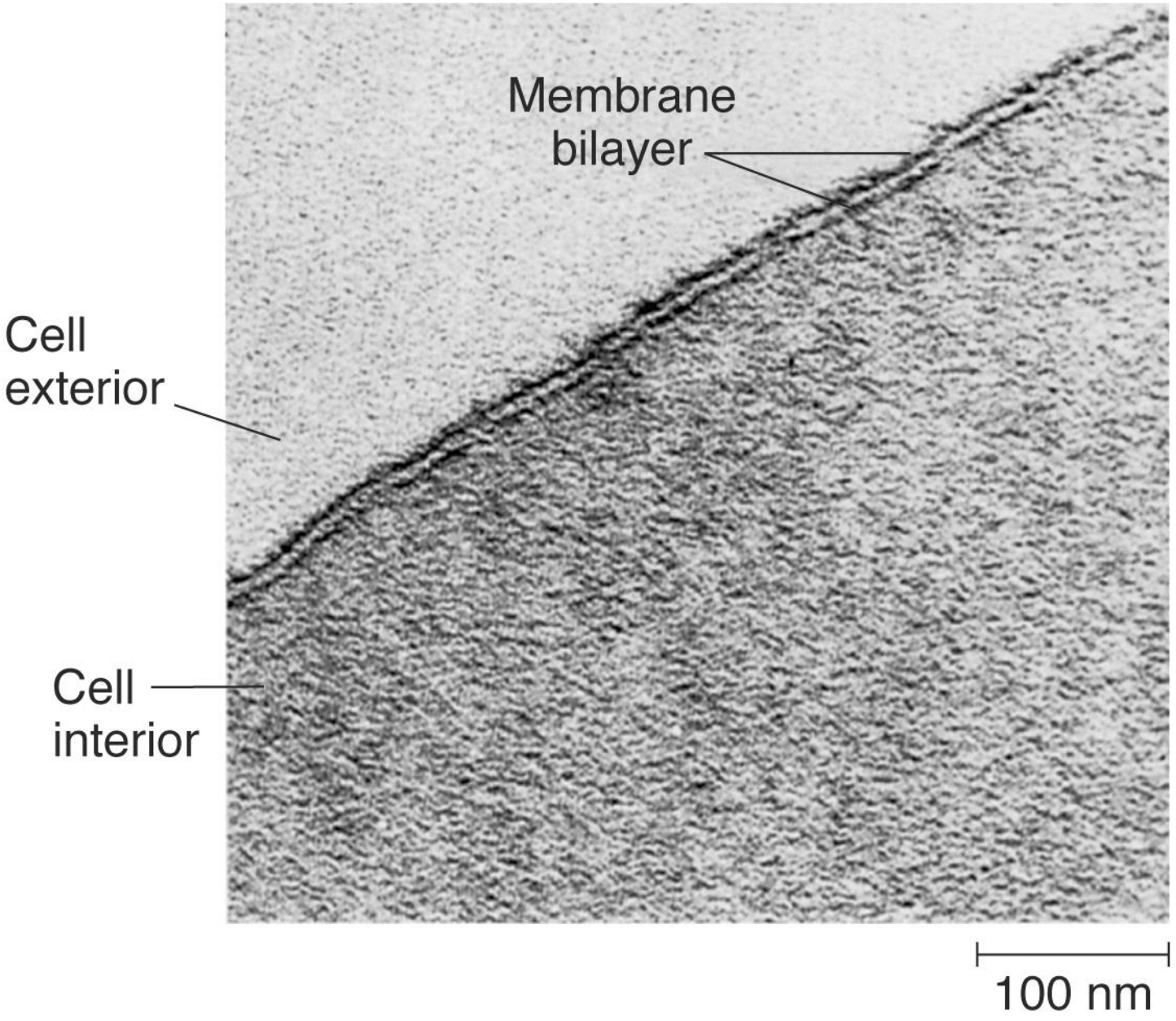
Membranes

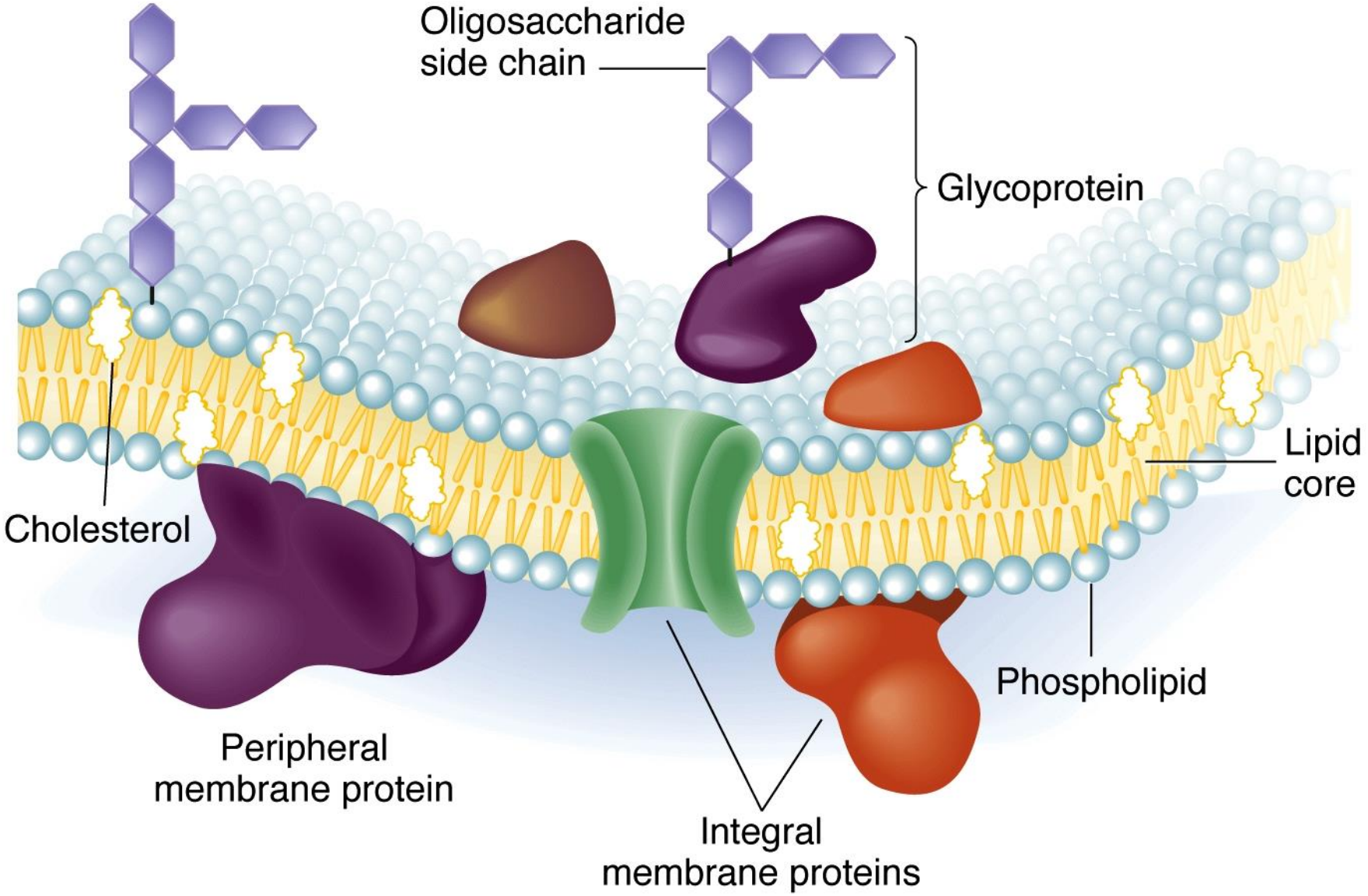
- Interesting facts: a Chimp brain- membrane of all cells. 100,000 m2, 3- soccer fields

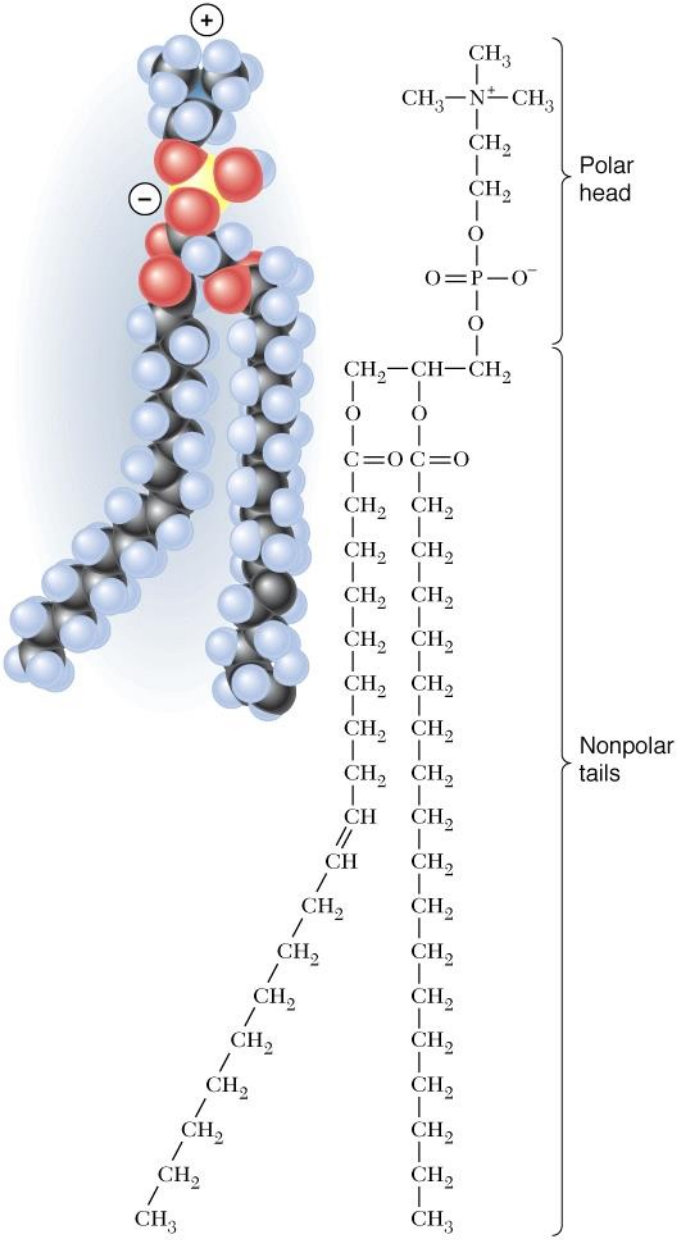
- Membrane-plasma membrane enclose cytoplasm. Very thin- good, ex: gasoline on surface of water, but carries out essential regulation of the cell.

