Statistical physical approach to ionic channels

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Experiments on single ionic channels have contributed to a large extent to our current view on the function of cell membrane. In these experiments the main observables are the physical quantities: ionic concentration, membrane electrostatic potential and ionic fluxes, all of them presenting large fluctuations.

Real molecular channels are active pores with open and close dynamical states. By skipping their molecular complexity, here we present a simpler modeling based on statistical physics. These models present a minimum set of degrees of freedom, specifically ion positions and gate states, which follow Langevin equations constructed from a unique potential energy functional and by using standard rules of statistical physics. Numerical simulations are implemented and the results show that they have dynamical properties very close to those observed in experiments of Na and K molecular channels.

In particular, a significant effect of the external ion concentration on gating dynamics is predicted, which is consistent with previous experimental observations. Within this approach the excitability and oscillatory properties of a cell membrane have been studied.