Exploring the Promise of Nanomedicine: Nano-Scaled Biomaterials Integrating Synthetic Polymers, Oligonucleotides, and Polypeptides for Detection and Treatment of Disease

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The advent of nanomedicine within the past decade has led to the development of a number of emerging diagnostic and therapeutic avenues for the detection and treatment of cancer and other diseases. The small size and surface area of nanomedicines, including nanoparticles, makes them highly suitable for biomedical applications where their ability to be injected locally or systemically, extravasate into diseased tissue, enter cells, interact with targets at the molecular level, present surface-bound ligands to overcome physiological barriers and enable targeting, and act as carriers for delivery of active agents provides a range of opportunities. Nanomedicine open the doors to improved diagnostic, therapeutic, and theranostic technologies that offer higher efficacy, individualization, and safety compared to those currently available. While to date only a few nanoparticle-based systems have entered the market as therapeutics or biotechnological tools, it is expected that nanotechnology will revolutionize health care in the near future.

Our laboratory has focused on exploring the potential of nanomedicine in four fronts. Specifically, we are working on the development of (1) molecularly responsive hydrogels enabled by responsive oligonucleotides that could be used for stimuli-triggered drug release, biosensing, and tissue engineering; (2) near infrared fluorescent nanomaterials as highly specific agents for optical imaging of tumors which could be used for early detection and monitoring of cancer, and for fluorescence-guided resection of tumors; (3) organic nanostructures for photoablation of tumors which could provide a localized and more effective treatment strategy compared to chemotherapy; and (4) particles for targeted delivery of poorly soluble chemotherapeutic agents to tumors which could improve the drug's bioavailability and therapeutic efficacy. All of the materials being developed take advantage of one of the main features of nanomedicine: the ability to integrate several functionalities into a single entity, whether it is biopolymers, synthetic polymers, fluorescent tags, or ligands, providing the means to tailored designs specific for a given application.

This seminar will describe the various materials that we are currently developing, and provide a glance into the enormous potential of nanotechnology in biomedicine. In addition, case scenarios based on Dr. Betancourt's projects at InnoSense, LLC, will also be discussed to show the process of biomedical product development at a small technology company.

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EDUCATIONAL BACKGROUND AND TRAINING:

Postdoctoral Fellow, Department of Chemical Engineering, The University of Texas at Austin (2008)
Ph.D. Biomedical Engineering, The University of Texas at Austin (2007)
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BIOSKETCH:

Dr. Betancourt is an Assistant Professor in the Department of Chemistry and Biochemistry and a faculty member of the Materials Science, Engineering, and Commercialization Program at Texas State University-San Marcos. Dr. Betancourt leads the research of the Biomaterials and Nanomedicine laboratory, which focuses on the development of functional polymeric nanostructures for the detection, monitoring, and treatment of cancer and other diseases.

Prior to joining Texas State University in 2011, Dr. Betancourt worked at InnoSense LLC, a technology company serving the aerospace, energy, defense, and health care market. During her three-year tenure at InnoSense, Dr. Betancourt held the positions of Research Scientist, Team Leader, and Deputy Director-R&D. At InnoSense, Dr. Betancourt was responsible for developing novel technologies in the areas of biosensors, biomaterials, therapeutics, theranostics, contrast agent, drug delivery, and specialty materials. She secured funding for support of R&D of biomedical and specialty material technologies as a Principal Investigator through small business innovation research (SBIR) grants from federal agencies, including two Phase I SBIRs from the National Institutes of Health totaling $384k, and two Phase I and one Phase II SBIR grants from NASA totaling $800k.

Dr. Betancourt is currently a recipient of a grant by the Research Corporation for the Advancement of Science, and is co-PI in a NSF PREM grant (2012). In addition, she is principal investigator of two Small Business Technology Transfer (STTR) grants from the NIH in partnership with CHEMTOR, LLC. Additional awards include the David and Mary Miller Fellowship (2006-2007), NSF IGERT Graduate Research Fellowship (2004-2006), Thrust 2000 Fellowship (2003-2007), Lindsay Scholarship (2001-2002), and the American Chemical Society Scholars Program scholarship (1999-2002). During her graduate studies, Dr. Betancourt was recipient of the Schlumberger Grand Award for best paper and presentation and Schlumberger Centaur Award in Nano/Microelectronics and MEMS in the Graduate and Industry Networking Conference (2006), and the Best Paper award in the Nano-Night 2005 Scientific Forum in Nanotechnology (2005). Dr. Betancourt graduated Magna Cum Laude with her B.S. in Chemical Engineering. She also participated in Omega Chi Epsilon Chemical Engineering Honor Society, Tau Beta Pi Engineering Honor Society, and Phi Theta Kappa International Honor Society.

Dr. Betancourt's work has been documented in six peer-reviewed publications, two review articles, two book chapters, and multiple professional presentations.