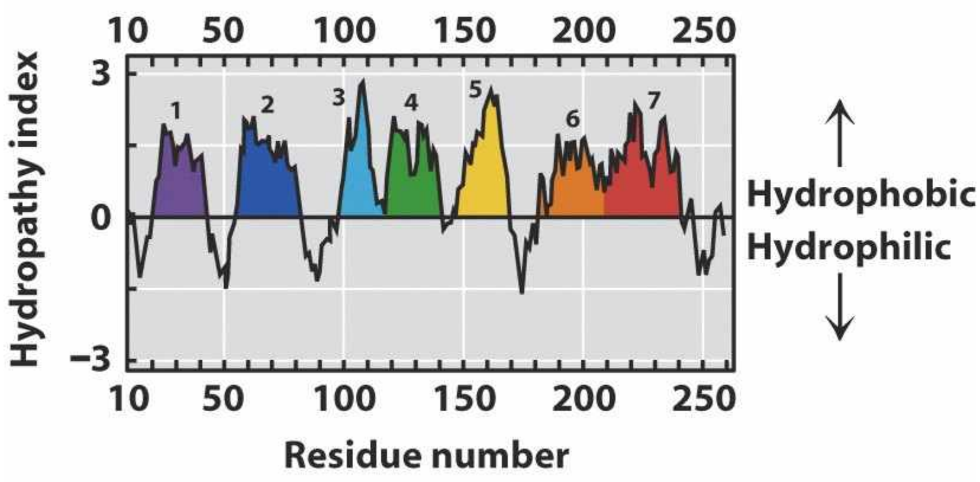
Bacteriorhodopsin
(a light-driven proton pump)

