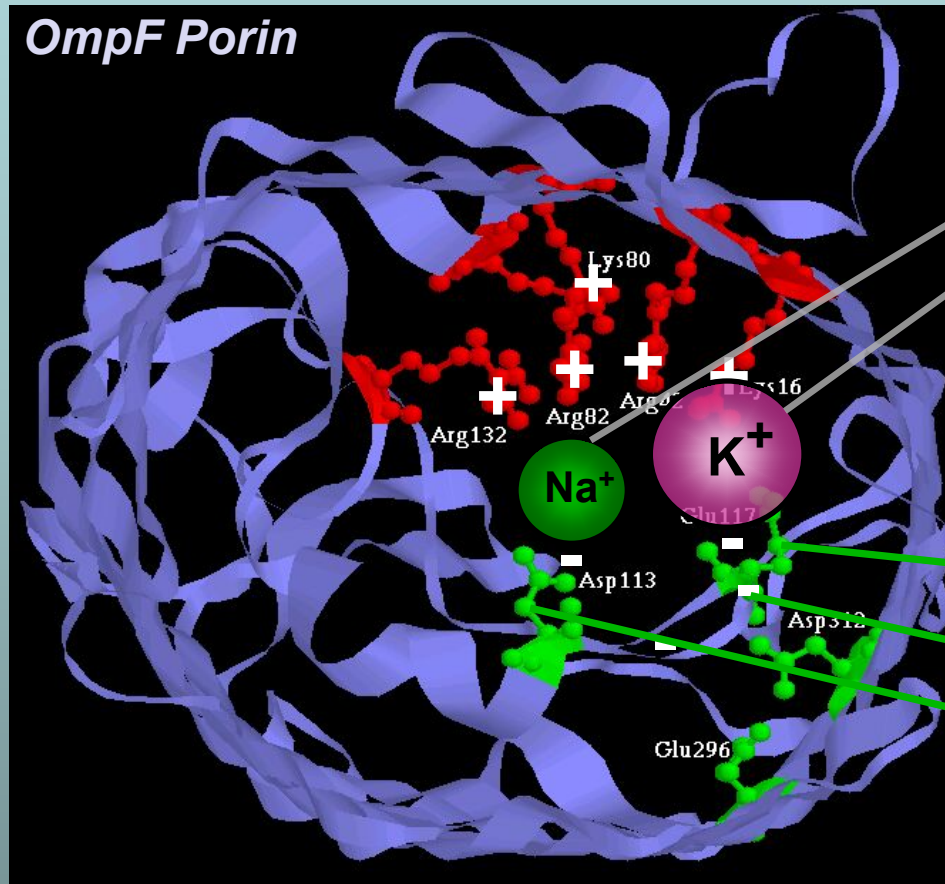
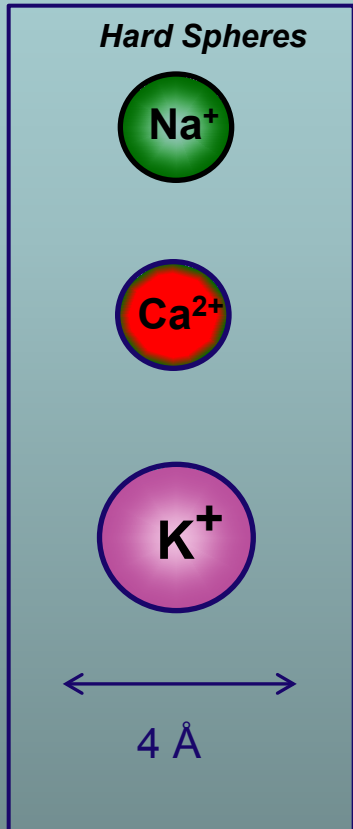


# Crowded Channels and Active Sites

# Active Sites of Proteins are Very Charged

7 charges ~ 20 M net charge =  $1.2 \times 10^{22} \text{ cm}^{-3}$

liquid **Water** is **55 M**  
solid **NaCl** is **37 M**



Ions are Crowded

Induced Fit of Side Chains

Selectivity Filters and Gates of Ion Channels are **Active Sites**

Figure adapted from Tilman Schirmer

# Crowded Active Sites

*in 573 Enzymes*

Enzyme Type		Catalytic Active Site			Protein
		Density (Molar)			Elsewhere
		<i>Acid</i> (positive)	<i>Basic</i> (negative)	<i>Total</i>	
	<b>Total (n = 573)</b>	<b>10.6</b>	<b>8.3</b>	<b>18.9</b>	<b>2.8</b>
<i>EC1</i>	Oxidoreductases (n = 98)	7.5	4.6	12.1	2.8
<i>EC2</i>	Transferases (n = 126)	9.5	7.2	16.6	3.1
<i>EC3</i>	Hydrolases (n = 214)	12.1	10.7	22.8	2.7
<i>EC4</i>	Lyases (n = 72)	11.2	7.3	18.5	2.8
<i>EC5</i>	Isomerases (n = 43)	12.6	9.5	22.1	2.9
<i>EC6</i>	Ligases (n = 20)	9.7	8.3	18.0	3.0