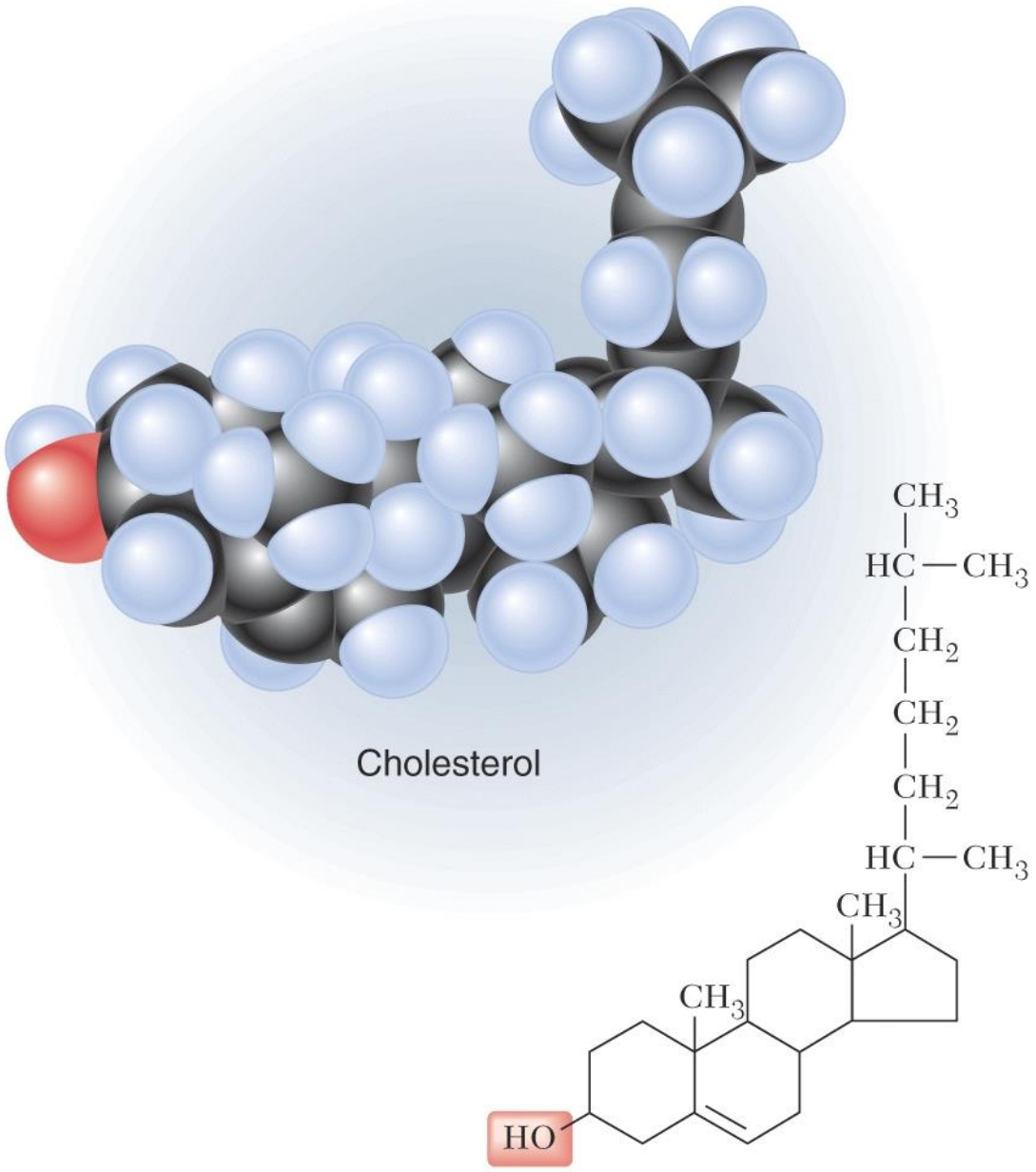

Membrane
bilayer
Cell
exterior
Cell
interior
100 nm

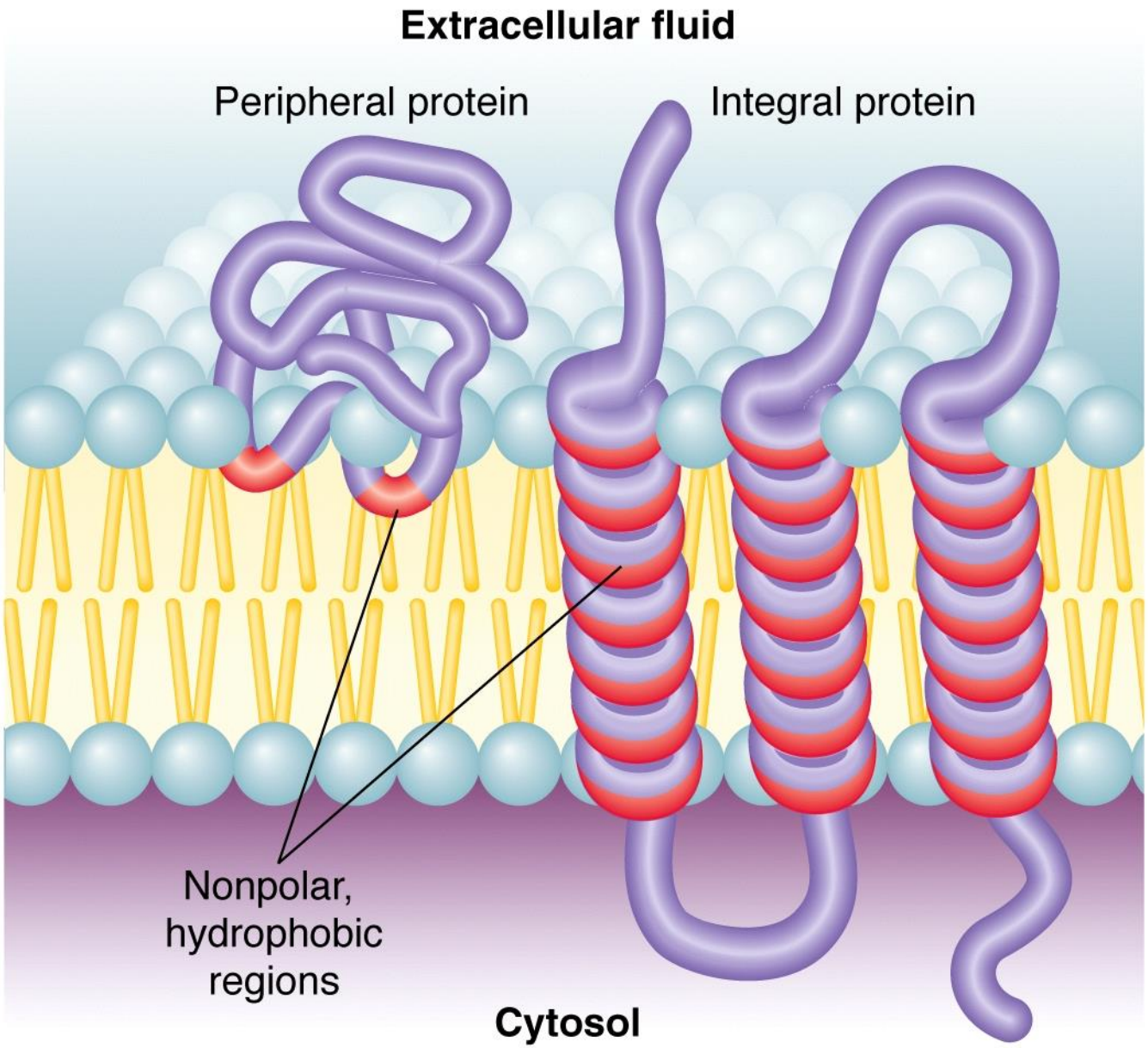
Membrane composition

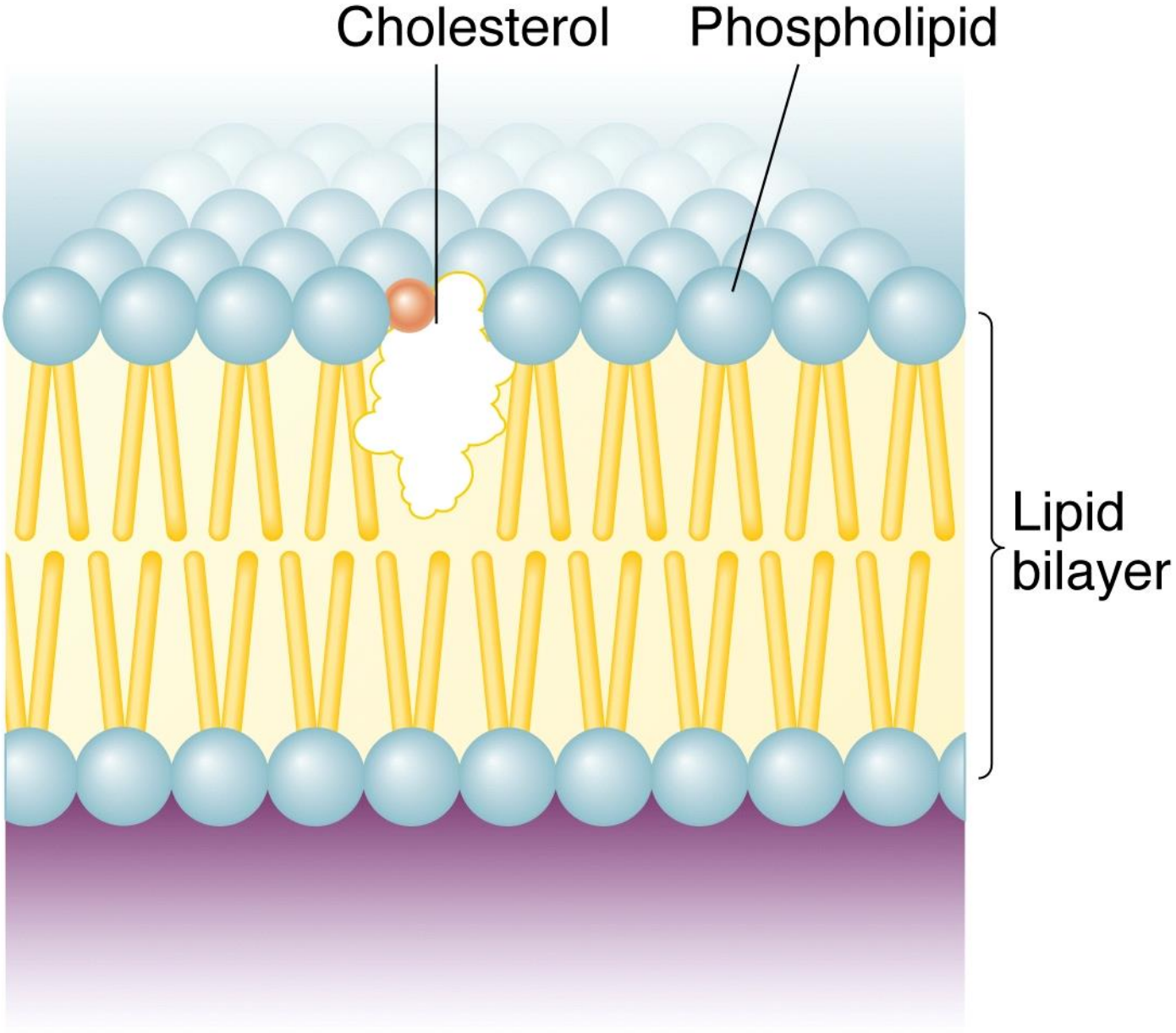
-lipid bilayer: impermeable to passage of most water-soluble molecules

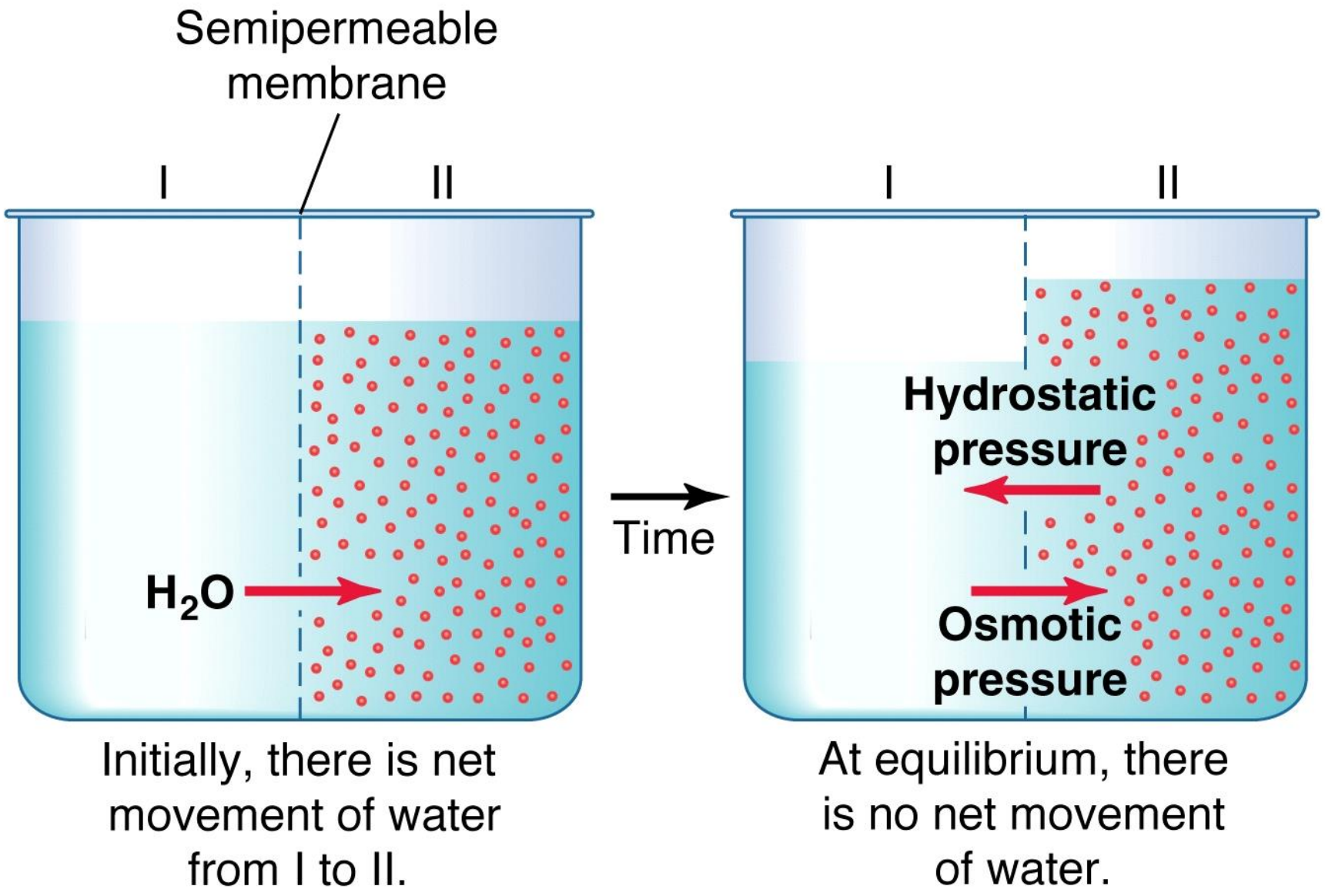

Oligosaccharide
side chain
Glycoprotein
Lipid
core
Cholesterol
Phospholipid
Peripheral
membrane protein
Integral
membrane proteins


Polar head
Nonpolar tails


Cholesterol
CH3
HC — CH3
CH2
CH2
CH2
HC — CH3
CH3
CH3
HO


Extracellular fluid
Peripheral protein
Integral protein
Nonpolar,
hydrophobic
regions
Cytosol


Cholesterol
Phospholipid
Lipid bilayer



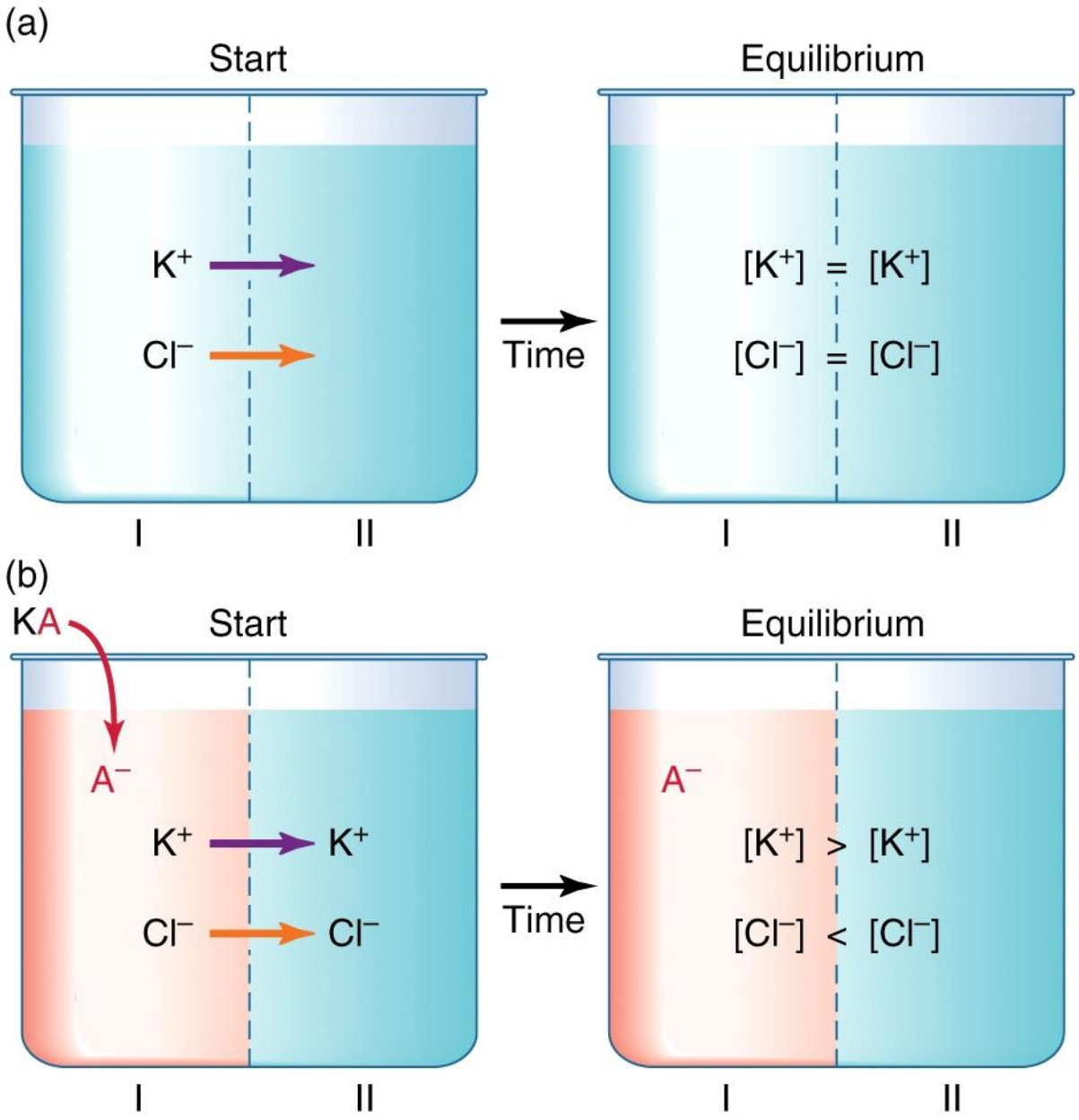
Initially, there is net movement of water from I to II.

