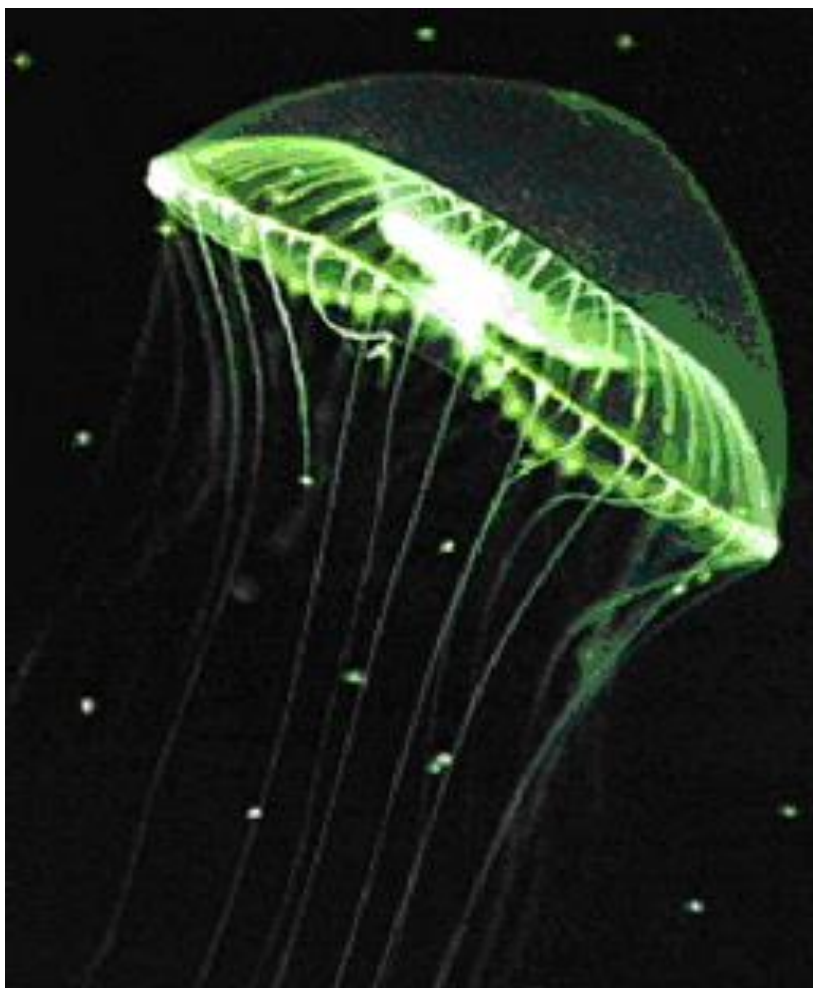
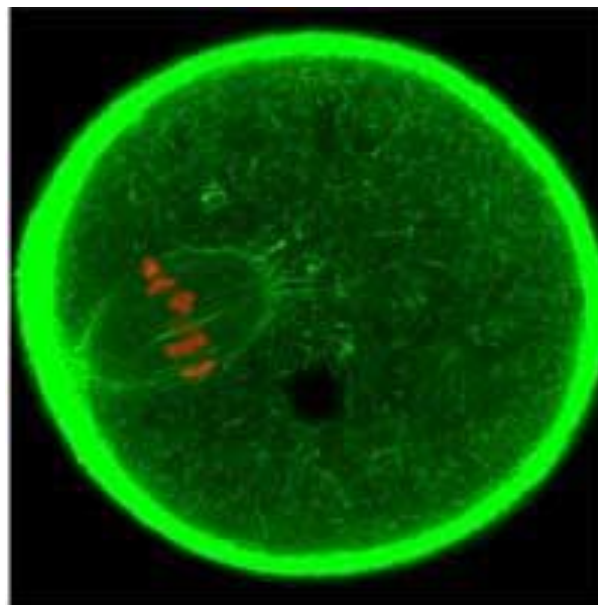


Ione	Raggio (Å)	Ione	Raggio (Å)
Na ⁺	1.02	Mg ²⁺	0.72
K ⁺	1.38	Ca ²⁺	1.00

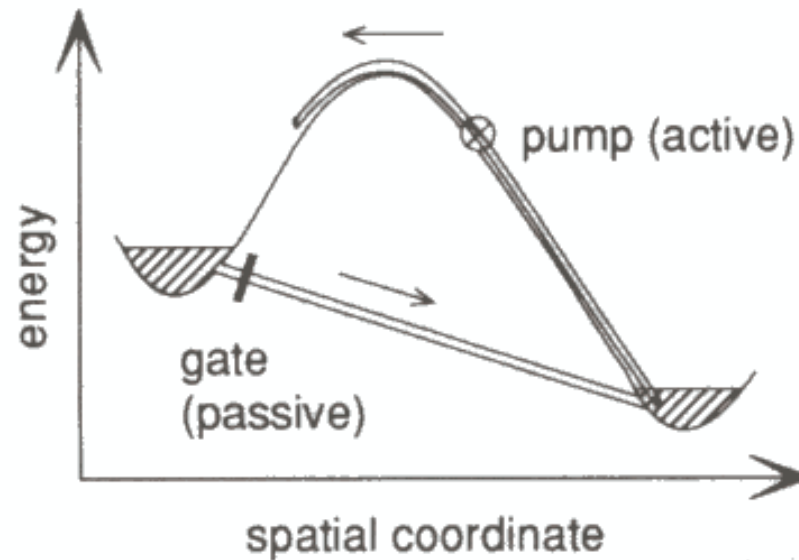


Green Fluorescent Protein (GFP) =
sensore fluorescente per Ca²⁺

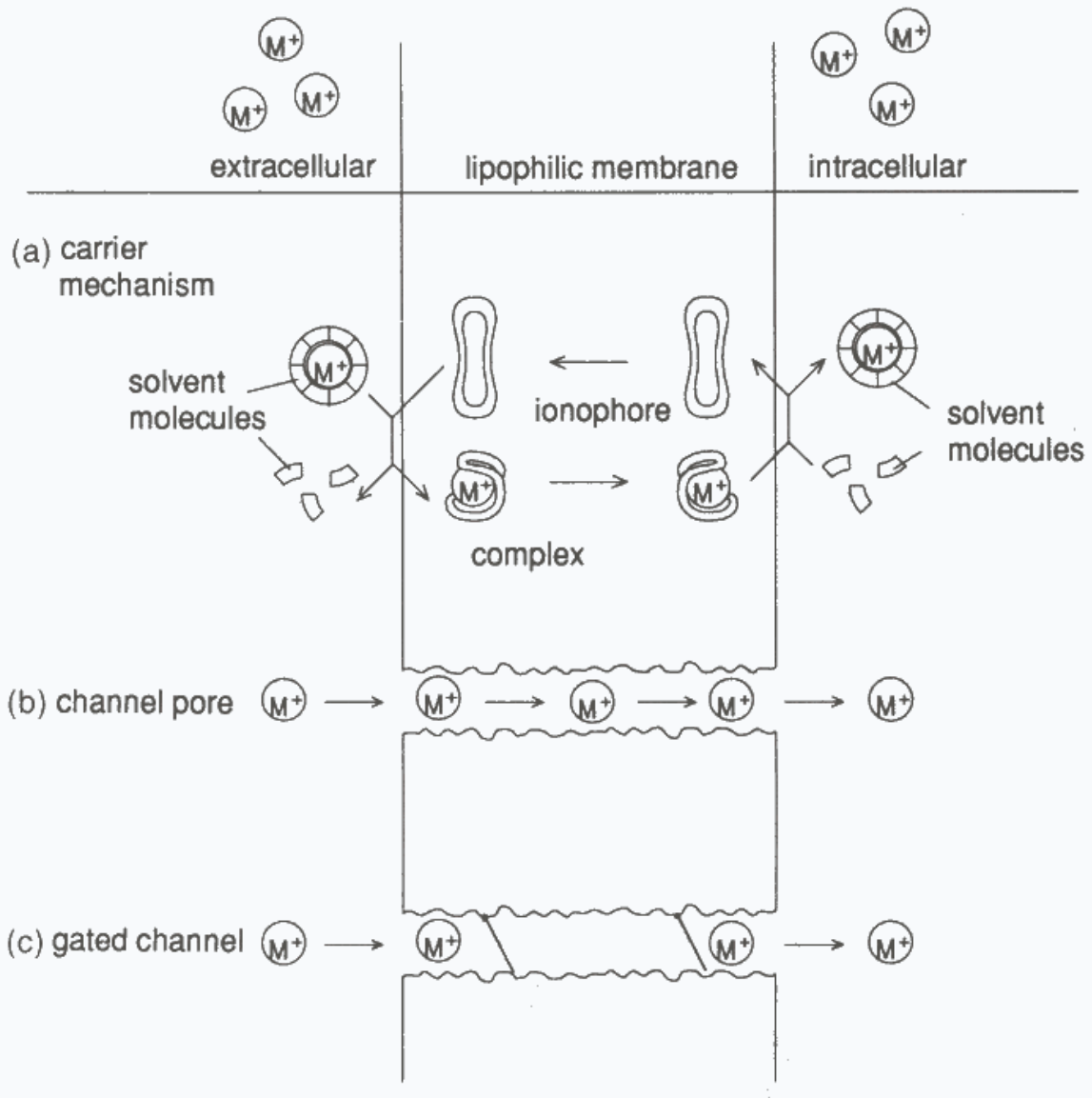


ione	Intracellulare (mM)	Extracellulare (mM)
Na ⁺	10	150
K ⁺	100	5
Mg ²⁺	2.5	1.5
Ca ²⁺	0.1 ^a	2.5
Cl ⁻	4	100

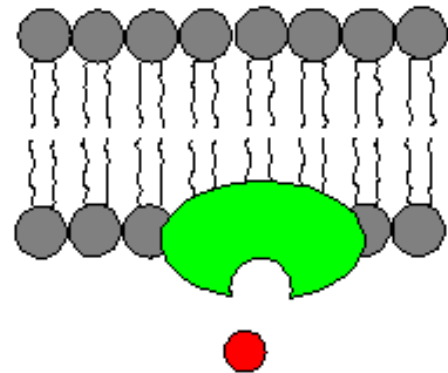
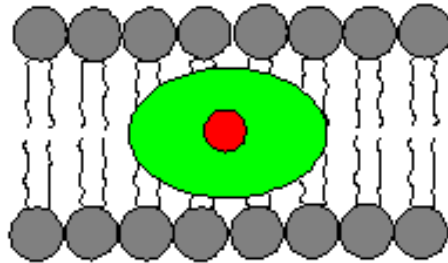
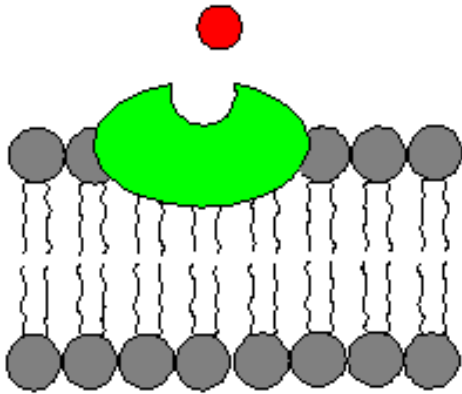
^a0.1 μM nel citoplasma della cellula a riposo



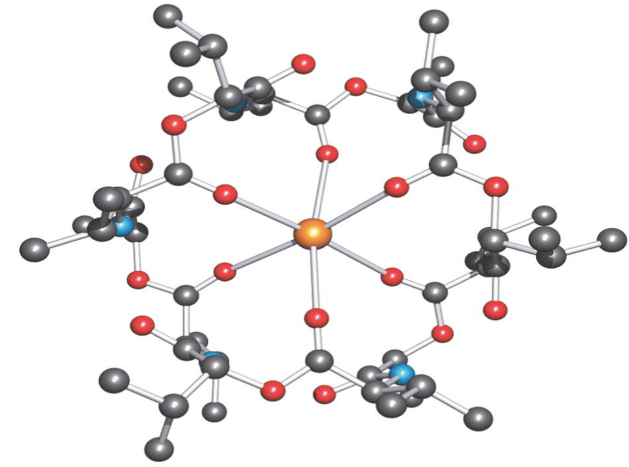
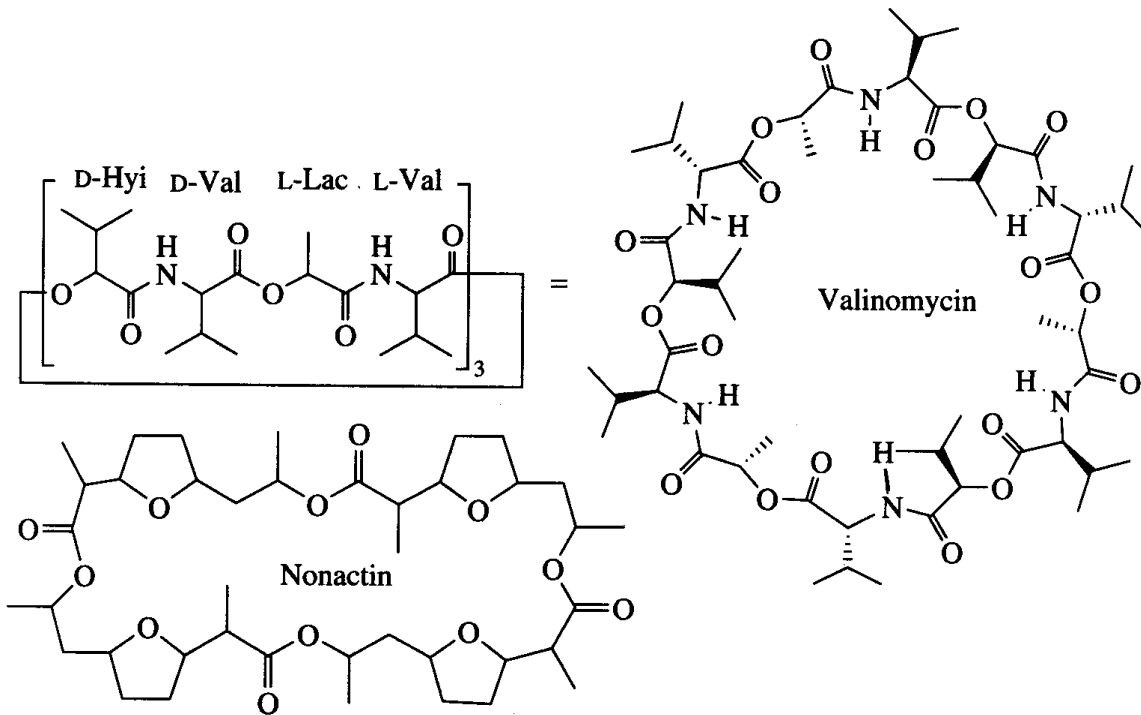
ion-transport mechanisms



