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Interfacing Nanoparticles to Biological Systems

By

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Nature has created biomolecular machines that function with remarkable efficiency and precision. In recent years, science has attained an unprecedented understanding of the mechanisms of biological "machines." This has inspired utilization of Nature's engineering for applications in computation, self-assembly, and mechanics. Because biomolecules are inherently on the nanoscale, nanotechnology has emerged as an appropriate means for controlling biology. This requires both understanding the inorganic properties of the nanoparticle as well as creating an interface that is compatible with the complex and highly disordered environments of real biological systems. We will discuss the use of nanoparticles composed of Au, Fe_3O_4, Fe_2O_3, $CoFe_2O_4$, and similar materials in biological applications by engineering both the inorganic properties of the nanoparticles along with creating optimal biological interfaces. We study the interface between the nanoparticle and covalently linked proteins and DNA. Labeling proteins with nanoparticles has been utilized for many applications but often the structure of the protein in the conjugate is not characterized. In addition, site-specific labeling of the protein with a nanoparticle has been achieved for only a limited set of proteins and nanoparticles. We present work in which we study the interface between nanoparticles and the protein cytochrome *c*. We vary nanoparticle ligand and composition, as well as labeling site on the protein. Biophysical techniques such as quantitative gel electrophoresis, circular dichroism, and optical spectroscopy are used to characterize the structure of the protein in the conjugate. These experiments allow us to understand some of the chemical interactions involved in non-specific adsorption, and come up with general design rules for optimal conjugation.

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