Hydropathy plots

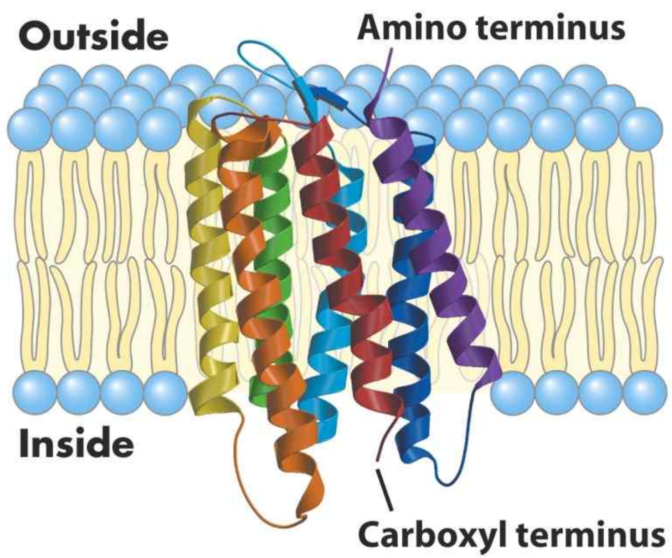


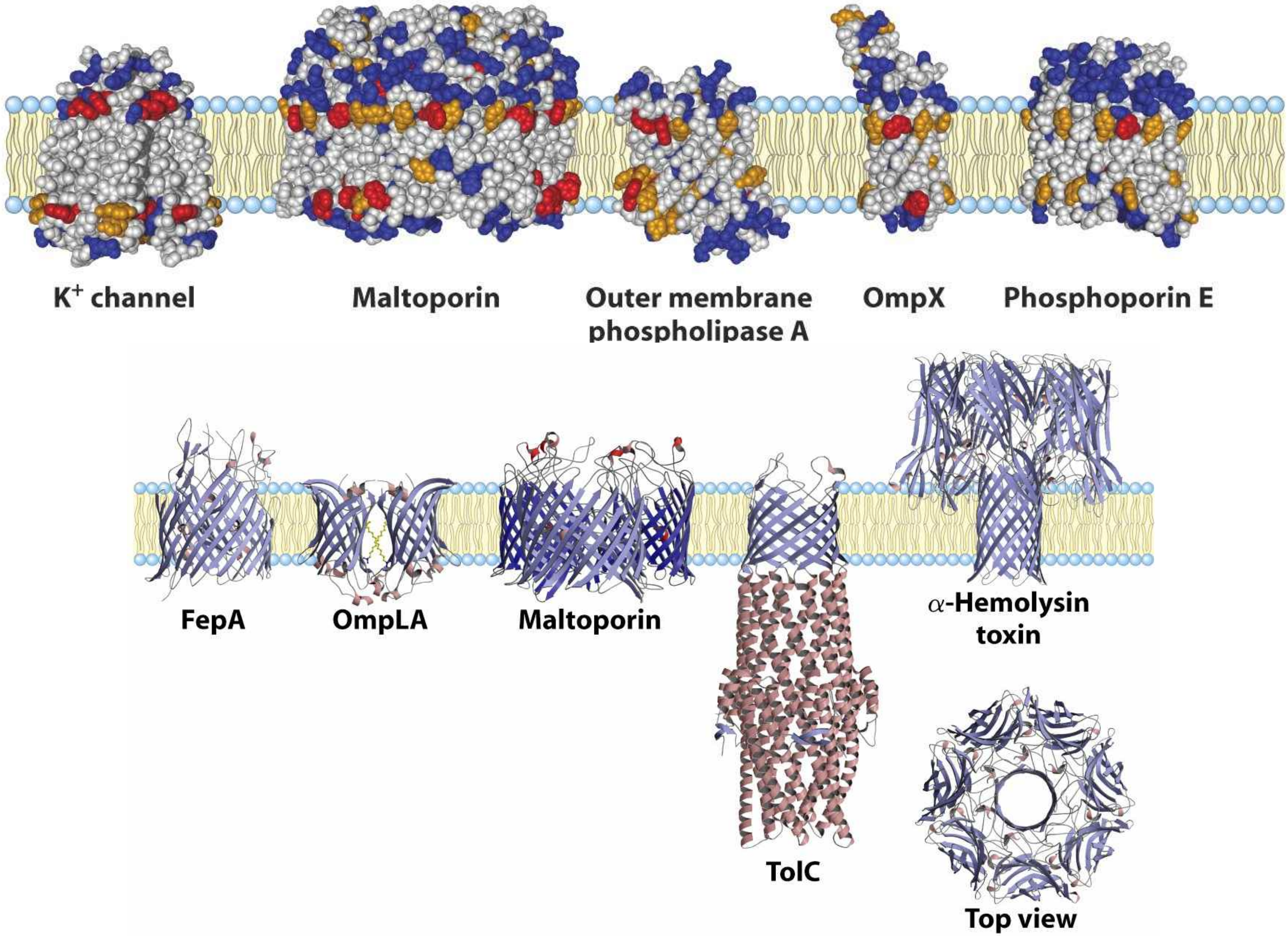
(a) Glycophorin





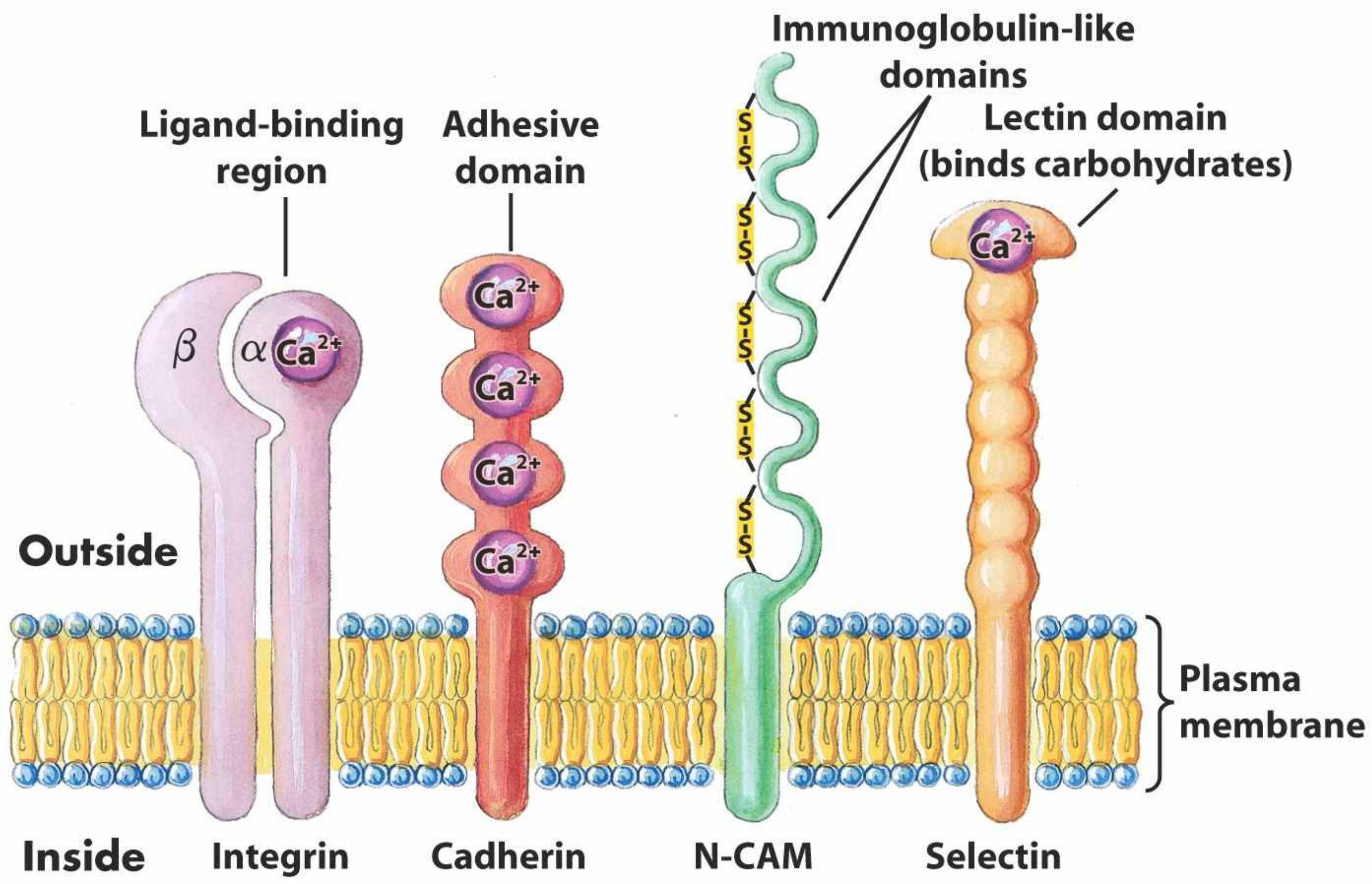
(b) Bacteriorhodopsin



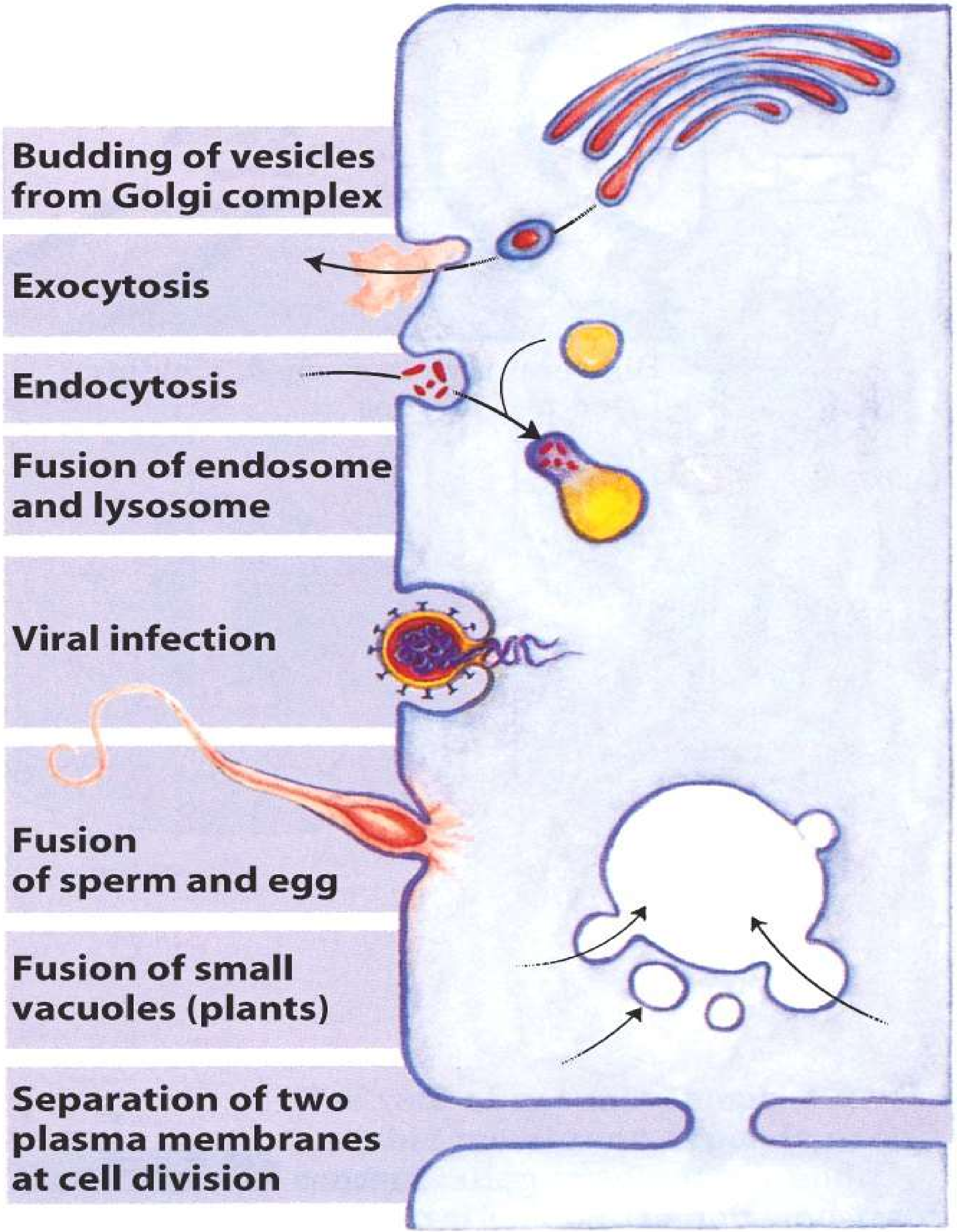


