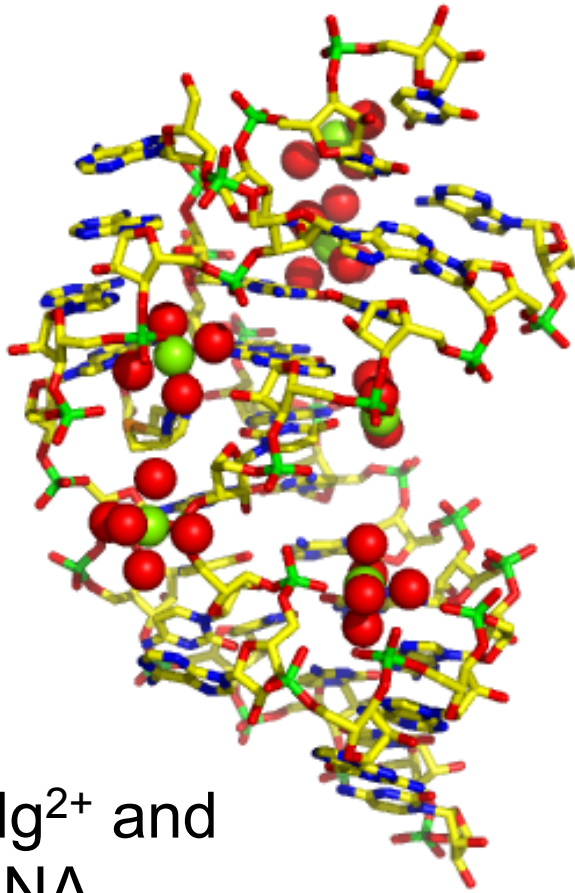
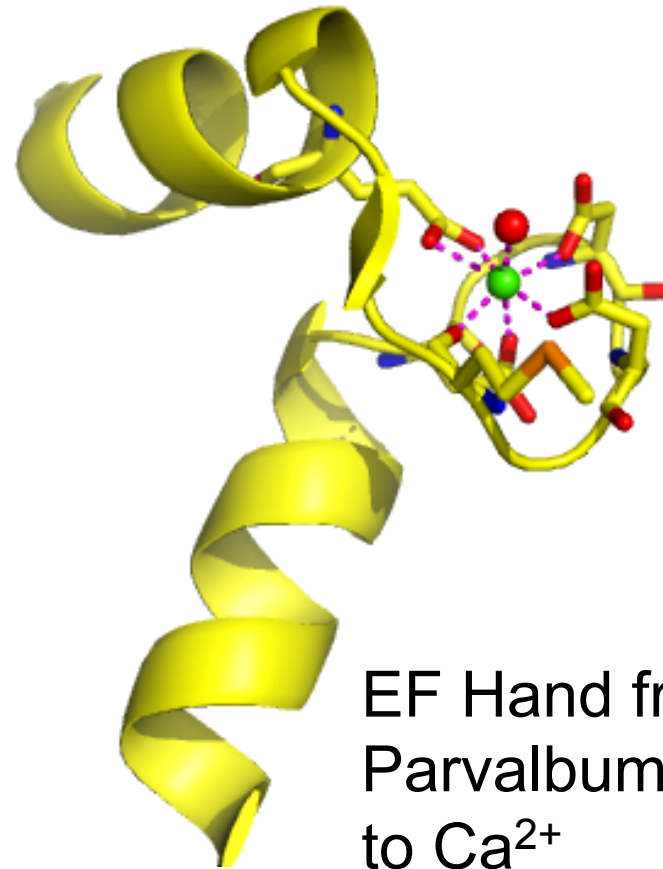


Hardened Metals



Mg²⁺ and
RNA



EF Hand from
Parvalbumin bound
to Ca²⁺

Sequence Alignment of EF Hand

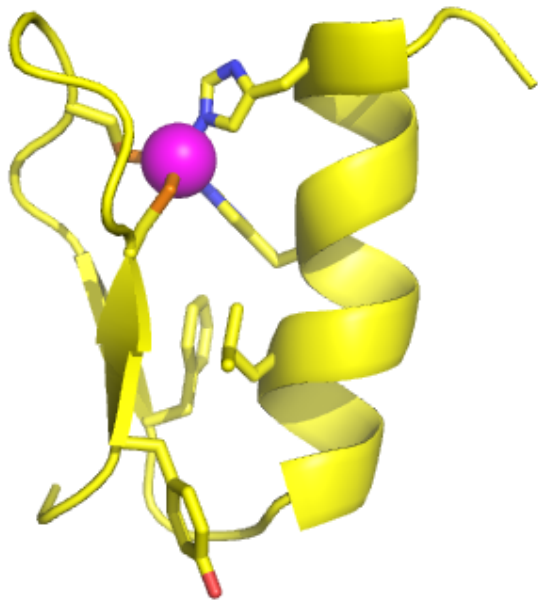
Parvalbumin 1	FAIIDQDKSGFIEEDELKLF
Parvalbumin 2	LKAGDSDGDGKIGVDEFTAL
Camodulin 1	FSLFDKDGDTITTKELGTV
Camodulin 2	INEVDADNGTIDFPEFLTM
Camodulin 3	FRVFDKDGNGYISAAELRHV
Camodulin 4	IREANIDGDGQVNYEEFVQM

