Nanoengineering Approaches for Infectious Disease Management

Abstract

A major thrust in my group is to develop technologies for infectious disease management to curb the emerging threat of antimicrobial resistance, one of the biggest health challenges of our century. In this regard, I will demonstrate three research approaches taken by my group, each pertaining to the broad area of drug delivery, diagnostics and biomaterials fabrication. In the first, I will demonstrate a novel drug delivery platform to co-target cancer and intracellular bacterial infections in cancer. We all may not know that bacteria can behave as both cancer-causative and cancer-prevailing agents. Thus, targeting bacteria that otherwise escape antimicrobial action by host cell-localization is important to curb secondary infections that may lead to life-threatening conditions like sepsis. Another way to manage sepsis is through rapid and early bedside diagnosis. In the second example, I will showcase a simple and disposable point-of-care (POC) device called Septiflo™ that can not only identify but also stratify bacterial infections based on their Gram status under 10 min from a drop of human blood. While conventional diagnostic systems rely on amplifying minute quantities of DNA or measuring the late host response, our system works by detecting naturally amplified pathogen-associated molecular patterns that are unique footprints of infection. The preliminary clinical results look promising as they show better performance than existing methods for bacteremia diagnosis. Finally, I will illustrate how free-floating scaffolds of living cells can be simply and conveniently assembled using external AC electric fields. While the 1D and 2D cellular architectures serve as biomaterial constructs, the 0D bacterial microarrays are ideal for label-free biosensing and single cell analysis.