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Simple Electrostatic Models for Complex Biological Problems

Prof. Gautam Basu
Department of Biophysics, Bose Institute, India

Interaction between two protein molecules or interaction between a small molecule and a large protein drive a plethora of biological functions.
However, to be biologically relevant, these interactions must be specific. In other words, the 'right' pair should interact but not the 'wrong' pair. Therefore, evolution must have incorporated both 'positive' and 'negative' design in the biologically relevant molecule-molecule interaction — the positive design optimizing the interactions between two cognate partners while the negative design keeping two non-cognate partners away from each other. I will use two examples — the case of discrimination between guanine and adenine by proteins, and, the case of protein-protein association kinetics — to show how simple electrostatic models can explain experimental data relating to both the phenomenon. Further, because the models are very simple although they explain complex processes, this is an example of Ockham's razor, a philosophy often used in science that the simplest among more complex hypothesis should be chosen.