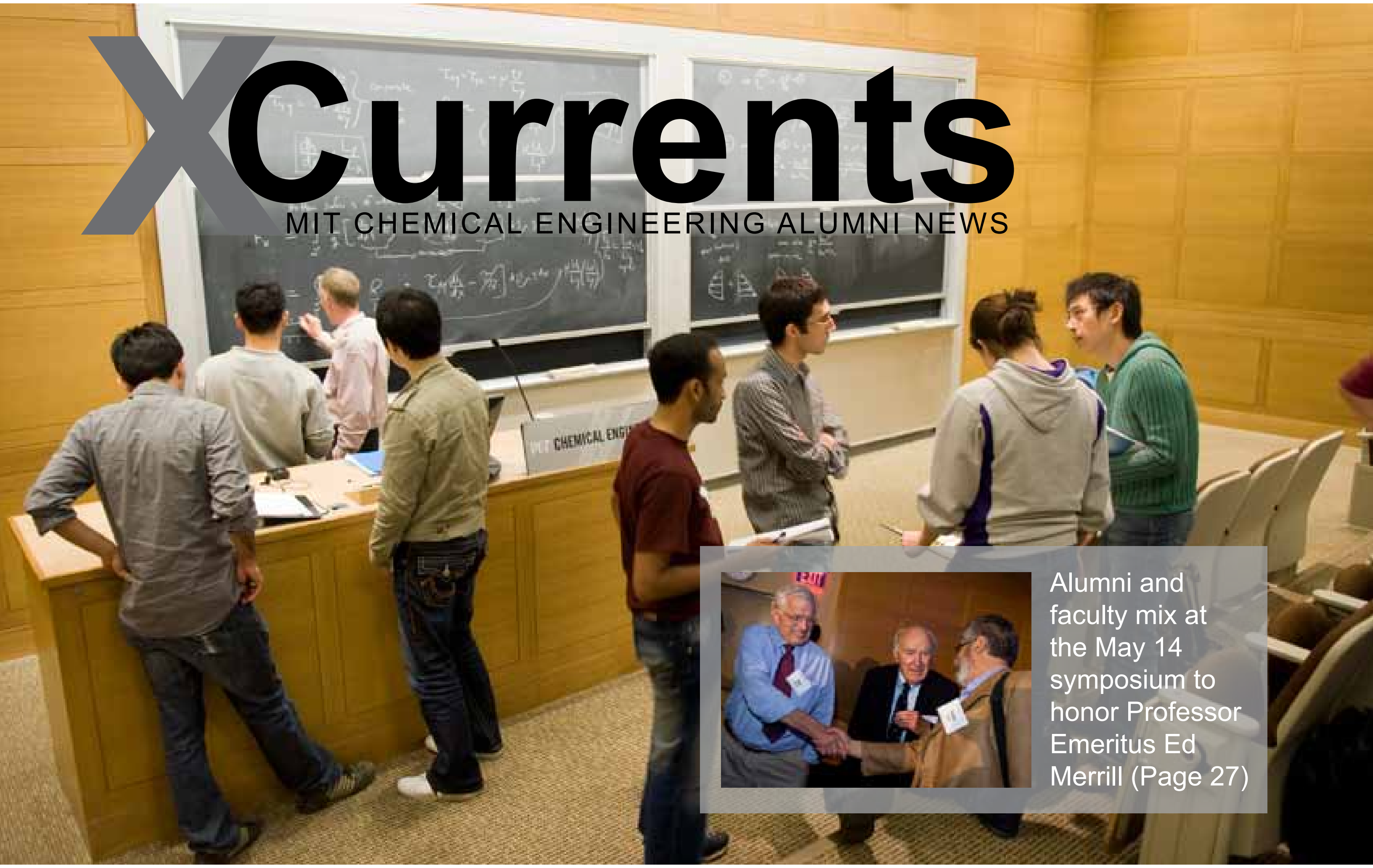
XCurrents

MIT CHEMICAL ENGINEERING ALUMNI NEWS



Alumni and faculty mix at the May 14 symposium to honor Professor Emeritus Ed Merrill (Page 27)

Letter from Department Head Klavs F. Jensen

As a new school year begins, I am happy for this opportunity to share with you some of the latest developments in the MIT Chemical Engineering Department, as well as some things that our alumni are doing outside the MIT campus. This was one of our priorities when we redesigned our Alumni News in the fall of 2009: we want to help create a dialogue with and among our Course X alumni. I am grateful for the positive response we've gotten, and based on your feedback, we've added more alumni highlights and expanded the research news from our faculty. We hope you enjoy it!