K+ channel
Maltoporin
Outer membrane phospholipase A
OmpX
Phosphoporin E
FepA
OmpLA
Maltoporin
TolC
α-Hemolysin toxin
Top view

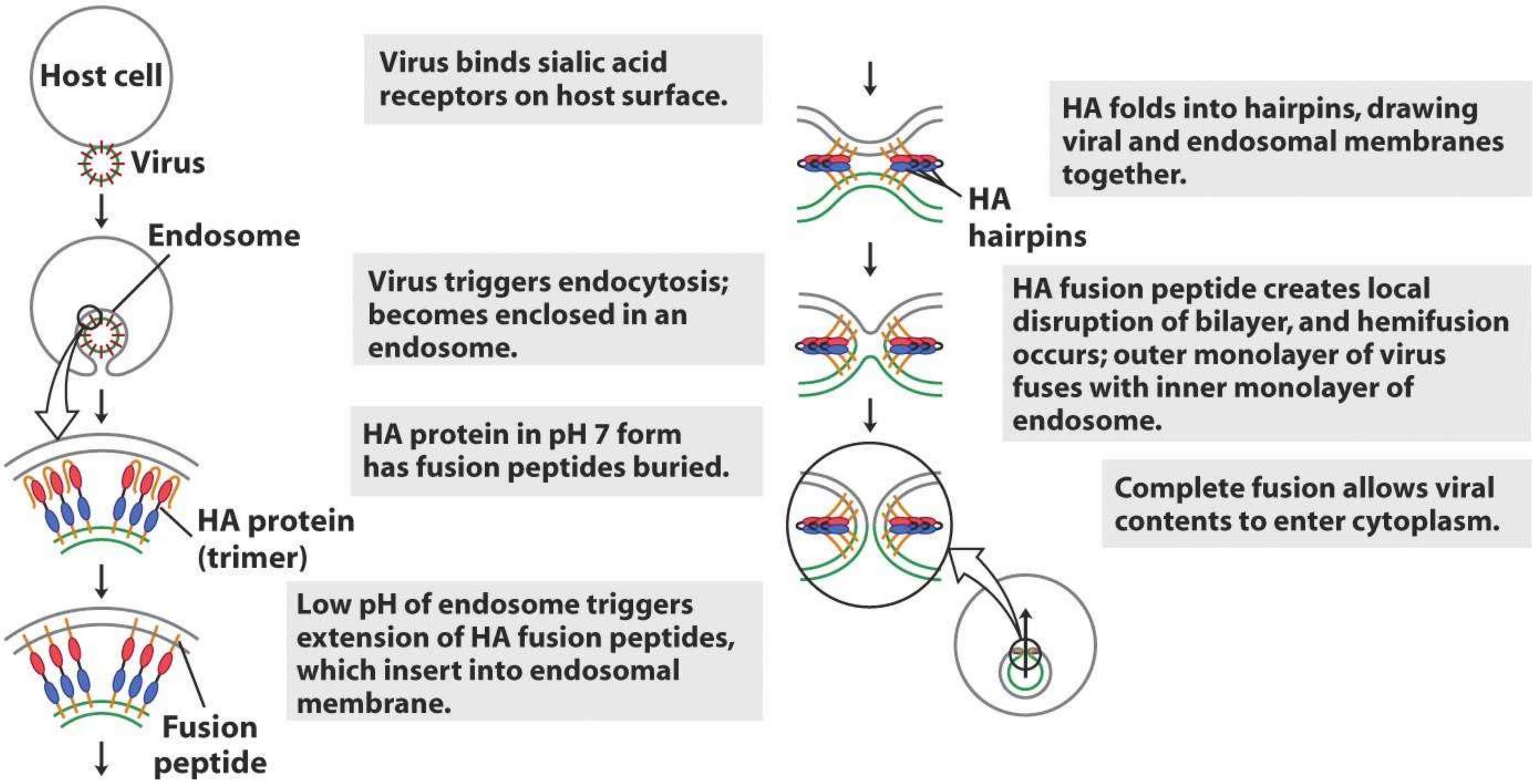
Integral proteins mediate cell-cell interactions and adhesion

