

Canali idrici

Acquaporine (AQP, varie isoforme)

Canali ionici

Na^+

K^+

Ca^{2+}

Cl^-

Anioni

Cationi

Per ciascuno di questi ioni vi sono più canali che si differenziano per la loro selettività, conduttanza e modalità di regolazione (*gating*)

Trasportatori di soluti

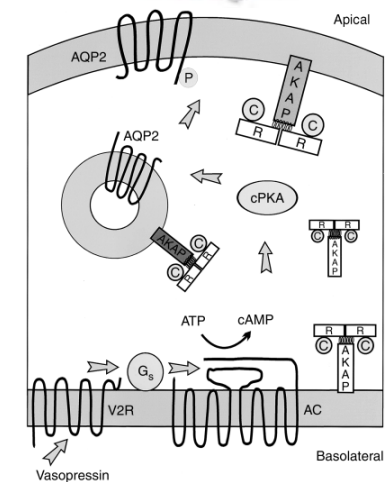
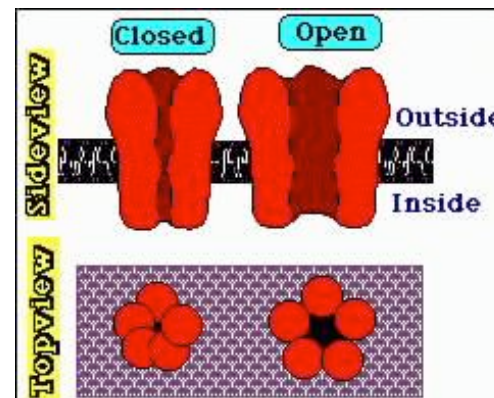
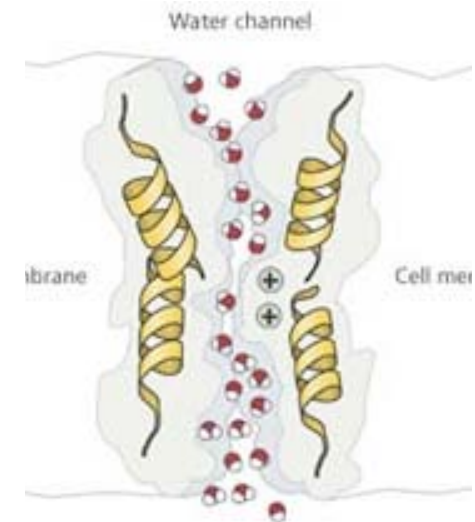
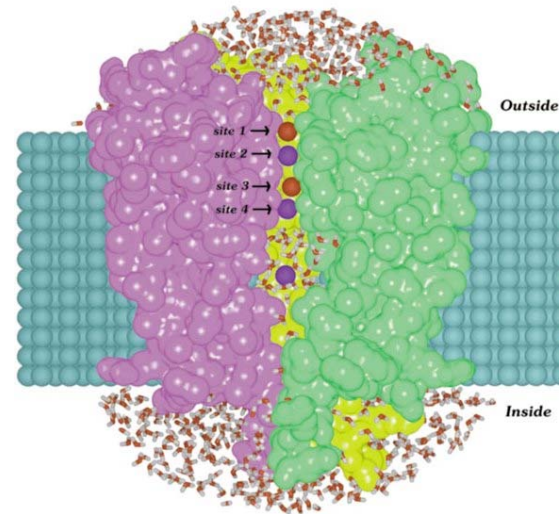
Uniporto

Glucosio (GLUT2)

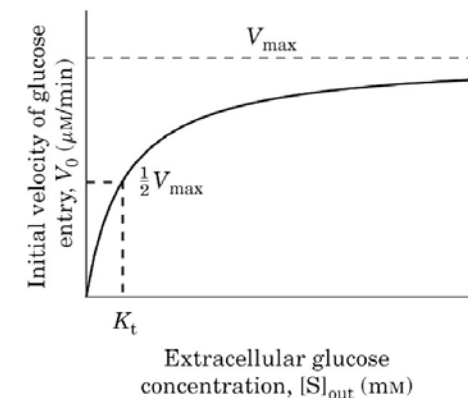
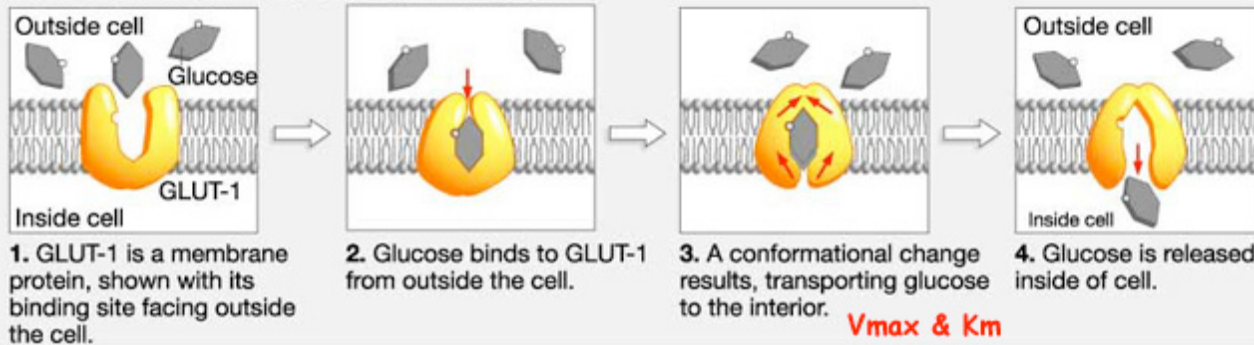
Fruttosio (GLUT5)

Urea (UT-A1)

Fe^{3+} (ferroportina/IREG-1)



HOW GLUT-1 FACILITATES GLUCOSE DIFFUSION



Simporto

1Na^+ -glucosio (SGLT2)

2Na^+ -glucosio (SGLT1)

Na^+ -aminoacido (più trasportatori)

Na^+ - Cl^- (NCC/TSC)

Na^+ , 1K^+ , 2Cl^- (NKCC2)

Na^+ - 3HCO_3^- (NBC1)

3Na^+ - P_i (trasportatore dei fosfati tipo IIa)

2Na^+ - 1I^- (NIS)

Na^+ -acido biliare (NTCP, varie isoforme)

3Na^+ -dicarbossilato (SDCT, varie isoforme)

H^+ -oligopeptide (PepT e PHT, varie isoforme)

H^+ - Fe^{3+} (DCT-1)

K^+ - Cl^- (KCC, varie isoforme)

Antiporto

Na^+ - H^+ (NHE, varie isoforme)

Cl^- - HCO_3^- (AE-1/ banda tre e pendrina)

3Na^+ - Ca^{2+} (NCX, varie isoforme)

Anioni organici (OAT, più trasportatori per anioni diversi)

Cationi organici (OCT e OCTN, varie isoforme)

ATPasi per il trasporto di ioni

Tipo P

Na^+ , K^+ -ATPasi

H^+ , K^+ -ATPasi

H^+ , Ca^{2+} -ATPasi (PMCA)

Tipo V

H^+ -ATPasi

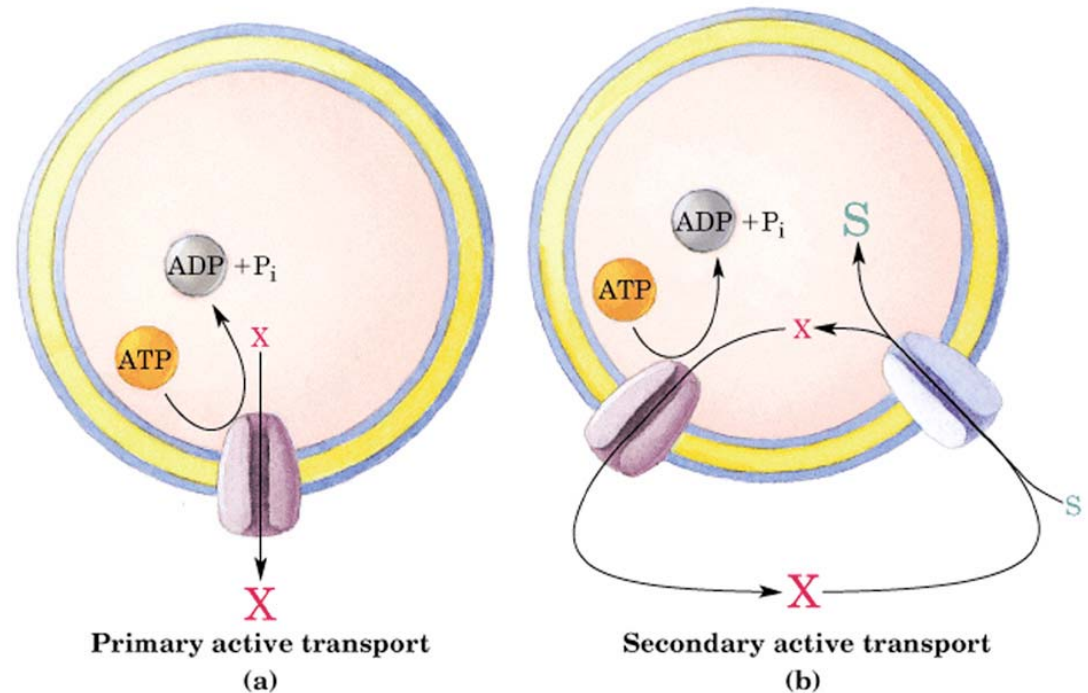
Trasportatori ABC

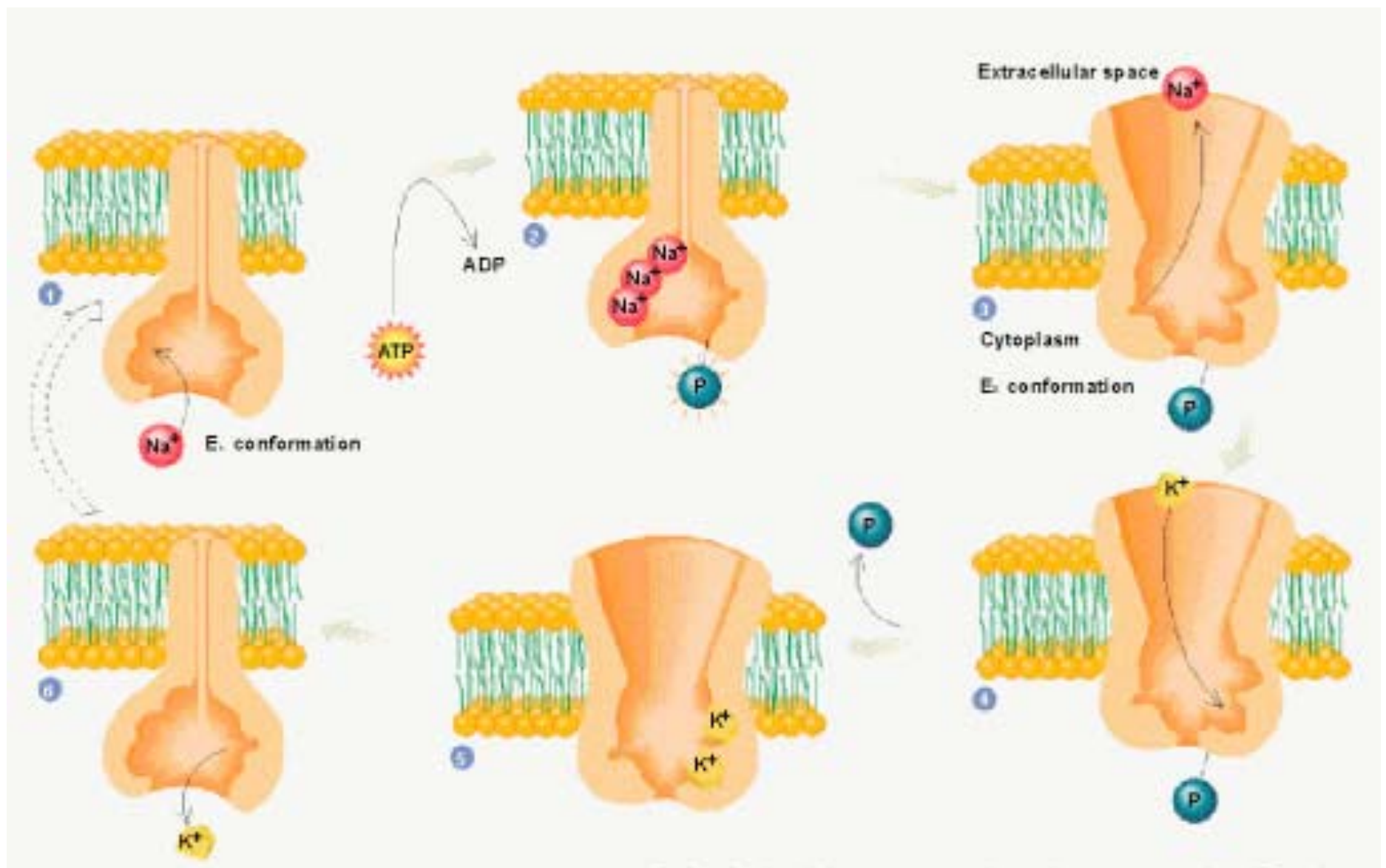
Regolatore della conduttanza transmembrana della fibrosi cistica (CFTR)

