Membranes and proteins

Andrei Leitão

Lipids

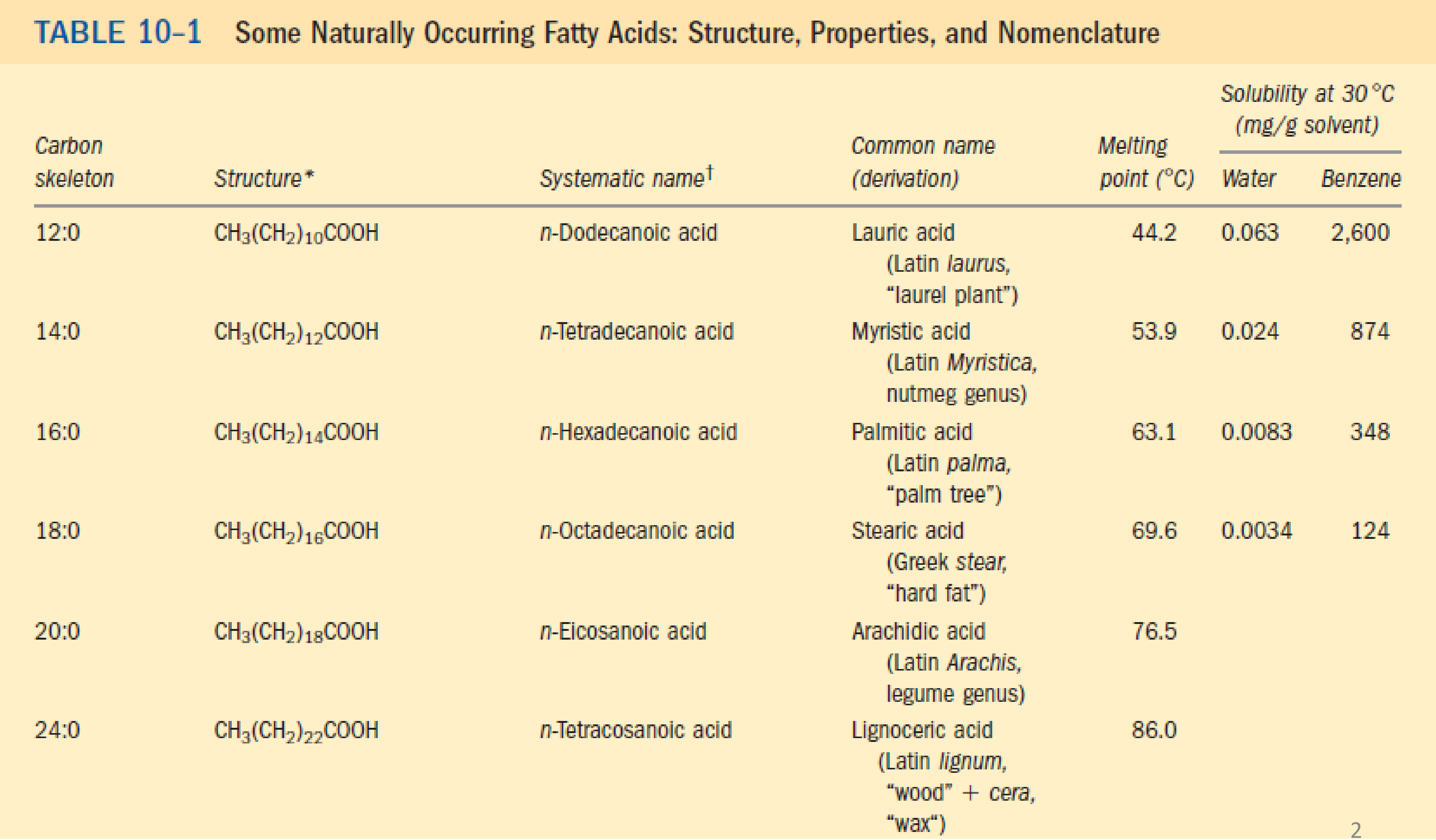
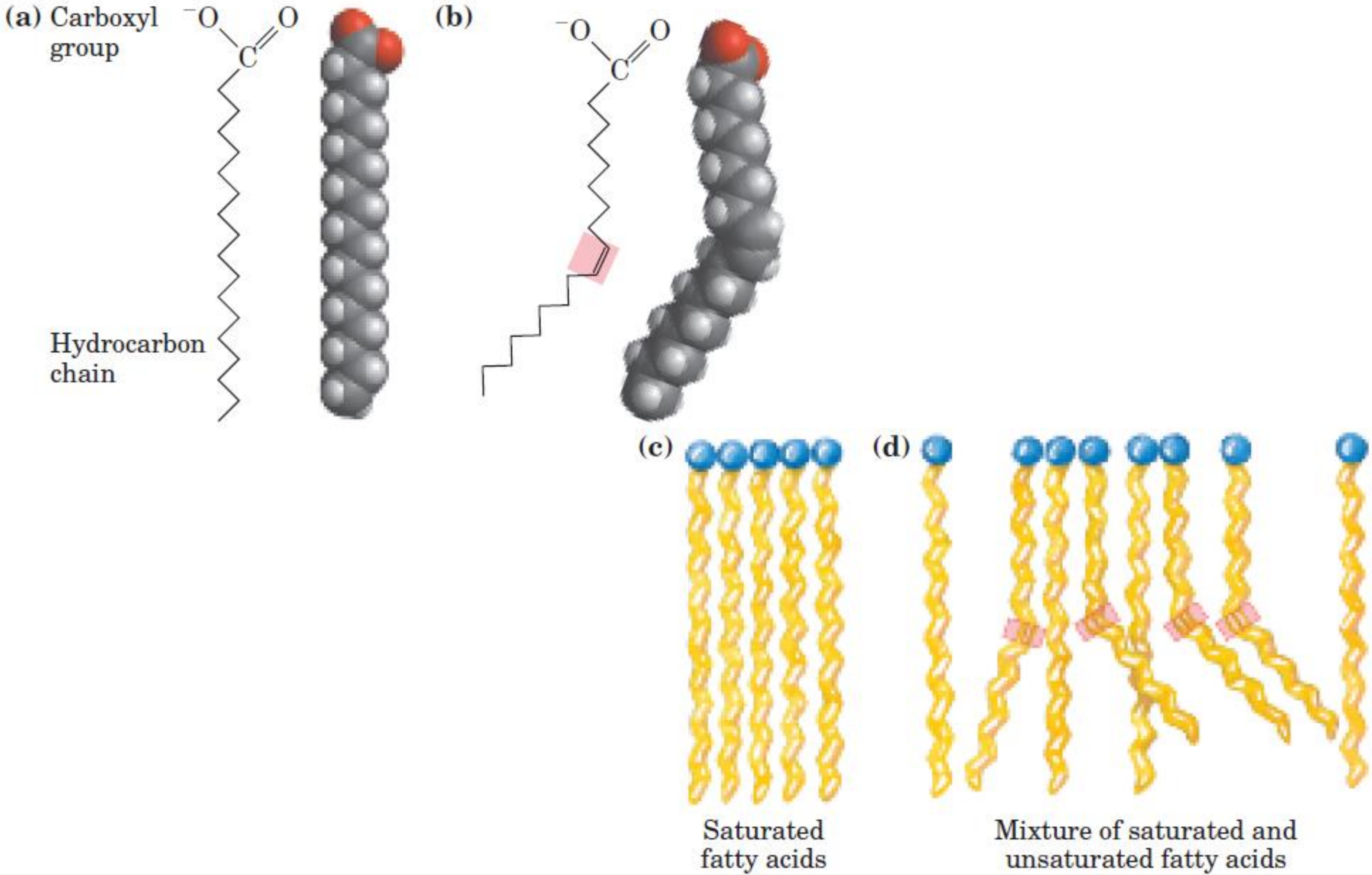


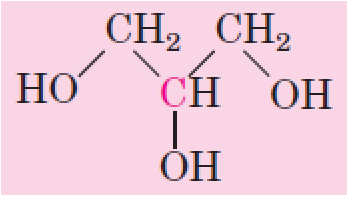
TABLE 10–1 Some Naturally Occurring Fatty Acids: Structure, Properties, and Nomenclature

Carbon skeleton	Structure*	Systematic name[†]	Common name (derivation)	Melting point (°C)	Solubility at 30 °C (mg/g solvent)	
					Water	Benzene
12:0	$CH_3(CH_2)_{10}COOH$	*n*-Dodecanoic acid	Lauric acid (Latin *laurus*, "laurel plant")	44.2	0.063	2,600
14:0	$CH_3(CH_2)_{12}COOH$	*n*-Tetradecanoic acid	Myristic acid (Latin *Myristica*, nutmeg genus)	53.9	0.024	874
16:0	$CH_3(CH_2)_{14}COOH$	*n*-Hexadecanoic acid	Palmitic acid (Latin *palma*, "palm tree")	63.1	0.0083	348
18:0	$CH_3(CH_2)_{16}COOH$	*n*-Octadecanoic acid	Stearic acid (Greek *stear*, "hard fat")	69.6	0.0034	124
20:0	$CH_3(CH_2)_{18}COOH$	*n*-Eicosanoic acid	Arachidic acid (Latin *Arachis*, legume genus)	76.5		
24:0	$CH_3(CH_2)_{22}COOH$	*n*-Tetracosanoic acid	Lignoceric acid (Latin *lignum*, "wood" + *cera*, "wax")	86.0		

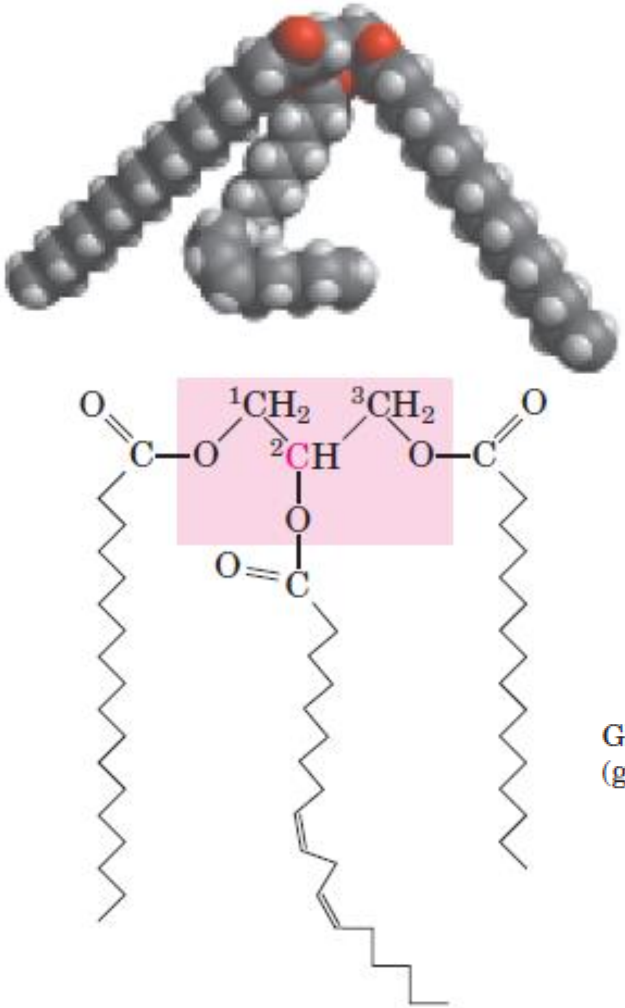
Fatty acids


(a) Carboxyl group
$^-$O
O
C
Hydrocarbon chain
(b)
$^-$O
O
C
(c)
(d)
Saturated fatty acids
Mixture of saturated and unsaturated fatty acids

Glycerol and triacylglycerol

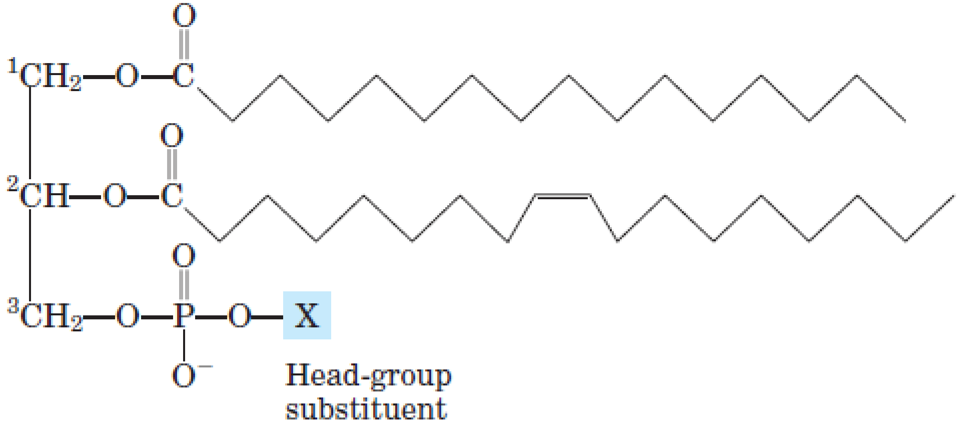


Glycerol



1-Stearoyl, 2-linoleoyl, 3-palmitoyl glycerol,
a mixed triacylglycerol

Glycerophospholipid
(general structure)



