HOPE COLLEGE CHEMISTRY SEMINAR

"Ion Discrimination by Nanoscale Design"

Susan Rempe

Sandia National Laboratories

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Abstract

Natural systems excel at discriminating between molecules on the basis of subtle structural and chemical differences. Membrane-spanning protein channels, for example, are exquisitely designed to differentiate between Na^+ (sodium) and K^+ (potassium) ions despite their identical charges and only sub-Angstrom differences in size. Consequently nearly all cells can selectively transport these ions across their membranes, a process that underlies such diverse physiological tasks as nerve cell signaling, heart rhythm control, and kidney function. While scientists have long known that ion selectivity lies in the ability of the channel to satisfy or frustrate ion solvation requirements, the persistent question revolves around how channels and other biological structures give rise to such a subtle effect between Na^+ and K^+. By understanding ion discrimination in natural systems, we can potentially gain insight into the fundamental workings of neural circuitry and biological filters, and facilitate the development of drugs that leave functioning channels in the heart unharmed. Furthermore, by understanding how protein structures lead to such a remarkable level of discrimination, we can also potentially harness nature's design principles in nano-scale devices that mimic biological function for the purpose of fast, efficient water desalination. Here we present a novel explanation for ion discrimination in the celebrated potassium-selective protein channels, we contrast this explanation of natural ion discrimination with the unexpectedly antithetical mechanism found in a natural potassium-selective ion carrier, and finally we describe current work toward implementing ion selectivity in synthetic channels for water purification.

Biography

Dr. Rempe grew up in northwest Montana. She earned Bachelor's degrees in History and German Literature from Columbia University, as a pre-medical student, and Chemistry from the University of Montana. She then earned Master's and Ph.D. degrees in Chemistry from the University of Washington working with Prof. Robert Watts on the theory of vibrational spectroscopy. She moved to the southwest for a postdoctoral fellowship at Los Alamos National Lab to study a new theory of liquids formulated by Dr. Lawrence Pratt. Finally she joined Sandia National Labs as a member of the Technical Staff in 2001, where she has applied theoretical methods in close collaboration with experimentalists to correlate structure with function in complex biological and synthetic systems.