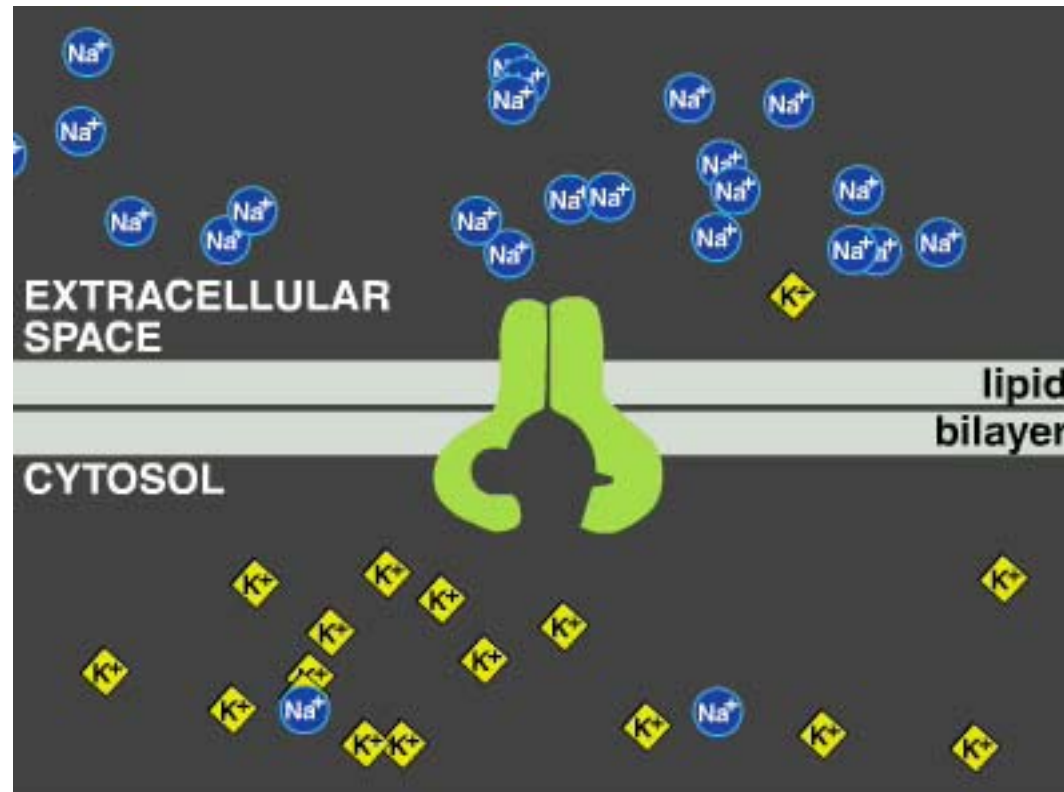
Proteina della resistenza multipla ai farmaci (MRP-1)

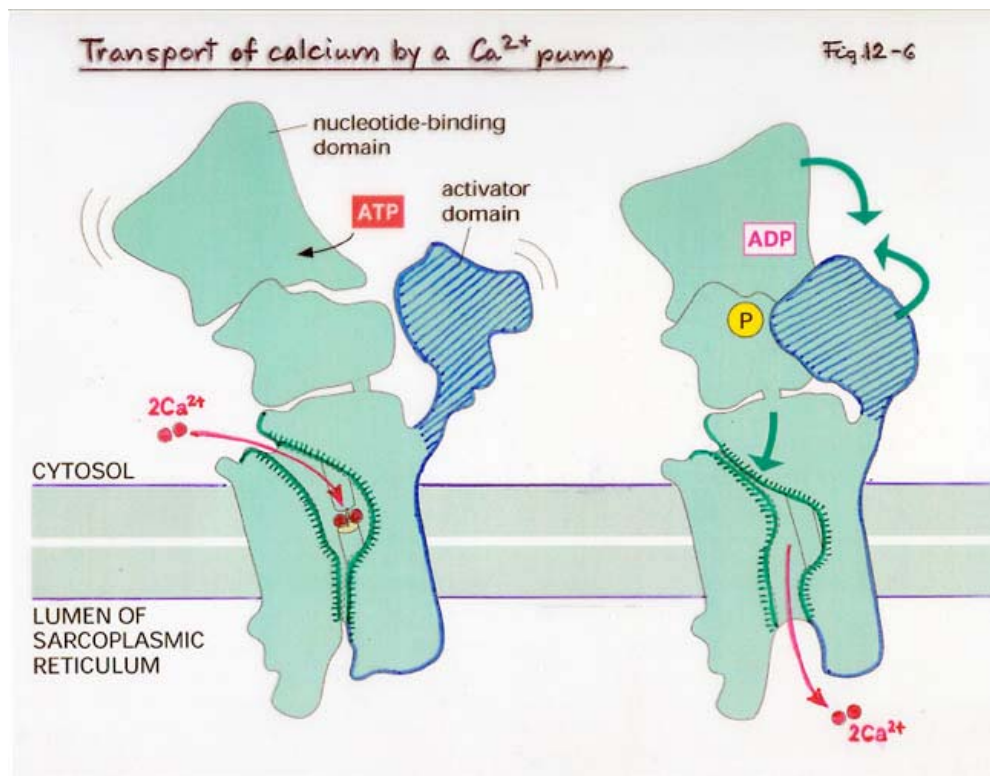
Anioni organici (MRP-2)

Two kinds of active transport









ATPasi per il trasporto di ioni

Tipo P

Na^+ , K^+ -ATPasi

H^+ , K^+ -ATPasi

H^+ , Ca^{2+} -ATPasi (PMCA)

Tipo V

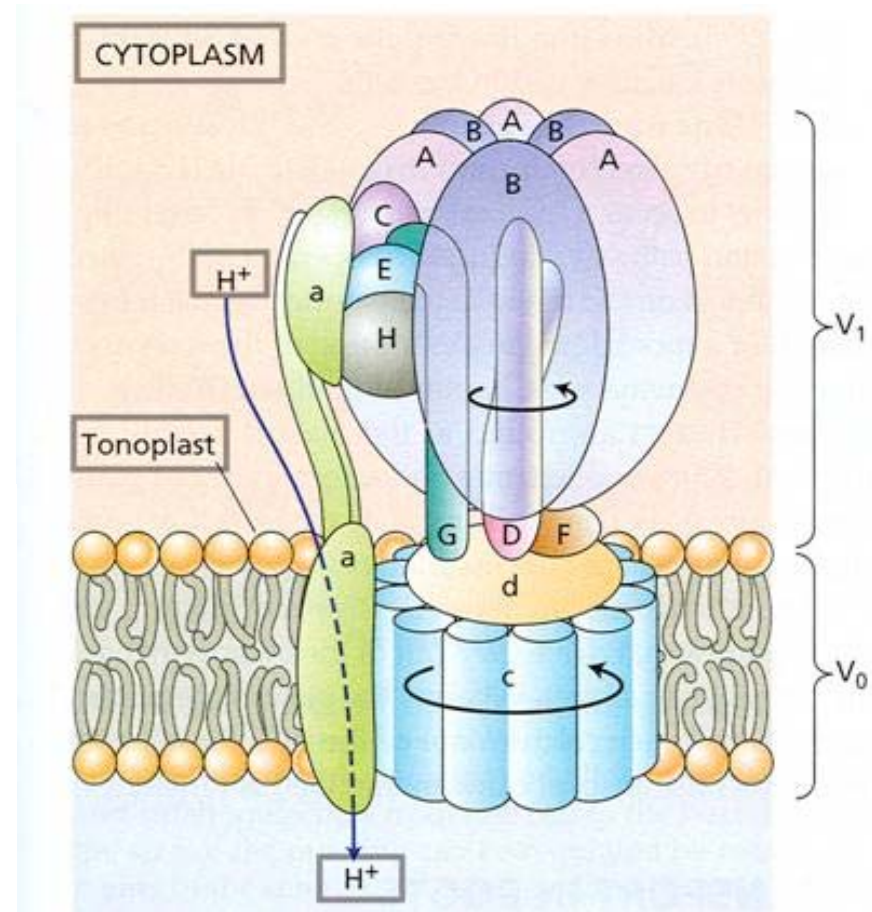
H^+ -ATPasi

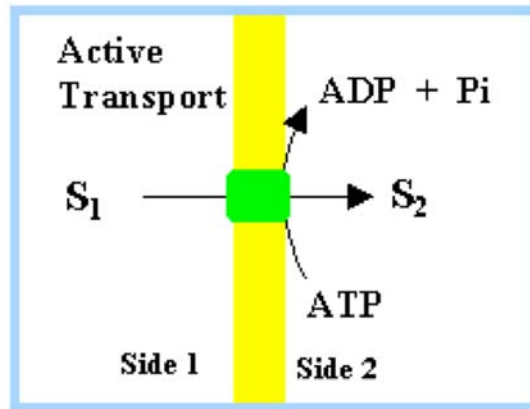
Trasportatori ABC

Regolatore della conduttanza transmembrana della fibrosi cistica (CFTR)

Proteina della resistenza multipla ai farmaci (MRP-1)

Anioni organici (MRP-2)





(Na⁺, K⁺)-ATPase

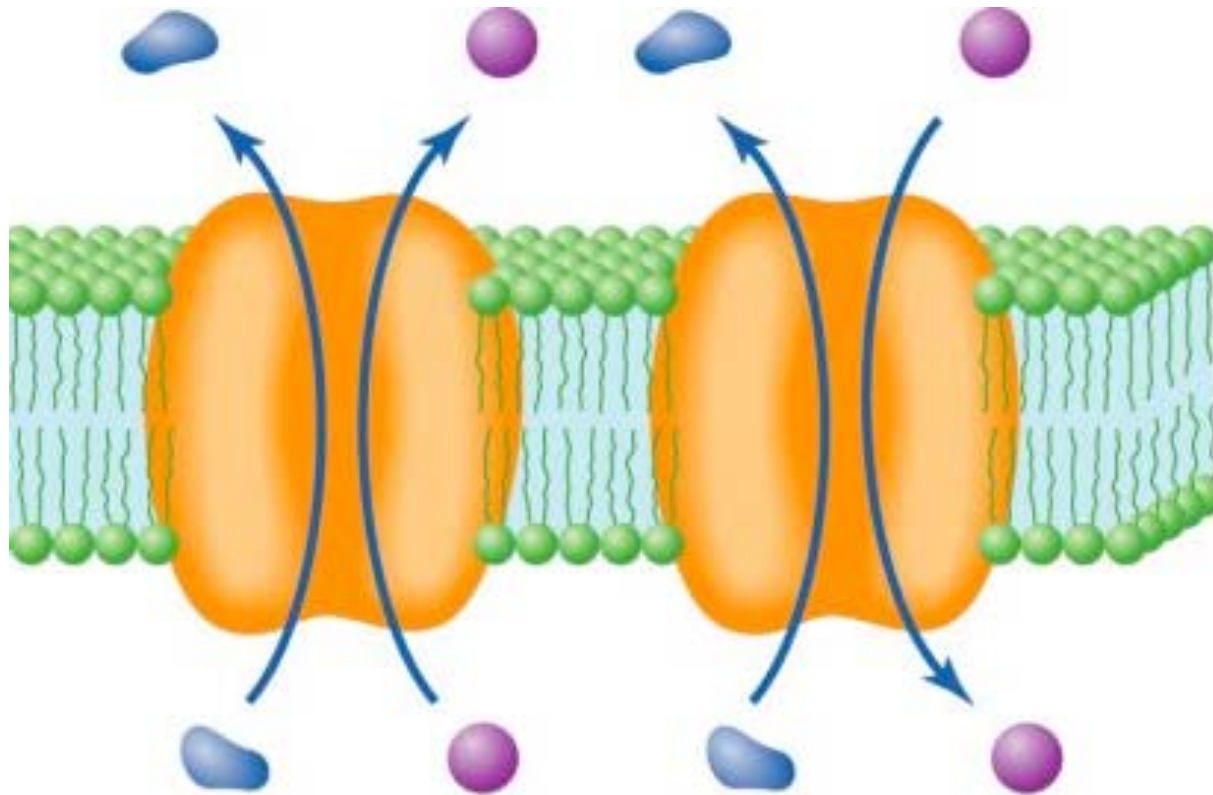
In plasma membranes of most animal cells, is an antiport ion pump. It catalyzes ATP-dependent transport of Na⁺ out of a cell in exchange for K⁺ entering the cell.

(H⁺, K⁺) -ATPase

Involved in acid secretion in the stomach, is an antiport pump. It catalyzes ATP-dependent transport of H⁺ out of the gastric parietal cell (toward the stomach lumen) in exchange for K⁺ entering the cell.