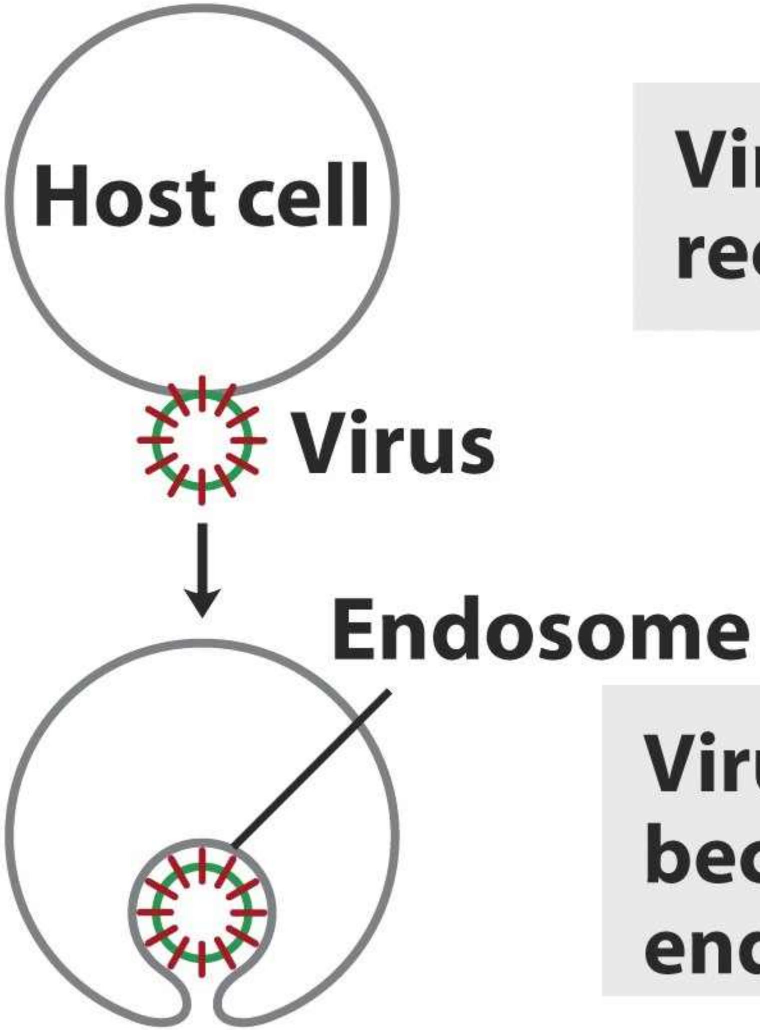


Membrane fusion is central to many biological processes



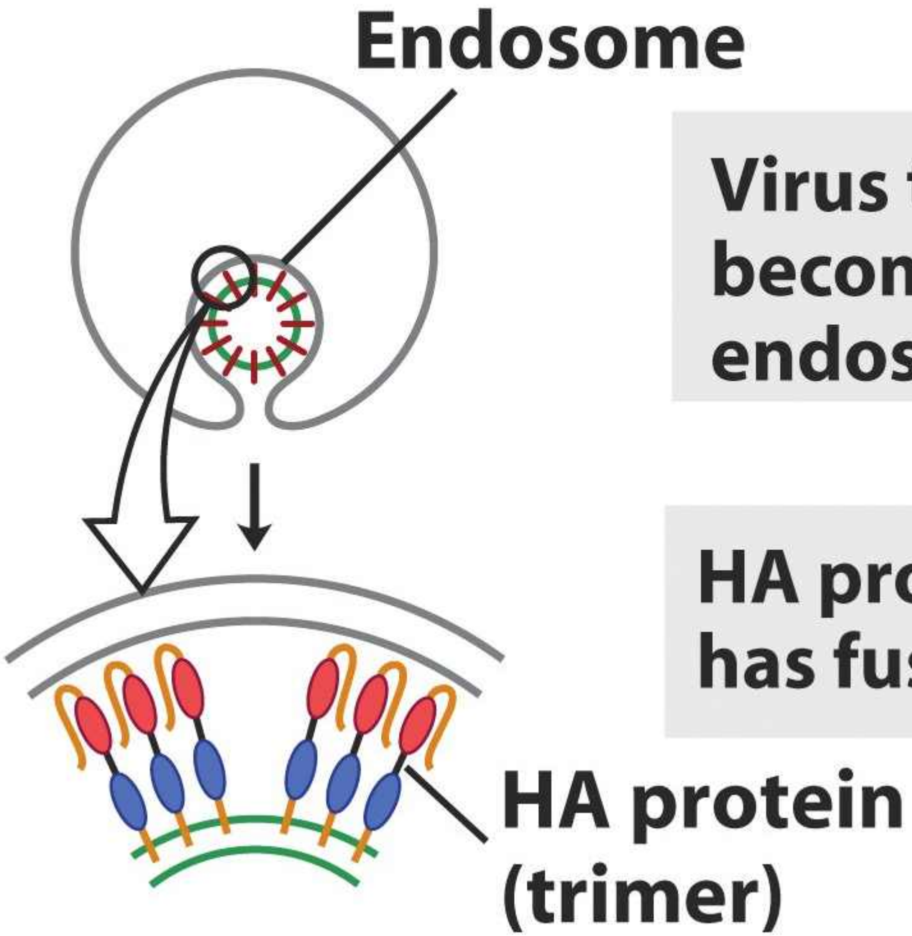
Membrane fusion during viral entry into a host cell





Virus binds sialic acid receptors on host surface.

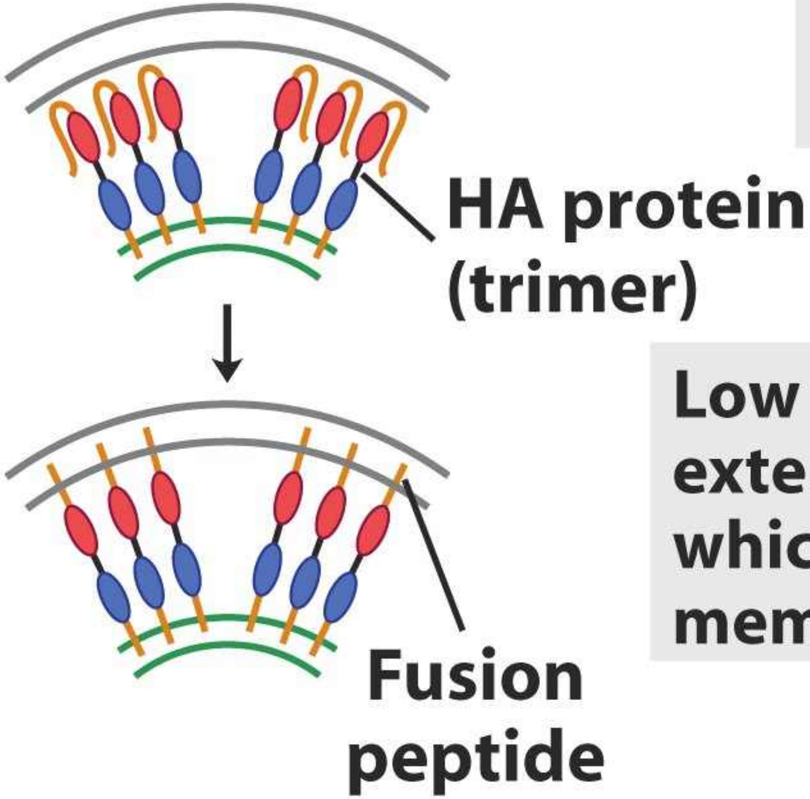
Virus triggers endocytosis; becomes enclosed in an endosome.



