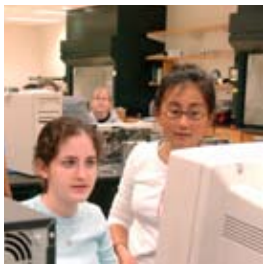
YALE BME NEWS

Department of Biomedical Engineering

WWW.ENG.YALE.EDU/BME Vol. 1 / No. 1 / Fall 2007

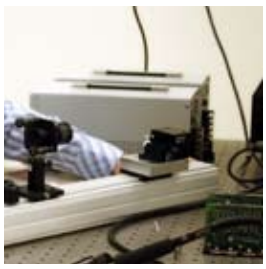













BME

Letter
From The Chair

It is an exciting time to be a biomedical engineer at Yale. This first issue of **Yale BME News**, a newsletter from the Department of Biomedical Engineering at Yale University, marks our fifth year as a department. During this time, we hired 6 new faculty members, who have built first-rate research programs in drug delivery, tissue engineering, biophotonics, and imaging science. We moved into the Malone Engineering Center, a 5-story, glass-covered, inspirational new research building on Yale's historic central campus. And we developed a department that bridges Yale's outstanding schools of engineering and medicine. We worked hard in these years, but we had great help from colleagues throughout Yale, and we are supported by engineering and medical schools with long histories of excellence in research and education.

As you browse through this inaugural issue, you will find evidence of our progress in research, education, and collaboration. What this issue cannot capture is the spirit of adventure, scholarship, and community that fills our labs and classrooms. Still, I want to highlight a few things of which I am most proud.

We have awarded Yale degrees in biomedical engineering to outstanding students for over 10 years now; students appeared before we became a department. Biomedical engineering continues to be a popular choice for Yale engineering undergraduates: twenty-three exceptional students earned the B.S. in BME at Yale in 2007. These young people are now pursuing advanced degrees in engineering, studying medicine and law, and building careers in industry. Our graduate program is currently populated by 48 of the brightest young biomedical engineers in the country, working on projects ranging from design of new vaccines, to repair of damaged optic nerves, to construction of image-guided neurosurgery systems, to analysis of microscopic changes in the brain during activity and disease.

Our faculty continues to grow in both number and accomplishments. Our newest junior faculty members—Erin Lavik, Michael Levene, and Tarek Fahmy—have quickly established themselves as outstanding independent researchers, graduate student mentors, and teachers. Of the many recent accomplishments of our senior faculty members, I have space to enumerate only a few. After a short time at Yale, Rich Carson is leading our graduate admissions, serving as Director of Yale's PET Center, and continuing to win awards for his pioneering research, most recently the Kuhl-Lassen Lecture Award for Research in Brain Imaging. Jim Duncan continues to be a key person in bridging the engineering and medical campuses: he was recently appointed Associate Chair of the department to facilitate his work in this area. Significantly, Jim was also named the Ebenezer K. Hunt Professor of Biomedical Engineering, which is well-deserved recognition for his consistently outstanding work in image analysis research, teaching, and mentorship.

In upcoming issues we will tell you more about other exciting developments such as the new Core Center for Quantitative Neuroscience with Magnetic Resonance, led by Fahmeed Hyder; and newly occupied laboratories for Vascular Biology and Therapeutics, an interdisciplinary community in which Laura Niklason, Themis Kyriakides, and I have laboratory space that is uniquely designed and equipped for vascular bioengineering.

I am delighted to be part of this vibrant, expanding community. I invite you to learn more about us: through this newsletter, through our website, or by visiting us in New Haven.

W. Mark Saltzman, Ph.D.
Goizueta Foundation Professor of Chemical and Biomedical Engineering
Professor of Cellular & Molecular Physiology
Chair, Biomedical Engineering

In This Issue

Newly Funded Research Programs Led By Yale BME Faculty

NIH Awards $7.2 Million Grant to Cardiovascular Imaging at Yale

The National Institute of Health (NIH) recently awarded a group of Yale University researchers $7.2 million for their project entitled "LV Strain Quantification from 4D Echocardiography." Professor James Duncan of Yale biomedical engineering will team up with Yale cardiologist Albert J. Sinusas, M.D., professor of medicine and diagnostic radiology, to develop hardware and software with the capability to analyze three-dimensional images of the human heart. These faculty will work with collaborators from the University of Washington and Philips Medical Systems to create a viable imaging system using mathematical models that will provide doctors with real-time quantitative information for cardiac imaging.

NSF Funds Vaccine Delivery Through the Use of Nanoparticles

A group of Yale scientists including biomedical engineers and cell biologists, were recently awarded a $1 million grant from the National Science Foundation (NSF) to study the delivery of nanoparticles for disease treatment and prevention. Led by biomedical engineering professor Tarek Fahmy, this two years of funding will provide the means to analyze the development of nanoparticles with the capability to evade barriers in the body while stimulating an immune response through antigen-presenting cells. These "smart nanoparticles" will serve to mimic the properties of bacteria and viruses as a safe and effective vaccine delivery system. In addition, the group will track the nanoparticles using dendritic cells to analyze their internalization and release characteristics. Co-investigators for the grant include Dr. Mark Saltzman, BME, and Dr. Michael Caplan, professor of physiology and cell biology.

