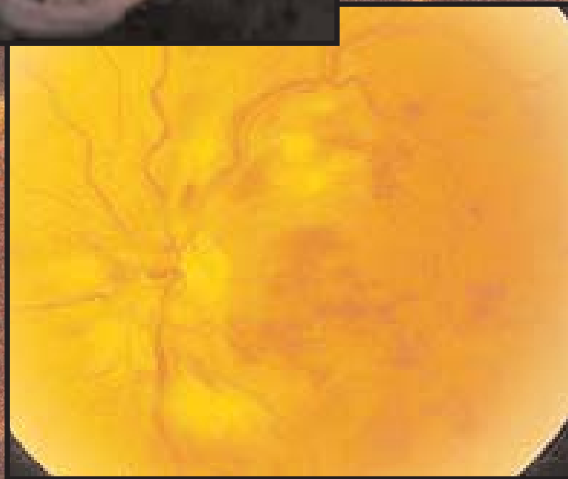


# BME IIT

*Newsletter Fall 2005*



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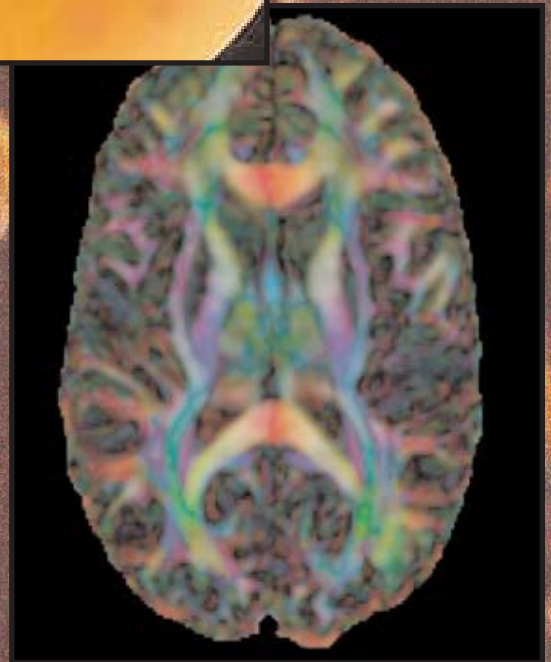
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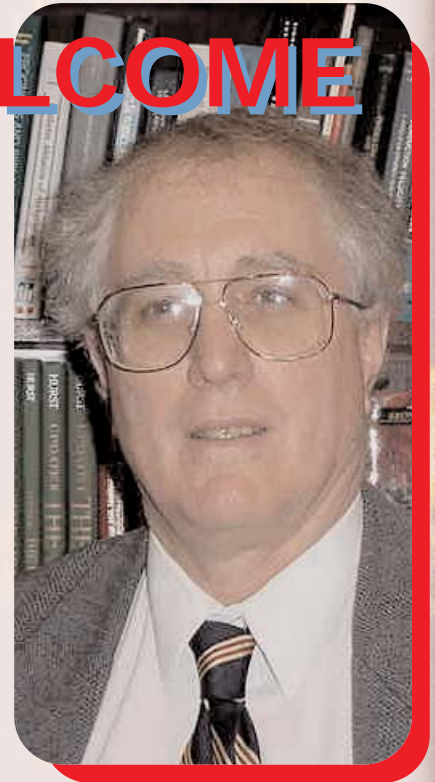
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# CHAIR'S WELCOME



Welcome to our inaugural newsletter. The BME Department has just entered its fourth year and has now reached its first steady state with all four years of undergraduate students. For such a short existence, there has been a remarkable growth and significant successes, both by the faculty and students. Currently, we number about 140 undergraduate students; in the last two years we entered our largest classes of 50 students each year. The students that we are entering are among the strongest academically in the College. A senior, Sean Pitroda, was recently awarded the prestigious Tau Beta Pi scholarship. He was also accepted into a Howard Hughes summer program at the University of Chicago where he studied islet cell transplantation and recently has had his work entitled, "Characterization of Tissue Factor Expression in Isolated Human Islets," published in the University of Chicago Undergraduate Biological Sciences Journal. Two other seniors, Grace Lin and Shravani Pasupneti both were recognized as Takeda Pharmaceuticals North American Scholars and received a \$5000 scholarship. Our engineering students are diversified too. Emily Hammes and Daniel Crandall both have received several prizes in the Creative Writing Contest sponsored by the Humanities Department.