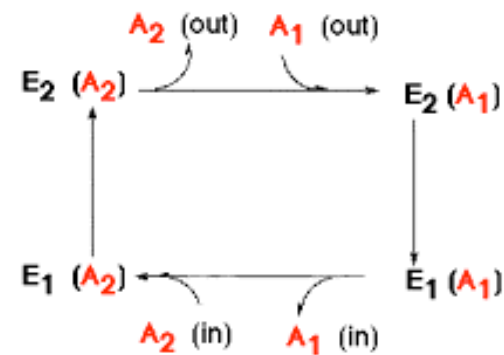
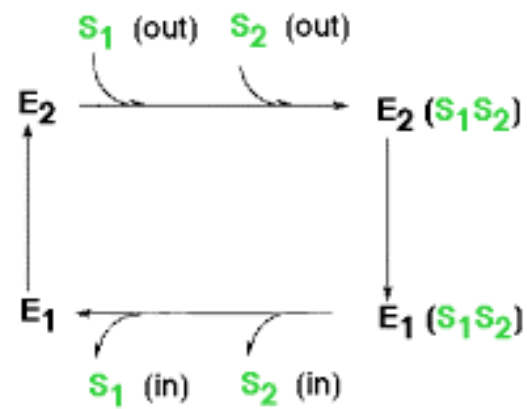
Ca⁺⁺-ATPases

In endoplasmic reticulum (ER) and plasma membranes of many cells, catalyze ATP-dependent transport of Ca⁺⁺ away from the cytosol, into the ER lumen or out of the cell. Some evidence indicates that these pumps may be antiporters, transporting protons in the opposite direction. Ca⁺⁺-ATPase pumps function to keep cytosolic [Ca⁺⁺] low, allowing Ca⁺⁺ to serve as a signal.



