Interfacing Nanoparticles to Biological Systems

Kimberly Hamad-Schifferli

Departments of Biological Engineering and Mechanical Engineering
Massachusetts Institute of Technology

Nanoparticles have been conjugated to biological systems for numerous applications such as self assembly, sensing, imaging, and therapy. This involves exploiting not only the material properties of the nanoparticle, but also creating an interface to a biological system. While the development of new applications of nanoparticles in biology has grown rapidly, the biggest challenge in using nanoparticles is their interface with biomolecules. Proteins and DNA can non-specifically adsorb on the nanoparticle surface, altering biomolecular structure and function, thus creating adverse biological effects. The biological-inorganic interface becomes much more relevant at nanometer lengthscales due to the fact that surface to volume ratios increase dramatically and that nanoscale surfaces are physically and chemically different from bulk 2-dimensional surfaces. Consequently, nanoscale surfaces and their interaction with biological molecules have been poorly understood and difficult to characterize. Therefore, exploiting the advancements in nanoparticles requires strategic engineering of their interface with biology. We utilize strategies that engineer both the material properties of the nanoparticle as well as its biological interface. Specifically, we will present work on developing multifunctional nanoparticles for therapy and diagnostics. Small gold clusters encapsulated in dendrimers have novel material properties that allow it to be imaged by multiple modes, fluorescence and MRI. Due to the dendrimer it simultaneously exhibits advantageous biological properties such as cellular uptake and the ability to be biofunctionalized. Potential applications in therapy and disease diagnosis will be discussed.