Transporters

J. Abramson, I. Smirnova, et al. (2003) Structure and mechanism of the lactose permease of *Escherichia coli.* *Science* 301:610-615.

J.D. Horisberger (2004) Recent insights into the structure and mechanism of the sodium pump. *Physiology* 19:377-387

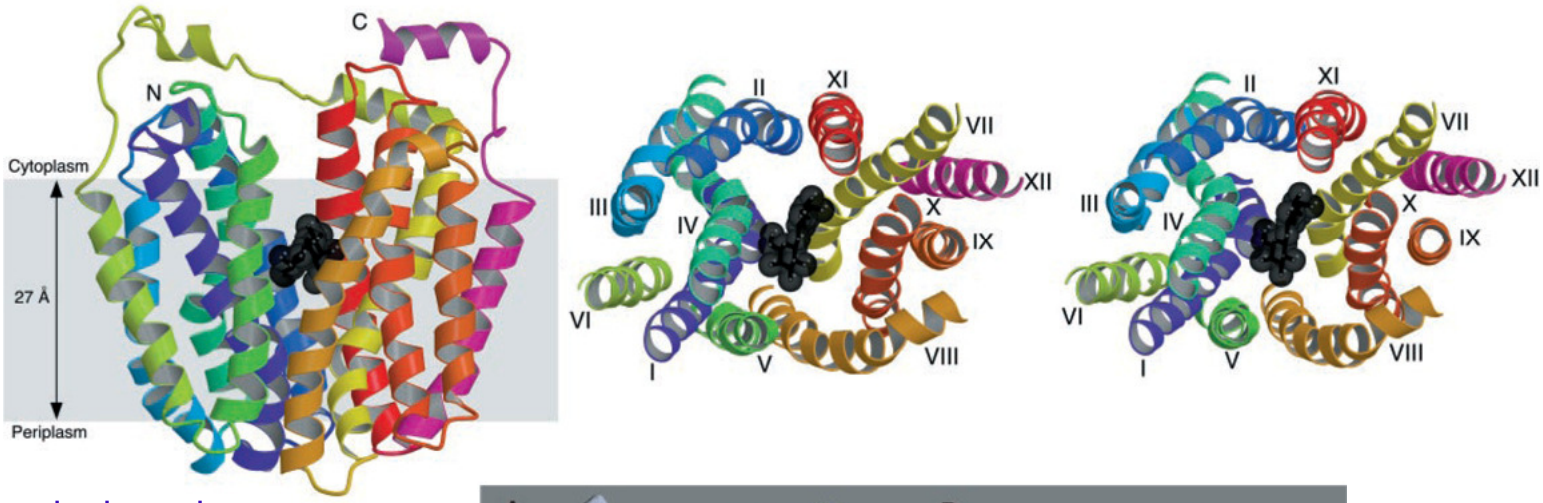
P. Läuger (1987) Voltage dependence of sodium-calcium exchange: Predictions from kinetic models. *J. Membrane Biol.* 99:1-11.

N. Reyes and D.C. Gadsby (2006) Ion permeation through the Na^+, K^+ - ATPase. *Nature* 443:470-474.

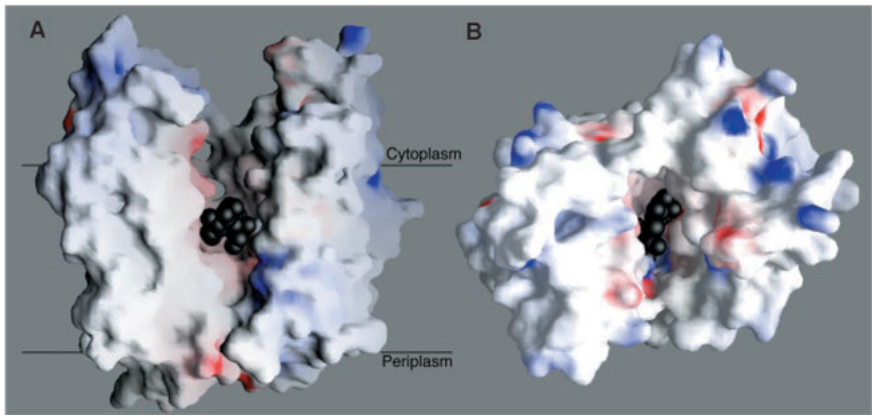
T. Shinoda, H. Ogawa, et al. (2009) Crystal structure of the sodium-potassium pump at 2.4 Å resolution. *Nature* 459:446-450.