Phosphatidylipids

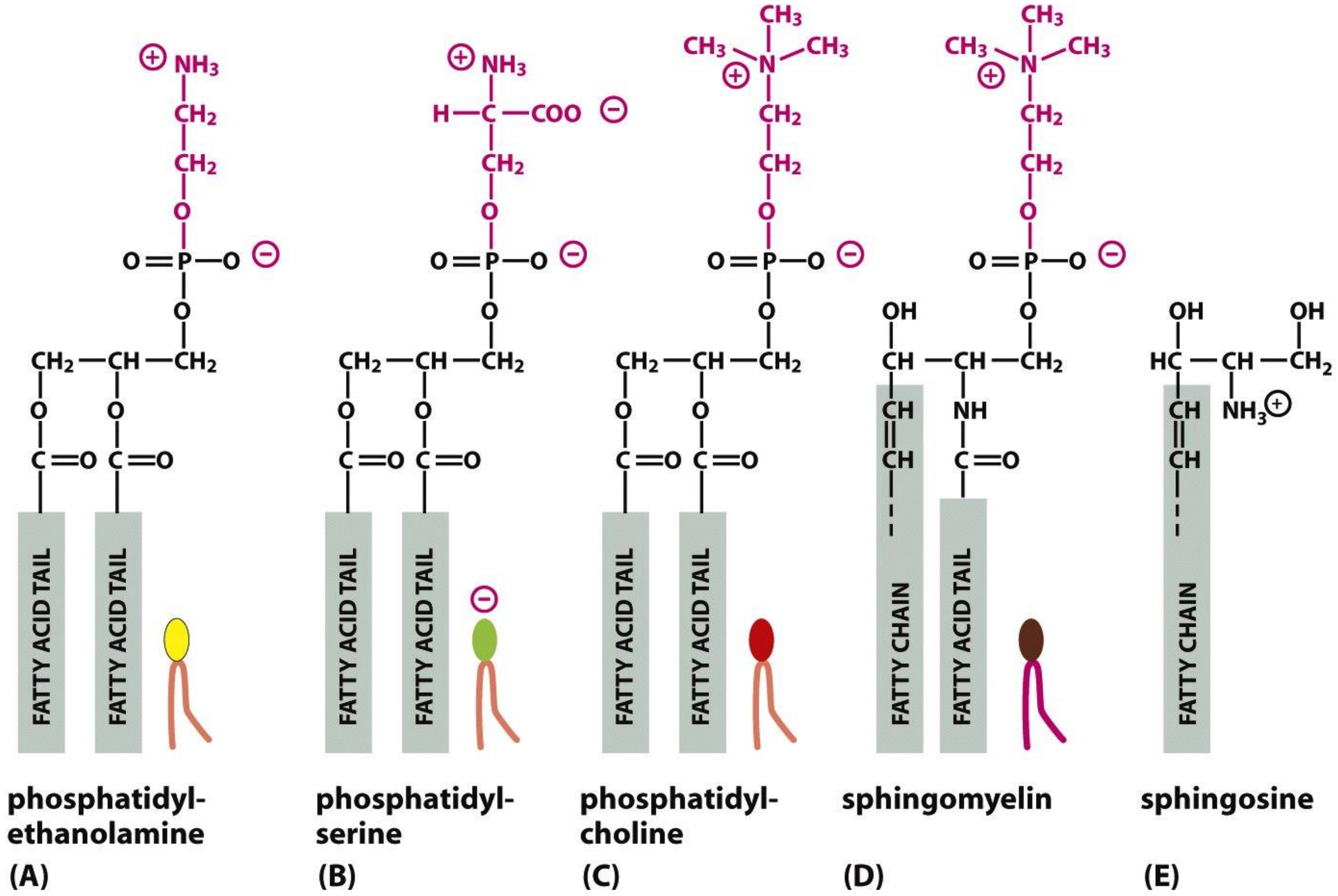


Figure 10-3 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Cholesterol

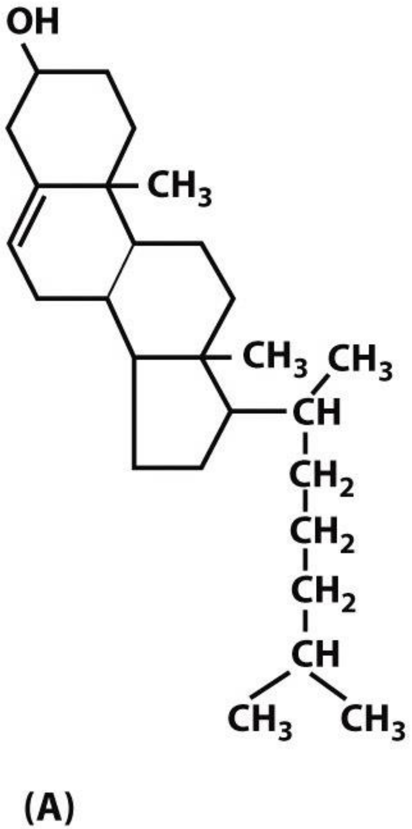


Figure 10-4 Molecular Biology of the Ce

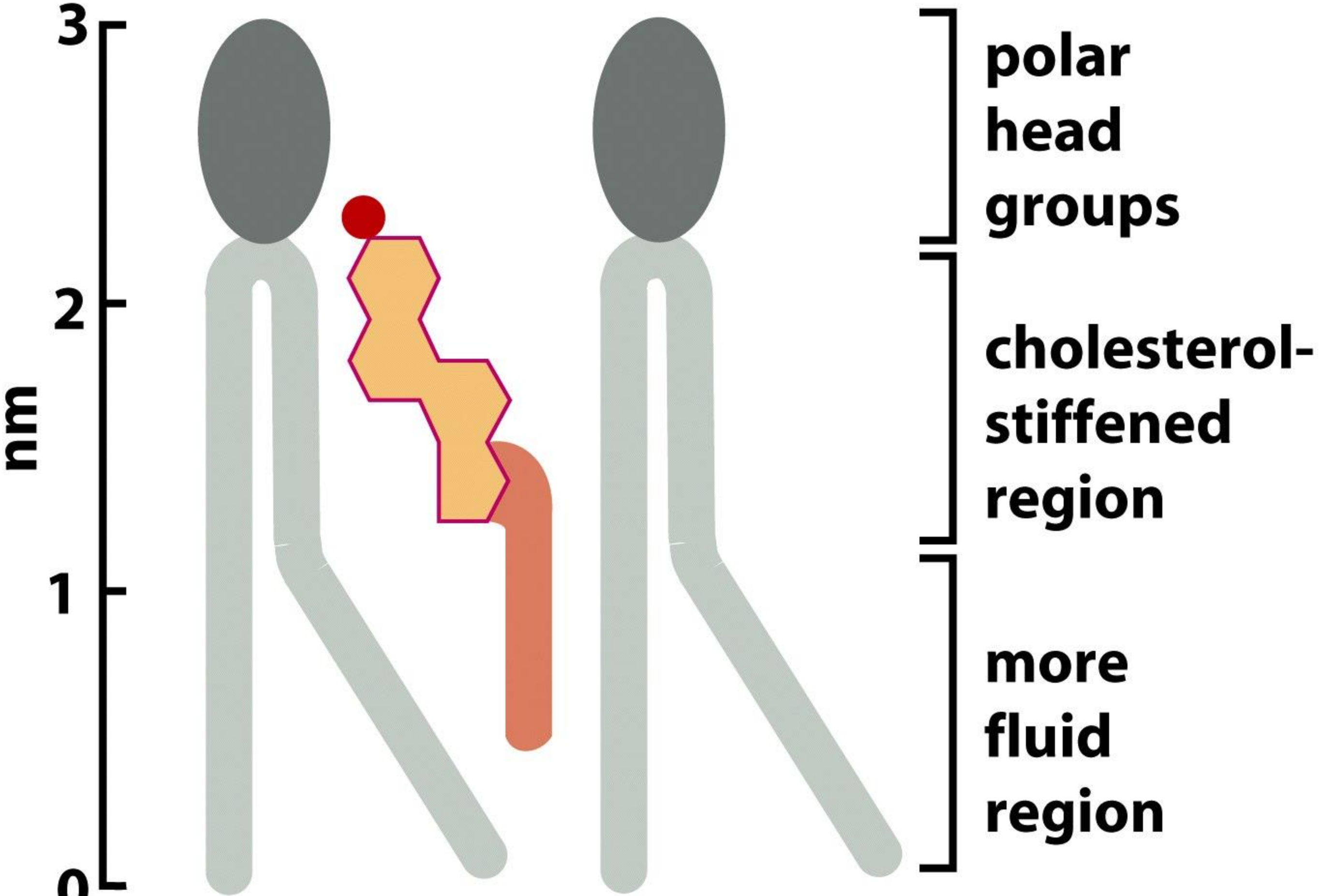
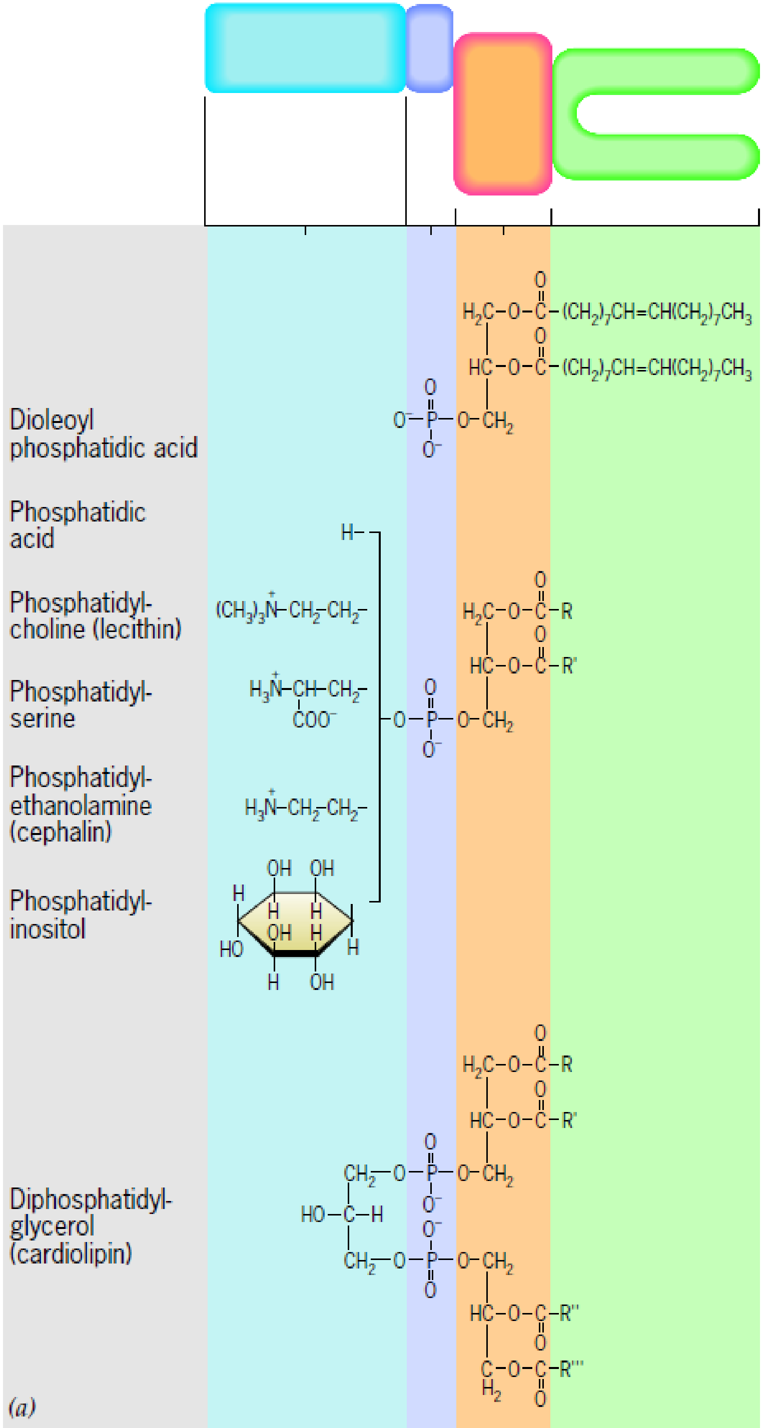
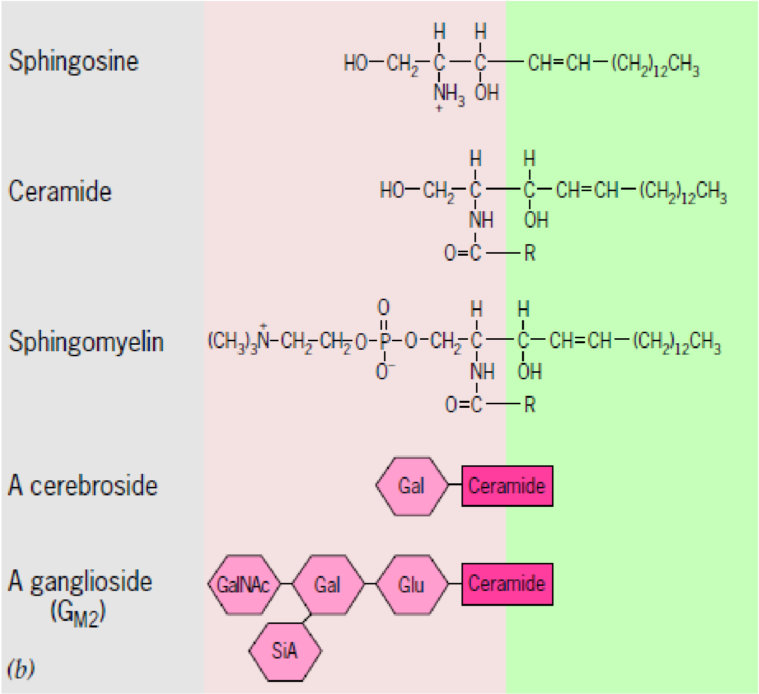


Figure 10-5 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Lipids


Dioleoyl phosphatidic acid
Phosphatidic acid
Phosphatidylcholine (lecithin)
Phosphatidylserine
Phosphatidylethanolamine (cephalin)
Phosphatidylinositol
Diphosphatidylglycerol (cardiolipin)
(a)


Sphingosine
Ceramide
Sphingomyelin
A cerebroside
Gal
Ceramide
A ganglioside (G_{M2})
GalNAc
Gal
Glu
Ceramide
SiA
(b)

Composition of cell membranes

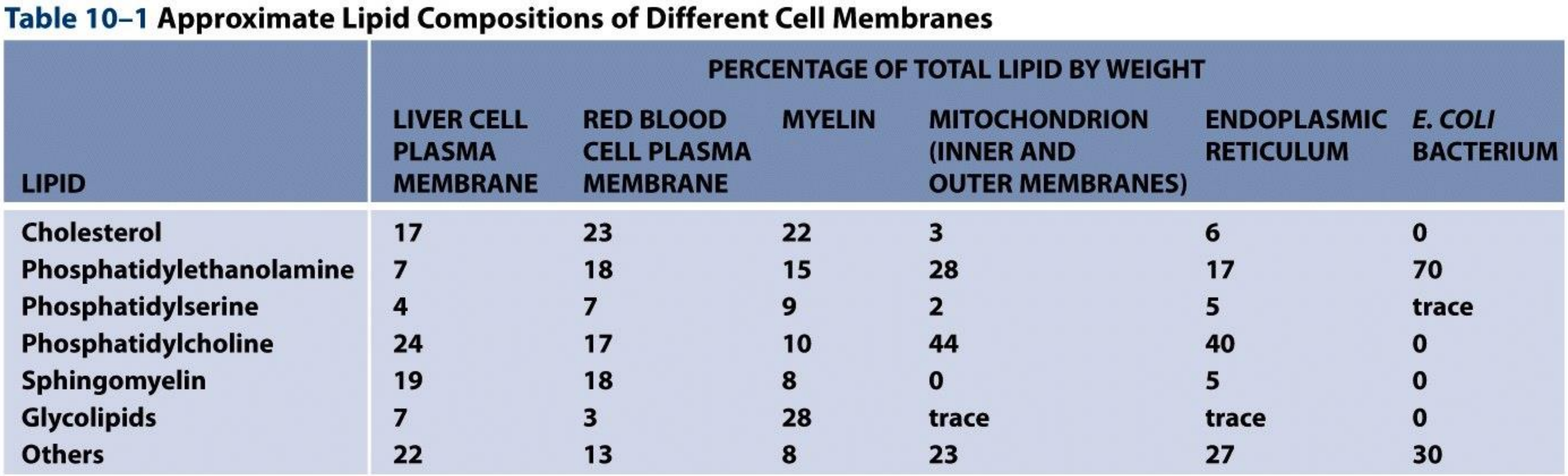


Table 10–1 **Approximate Lipid Compositions of Different Cell Membranes**

	PERCENTAGE OF TOTAL LIPID BY WEIGHT					
LIPID	**LIVER CELL PLASMA MEMBRANE**	**RED BLOOD CELL PLASMA MEMBRANE**	**MYELIN**	**MITOCHONDRION (INNER AND OUTER MEMBRANES)**	**ENDOPLASMIC RETICULUM**	***E. COLI* BACTERIUM**
Cholesterol	17	23	22	3	6	0
Phosphatidylethanolamine	7	18	15	28	17	70
Phosphatidylserine	4	7	9	2	5	trace
Phosphatidylcholine	24	17	10	44	40	0
Sphingomyelin	19	18	8	0	5	0
Glycolipids	7	3	28	trace	trace	0
Others	22	13	8	23	27	30

Go figure...

