BIOSKETCHES & ABSTRACTS

Herbert D. Doan

Nanotechnology Symposium

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Presentations: Forum Hall: Floor 4
Poster Session: Atrium: Floor 4
Palmer Commons, 100 Washtenaw Ave
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Hosted by
Michigan Nanotechnology Institute for Medicine and Biological Sciences (MNIMBS)

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Shuming Nie, PhD

Departments of Biomedical Engineering and Chemistry
Emory University and Georgia Institute of Technology

Dr. Shuming Nie is Wallace H. Coulter Distinguished Chair Professor in Biomedical Engineering at Emory University and the Georgia Institute of Technology, with joint appointments in chemistry, materials science and engineering, and hematology and oncology. He is the Principal Investigator and Director of the Emory-Georgia Tech Nanotechnology Center for Personalized and Predictive Oncology, one of the eight national centers funded by the National Cancer Institute (NIH/NCI). His research interest is broadly in biomolecular engineering and nanotechnology, with a focus on bioconjugated nanoparticles for cancer molecular imaging, molecular profiling, pharmacogenomics, and targeted therapy. His research program is currently supported by three large-scale grants from the National Institutes of Health. Professor Nie has published about 170 scholarly papers, filed 40 patents/inventions, and delivered more than 450 invited talks and keynote lectures. In recognition of his work, Professor Nie has received many awards and honors including Innovation of the Year Award (Emory University, 2010), the Merck Award (2007), Elected Fellow of the American Institute of Biological and Medical Engineering (2006), the Cheung Kong Professorship (The Ministry of Education of China, 2006), the Rank Prize in Opto-electronics (London, UK, 2005), the Georgia Distinguished Cancer Scholar Award (Georgia Cancer Coalition, 2002-2007), the Beckman Young Investigator Award, the National Collegiate Inventors Award, and the NSFC Overseas Young Scholar Award. Professor Nie received his BS degree from Nankai University (China) in 1983, earned his MS and PhD degrees from Northwestern University under the direction of Professor Richard P. Van Duyne (1984-1990), and did postdoctoral research at both Georgia Institute of Technology and Stanford University (1990-1994).

Presentation: Nanotechnology for Molecular Imaging and Image-Guided Surgery

Abstract: Polymeric molecules have fascinated scientists for years. From a natural standpoint, however, these molecules remain relatively unsophisticated. Perhaps the most well known example of advanced properties in macromolecules comes from biopolymers like DNA and proteins. Our laboratory has focused on creating novel polymeric molecules with increased functionality in order to enable new properties and applications. This lecture will highlight two efforts in the biomimetic arena. We will discuss how the design has led to novel antibiotics, on one hand, and cell penetrating peptide mimics on the other. The development of biocompatible nanoparticles for in-vivo molecular imaging and targeted therapy is an area of considerable current interest across a number of science, engineering, and biomedical disciplines. The basic rationale is that nanometer-sized particles have functional and structural properties that are not available from either discrete molecules or bulk materials. When conjugated with biomolecular targeting ligands such as monoclonal antibodies, peptides or small molecules, these nanoparticles can be used to target malignant tumors with high specificity and affinity. In the “mesoscopic” size range of 10-100 nm diameter, nanoparticles also have large surface areas for conjugating to multiple diagnostic (e.g., optical, radioisotopic, or magnetic) and therapeutic (e.g., anticancer) agents. Recent advances have led to the development of biodegradable nanostructures for drug delivery, iron oxide nanocrystals for magnetic resonance imaging (MRI), quantum dots (QDs) for multiplexed molecular diagnosis and in-vivo imaging, and nanoscale carriers for short-interfering RNA (siRNA) delivery. We have developed biocompatible and nontoxic nanoparticles for in-vivo tumor targeting and detection based on self-assembled nanostructures and pegylated colloidal gold. In particular, colloidal gold has been safely used to treat rheumatoid arthritis for 50 years, and has recently been found to amplify the efficiency of Raman scattering by 14-15 orders of magnitude. Here we show that large optical enhancements can be achieved under in-vivo conditions for tumor detection in live animals. A major finding is that small-molecule Raman reporters such as organic dyes are not displaced but are stabilized by thiol-modified polyethylene glycols. These pegylated SERS nanoparticles are considerably brighter than semiconductor quantum dots with light emission in the near-infrared window. When conjugated to tumor targeting ligands such as single chain variable fragment (ScFv) antibodies, the conjugated nanoparticles are able to target tumor biomarkers such as epidermal growth factor receptors (EGFR) on human cancer cells and in xenograft tumor models.

Barbara Baird, PhD
Professor and Chair of Chemistry and Chemical Biology
Cornell University, Ithaca, NY

Barbara A. Baird is the Horace White Professor and Chair of Chemistry and Chemical Biology at Cornell University. She received her B.A. in Chemistry from Knox College and her Ph.D. in Chemistry from Cornell University. Her postdoctoral studies were carried out as a Damon Runyon Fellow in the Immunology Branch of the National Cancer Institute at the National Institutes of Health before she joined the Cornell faculty in 1980. The Baird research laboratory integrates biochemical, biophysical, and nanotechnology approaches to investigate basic mechanisms of cell surface receptors for mediating transmembrane signals in immune responses, particularly the IgE receptor (FcεRI) on mast cells. Dr. Baird has led a number of programs at Cornell; recent positions include Director of the Nanobiotechnology Center (a Science and Technology Center of the National Science Foundation), Director of Graduate Studies in Chemistry, Director of Cornell's NIH training grant in Molecular Biophysics, Co-Director of the W.M. Keck Foundation Program in Molecular and Cellular Biophysics of Signal Transduction. Dr. Baird has served on the Council of the NIH National Institute of Allergy and Infectious Diseases and on scientific advisory/review committees for Los Alamos National Laboratory, Brookhaven National Laboratory, and centers at several universities. She is Fellow of the American Association for the Advancement of Science and a Fellow of the American Academy of Arts and Sciences.