Virus triggers endocytosis; becomes enclosed in an endosome.

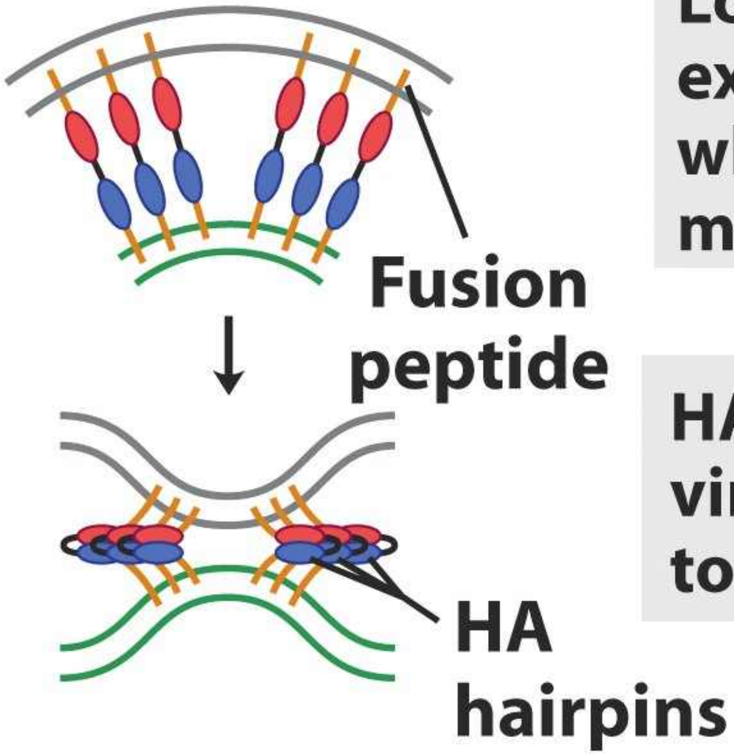
HA protein in pH 7 form has fusion peptides buried.

HA: hemagglutinin



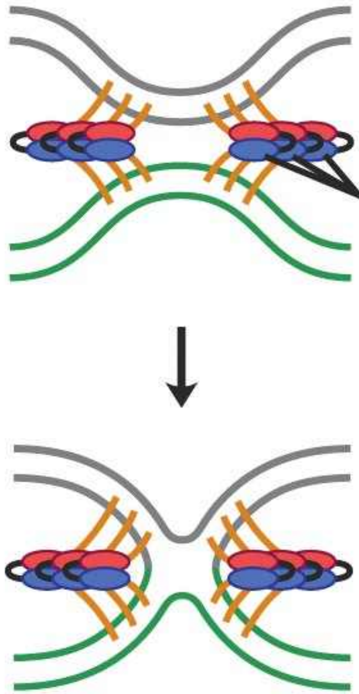
HA protein in pH 7 form has fusion peptides buried.

Low pH of endosome triggers extension of HA fusion peptides, which insert into endosomal membrane.



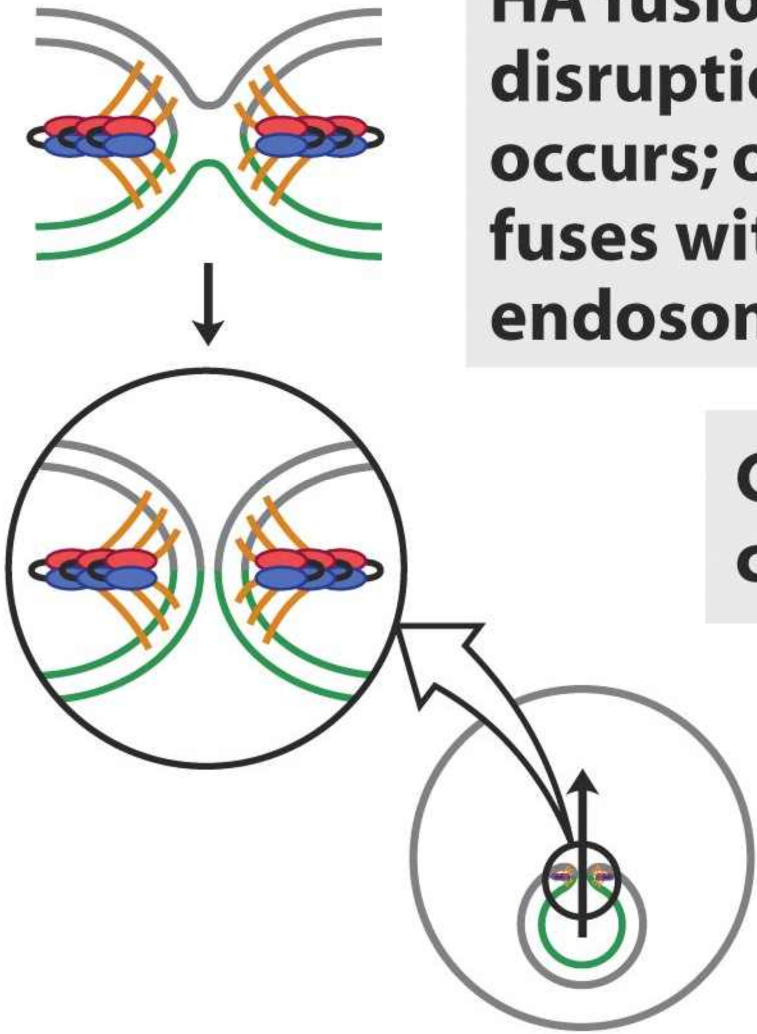
Low pH of endosome triggers extension of HA fusion peptides, which insert into endosomal membrane.

HA folds into hairpins, drawing viral and endosomal membranes together.



HA folds into hairpins, drawing viral and endosomal membranes together.