Ionofori

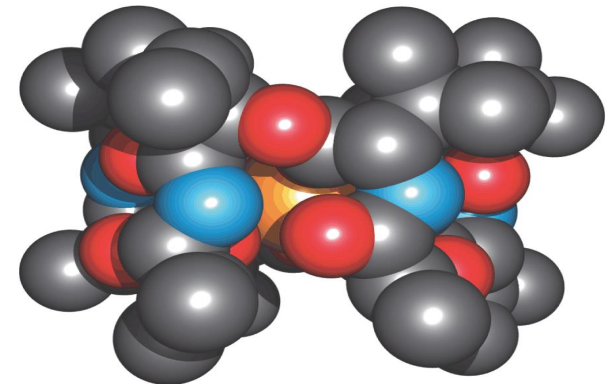


Ionofori



(b)

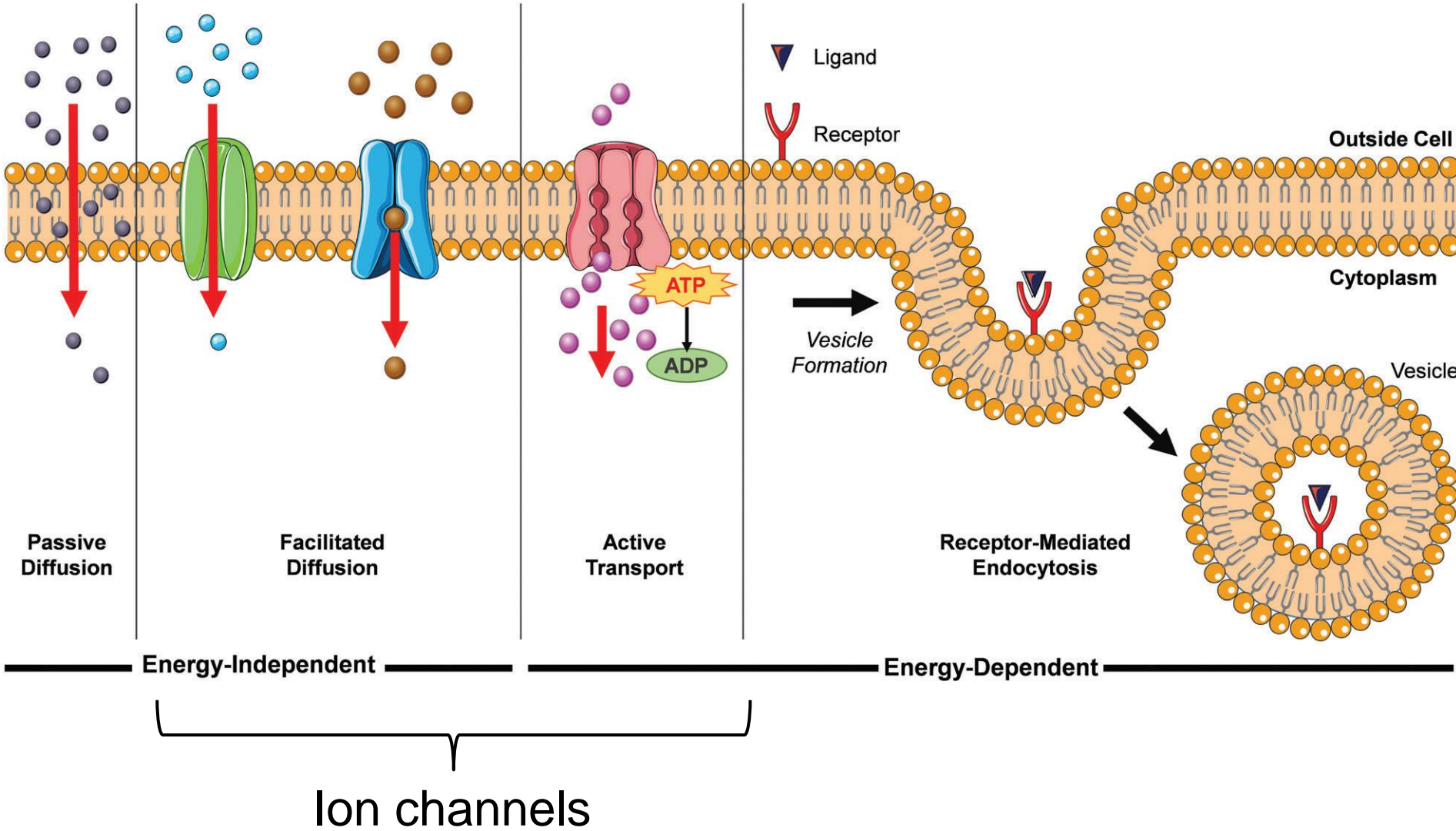
Addotto valinomycinina – K⁺



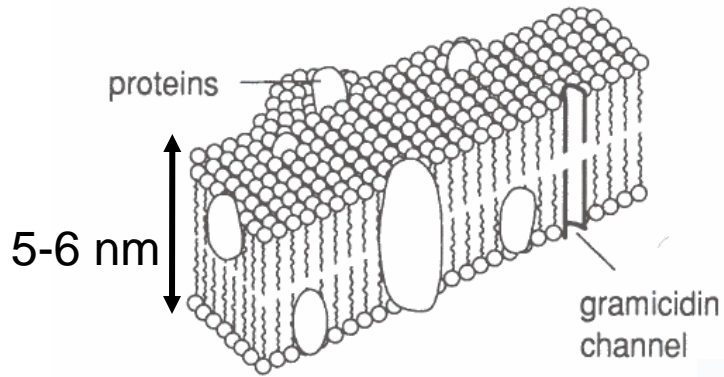
La valinomicina trasporta $10^3 - 10^4$ ioni K^+ al secondo attraverso la membrana dei mitocondri senza alterare la concentrazione di Na^+ .

La selettività K^+/Na^+ è dell'ordine di 10^4 .

Meccanismi di trasporto trans-membrana



Ion channels

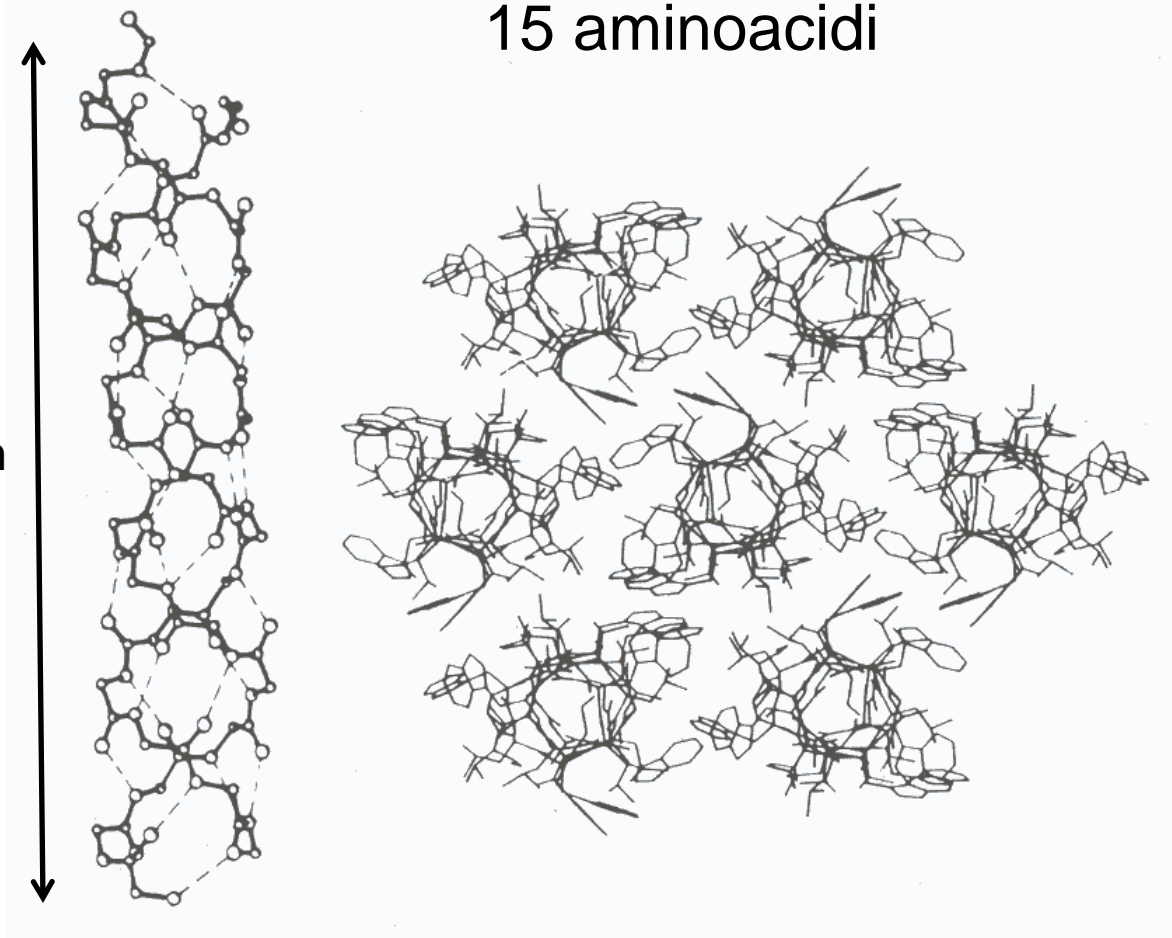


fluid double layer

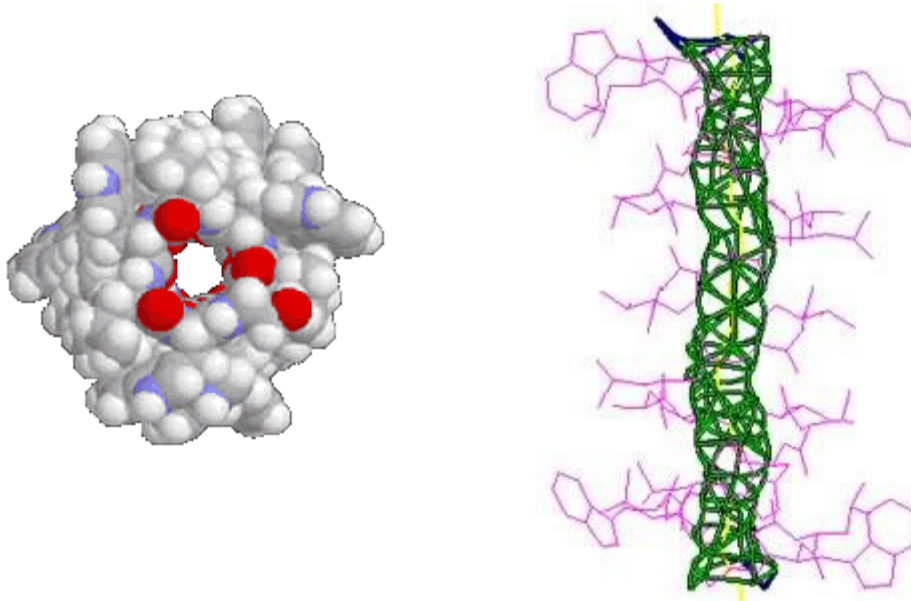
0.4 nm

3 nm

Gramicidina A
15 aminoacidi

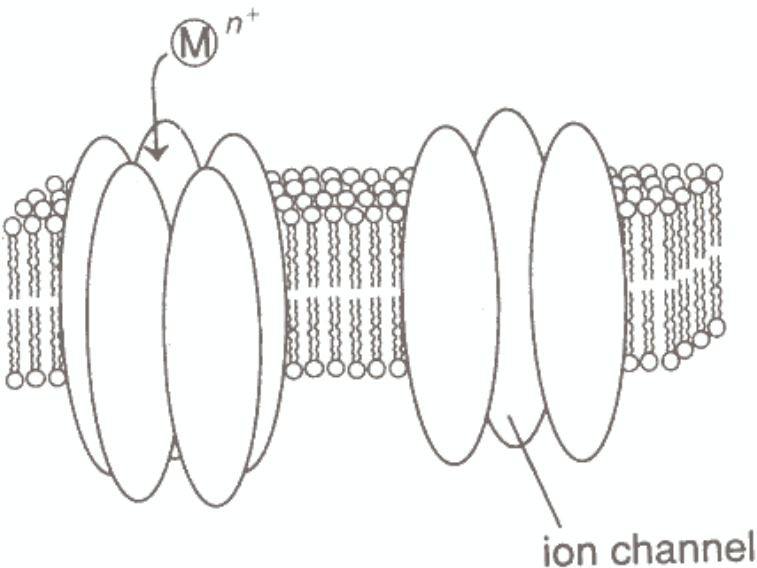


Gramicidina A

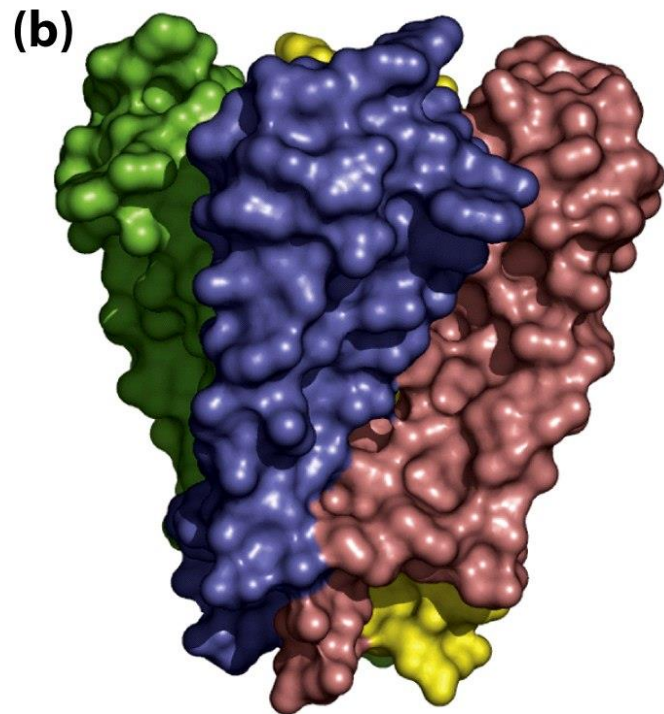
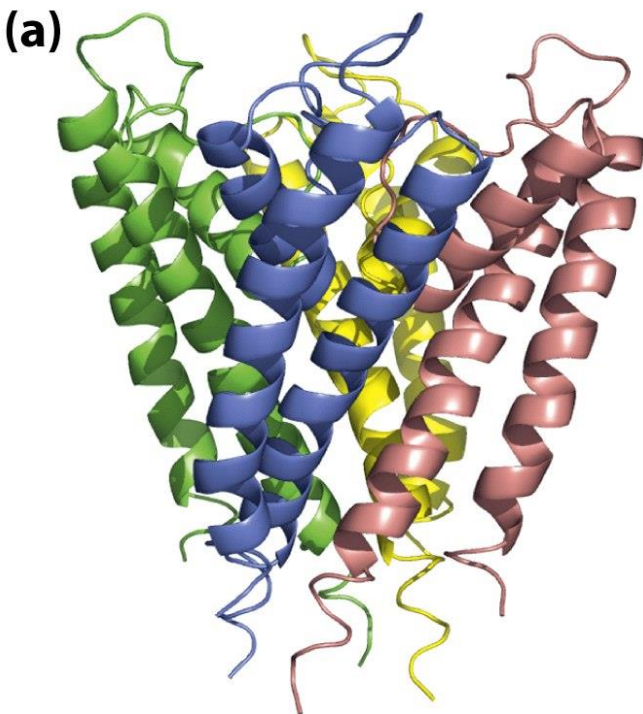


La gramicidina A trasporta 10^7 ioni K^+ o Na^+ al secondo attraverso la membrana. I cationi divalenti bloccano il poro.

