Stevens Institute of Technology

Nanotechnology Graduate Program

Polymeric Biodegradable Micelles for Gene Delivery

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Gene-loaded nanoparticles have been proposed as a safer non-viral carrier for gene delivery to many important tissues. However, a major limitation to achieve a high level of gene expression is their poor stability in physiological media; they severely aggregate and/or dissociate upon challenging by salt and serum, rendering them inefficient when administered in vivo. However, making them too stable will impede DNA unpacking after they reach the cytosol and nucleus. Hence the stability should be tailored by considering the specific tissue and factors associated with delivery. Control of nanoparticle stability, DNA/RNA release, cell binding, and intracellular trafficking will be key to understanding the rate-limiting steps for gene delivery and optimizing transgene expression efficiency in vivo. We have developed a series of biocompatible and biodegradable polymers that self-assemble with DNA to form micellar nanoparticles consisting of DNA/polyphosphoramidate complex core and a polyethylene glycol (PEG) corona rendering the particles more stable in aqueous medium. Size, morphology and stability can be controlled by adjusting the structure of the carrier polymer. Characterization and structure-biophysical properties-transfection efficiency relationships of these micelles will be discussed in this talk. A new micelle system with microenvironment-sensitive DNA release property will also be discussed. These favorable characteristics make this micelle system an ideal platform for systematic investigation of delivery mechanisms and optimization of tissue-targeted delivery systems.

Dr. Hai-Quan Mao received his B.S. in Chemistry in 1988 and Ph.D. degree in Polymer Chemistry in 1993 from Wuhan University in China. He completed his postdoctoral training with Prof. Kam W. Leong in the Department of Biomedical Engineering at The Johns Hopkins University School of Medicine from 1995 to 1999. Dr. Mao joined the Johns Hopkins Singapore in 1999 as a Co-PI in the Tissue and Therapeutic Engineering Lab. Dr. Mao joined the Department of Materials Science and Engineering and Whitaker Biomedical Engineering Institute in Johns Hopkins University in April 2003 as an assistant professor. Dr. Mao's research focuses on developing nanomaterials for drug/gene delivery and controlling stem cell proliferation/differentiation. He has more than 60 peer-reviewed publications. He is co-inventor of 16 issued US patents and 10 pending patent applications. He is a recipient of the Cygnus Award for Outstanding Work in Drug Delivery (1997) and the Capsugel Award for Outstanding Research in Innovative Aspects of Controlled Drug Release (1998) from the Controlled Release Society, and the National Science Foundation Faculty Early Career Award (2008). Dr. Mao has been appointed to the editorial board of hte journal Tissue Engineering since 2006. He has authored and coauthored over 330 reviewed scientific papers, book chapters and reviews, 2 edited books, 9 patents, 12 patent applications and 190 conference proceedings.

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