HA fusion peptide creates local disruption of bilayer, and hemifusion occurs; outer monolayer of virus fuses with inner monolayer of endosome.



HA fusion peptide creates local disruption of bilayer, and hemifusion occurs; outer monolayer of virus fuses with inner monolayer of endosome.

Complete fusion allows viral contents to enter cytoplasm.

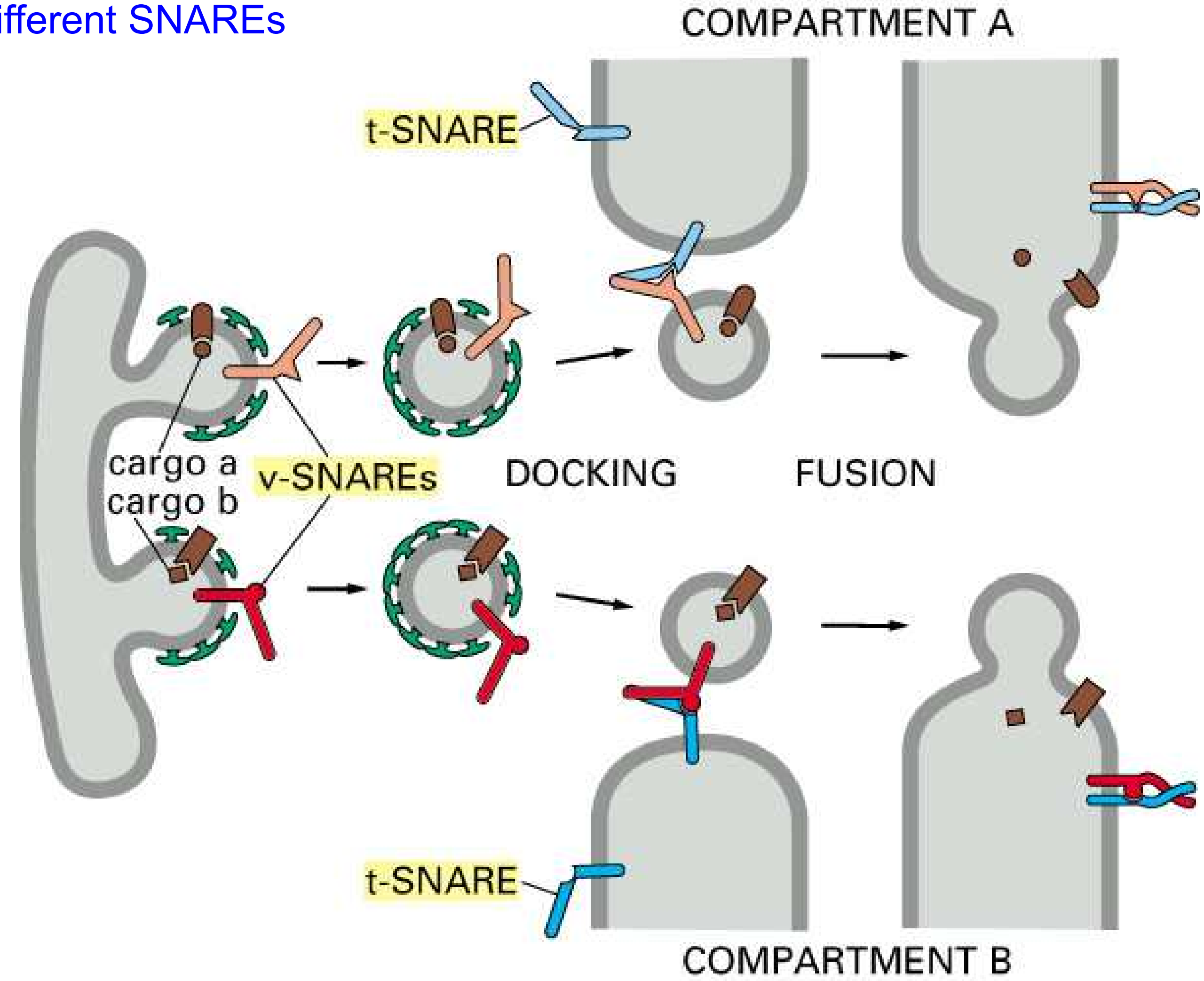
* Influenza viruse (AI, SI)

H: hemagglutinin (16)
N: neuraminidase (9)

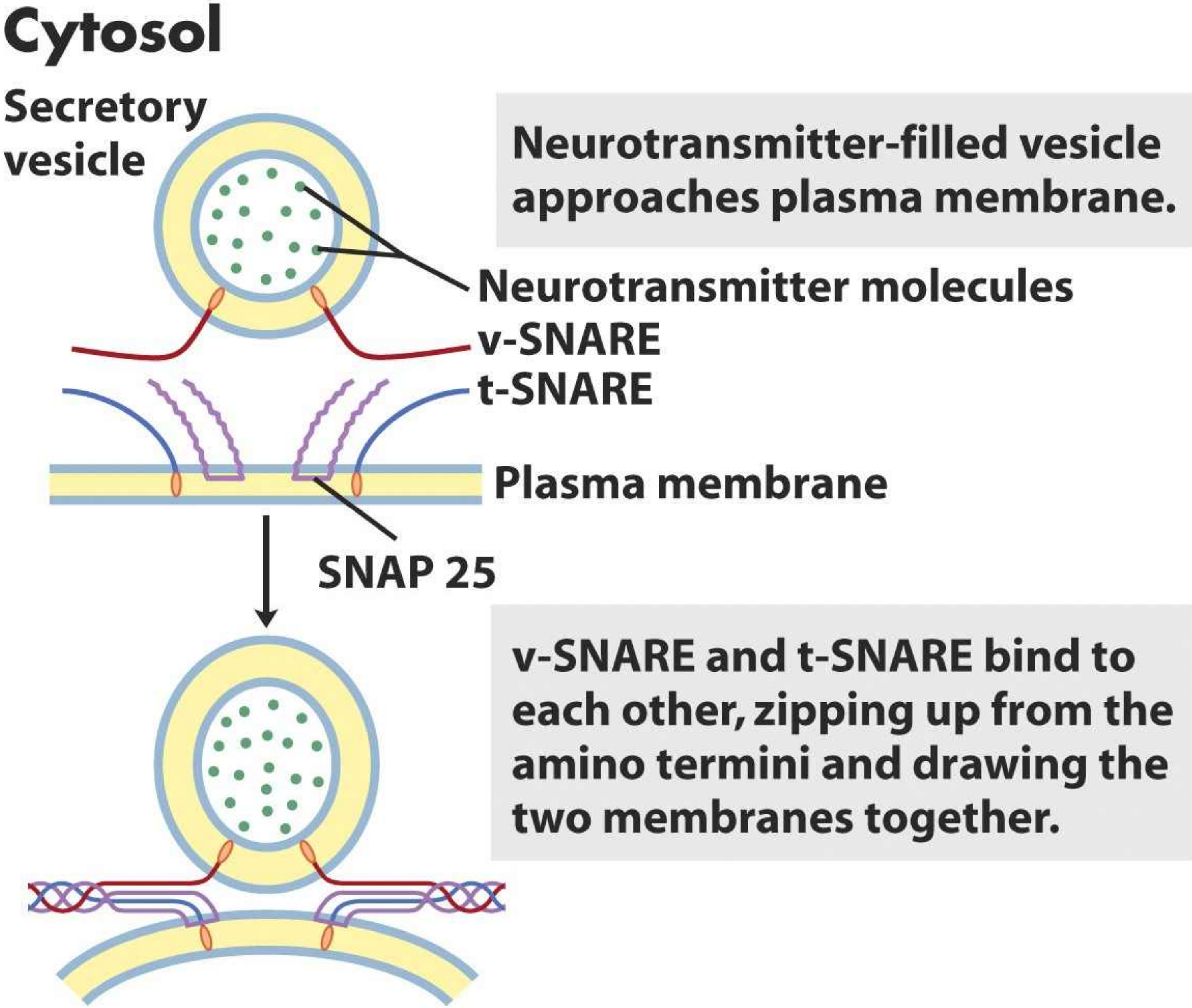
The role of SNAREs in guiding vesicular transport