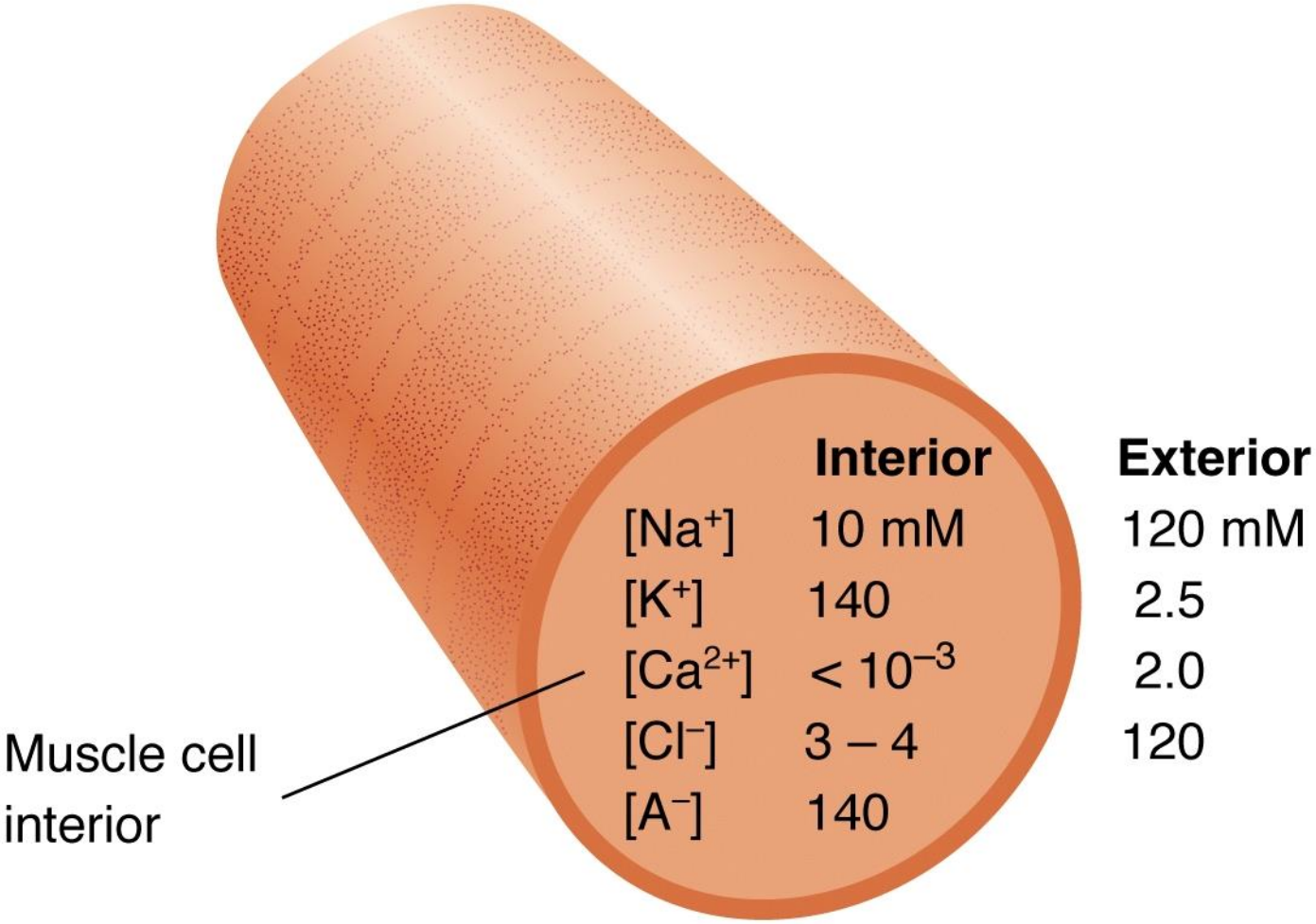
At equilibrium, there is no net movement of water.

Table 4-1 **Osmotic pressure of sucrose solutions of various concentrations***

Sucrose (%)	Osmotic pressure (atm)	Ratio of osmotic pressure to percentage of sucrose
1	0.70	0.70
2	1.34	0.67
4	2.74	0.68
6	4.10	0.68

* Results were obtained by Pfeffer (1877) in experimental measurements.


(a)
Start
Equilibrium
K+
Cl−
Time
[K+] = [K+]
[Cl−] = [Cl−]
I
II
I
II
(b)
KA
Start
Equilibrium
A−
K+
K+
Cl−
Cl−
Time
A−
[K+] > [K+]
[Cl−] < [Cl−]
I
II
I
II

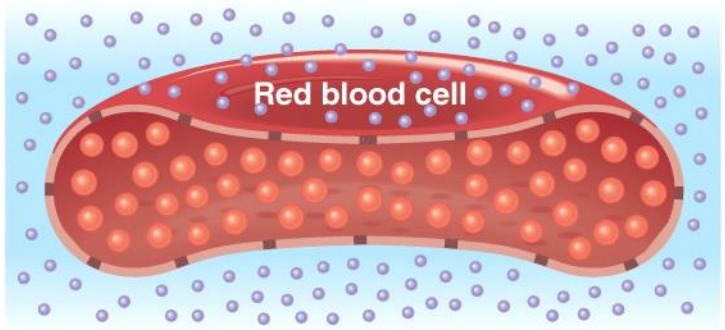


[A^-] = molar equivalent of negative charges carried by other molecules and ions.

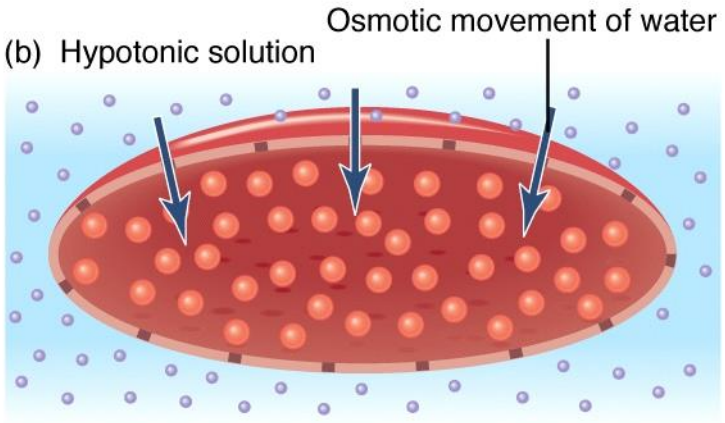
Table 4-2 Internal and external concentrations of some electrolytes in specific nerve and muscle tissues

Tissue	Internal concentrations (mM)			External concentrations (mM)			Ratios, inside/outside		
	Na^+	K^+	Cl^-	Na^+	K^+	Cl^-	Na^+	K^+	Cl^-
Squid nerve	49	410	40–100	440	22	560	1/9	19/1	1/14–1/6
Crab leg nerve	52	410	26	510	12	540	1/10	34/1	1/21
Frog sartorius muscle	10	140	4	120	2.5	120	1/12	56/1	1/30