Our graduate doctoral program has also grown rapidly and now numbers 28 PhD students. We recently graduated our first doctoral student, Seda Kizilel.. She is now doing postdoctoral studies at the University of Chicago working on cell encapsulation techniques. Three of our graduate students have been awarded external funding to continue their studies. Susan Zawaski has received an NSF Doctoral Fellowship to explore the activation of the coagulation system in flowing blood; Astrid Zayas-Santiago is working under a State of Illinois Minority Fellowship to study retinal cell growth and most recently, Pat Caviness was awarded the Fieldhouse Research Fellowship for studies to investigate transport across the blood brain barrier.

As a new program we have been very busy, developing the curriculum, designing the laboratories, testing the experimental modules and in our spare time, teaching the courses,



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*writing grant applications and manuscripts for publications and having babies (some of us anyhow.) Two of our faculty, Jennifer Kang Derwent and Viji Balasubramanian, have both delivered their first child in the past year. Jennifer not only managed to become a mother, but during the same year she designed and developed the first undergraduate laboratory, the Measurements and Instrumentation Laboratory, and submitted a grant to NIH. Kudos to her threefold. BME has inaugurated three undergraduate teaching laboratories thus far (see pictures within) and our design laboratory is being prepared for next year. These labs are state of the art undergraduate labs devoted to a "hands on" experience for the students in the principles of biomedical engineering.*

*Faculty, in a short time, have become quite productive with respect to research efforts. BME was recently awarded the prize at Research Day at IIT last spring for the most grant dollars per faculty member. Moreover, the Department is 2nd in research expenditures for this academic year. Over the first 4 years of existence the Departmental faculty have acquired over \$8M in external funding. These achievements were accomplished through the continuing hard work of our more senior faculty - Phil Troyk who continues his work on several multi-million dollar NIH grants in the area of prosthetic vision and the area of robotic control by muscle, and David Mogul who was awarded an NIH grant to study mechanisms for controlling the abnormal electrical brain signals in epilepsy. However, our junior faculty are starting to achieve success in the research area too. Mark Anastasio is particularly noteworthy having received a Whitaker Investigatorship and two NIH Grants thus far. Connie Hall and Jennifer Kang Derwent also hold Whitaker Investigatorships. These awards are very competitive with less than 20% of applicants receiving funding. Other junior faculty hold awards from DARPA (Viji Balasubramanian) and NIH (Viji Balasubramanian, Konstantinos Arfanakis) and Eric Brey has recently received a grant from the Veterans Administration.*

*Faculty have also been active in delivering IPROs to students. Manny Opara has conducted several of these interprofessional courses. He has students attempting to design and develop a non-invasive means for measuring blood glucose. Paul Fagette, the resident historian for the BMES, has had the students delivering projects for display at the Museum of Science and Technology. Most recently, he has a group of students recreating the first dialysis machine developed by Kolff in the 1940s. There are no known versions of the original apparatus existing and the re-creation will be displayed by the Museum.*

*In short, the BME Department has advanced significantly in the short time that it has existed. The Department has developed three track areas in the field, Neural Engineering, Medical Imaging, and Cell and Tissue Engineering. The faculty have organized the curriculum to educate both undergraduates and graduate students in these areas. The students that are being attracted to BME are of the highest quality. Faculty are contributing significantly to these areas through their publications and their work is being recognized by the peer-reviewed grants they have received. These are palmy days for biomedical engineering at IIT.*