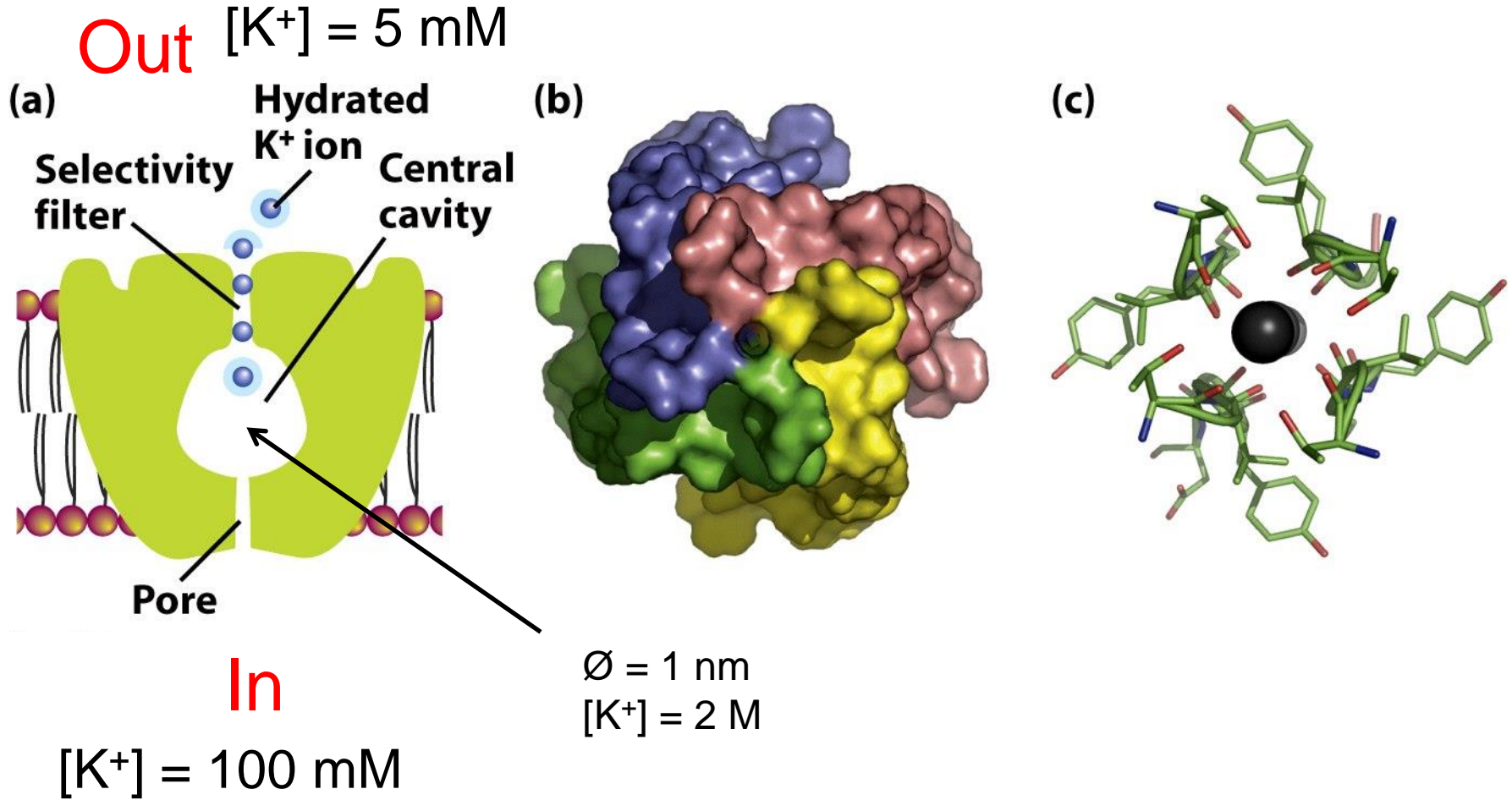
Proteine trans-membrana

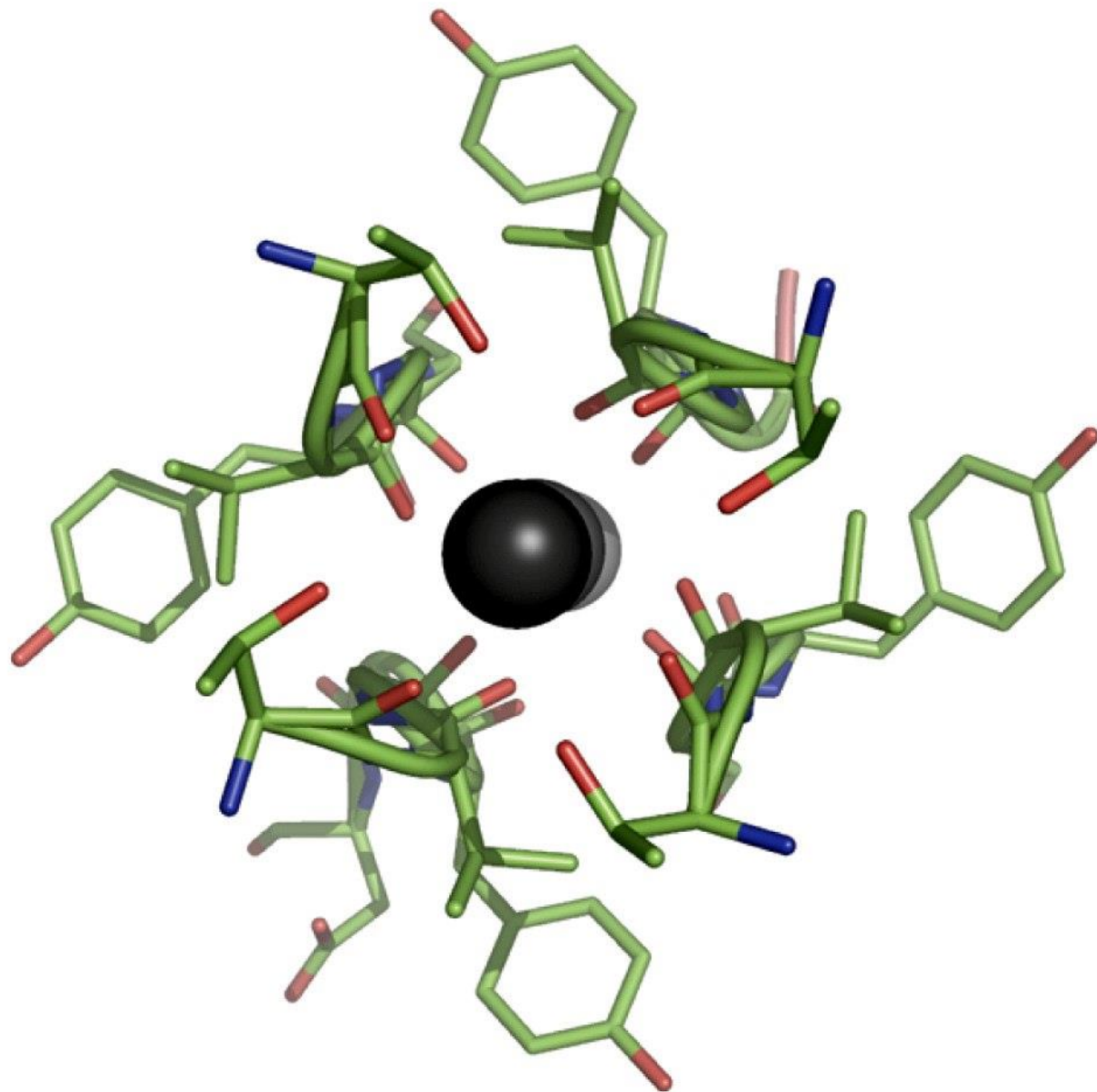


Canale del K^+

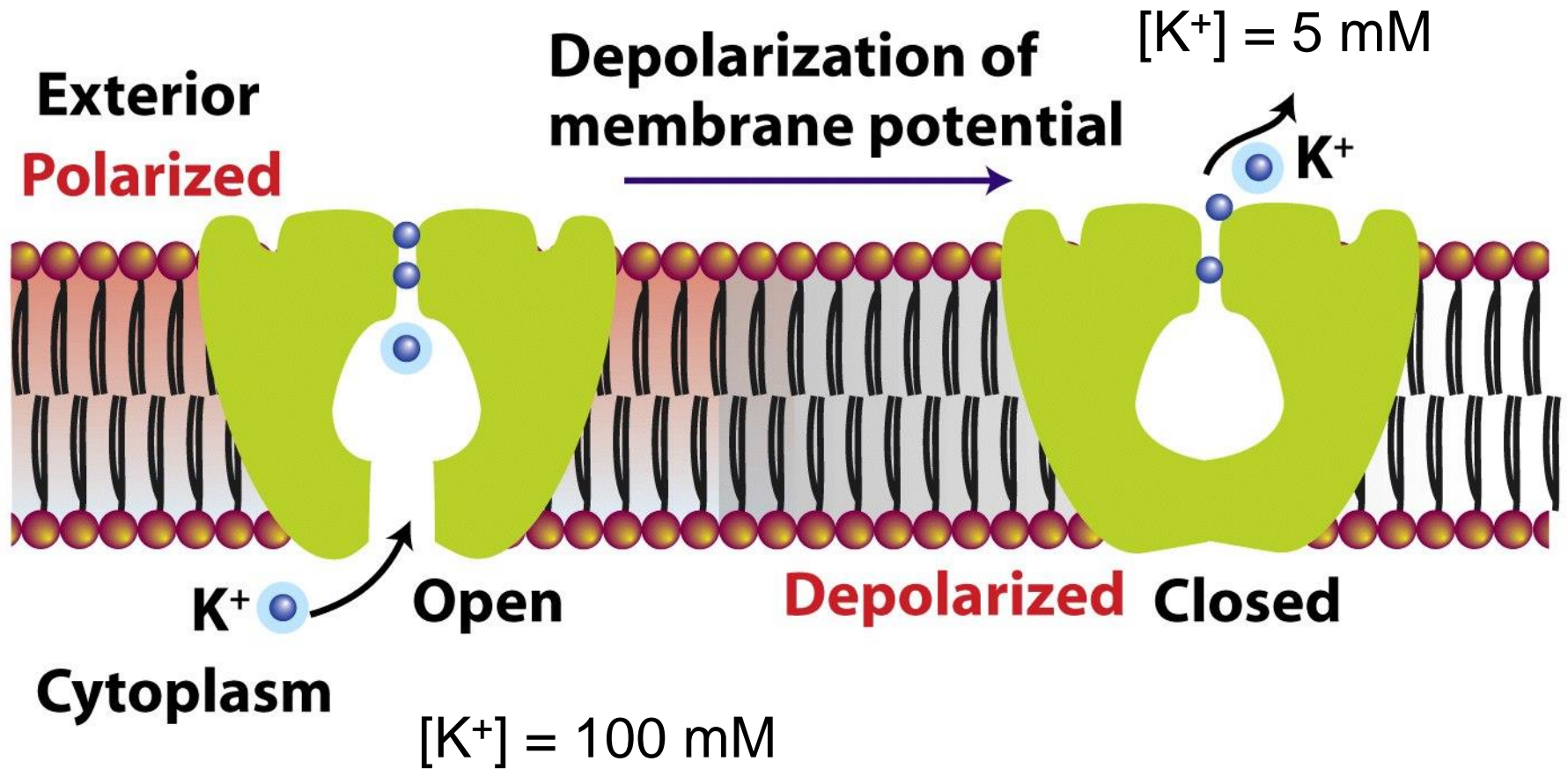


Canale del K^+ *potential gated*

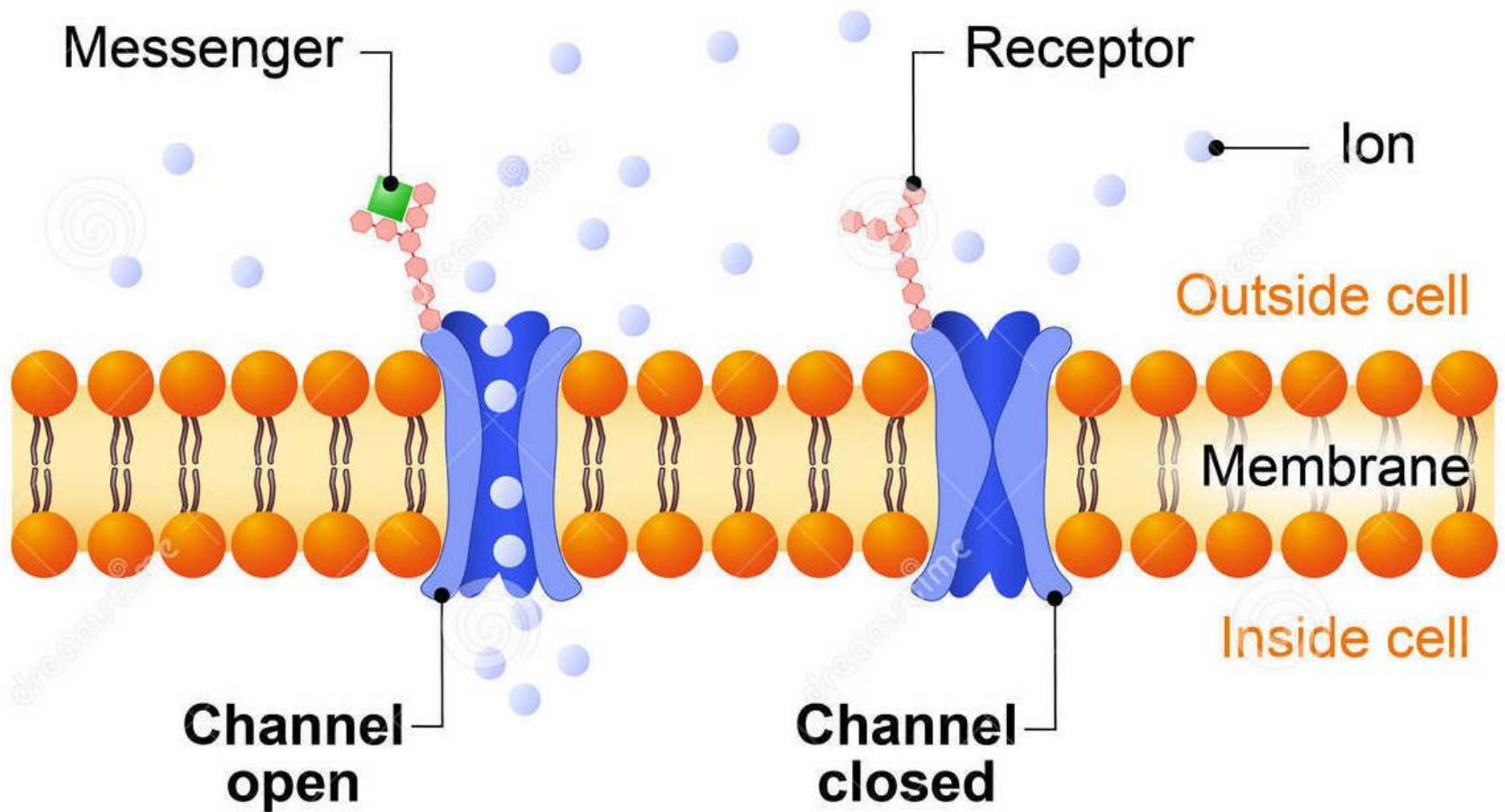




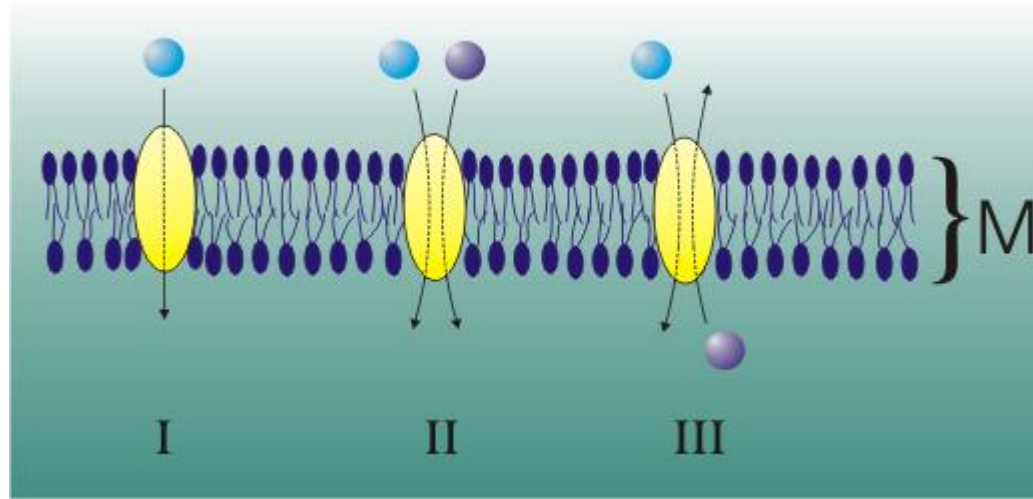