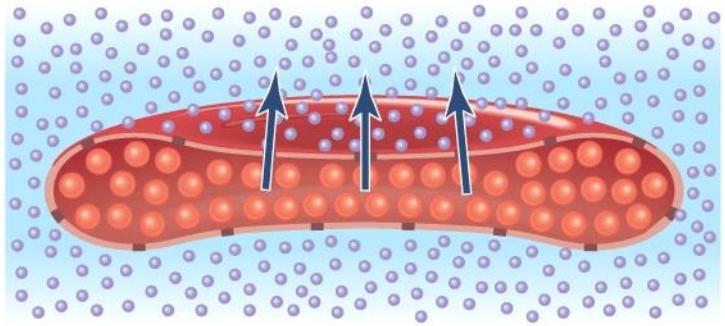
(a) Isotonic solution

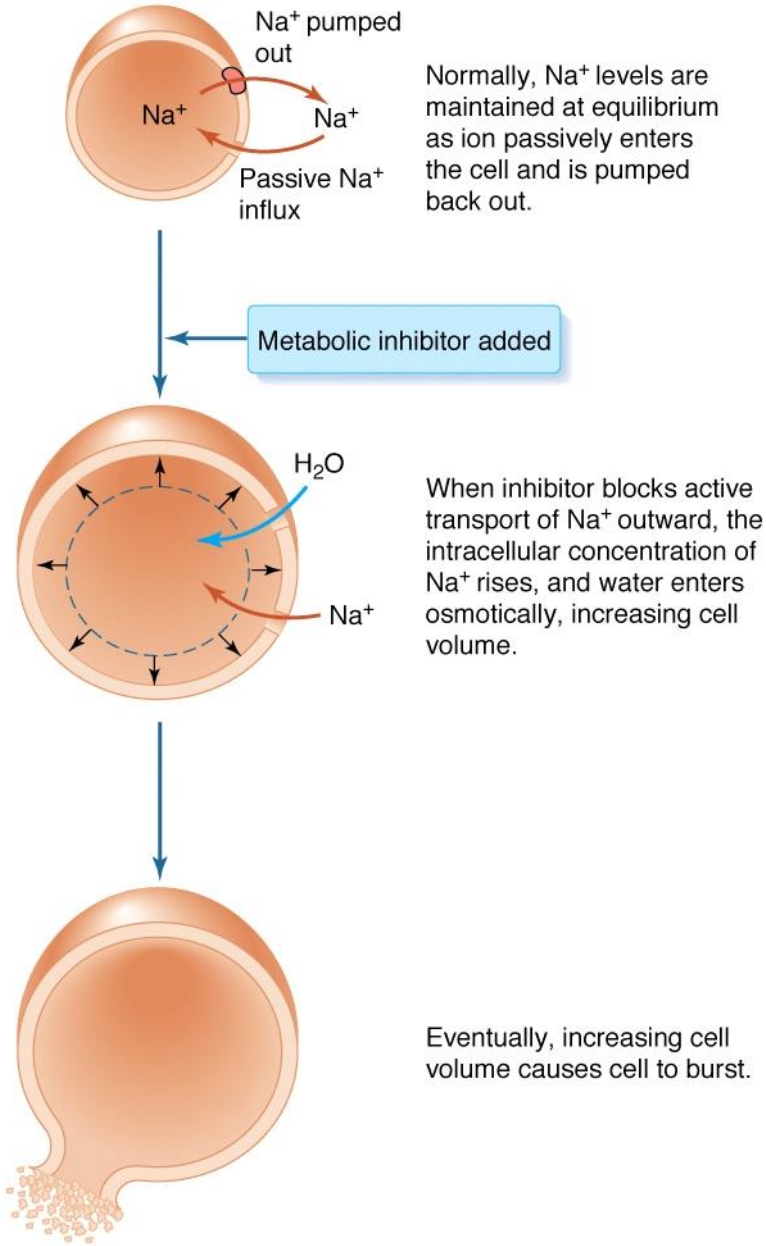


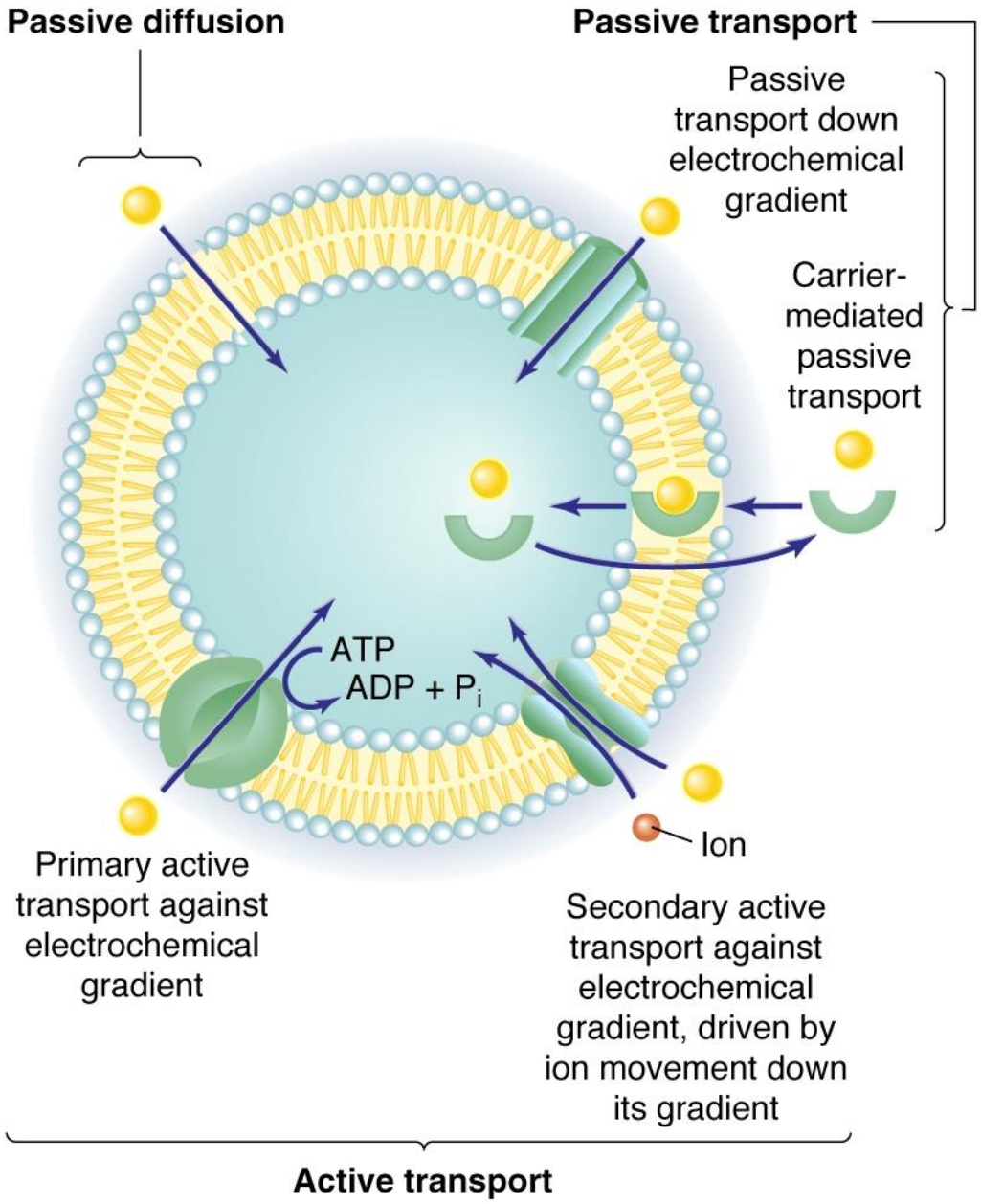
(b) Hypotonic solution



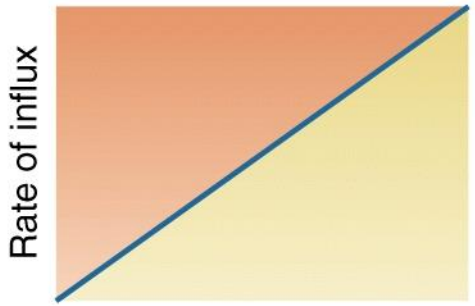
(c) Hypertonic solution



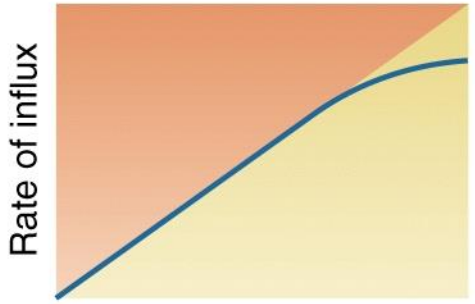

Na+ pumped out
Na+
Na+
Passive Na+ influx
Normally, Na+ levels are maintained at equilibrium as ion passively enters the cell and is pumped back out.
Metabolic inhibitor added
H2O
Na+
When inhibitor blocks active transport of Na+ outward, the intracellular concentration of Na+ rises, and water enters osmotically, increasing cell volume.
Eventually, increasing cell volume causes cell to burst.


Passive diffusion
Passive transport
Passive transport down electrochemical gradient
Carrier-mediated passive transport
ATP
ADP + P_i
Primary active transport against electrochemical gradient
Ion
Secondary active transport against electrochemical gradient, driven by ion movement down its gradient
Active transport

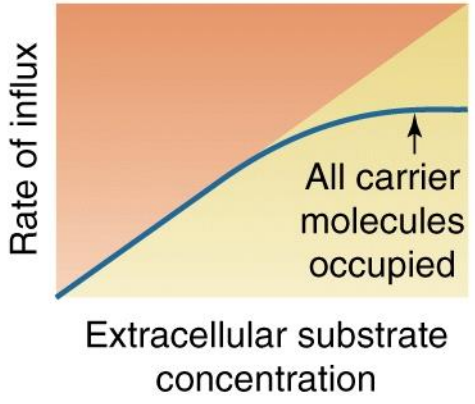
(a) Passive diffusion through membrane

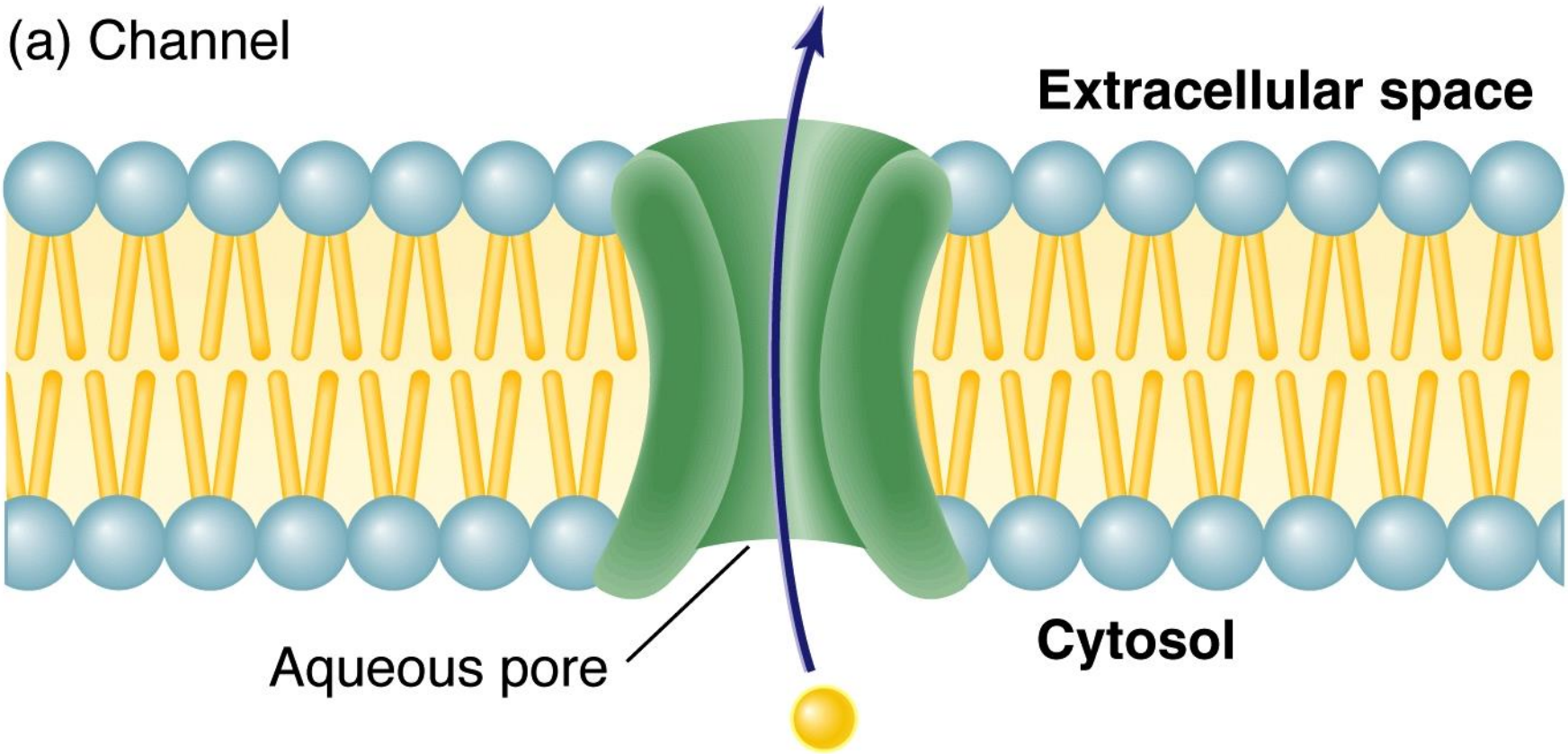


(b) Passive transport through channels

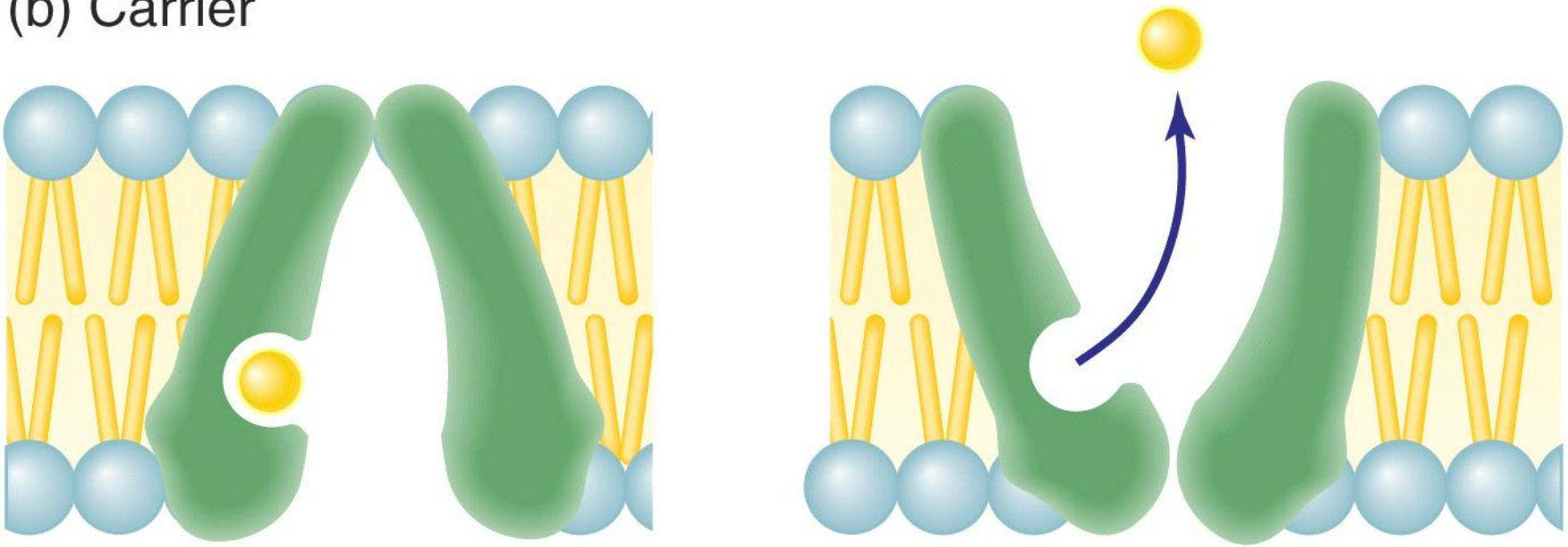


(c) Carrier-mediated transport (passive or active)