Presentation: Zooming in on Spatial Control of Cellular Responses

Abstract: A goal in modern medicine is to address human physiology in terms of its hierarchical organization. At a fundamental level, cells respond to external stimuli in terms of collective molecular interactions that are regulated in time and space. Small molecules may engage receptors to initiate the stimulus, and the system amplifies from this nanoscale to micron scale assemblies within the cell and often to longer length scales involving surrounding tissue and ultimately the whole organism. A striking example of signal integration over multiple length scales is the allergic immune response. IgE receptors (FcεRI) on mast cells are the gate keepers of this response, and this system has proven to be a valuable model for investigating receptor-mediated activation of hematopoietic cells. For cellular stimulation, IgE receptors must be clustered on the cell surface, typically by a multivalent ligand (antigen). This causes their phosphorylation within membrane compartments, thus initiating intracellular signaling leading to multiple responses, including degranulation to release mediators of allergies and inflammation. My talk will describe our collaborative efforts that integrate physical, biological, and nanotechnology approaches to examine the spatial orchestration of these events on the length scales at which they occur.

James R. Baker, Jr., MD
Professor of Medicine
Division Chief of Allergy and Clinical Immunology
Director, Michigan Nanotechnology Institute for Medicine and Biological Sciences

Dr. Baker joined the faculty of the University of Michigan in 1989 and is currently Professor of Medicine and Division Chief of Allergy and Clinical Immunology in the Department of Internal Medicine, Professor of Pathology, and Professor of Biomedical Engineering in the School of Engineering at the University of Michigan. In July, 1998 Dr. Baker was appointed Director of the U-M's newly organized Center for Biologic Nanotechnology and in 2001 was inaugurated as the first recipient of the Ruth Dow Doan Endowed Professorship in Biologic Nanotechnology. Following the success of the Center for Biologic Nanotechnology, in April 2005, U-M's Board of Regents formed the Michigan Nanotechnology Institute for Medicine and Biological Sciences (MNIMBS) and appointed Dr. Baker as its first Director. Under his leadership, MNIMBS merges academic expertise and institutional resources across the university to develop and market applications for nanotechnology in medicine, the biological sciences and the environment.

Dr. Baker's research includes the application of nanomaterials to cellular engineering, drug delivery and gene transfer, and is supported by over $60 million dollars in federal grants and contracts. These studies have produced new vector systems for gene transfer using dendritic polymers with potential to revolutionize pharmaceutical therapy. Dr. Baker's work with synthetic lipid and polymeric nanostructures has resulted in the development of a new class of antimicrobial agents with activity against bacteria, spores, fungi and viruses. These projects led to two start-up biotechnology companies, NanoBio Corporation and Avidimer Therapeutics, both located in Ann Arbor, Michigan where Dr. Baker serves as the Chief Scientific Officer of both corporations.

Dr. Baker is recognized as both a national and international leader in the fields of Allergy and Clinical Immunology and Biologic Nanotechnology and awarded U-M Dean's Innovation Award in 2001, given to faculty whose innovations radically improved or transformed clinic outcomes, educational processes, or research processes. In 2008, he was awarded the Distinguished University Innovator Award, given in recognition of individuals who have made important and lasting contributions to the University of Michigan by their efforts to move new innovations into the private sector for public benefit, and by demonstrating extraordinary entrepreneurial leadership. Dr. Baker serves on the editorial boards of three noteworthy journals and is one of three editors of the National Nanotechnology Initiatives' Research Directives. He has chaired numerous study sections for NIH and serves on internal and external advisory boards and committees including the Nanotechnology Technical Advisory Group (N-TAG) of the President's Council of Advisors on Science and Technology (PCAST) for the Executive Office of the President of the United States, the advisory to a sub-committee of the Defense Intelligence Agency. In 2006 he began a 5 year appointment as a Director of the American Board of Allergy and Immunology (ABAI).

Presentation: Nanotechnology Moves Beyond the Clinic into the Marketplace

Abstract: Nanotechnology has been proposed as a means to develop therapeutics for a variety of diseases ranging from infections to cancer. As with most drug development, there have been many problems as these molecules have moved from proof of concept studies in cells or animals to clinical trials in human beings. Despite this, the first therapies based on nanotechnology are now finishing clinical trials, and this should allow the new therapies to be available for use in the next few years. I will describe the benefits of these products for treating human disease as well as the developmental process that nanoparticle therapeutics have taken to reach the public. I also will talk about new approaches to nanoparticle drugs that may facilitate future therapies based on nanotechnology. In summary, the promise of these nanotechnology approaches to human therapeutics remains substantial despite the difficulties encountered in their development.