The Department of Physics and Astronomy
Presents Research Seminar Speaker

Dr. Igal Szleifer

Department of Biomedical Engineering
Department of Chemistry
Department of Biological and Chemical Engineering
Northwestern University

Friday February 12, 2010
Time: 3:00-4:00 p.m.
Location: MB 0.302

Targeted delivery of lipid agents and nanoparticles to cancer cells: How to combine chemical reaction equilibrium and physical interactions for biological activity

One of the major challenges in drug delivery is the ability to target exclusively sick cells without interacting with healthy cells. This is particularly important for cancer drug delivery. In this presentation we show how we can take advantage of the modifications that occur on the plasma membrane of cancer cells to target surface modified nanoparticles. The basic idea is to take advantage of the over-expressed receptors and the different lipid composition of the plasma membrane in (some) cancer cells. To this end we show, as a proof of concept, how modifying the surface of the nanoparticles with binary mixtures of short polymers can increase the binding to the cells by orders of magnitude. One of the polymers in the mixture is aimed at protecting the nanoparticle and the other is a polybase with a functional ligand as its end-group that specific targets the overexpressed receptors in the cancer cell. We show how the combination of electrostatic interactions, specific binding, acid-base equilibrium and molecular organization in the nanoparticle and on the lipid layer provides for a non-trivial synergetic effect with highly improved binding capabilities. We will show how the approach of the nanoparticle to the lipid layer results in a highly inhomogeneous segregation of lipids in the cell membrane and of polymers in the nanoparticle. The molecular segregation can be used as a tool not only for drug delivery but also for molecular recognition of surface domains. The complex non-additive interplay between chemical reactions and physical interactions in highly inhomogeneous environments that we predict points out to the need to develop novel intuition for these strongly coupled systems. The relevance for the fundamental understanding of processes in cell biology as well as in the design of responsive materials will be discussed.