NIH Provides $2 Million for New Magnetic Resonance System

A group of Yale imaging faculty, led by Douglas L. Rothman, professor of diagnostic radiology and biomedical engineering, have received a $2 million High-End Instrumentation (HEI) grant from the National Center for Research Resources (NCRR). The funding was recently used to purchase a 7-Tesla human magnetic resonance (MR) system that will help to explore the diagnosis and treatment of diseases such as epilepsy, diabetes, and learning disorders. As a facet of the National Institute of Health (NIH), the NCRR serves to, "...provide laboratory scientists and clinical researchers with the environments and tools they need to understand, detect, treat, and prevent a wide range of diseases."

Malone Engineering Center: A Home for BME

The Yale University campus welcomed its newest addition, the five-story, 63,117 square foot "Daniel L. Malone Engineering Center," on October 10, 2005. An element of Yale's $500 million commitment to science and engineering, the building is located on Prospect Street near the Arthur K. Watson Hall, and is the second new engineering building to be commissioned since the 1900s. Designed by Cesar Pelli & Associates, the center features a limestone veneer and glass wall, designed to reflect its historic New Haven surroundings.

The Daniel L. Malone Engineering Center was built largely due to a generous $24 million contribution by John C. Malone, '63 E. John Malone has served as the chair of Liberty Media since 1990 and the chair of Media International since June 2004. In addition, he worked at Tele-Communications Inc., serving as the president, chair, and chief executive officer, and earned a Sheffield Fellowship in 1999.

The Center is named after John C. Malone's father, the late Daniel L. Malone. Daniel Malone served as an engineer for General Electric, building wartime radar systems, commercial televisions, and military communications. In 1960, Daniel Malone co-founded La Pointe industries, which is a supplier of military communication systems and components.

Yale President Richard C. Levin, John C. Malone, and various engineering deans and faculty attended the dedication ceremony on October 10, 2005. The highlight of the dedication featured a nylon polymer ribbon cutting ceremony, in which a member of the department mixed chemicals to create a nylon ribbon. With President Levin holding the blue strand, Malone did the honors, commemorating the noteworthy day.

According to the dean of Yale Engineering, Paul Fleury, the building, "Stands as a statement to all that Yale Engineering is an integral part of this university's most vibrant intellectual life. The research and teaching

that will take place here will center upon those forefront areas of biomedical engineering, materials science and nanotechnology that underpin 21st-century progress."

The building boasts many sustainable design features, such as sensors that reduce energy consumption and a plumbing system that promotes water conservation. It was constructed from materials of high recycled content, and when possible, locally manufactured materials and products. Over 75% of the building's woodwork came from sustainably-managed forests and the building is designed so that the wastewater from the labs are treated on sight and reused as water for flushing toilets. This process, as well as other water conservation measures allows the center to use 85% less potable water over a conventionally equipped building, saving 95,000 gallons of water a year. In addition, the 100% filtered outdoor air that supplies the building maintains the high indoor air quality. These intricate design parameters helped earn the building a LEED Gold Rating in 2006, a standard created by the U.S. Green Building Council in 2000 to promote sustainable design.

The Center features undergraduate facilities, such as the Frederick P. Rose Teaching Laboratory, as well as offices and laboratories for students and faculty to conduct research. The architects and engineers of the building designed the labs so that they can be modified as their research evolves. The Malone Engineering Center currently houses the Biomedical Engineering department, as well as the Yale Institute for Nanoscience and Quantum Engineering.

John Malone (2nd from Rt.) tours one of the laboratories with his son Evan (far Lt.), President Richard Levin (2nd from Lt.), and Dean of Engineering Paul Fleury (Rt.).

Students perform experiments in the Frederick P. Rose Teaching Laboratory.

John Malone and President Richard Levin cut a chemically created "nylon ribbon" during the Malone Center Dedication Ceremony.

A research assistant performs an experiment with an undergraduate researcher in one of the Malone Engineering Center laboratories.

Yale Biomedical Engineering Professors Receive Prestigious Early Career Awards

Two of Yale's BME faculty were recently honored as recipients of the Wallace H. Coulter Foundation Early Career Translational Research Award in Biomedical Engineering. The Wallace H. Coulter Foundation, a non-profit, private foundation, "seeks to support biomedical research that is translational in nature, and to encourage and assist eligible biomedical engineering investigators to establish themselves in academic careers involving translational research." Each award provides two years of funding for a faculty member who has a primary appointment in a Biomedical Engineering program.

Dr. Erin Lavik received the award for her work on "Sustained delivery of timolol maleate for management of elevated IOP for glaucoma." This work was done in collaboration with researchers Young Kwon and Markus Kheun at the University of Iowa.

Dr. Tarek Fahmy received the foundation award for his work on "Multimodal nanoparticles for targeting autoimmune T cells in systemic lupus erythematosus: A strategy for non-invasive diagnosis and targeted drug delivery."

The foundation's namesake and benefactor, Wallace H. Coulter, was an engineer who most famously invented the "Coulter Counter," a device used to automate the process of counting blood cells, based on the "Coulter Principle" of counting microscopic particles suspended in a fluid. He and his brother later founded Coulter Electronics to develop and manufacture their invention and concept, which to date is still one of the most used concepts in medical diagnostics. The Coulter Foundation's contributions provide funding to numerous biomedical engineering programs and faculty.

Recent BME Publications

Yale Engineering was recently ranked No. 1 in citation impact of its faculty research papers for the past five year period by Science Watch Newsletter. Here are just a few of the most recent contributions from Yale's Biomedical Engineering faculty and students.

Reeves N.P., Narendra K., and Cholewicki J. (2007). Spine stability: the six blind men and the elephant. Clin. Biomech. 22(3):266-274.