Hooke’s “cell” image

Is there any error? **Yes!**

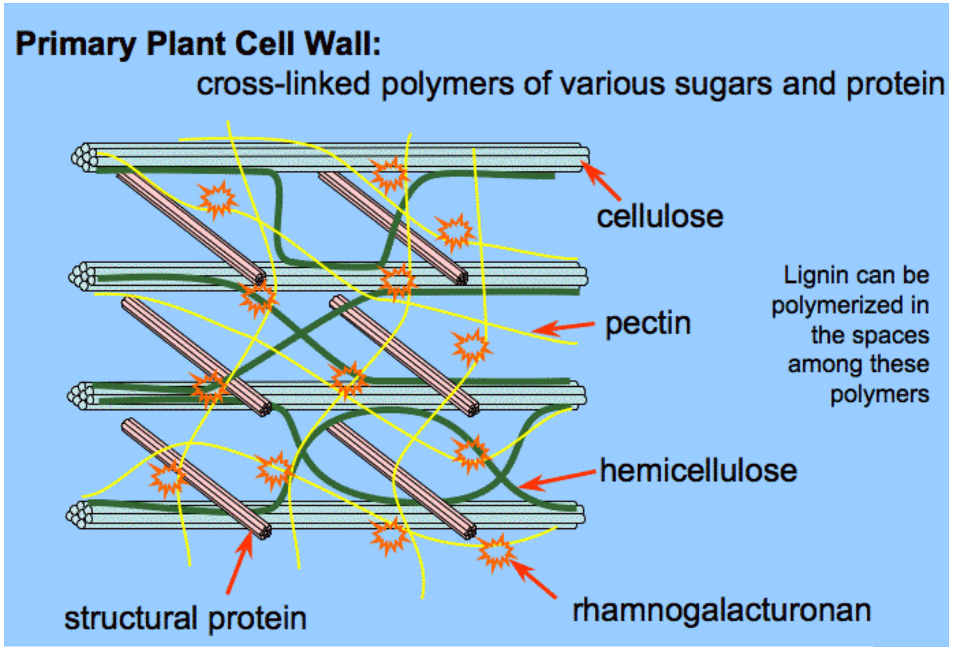
It is not a cell...
It is a cell wall of a vegetable

It is not made with lipids...
but saccharides

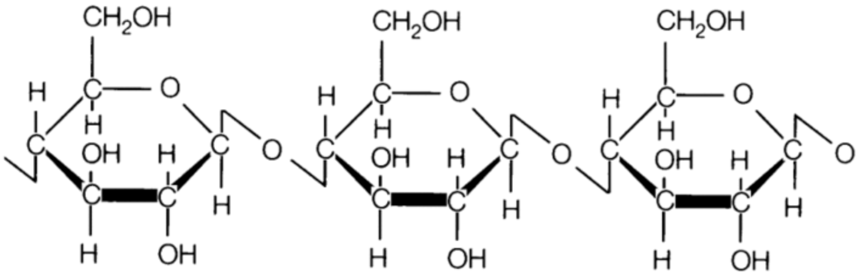
http://plantphys.info/plant_physiology/basiccytology1.shtml

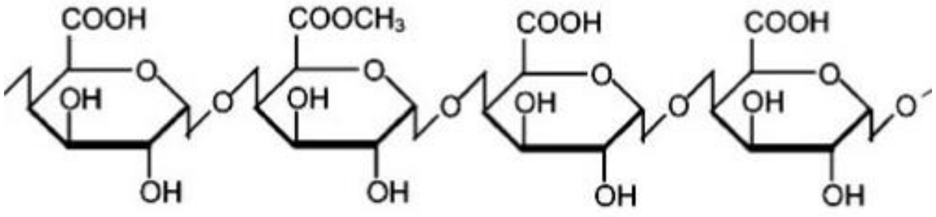
http://www.intechopen.com/books/biodegradation-life-of-science/biodegradable-polymers

The Granger Collection, New York; Inset Biophoto Associates/Getty Images, Inc.;



Primary Plant Cell Wall:
cross-linked polymers of various sugars and protein





Low methoxyl pectin

Plasma membrane

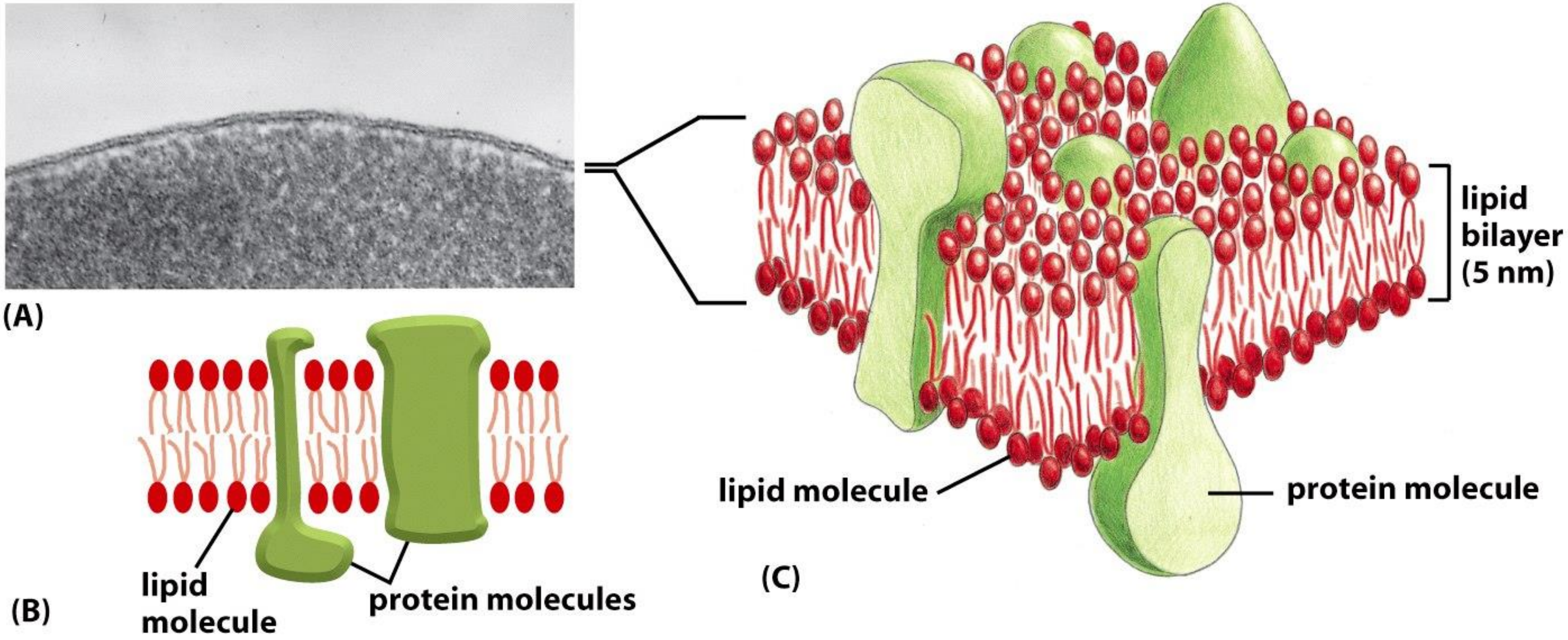


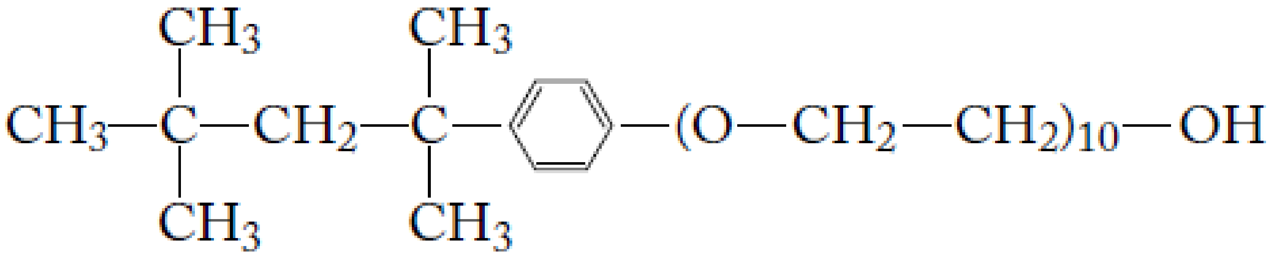
Figure 10-1 Molecular Biology of the Cell 5/e (© Garland Science 2008)

Micelle and bilayer

shape of
molec

$CH_3—(CH_2)_{11}—OSO_3^{-}Na^{+}$

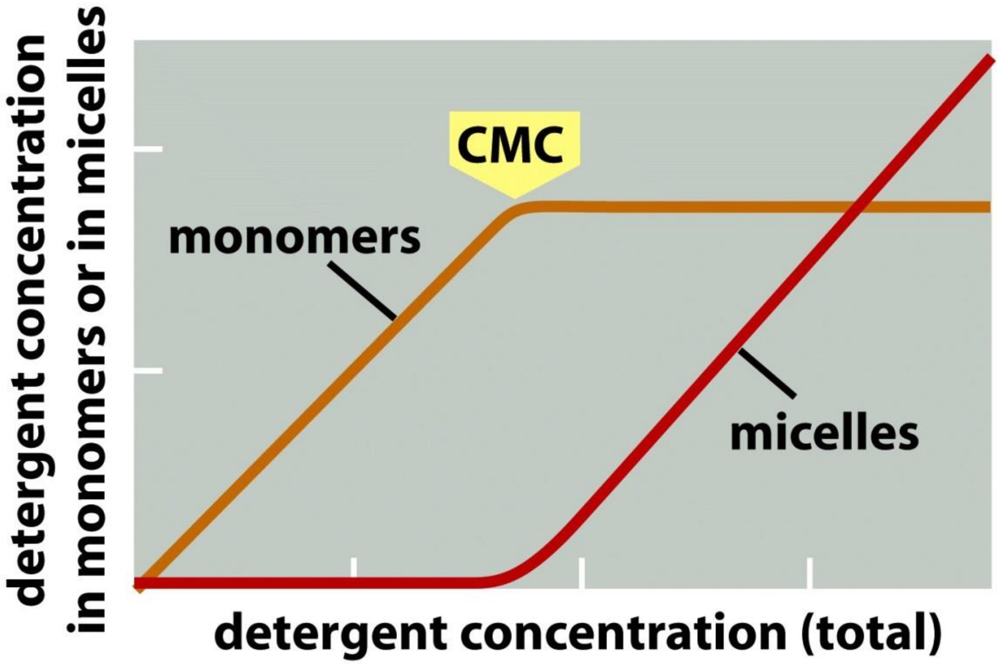
Sodium dodecyl sulfate (SDS)

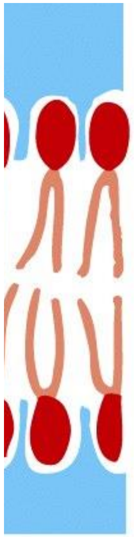


$CH_3—C(CH_3)_2—CH_2—C(CH_3)_2—C_6H_4—(O—CH_2—CH_2)_{10}—OH$

Triton X-100

lipid micelle



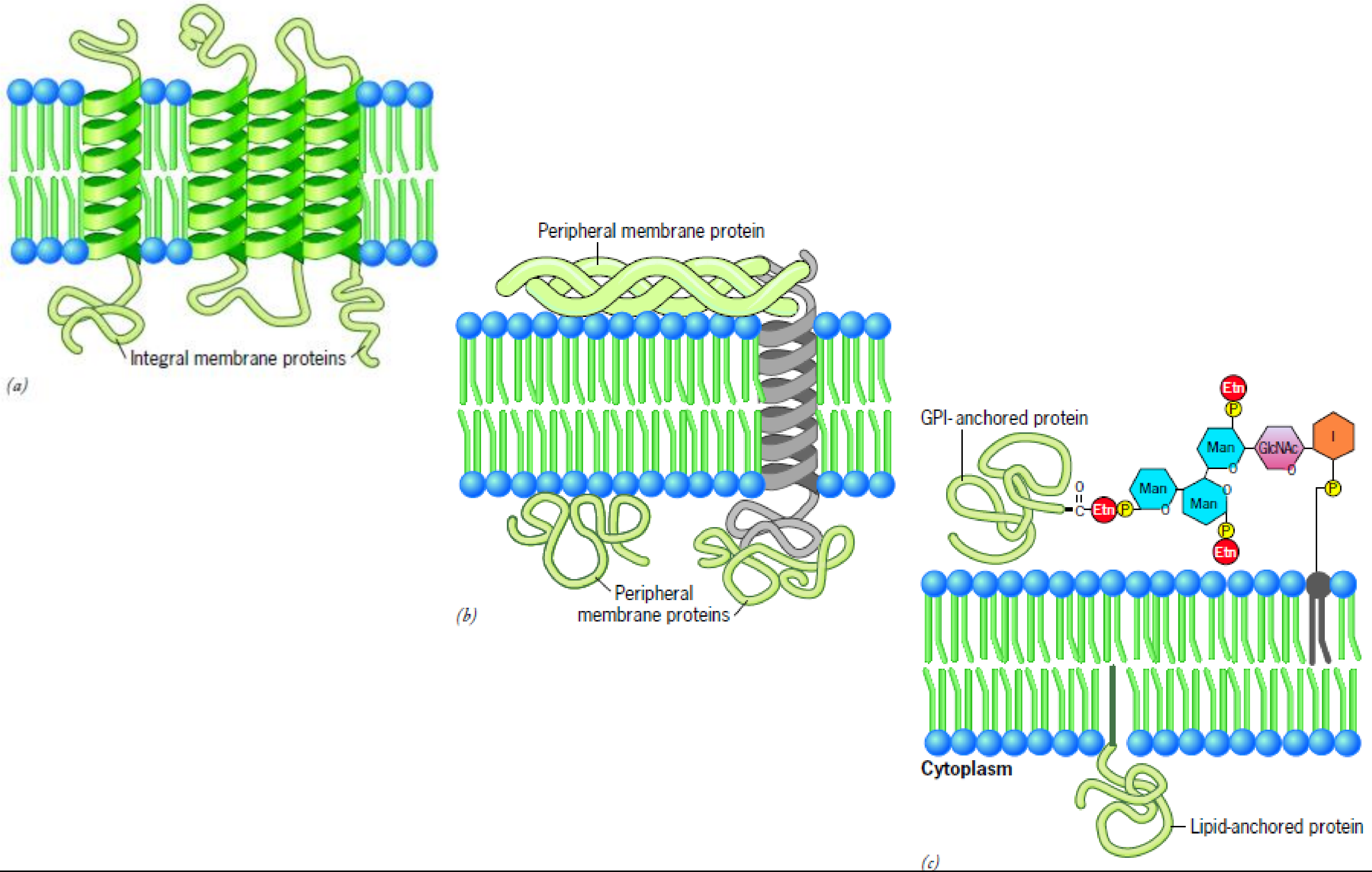


lipid bilayer

(A)

