

Mesoscopic Non-Equilibrium Thermodynamics and Kinetic Cycle Diagrams: a Comparison of the Description of the Calcium Pump

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We analyse the operation of the ion pump Ca^{2+} -ATPase using a kinetic cycle diagram. Using the methodology of Hill [1], we obtain the cycle fluxes, entropy production and the efficiency of the pump. We compare these results with a mesoscopic non-equilibrium description [2] of the pump and show that the kinetic and the mesoscopic pictures are in accordance with each other. This gives further support to the mesoscopic theory, which is less restricted and also can include the heat flux. We proceed to show how the mesoscopic approach can be used to identify fast and slow steps of the model in terms of activation energies, and how this can be used to simplify the kinetic diagram. We also discuss how temperature differences can be introduced in the two descriptions, as additional variables.

[1] T. L. Hill (1989) Free Energy Transduction and Biochemical Cycle Kinetics. Springer-Verlag, New York, USA

[2] D. Bedeaux and S. Kjelstrup (2008) The Measurable Heat Flux That Accompanies Active Transport by Ca^{2+} - ATPase. Phys Chem Chem Phys 10:7304–7317