Canale del K^+ *potential gated*



Ligand-gated ion channel



Pompe ioniche (ATPasi)

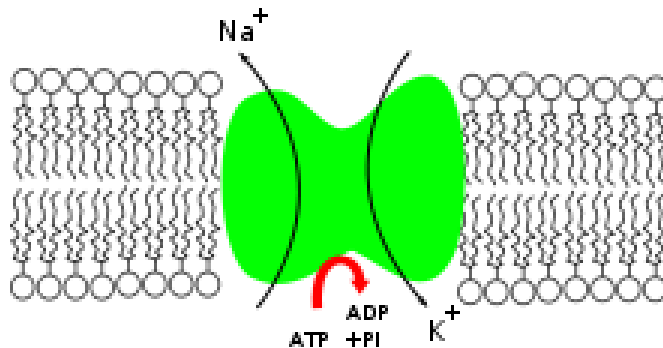


Uniporto

Simporto

Antiporto

Pompa ionica *antiporto* Na^+/K^+ -ATPasi

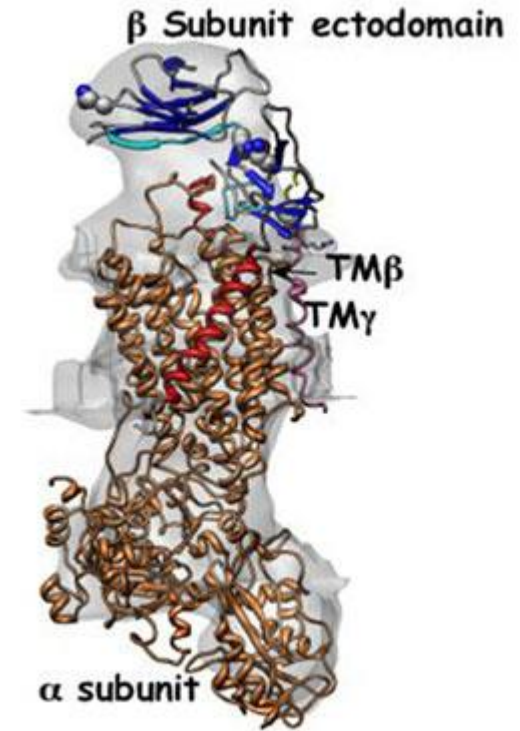
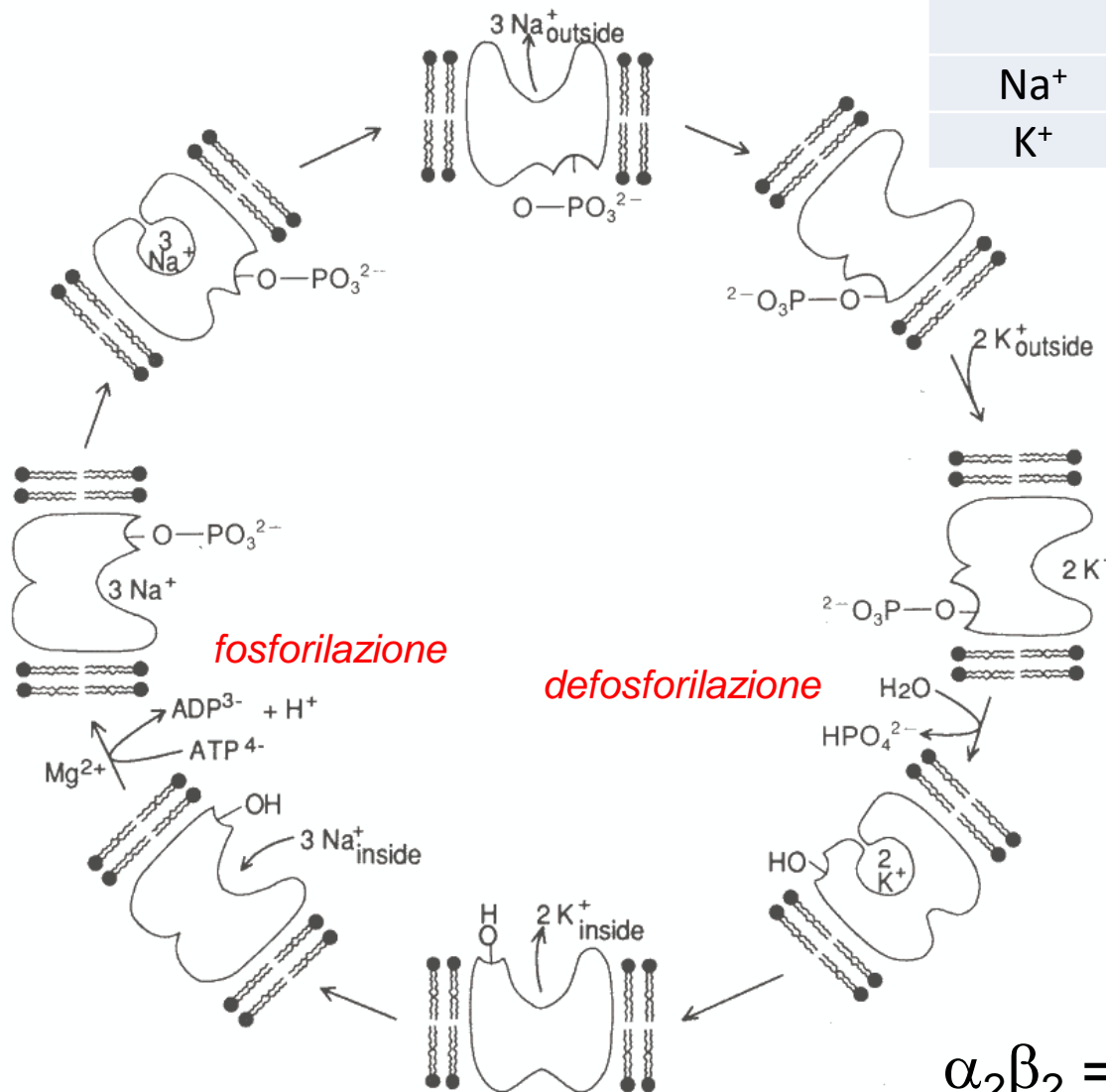