Structure of a bacterial transporter, LacY, which transports lactose into the cell using energy stored in the gradient of H^+ ions.

The molecule has 12 transmembrane α helices forming a cavity. The solved version was a mutated form of the molecule that is thought to be trapped in the structure with the cavity open to the cytoplasm. It is shown with a high-affinity substrate in the transport cavity.

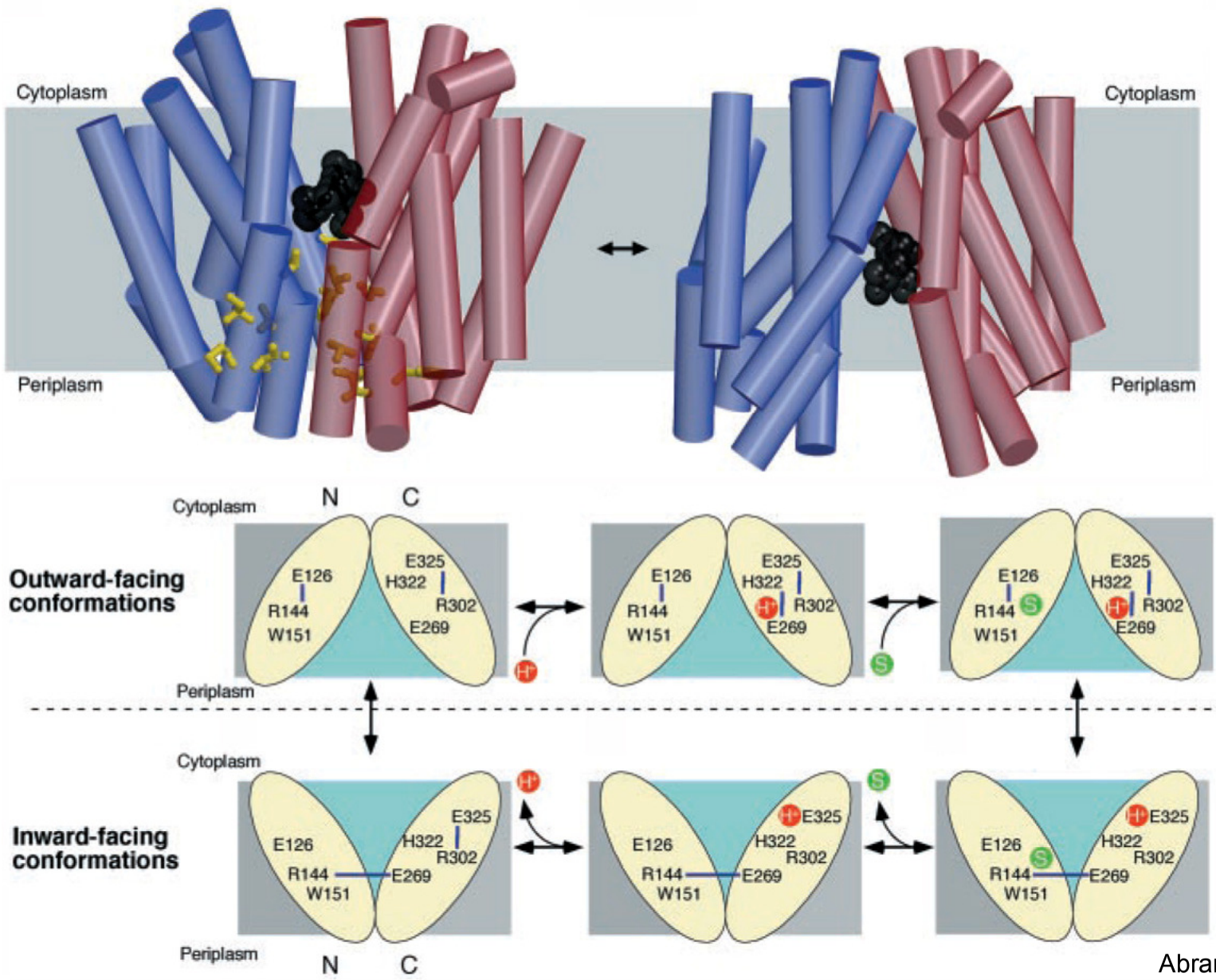


N-terminal purple
C-terminal pink



Abramson et al. 2003

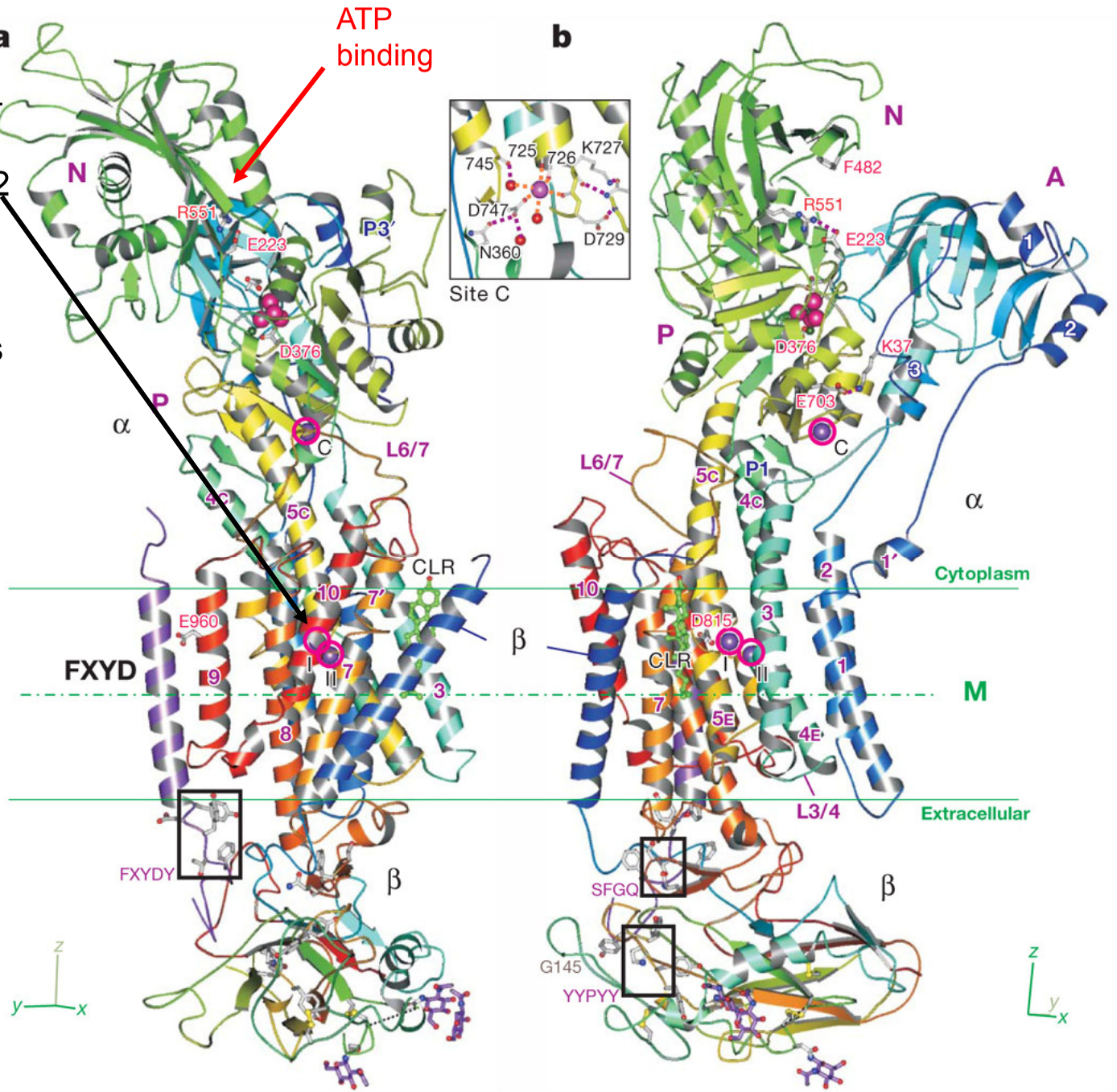
Presumed transport mechanism. A cycle involving H^+ binding, lactose binding, translocation, unbinding, and reverse-translocation.



