MAR15-2014-020597

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Hands-on-Entropy, Energy Balance with Biological Relevance[1]

MARK REEVES, George Washington University

Entropy changes underlie the physics that dominates biological interactions. Indeed, introductory biology courses often begin with an exploration of the qualities of water that are important to living systems. However, one idea that is not explicitly addressed in most introductory physics or biology textbooks is important contribution of the entropy in driving fundamental biological processes towards equilibrium. From diffusion to cell-membrane formation, to electrostatic binding in protein folding, to the functioning of nerve cells, entropic effects often act to counterbalance deterministic forces such as electrostatic attraction and in so doing, allow for effective molecular signaling. A small group of biology, biophysics and computer science faculty have worked together for the past five years to develop curricular modules (based on SCALEUP pedagogy). This has enabled students to create models of stochastic and deterministic processes. Our students are first-year engineering and science students in the calculus-based physics course and they are not expected to know biology beyond the high-school level. In our class, they learn to reduce complex biological processes and structures in order model them mathematically to account for both deterministic and probabilistic processes. The students test these models in simulations and in laboratory experiments that are biologically relevant such as diffusion, ionic transport, and ligand-receptor binding. Moreover, the students confront random forces and traditional forces in problems, simulations, and in laboratory exploration throughout the year-long course as they move from traditional kinematics through thermodynamics to electrostatic interactions. This talk will present a number of these exercises, with particular focus on the hands-on experiments done by the students, and will give examples of the tangible material that our students work with throughout the two-semester sequence of their course on introductory physics with a bio focus.

[1]Supported by NSF DUE.