Metal Ion Specificity of CP1

CP1 (CCHH) P Y K C P E C G K S F S Q K S D L V K H Q R T H T G

CP1 (CCHC) P Y K C P E C G K S F S Q K S D L V K H Q R T C T G

CP1 (CCCC) P Y K C P E C G K S F S Q K S D L V K C Q R T C T G



softer

↓
Mn²⁺
Fe²⁺
Co²⁺
Zn²⁺
Cd²⁺

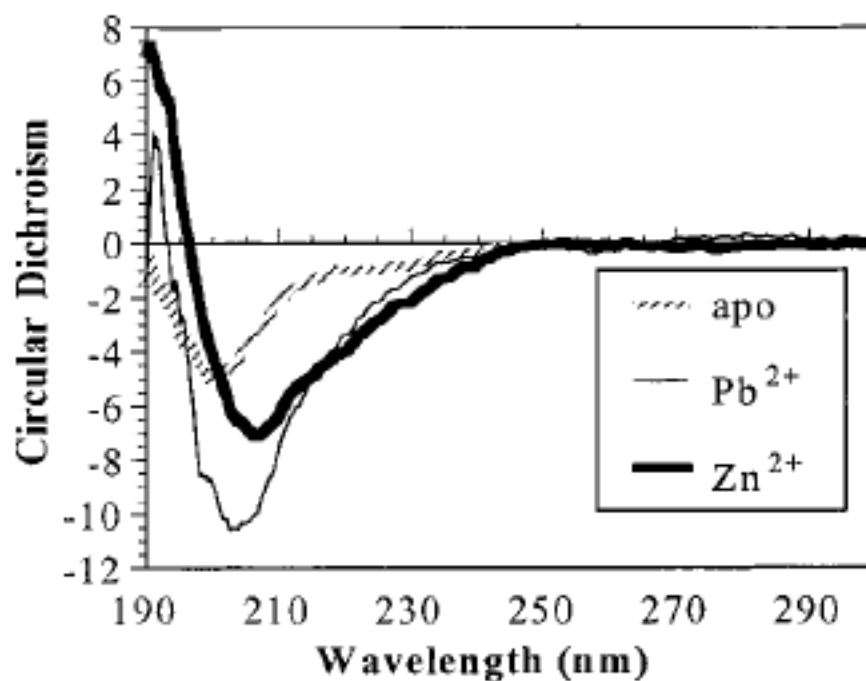
softer



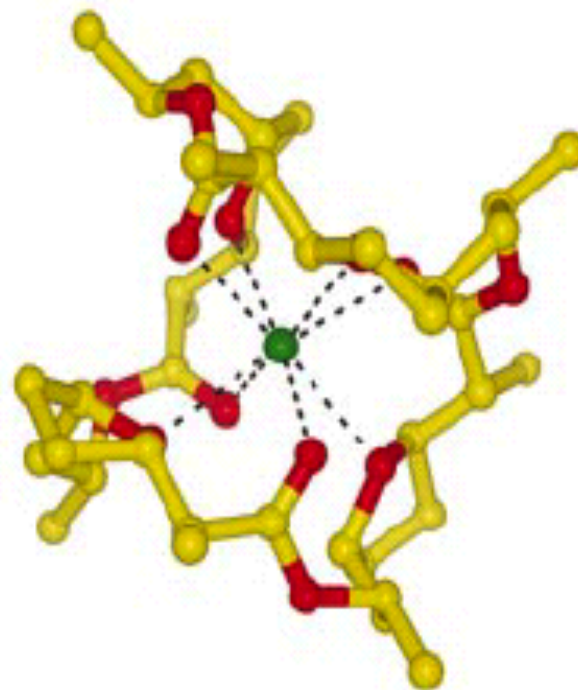
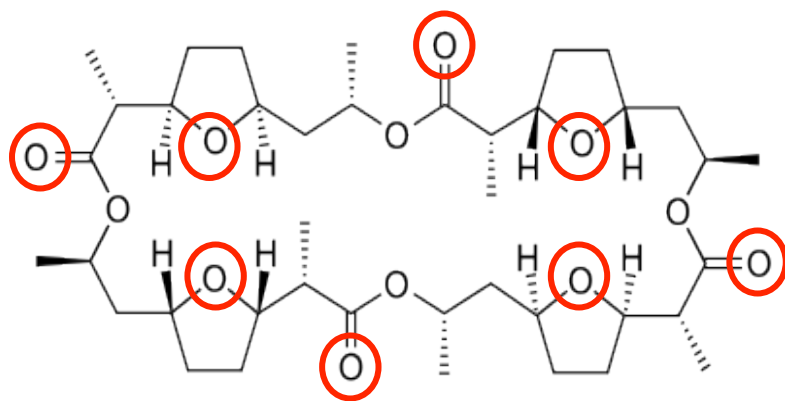
	K _d		
	CP1 (CCHH)	CP1 (CCHC)	CP1 (CCCC)
Mn ²⁺	> 10 μM		
Fe ²⁺	2.5 μM	2.4 μM	
Co ²⁺	63 nM	63 nM	350 nM
Zn ²⁺	5.7 pM	3.2 pM	1.1 pM
Cd ²⁺	2 nM	6.4 pM	0.040 pM