Fahmy T., Schneck J.P., and Saltzman W.M. (2007). A nanoscopic multivalent antigen-presenting carrier for sensitive detection and drug delivery to T cells. Nanomedicine, 3(1):75-85.

Rodriguez M., Liow J-S, Thada S., Sibomana M., Chelikani S., Mulnix T., Johnson C.A., Michel C., Barker W.C., and Carson R.E. (2007). Count-rate dependent component-based normalization for the HRRT. IEEE Trans Nucl Sci, 54(3):486-495.

Bansal R., Staib L. H., Xu D., Zhu H., and Peterson B.S. (2007). Statistical Analyses of Brain Surfaces Using Gaussian Random Fields on 2D Manifolds. IEEE Transactions on Medical Imaging, 26(1):46-57.

Dahl S.L., Rhim C., Song Y.C., and Niklason L.E. (2007). Mechanical Properties and Compositions of Tissue Engineered and Native Arteries. Annals of Biomedical Engineering, 35(3):348-355 (Epub 2007 Jan 6.)

Jay S.M., Skokos E., Laiwalla F., Krady M., and Kyriakides T.R. (2007). Foreign body giant cell formation is preceded by lamellipodia formation and can be attenuated by inhibition of Rac activation. Am. J. Pathol., 171(2):632-40.

Chester D.W., Klemic J.F., Stern E., Sigworth F.J., and Klemic K.G. Holey carbon micro-arrays for transmission electron microscopy: A microcontact printing approach. Ultramicroscopy, 107(8):685-91, 2007. Epub 2007 Jan 30

Meltzer J.A., Negishi M., and Constable R.T. Biphasic hemodynamic responses influence deactivation and may mask activation in block-design fMRI paradigms. Hum Brain Mapp. Epub 2007 Apr 20

Trubel H.K.F., Sacolick L.I., and Hyder F. (2006). Regional temperature changes in the brain during somatosensory stimulation. J Cereb Blood Flow Metab., 26:68-78

Munbodh R., Jaffray D., Moseley D., Chen Z., Knisley J., and Duncan J. (2007) A frequency-based approach to locate common structure for 2D-3D intensity-based registration of setup images in prostate radiotherapy. Medical Physics, 34(7):3005-3017

Faculty Spotlight

An Introduction of Yale's Biomedical Engineering Faculty

Erin Lavik has earned distinction as a Top Young Innovator by MIT's "Technology Review" magazine and received an Early Career Award from the Coulter Foundation. Her current research focuses on developing new therapeutic approaches for the treatment of spinal cord injury and retinal degeneration. Lavik's group is working to create the appropriate environment for repair using biodegradable polymers. She works to functionalize the polymers and process them into three dimensional scaffolds with controlled pore architectures that mimic the structure of tissues in the spinal column.

R. Todd Constable, Co-Director of Yale School of Medicine's Magnetic Resonance Research Center, has current research interests involving the development of MRI techniques to provide functional and quantitative information in addition to high quality pictures of anatomy to answer fundamental questions in the basic sciences and medicine. His laboratory focus is to examine the relationship between the increment in the functional magnetic resonance signal measured during a task and the influence of baseline brain activity on the size of this increment. In addition, he is developing MR imaging pulse sequences aimed at improved imaging of the liver and pancreas in order to better diagnose patients with disease or to follow the efficacy of treatment. Constable has joint appointments in Radiology and Neurosurgery.

Tarek Fahmy was recently honored by the Coulter Foundation with an Early Career Award. Fahmy's research interests focus on the engineering, fabrication, and application or nanobiomaterials for the understanding and modulation of the immune response. He is currently investigating multiple research areas including in vitro detection of the immune response to different antigens, delivery of drug and antigen for in vivo modulation of immune cell system cell function, and magnetic resonance imaging of the immune system and lymphoid organs.

Richard E. Carson's research involves using Positron Emission Tomography (PET) as a tool to noninvasively measure a wide range of in vivo physiology in humans. He focuses on the development of applications of new tracer kinetic modeling methods and PET reconstruction and image quantification, with a biological focus on the measurement of dynamic changes in neurotransmitters. In addition to his BME appointment, Carson is Co-Director of the Yale PET Center and has a joint appointment in Diagnostic Radiology. Dr. Carson serves as the Graduate Student Coordinator for BME.

Lawrence H. Staib's research centers on techniques that can be used to obtain accurate analysis and quantification of medical images. He is currently developing methods for the segmentation of anatomic object boundaries from structural images using geometric models of deformable objects to measure various geometric features that may be indicative of disease. In addition, he is interested in the analysis of diffusion tensor magnetic resonance images and functional magnetic resonance images. His primary application is the measurement of neuroanatomy and function. Staib holds joint appointments in BME and Diagnostic Radiology.

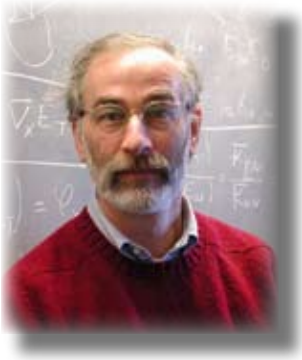
James S. Duncan has been honored as an IEEE Fellow and was recently named as the Ebenezer K. Hunt Professor of Biomedical Engineering. His current research focus is the development of biomedical imaging as a tool for understanding basic anatomical and physiological relationships in normal and abnormal states improving accurate and reproducible clinical diagnosis. He examines how to find the boundary of deformable objects efficiently and reproducibly. His current research has included segmentation of the left ventricle of the heart and of the temporal lobes of the brain using Magnetic Resonance images. Duncan serves as the Undergraduate Student Coordinator for BME.