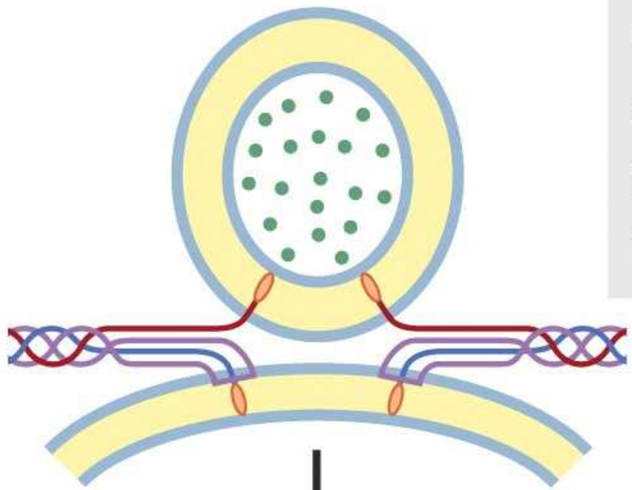
(SNAREs and targeting GTPase, *Rabs*)

> 20 different SNAREs



* SNARE: Soluble N-ethylmaleimide-sensitive factor Attachment protein Receptor


Cytosol
Secretory vesicle
Neurotransmitter-filled vesicle approaches plasma membrane.
Neurotransmitter molecules
v-SNARE
t-SNARE
Plasma membrane
SNAP 25
v-SNARE and t-SNARE bind to each other, zipping up from the amino termini and drawing the two membranes together.



