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APh 161
Homework 3: Poster Session

Title:

The Na⁺/K⁺ ATPase : Maxwellian Demon of the Cell

Abstract:

The Na⁺/K⁺ ATPase is an enzyme present on the membranes of virtually every cell in the human body. It is responsible for the maintenance of extra sodium (Na⁺) ions outside of the cell and extra potassium (K⁺) inside of the cell. The Na⁺/K⁺ ATPase exchanges two extracellular K⁺ ions for three intracellular Na⁺ ions. This active ion transport is driven by the energy liberated by the hydrolysis of one ATP into ADP. By reducing entropy, the Na⁺/K⁺ ATPase acts as one of Maxwell's 'intelligent finite beings,' although the entropy reduction is certainly balanced elsewhere in the cell by an increase in entropy. This project will seek to characterize the energetics of this membrane transport enzyme using statistical mechanics. Beginning by assuming an equilibrium model, the influence of membrane potential, ion-ion interactions and saturation of the enzyme will be considered. The energy differential across the pore, the probability of occupied states, and equilibrium binding constants will be modeled. We hope that we can use this model to sketch out a non-equilibrium transport statistical mechanical theory that more closely resembles the situation present in actual cells.