The blue lines are H bonds.

Abramson et al. 2003

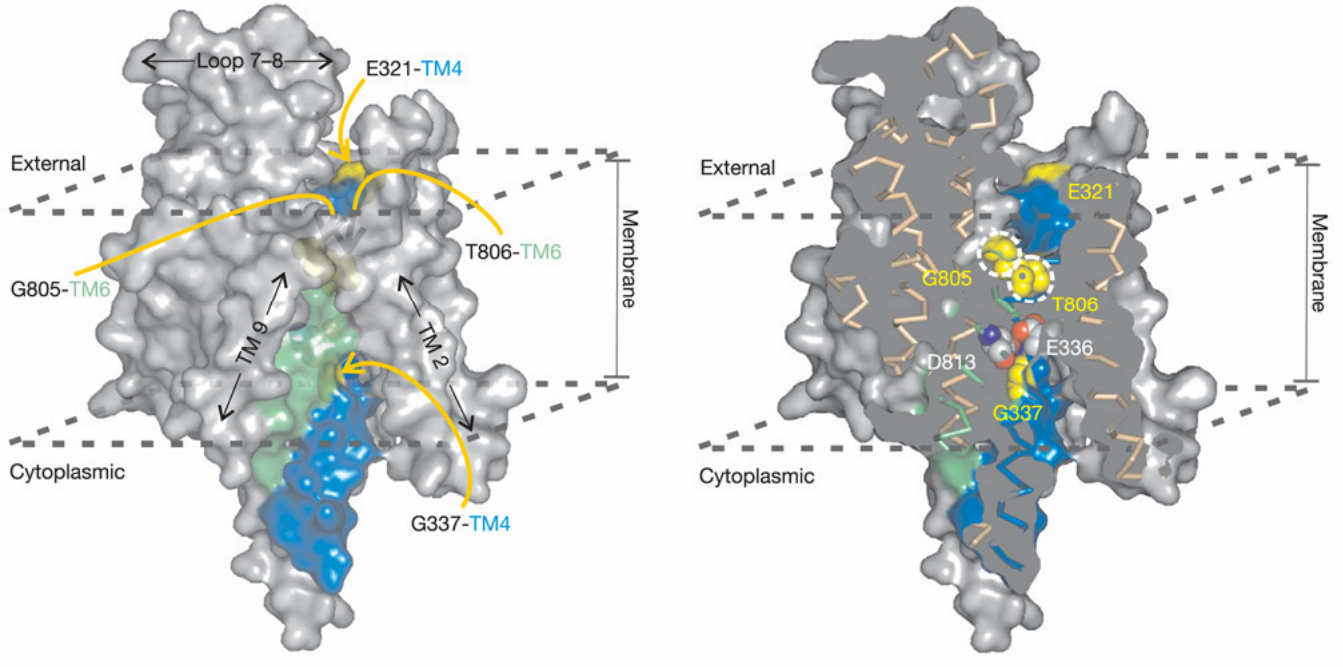
The structure of a Na-K ATPase with the molecule frozen with 2 K^+ ions bound. Two subunits of the enzyme are shown (α and β) from two views about 90˚ apart.



N-terminal blue
C-terminal red

Shinoda et al. 2009

The structure contains an internal-facing and external-facing vestibule. Presumably, these are the binding sites for Na and K, but the nature of occlusion is not clear.