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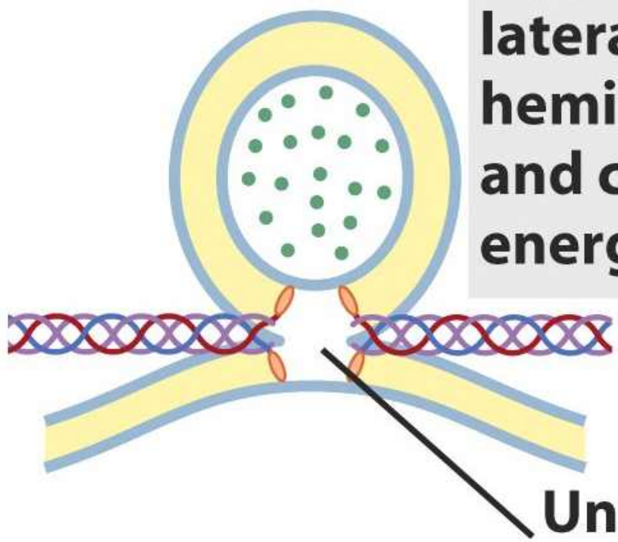
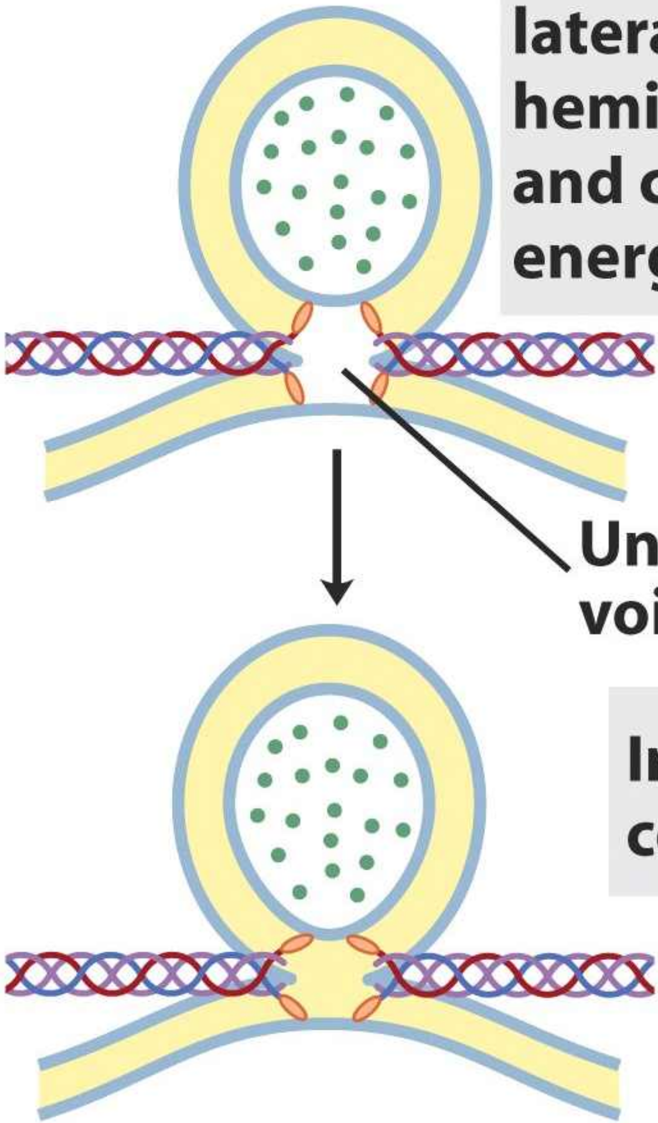
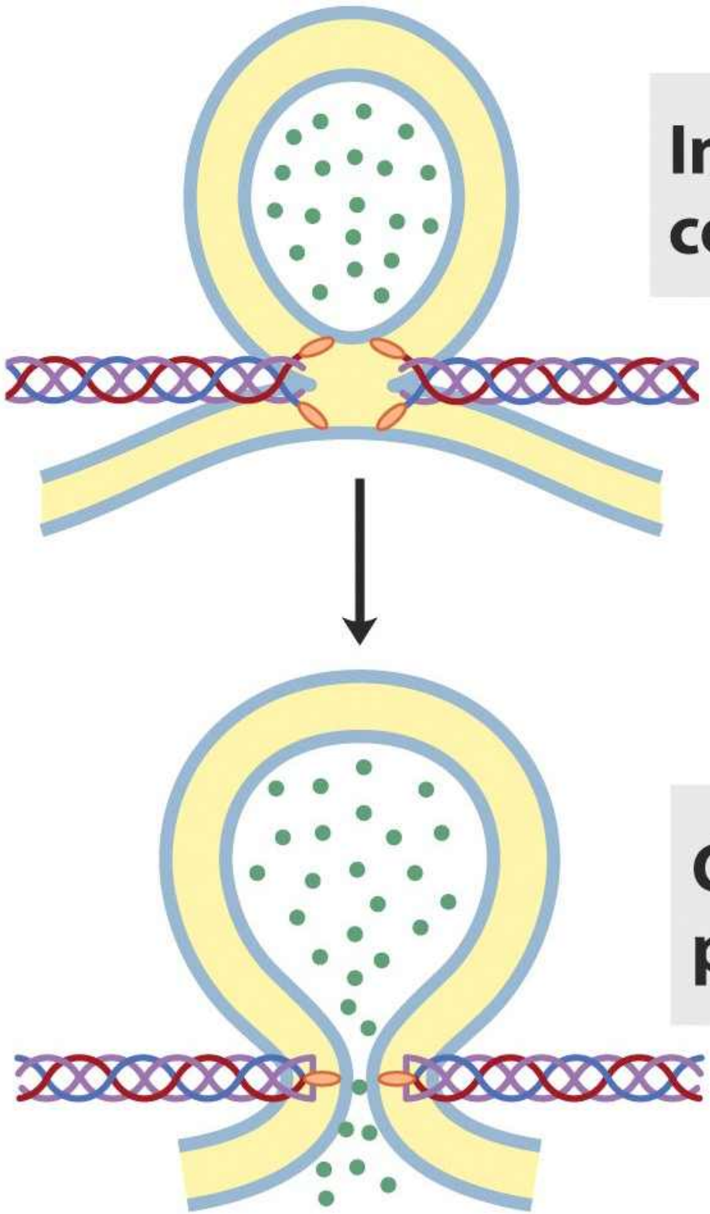


Zipping causes curvature and lateral tension on bilayers, favoring hemifusion between outer leaflets and causing formation of an energetically unfavorable void space.

Zipping causes curvature and lateral tension on bilayers, favoring hemifusion between outer leaflets and causing formation of an energetically unfavorable void space.

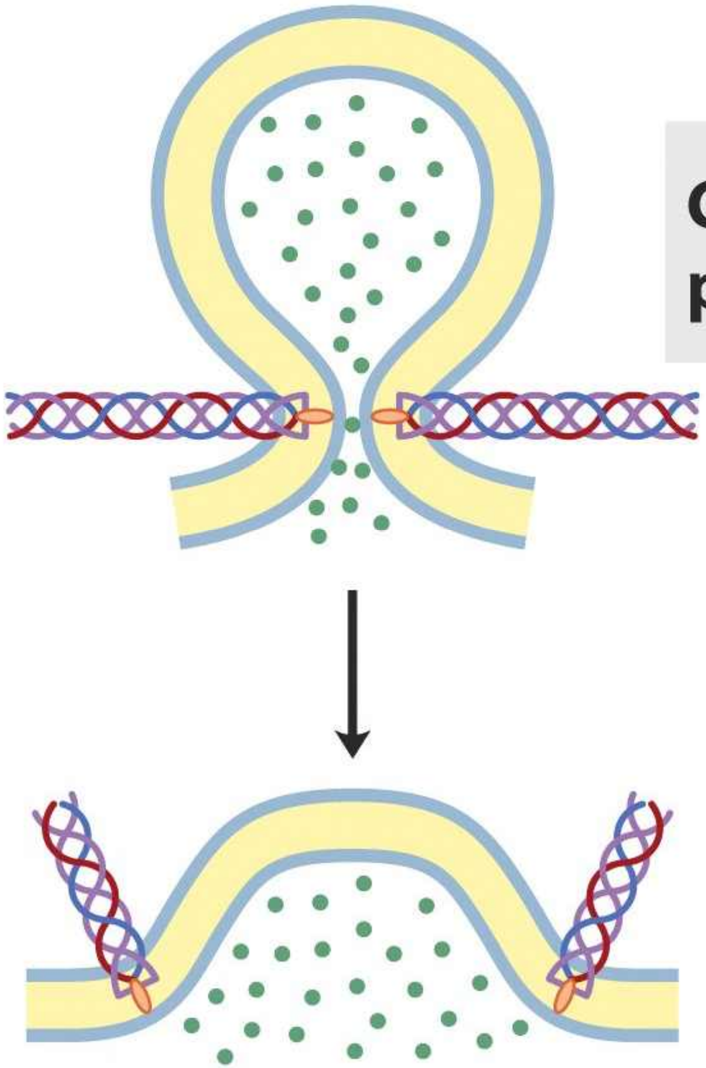


Inner leaflets of both membranes come into contact.



Inner leaflets of both membranes come into contact.

Complete fusion creates a fusion pore.



Complete fusion creates a fusion pore.

Pore widens; vesicle contents are released outside cell.