Pb²⁺ and Zinc Fingers

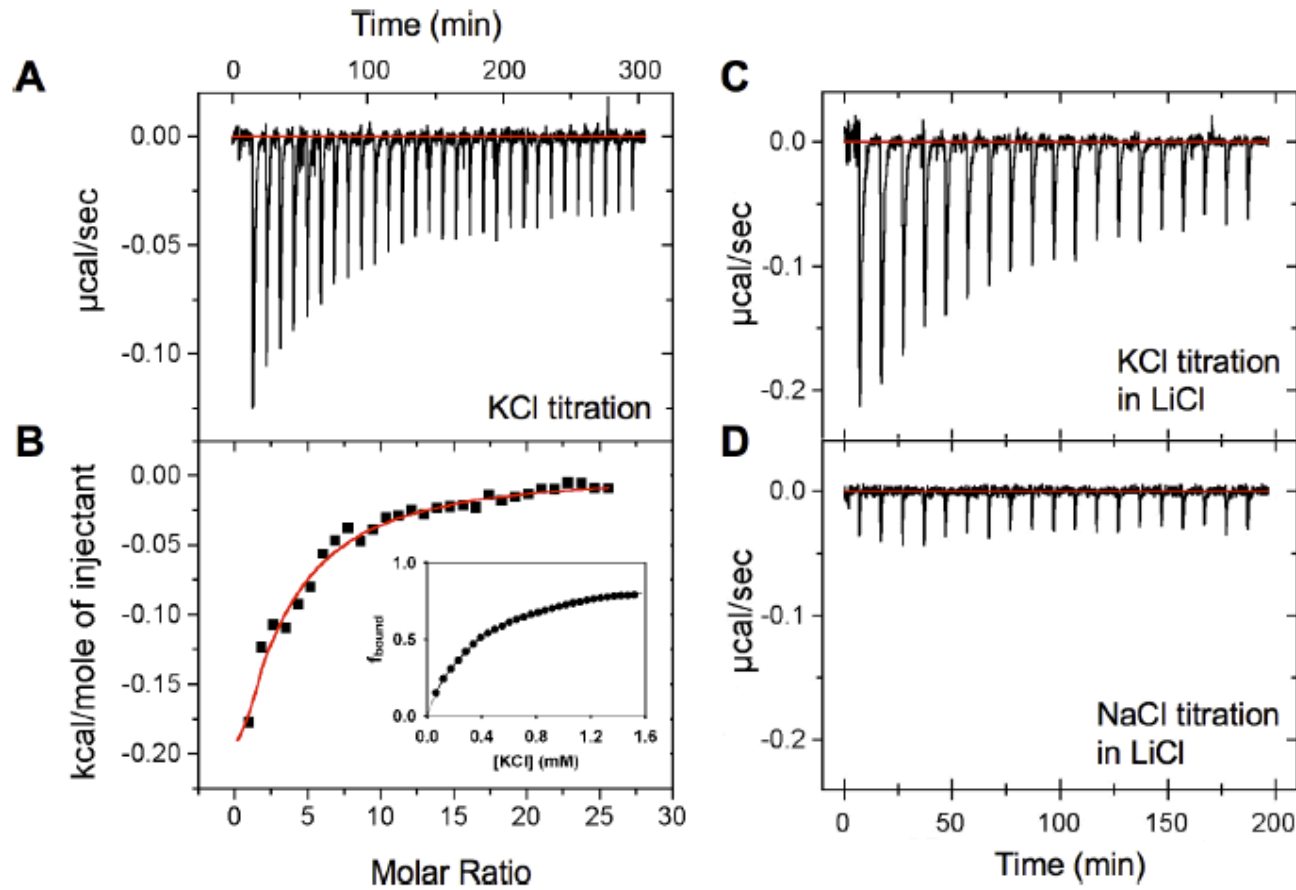
peptide	K_d^{Zn}	K_d^{Pb}
CP-CCHH ^a	5.7×10^{-12}	5×10^{-11}
CP-CCHC ^a	3.2×10^{-12}	8×10^{-11}
CP-CCCC ^a	1.1×10^{-12}	3.9×10^{-14}