During the 2009-2010 academic year, the Department continued to excel, and retained its number-one ranking in the US News and World Report listing of top undergraduate and graduate programs; we have now held the first place position in chemical engineering for the past 21 years. Sponsored research volume increased significantly once again for our faculty, rising from last year's $41.2 million to a total of $50.4 million over the past year, representing a 22% increase. This is due in no small part by the gracious support by our alumni and friends of the Department throughout the year, of which our faculty and students are very grateful.

Highlights

find the latest news online:

web.mit.edu/cheme/

MITChemEng MITChemE

Massachusetts Institute of Technology

Letter from the Department Head continued

This fall, we welcome four new professors in the Department, each one bringing a new insight and expertise to our faculty. Daniel G. Anderson holds a joint appointment with the Harvard-MIT Division of Health Sciences and Technology; he has spent the last eleven years working in the Langer Lab and will continue his work with advanced biomaterials and drug delivery systems. Our second new professor is Richard D. Braatz, who is the new Edwin R. Gilliland Professor of Chemical Engineering, following the retirement of previous Gilliland Professor Ken Smith. Richard comes to us from the University of Illinois at Urbana-Champaign and is a leader in systems engineering. Allan S. Myerson, joining the Department as a professor of the practice, was previously in administration at the Illinois Institute of Technology in Chicago. His research includes industrial applications of crystallization. Our final new professor is Yuriy Román, who comes to us fresh from his post-doctoral research with Professor Mark E. Davis at the California Institute of Technology, working in the synthesis and characterization of microporous and mesoporous materials. You can find more information on our new faculty members on page 10.

Klavs Jensen provides a retrospect on the career of Professor Emeritus Ed Merrill at the May 14th symposium in his honor.

As mentioned, Professor Ken Smith retired in January of this year, giving us a great excuse for cake and champagne during our annual IAP faculty retreat. We thank Ken for his tremendous contributions through research, education and service to MIT and to the profession of chemical engineering. More information on his retirement can be found on page 7.

All of our faculty have been busy and enjoyed several national recognitions during the spring. Bob Cohen was elected into the National Academy of Engineering, and was also elected as a Materials Research Society Fellow. Kristala J. Prather won the NSF CAREER Award. Professor Gregory N. Stephanopoulos won the 2010 American Chemical Society E.V. Murphree Award and the BIO George Washington Carver Award for Innovation in Industrial Biotechnology while junior faculty member Chris Love was named the W.M. Keck Foundation Young Scholar in Medical Research. Paula Hammond also received the 2010 Distiguished Scientist Award from the Harvard Foundation. Of particular note is the awarding of the AIMBE Pierre Galletti Award, which is the AIMBE top honor, to Emeritus Professor Edward Merrill this spring.

This past May, the Department hosted a Symposium to Honor Professor Emeritus Ed Merrill, for his sixty years as a member of the MIT faculty. It was an wonderful event, with alumni from all over the world packing 66-110 to celebrate this inspiring teacher, advisor, colleague, and pioneer in the field of biomedical engineering. Speakers included former students, colleagues and current researchers who today continue to build upon his work in polymer synthesis, physical chemistry and biomaterials. We have much more on the symposium and Ed's legacy of biomedical advances in this edition, including current work by Professors Langer, Anderson, Love, Chakraborty and Strano. This and other research news can be found on page 16.

In keeping with the Ed Merrill theme, our 2010 Alan S. Michaels lecturer was Robert L. Bratzler '75, an academic descendent of Ed's. Bob discussed "Starting and Building Biotech Companies: From Sepracor to Selecta." He is the executive chairman of Selecta Biosciences, a Watertown-based biotech company pioneering the development of targeted nanoparticle vaccines for treatment and prevention of diseases. Bob shared advice and anecdotes from his experience of starting several successful biotechnology companies to a packed audience.