W. Mark Saltzman, Chair of the Department of Biomedical Engineering, has earned the Distinguished Lecturer Award from the Biomedical Engineering Society in addition to numerous other distinctions. Saltzman's research interests include tissue engineering and drug delivery. His current projects focus on the development of technology using bio-compatible polymeric materials for the controlled delivery of drugs, proteins, and genes for the treatment of cancer, disease, and other applications. In addition, his group has developed new polymeric materials that influence the growth and assembly of tissues.

Michael Levene's Biophotonics laboratory develops advanced optical tools to address a wide variety of biological problems. His current research projects include the development and application of laser-scanning microscopies, such as multiphoton microscopy or Stimulated Brillouin Scattering Microscopy, and of the fluorescence fluctuation analyses, such as fluorescence correlation spectroscopy. His current projects include the imaging of NADH to examine the metabolic dysfunction of astrocytes in temporal lobe epilepsy and the development of micro-optical probes for deep-brain imaging.

Fahmeed Hyder, holding a dual appointment in BME and Diagnostic Radiology, was awarded the Niels Lassen Award by the International Society for Cerebral Blood Flow and Metabolism for outstanding contribution by a young scientist. His major research focuses include the quantitative characterization of biophysical and neurophysiologic events that contribute to the blood oxygenation level dependent fMRI (functional Magnetic Resonance Imaging) contrasts. In addition, he develops NMR methods to probe the metabolism of natural substrates including ^{1}H, ^{13}C, ^{19}F.

Jacek Cholewicki, a joint professor of BME and Orthopaedics, was previously honored with the International Society for the Study of Lumbar Spine (ISSLS) Award. He performs research focusing on spine biomechanics. His particular analysis is on the muscle function in the lumbar spine in relation to clinical instability. Using electromyography and biomechanical modeling, Cholewicki compares muscle co-activation in healthy volunteers with that of patients suffering from lower back pain with no clear pathoanatomic diagnosis.



Steven Zucker's current research explores the characterization of neuron function by putting together the requirements of vision systems with insights from neurophysiology and applied mathematics to develop an abstract theory of computational vision. Based on differential geometry, his approach leads to methods of curve detection, shading and texture analyses, stereo, color, and generic shape description. In addition to his role in BME, Zucker is the Acting Chair for Computer Science and Director of the Program in Applied Mathematics.

As Director of Magnetic Resonance at Yale Medical School, **Douglas L. Rothman** holds a joint appointment in BME and Diagnostic Radiology. Rothman's current research focuses on the metabolic basis of brain functional imaging with the development of magnetic resonance (MR) methods for studying brain energy and neurotransmitter metabolism. In addition, he is developing methods for studying liver and muscle carbohydrate metabolism.

Themis R. Kyriakides studies the effects observed when foreign materials are implanted into the body. His work focuses on the cellular and molecular events that occur at the interface between implanted biomaterials and tissues. His research interests include the study of biomaterial-induced inflammation, wound healing, tissue regeneration, and extracellular matrix remodeling. Kyriakides and his group are currently working to develop useful biomedical products such as biodegradable polymers and artificial skin, and biomaterials with the ability for gene delivery. Kyriakides holds joint appointments in Biomedical Engineering and Pathology.

Hemant D. Tagare is an Associate Professor of BME with a joint appointment in Diagnostic Radiology. Tagare's research focuses on mathematical theory of non-rigid correspondence and non-rigid shape change with applications to heart motion analysis. In addition to this work, Tagare is analyzing the indexing and rapid retrieval of images based on their content, and examining segmentation with deformable contours. He is also looking at visual attention and its use in object recognition.

Robin de Graff holds a joint appointment in BME and Diagnostic Radiology. His research focuses are Nuclear Magnetic Resonance (NMR) spectroscopy methods that can be used to measure cellular metabolic pathways of animals and humans in vivo. In addition, he studies the cerebral energetics and neurotransmitter metabolism in the brain during periods of increased neuronal activation. His specific applications lead to the study of NMR spectroscopy and imaging methods for applications that utilize very high magnetic fields.

Frederick J. Sigworth works to clarify the transduction mechanisms of channel proteins, such as the voltage-gated Shaker potassium channel, that act as molecular transducers responding to stimuli by opening a pore to allow ionic current to flow. By utilizing patch-clamp recordings for the sensitive measurements of single-molecule behavior, his group seeks to extend the sensitivity of this method by exploiting microfabrication technology. In addition, Sigworth uses single-particle imaging in cryo-electronmicroscopy to obtain three-dimensional structures of membrane proteins without the need for crystals. Sigworth holds a joint appointment in BME and Physiology.

Xenophon Papademetris works to develop image analysis methodology for the automated quantification of three-dimensional images and image sequences with applications in whole organ segmentation. In addition to this work, Papademetris examines fat quantification in whole body mouse imaging, non-rigid brain registration and non-rigid motion and deformation analysis. Papademetris holds a joint appointment in BME and Diagnostic Radiology.