Ione	Intracellulare (mM)	Extracellulare (mM)
Na^+	10	150
K^+	100	5

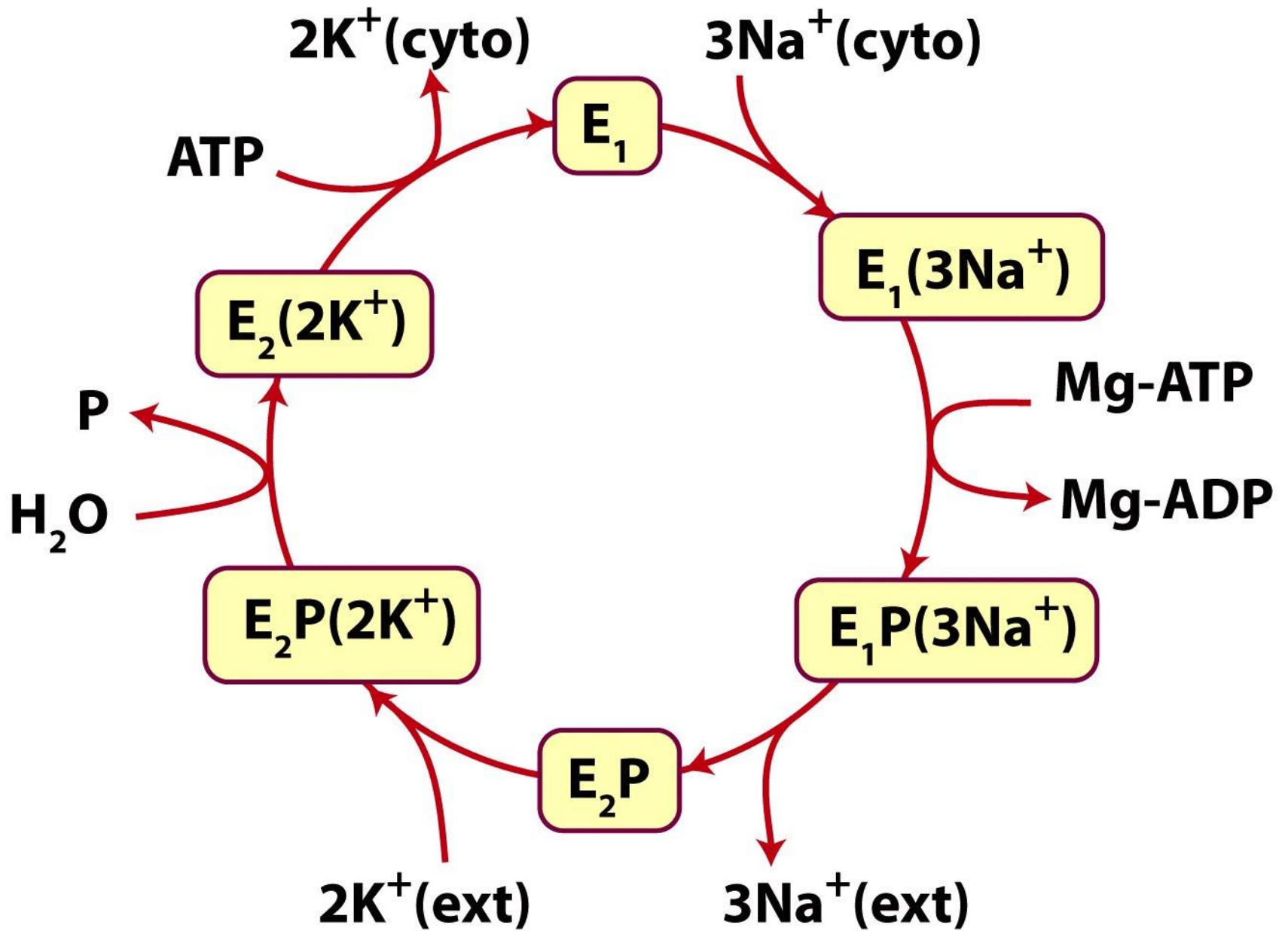
Pompa ionica *antiporto* Na⁺/K⁺-ATPasi

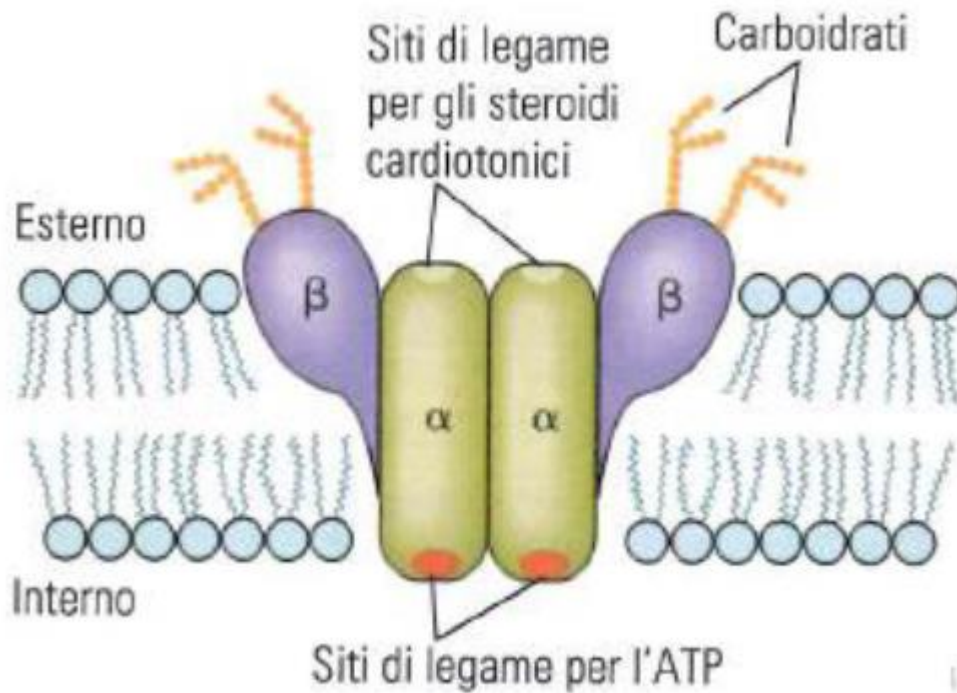


Ione	Intracellulare (mM)	Extracellulare (mM)
Na ⁺	10	150
K ⁺	100	5



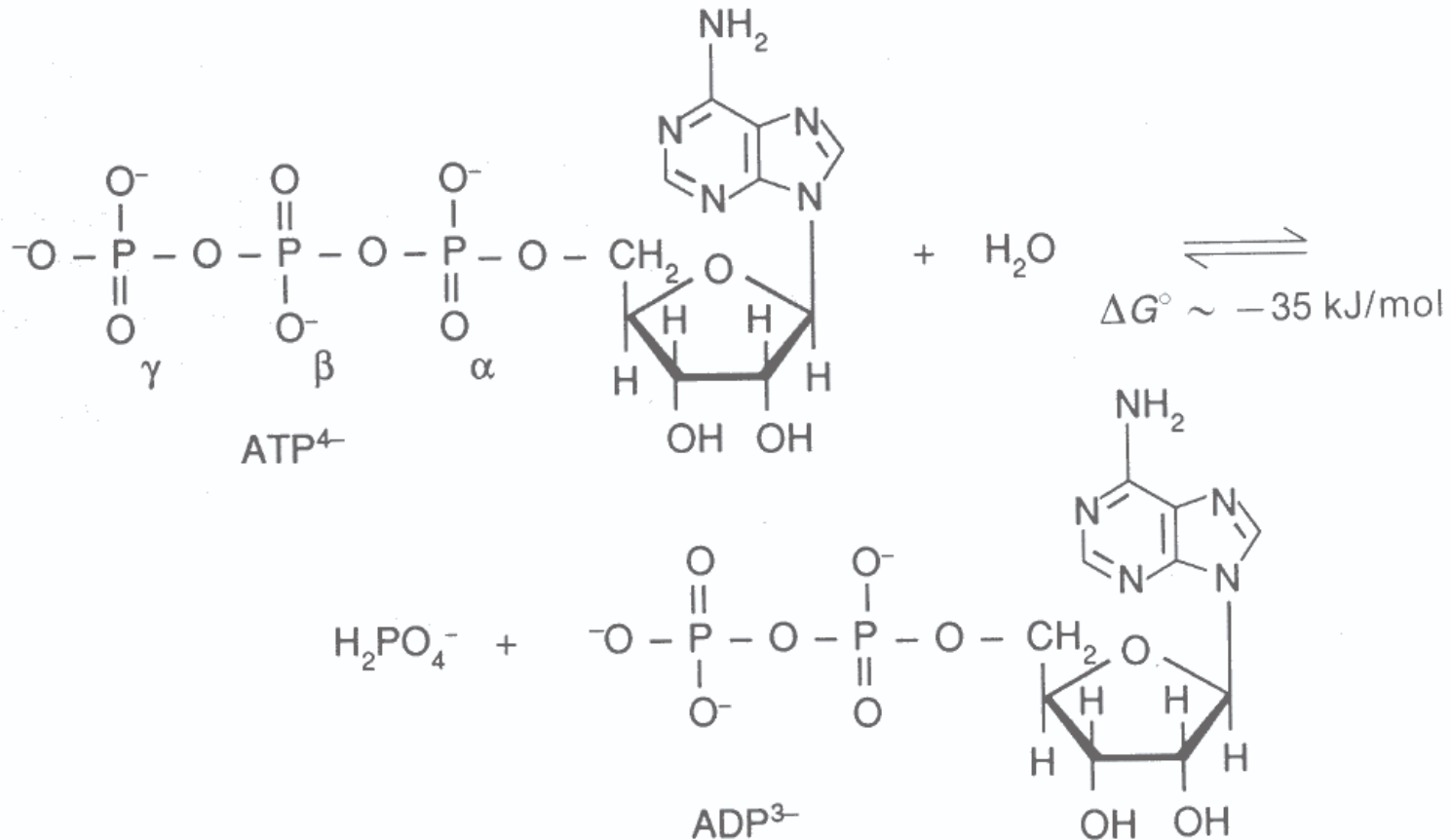
$$\alpha_2\beta_2 = 2 \times 112(\alpha) + 2 \times 35(\beta)$$





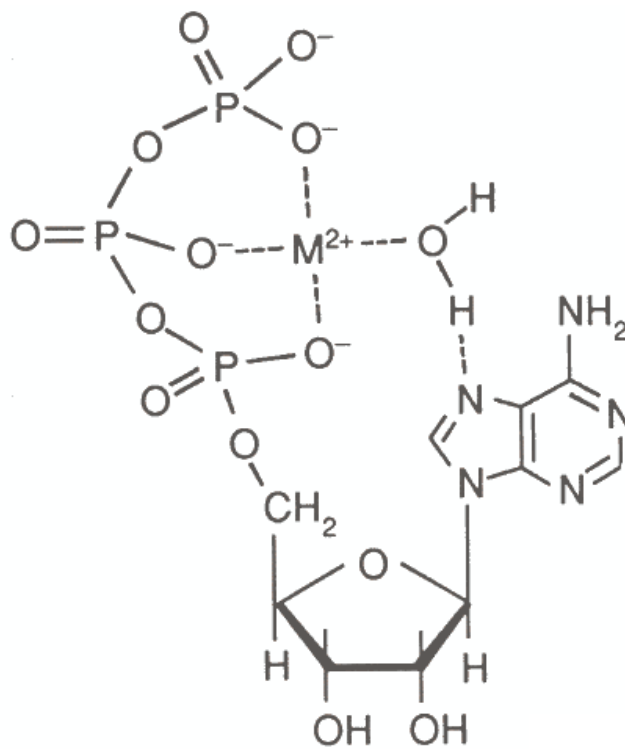
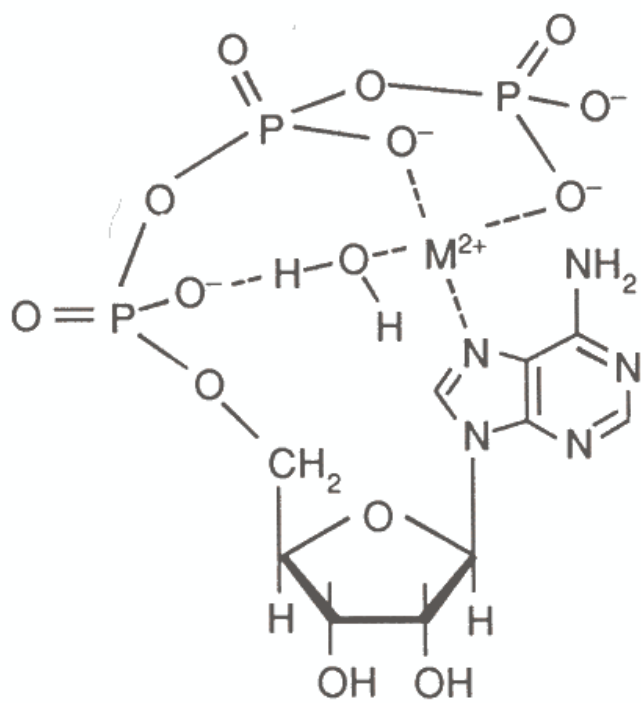
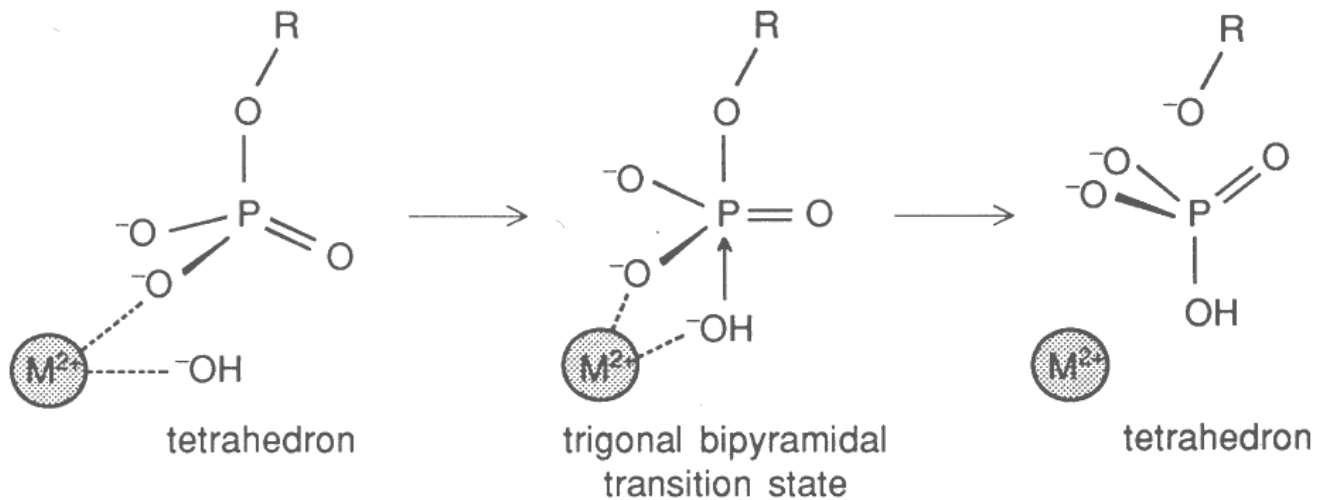
A livello del muscolo cardiaco, l'inibizione della pompa Na⁺/K⁺ da parte della digitalina fa aumentare [Na⁺] all'interno della cellula, portando all'attivazione della pompa antiporto Na⁺/Ca²⁺, e quindi ad un aumento della [Ca²⁺] intracellulare che ha come conseguenza l'intensificazione della contrazione muscolare (effetto cardiotonico).

Magnesio



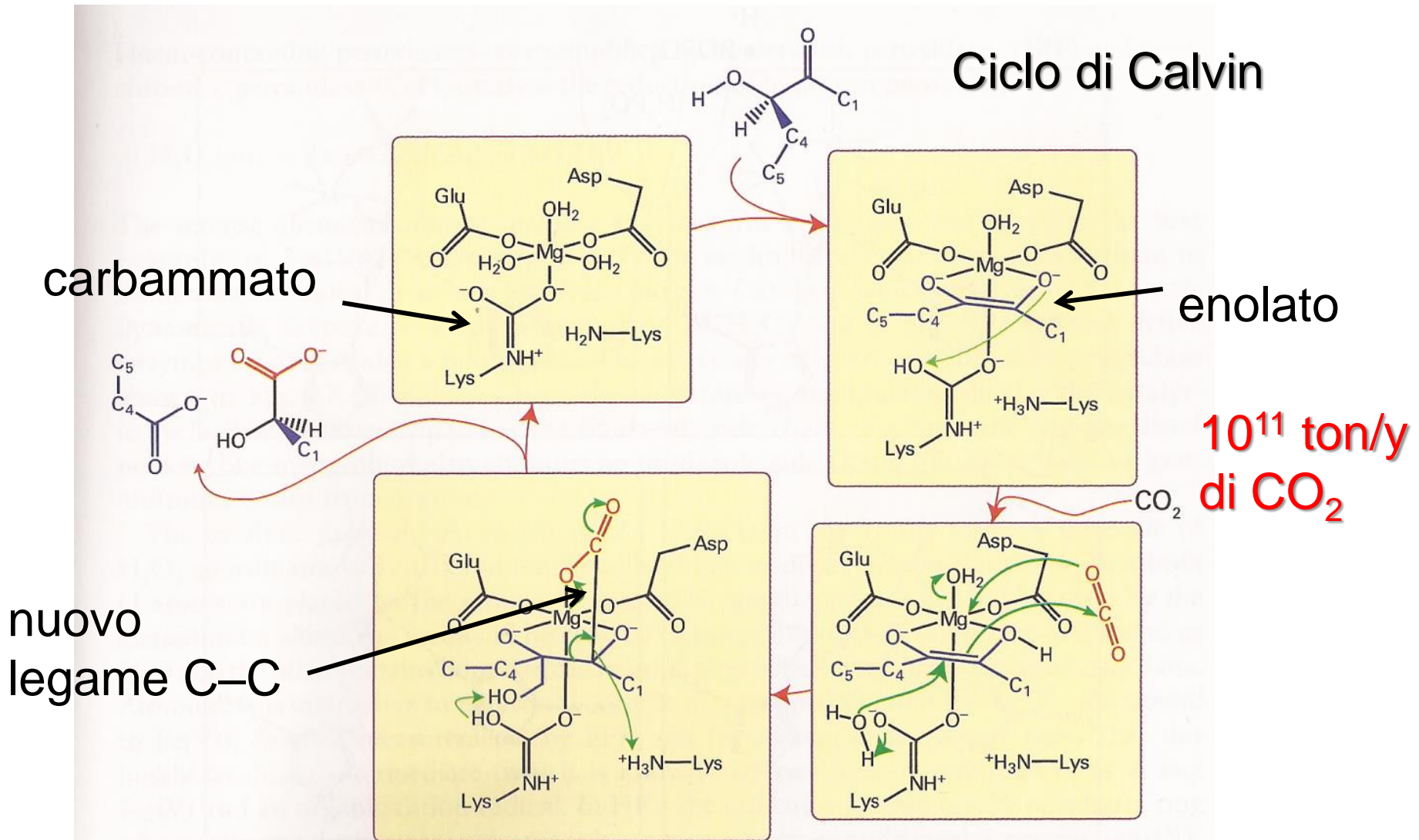
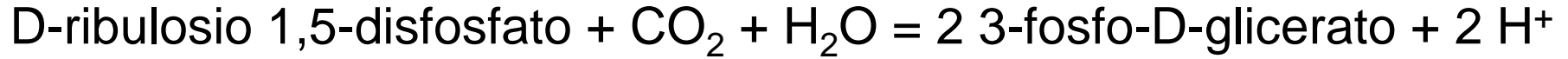
In media, un adulto sintetizza ed usa ogni giorno una quantità di ATP che corrisponde al proprio peso corporeo