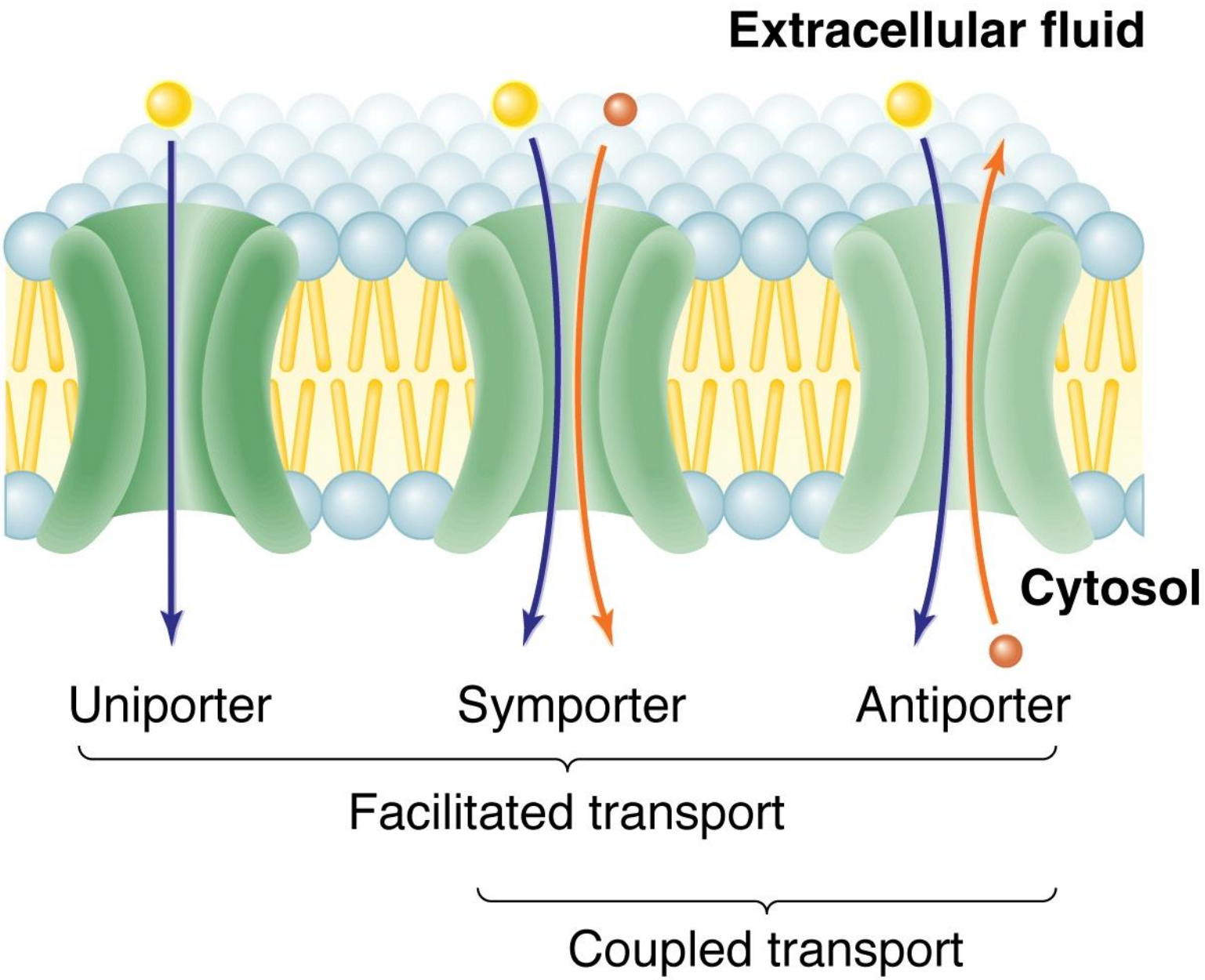


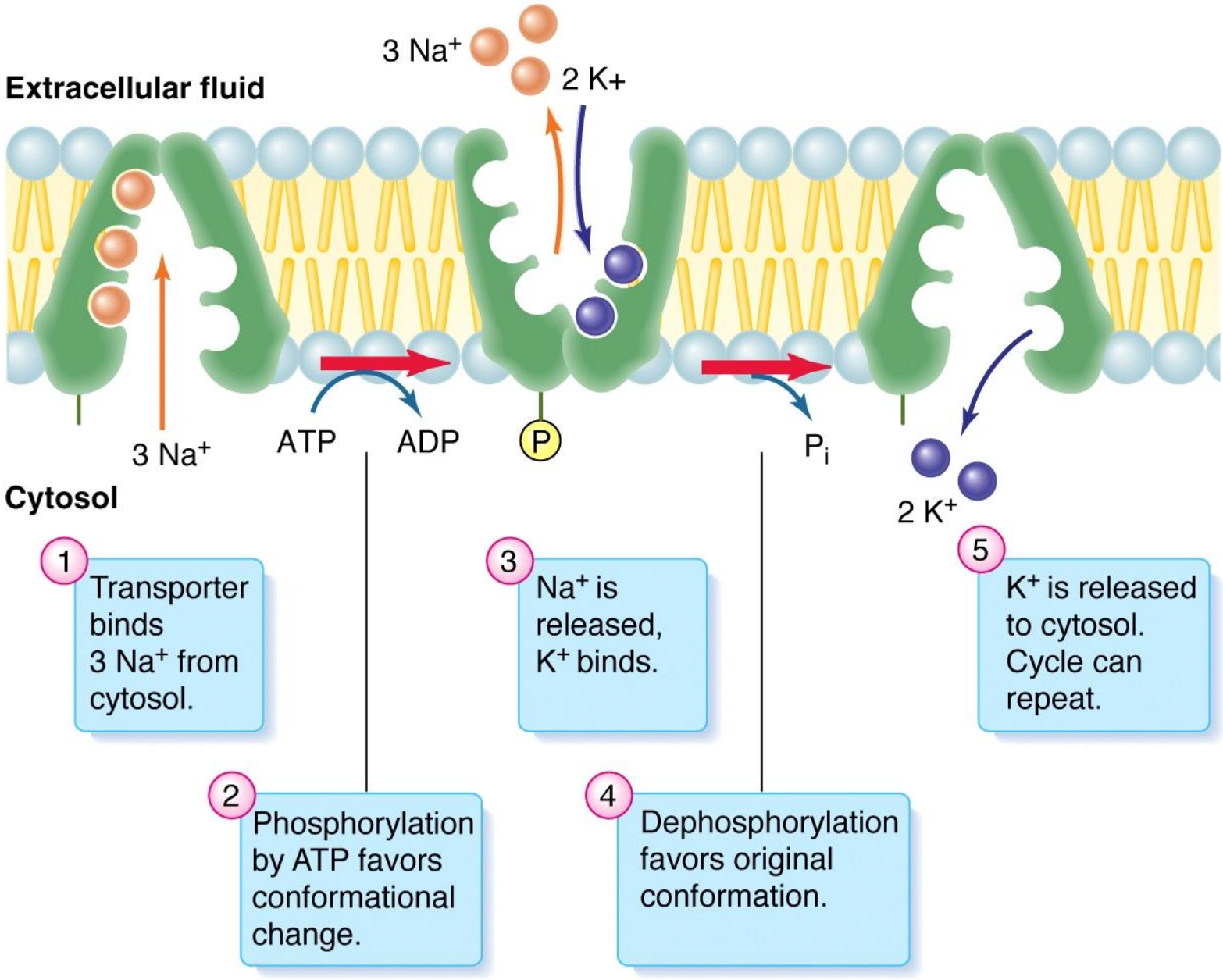

(a) Channel
Extracellular space
Cytosol
Aqueous pore

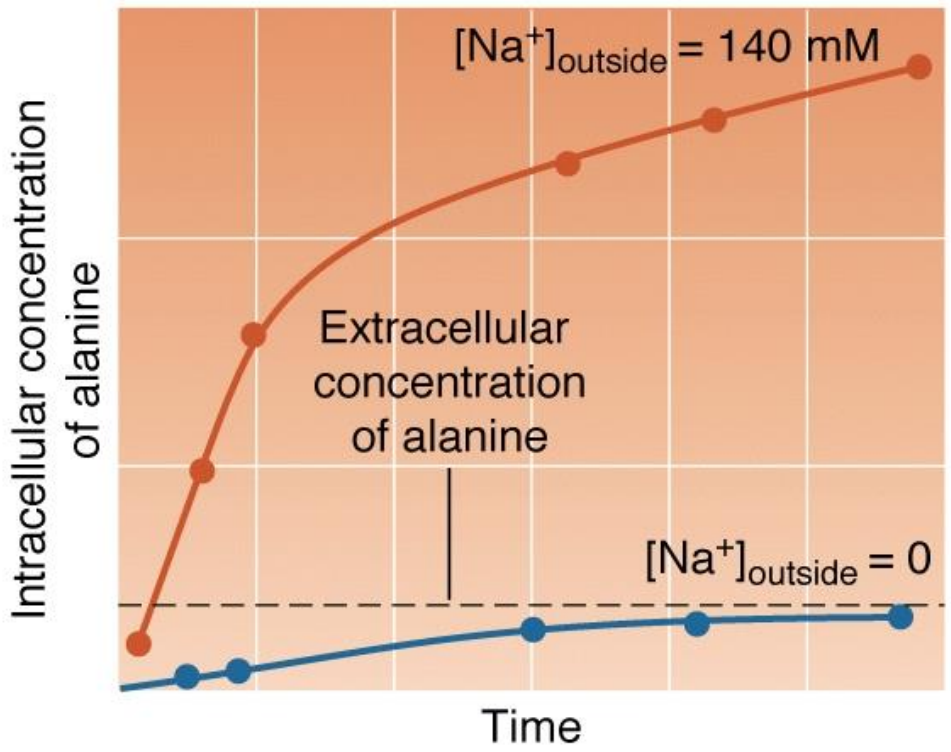
(b) Carrier

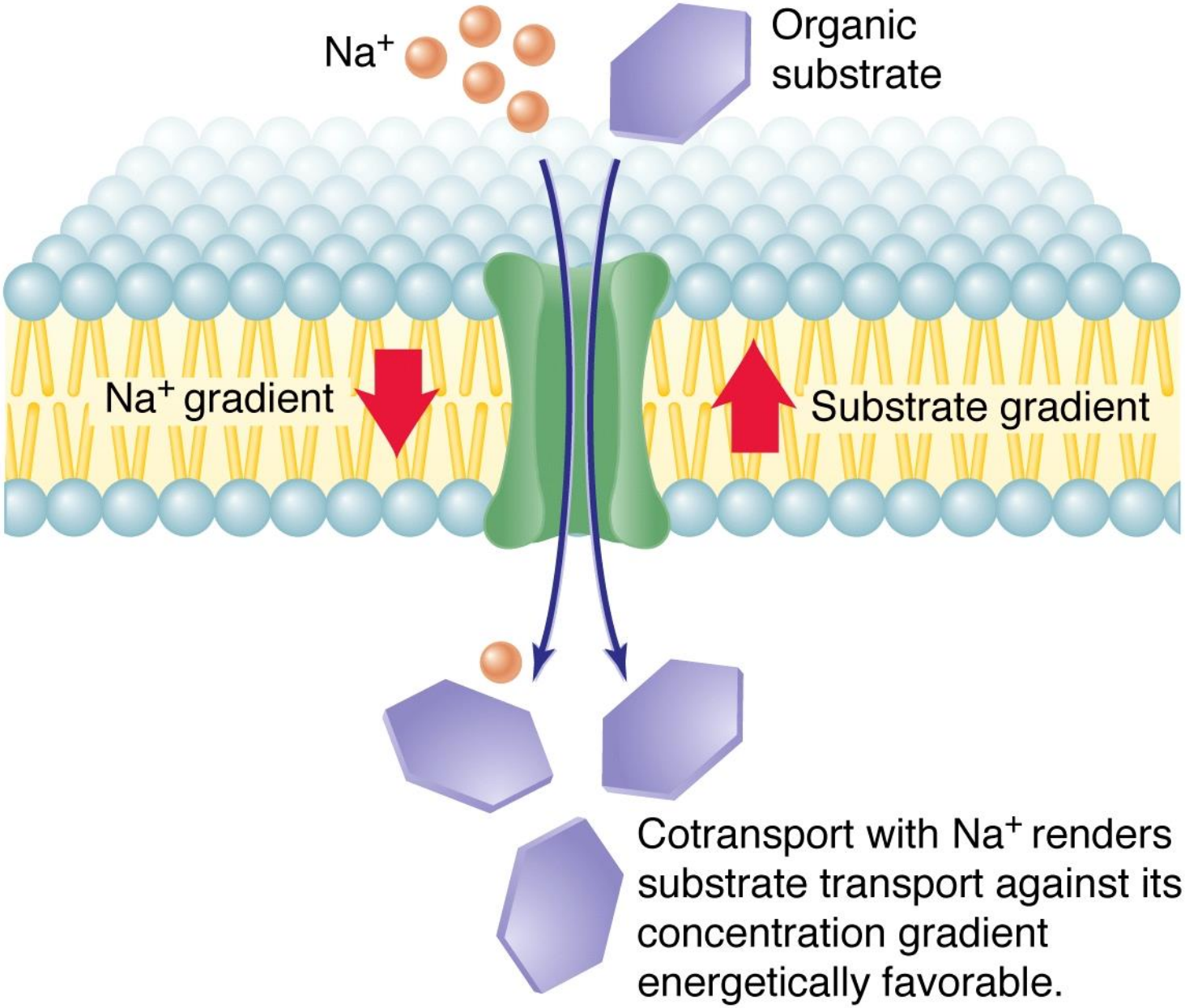


Conformational change


Extracellular fluid
Cytosol
Uniporter
Symporter
Antiporter
Facilitated transport
Coupled transport


3 Na+
2 K+
Extracellular fluid
3 Na+
ATP
ADP
P
Pi
2 K+
Cytosol
1
Transporter binds 3 Na+ from cytosol.
2
Phosphorylation by ATP favors conformational change.
3
Na+ is released, K+ binds.
4
Dephosphorylation favors original conformation.
5
K+ is released to cytosol. Cycle can repeat.


$[Na^+]_{outside}$ = 140 mM
Extracellular concentration of alanine
$[Na^+]_{outside}$ = 0
Intracellular concentration of alanine
Time


Na+
Organic substrate
Na+ gradient
Substrate gradient
Cotransport with Na+ renders substrate transport against its concentration gradient energetically favorable.