Nonactin is a K^+ -Selective Ionophore



Isothermal Titration Calorimetry



Results from ITC

Table 1. Thermodynamic Parameters Obtained for Ion Binding to KcsA

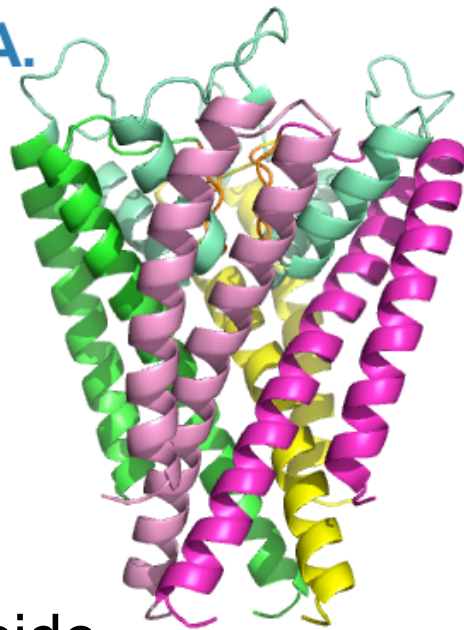
Ion	Radius	K_D (mM)	ΔG° (kcal M^{-1})	ΔH° (kcal M^{-1})	ΔS° (cal $M^{-1} K^{-1}$)
Na ⁺	0.95 Å	nhd			
K ⁺	1.33 Å	0.43 ± 0.04	-4.54 ± 0.06	-1.24 ± 0.13	11.2 ± 0.48
Rb ⁺	1.48 Å	0.12 ± 0.06	-5.29 ± 0.29	-1.93 ± 0.24	11.4 ± 1.27
Cs ⁺	1.69 Å	0.44 ± 0.13	-4.53 ± 0.17	-1.81 ± 0.30	9.23 ± 1.18
Mg ²⁺	0.65 Å	nhd			
Ca ²⁺	0.99 Å	nhd			
Ba ²⁺	1.35 Å	0.19 ± 0.06	-5.03 ± 0.15	5.51 ± 0.68	35.7 ± 2.37



Tetrameric Structure of K⁺ Channel

outside

A.

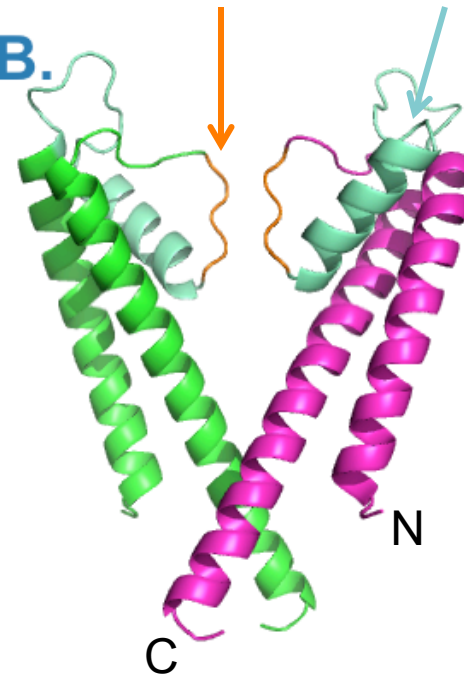


inside

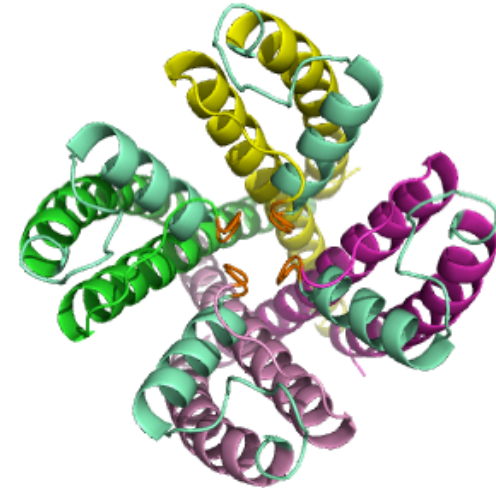
Filter

Pore helix

B.



C.