S_N2

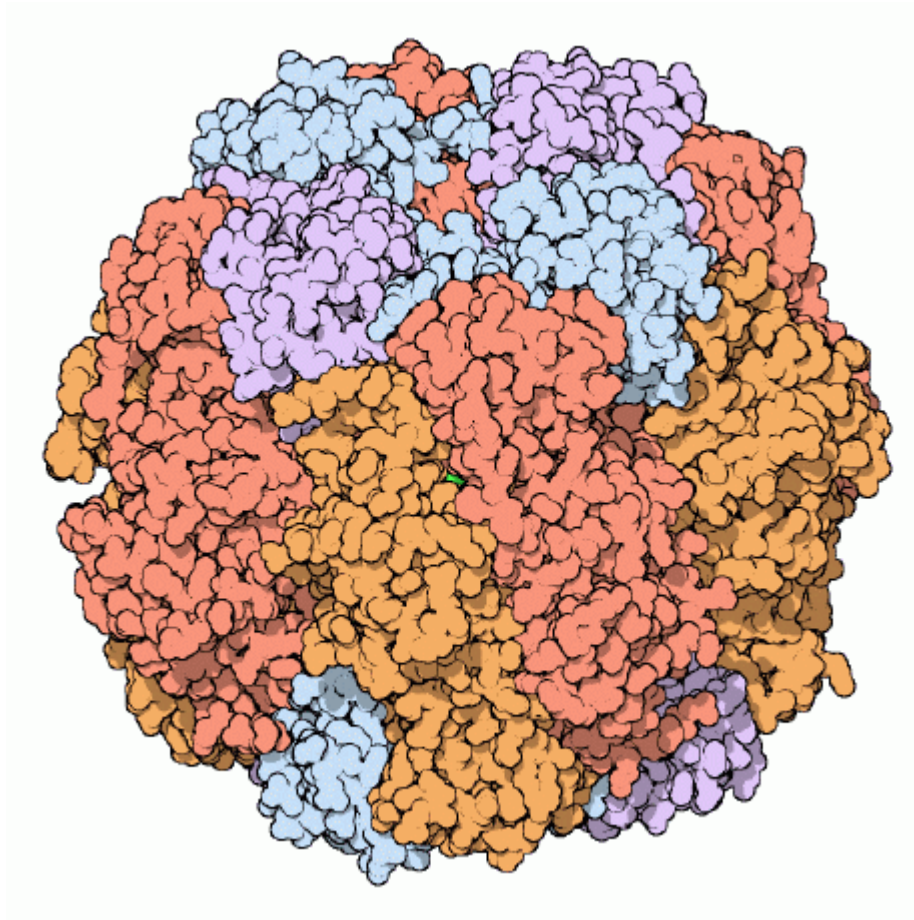


Ribuloso bisfosfato carbossilasi (*RuBisCo*)

l'enzima più abbondante della biosfera



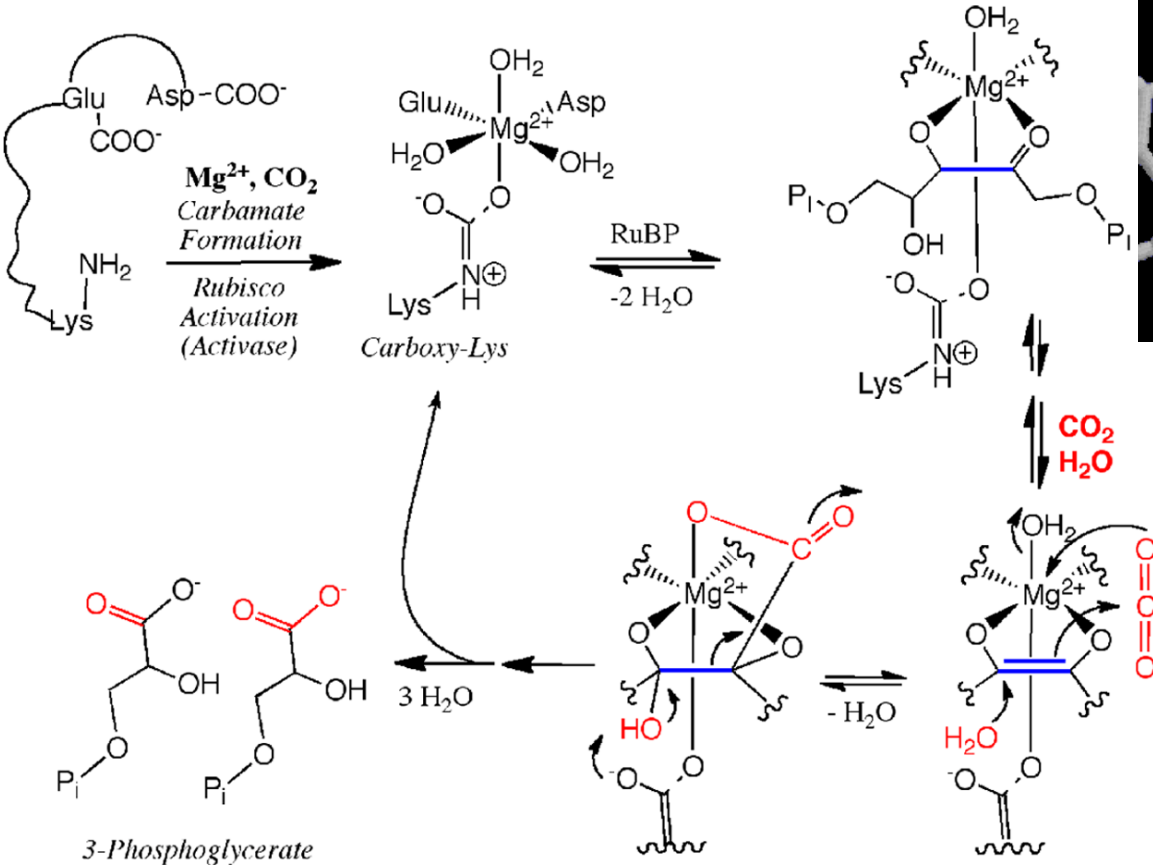
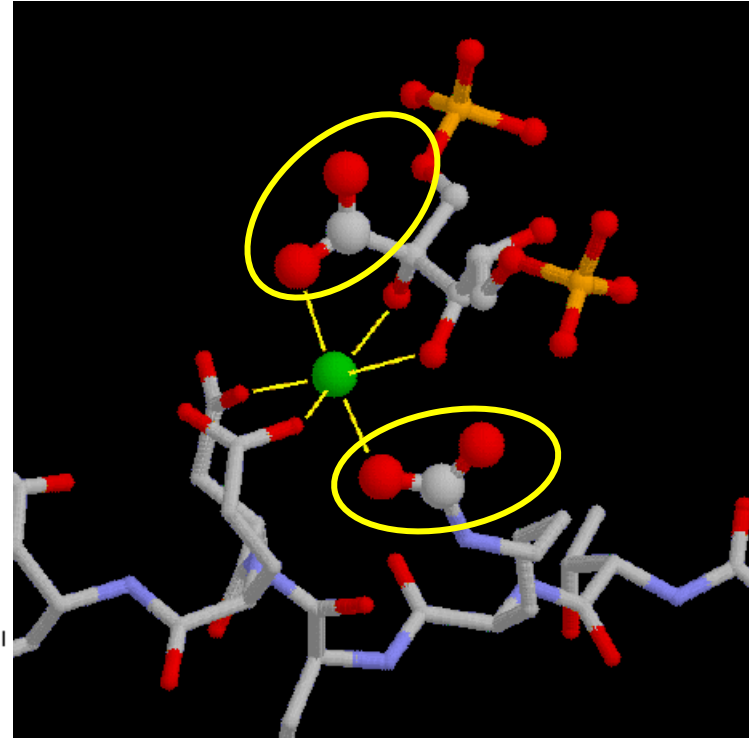
Rubisco



16 subunità, L_8S_8

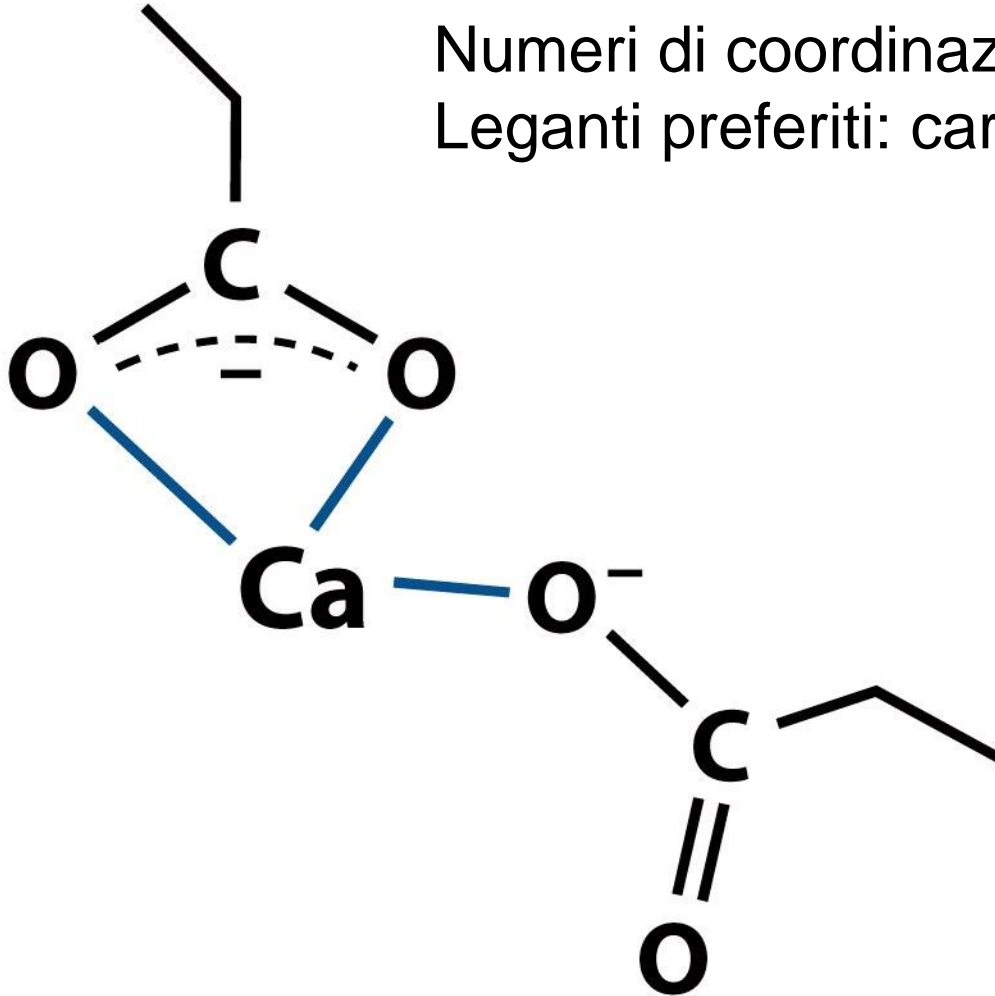
Rubisco

soltanto 3 cicli/secondo

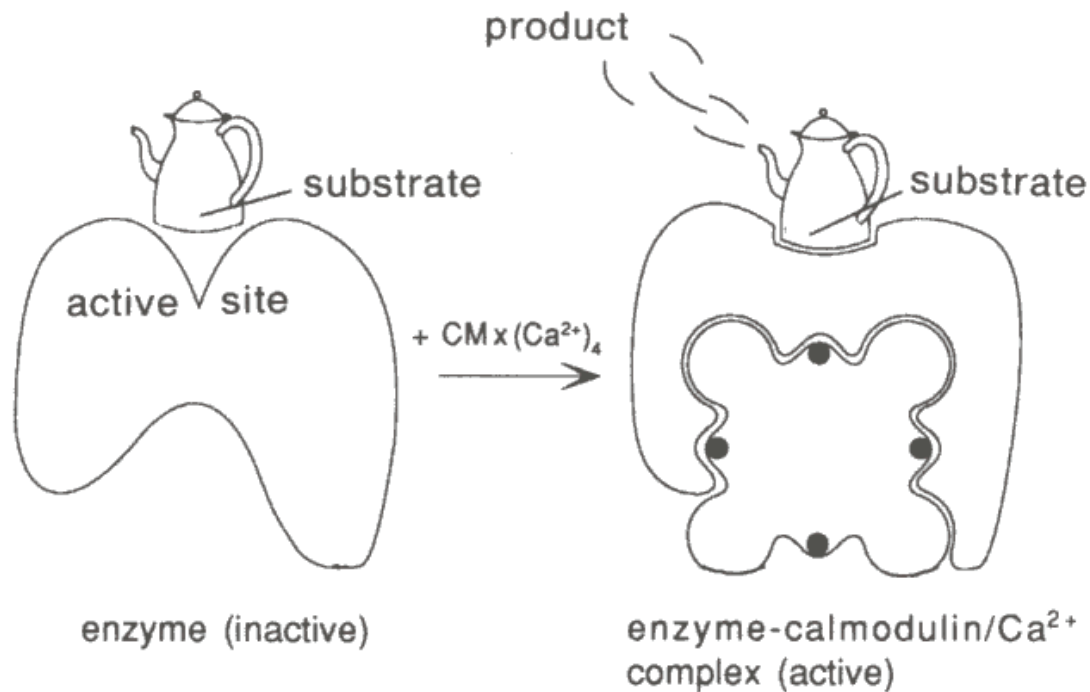
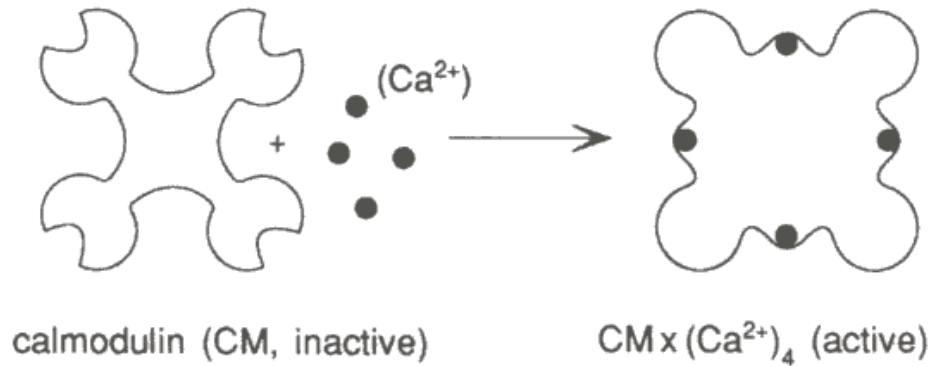


