Engineering Precision Biomaterials: Implications for Therapeutic Delivery and Immune Modulation

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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 and molecular assembly lay the groundwork for creating biomaterials with a high level of control at the sub-cellular scale. These subtle interactions with cell and tissue assemblies can modulate properties such as adhesion, uptake, transport, 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. High aspect ratio polymeric structures that assemble into porous matrices when injected in vivo can be tuned in terms of geometry and designed to capture and potentiate endogenous cytokines demonstrating both tissue- and cell- specific immune activation[1]. Additionally, DNA scaffolded particles can be designed to engage with immune cell subsets and enhance cell-specific targeting, allowing for highly programmable drug delivery systems with nanometer-scale precision[2,3,4]. By leveraging the specific binding properties of DNA, one can control the ratiometric and spatial arrangement of ligands and therapeutic payloads on a particle's surface. This "architectural" approach enhances how these particles interact with biological barriers, significantly improving targeted delivery and the immune system's response to disease.

References:

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