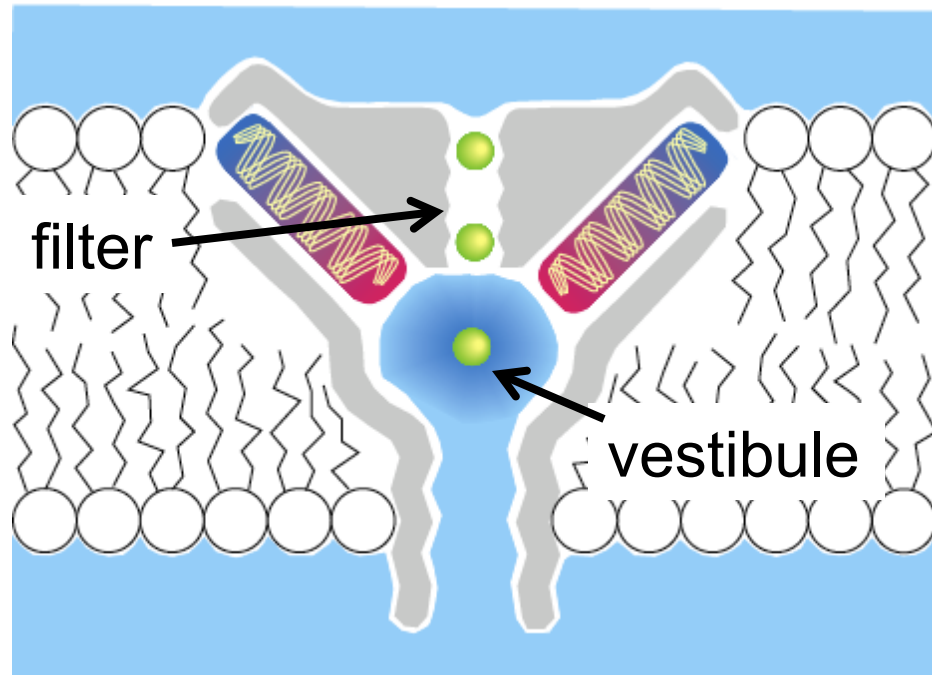
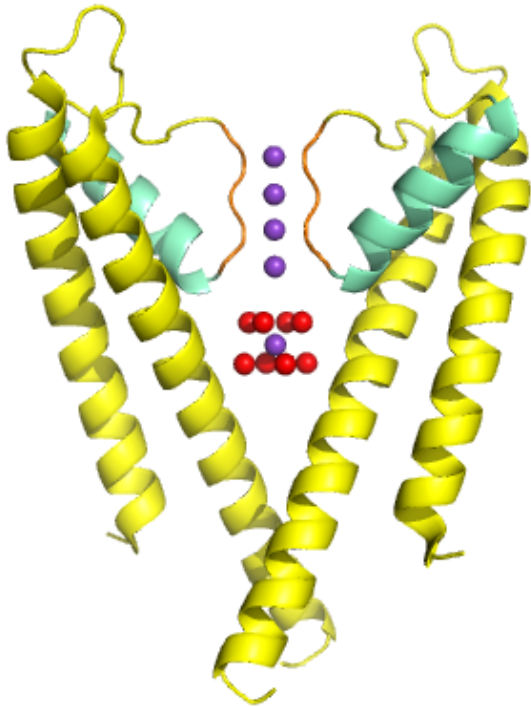


Looking from outside in

MacKinnon (1998) *Science* **280**, 69.

