Chemical Equilibrium in Confined Environments

Igal Szleifer
Department of Biomedical Engineering and
Chemistry of Life Processes Institute
Northwestern University
Evanston, IL USA

The coupling between molecular organization, physical interactions and chemical equilibrium of fluid mixtures in confined environment leads to non-trivial behavior that is seemingly counterintuitive. The optimal state of the system results from changes in the molecular organization that optimize the overall free energy which in general does not correspond to the optimal state of each of the different contributions. As a proof of concept we will show the structural organization of nuclear pore complexes (NPC), the gate keeper between the cytoplasm and the nucleus in eukatyotic cells. The NPC is formed by disordered proteins that control the transport of molecules and proteins between the two cellular compartments. Further, we will show how the transport of different types of nanoparticles changes the molecular organization within the NPC and controls the transport. The clear non-additive nature of the interactions, e.g. electrostatic and hydrophobic, is a general feature of complex nanoconfined molecular system with implications in the design of nanopores, coated nanoparticles and the understanding of biological processes at the subcellular level.