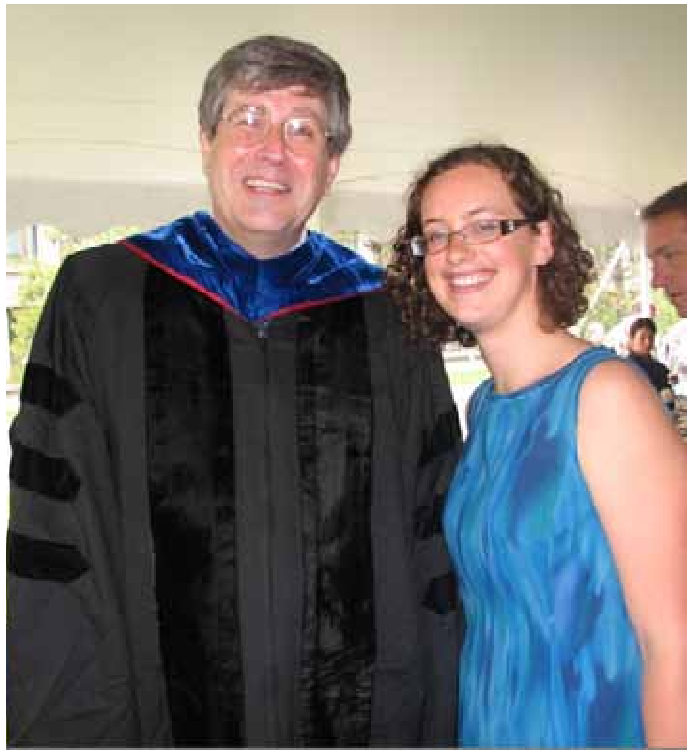
Chaitan Khosla, the Wells H. Rauser and Harold M. Petiprin Professor at Stanford University was our 2010 Warren K. Lewis Lecturer. Chaitan spoke on "The Untold Story of Gluten: Viscoelastic Wonder, Rat Poison, or Autoimmunity's Rosetta Stone?" He presented issues surrounding the "fascinating material" gluten and celiac disease. Over the past two decades Chaitan has studied polyketide synthases as paradigms for modular catalysis, and has exploited their properties for engineering novel antibiotics. More recently, he has investigated celiac sprue pathogenesis with the goal of developing therapies for this widespread but overlooked disease.

This fall we also hosted the 2010 Hoyt C. Hottel Lecture, honoring Professor Hottel's work in energy technology. On September 22nd, Dr. Steven E. Koonin, the Under Secretary for Science at the US Department of Energy, spoke on "Energy Innovation at Scale." More information is available at the web page (web.mit.edu/cheme/news/hottel.html).

April 10th, 2011, marks the 150th anniversary of MIT's founding. The Institute has many events and several symposia planned to celebrate the event; you can find more information at the website mit150.mit.edu. In this retrospective spirit, our Spring 2011 newsletter will include an historical perspective of MIT Chemical Engineering, as well as what we are doing today and in the future to further the legacy that you and I continue to learn from and contribute to.

Thanks to the efforts of Arup K. Chakraborty, the Graduate Committee and the Student Office, we had an excellent year recruiting a very talented class of graduate students. The generous external support of our doctoral program through graduate fellowships continues to be an essential asset in our effort to attract the very best students. Beyond its value as a recruiting tool, funding for graduate fellowships is a critical element of our graduate educational philosophy. By providing fellowship support for first year doctoral students, we enable the students to focus on the core subjects of chemical engineering and explore the breadth of research opportunities without being conflicted by teaching assistantships or sponsor requirements.

The financial situation has impacted the Department and we have learned to live within our means, but fortunately been able to avoid reduction in staff and activities. The support you have given us over the years, and continue to provide, has helped us buffer the effects of the financial downturn. We deeply appreciate that many of you have continued to support the Department through the recession in spite of the economic hardships placed on everyone.



At June's commencement reception, Klavs Jensen talks with one of Course X's newest alums, Rachel Licht '10, a Fullbright Scholar currently in France studying the production of cellulosic ethanol by fermentation.

We hope you enjoy this issue of the newsletter and look forward to your feedback.

Thank you for your support and best regards.

Klavs F. Jensen
Department Head
MIT Chemical Engineering Department

Practice School News

The David H. Koch School of Chemical Engineering Practice holds a special place in the hearts of many of our alumni, and I am happy to share with you some of the most recent happenings in the School as well as some upcoming developments.