The Pore

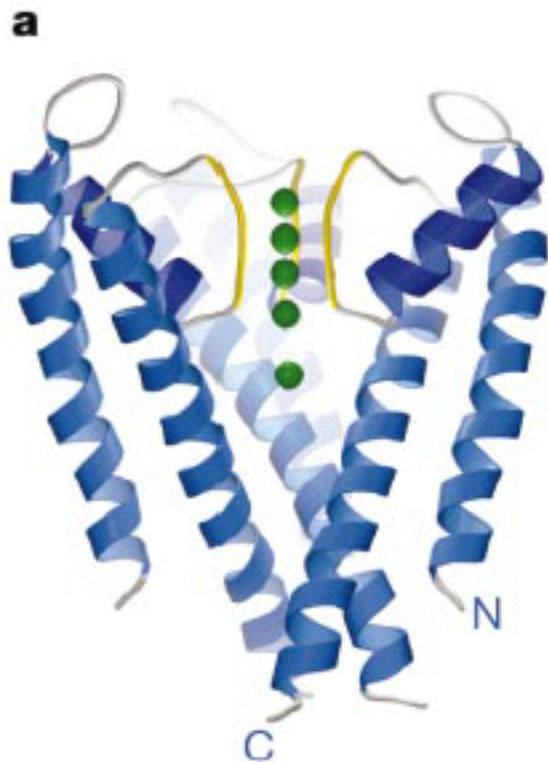
outside



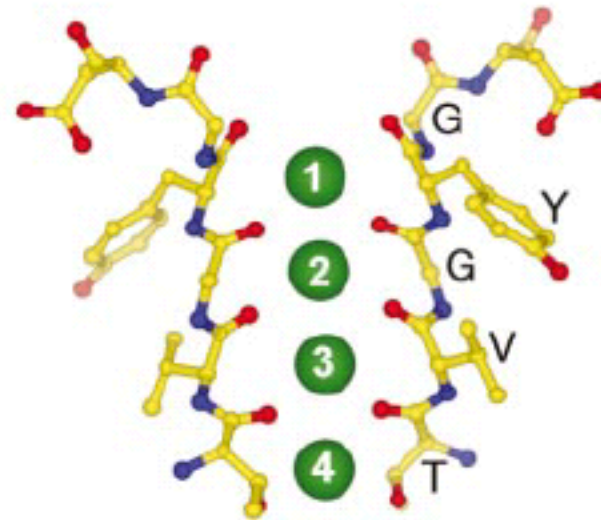
inside

Structure and Conduction Pore

outside

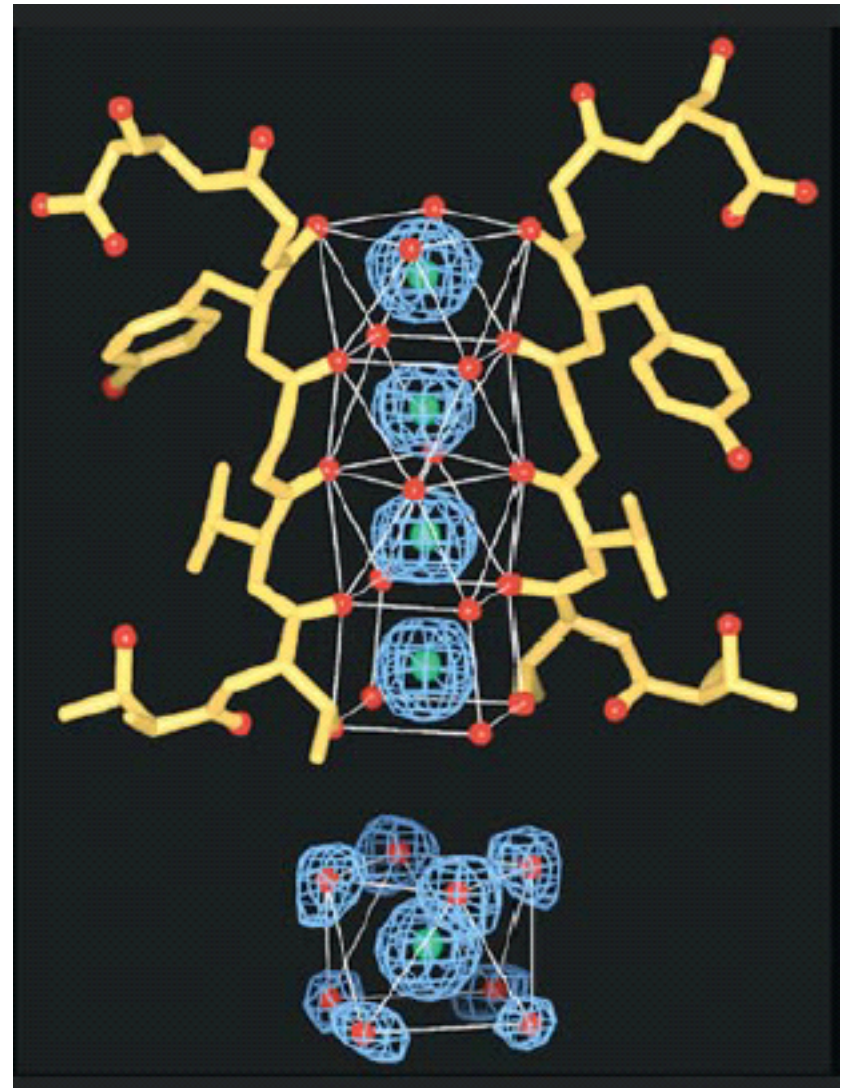
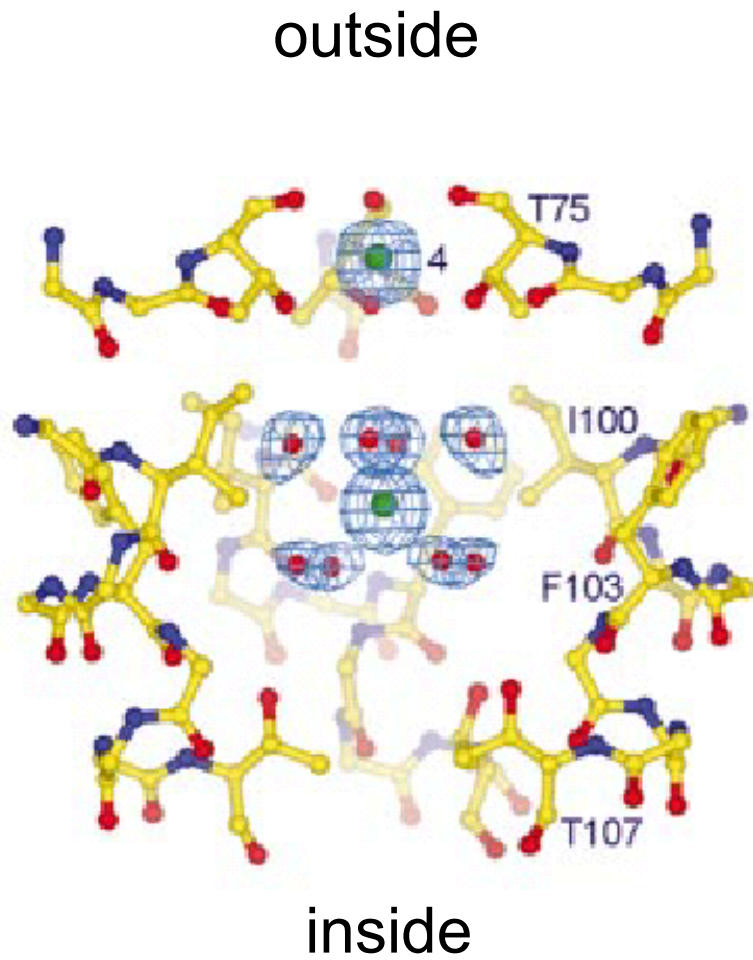