symport

antiport



Extracellular

Intracellular

ATP

2K^+

3Na^+

ADP + Pi

Na^+

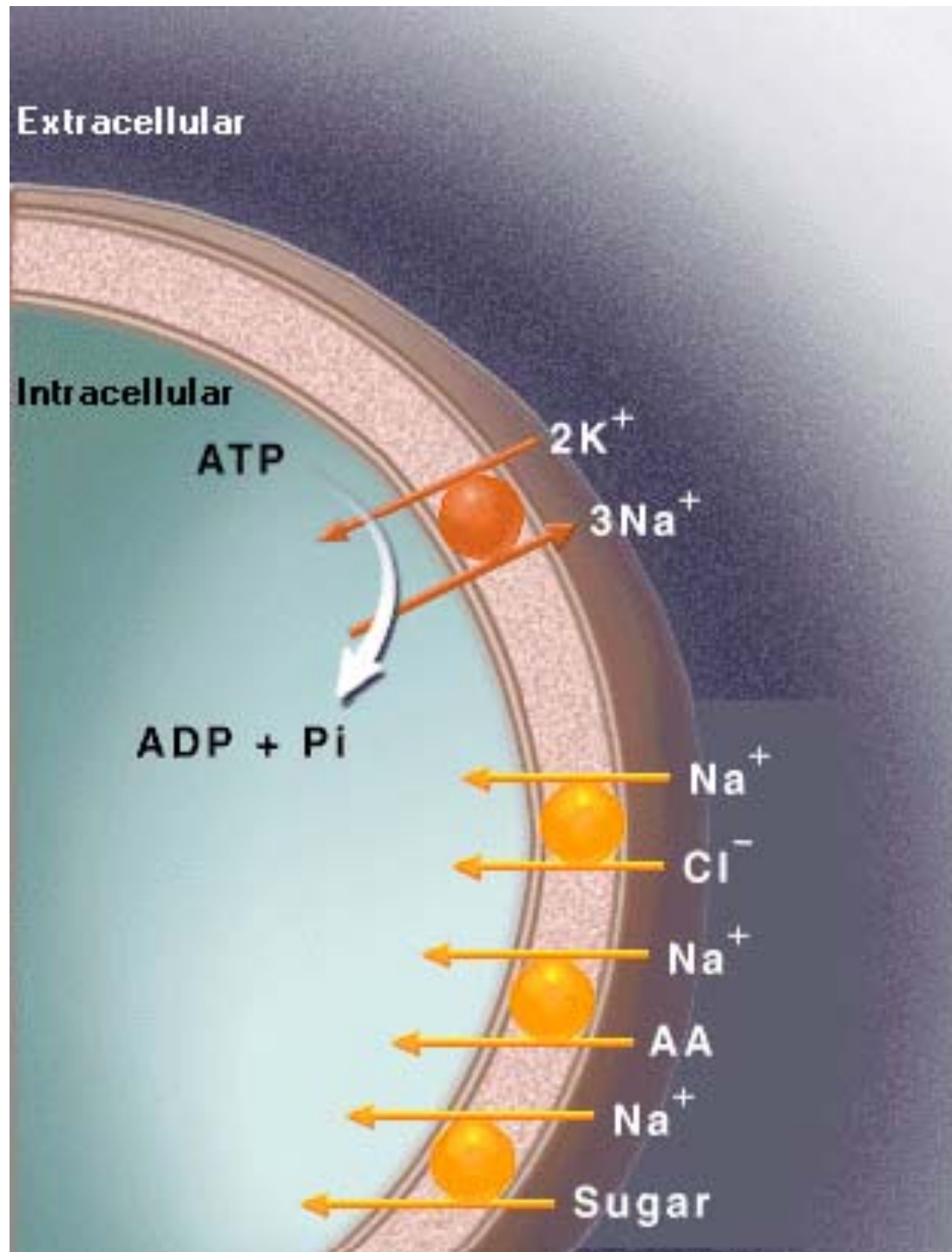
Cl^-

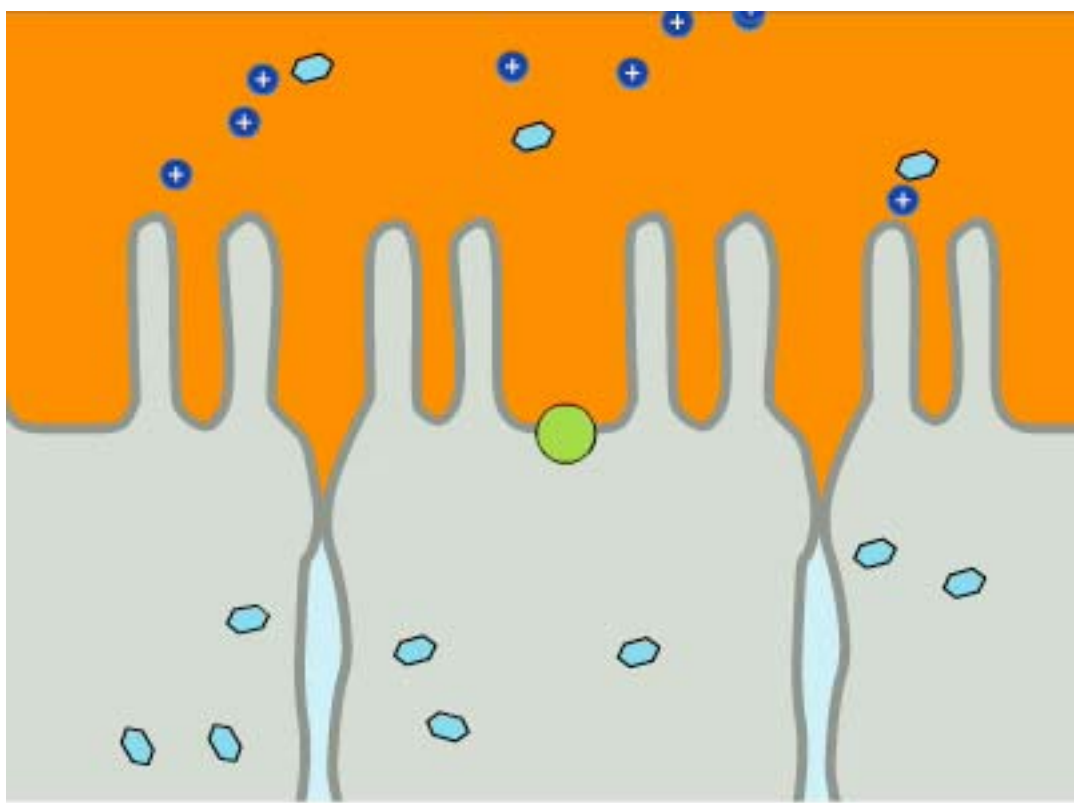
Na^+

AA

Na^+

Sugar





Extracellular

Intracellular

ATP

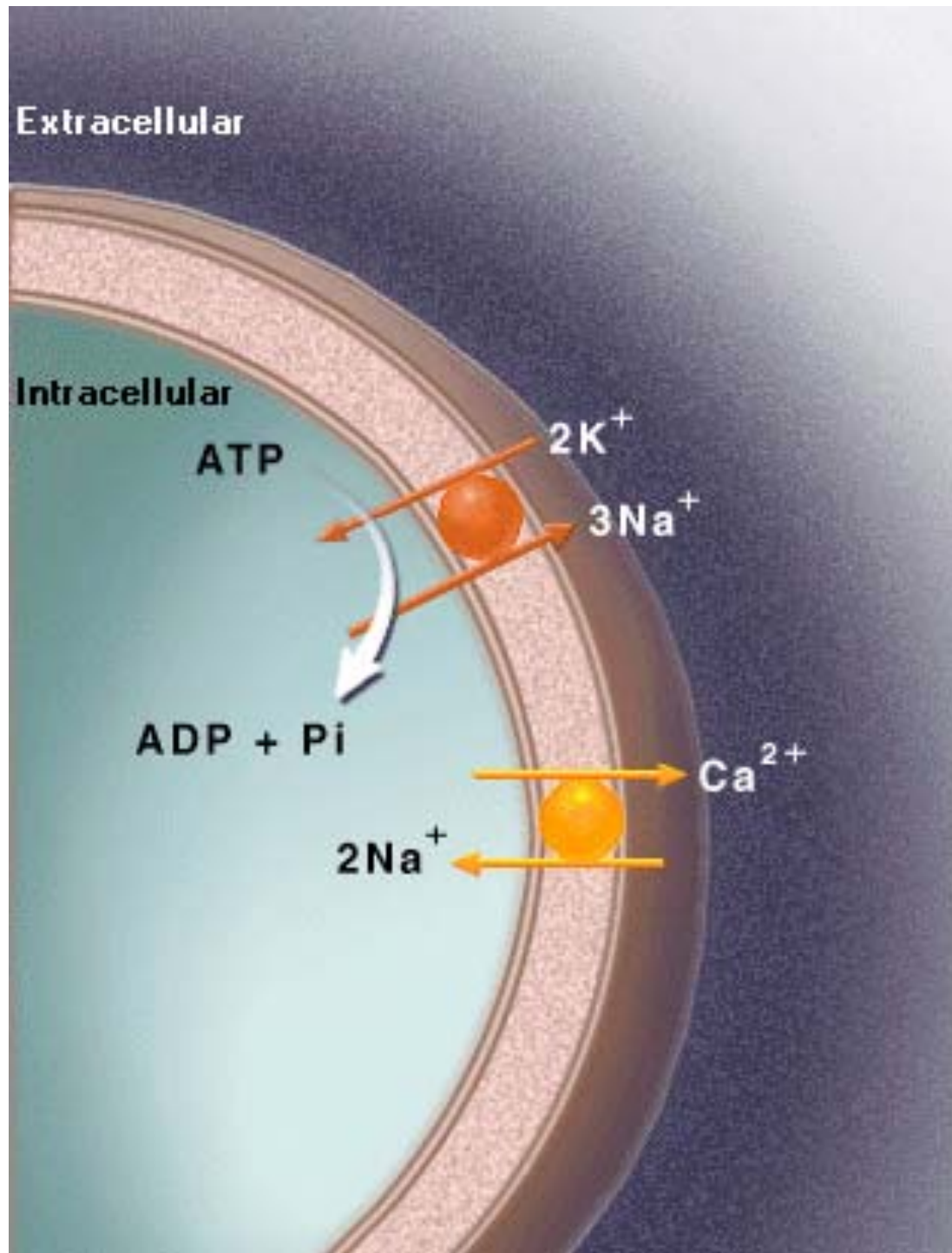
2K^+

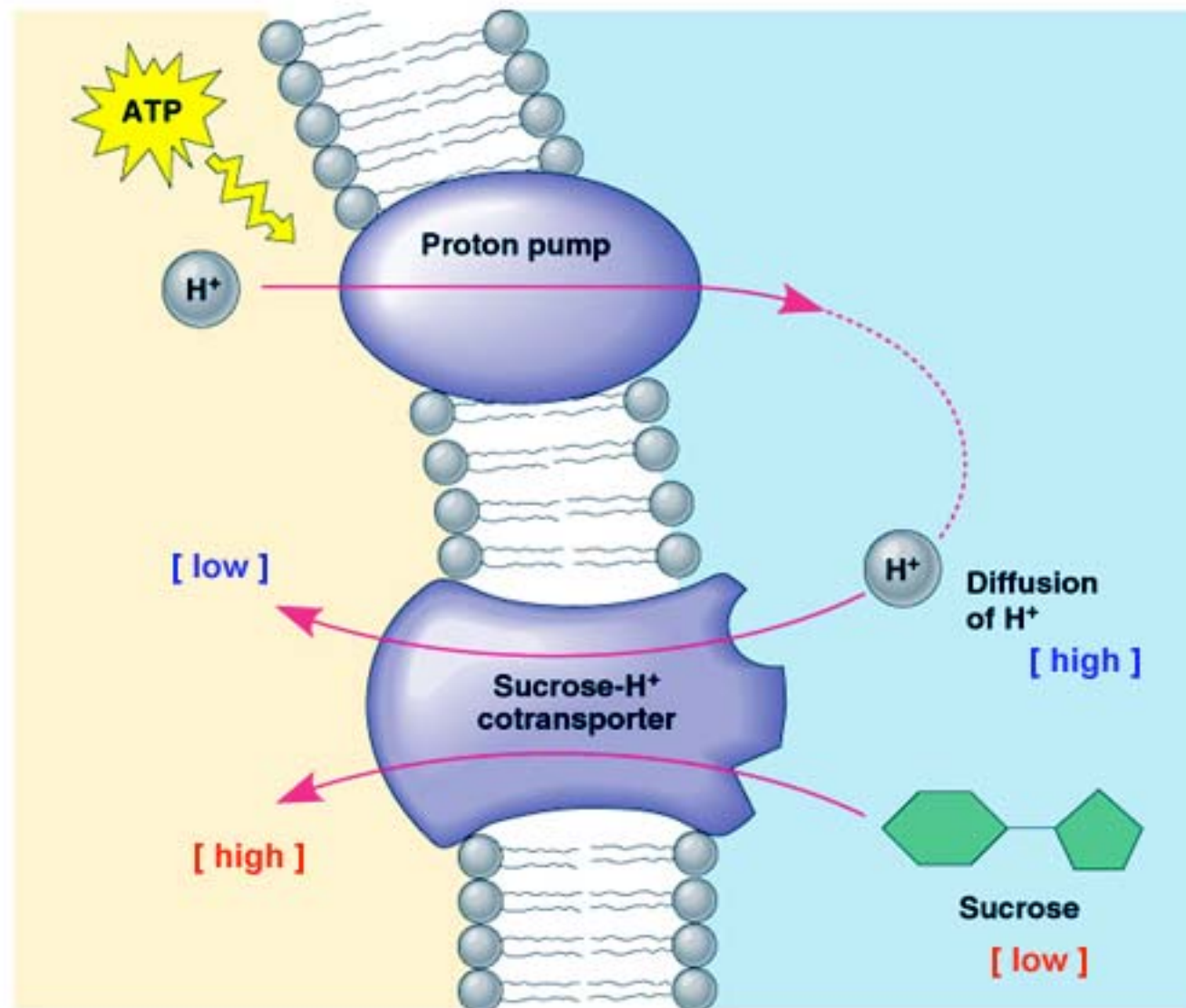
3Na^+

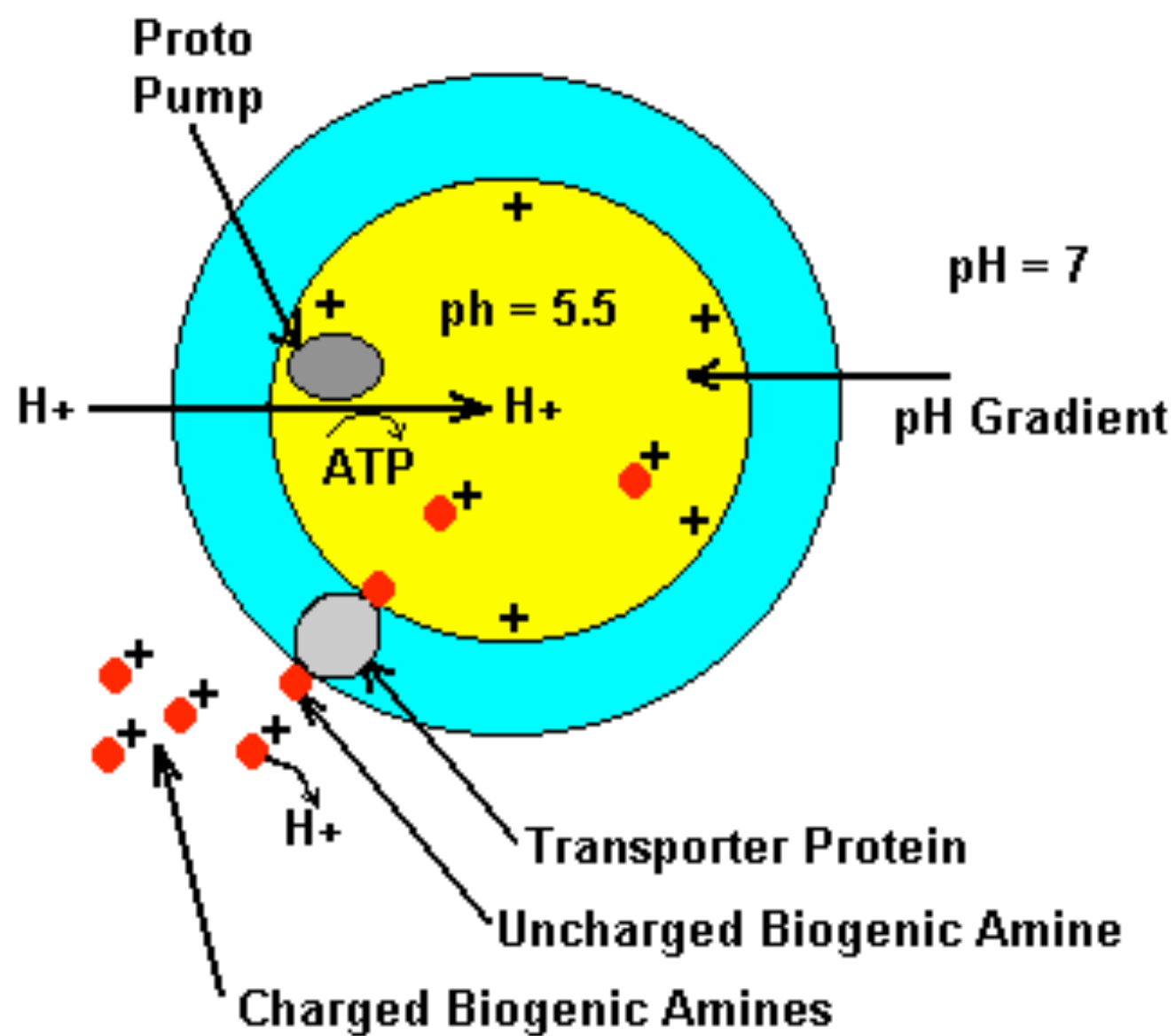
ADP + Pi

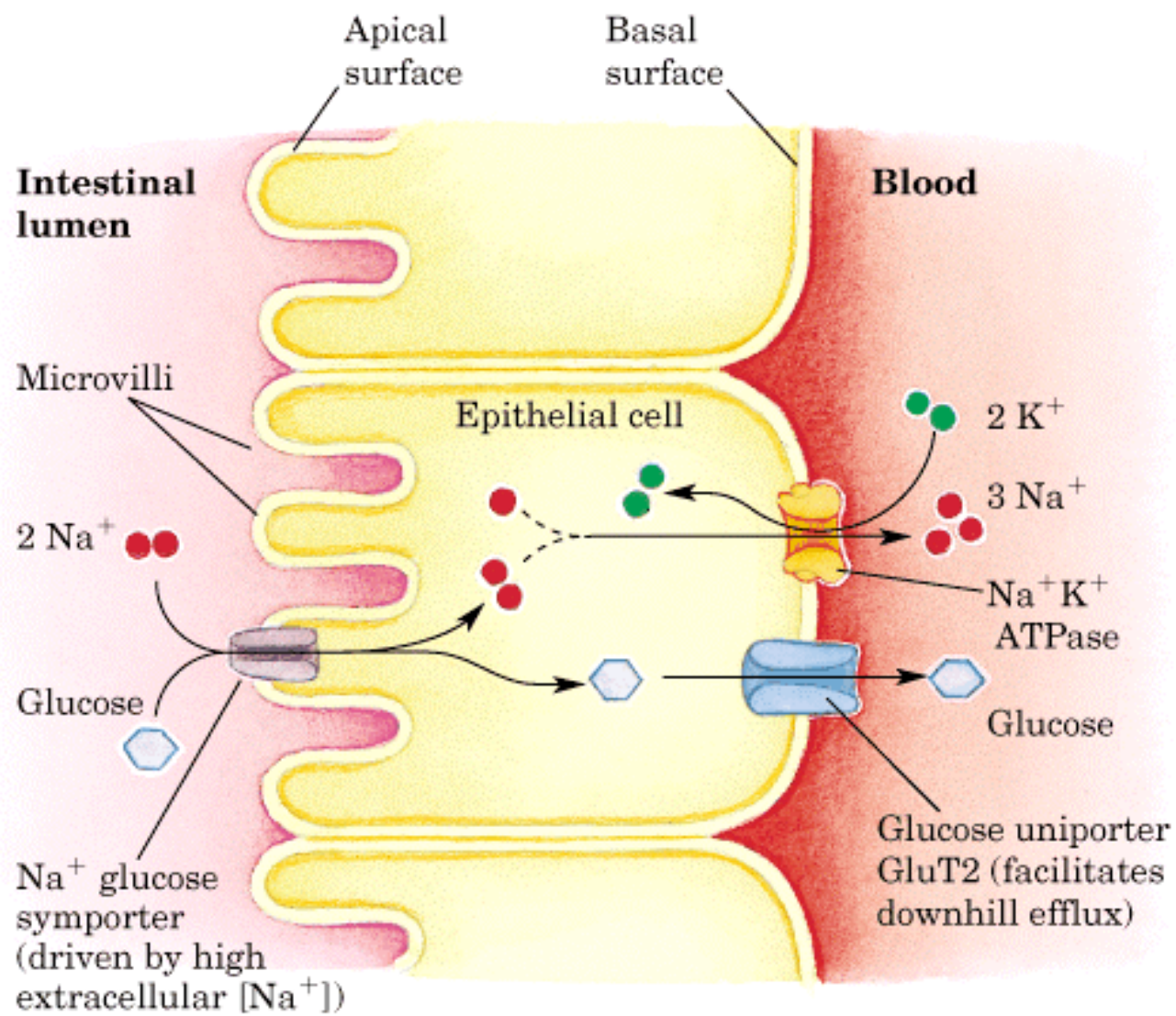
Ca^{2+}

2Na^+









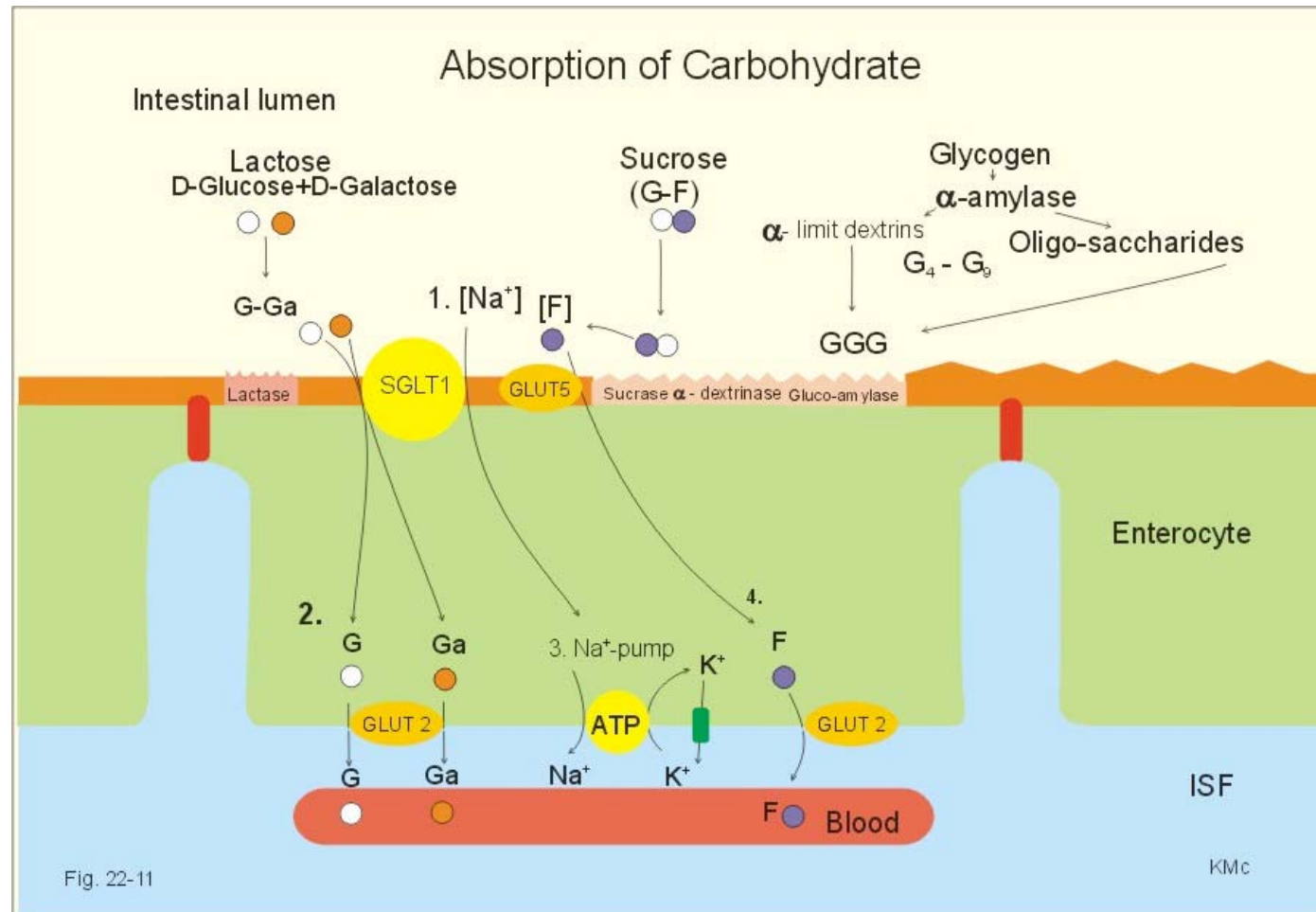
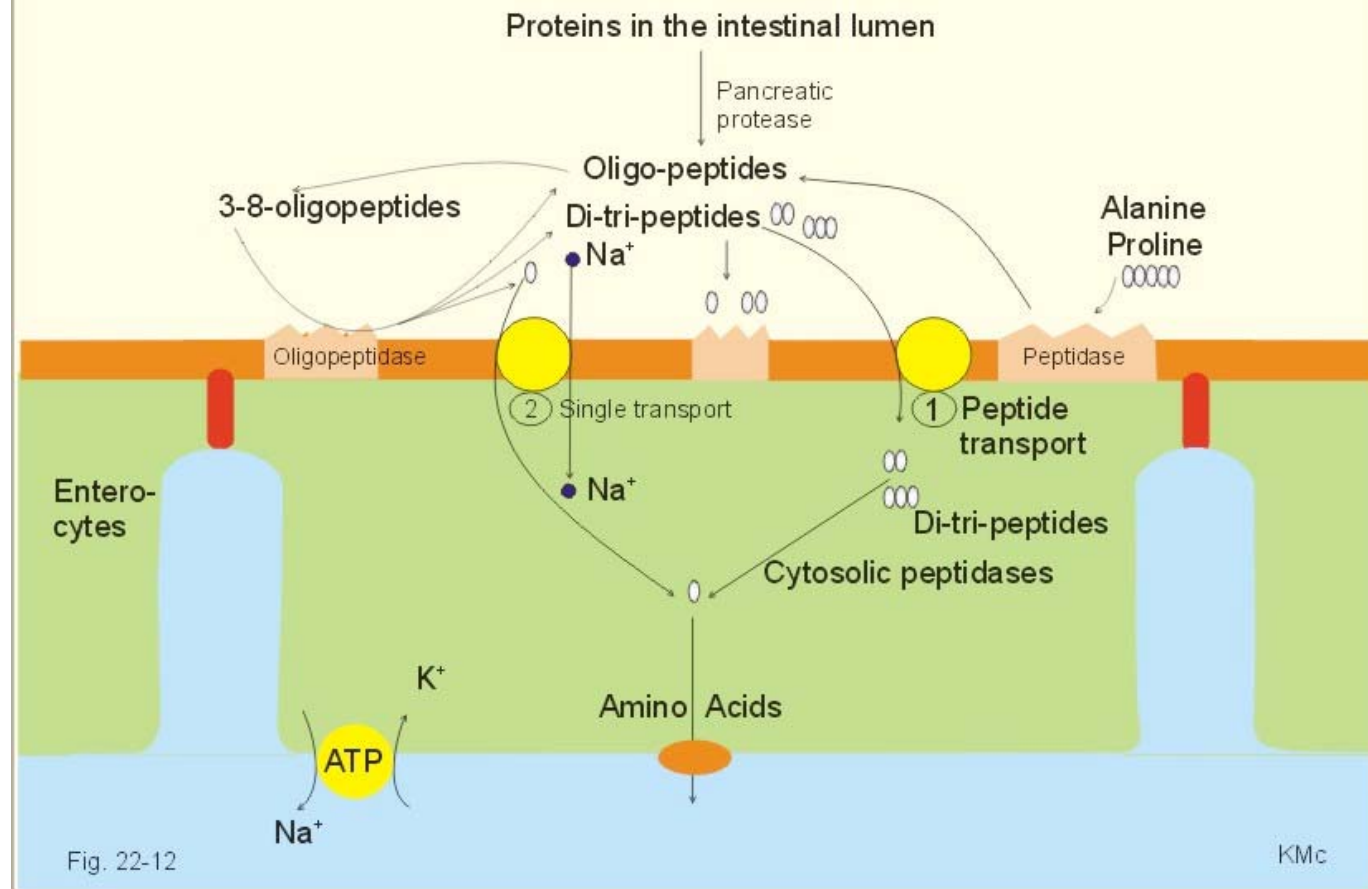