Figure 10-7 Molecular Biology c

Types of membrane proteins



Asymmetry of membrane

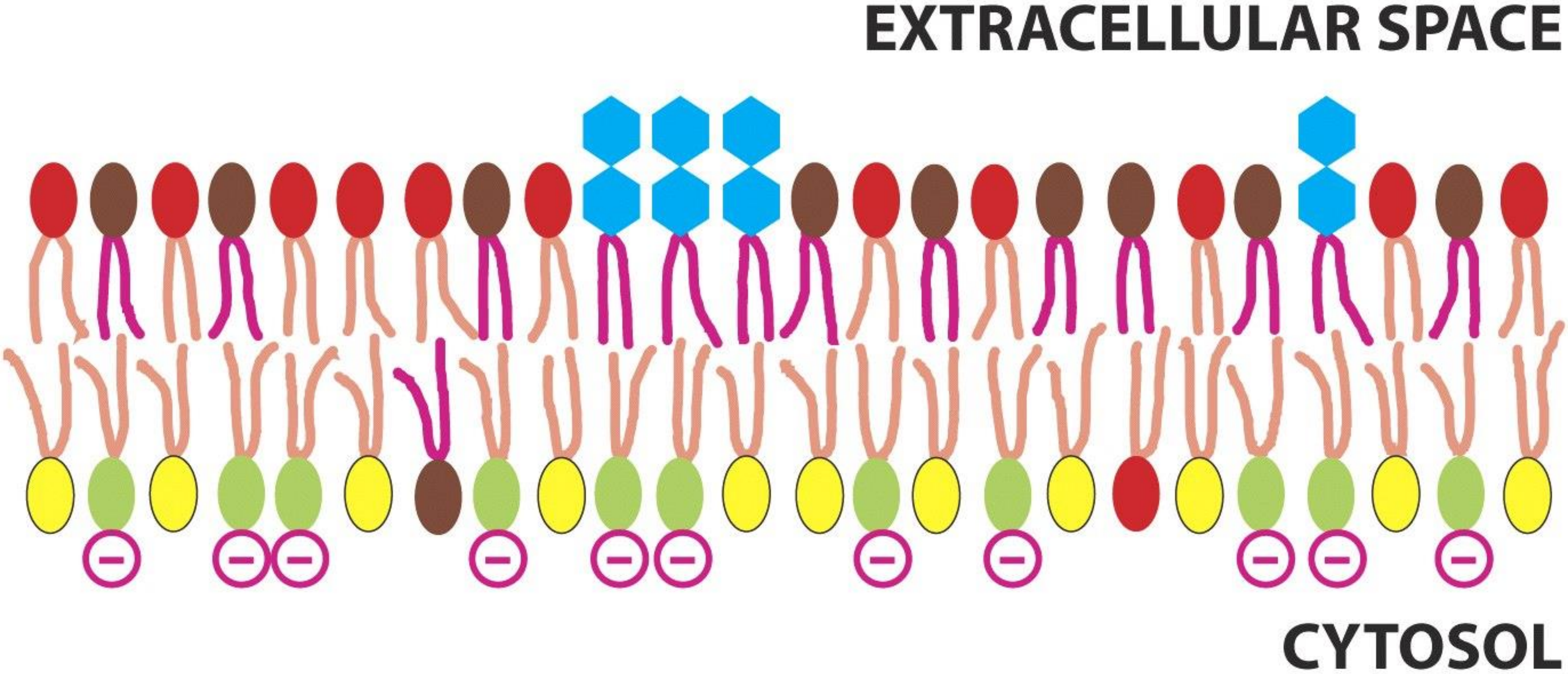


Figure 10-16 *Molecular Biology of the Cell* (© Garland Science 2008)

Asymmetry of membrane

Apical plasma membrane

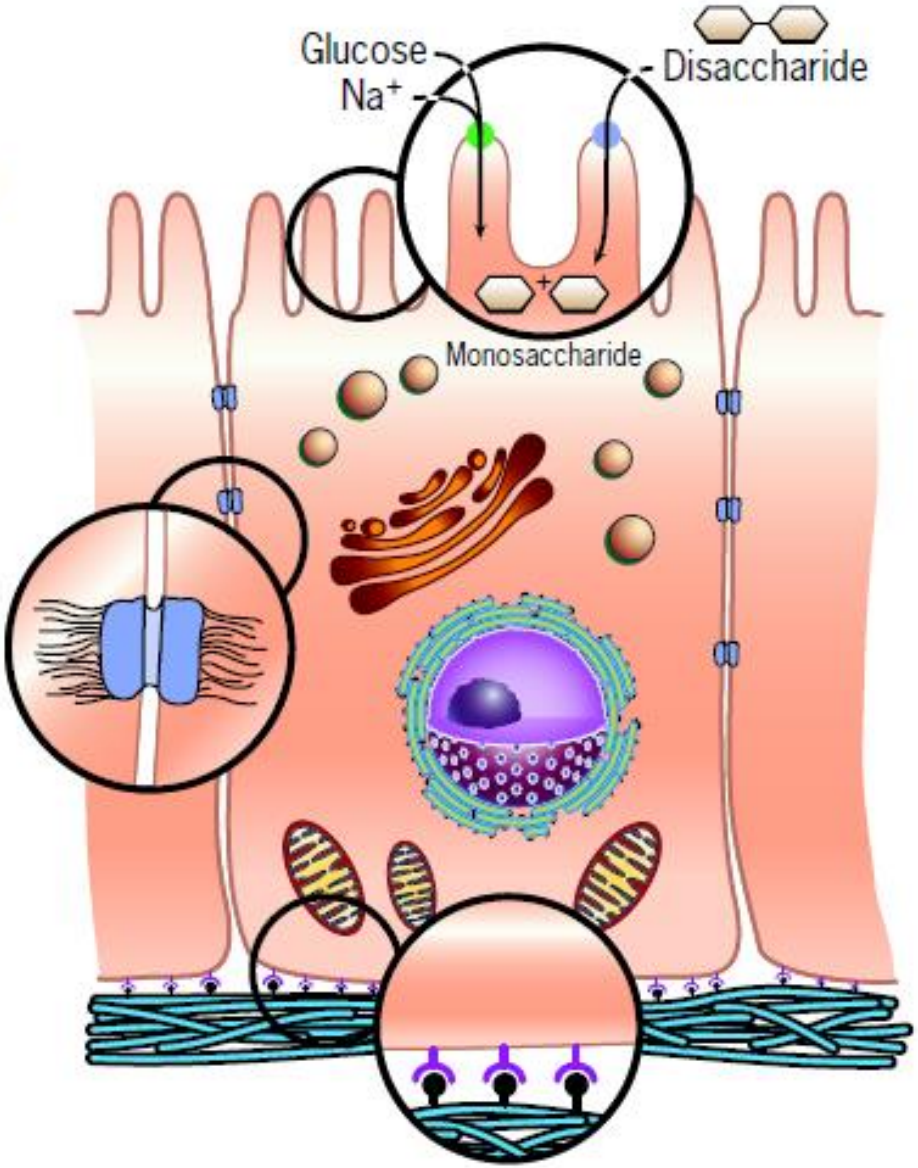
- regulation of nutrient and water intake
- regulated secretion
- protection

Lateral plasma membrane

- cell contact and adhesion
- cell communication

Basal membrane

- cell-substratum contact
- generation of ion gradients



Lipid droplets

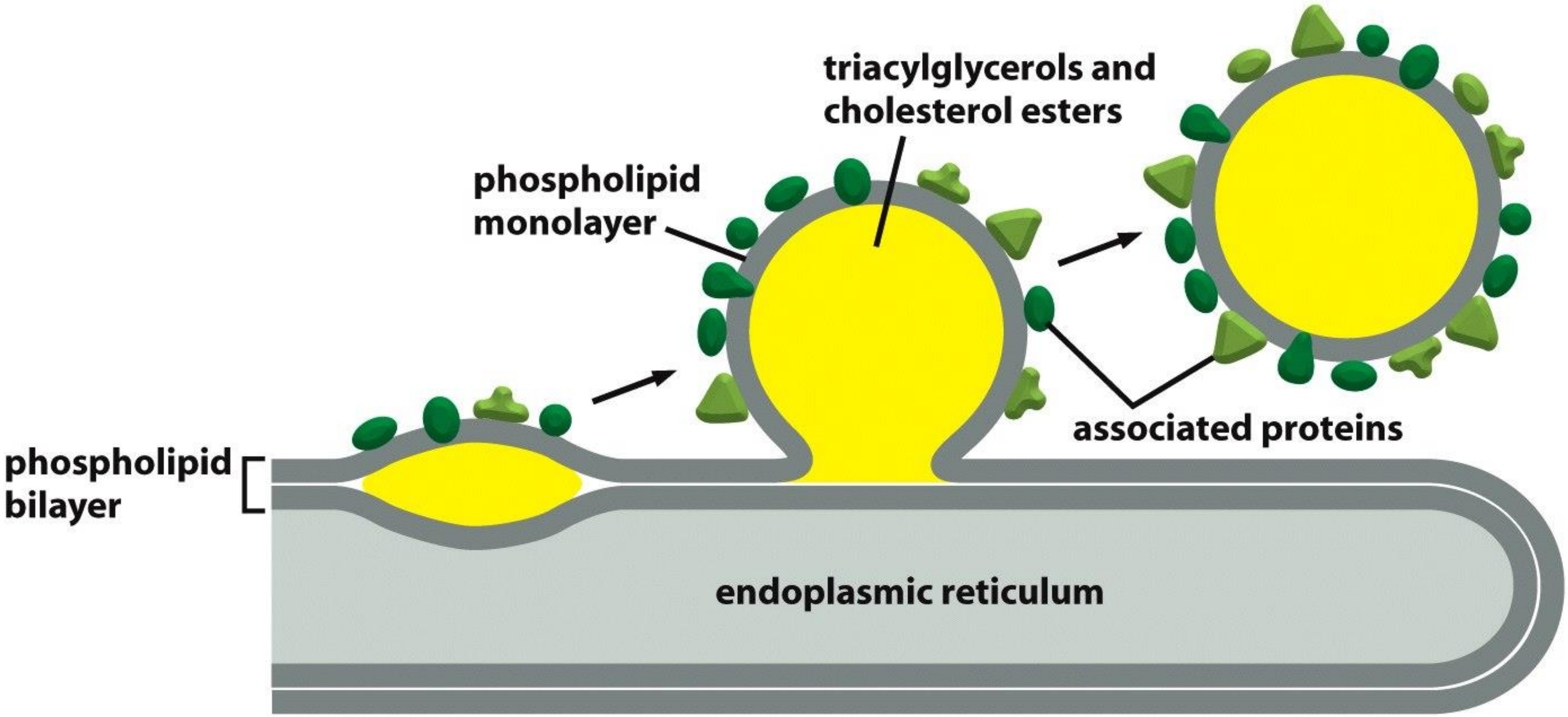
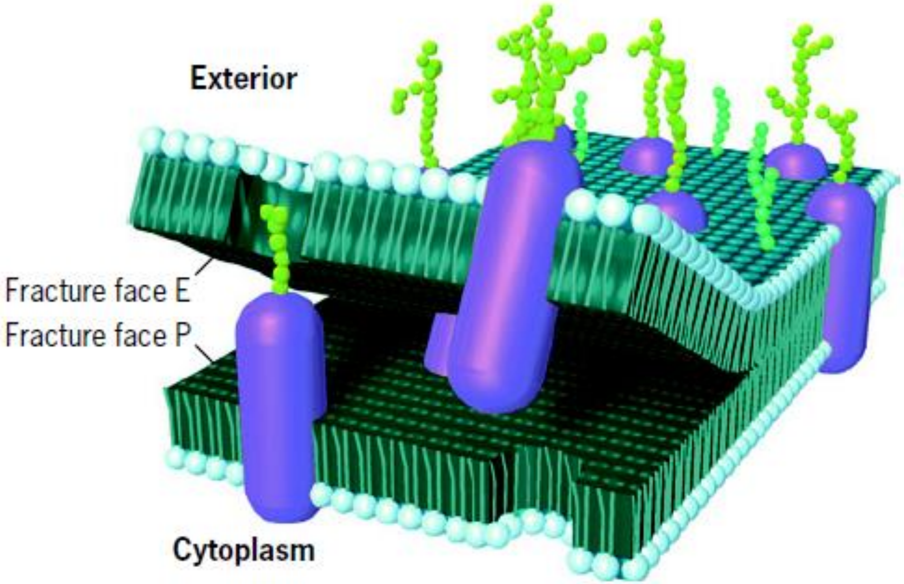


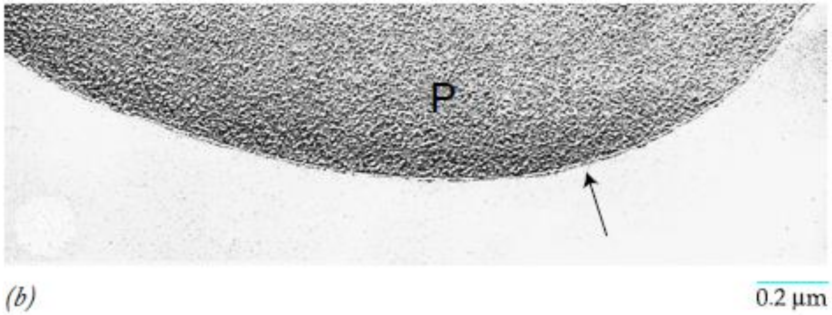
Figure 10-15 *Molecular Biology of the Cell* (© Garland Science 2008)

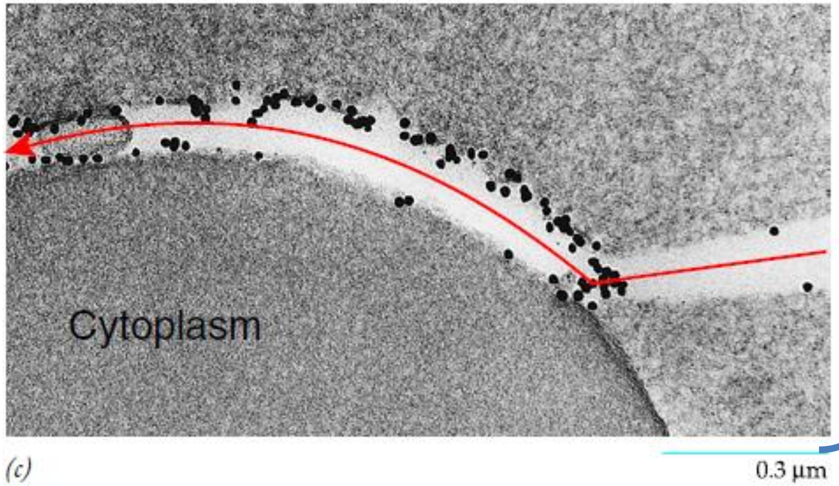
Distribution of integral proteins

Freeze fracture: a technique for investigating cell membrane structure



E: ectoplasmic face
P: protoplasmic face

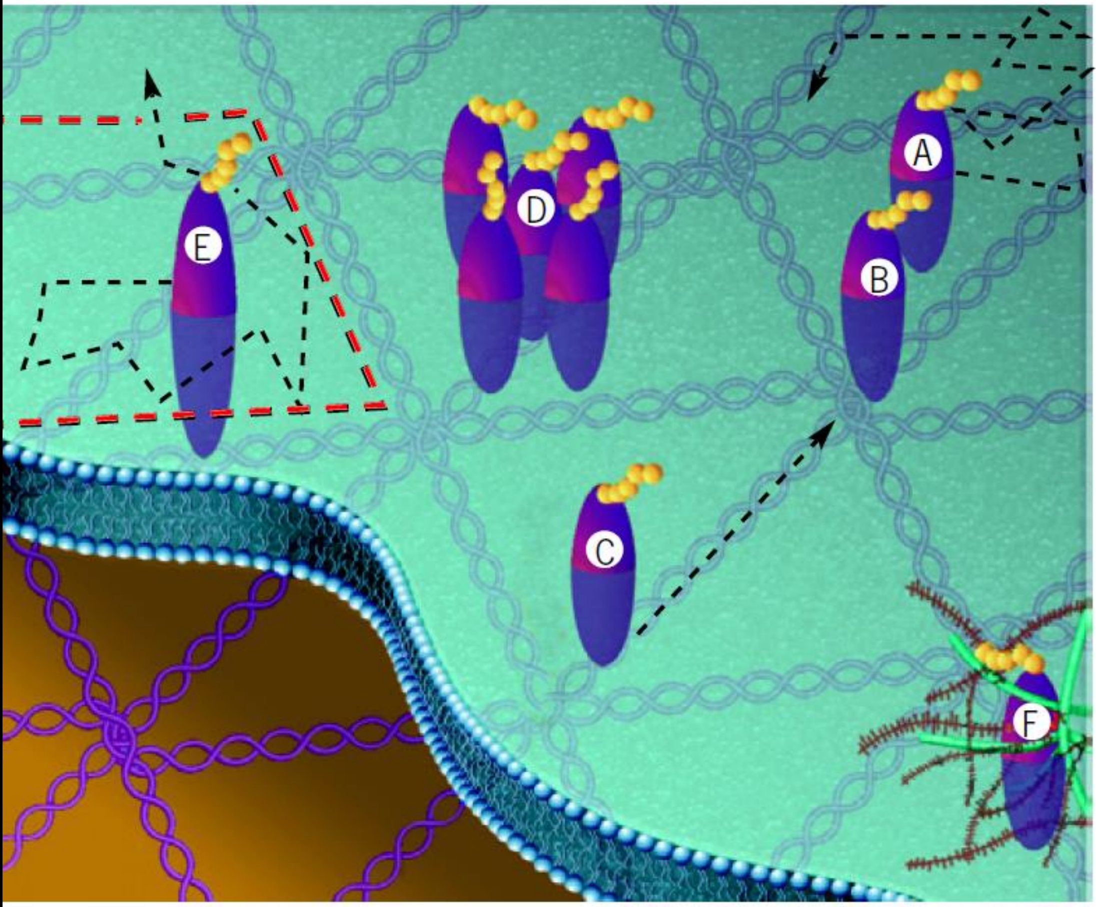




Surface of an erythrocyte

Karp, G. “Cell and Molecular Biology-Concepts and Experiments”
Chapter 4. The Structure and Function of the Plasma Membrane

Integral protein movement is not all random



Protein A is capable of diffusing randomly throughout the membrane, though its rate of movement may be limited.