# FACULTY

VINCENT T. TURITTO, DEngSci  
turitto@iit.edu



Vincent Turitto is the Director of the Pritzker Institute of Biomedical Science and Engineering and Chairman of the Department of Biomedical Engineering at Illinois Institute of Technology. He received a doctoral degree in Chemical Engineering from Columbia University in 1972 where he studied the influence of blood flow on platelet transport. He was appointed Professor of Medicine at Mount Sinai Medical Center with a tenured appointment in the Division of Thrombosis in 1989. He became the Herbert Herff Professor of Biomedical Engineering at The University of Memphis in 1990 and, subsequently, the Chairman of the Department of Biomedical Engineering in 1993. At the University of Memphis, he helped establish the Joint Program in Biomedical Engineering between the University of Memphis and the University of Tennessee. While he was Chair, he directed sponsored research in the department and provided supervision to graduate students in their research investigations related to the influence of fluid dynamics on cell function. He joined Illinois Institute of Technology in 2001 and helped create the Department of Biomedical Engineering, established in 2002, through support from the Whitaker Foundation. Most recently, he has helped establish a Center in Neural Computation and Engineering with the University of Chicago in 2003. His research interests include the design and use of flow chambers for the study of fluid interactions with cells and tissues, magnetic particle removal of toxins from circulating blood and surface pattern formation for cellular attachment. He is the author of over 100 scientific publications, co-author of a patent on a Continuous Flow Kinetic Reactor and recipient of numerous awards of support from nationally competitive funding agencies.

MARK A. ANASTASIO, PhD  
anastasio@iit.edu



My research activities are focused generally in the areas of imaging physics and tomographic reconstruction algorithms. Current research foci are: Megavoltage computed tomography (CT) for radiation therapy tumor imaging. We are developing and investigating dose-efficient tomographic imaging methods based on the local tomography paradigm that will facilitate patient positioning verification in conformal radiation therapy treatments. We are collaborating with clinical and basic science faculty at The University of Chicago Medical Center on this project.

Development of phase-contrast tomography. We are currently developing and investigating reconstruction algorithms for in-line X-ray phase-contrast microtomography, and evaluating their use for reconstructing the microvascular structure of biological tissues and tumors. The aim of these reconstruction algorithms is to produce an accurate map of the X-ray refractive index distribution of the sample. We are assessing the developed algorithms by use of simulation studies and experimental data studies. We are collaborating with BME researchers at IIT and physicists at Argonne National Laboratory on this project.

Development of imaging algorithms for thermoacoustic tomography. Thermoacoustic tomography (TAT) is an emerging imaging technique with great potential for a wide range of biomedical imaging applications. We are currently developing and evaluating tomographic reconstruction algorithms for TAT. These algorithms produce images that have greatly improved accuracy and statistical properties, which will facilitate diagnostic tasks. We are collaborating with researchers at The University of Chicago and Texas A&M University on this project.

Development of intensity diffraction tomography. Diffraction tomography (DT) is an imaging technique for reconstructing the complex-valued refractive index distribution of an object. We are analytically and numerically investigating the I-DT reconstruction theory and generalizing it to accommodate scanning geometries that are of practical importance.

**KONSTANTINOS ARFANAKIS, PhD**  
arfanakis@iit.edu



Dr. Konstantinos Arfanakis focuses his research on the use of Magnetic Resonance Imaging to study brain function and brain connectivity. His lab is involved in building software used to acquire MRI data that describe different properties of neural tissue, such as blood oxygenation and proton diffusion, developing post-processing methods to extract useful information from the acquired data, and visualization techniques to display the final results. The goal behind the research of Dr Arfanakis' lab is to improve existing imaging methods used in clinical applications, or to implement new methods in collaboration with clinicians such as neuroradiologists, neurologists, neuropsychologists, and anatomists. This research work utilizes principles from physics, electrical engineering, and computer science.