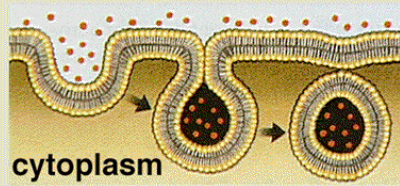
Table 1 Summary of the properties of the glucose transporters

Transporter	Type	Tissue distribution	Kinetic properties	Biological role	Disorder
SGLT1	Na ⁺ -linked secondary active transport	Intestinal mucosa, pars recta of renal proximal tubule	$K_m \sim 0.2$ mmol/L $V_{max} \sim 4$ μ mol/min per mg protein	Intestinal glucose absorption, renal reabsorption	Glucose/galactose malabsorption
SGLT2	Na ⁺ -linked secondary active transport	First part of renal proximal tubule	$K_m \sim 10$ mmol/L $V_{max} \sim 10$ μ mol/min per mg protein	Major fraction of renal glucose reabsorption	Renal glycosuria
GLUT1	Facilitated transport	Widespread, highest levels in erythrocytes, vascular endothelium	$K_m \sim 20$ mmol/L	General basal glucose transport, transport across blood-brain barrier	Infantile seizures, developmental delay and hypoglycorrhachia
GLUT2	Facilitated transport	Hepatocytes, pancreatic β -cells, basal membranes of intestinal mucosal and renal proximal tubular cells	$K_m \sim 40$ mmol/L	Intestinal absorption, renal reabsorption, pancreatic and hepatic control of glucose homeostasis	Fanconi-Bickel syndrome — hepatic and renal glycogen storage, renal proximal tubular defect
GLUT3	Facilitated transport	Neurons	$K_m \sim 10$ mmol/L	Glucose transport into neurons in brain	Not defined
GLUT4	Facilitated transport	Skeletal muscle, cardiac muscle, adipose tissue	$K_m \sim 3$ mmol/L	Insulin-dependent glucose transport	? Role in insulin resistance
GLUT5	Facilitated transport	Intestinal mucosa		Fructose absorption	None defined — deficiency does not appear to be cause of isolated fructose malabsorption

Absorption Of Peptides And Amino Acids

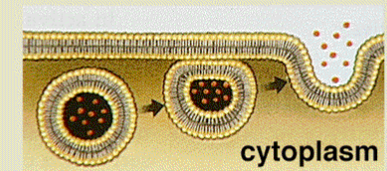


Endocytosis

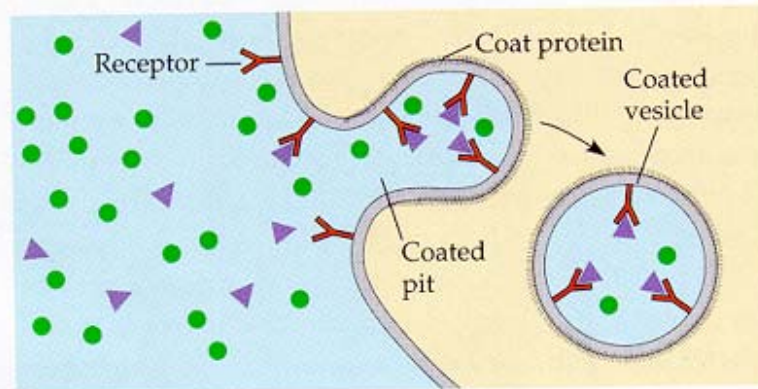


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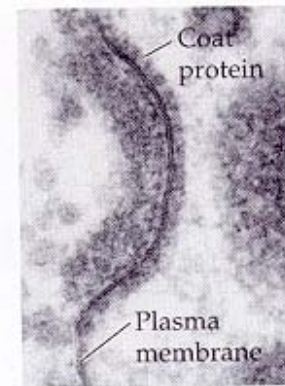
Exocytosis



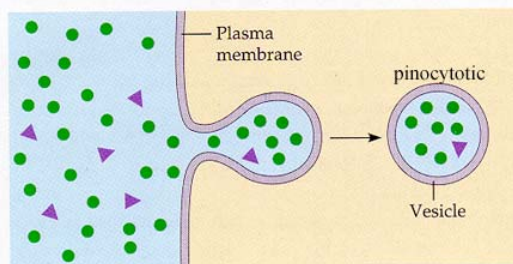
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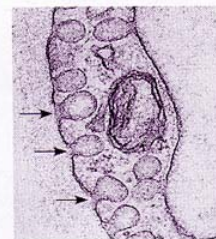
(c) Receptor-mediated endocytosis



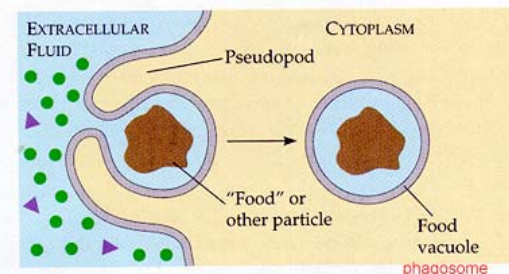
0.25 μm



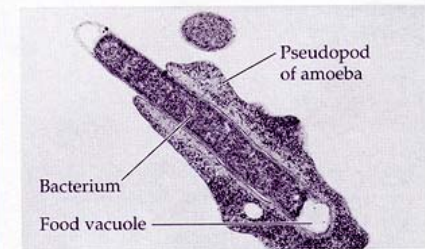
(b) Pinocytosis



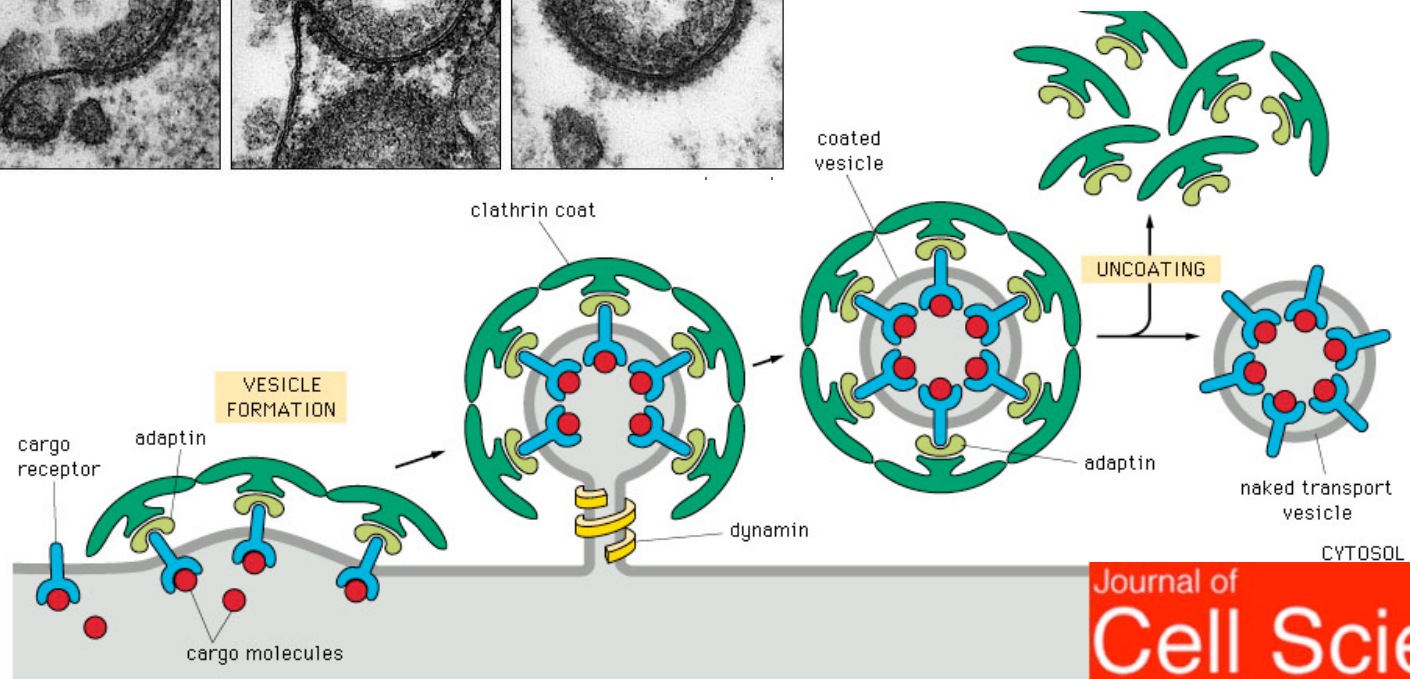
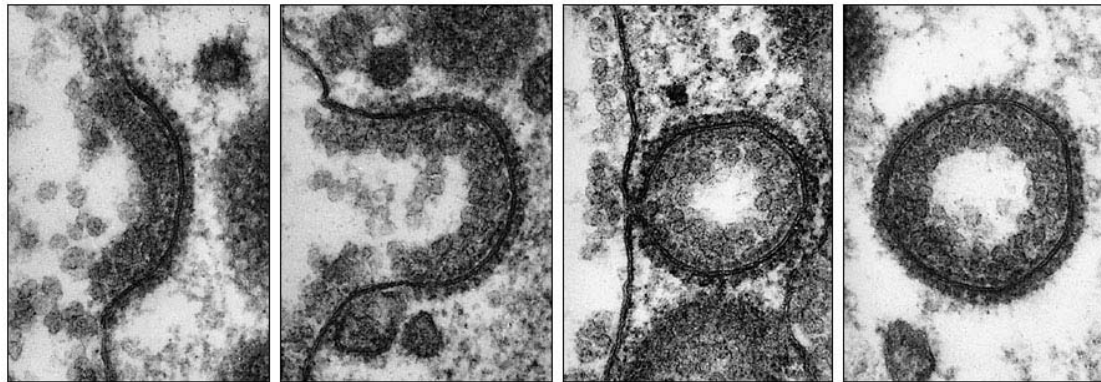
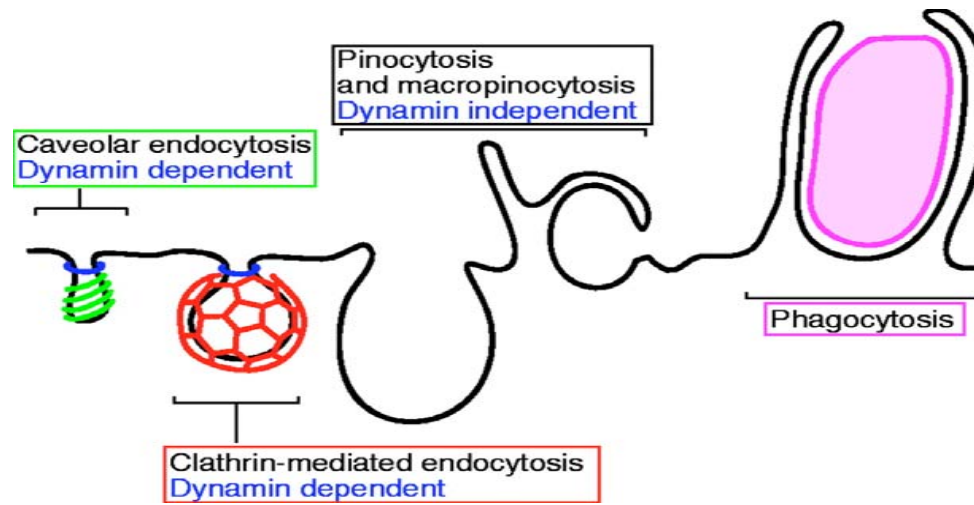
0.5 μm