Protein B is immobilized. It interacts with the underlying membrane skeleton.

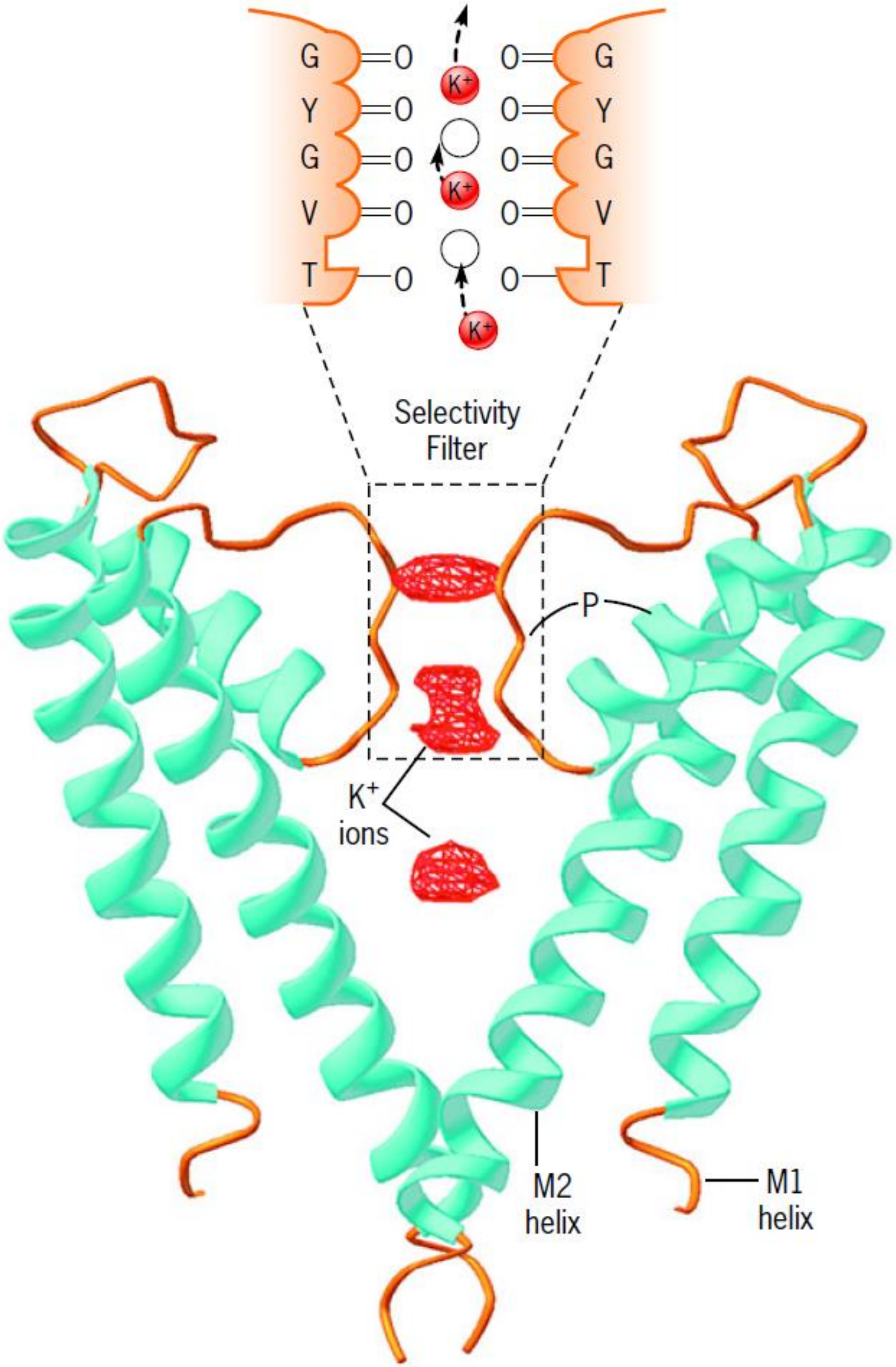
Protein C moves in a particular direction. It interacts with a motor protein at the cytoplasmic surface of the membrane.

Protein D is restricted by other integral proteins of the membrane.

Protein E is restricted by fences formed by proteins of the membrane skeleton, but it can hop into adjacent compartments through transient openings in a fence.

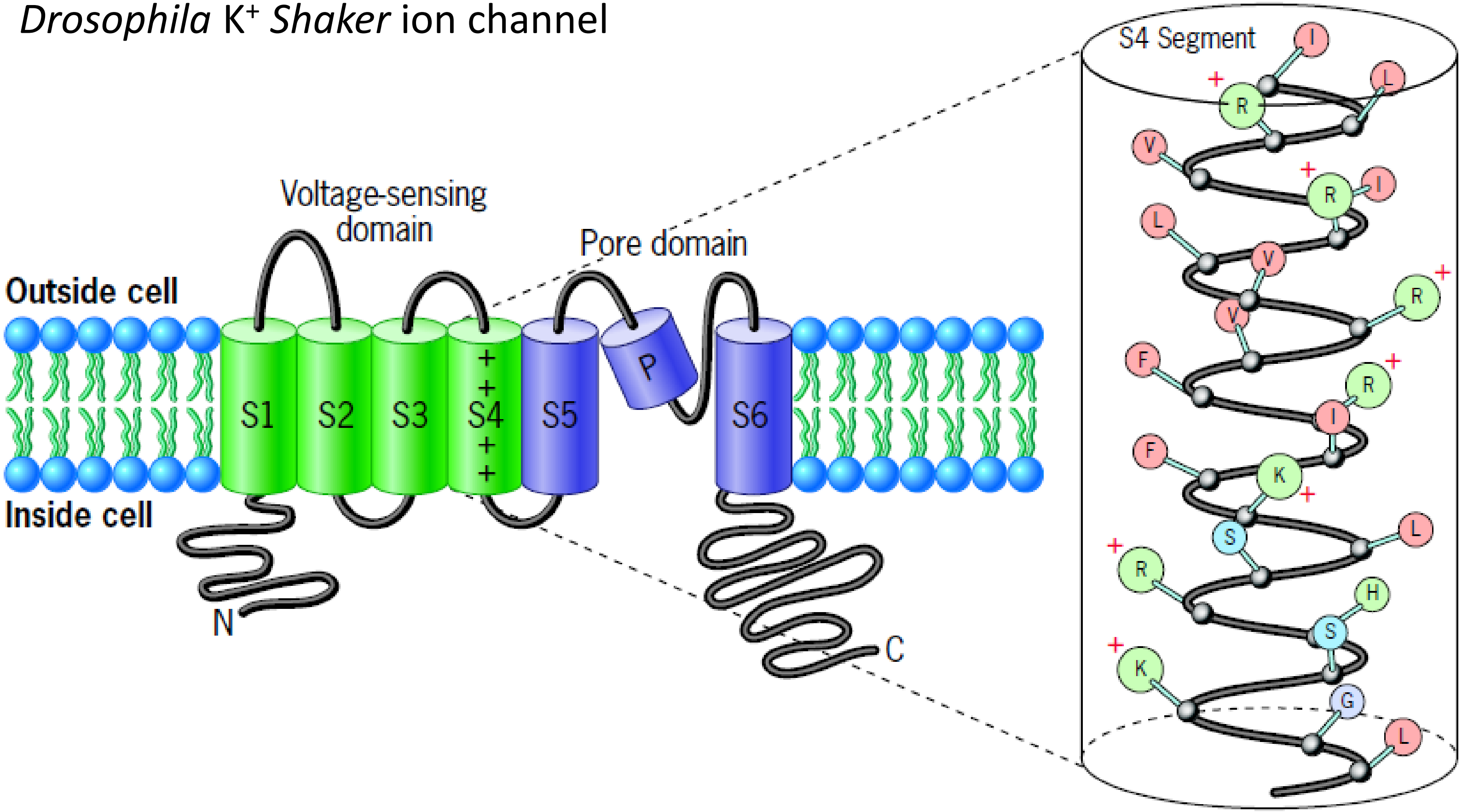
Protein F is restrained by extracellular materials.

Potassium channel

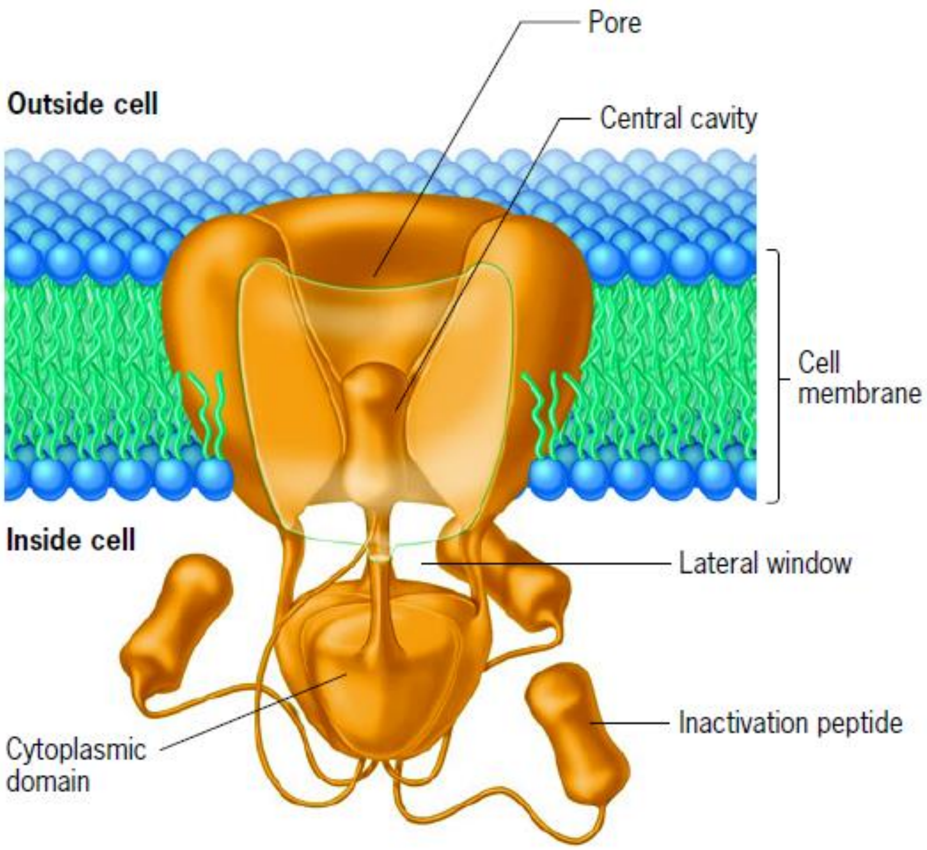


Voltage-gated K^+ channel

Drosophila K^+ *Shaker* ion channel



Voltage-gated K$^+$ channel



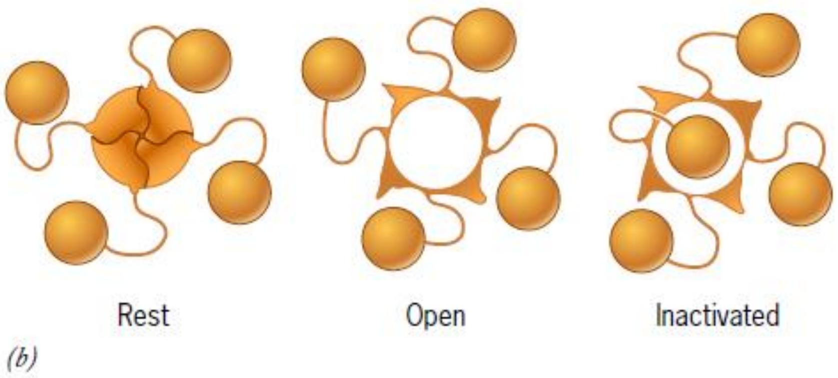
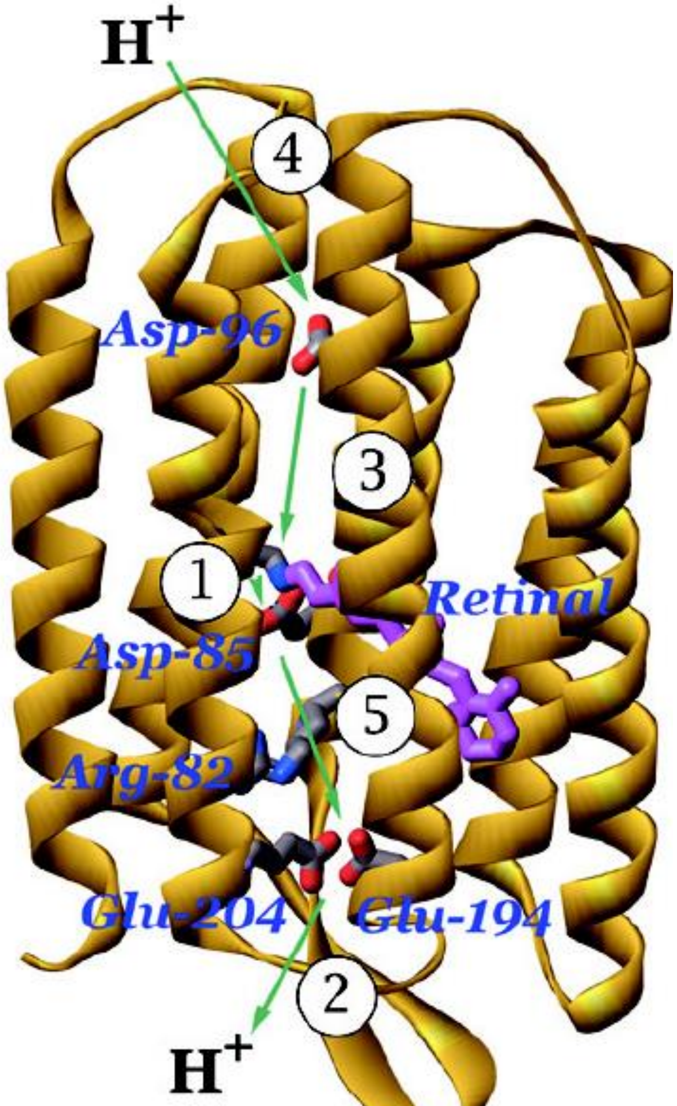
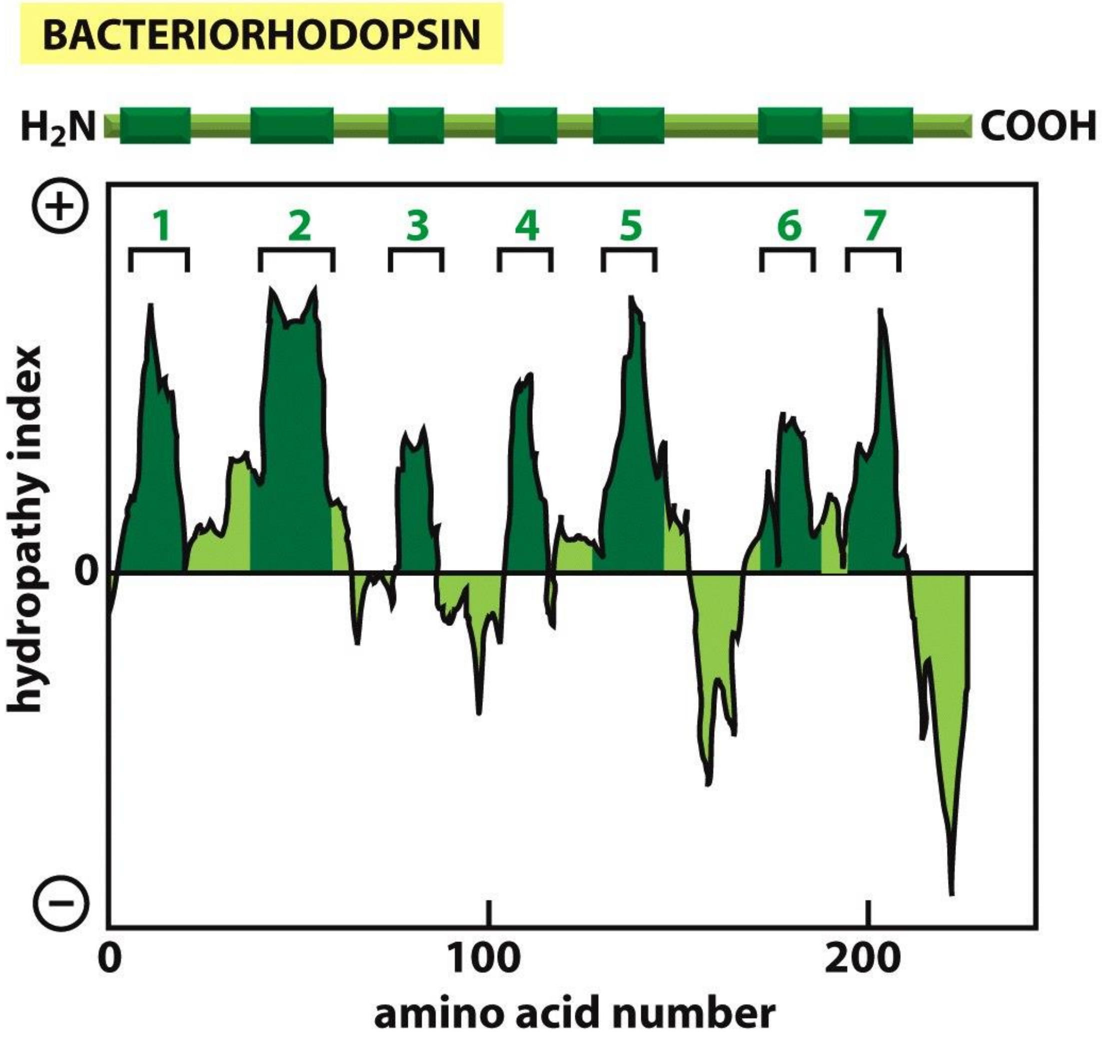


