NSF Workshop on Biologically-Enabled Wireless Networks Design and Modeling

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Introductory white paper

Research Interests

My research group investigates how living cells exchange biophysical information with their microenvironment, especially mechanical force-based signals. We seek to leverage this signaling to directly manipulate cell behavior, with an eye towards engineering cell-material interfaces for tissue engineering systems and cellular microdevices. In the area of synthetic biology, we have implemented genetic strategies to control the mechanobiology of living cells, which have enabled us to reprogram the behavior of various cell types in ways that alter their sensitivity to constraints imposed by their material 'niche.' We are also actively involved in the generation of "smart" materials that mimic cellular structural networks. In the area of wireless-to-bio signal transduction, we have previously contributed to new strategies for the reversible actuation of receptor-mediated signaling at the cell surface by manipulating receptor clustering via superparamagnetic nanoparticles.

Challenges

The field of synthetic biology has made great strides over the past decade in the manipulation of prokaryotic systems to accomplish specific technological goals, such as bioremediation and synthesis of value chemicals, to name only two examples. An important challenge is to translate these advances to eukaryotic systems, where the biology and regulatory issues can be considerably more complex. In the field of wireless signal transduction, an important challenge is to build molecular specificity into what are fundamentally nonspecific inputs (magnetic forces, light, electrical current, etc.). This in turn will require a deeper understanding of how living systems naturally transduce broad physical inputs into highly specific biochemical signals.