Dr. Laura Niklason holds a joint appointment in Biomedical Engineering and Anesthesiology. She was recognized in US News & World Reports as one of their twenty-one Innovators and was named "Eminent Scientist of the Year" by the International Research Promotion Council. Niklason's group currently focuses on the studies of vascular biology and cardiovascular tissue engineering. Her research interests include vascular tissue engineering, adult stem cell differentiation into cardiovascular phenotypes, cardiac tissue engineering, biomimetic culture conditions for cardiovascular tissues, and vascular remodeling as it pertains to disease processes.

Check out our web-site for more information, such as recent research developments and publications by the Yale BME Faculty. Visit us at www.eng.yale.edu/bme.

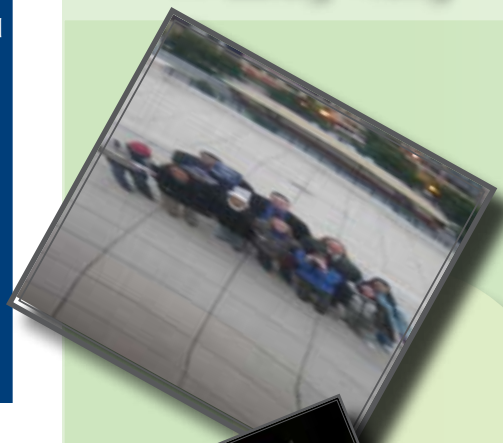
Conference In the Windy City

This past October, Yale Biomedical Engineering graduate and undergraduate students, in addition to a group of biomedical engineering professors, ventured to Chicago for the annual Biomedical Engineering Society (BMES) Conference hosted by Northwestern University. The conference, titled "Unlimited Horizons", brought together some of the brightest minds in Biomedical Engineering for a four day event.

Prior to the conference, students and faculty submitted abstracts of their work that were judged by a panel. Those selected presented a poster or talk about their work during the event (Yale presentations listed at right, presenters in bold).

During the conference, Yale hosted their first annual BMES reception to welcome alumni and friends from the Chicago area. In addition, perspective undergraduates looking to learn more about Yale's graduate program were invited to attend. Current graduate students and faculty were on hand to answer questions and chat about their experiences. Door prizes, great food, and a warm atmosphere overlooking the Chicago River made for a memorable evening with many special alumni and friends.

The trip would not have been complete without a little time to take in the sights of the city. A BMES reception was organized one evening at Chicago's legendary Field Museum, where students and faculty shared stories and research interests while eating in the shadow of Sue the dinosaur, the world's most famous tyrannosaurus rex. In addition the Yale group spent their free time visiting historic and cultural landmarks such as The Art Institute of Chicago, Millennium Park and the Magnificent Mile. The group even enjoyed a meal at the famous Gino's East to savor some of their legendary deep dish pizza.



BMES 2006
Talks and Presentations

M. Cartiera, E. Ferreira, C. Caputo, M.E. Egan, M.J. Caplan, W.M. Saltzman
Correction Of Cystic Fibrosis Defects With Curcumin Encapsulated Nanoparticles

Y. Cu, C. Lemoellic, M.J. Caplan, W.M. Saltzman
Lectin-Coated PLGA Microparticles for DNA Delivery In Mammalian Cells

S. Demento, W.M. Saltzman, M.J. Caplan, T. Fahmy
LPS-Coated PLGA Nanoparticles As Vaccine Delivery Vechicles

P. Fong, T. Fahmy, W. M. Saltzman
Carigent Therapeutics: High Surface Density of Targeting Ligand For Drug Delivery Nanopaticles

M. Ford, **C. Williams**, M. Michaud, J.A. Madri, E. Lavik
Macroporous Hydrogels For The Formation Of Stable Microvascular Networks

S. Jay, C. Chung, J. Doll, S. Crawford, W.M. Saltzman
Sustained Release of PEDF For The Treatment of Hepatocellular Carcinoma

L. Qian, D. Krause, W.M. Saltzman
Three-Dimensional Culture Of Fetal Liver Cells

R. Samstein, F. Balderrama, J. Lapiera, W.M. Saltzman, T. Fahmy
Using Bile Salts As a Vector for Oral Delivery of Drug or Biodegradable Particles

W. Mark Saltzman
Drug Delivery To The Brain Using Implanted Polymers

W. M. Saltzman and **T. Fahmy**
Multimodal Antigen-Presenting Carriers For T Cell Non-Invasive Detection And Drug Delivery

A. Sawyer, K. Neeves, C. Foley, K. Andersen, W.L. Olbricht, W.M. Saltzman
Nanoparticle Penetration In The Brain with Convection-Enhanced and Enzyme Delivery

E. Steenblock, T. Fahmy
Artificial Antigen Presentation Using Biodegradable Polymers

R. W. Sirianni, J. Kremer, Y. Chen, W.M. Saltzman
Local Delivery of Paclitaxel To Heterogeneous Tissue: The Impact of Extracellular Matrix Components.

Spring 2007
BME Seminar Series

This Spring, the Biomedical Engineering Department hosted a series of seminars aimed at expanding the knowledge and information available to Faculty, Staff, and Students. Hosted by the Department Chair, the seminar speakers visited Yale to share their expertise on particular research topics.

