CUHK BME – iTERM Joint Seminar

Therapeutic Immunoengineering: From Gene Delivery to Programmable Immune Niches

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Venue : Room 1122, William M W Mong Engineering Building, CUHK

Abstract

The immune system offers powerful opportunities for treating cancer, infectious disease, and other complex disorders, but realizing this potential requires precise control over where, when, and in which cells therapeutic cargos and signals are delivered. Advances in gene delivery and biomaterials engineering are creating new ways to manipulate these interactions and program immune responses for therapeutic benefit. In this seminar, I will discuss our efforts to engineer delivery systems across multiple scales, from nanoparticles that control intracellular delivery to biomaterial microenvironments that regulate local interactions among therapeutic vectors, immune cells, and tissues. Much of this work has been motivated by cancer immunotherapy, where the ability to generate potent immune responses while controlling their spatial distribution and systemic exposure remains an important challenge.

Lipid nanoparticles provide a versatile platform for delivering nucleic acids and programming cellular function, while engineering their composition and structure can alter interactions with biological systems and expand their therapeutic applications. Beyond individual nanoparticles, we are exploring engineered composite materials as localized immune niches that spatially organize gene delivery and immune modulation. By integrating lipid nanoparticles or adeno-associated viral vectors within these microenvironments, we seek to achieve sustained and localized control over therapeutic gene expression and host responses, with applications in cancer and other diseases requiring targeted immune modulation. Together, these approaches illustrate a broader vision for therapeutic immunoengineering in which delivery vehicles and tissue microenvironments are designed in concert to control the spatial, cellular, and temporal dimensions of immune modulation.

Biography

Hai-Quan Mao, PhD, is Professor of Materials Science and Engineering and Biomedical Engineering at Johns Hopkins University and Director of the Institute for NanoBioTechnology. His research lies at the interface of biomaterials, nanotechnology, and medicine, with a focus on engineering new approaches for gene delivery, immunotherapy, and regenerative medicine.

Dr. Mao's laboratory develops lipid and polymeric nanoparticles for nucleic acid delivery and biomaterial

platforms that create programmable microenvironments for therapeutic applications. His group has pioneered scalable technologies for the controlled assembly of nucleic acid nanoparticles and, more recently, developed strategies to direct lipid nanoparticles to specific tissues and immune-cell populations, program T-cell responses for cancer immunotherapy, and integrate gene delivery systems with engineered biomaterial niches. His work spans fundamental studies of nanoparticle assembly and biological interactions through translational development of therapeutic technologies.

Dr. Mao is a Fellow of the National Academy of Inventors, the American Institute for Medical and Biological Engineering, and the Royal Society of Chemistry. He has authored more than 250 peer-reviewed publications and is an inventor on more than 40 issued U.S. patents. His research has also contributed to multiple technologies and companies translating biomaterials and drug-delivery innovations toward clinical applications.

***** ALL ARE WELCOME *****

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