The Spring 2010 semester saw our students and directors fan out to General Mills (GMI) in Minneapolis, Novartis in Switzerland, and stations at our two newest locations: Morgan Stanley in New York and Mawana Sugars in India. We also welcomed two new station directors: Bob Hanlon and Christopher Marton. Chris recently graduated with his PhD in Chemical Engineering from MIT and is an alumnus of the General Mills and Cabot stations. Bob directed the Mawana Sugars station; this was not his first stint as a station director, since he also directed the Syntex Chemicals station in Boulder, Colorado, back in 1987. In the intervening years between his two directorships, Bob led a very successful career first at Mobil, and them at Rohm and Haas, and has always been a staunch supporter of the Practice School program. We're happy to have both of them join us!

On page 6, Bob recounts his experience as Station Director in India. Appropriately, the lessons learned there mirror those that many of you experienced during your time in the Practice School. Even as we expand to new places and industries around the world, the traditional Practice School experience has not changed, just as the same foundation of chemical engineering education prepares students to solve an evolving range of environmental, engineering, even economic problems in today's world.

In March, we commemorated the twentieth anniversary of the naming of the David H. Koch School of Chemical Engineering Practice with a reception in the Department and Dinner in Mr. Koch's honor at Gray House, President Susan Hockfield's residence. We also celebrated Mr. Koch's upcoming 70th birthday and presented him with a montage of photos from recent Practice School stations and notes from students. It was a great evening and opportunity to thank Mr. Koch for his critical support of the Practice School.

Alan Hatton and Course X graduate student Emily Chang present mementos to David Koch '62 to celebrate twenty years of his support for the Practice School.

This fall, the Practice School moves into yet another locale: Brazil. We currently have seven students working at Vale Soluções em Energia (VSE) in Sao Jose Dos Campos, about 100 km north of Sao Paulo. I look forward to sharing with you in the next newsletter their experiences as we continue the tradition of providing unique and challenging opportunities to hone students' technical leadership skills. I extend a tremendous thank you to our host companies who have helped provide the kind of education that only these hands-on, real-world challenges can offer!

The Stations

Mawana Sugar Works, New Delhi, India
Directed by Bob Hanlon

At this second iteration of our station in India, our students faced issues concerning crystallization, evaporation, fluidized-bed drying, dust collection, and utilities management. They were able to use their problem-solving skills to offer solid improvement opportunities for the refinery, and were able to improve their own written and oral communications as well.

The Mawana community set a very high standard for hosting: superb food, superb accommodations, and an extremely responsive approach to our every need, including the occasional Domino's pizza delivery! Bob recounts that the huge and enthusiastic effort to get the students 'off campus' to experience India was very welcomed and appreciated. Trips to the Taj Mahal, Jaipur, and the Ganges River for water rafting are now part of their 'Great Moments in Life' memories. The opportunity to experience both Holi, the absolutely wonderful celebration of color, and Kumbh, the holy bathing ceremony in the Ganges that occurred when our rafts tipped, was icing on the cake. This complete program was what the Practice School is all about: work hard, play hard, learn.

Morgan Stanley & Co., Purchase, New York
Directed by Christopher Marton

Morgan Stanley was a most gracious host to a group of eight students at its Westchester campus. The station had a decidedly MIT feel with Course X and Practice School alumnus Jay Dweck '77 serving as host and MIT Professor Emeritus Gregory McRae serving as our primary point of contact.

The students quickly immersed themselves in the technology of large computer systems, and were surprised by the opportunities for chemical engineering available within a bank. Some of the projects focused on the assessment of power generation options, motivated by Morgan Stanley's commitment to achieving carbon neutrality. Other projects required the students to take a systems-level view of a datacenter to assess performance and identify opportunities for improvement. Above all, the students learned that

Morgan Stanley station attendees show off their professional look in Times Square in New York City.

good technical and economic analysis go hand-in-hand, and that one side without the other is not likely to be useful.

Conceptually challenging work, aggressive deadlines, engaged sponsors, assorted international cuisines, ice-cream cake, and New York City at arm's length – this station had it all!

Novartis Pharmaceutical Corp., Basel, Switzerland
Directed by Claude Lupis

For station director Claude Lupis, returning to Basel felt like going to a second home. The Novartis coordinator, Walter Bisson, and his team organized flawlessly all the details of the group's stay (work permits, accommodations, schedules, etc.). The projects were conducted mostly on three sites: Rosen and Stein in Switzerland, and Wehr in Germany, while the presentations were held on the Novartis campus in San Johann. The splendidly efficient Swiss public transportation and the excellent cooperation from all our project sponsors minimized any difficulty created by the distance between these sites.