(a) Phagocytosis

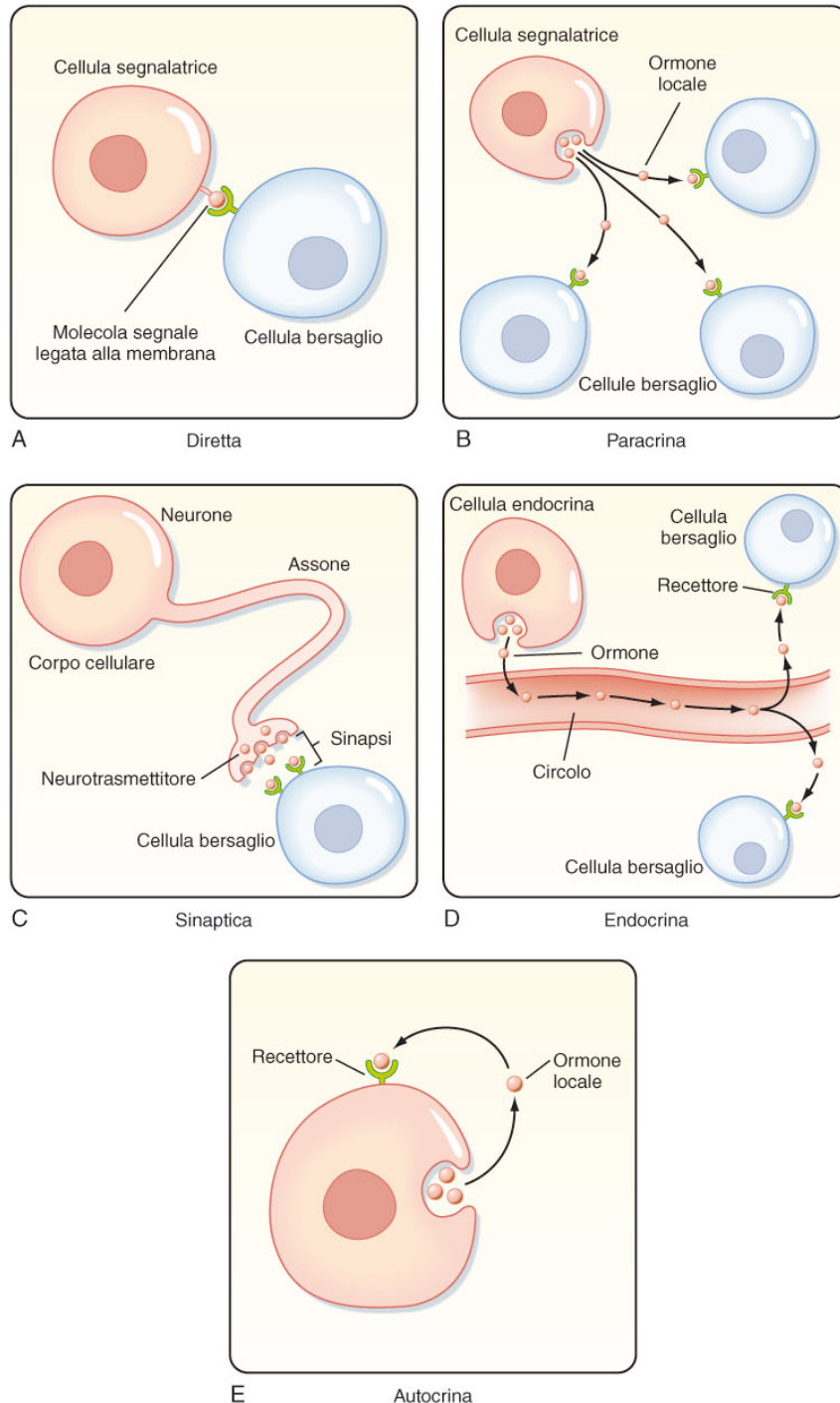


1 μm



COSA DOBBIAMO RICORDARCI:
2. I TRASPORTI DI MEMBRANA

1. Il concetto di diffusione e leggi che ne regolano la velocità
2. La diffusione dei gas
3. La diffusione facilitata: canali e trasportatori
4. Trasporto dell'acqua: acquaporina
5. Trasporto dell'acqua: osmosi
6. La diffusione facilitata del glucosio: i trasportatori GLUT
7. Trasporto attivo primario: Na/K ATPasi
8. Trasporto attivo secondario: Simporto e Antiporto
9. Trasporti attraverso gli epiteli
10. Eso e Endocitosi



Trasporto selettivo di molecole (trasportatori)

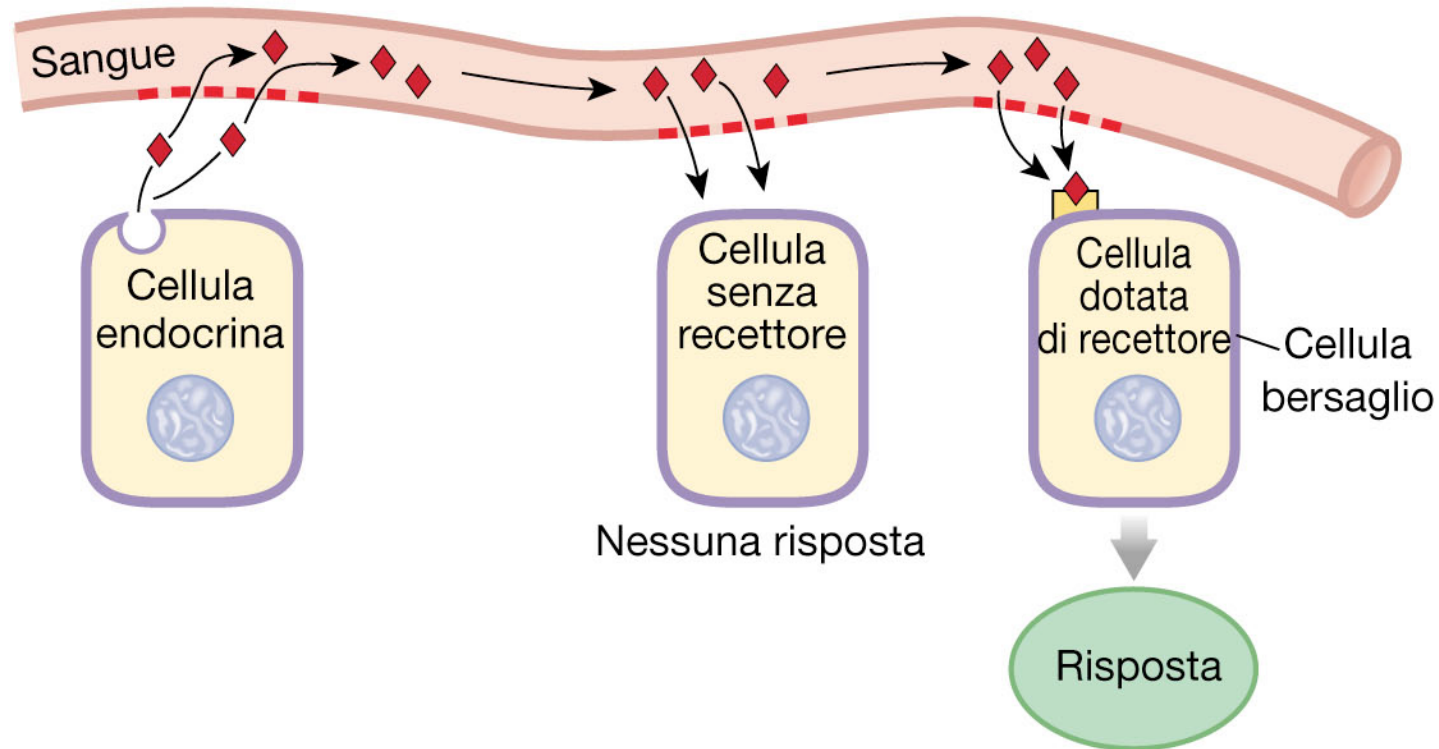
Riconoscimento di cellule e substrati (integrine, matrice)

Comunicazione intercellulare (recettori e proteine trasduttrici)

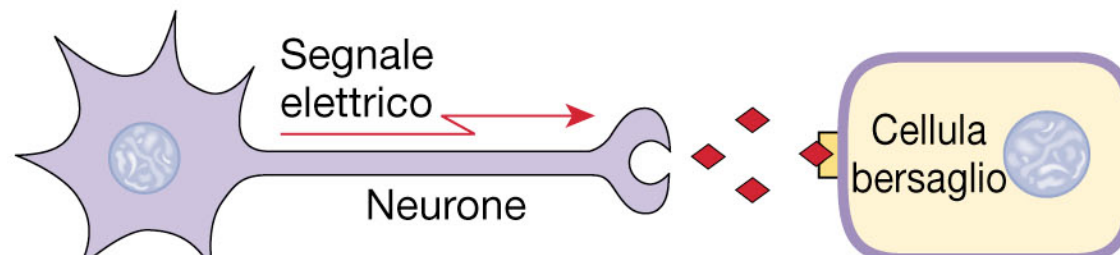
Attività enzimatica

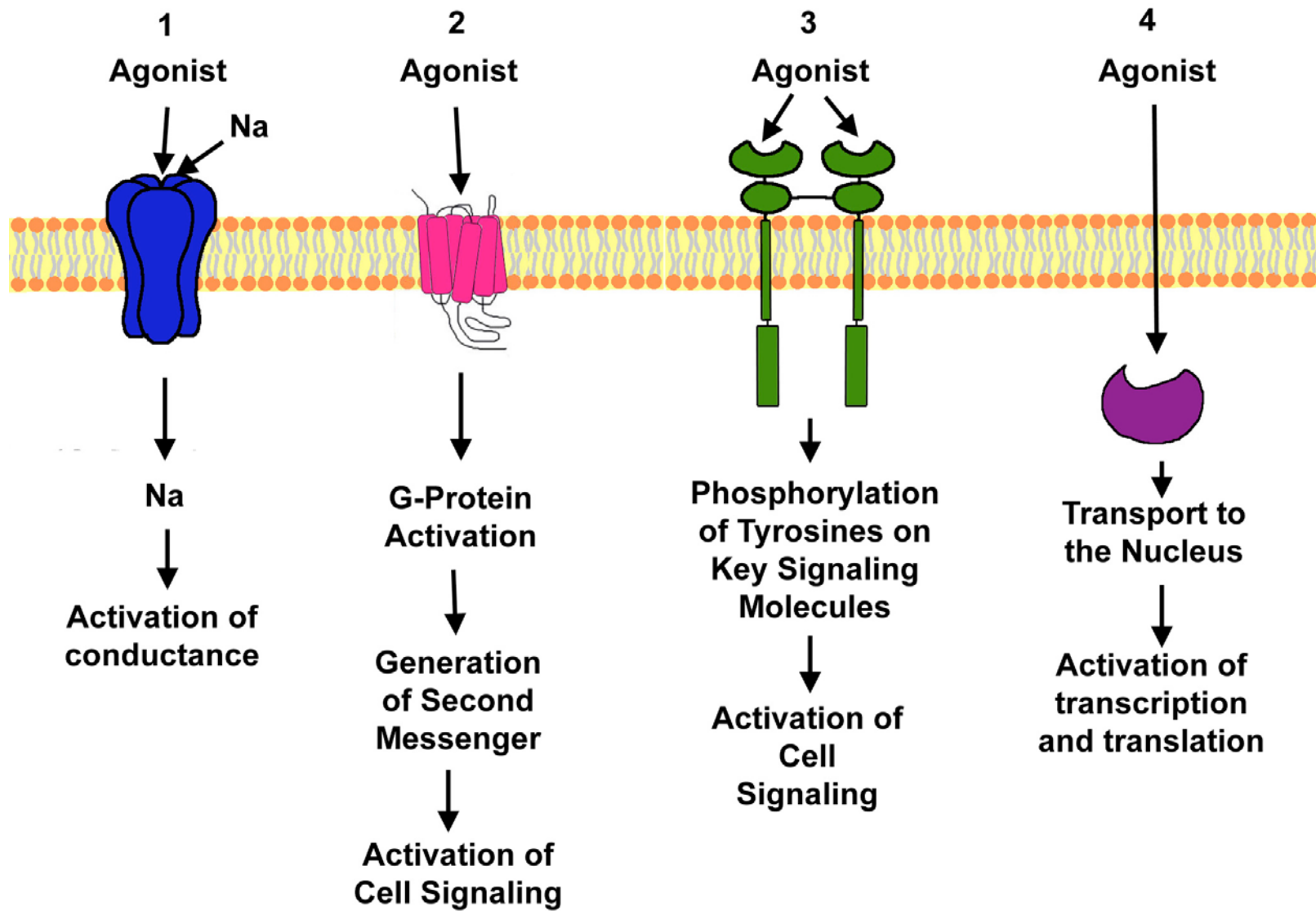
Determinazione della forma cellulare (citoscheletro)