b



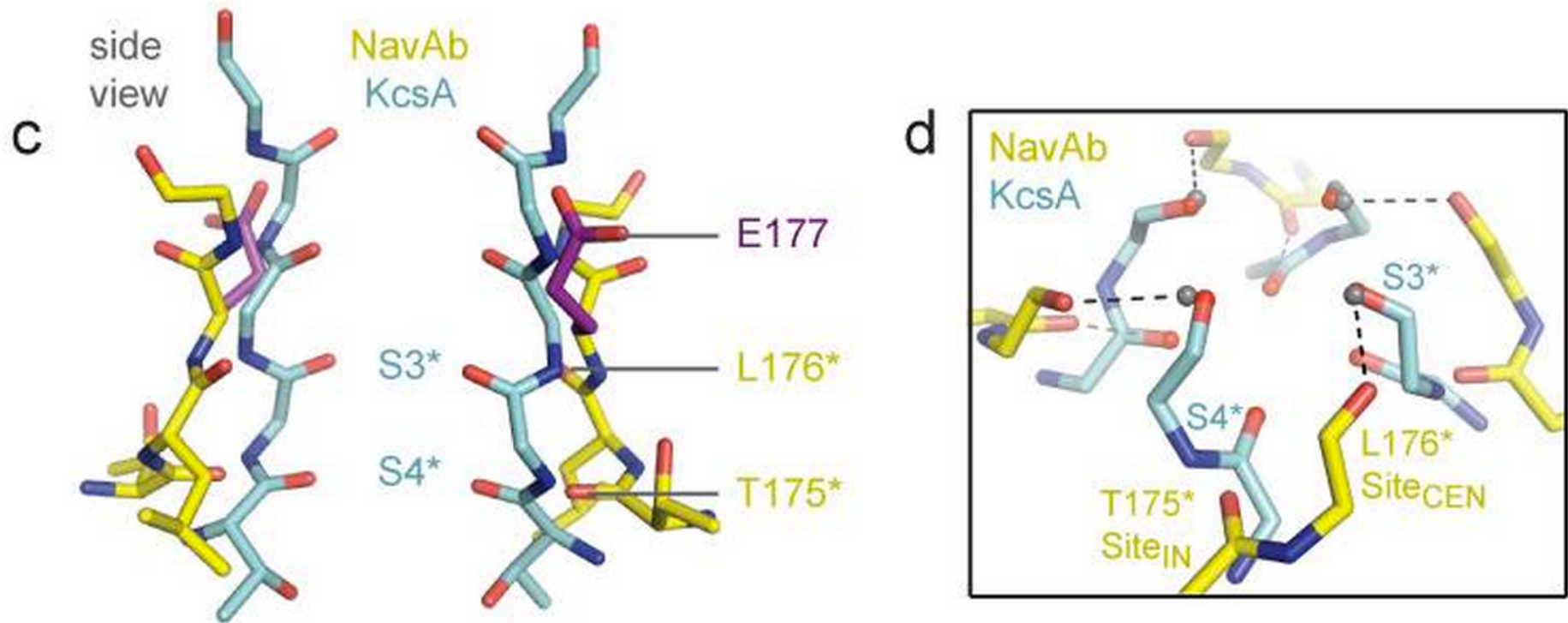
inside

Selection Filter and Channel

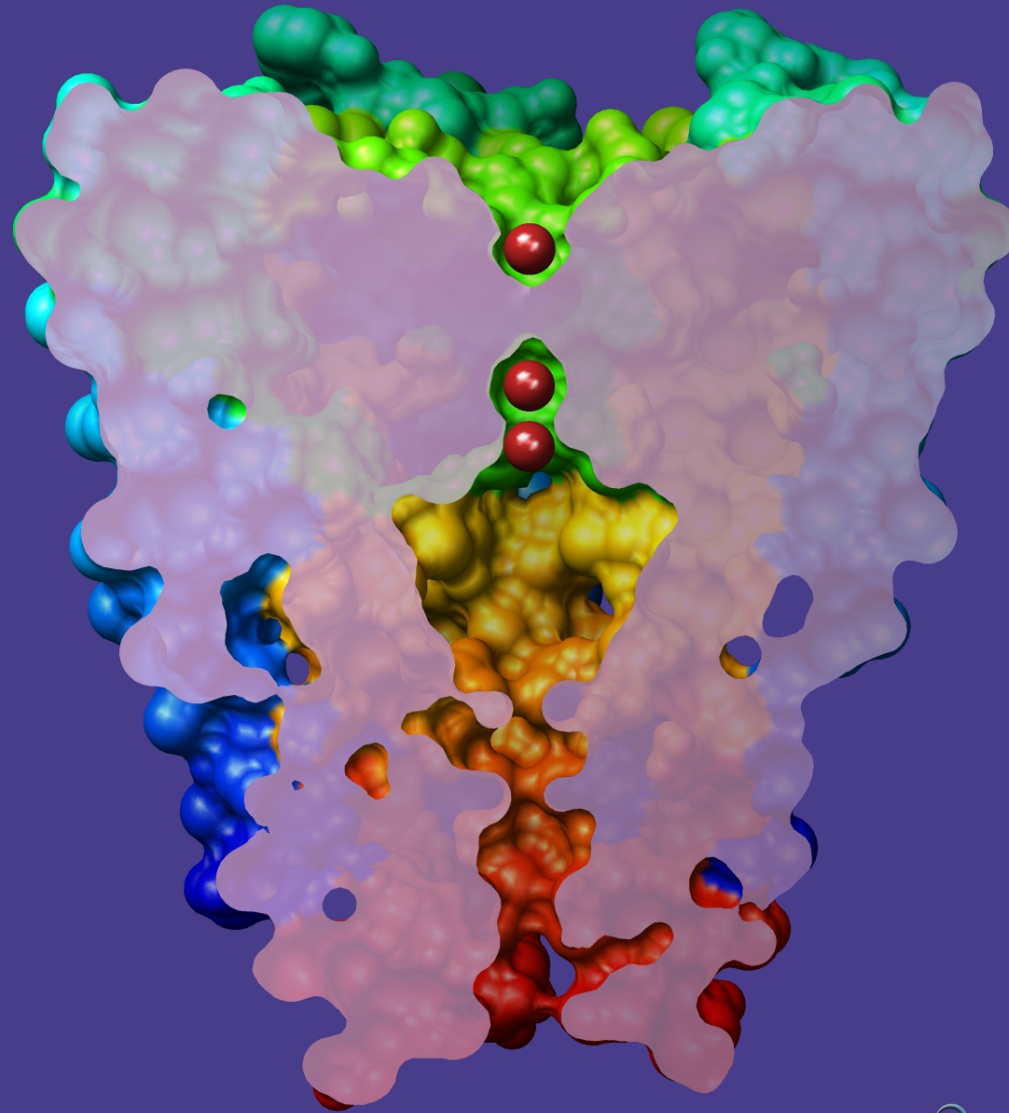


MacKinnon (2001) *Nature* **414**, 43.