Eight students attended the station and worked on a variety of projects. These addressed issues related to shortening the pipeline lead time of a drug substance, the continuous manufacturing of an emulsion, the applications in production of near infrared spectroscopy and ion trap mobility spectroscopy, solvent recovery, and potential energy savings from utilization of a steam plant free capacity. The results of the work of the students appeared to greatly satisfy the expectations of their sponsors.

Basel, being situated at the confluence of Switzerland, France and Germany, always provides a much enriching European experience to our students. They were treated to a guided tour of Colmar in Alsace, France, and also of Lucerne in Switzerland at the height of the "Mardi Gras" festivities. That was followed a week later by "Fasnacht" in Basel, an ancient three-day masked carnival starting on a Monday at 4am. Our students did not miss that start.

General Mills, Minneapolis, Minnesota
Directed by Bob Fisher

As usual, six projects were undertaken at the General Mills station. Two of the first session efforts were extended to continue focus on aspects of two particular product lines. Transport mechanisms and multiple components of these food matrices were addressed. Storage for a major product needed to be evaluated and refined. Another project focused on improving the weight distribution of a filling operation. The objective was to obtain optimal operational conditions to create desired ranges of product characteristics. This required understanding material property interactions in a multi-component product and the innate variability in mixing behavior of different/irregularly shaped particulates in a viscous media. The remaining project was related to improving the energy balance and controllability of a high throughput "early stage pre-product."

All projects related to GMI's emphasis on nutritional value by reducing and/or eliminating certain "high profile" ingredients. They involved use of Design of Experiments techniques to determine process control variables along with the development of mechanistic models based on the fundamentals associated with energy input schemes and transport processes. Of course, we were involved with technology assessment and the rheological behavior of both complex media and nano-emulsions. The existence of multiple phases in these systems provided very interesting and challenging problems. The operational principles are confidential; however start-up procedures were critical, as was the establishment of operational maps. Design modifications were suggested as a result of extensive simulations using newly developed models which were validated experimentally, and established as robust. Some of the modifications were implemented while we were still at the station and proven either successful or suggestive of further modifications or processing changes.

Our students always take advantage of the area's cultural and sporting entertainment, and during this session, they were subject to a very special treat: our group went on a dinner cruise along the Mississippi River, which included traveling through the multiple locks system that produces an elevation change of nearly 100 feet.

Best regards,

T. Alan Hatton
Director
David H. Koch School for
Chemical Engineering Practice

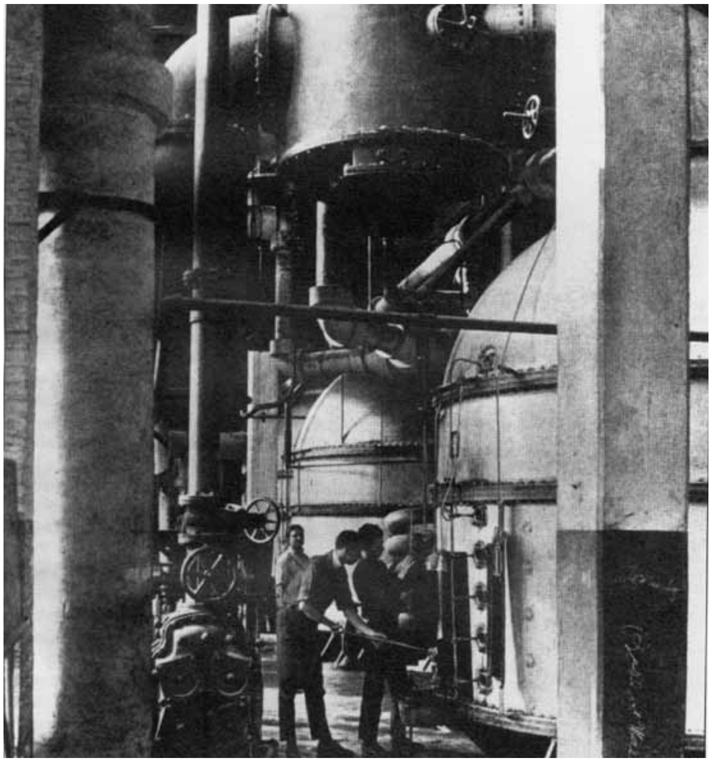
Sweet Practice School Lessons Then and Now