Figure 4.43 **Conformational states of a voltage-gated K$^+$ ion channel.** (*a*) Three-dimensional model of a eukaryotic K$^+$ ion channel. Inactivation of channel activity occurs as one of the inactivation peptides, which dangle from the cytoplasmic portion of the complex, fits into the cytoplasmic opening of the channel. (*b*) Schematic representation of a view into a K$^+$ ion channel, perpendicular to the membrane from the cytoplasmic side, showing the channel in the closed (resting), open, and inactivated state. (B: REPRINTED FROM NEURON, VOL. 20, C. M. ARMSTRONG AND B. HILLE, VOLTAGE-GATED ION CHANNELS AND ELECTRICAL ESCITABILITY, P. 377; COPYRIGHT 1998, WITH PERMISSION FROM ELSEVIER SCIENCE.)

Bacteriorhodopsin: light-driven proton-pump





β-barrel transmembrane proteins

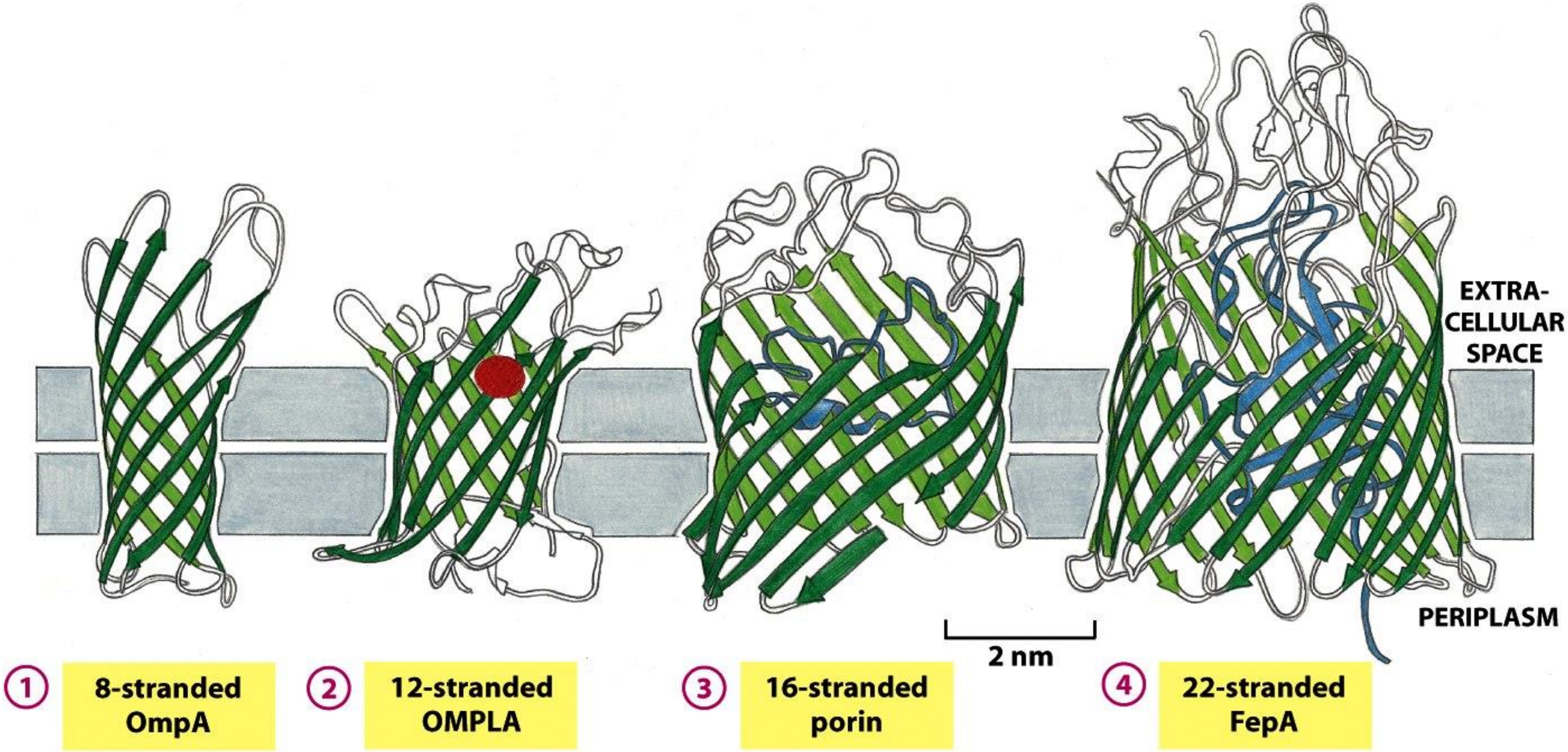
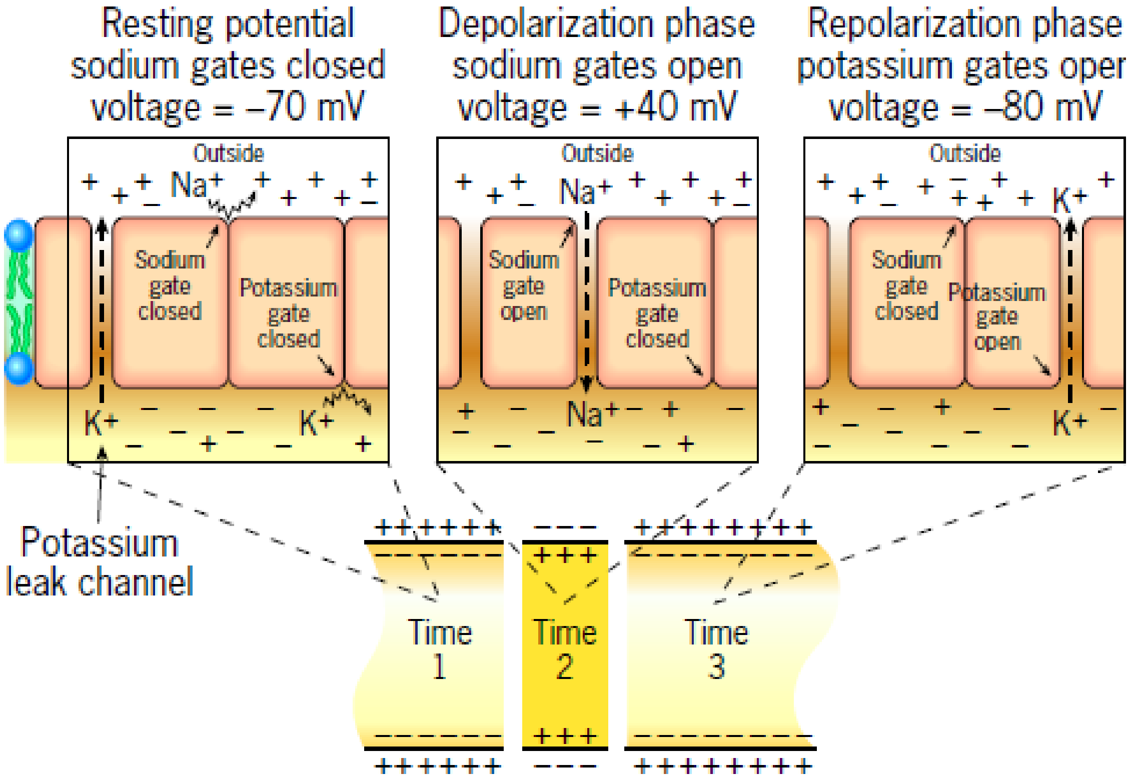
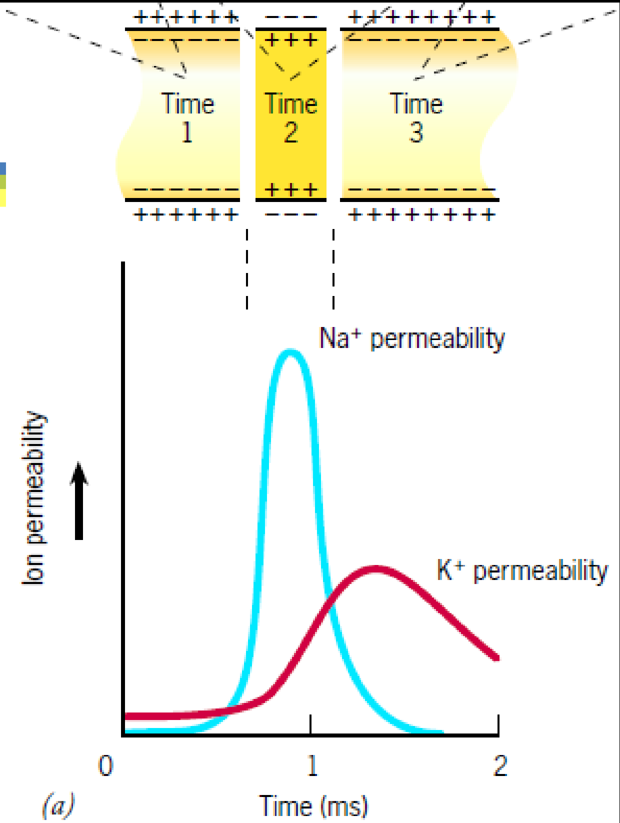
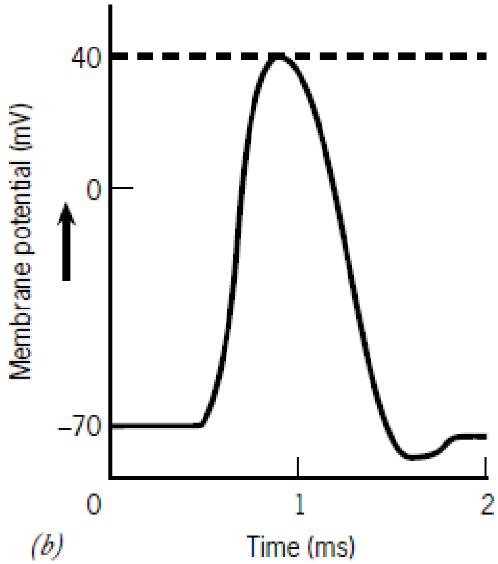


Figure 10-26 *Molecular Biology of the Cell* (© Garland Science 2008)

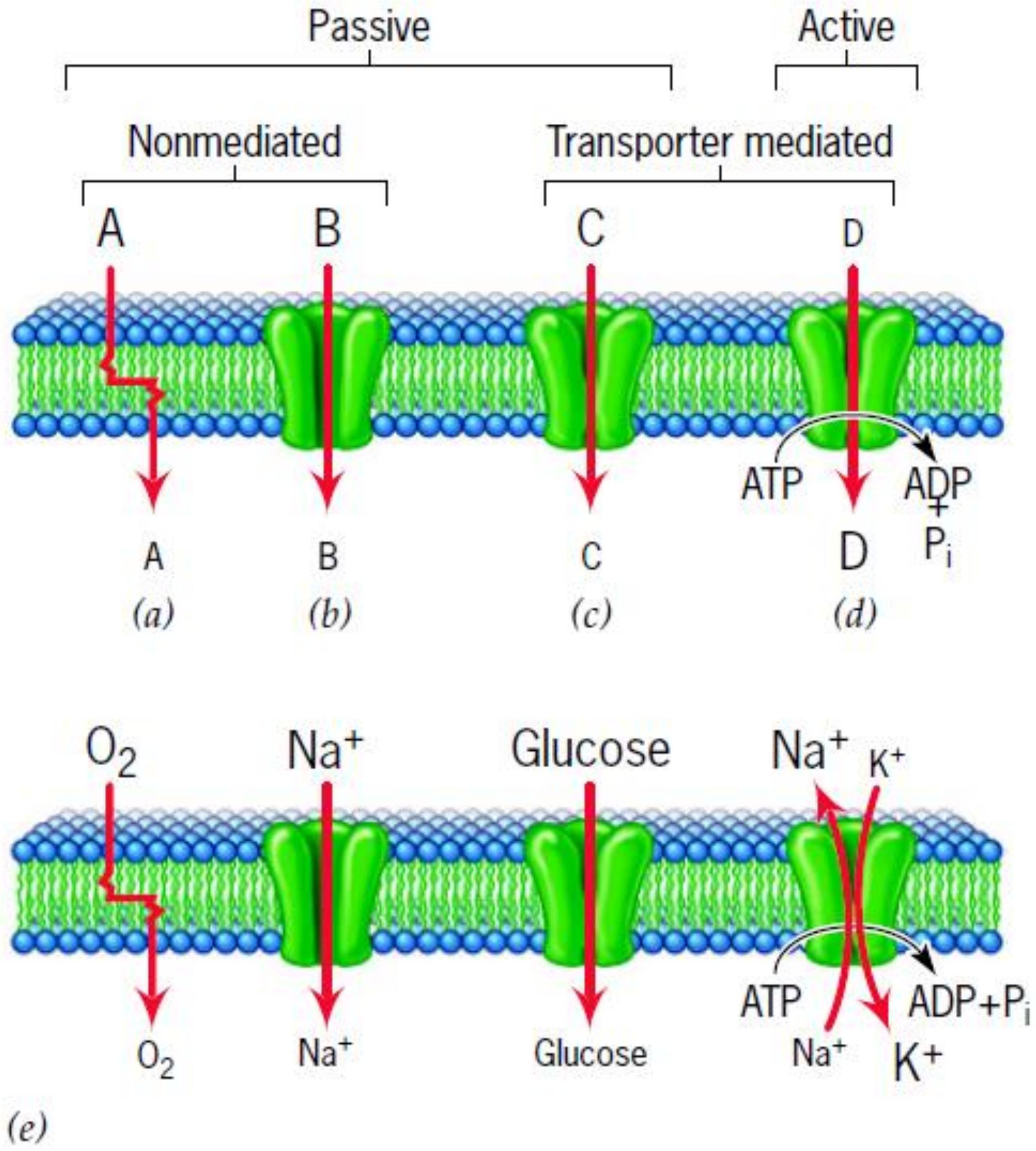
Membrane potential







Basic mechanisms by which solute molecules move across membranes



(a) Simple diffusion.