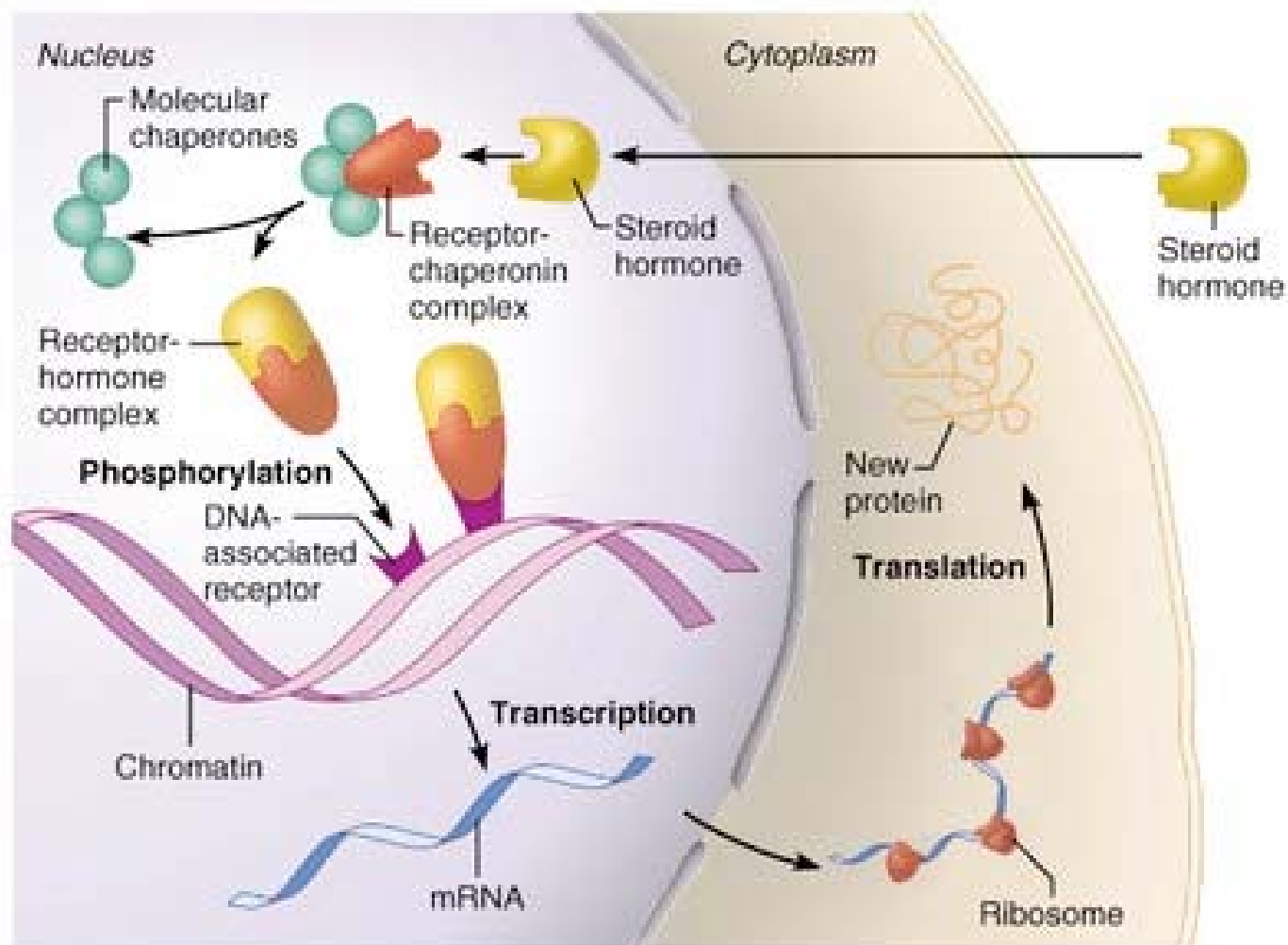
(a) Gli ormoni sono secreti nel sangue dalle ghiandole endocrine o da altre cellule. Solo le cellule bersaglio dotate di recettori per l'ormone rispondono al segnale.



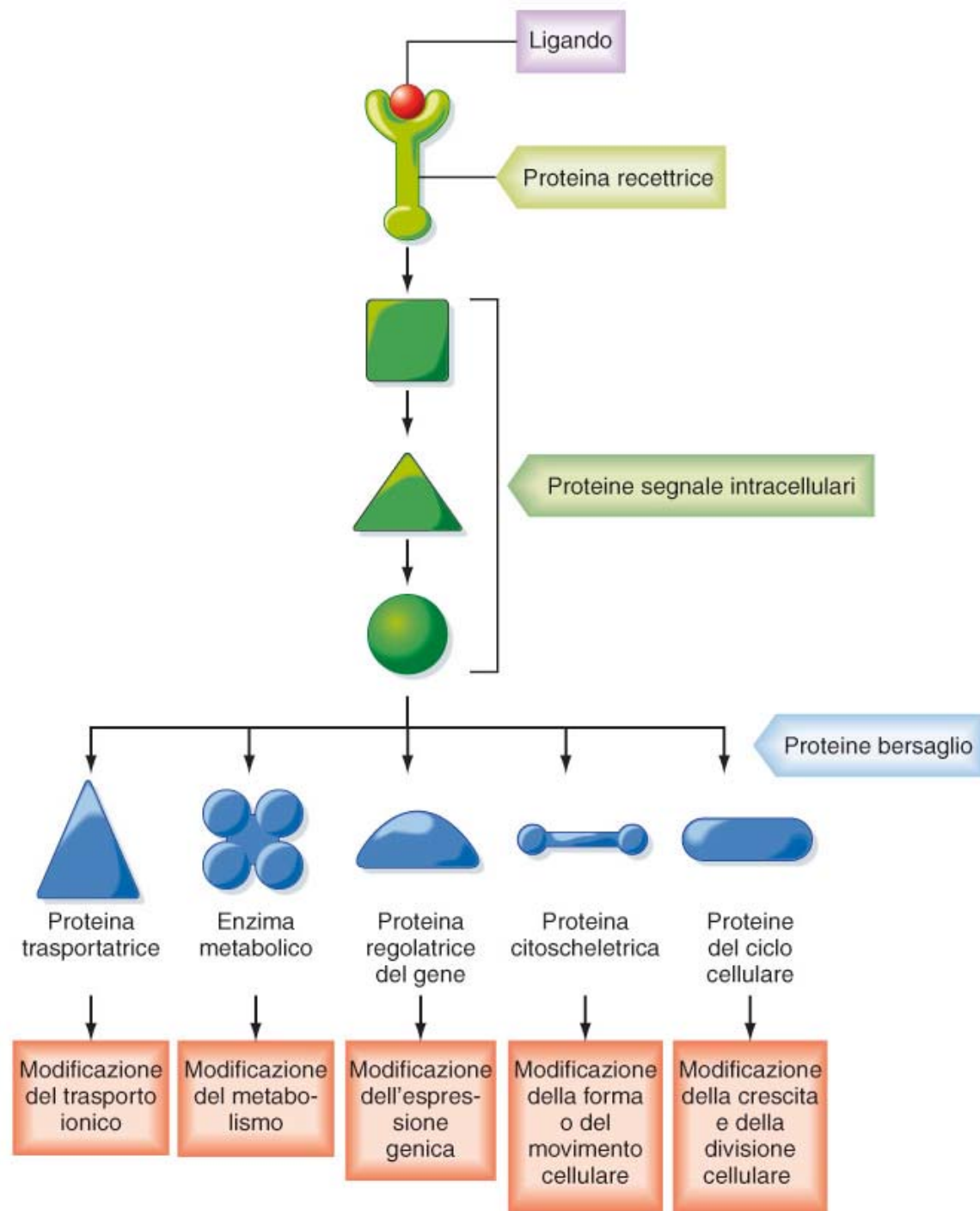
(b) I neurotrasmettitori sono molecole secrete da neuroni, che diffondono a breve distanza verso la cellula bersaglio. I neuroni comunicano anche tramite segnali elettrici.

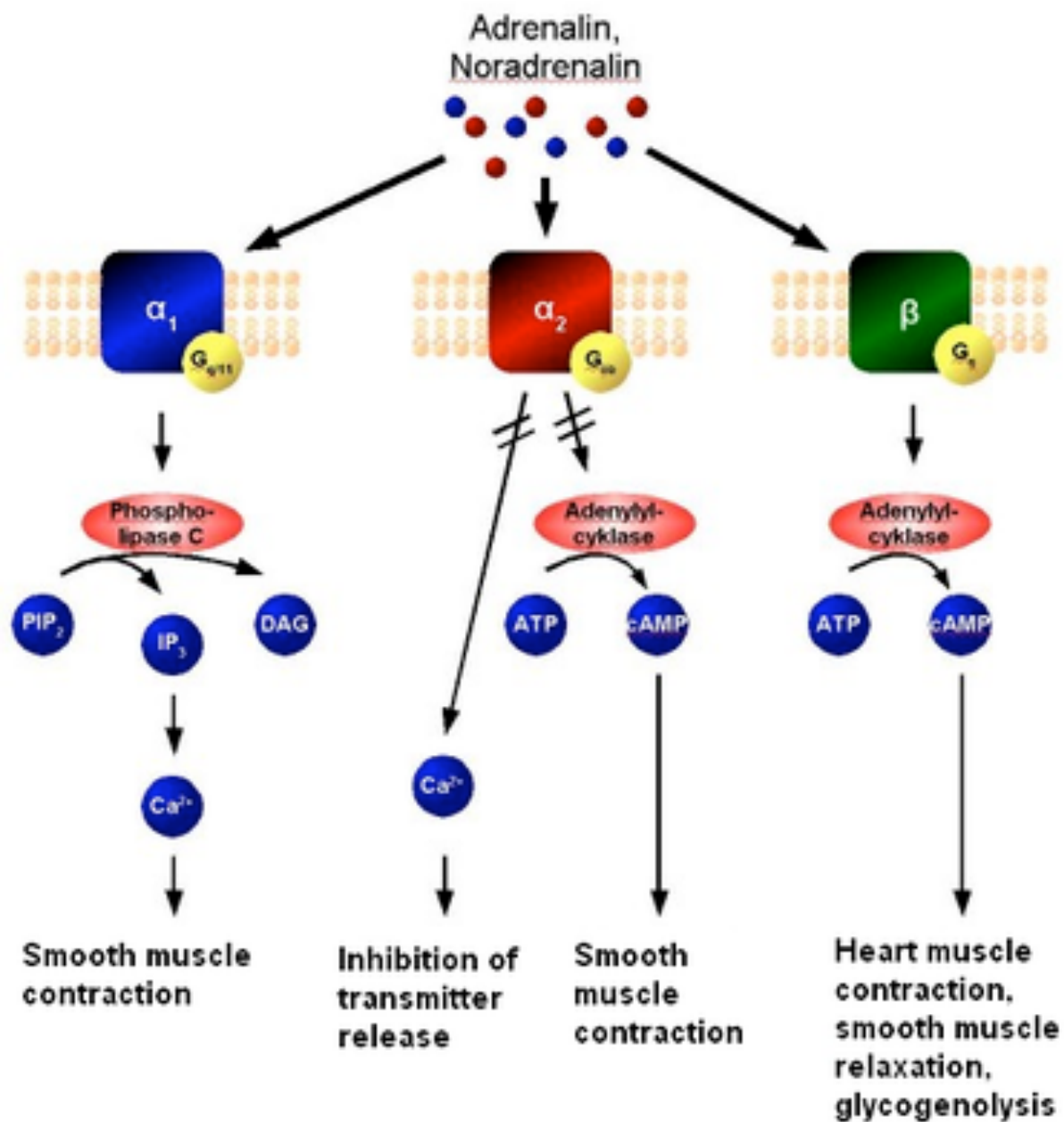




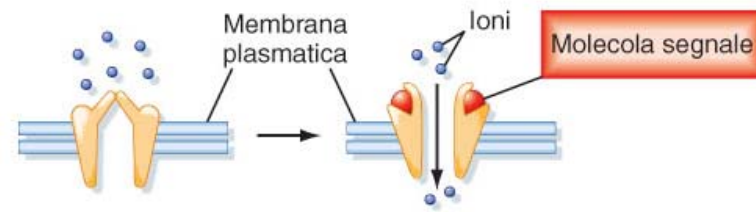


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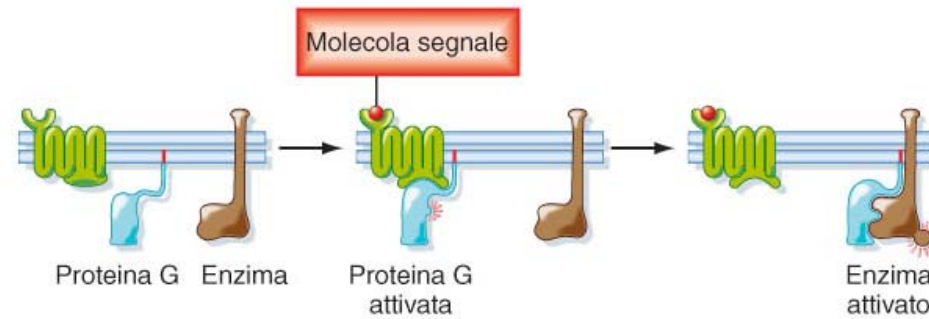


Recettori legati ai canali ionici



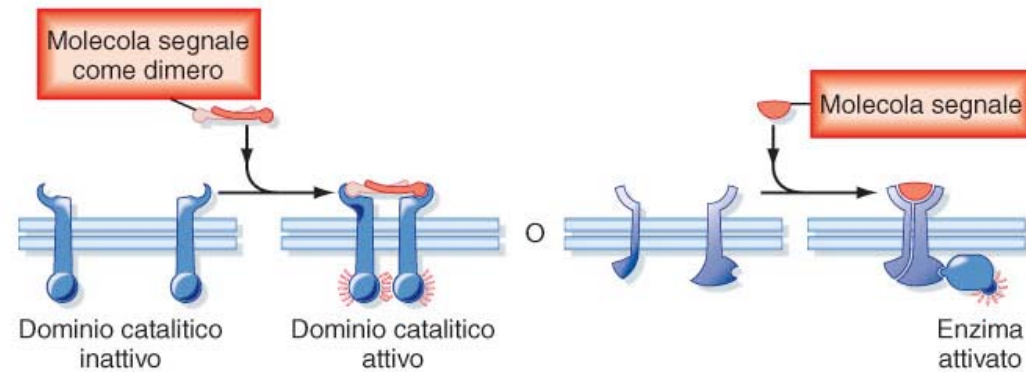
A

Recettore accoppiato a proteine G (GPCR)