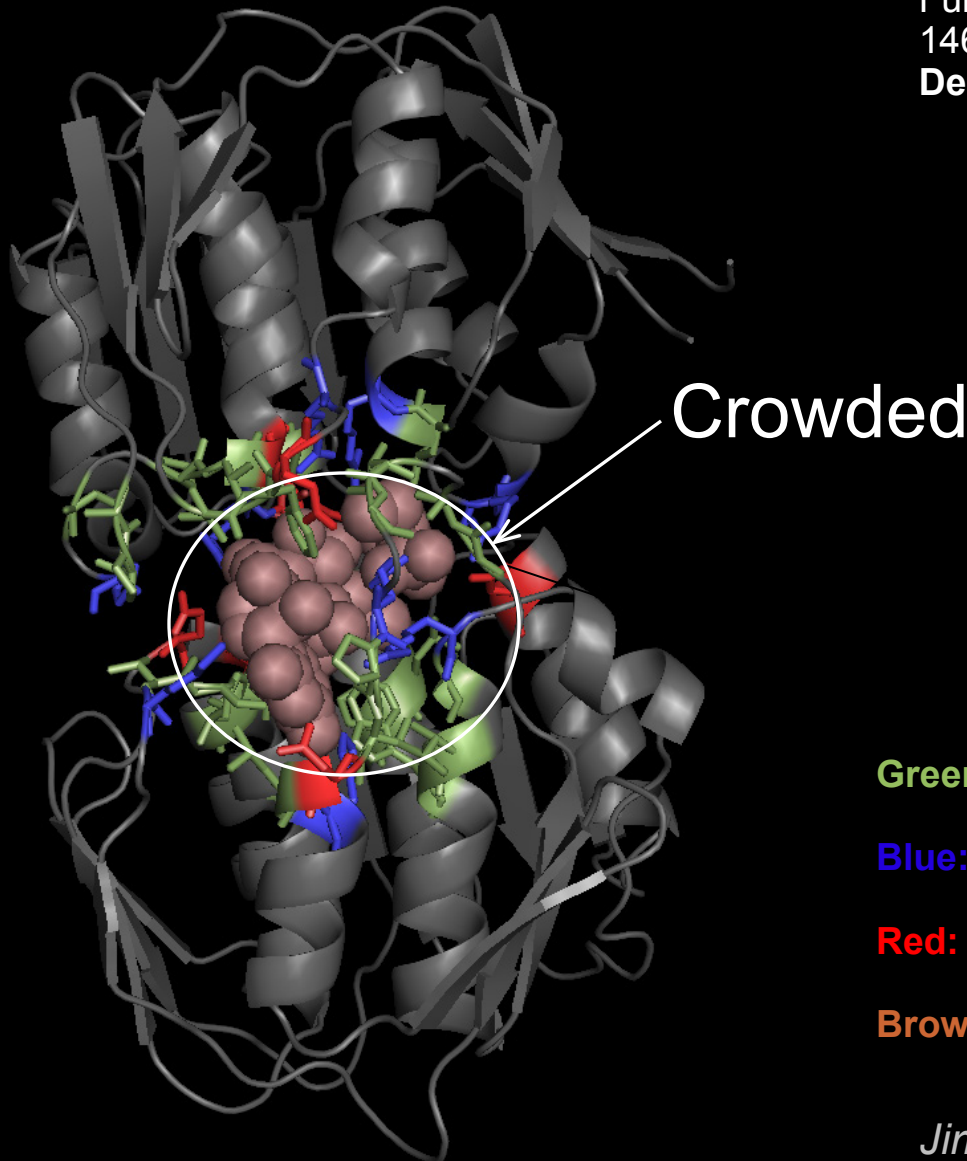
# EC2: TRANSFERASES

Average Ionizable Density: 19.8 Molar

Example:  
UDP-N-ACETYLGLUCOSAMINE  
ENOLPYRUVYL TRANSFERASE  
(PDB:1UAE)

Functional Pocket Molecular Surface Volume:  
1462.40 Å<sup>3</sup>

Density : 19.3 Molar (11.3 M+ . 8 M-)



Green: Functional pocket residues

Blue: Basic = Probably Positive = R+K+H

Red: Acid = Probably Negative = E + Q

Brown URIDINE-DIPHOSPHATE-N-  
ACETYLGLUCOSAMINE

*Jimenez-Morales, Liang, Eisenberg*