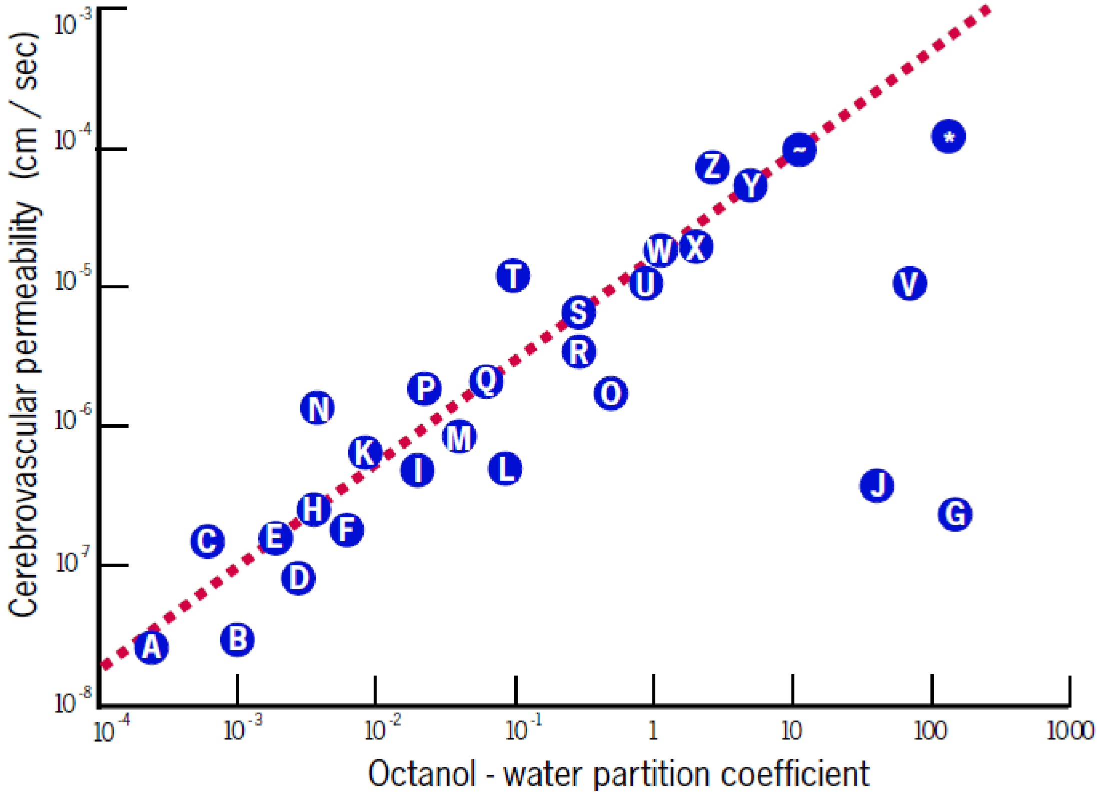
(b) Simple diffusion through an aqueous channel.

(c) Facilitated diffusion.

(d) Active transport.

(e) Different mechanisms with examples.

Permeability vs. partition

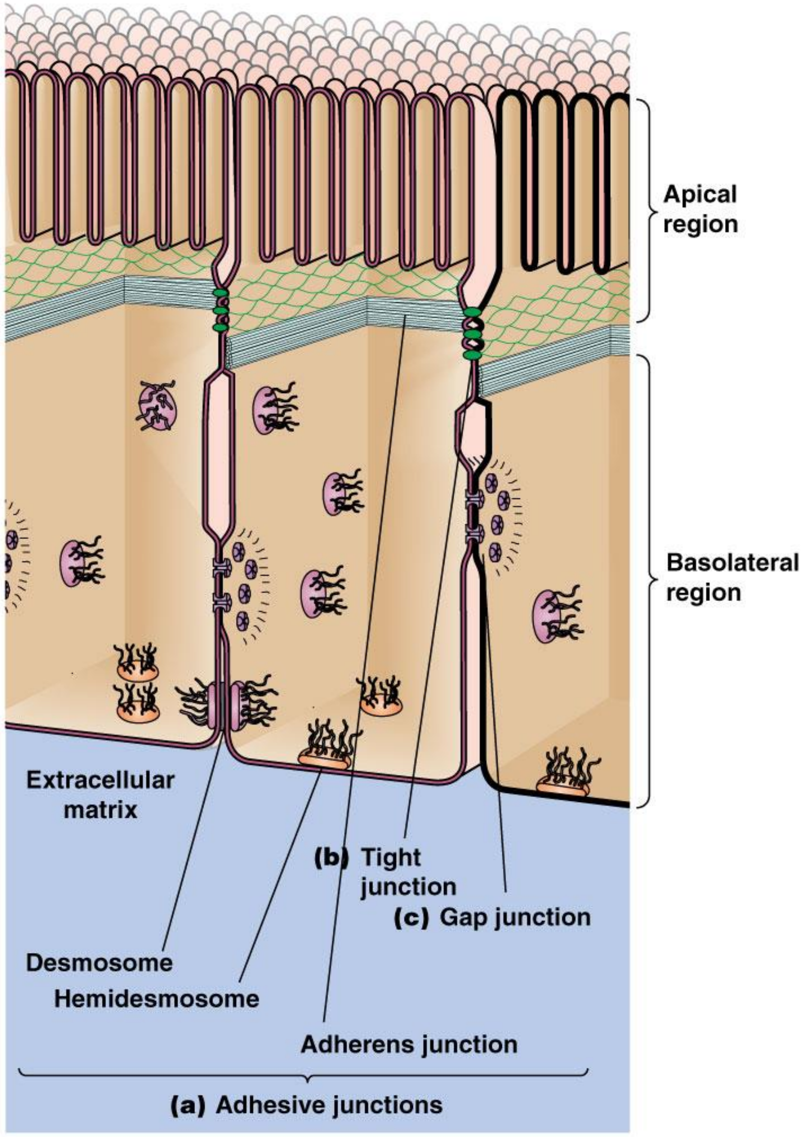


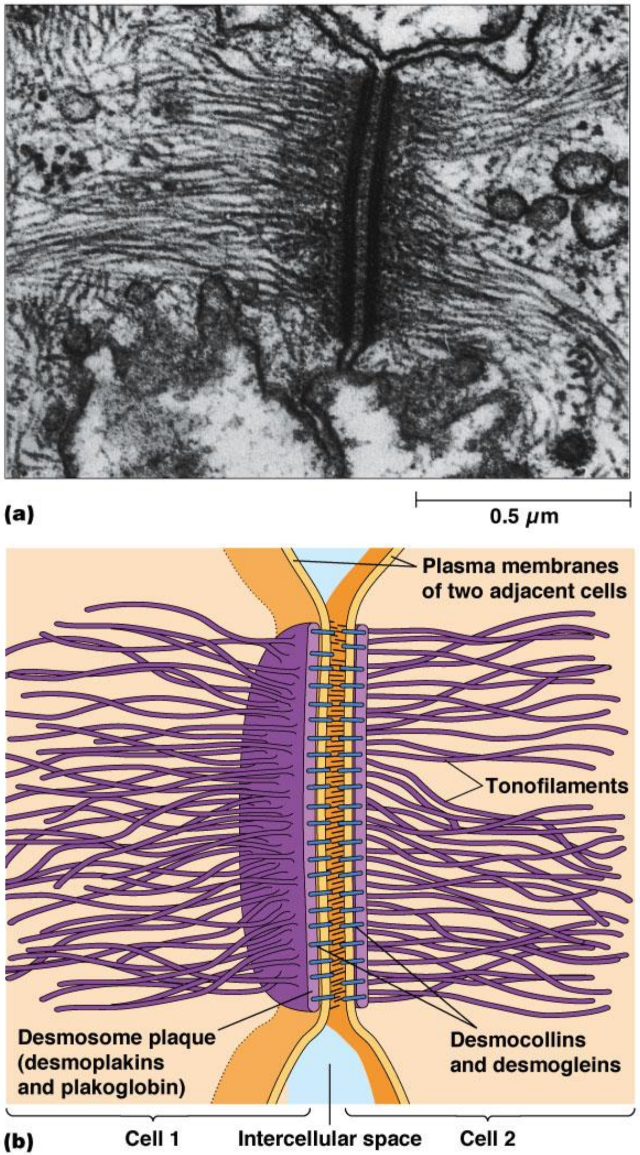
A. Sucrose
B. Epipodophyllotoxin
C. Mannitol
D. Arabinose
E. *N*-methyl nicotinamide
F. Methotrexate
G. Vincristine
H. Urea
I. Formamide

J. Vinblastine
K. Curare
L. Thiourea
M. Dianhydrogalacticol
N. Glycerol
O. 5-FU
P. Ethylene glycol
Q. Acetamide
R. Ftorafur

S. Misonidazole
T. Propylene glycol
U. Metronidazole
V. Spirohydantoin mustard
W. Procarbazine
X. PCNU
Y. Antipyrine
Z. Caffeine
~. BCNU
***.** CCNU

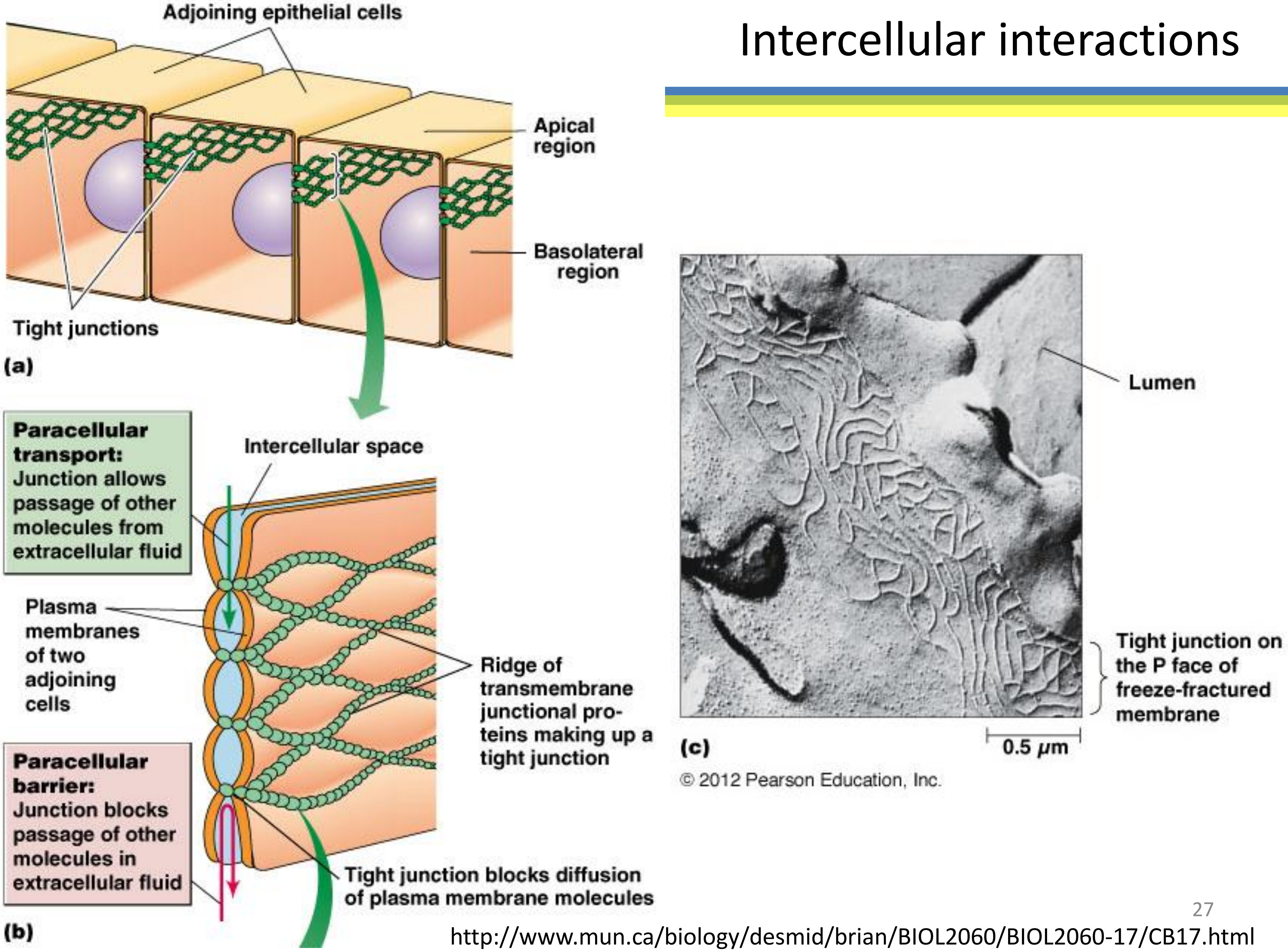
Intercellular interactions





http://www.mun.ca/biology/desmid/brian/BIOL2060/BIOL2060-17/CB17.html

Intercellular interactions



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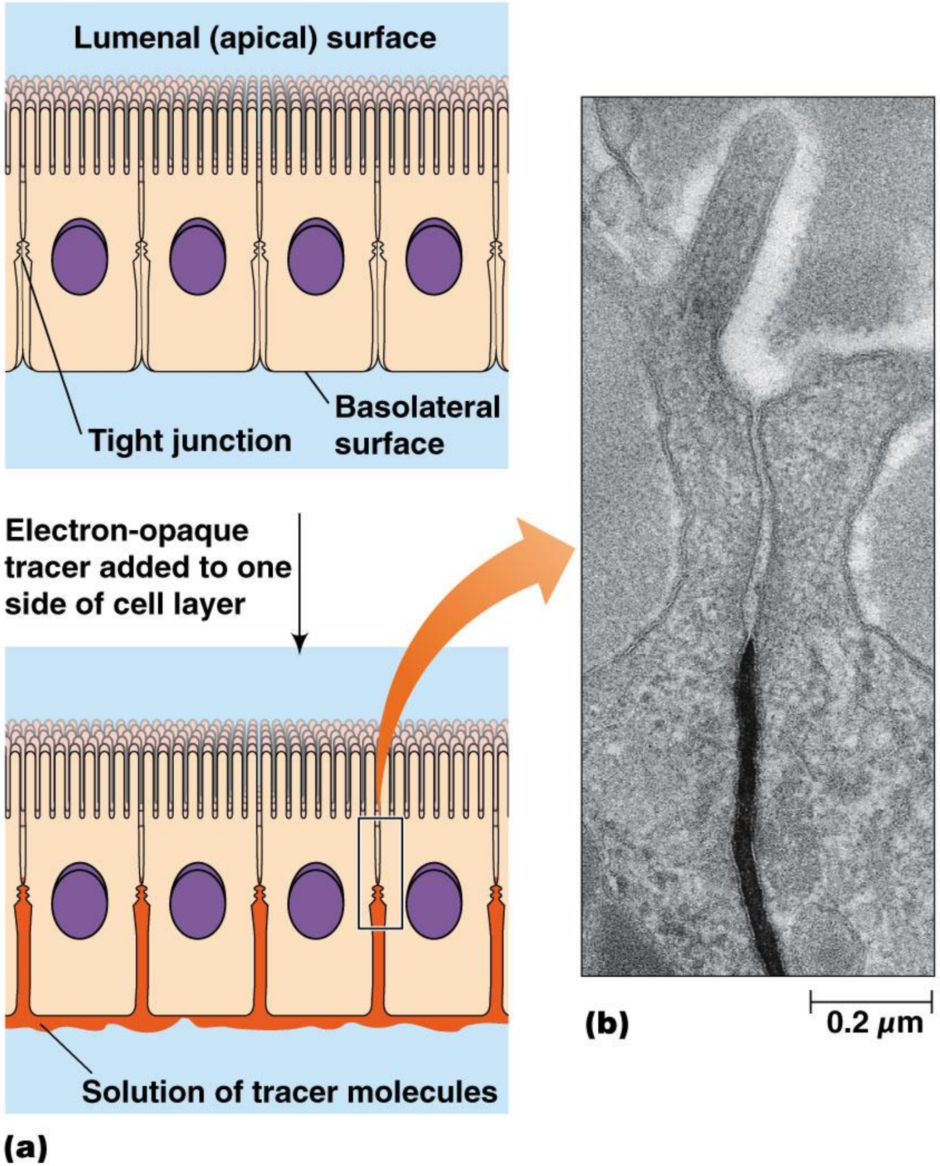
Intercellular interactions