Dr. Semahat Demir
Program Director for Biomedical Engineering
NIH
Funding Opportunities at NSF

Dr. Tzung Hsiai
University of Southern California
Assistant Professor of Biomedical Engineering and Medicine/Cardiology
Shear Stress Regulates Vascular Oxidative Stress

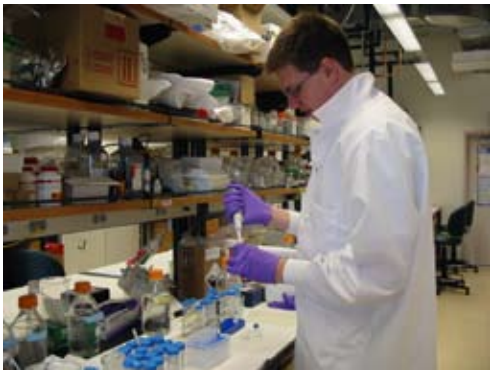
Dr. Jay Humphrey
Biomedical Engineering
Texas A&M University
Bridging Vascular Biology and Mechanics: A Role for Modeling?

Ms. Princess Imoukhuede
Dept. of Bioengineering
California Institute of Technology
GAT1: Fluorescent constructs reveal motifs for correct transporter trafficking and dimerization and reveal its lateral mobility

Dr. Shuming Nie
Emory University
Biomolecular & Nanotechnology Engineering
Biomedical Engineering and Nanotechnology for Targeted Molecular Imaging and Therapy

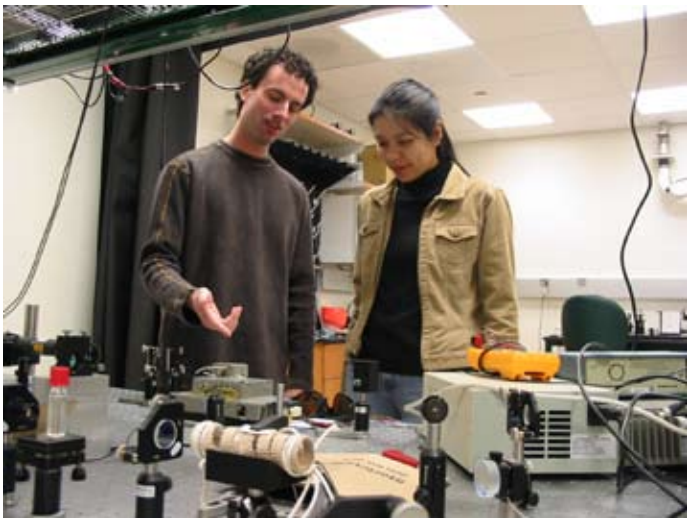
Dr. Patrick S. Stayton
Dept. of Bioengineering
University of Washington
Smart Biohybrid Materials that Talk and Listen in Nanospace

Yale BME Undergraduate Internships



Karlo Perica, '07, works to fabricate nanoparticles in the lab of Dr. Tarek Fahmy.

Each year, the Department of Biomedical Engineering at Yale University invites students from around the world to apply for our Undergraduate Internship research program. This 10 week summer program allows promising engineering students to work with Yale biomedical engineering research teams in a variety of areas including biomedical image analysis, drug delivery, optical imaging, magnetic resonance imaging and spectroscopy, tissue engineering, positron emission tomography (PET), and biomechanics. With facilities located in both Yale Engineering and Yale School of Medicine, the students are offered a wide variety of services and support.



Dr. Michael Levene explains the workings of an IR laser setup to summer intern Aigerim Djamanakova, '07.

This past summer, 10 talented student researchers from various undergraduate institutions worked on projects ranging from the fabrication of artificial lung tissue, to image analysis of bipolar disorder using magnetic resonance imaging (MRI) of brain tissue. The students attended weekly seminar meetings where they were introduced to various areas of biomedical engineering through presentations and discussions by current Yale faculty. Dr. W. Mark Saltzman, Department Chair of biomedical engineering, is encouraged by the program and its future, "Thanks to the help of generous supporters, we are fortunate to have the ability to cultivate a new generation of young scientists and engineers."

2006 Summer Interns

Maegen Bradley (Tufts University)
Tissue Engineering of Whole Rat Lung

Andrea A. Brock (St. Louis University)
Eigenanalysis of Diffusion Tensor Imaging Data in Bipolar Disorder

Colin Compas (Vanderbilt University)
Image Registration in Surgical Resection Images

Aigerim Djamanakova (Yale University)
Mesoporous Silica Nanoparticles for Targeted Ultrasound-Induced Cavitation

Won-Hoon Jason Lee (Yale University)
Input Function Characterization in PET Brain Studies Using Segmented MR Defined Carotid Arteries

Karlo Perica (Yale University)
A Novel Formulation for Oral Drug Delivery Using Bile Salts

Sandeep Saluja (Yale University)
Sustained Delivery of Timolol Maleate for Management of Elevated IOP for Glaucoma

Robert M. Samstein (Yale University)
Targeted Chemotherapy and Novel Methods of Oral Delivery

Susan Saucier (The University of Maine)
Alginate-based Scaffolds for Tissue Engineering and Gene Delivery

Colin Shea (University of Virginia)
Fuzzy C-Means Clustering of fMRI Activations

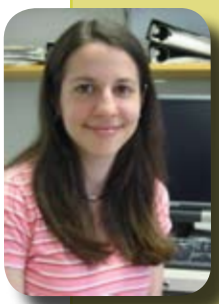
Life After Graduate School

These Talented 2006-2007 Yale Doctoral graduates have completed their degrees and are ready to take on the world of Biomedical Engineering.