http://en.wikipedia.org/wiki/Oral_rehydration_therapy

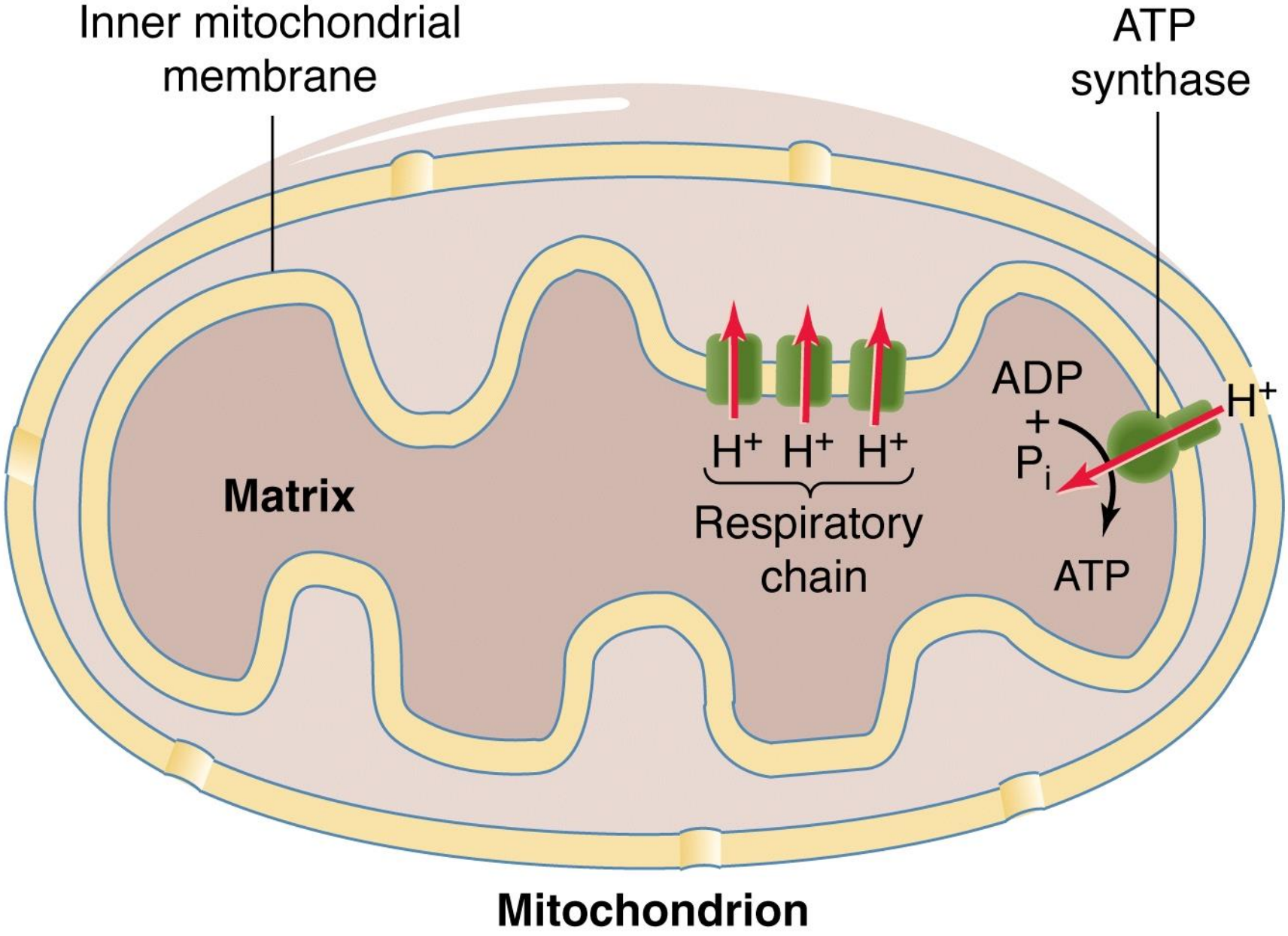
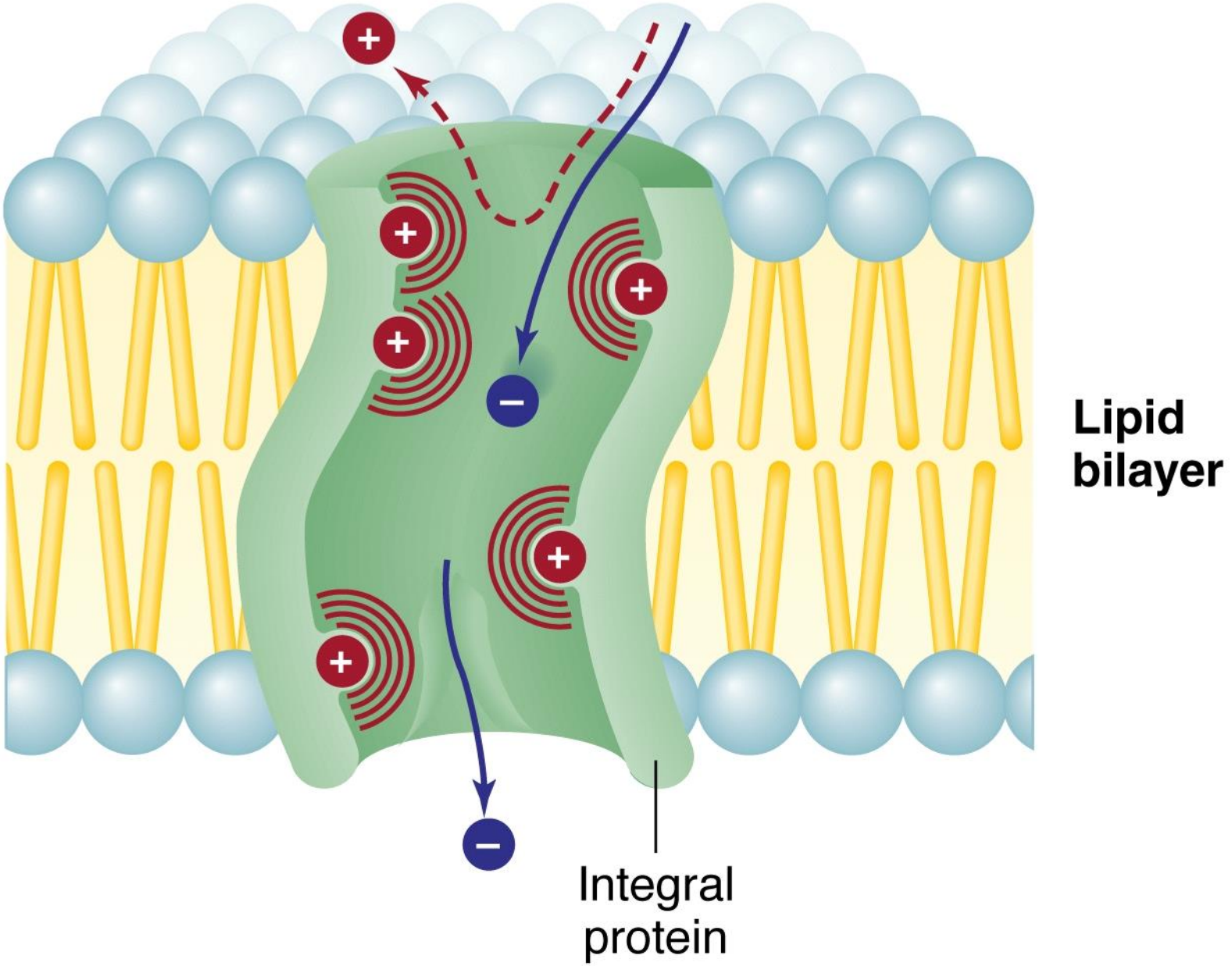
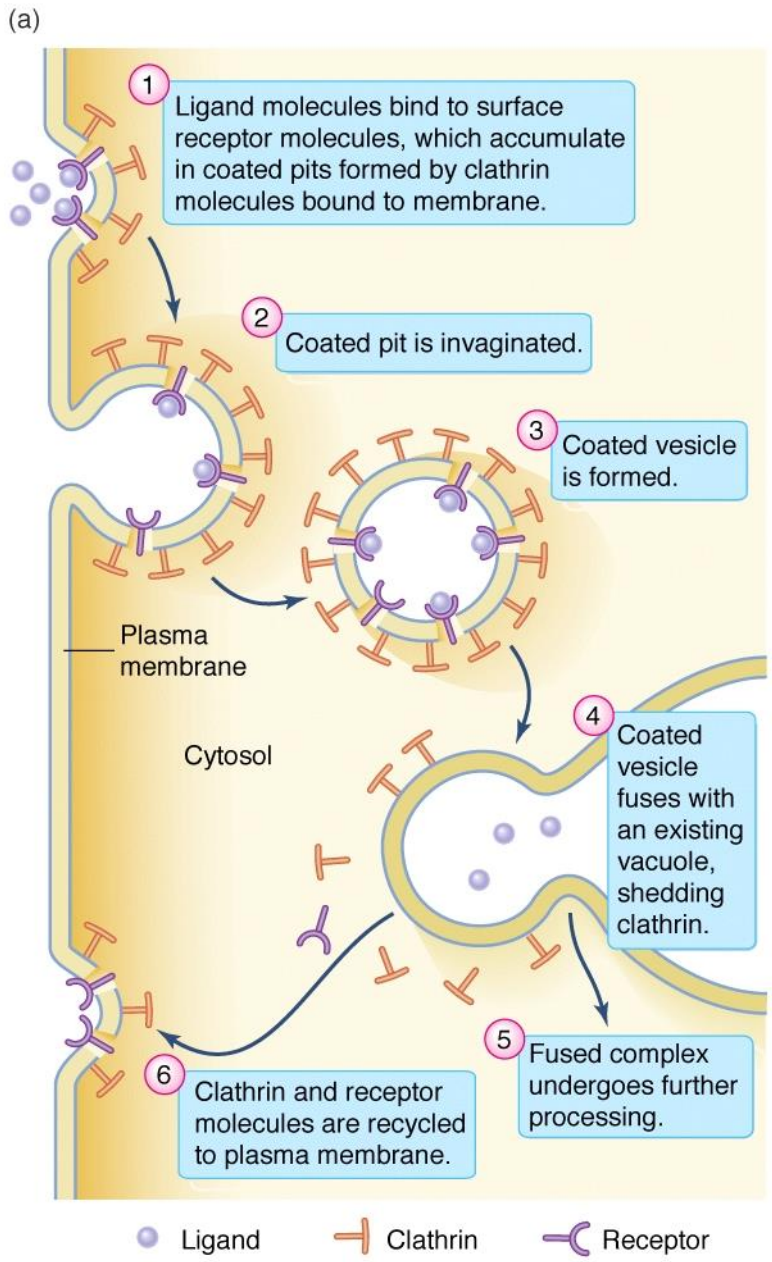

Inner mitochondrial membrane
ATP synthase
Matrix
H+ H+ H+
Respiratory chain
ADP
+
Pi
H+
ATP
Mitochondrion

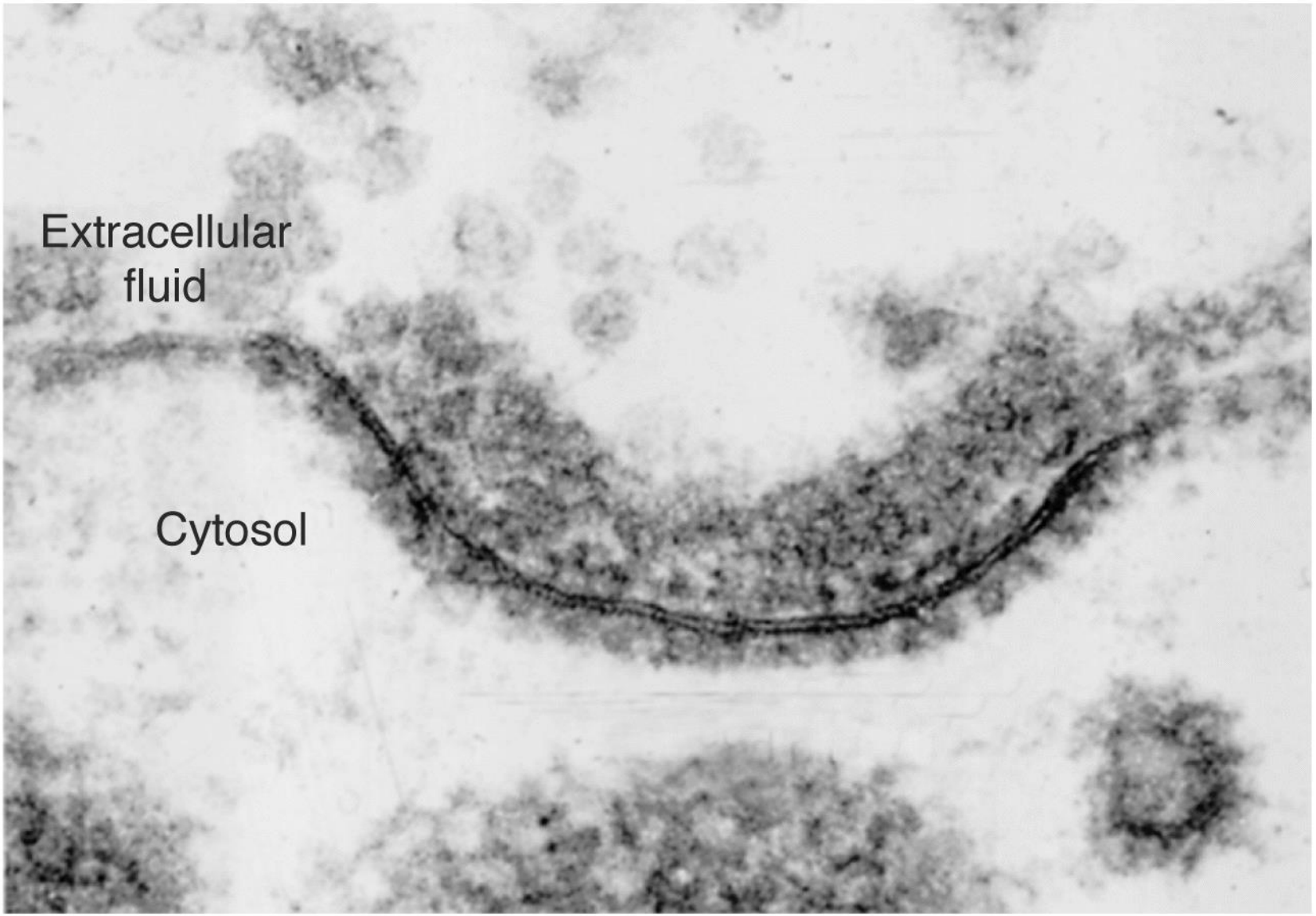
Table 4-3 **Ionic radii and hydration energies of the alkali metal cations**

Cation	Ionic radius (Å)		Free energy of hydration ($kcal \cdot mol^{-1}$)
Li^+	0.60		2122
Na^+	0.95		298
K^+	1.33		280
Rb^+	1.48		275
Cs^+	1.69		267

