Designing Nanostructured Materials to Enhance Therapeutic Delivery

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The field of nanomedicine offers great potential to revolutionize clinical care, including medical devices, regenerative medicine, and molecular imaging approaches. Recent advancements in nanofabrication applied to biocompatible materials lay the groundwork for creating biomaterials with a high level of control at the molecular scale. These subtle interactions with cell and tissue assemblies can modulate properties such as mechanotransduction, adhesion, and immune activation. In this talk, I will present an overview of our recent work in developing injectable nanostructured materials for the modulation of fibrosis and immune activation. Specifically, I will discuss the fabrication of high aspect ratio polymeric structures that assemble into porous matrices when injected in vivo. These structures can be tuned in terms of geometry and modified to allow site-specific coupling to therapeutic proteins. Nanowires and nanoparticles conjugated with antibodies can be designed to capture and potentiate endogenous cytokines demonstrating both tissue- and cell- specific immune activation. Additionally, nanostructures can be used to modulate the microenvironment after injury, modulating fibroblast activation and the fibrotic response. By gaining a better understanding of how small scale topographies can influence the biological microenvironment, we can design platforms for applications in therapeutic delivery and tissue regeneration.