Margaret Cartiera

Margaret Cartiera recently completed her thesis, "An Analysis of the Interaction and Intracellular Fate of Nanoparticles in Epithelial Cells: Application in Oral Delivery of PLGA Nanoparticles Encapsulating Curcumin for Treatment of Cystic Fibrosis" under the direction of Professor W. Mark Saltzman. While at Yale, her graduate research focused on the interest surrounding the interaction of PLGA nanoparticles (NPs) with epithelial cells. She conducted in vivo work to investigate whether NPs could serve as vechicles for oral drug delivery, capable of improving the bioavailability of curcumin in the treatment of Cystic Fibrosis. During her time at Yale, Cartiera earned the Dwight N. and Noyes D. Clark Fellowship Award. Following graduation, she will begin working at a biotech start-up company on cutting edge scientific developments.

Christine DeLorenzo



Christine DeLorenzo, of Brooklyn, NY, a recipient of an NIH/NLM bioinformatics training grant, recently completed her degree at Yale in the laboratory of James Duncan. Her research focused on the fact that during neurosurgery, the brain deforms, making it difficult for neurosurgeons to use preoperative images to navigate through the brain anatomy. DeLorenzo worked to track this brain shift using digital cameras in the operating room and cortical surface deformation with a biomechanical model to determine deformation within the brain volume. This method can be used to provide neurosurgeons with accurate images of the intraoperative brain, which helps make neurosurgery safer. Due to the close ties with Yale-New Haven Hospital neurosurgeons, DeLorenzo was able to test her prototypes in a working environment during surgeries. Her thesis, "Image-Guided Intraoperative Brain Deformation Recovery" reflects her findings in this study. After graduation, Christine plans to complete a post-doctorate experience.

Eliezer Kahn

Eliezer Kahn, from Teaneck, New Jersey, completed his degree with a thesis entitled, "Computational Strategies for Meshfree Nonrigid Registration." During his doctoral experience at Yale, Kahn worked under the direction of his advisor, Professor Lawrence Staib, conducting research on nonrigid registration of biological shapes, such as the human brain. With this research he was able to develop a novel algorithm for nonrigid registration based on the use of advanced numerical methods. Kahn is currently working at the Johns Hopkins University Applied Physics Laboratory in Maryland.

Qin Qin

During his time at Yale, Qin Qin, of Beijing, China, studied the biological significance of the many magnetic resonance (MR) parameters that can be measured to improve the fundamental understanding of a living organism's function and diseases. Due to the complexity of the human body, accurate spatial specificity and high signal sensitivity are both critical for correct tissue characterization. Under the direction of Dr. John Gore and Dr. Robin De Graff, Qin developed novel MR pulse sequences to achieve maximum signal-to-noise ratio from regions of interest for quantitative measurement. His thesis work, "2D Arbitrary Shape Selective Excitation for T2 and Magnetic Resonance Spectroscopy Measurements" details his research findings. He is currently conducting a postdoctoral fellowship in the Radiology Department at Johns Hopkins Hospital using multi-parametric MRI techniques to model the effects of stroke on the brain.

Peter Reeves

Peter Reeves, a recent BME graduate from Canada, worked with Dr. Jacek Cholewicki on his thesis research entitled, "Turning-out instability: the importance of feedback control on the spine." His research involved defining spine stability and how it is achieved to learn more about the proper function as well as the dysfunction leading to lower back pain. During his time at Yale, Peter was awarded the International Society for the Study of the Lumbar Spine (ISSLS) Award. After graduation, Reeves will be accepting a position as a Research Associate at Michigan State University College of Osteopathic Medicine.

Eric Stern

Eric Stern, from Long Island, NY, completed both his undergraduate and graduate experiences in the BME program at Yale. As a graduate student, he worked under the direction of Dr. Mark Reed to design highly sensitive chemical and biological sensors for basic research and clinical applications. He created nanoscale solid-state electronic devices capable of detecting specific proteins and DNA strands without the need for fluorescent or radioisotope labels. His thesis, entitled, "Label-Free Sensing with Semiconducting Nanowires" details his years of work in this area. Stern has accepted a postdoctoral fellow position with Dr. Tarek Fahmy at Yale University, but is currently working in residence at Harvard University with Professor David Mooney. He plans to focus on the production of low-cost, point-of-care diagnostic platforms and novel drug delivery fabrication methods.

Ping Yan

Ping Yan of the People's Republic of China worked with Professor James Duncan to complete her thesis work entitled, "Cardiac Motion Analysis From Echocardiography". Her graduate research was to build a new model that would be robust, efficient, physically plausible and imaging modality-independent from which a computational platform for 3D+T/4D cardiac deformation analysis can be constructed. During her time at Yale, Ping was awarded the first Robert E. Apfel Fellowship and the Institute for Pure and Applied Mathematics (IPAM) workshop Fellowship. After graduation, Yan will complete a post doctorate experience at Yale.

Yale Undergraduates In *Motion*

Yale Undergraduates excel in the classroom and beyond. Here are just a few of the many exciting opportunities and honors earned by our BME students.

Katherine Johnson, '07, has been awarded a post baccalaureate fellowship by the National Cancer Institute at the National Institute of Health. Katherine will be performing work in the area of papillomaviruses.

Kelly Karns, '07, was recently chosen as a recipient of the 2007 Gates Cambridge Scholarship, established by the Bill and Melinda Gates Foundation in 2000. The scholarship, given each year to approximately 150 students selected from around the world, provides funding for students to attend Cambridge University for 1-3 years. The funding provides for tuition and fees, an allowance, and airfare, totaling about $40,000 annually. While at Cambridge, Kelly will be earning a Masters of Philosophy degree in Bioscience Enterprise.