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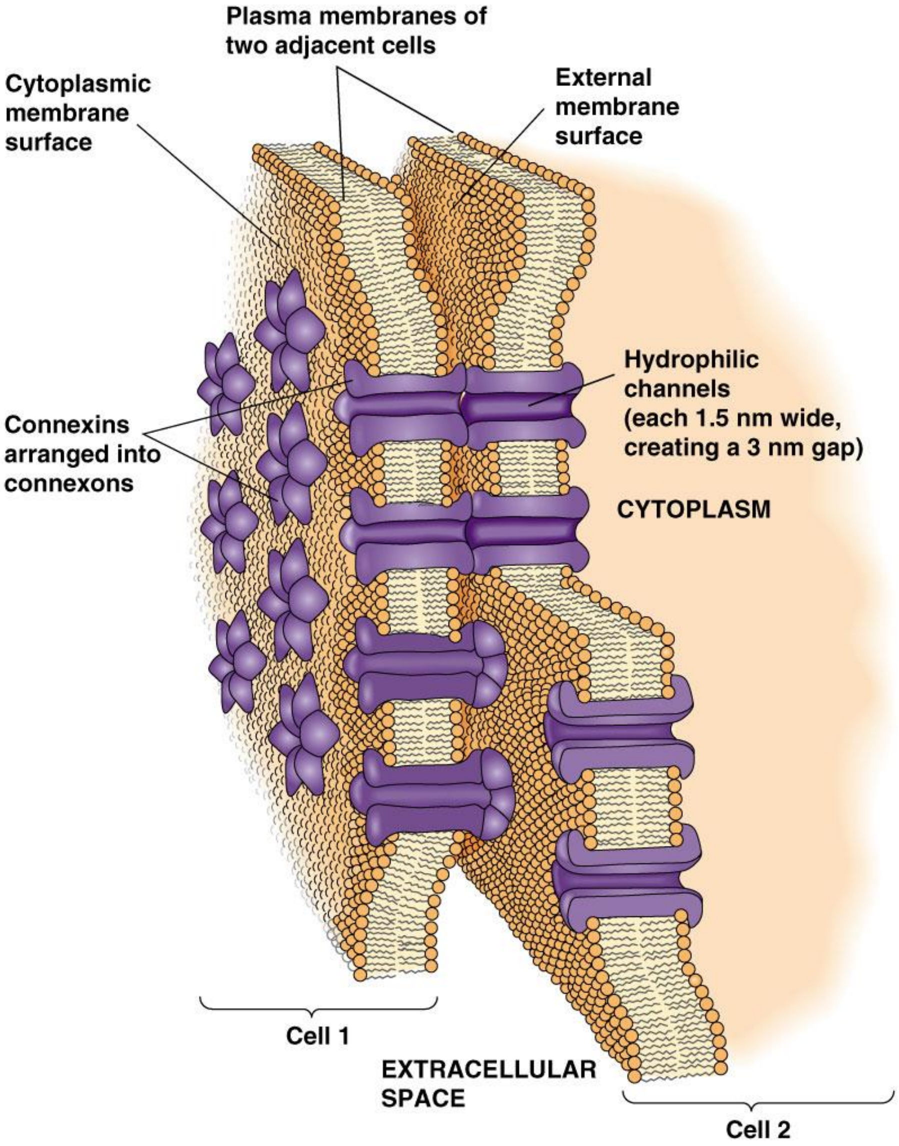
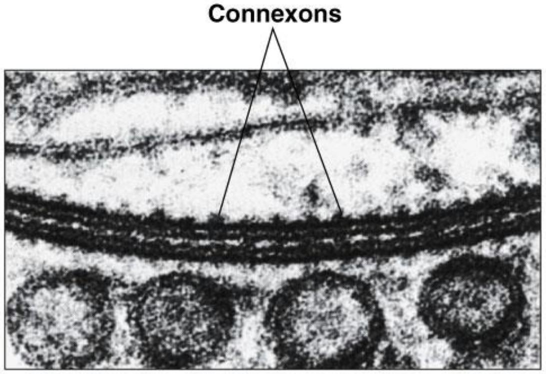
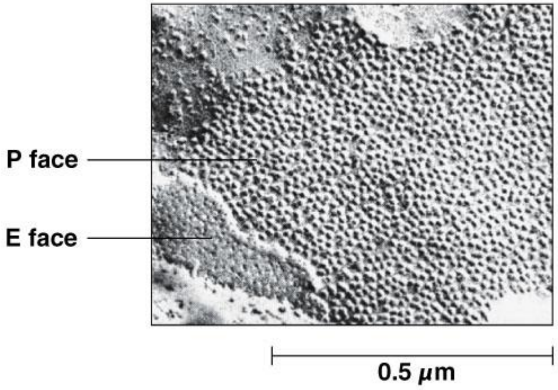
Intercellular interactions



(a) Gap junction diagram



(b) Electron micrograph of a gap junction



(c) Freeze-fracture of a gap junction

http://www.mun.ca/biology/desmid/brian/BIOL2060/BIOL2060-17/CB17.html

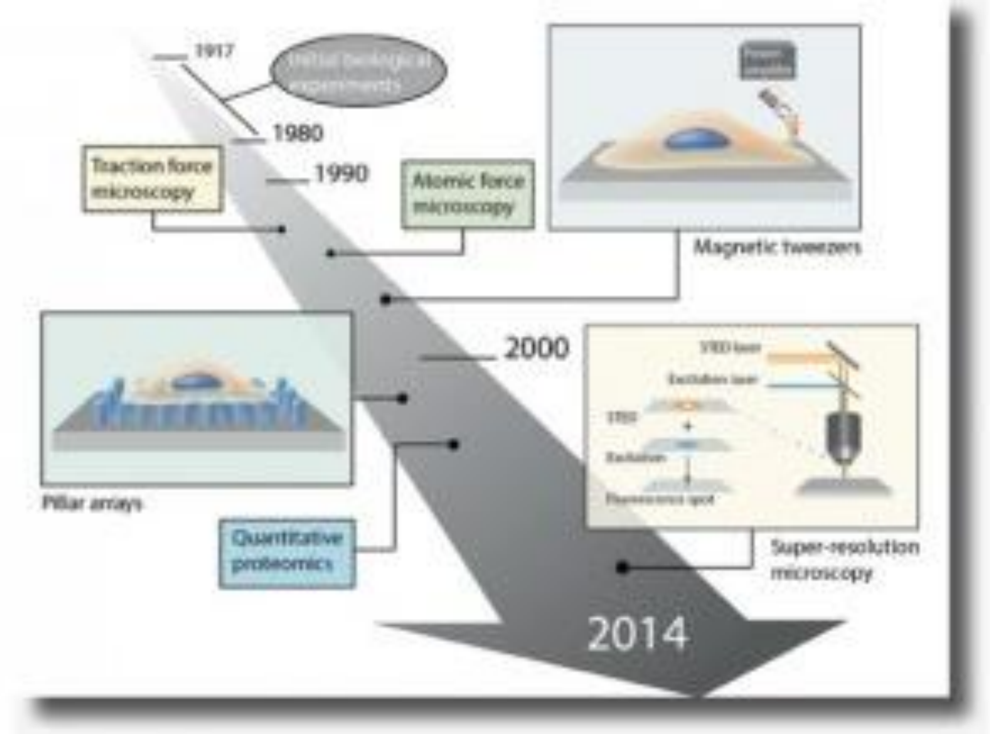
Mechanobiology

- Mechanobiology is the study of the interrelationship of force and biology.

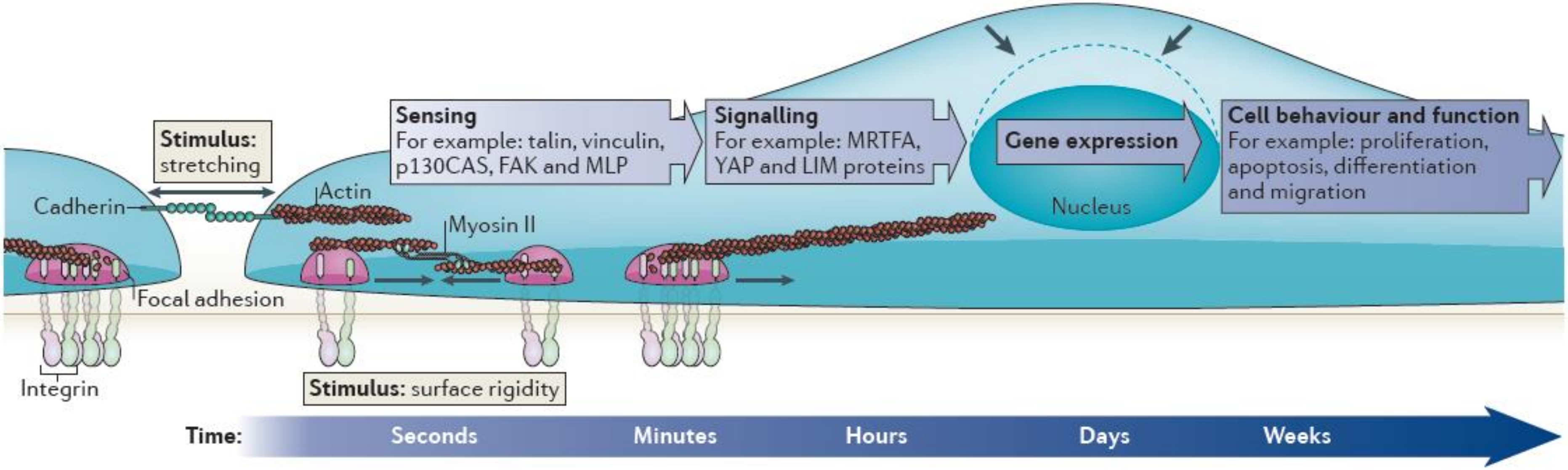
http://www.bioe.psu.edu/mechlab/

- Mechanisms of force sensation and transduction that control cell behavior in health and disease.

http://www.mechanobiology.nl/MechBio2016



Mechanobiology

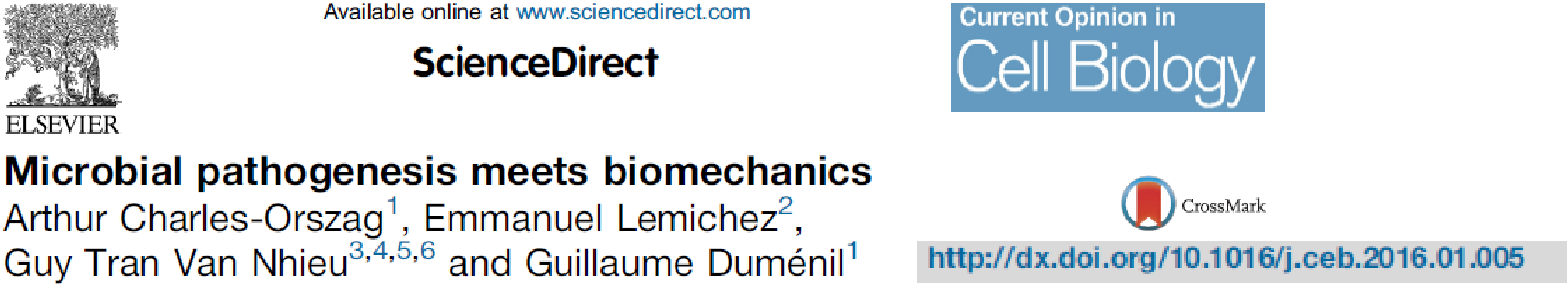


Read this paper:

Iskratsch, T.; Wolfenson; H.; Sheetz, M.P.
Appreciating force and shape — the rise of mechanotransduction in cell biology
Nat. Rev. Mol. Cell Biol. **2014**, *15*, 825 link

Mechanobiology & biomechanics

Working groups:



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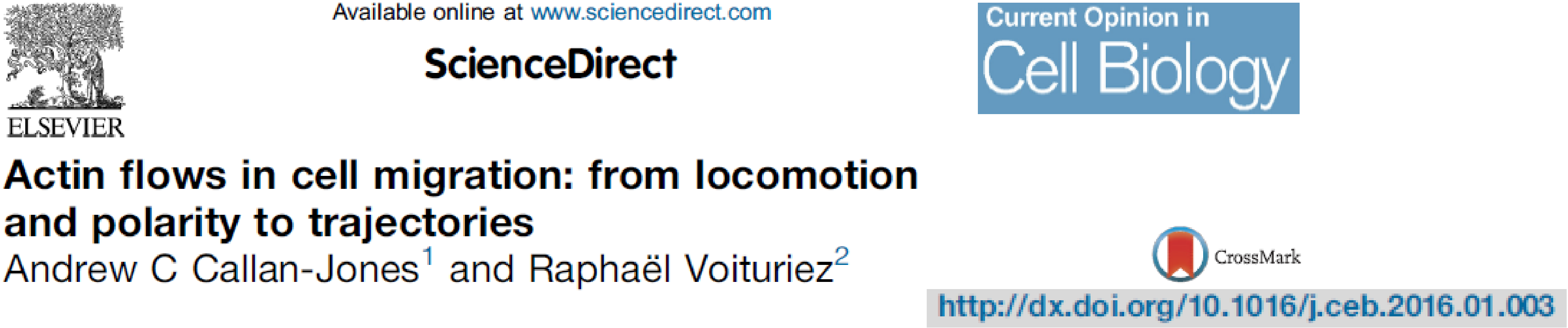
Microbial pathogenesis meets biomechanics

Arthur Charles-Orszag[1], Emmanuel Lemichez[2],
Guy Tran Van Nhieu[3,4,5,6] and Guillaume Duménil[1]

CrossMark

http://dx.doi.org/10.1016/j.ceb.2016.01.005



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Andrew C Callan-Jones[1] and Raphaël Voituriez[2]

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Mechanobiology & biomechanics

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Erin L Barnhart

http://dx.doi.org/10.1016/j.ceb.2016.02.022

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Current Opinion in Cell Biology

A question of time: tissue adaptation to mechanical forces

Tom Wyatt[1,2,3,4], Buzz Baum[1,4] and Guillaume Charras[2,4,

http://dx.doi.org/10.1016/j.ceb.2016.02.012

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Actomyosin-driven left-right asymmetry: from molecular torques to chiral self organization

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