Na-Selective Channel



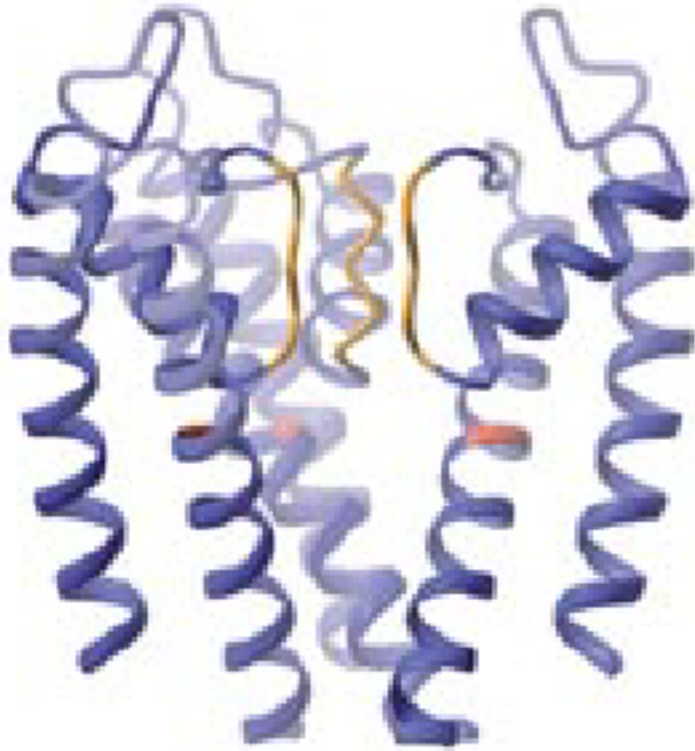
KcsA Structure Is “Closed”



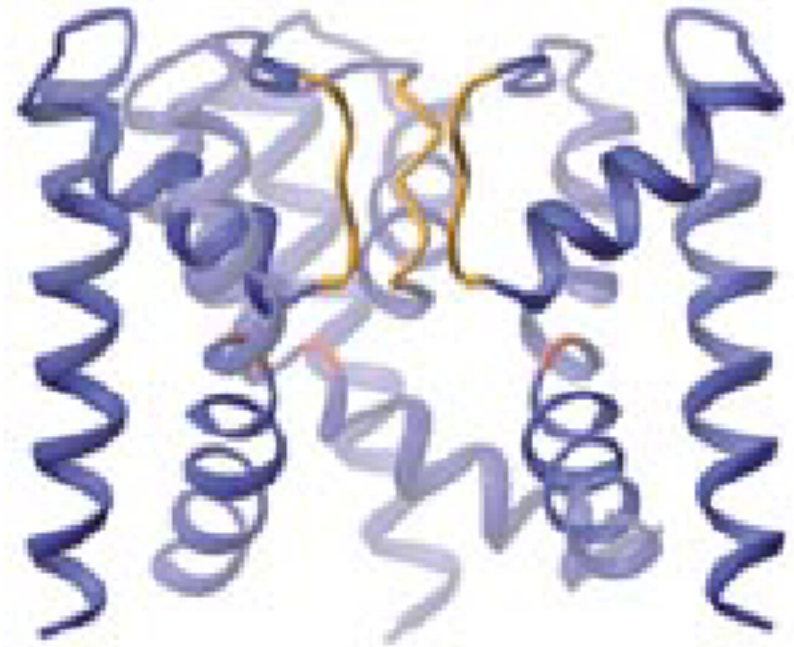
KcsA vs. MthK

Closed

Opened



KcsA



MthK