Calcio

Numeri di coordinazione elevati: 7 – 8
Leganti preferiti: carbossilati

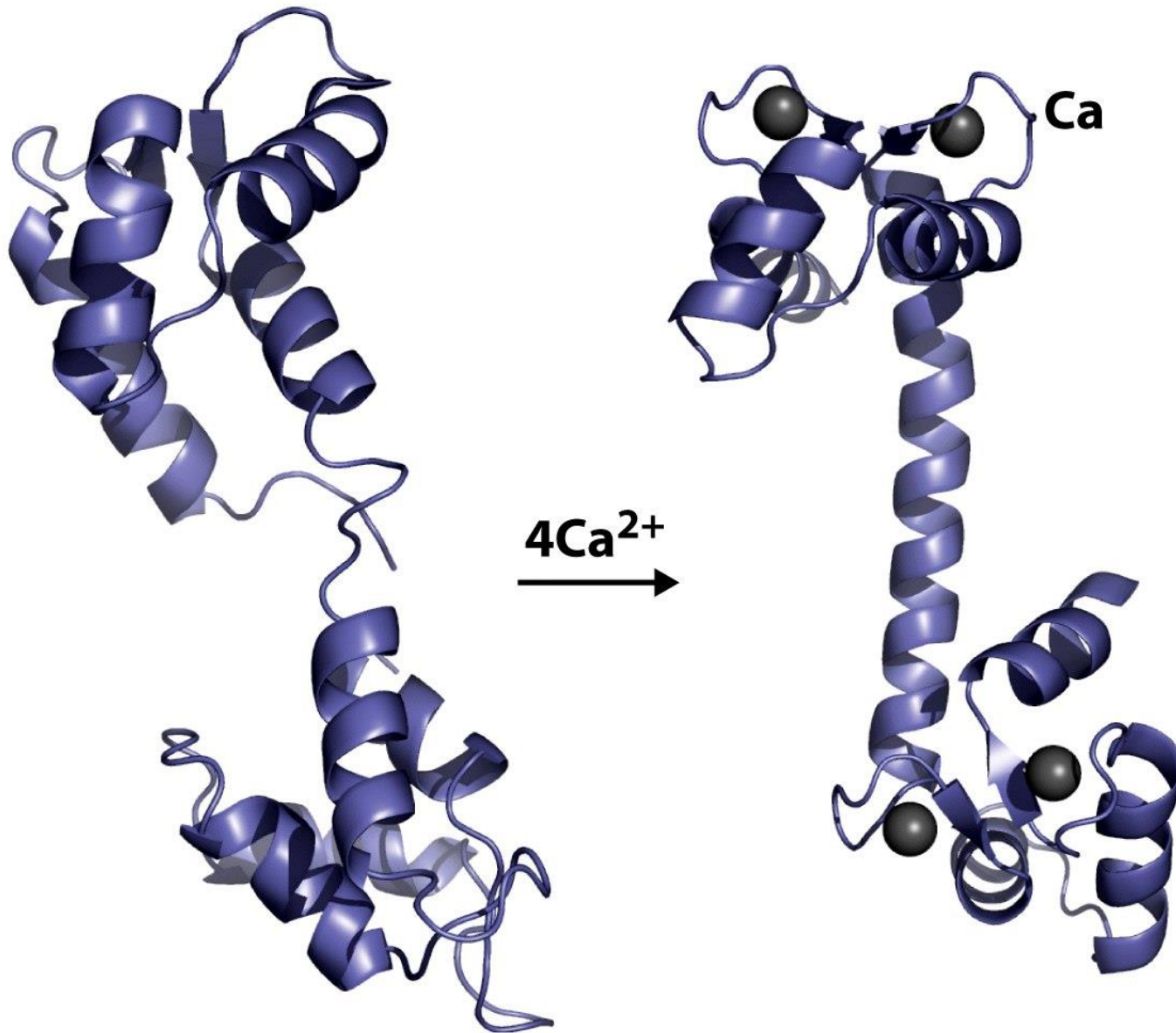


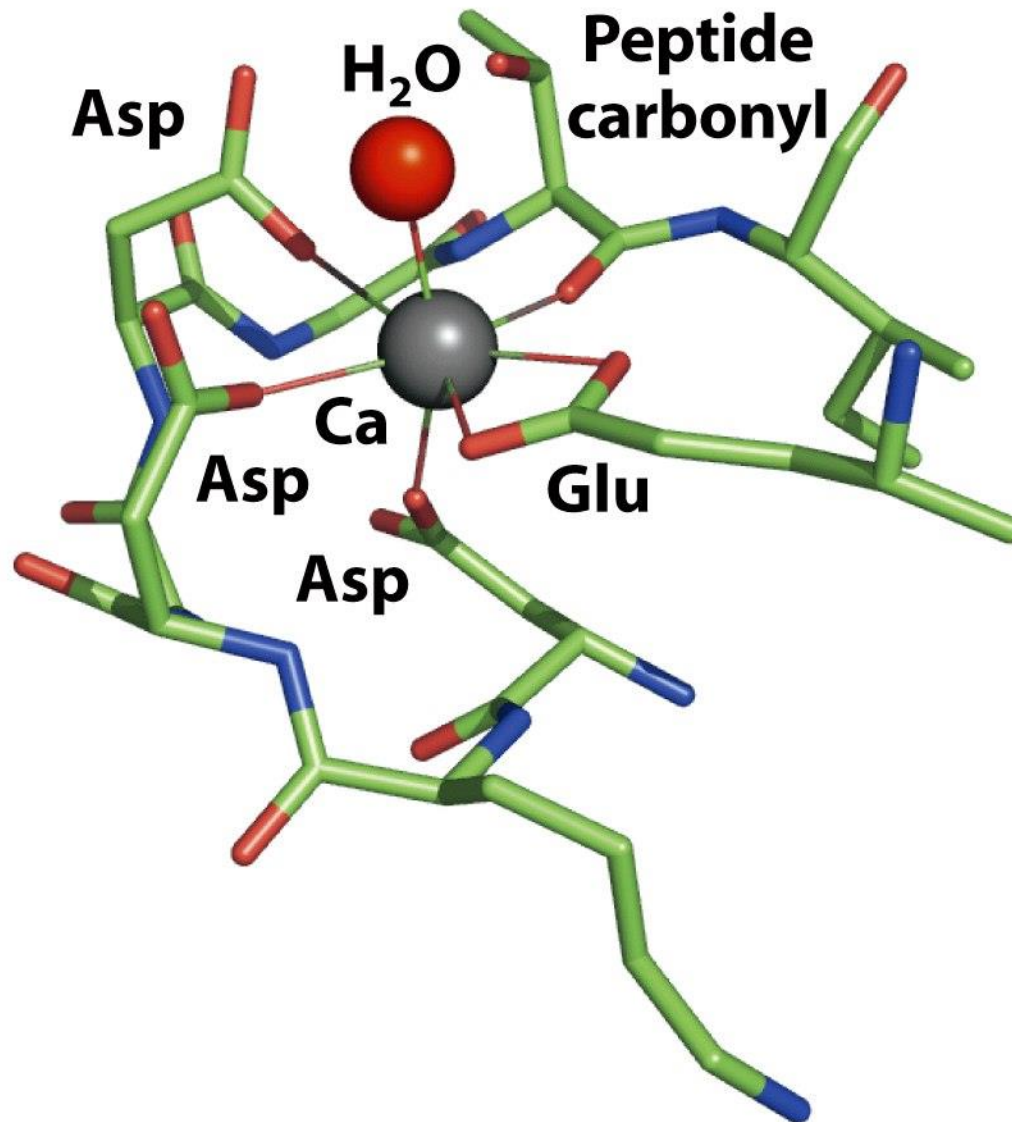
Ca²⁺: messaggero secondario



e.g.: NO sintasi (NO), adenilato e guanilato ciclasti (cAMP, cGMP), NAD kinasi (NADP)

Variazione conformazionale in una calmodulina

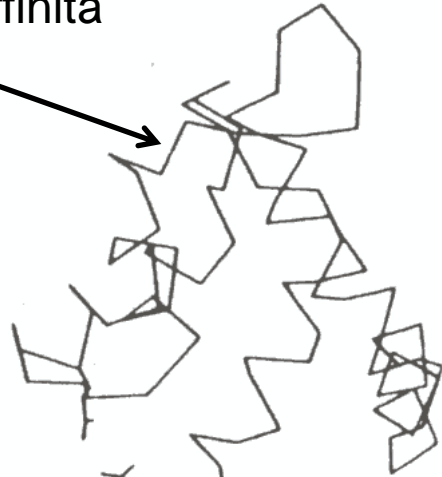
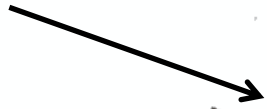




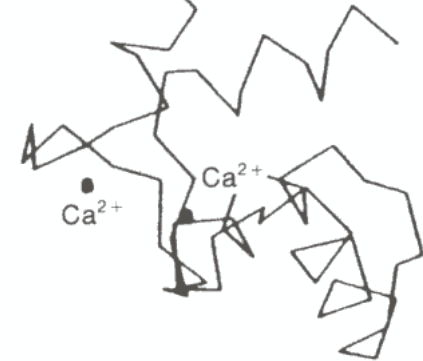
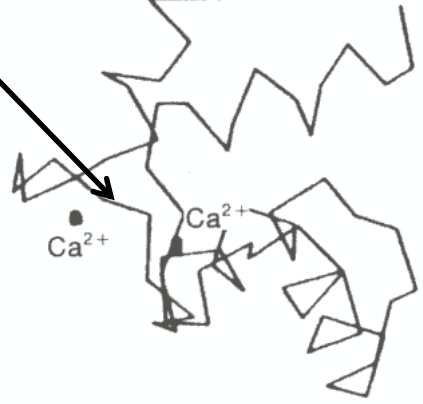
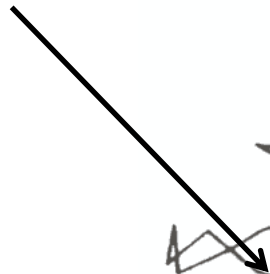
Uno dei siti di coordinazione del Ca^{2+} della calmodulina

Troponina-C

Siti di binding ad affinità minore



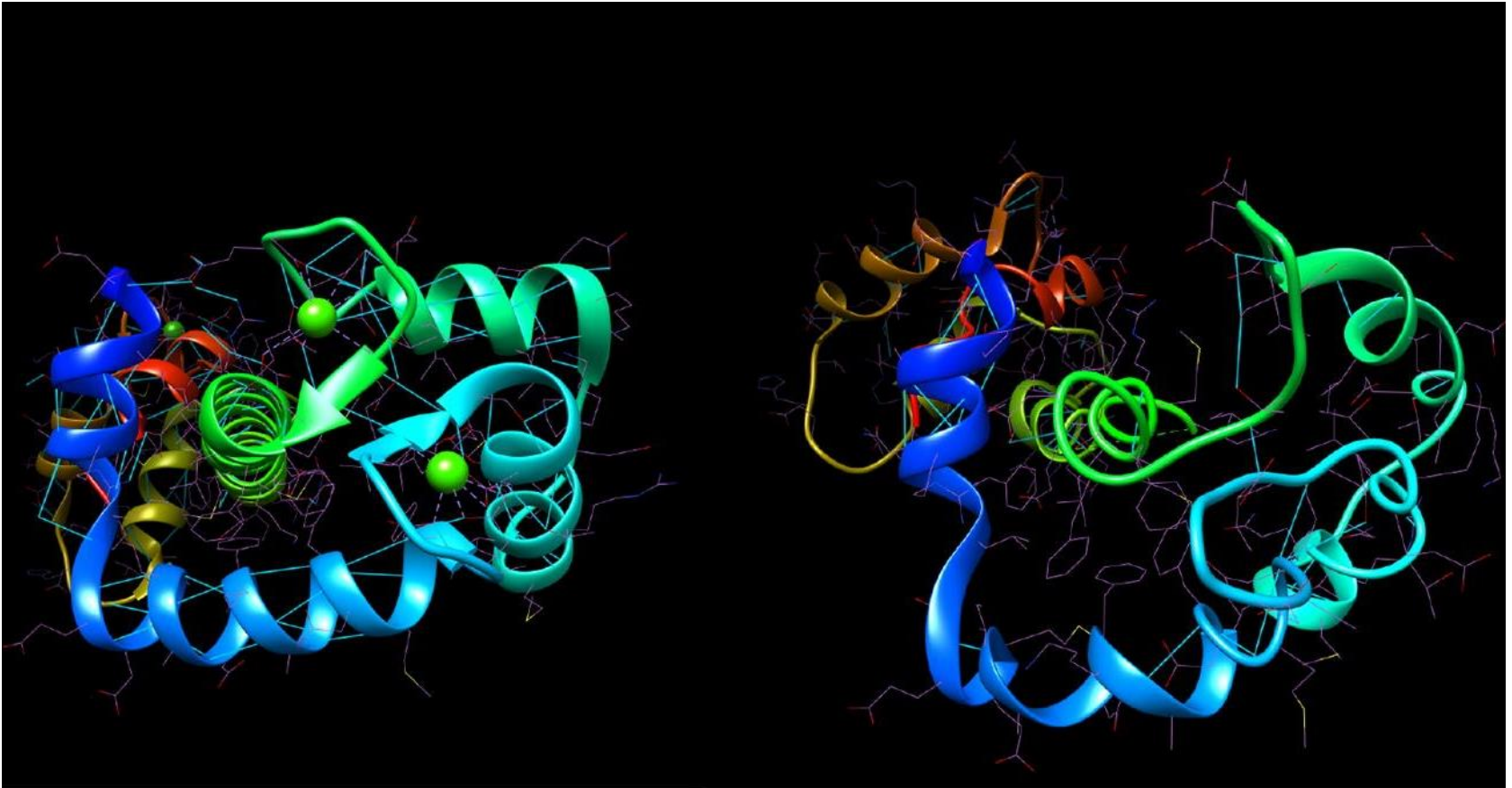
Siti di binding ad elevata affinità ($K > 10^6$)



→ *actina*
miosina

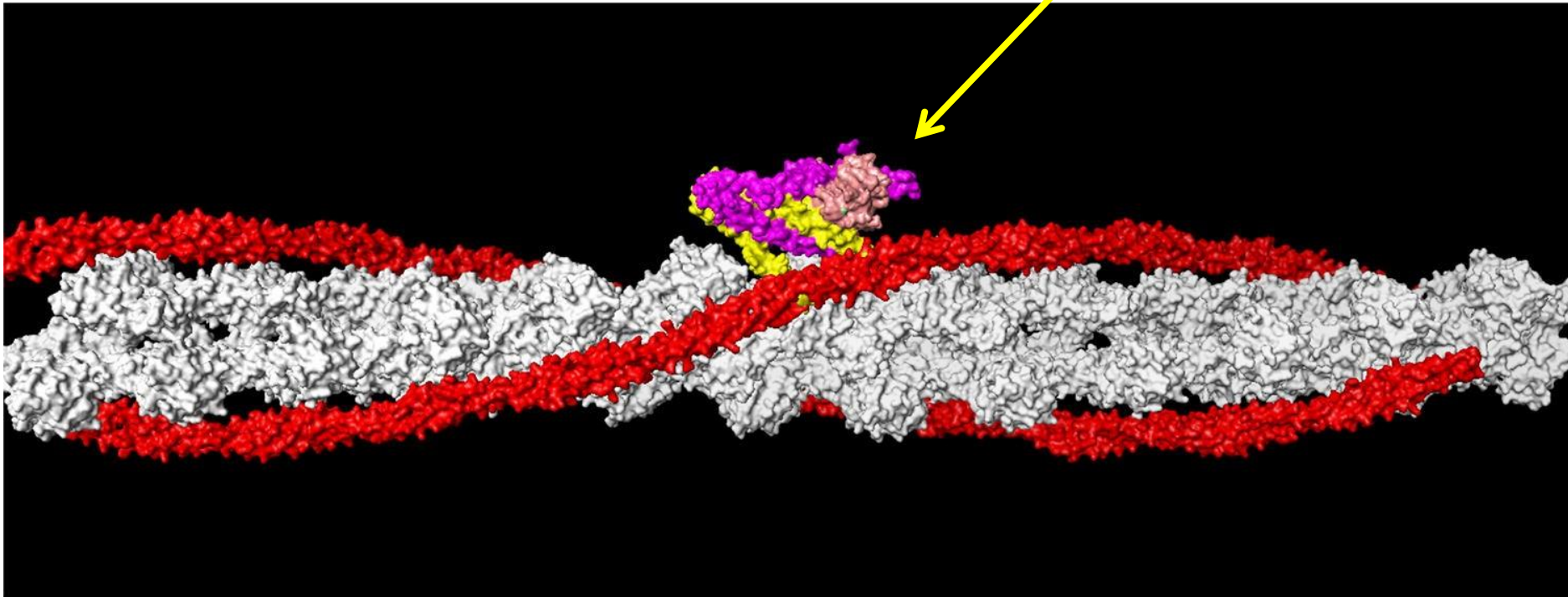
(componenti proteici del filamento muscolare)

