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POISSON-NERNST-PLANCK (PNP) THEORY OF AN OPEN IONIC CHANNEL. Robert Eisenberg and Duanpin Chen Dept. of Physiology, Rush Medical College, 1750 W. Harrison, Chicago IL

The structure of an ionic channel is the location of its atoms and their permanent electric charge. The electric field within a channel's pore is determined by all types of charge, namely the permanent charge of the channel protein, the mobile charge of ions within the pore, and the induced charge in pore and protein. Permanent charge is significantly shielded by permeating ions whose concentration and flux in turn depend on the electric field. A channel and its contents form a thoroughly coupled system, requiring simultaneous analysis of electric field and electro-diffusion, as do semiconductors like transistors. Asymptotic analysis of a PNP theory gives surprising results. Even though its pore is always open, in just one conformation, and its ions are points, able to flow through each other, its net and unidirectional fluxes are not independent if the pore contains an access resistance or selectivity filter. Rather, the fluxes vary together, as bath concentrations are varied. The electric field changes shape because the shielding of the permanent charge varies: potential barriers can change into potential wells (i.e., binding sites) as concentrations change. In this way, fluxes are coupled to concentrations in the bath, and to one another, as they are in traditional single file channels or mediated transport systems.