**Projects:** Bi-exponential fit of the diffusion tensor equation to separate extracellular from intracellular diffusion effects in white matter; Application of the bi-exponential diffusion theory in patients with mild traumatic brain injury to detect diffuse axonal injury; Diffusion and diffusion tensor white matter fiber tractography for early diagnosis of Alzheimer's disease; Validation of diffusion tensor white matter fiber tractography algorithms by measuring electrical activity in subjects with surface electrodes; Diffusion tensor acquisition schemes optimized for fiber orientation and fiber type; Application of independent component analysis on diffusion tensor raw data to detect stroke; Functional MRI and diffusion tensor MRI to study language reorganization in patients with stroke in the left cerebral hemisphere; Automated system for performing functional MRI studies in a clinical setting.

**VIJI BALASUBRAMANIAN, PhD**  
balasubramanian@iit.edu



The focus of my research pursuits is to provide elegant and sophisticated solutions to existing medical problems. I design and build model experimental systems using principles and tools of traditional engineering, biological, chemical, and physical sciences that aim to enhance our current understanding of the human physiological processes. Currently, my research is directed towards applying biofluid mechanical principles to the molecular and protein biology of hemostasis and thrombosis with the intention of making novel contributions, generating new paradigms and treatment strategies. I have recently been instrumental in describing a heretofore unknown circulating form of tissue factor present in normal human blood. My current research efforts are directed at studying this protein under physiologically relevant hemodynamic conditions and characterizing its role in thrombosis in the human vasculature. 'Engineering' materials to be blood-compatible upon implantation in the human vasculature is another primary area of my research. Studies are underway in my laboratory in the design, development, and characterization of such materials.

**ERIC M. BREY, PhD**  
ebrey@lumc.edu



Angiogenesis plays a fundamental role in a number of pathological entities and surgical interventions. While angiogenic therapies have shown promise in pre-clinical models, translating success in animals to human application has met with limited success when angiogenesis is used as the single therapeutic mechanism. Progress in this field has been limited, at least in part, by our incomplete understanding of the basic mechanisms governing vascular assembly. Our work focuses on the three-dimensional interactions between the extracellular matrix (ECM) and endothelial cells in the development of microvascular networks. In addition, we are studying pathological changes in the ECM and their effect on microvascular structure and stability. Based on these studies we are developing novel angiogenic therapies. Recombinant technologies and molecular techniques are being used to engineer proteins with biologic function unique from those found in nature. These proteins are being designed to target specific tissue beds and elicit a persistent angiogenic response. Essential to our work are the development of novel models and quantitative methods for studying microvascular networks. We have designed and continue to design both in vitro and in vivo tools that allow unique insight into the 3D nature of microvascular formation. These tools allow a quantitative understanding of the effects of ECM and our therapies on angiogenesis. In addition, angiogenesis models are being developed as high-throughput screening tools for assessing new therapies.

**Contact Information  
Department of Biomedical Engineering  
Illinois Institute of Technology**

**10 West 32nd Street  
Engineering 1 Building, #116  
Chicago, IL 60616-3793**

**Contact Phone: 312.567.5100  
Fax: 312.567.5707  
E-mail: damico@iit.edu**

**Personnel**

**Vincent Turitto  
Chair, Department of Biomedical Engineering  
Director, Pritzker Institute of Biomedical Science and Engineering  
312.567.5100  
Fax: 312.567.5707  
turitto@iit.edu**

**Connie Hall  
Undergraduate Program Coordinator  
Assistant Professor  
312.567.3862  
Fax: 312.567.5707  
hallc@iit.edu**

**David Mogul  
Graduate Program Coordinator  
Associate Professor  
312.567.3873  
Fax: 312.567.5707  
mogul@iit.edu**

**Cathie D'Amico  
Department Administrator  
312.567.5324  
fax: 312.567.5707  
damico@iit.edu**