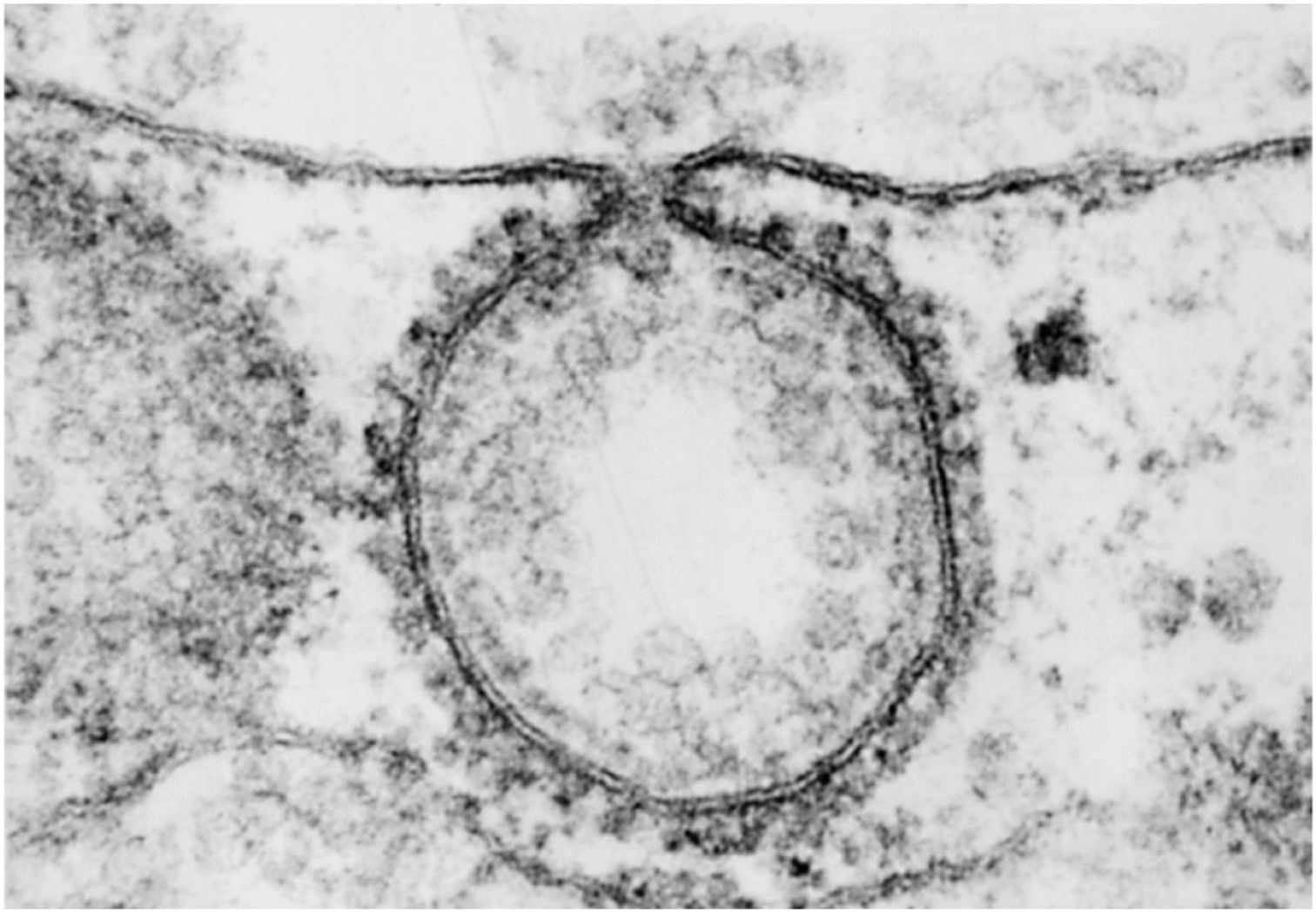

Lipid bilayer
Integral protein

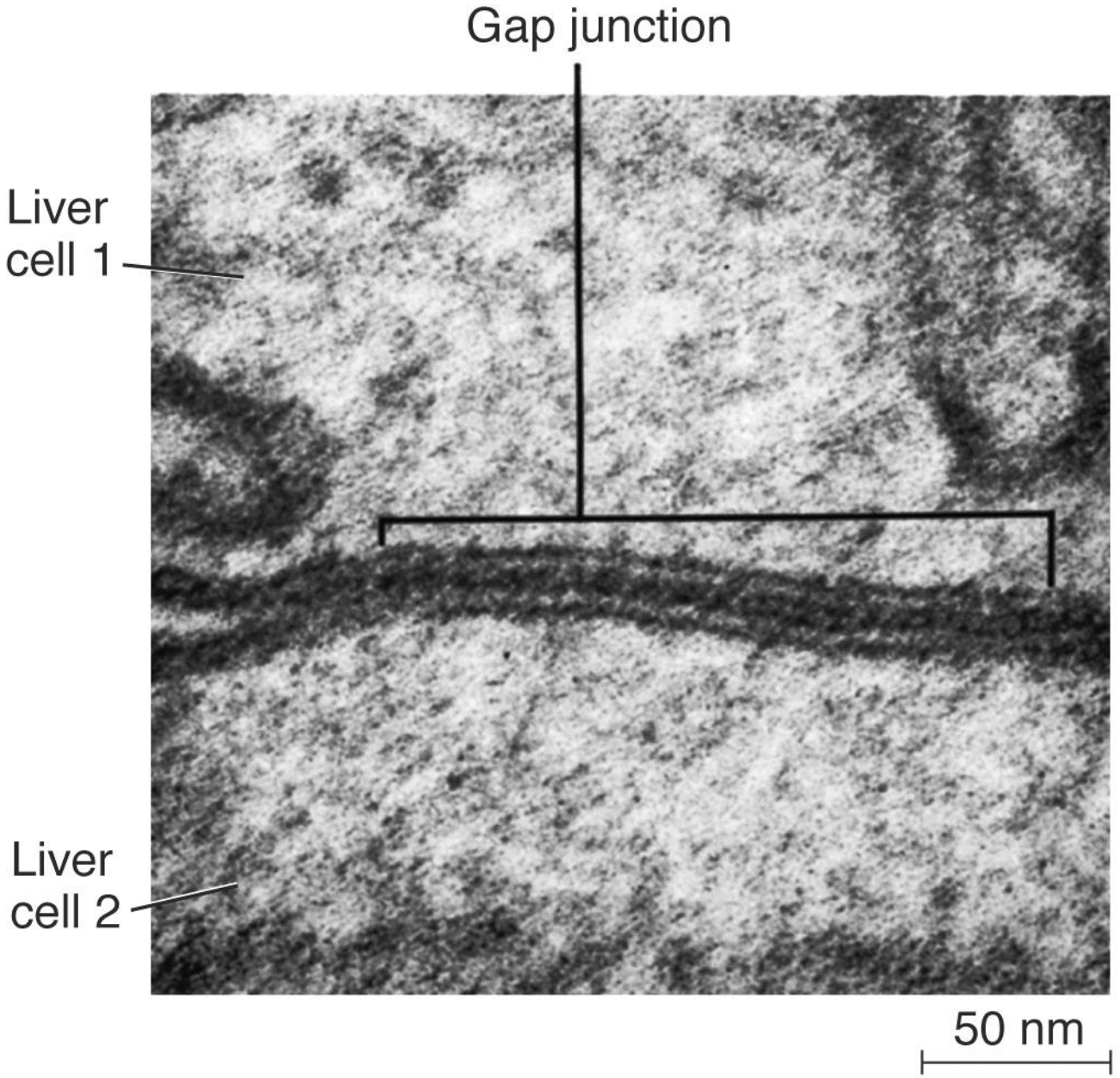

(a)
1
Ligand molecules bind to surface receptor molecules, which accumulate in coated pits formed by clathrin molecules bound to membrane.
2
Coated pit is invaginated.
3
Coated vesicle is formed.
Plasma membrane
Cytosol
4
Coated vesicle fuses with an existing vacuole, shedding clathrin.
5
Fused complex undergoes further processing.
6
Clathrin and receptor molecules are recycled to plasma membrane.
Ligand
Clathrin
Receptor

