Chemical Engineering

seminar

Antibiotic Functionalized Nanoparticles for Rapid Capture of Bacteria

March 14 at 10:30am in BDBB 105

abstract

Sepsis afflicts 30.7 million people globally per year and remains the primary cause of death from bacterial infections. Progressive emergence of multi-drug antibiotic resistance is a significant and growing factor in fatal bacterial toxemia. A number of approaches, founded on separation biophysics, have been demonstrated to isolate bacteria from simple fluids. Design-based development of such approaches is required to understand the parameters and conditions that control performance for potential translation to clinical practice. The design goal of this interdisciplinary research project is the reduction of pathogen load during sepsis under conditions that are estimated to provide clinical benefit. This presentation will describe the fabrication and characterization of colistin-functionalized nanoparticles. Colistin is an antibiotic with an uncommon mechanism of action due, in part, to polycationicity. Colistin-functionalized nanoparticles and microparticles rapidly bind the cell envelope of Acinetobacter baumannii, a Gram-negative bacteria. A. baumannii is an opportunistic pathogen with increasing prevalence in the United States and possessing a rapidly emerging multi-drug resistant (MDR) phenotype. A quantitative assessment of wild-type (WT) and colistin-resistant (CR) A. baumanii interaction with colistin-functionalized particles estimated that complexation reaches half-maximum saturation in approximately seven minutes regardless of phenotype. This rate of nanoparticle binding to bacteria is the fastest reported, to our knowledge, and is essential to inform the design of devices intended for the separation of bacteria from blood, including the dangerous CR and, potentially, MDR phenotypes. Electron micrographs superimposed with elemental information from energy-dispersive X-ray (EDX) spectroscopy confirm localization of colistin-functionalized particles on the bacterial surface. Quantitative characterization of nanoparticle-bacteria association mediated through colistin enables the design-based consideration of new approaches to bacterial detection and isolation with the potential for human benefit.

Giorgio Todd
Dept. of Biomedical Engineering
Vanderbilt University

biosketch

Giorgio Todd is a Professor and Chair of the Biomedical Engineering Department at Vanderbuilt University. He received his B.S. from LeHigh University and a PhD from Rice University. He is the Director of the Giorgio Lab Group. His research interests reflect an interdisciplinary range of projects spanning diagnostics, medical imaging, and therapeutics against cancer and cardiovascular pathologies. Lab members engage in projects dealing with novel metal nanoparticle designs for imaging applications, gene and cell therapy, RNAi therapeutics, and smart environmentally-responsive drug delivery systems.

Professor Todd is a member of the American Association for Cancer Research (AACR); American Institute for Medical and Biological Engineering (AIMBE); American Society of Engineering Educators (ASEE); American Society of Gene and Cell Therapy (ASGCT); Biomedical Engineering Society (BMES); Sigma Xi (SX).