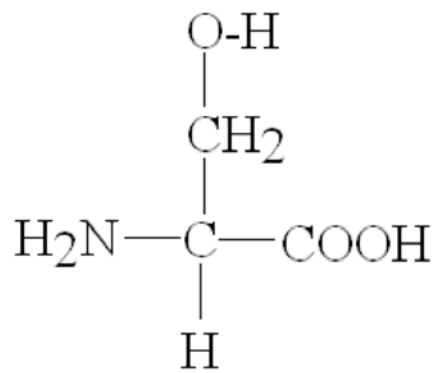
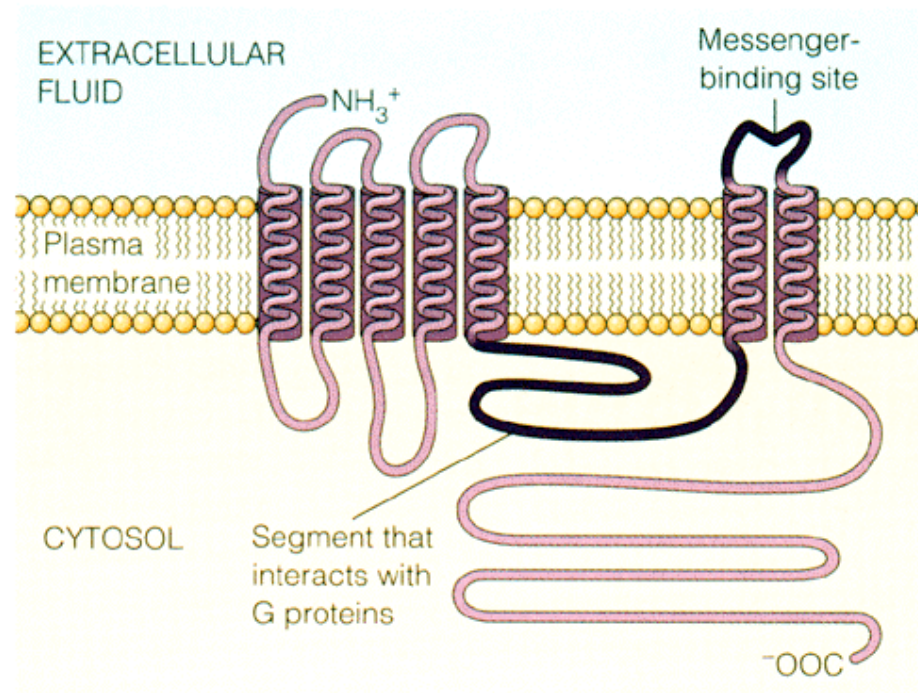
B

Recettori legati a enzimi

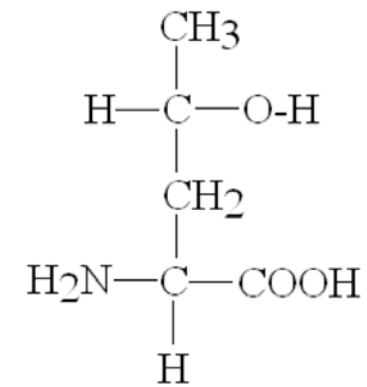


C

Attivazione di Ser-Thr protein-chinasi: Recettori eptaeliche e Proteine G

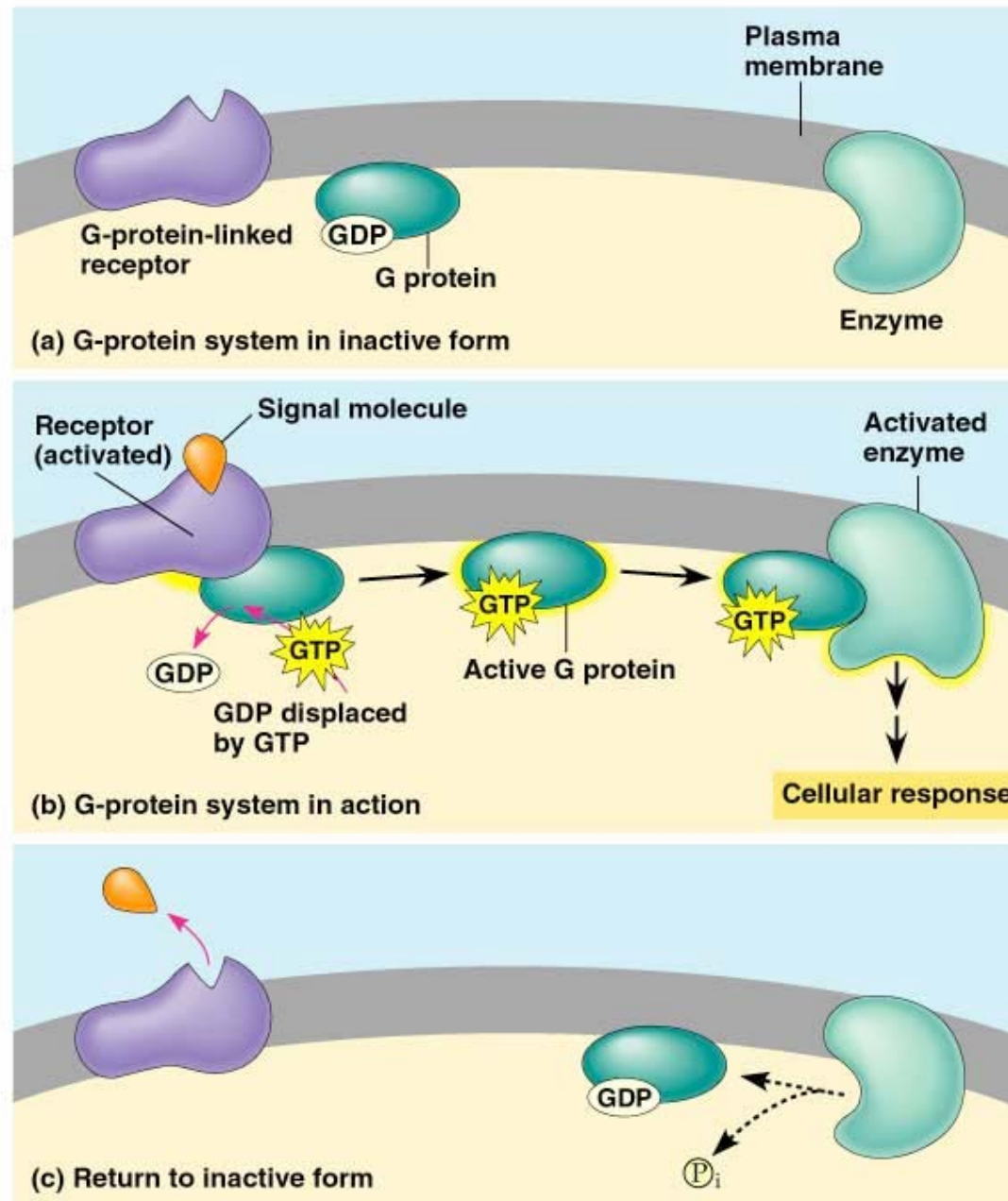


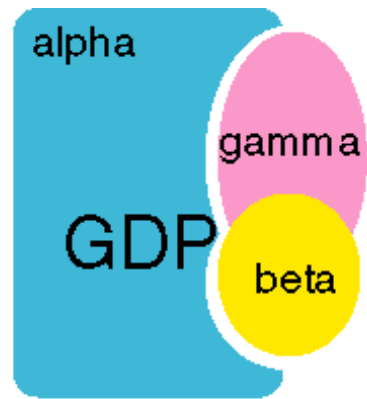
serine



threonine

Attivazione di Ser-Thr protein-chinasi: Recettori eptaeliche e Proteine G





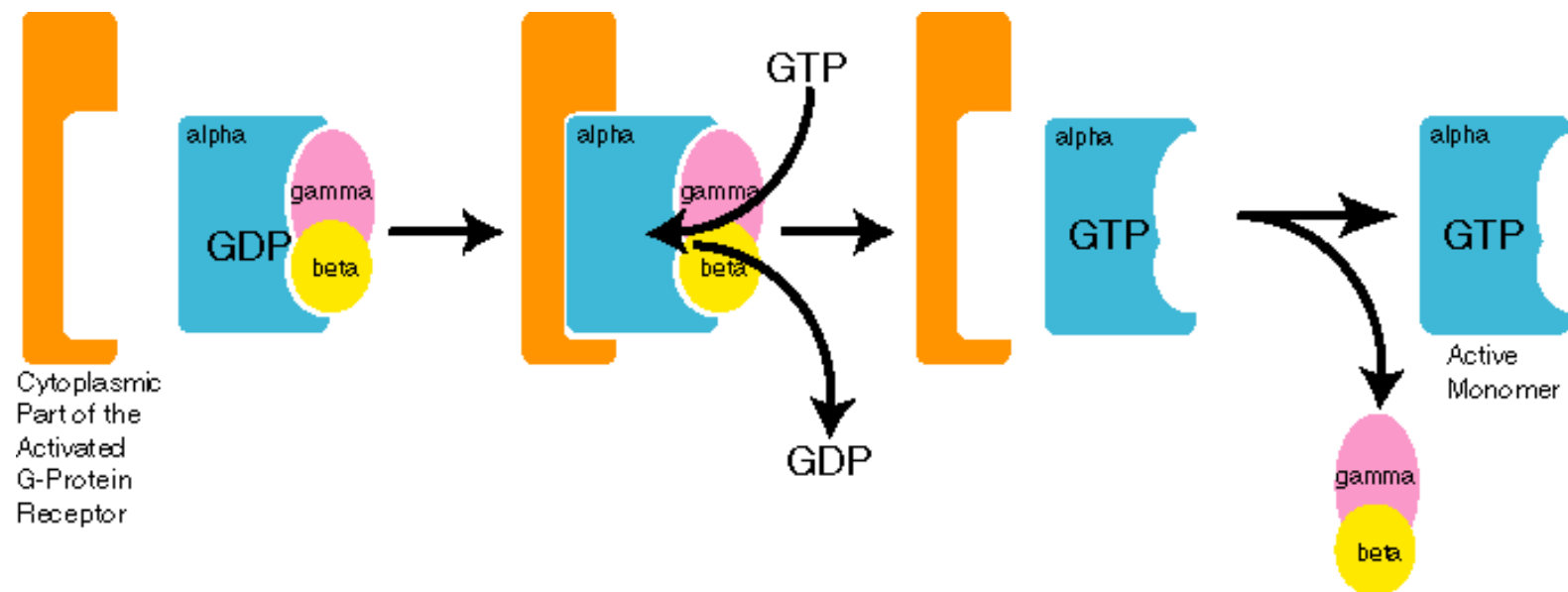
Inactive Heterotrimeric G-protein



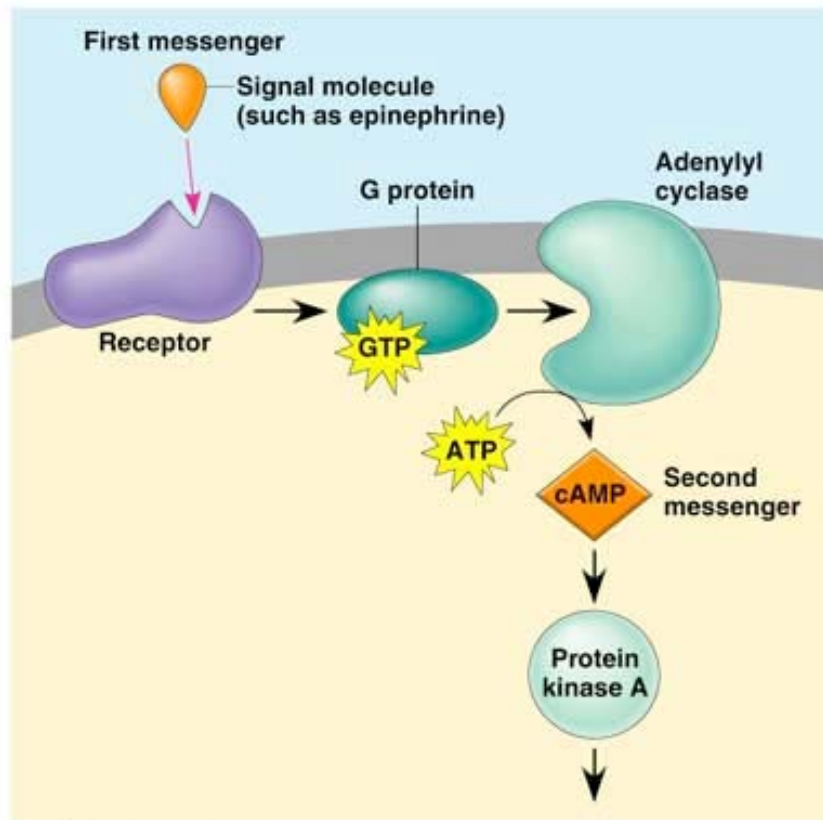
Active G-protein monomer



beta/gamma dimer



Adenilato ciclastasi - cAMP- Protein Kinasi A



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