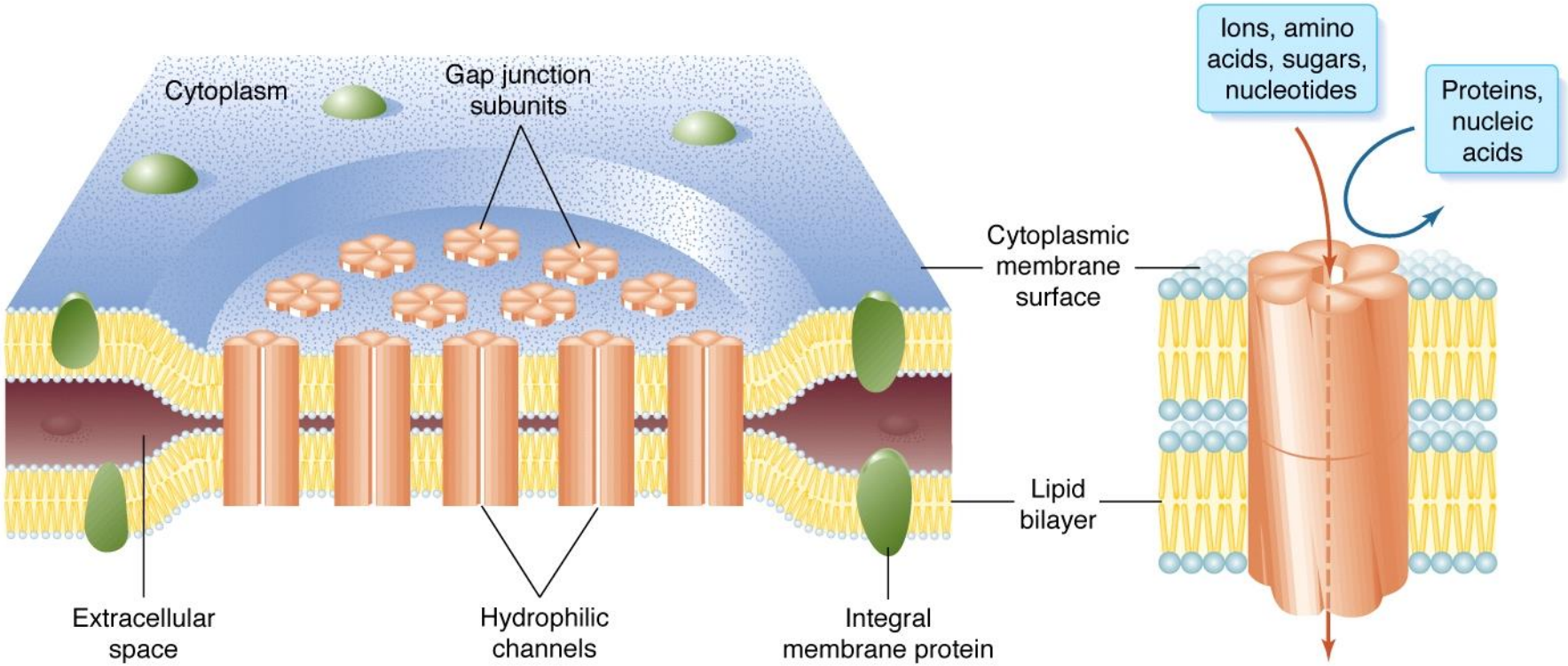
(b) Coated pit

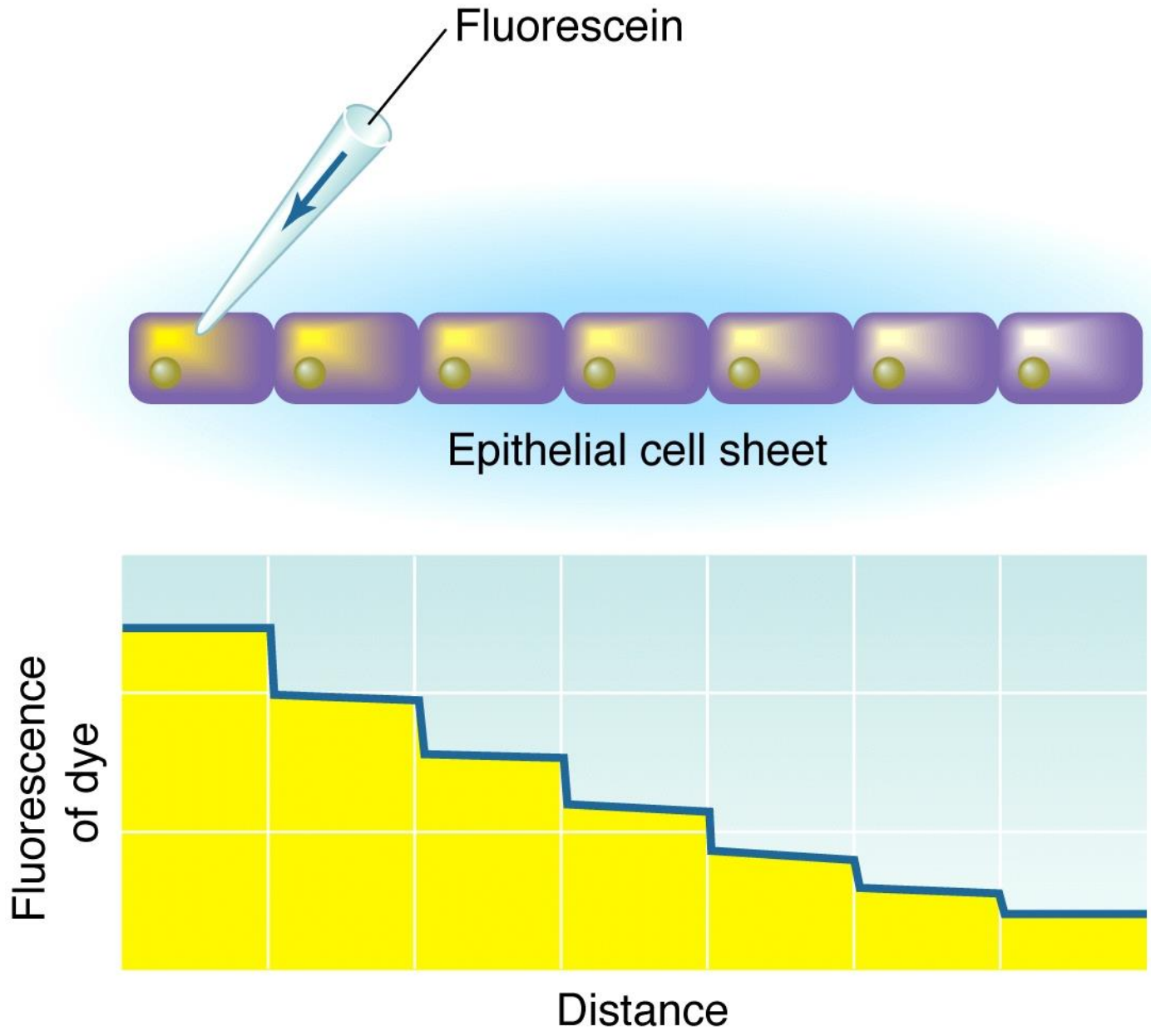


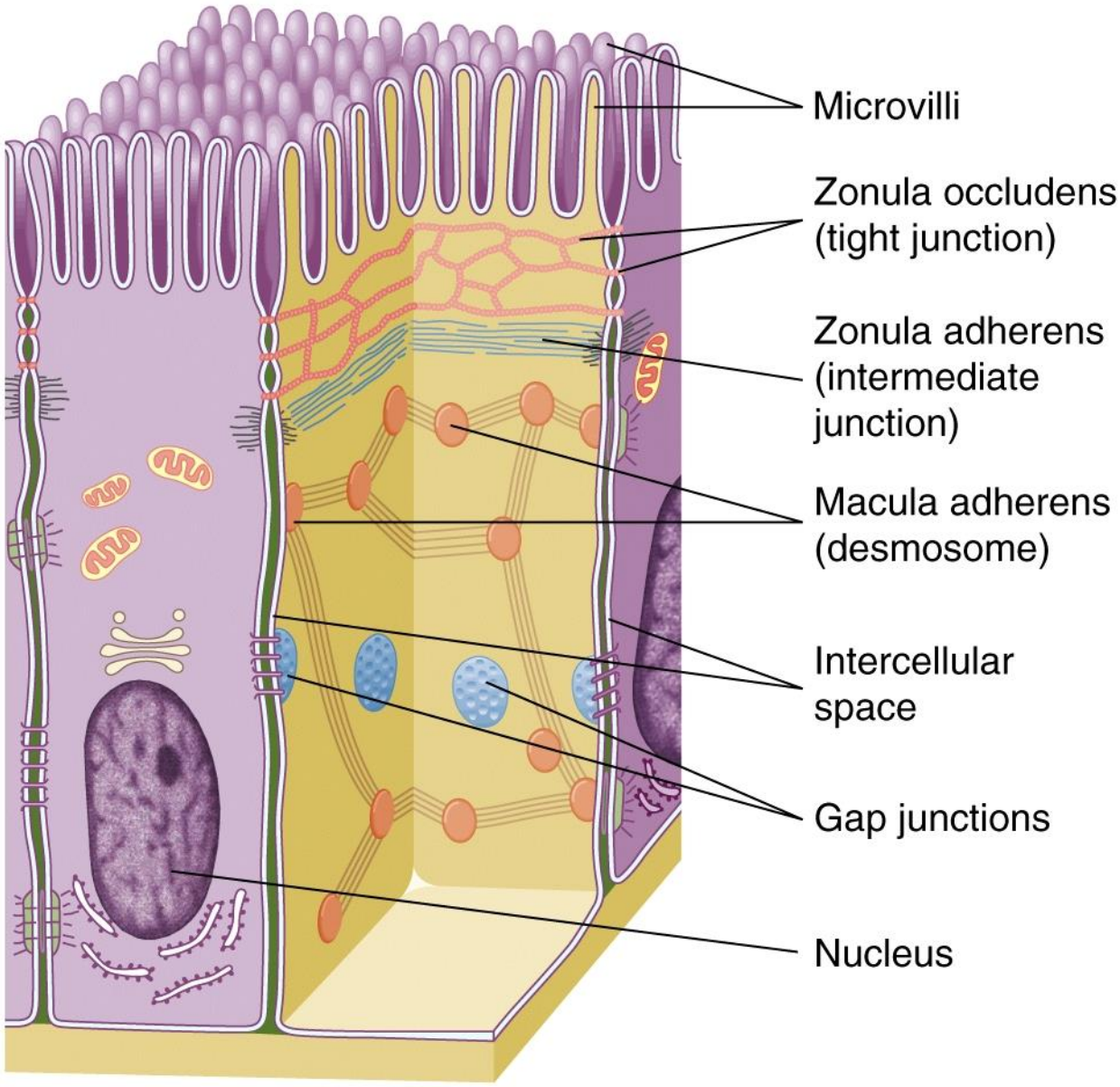
(c) Coated vesicle

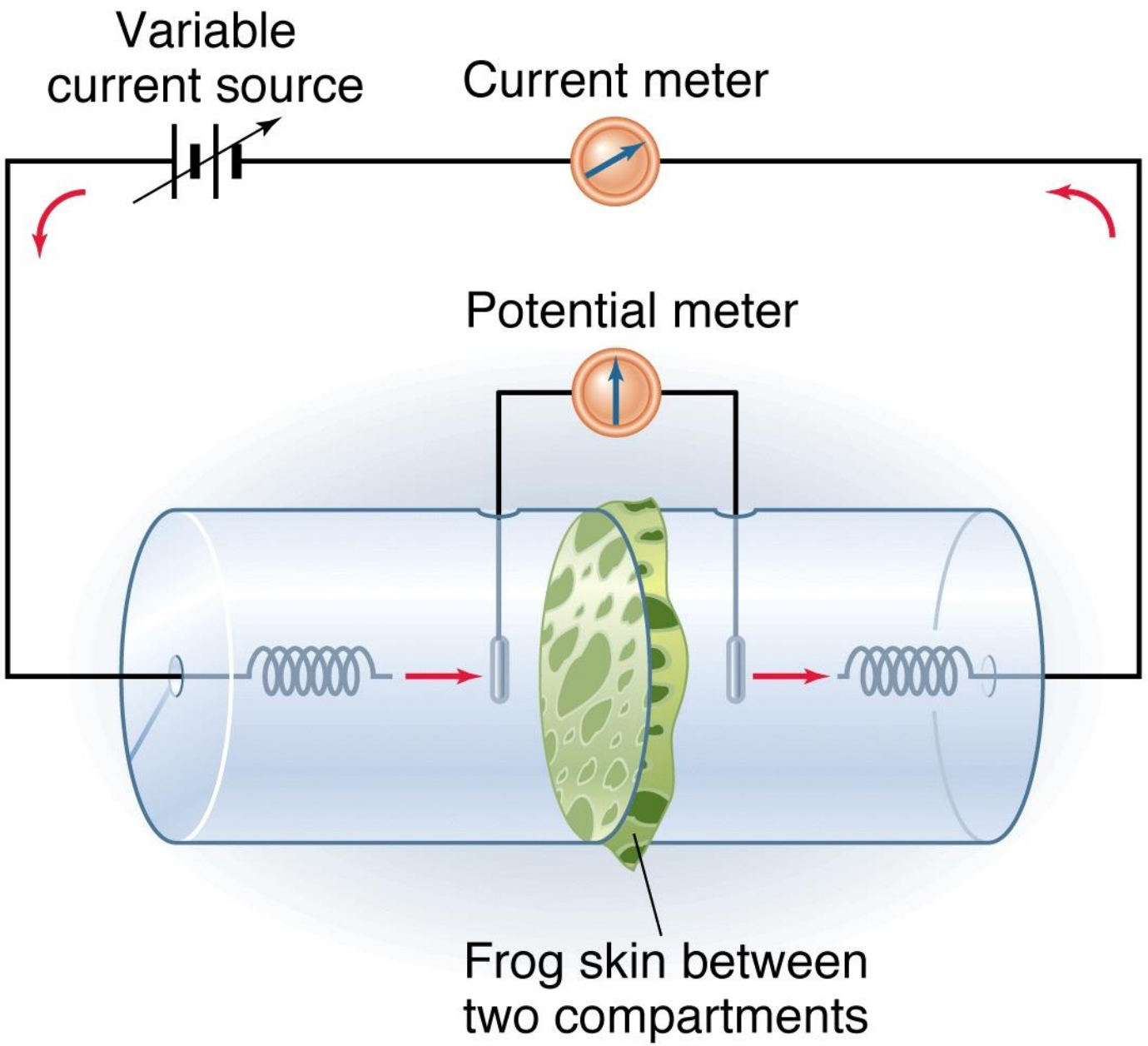


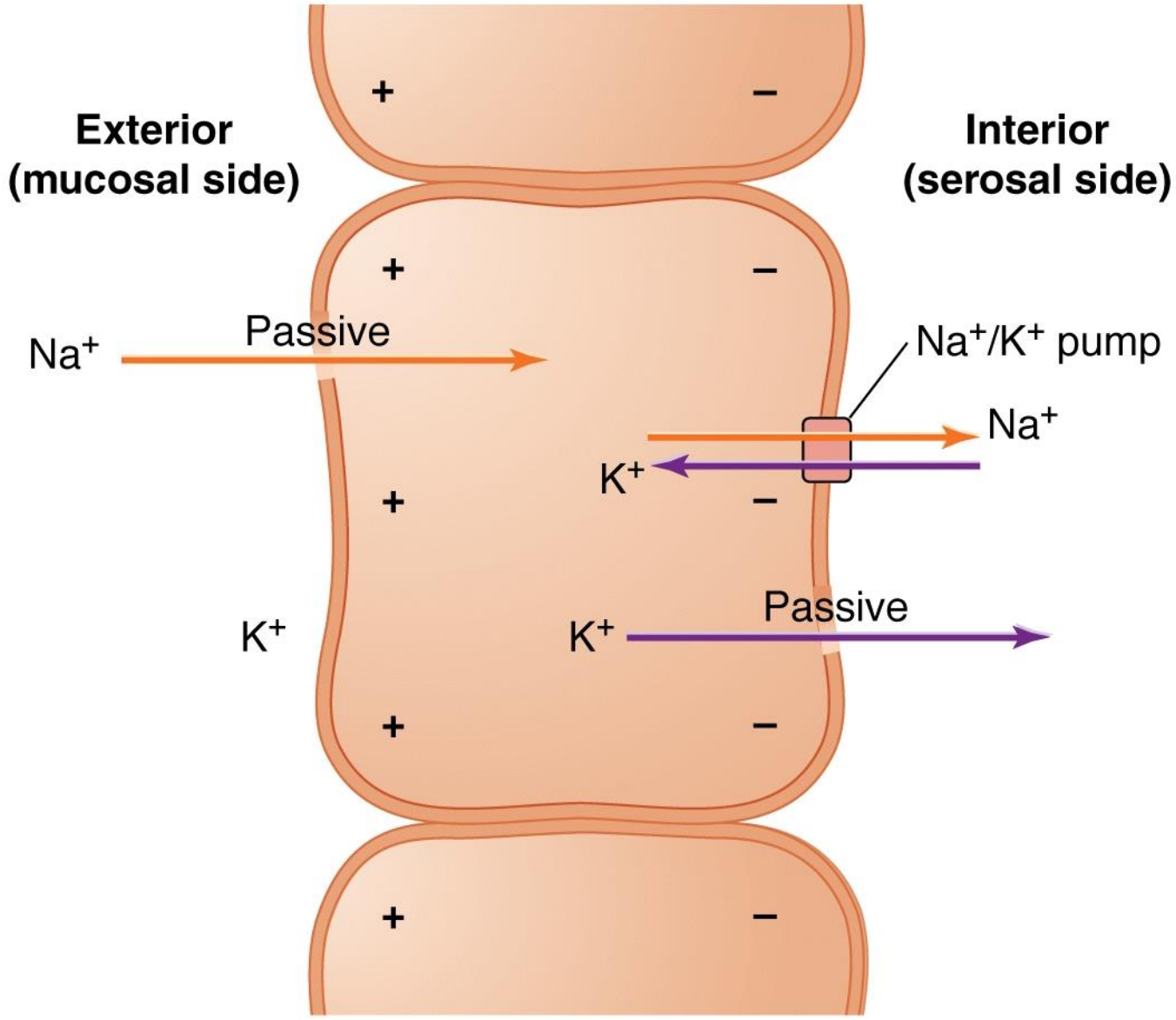

Gap junction
Liver cell 1
Liver cell 2
50 nm


Cytoplasm
Gap junction subunits
Ions, amino acids, sugars, nucleotides
Proteins, nucleic acids
Cytoplasmic membrane surface
Lipid bilayer
Extracellular space
Hydrophilic channels
Integral membrane protein

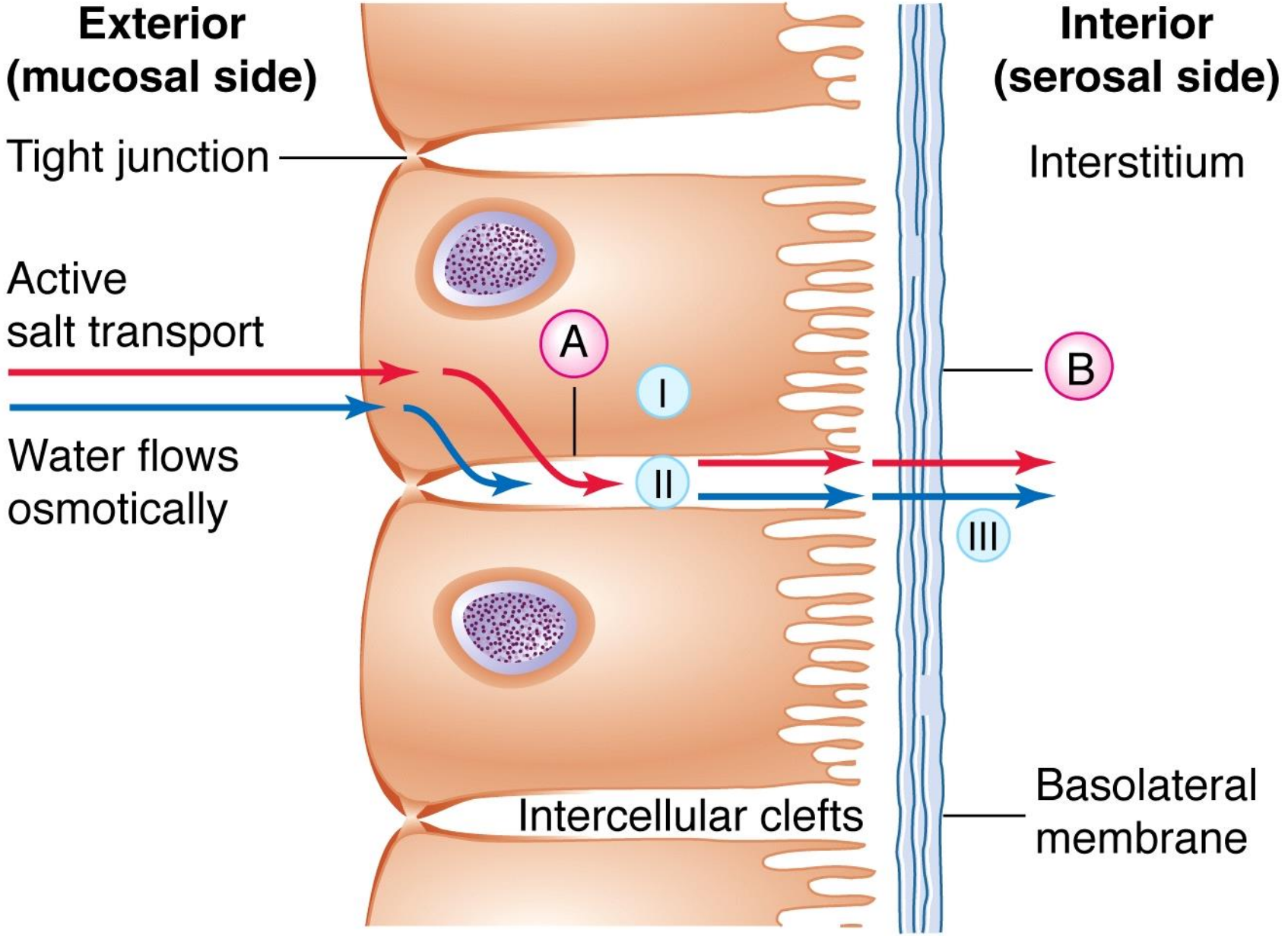

Fluorescein
Epithelial cell sheet
Fluorescence of dye
Distance


Microvilli
Zonula occludens (tight junction)
Zonula adherens (intermediate junction)
Macula adherens (desmosome)
Intercellular space
Gap junctions
Nucleus


Variable
current source
Current meter
Potential meter
Frog skin between
two compartments



Epithelial cell of frog skin


Exterior
(mucosal side)
Interior
(serosal side)
Tight junction
Interstitium
Active
salt transport
A
B
I
Water flows
osmotically
II
III
Intercellular clefts
Basolateral
membrane