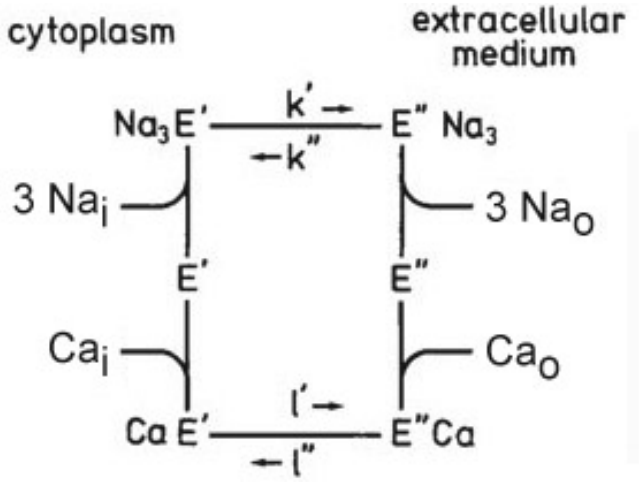


Reyes and Gadsby 2006

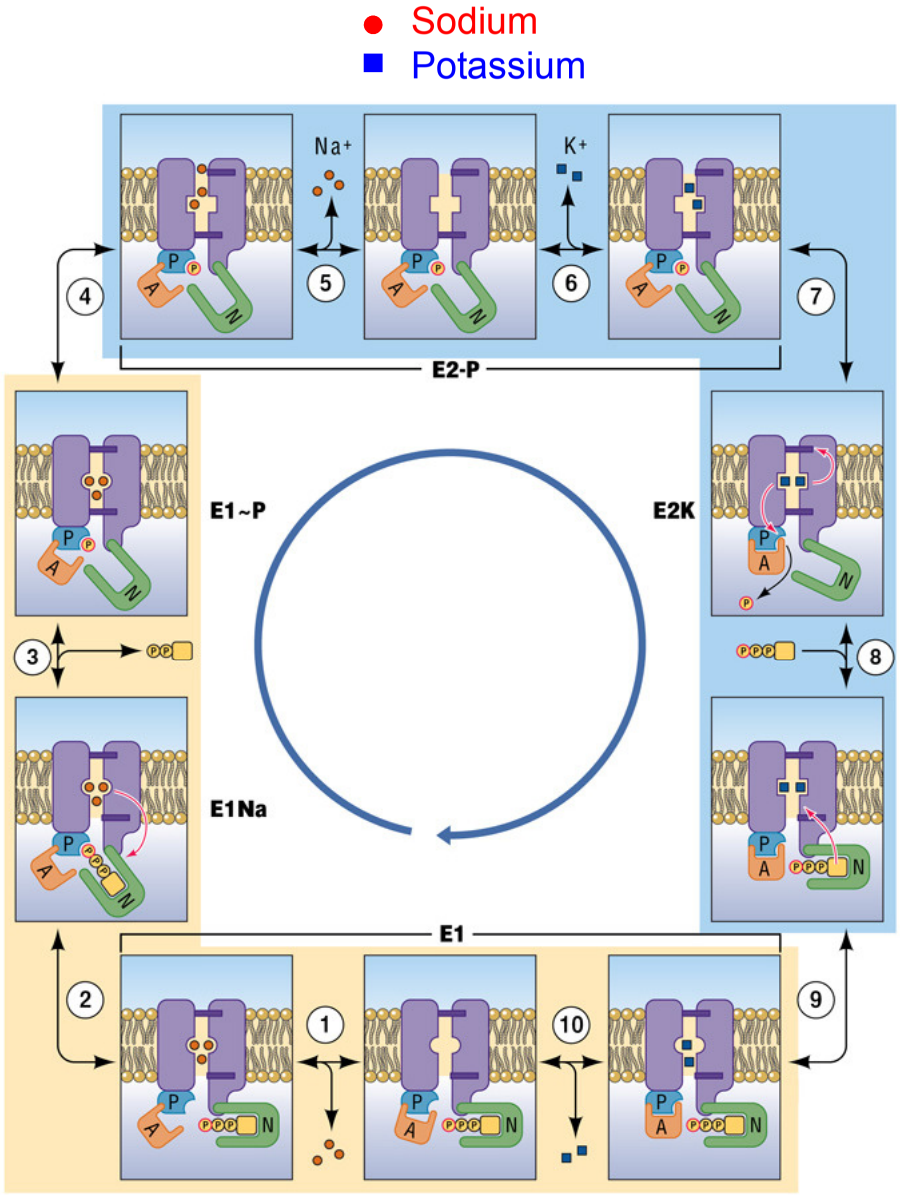
The sequence of steps in the Na-K ATPase is complex, involving separate transport of Na out, K in, and ATP cleavage.

Note the gates (black) that occlude the Na and K during the transport step.

Motivated by this model Läuger and others have analyzed a slightly simpler transporter, the Na-Ca cotransporter with a similar scheme.



P. Läuger 1987



Horisberger, 2004