Javier Lapeira, '07, spent this past summer in Brussels, Germany on a STARS II (Science, Technology and Research Scholars) fellowship where he performed cancer research at a biotech company. The fellowship, awarded to approximately ten Yale Juniors each year, provides funding to encourage underrepresented students in the sciences to pursue academic research. He recently presented his work at the National Conference of Undergraduate Research in San Francisco.

Its Never Too Early For Science

While science is an integral part of all high school curriculums, some students are not satisfied with the answers that they receive in the textbooks. They want to see science in action. As a senior at Covent of the Sacred Heart in Greenwich, Connecticut, Ayesha Samant made a name for herself. Last summer, Ayesha spent time performing research in the laboratory of Dr. Mark Saltzman, under the direction of Rachael Weiss Sirianni, a graduate student in Biomedical Engineering.

While at Yale, Semant worked with Sirianni on the controlled delivery of anti-depression medication using ethylene co-vinyl acetate (EVAc) matrices to encapsulate the drugs. The drug of interest is placed inside the EVAc matrix and released through diffusion out of the pore structure. This method of drug preparation provides for the drug to be released over months or years instead of being released all at once in a "burst effect".

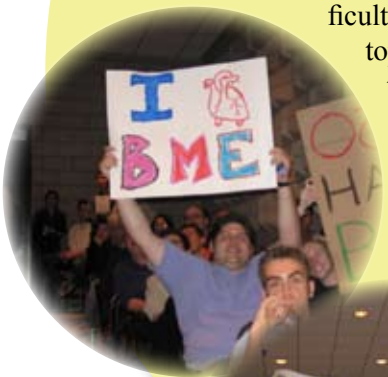
After completing her project, Ayesha was honored as one of 300 semi-finalists in the Intel Science Talent Search, the nations oldest award for pre-college scientists. In addition, Semant was chosen as a semi-finalist in the Siemens Westinghouse Science and Technology Competition.

On how she became interested in drug delivery, Ayesha remarked, "Drug delivery was naturally interesting to me because its uses are so widespread--from depression to cancer to diabetes."

This fall, Ayesha began her college career at the University of Pennsylvania and plans to major in life sciences and economics.

BME Faculty In Jeopardy!

Recently, two enthusiastic BME professors, Dr. Erin Lavik and Dr. Lawrence Staib, competed against the best and the brightest that Yale Engineering has to offer, in a fight for the ultimate prize: the year long reign as official "Engineering Jeopardy" Champions...and most importantly a pizza party for their entire department. Each department sacrificed two of their faculty to compete and challengers were faced with difficult questions testing all possible categories ranging in topic from pop culture to mathematics. A sampling of the questions included, "What famous Yalie wrote the epic novel "The Last of the Mohicans?" and "What reality TV show popularized the quest for the ultimate model?" (Ans: James Fenimore Cooper, and America's Next Top Model, respectively). Although the professors were given enthusiastic support by students and fellow faculty, the BME team came up short with a 3rd place ribbon. There's always next year!

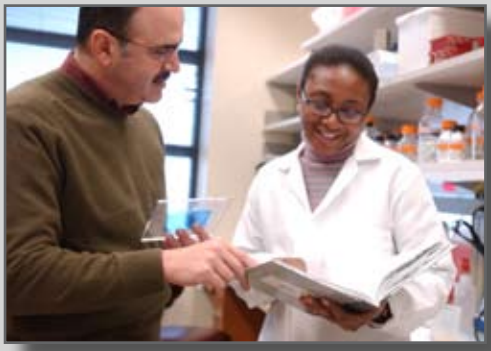


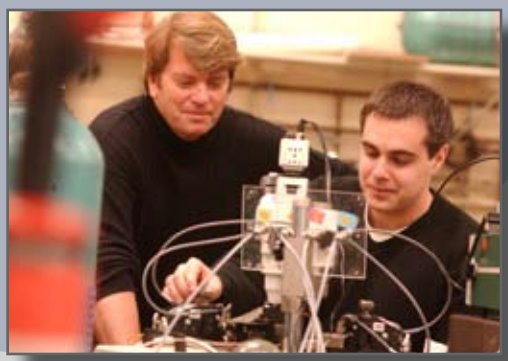
Time Out... For Fun

In addition to being great Biomedical Engineers, a group of graduate students and postdoctoral associates have a knack for playing basketball. These gentlemen in the department formed a competitive team that participates in weekend basketball games and tournaments. Having a chance to burn off some energy and interact outside of the lab in a team environment has increased the team atmosphere inside and outside of the lab. After a hard fought season, the team lost in the championship game. The group remains with high hopes for next season.

Yale BME

Where Medicine and Technology Collide





Editor and Design Layout: Jennifer Saucier-Sawyer
Photo Credits: Bridget Calendo, Yen Cu, Michael Marsland, Jennifer Saucier-Sawyer, Rachael Weiss Sirianni, Elona Vaisnys
Contributing Authors: Florence Kwo, W. Mark Saltzman, Jennifer Saucier-Sawyer

Questions or Comments?
E-mail us at yalebme@yale.edu or visit our web-site at www.eng.yale.edu/BME.
Yale BME NEWS is a bi-annual publication of the Yale Department of Biomedical Engineering.
Vol. 1, No. 1 highlights Yale Biomedical Engineering Department events through May of 2007.

Department of Biomedical Engineering
Yale University
Malone Engineering Center
P.O. Box 208284
New Haven, CT 06520-8284