Variazioni conformazionali indotte dal *binding* del calcio



Modello di filamento muscolare

Troponina

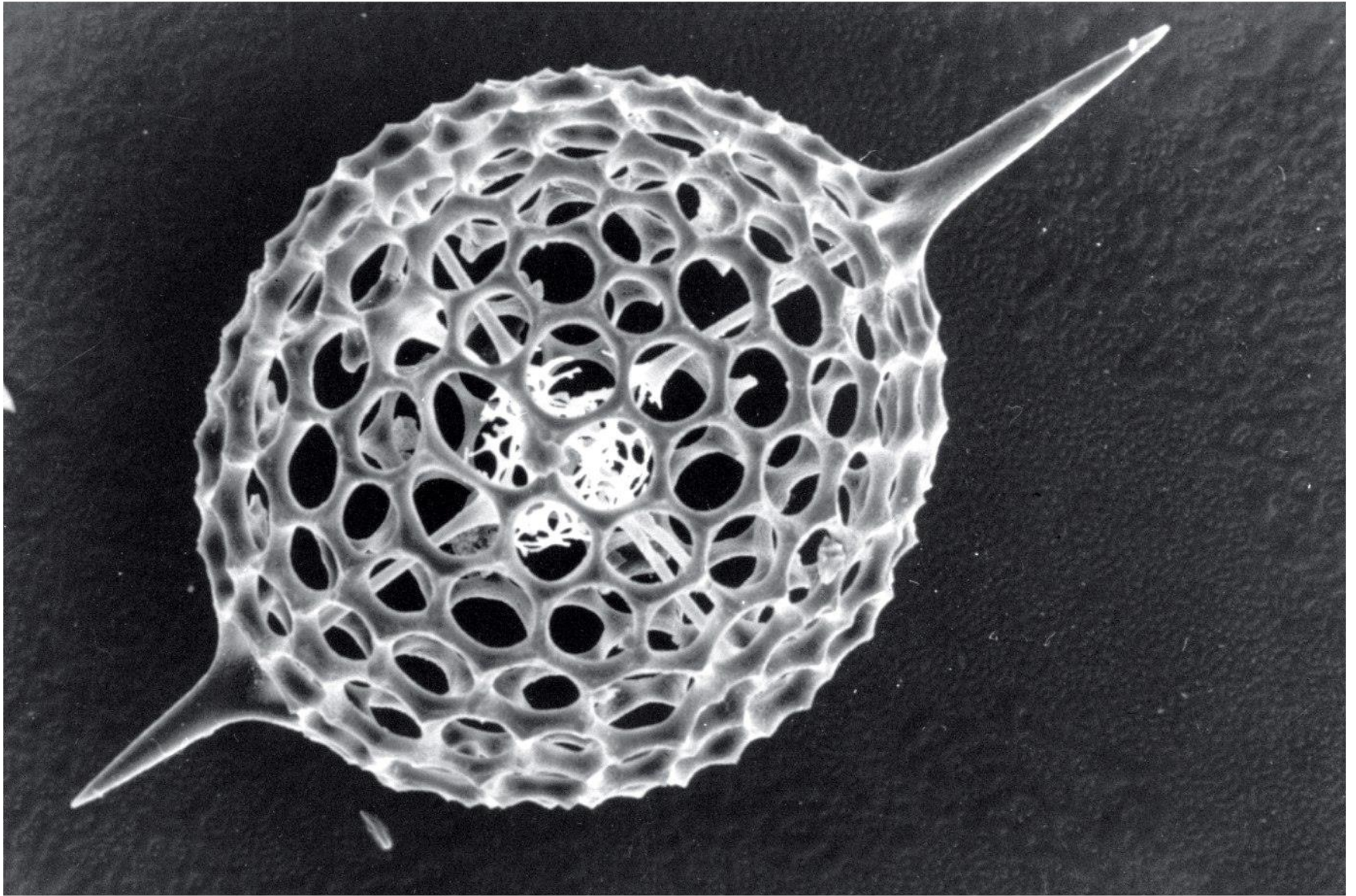


Actina = bianco

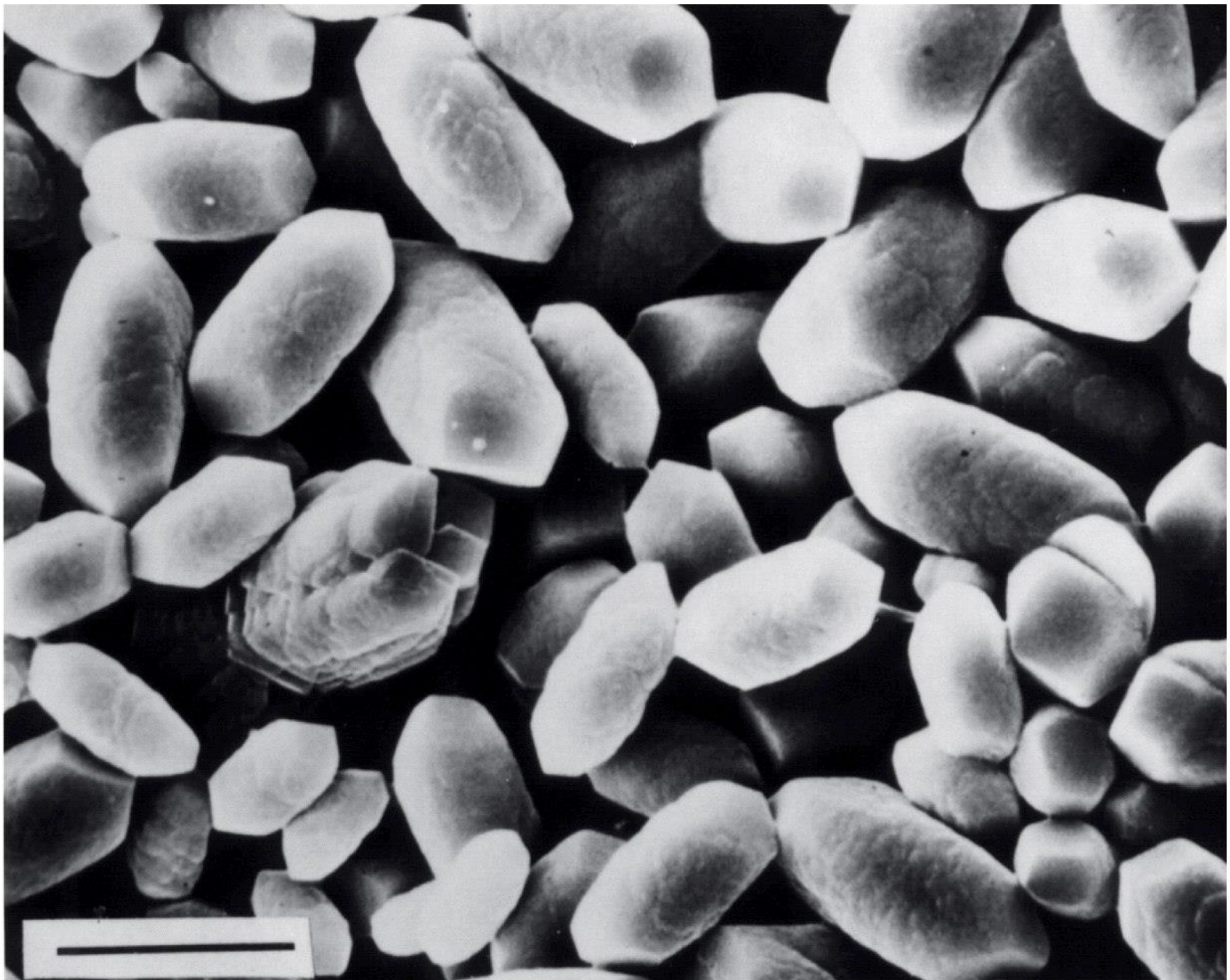
Tropomiosina = rosso

I principali biominerali di elementi alcalino-terrosi

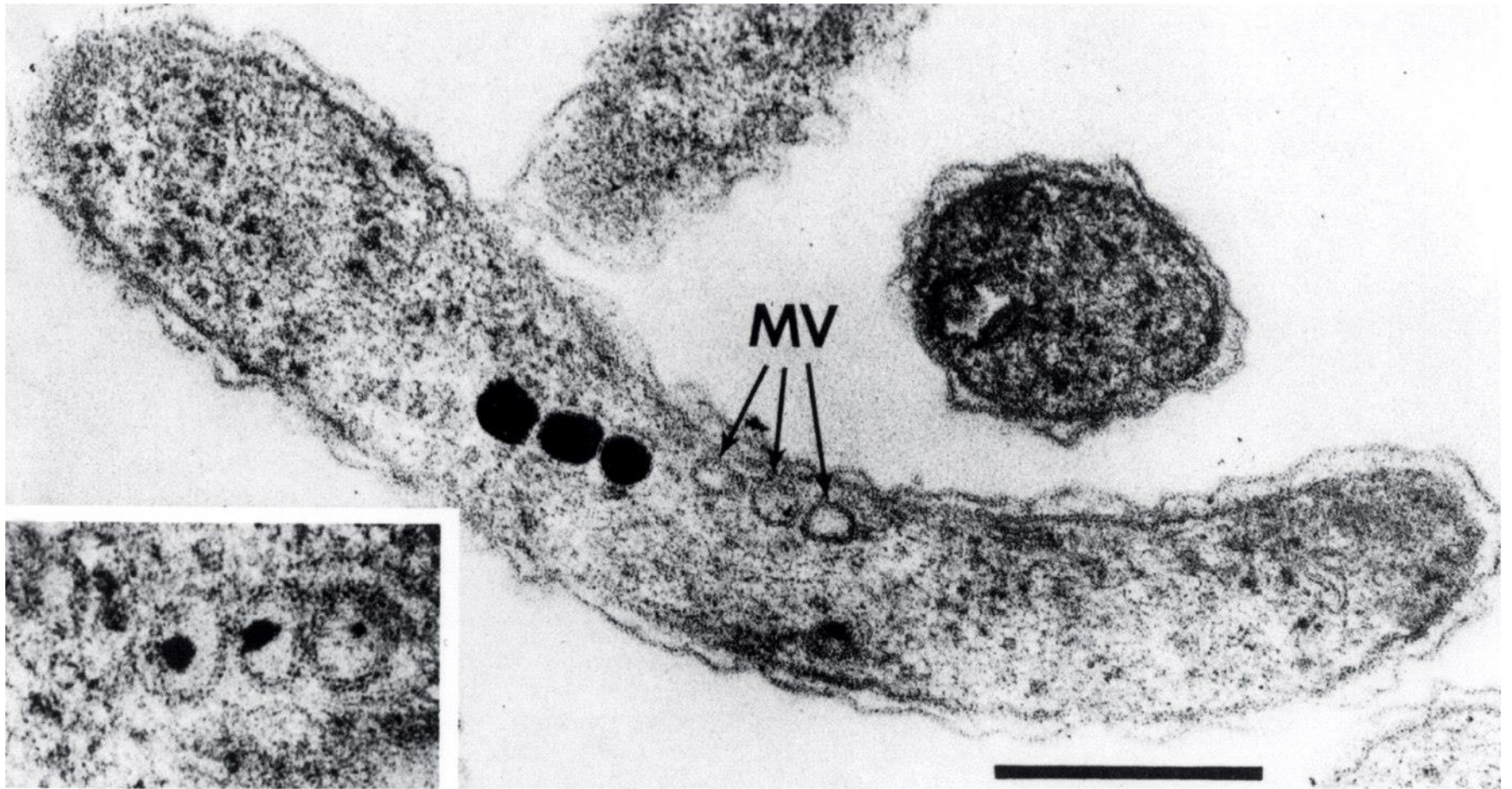
Composto	Minerale	Presenza negli organismi viventi
MgCO_3	Magnesite	Scheletro del corallo
CaCO_3	Aragonite	Conchiglie e perle
CaCO_3	Calcite	Uova di uccello, sistemi gravitazionali nell'orecchio interno
$\text{CaCO}_3 \cdot n\text{H}_2\text{O}$	Amorfo	Immagazzinamento di calcio nelle piante
$\text{Ca}(\text{C}_2\text{O}_4) \cdot n\text{H}_2\text{O}$	Whewellite (n = 1) Weddellite (n = 2)	Immagazzinamento di calcio nelle piante, calcoli renali
$3\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2$	Idrossiapatite	Ossa e denti nei vertebrati
$\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$	Gesso	Sistema gravitazionale nelle meduse
SrSO_4	Celestite	Esoscheletro di certo plankton
BaSO_4	Barite	Sistema gravitazionale nelle alghe



Microscheletro siliceo di una radiolaria



Cristalli di calcite nell'orecchio interno: sensori gravitazionali



Cristalli di magnetite in archeobatteri magnetotattici

Table 26.1 The approximate concentrations (mol dm⁻³), where known, of elements (apart from C, H, O, N, P, S, Se, Br, I, B, Si and W) in different biological zones

Element	External fluids (sea water)	Free ions in external fluids (blood plasma)	Cytoplasm (free ions)	Comments on status in cell
Na	$> 10^{-1}$	10^{-1}	$< 10^{-2}$	Not bound
K	10^{-2}	4×10^{-3}	$\leq 3 \times 10^{-1}$	Not bound
Mg	$> 10^{-2}$	10^{-3}	$\approx 10^{-3}$	Weakly bound as ATP complex
Ca	$> 10^{-3}$	10^{-3}	$\approx 10^{-7}$	Concentrated in some vesicles
Cl	10^{-1}	10^{-1}	10^{-2}	Not bound
Fe	10^{-17} (Fe(III))	10^{-16} (Fe(III))	$< 10^{-7}$ (Fe(II))	Too much unbound Fe is toxic (Fenton chemistry) in and out of cells
Zn	$< 10^{-8}$	10^{-9}	$< 10^{-11}$	Totally bound, but may be exchangeable
Cu	$< 10^{-10}$ (Cu(II))	10^{-12}	$< 10^{-15}$ (Cu(I))	Totally bound, not mobile. Mostly outside cytoplasm
Mn	10^{-9}		$\approx 10^{-6}$	Higher in chloroplasts and vesicles
Co	10^{-11}		$< 10^{-9}$	Totally bound (cobalamin)
Ni	10^{-9}		$< 10^{-10}$	Totally bound
Mo	10^{-7}		$< 10^{-7}$	Mostly bound