Bob Hanlon
Director of the Spring '10 Mawana Sugars Station

When I heard that I'd be running the Mawana Sugar Works (MSW) station, I recalled an old photograph in "The Flagship," John Mattill's great book on the history of the Practice School. The photo showed students working in the Revere Sugar Refinery. The date? 1920! I couldn't help but think, haven't all the sugar refining problems already been solved? Much to my delight, the short answer was 'No'!

Manufacturing plants must respond to competitive market forces or risk failure. The drive to continually improve quality, improve safety, and decrease costs never ends. There are always good problems to solve. MSW was no exception. The management there provided the students with an excellent set of problems, or 'opportunities' as we learned to call them, involving such classic chemical engineering operations as crystallization, evaporation, fluidized-bed drying, dust collection, and utilities management. All offered solid improvement opportunities to MSW's bottom line, which served as a great motivator for both students and company staff alike.

Referencing Mattill's book again, Dr. Arthur D. Little wrote back in 1915 on the purpose of the Practice School program: "In this [chemical engineering] profession, more truly than any other, one needs to get into the water to learn to swim." The MSW station clearly delivered on this objective. Upon receiving their Problem Statements, the students immediately participated in background discussions and plant tours with their consultants. The remaining schedule for their one-month projects followed the impossibly aggressive Practice School timeline, which in the end wasn't impossible after all. The students learned how to swim at MSW in a way that was strongly enhanced by the availability of a factory, a laboratory, and a highly engaged and supportive cast of company staff.



1920: Learning the intricacies of sugar boiling and graining at the Revere Sugar Refinery, Boston. Taken from The Flagship: The MIT School of Chemical Engineering Practice 1916-1991.

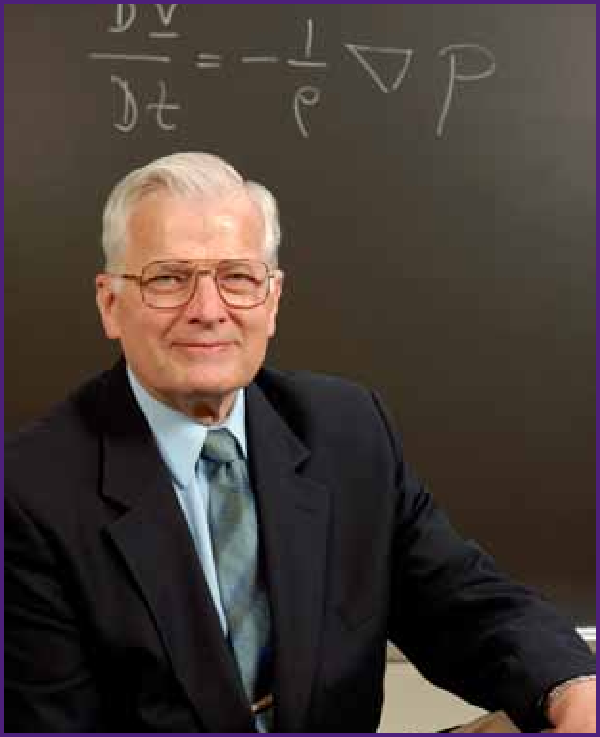
Bob Hanlon (third from right) and the Mawana Sugars student group take a break after participating in the Indian spring festival of Holi.

Of the many lessons learned by the students, two stood out. The first: brevity. The students learned how to tighten both written and oral communications to ensure effective and impactful communications to the extremely busy MSW employees whose time was precious.

The second lesson was lifted directly from Steven Covey: seek first to understand and then to be understood. At times the students became upset and frustrated when things didn't make sense to them. But they soon learned that what may be confusing to them is clear to those in the factory. There's a reason, usually based on work done long ago, behind most everything that's done in a plant. Whether the reason is right or not is a separate question. The fact is that there is a reason. Sometimes it's obvious. Sometimes it's not. Sometimes it's written down. Sometimes it's not. The students learned to first understand the reason and, as best as possible, the rationale behind it. And only then should they design and run experiments, analyze data and propose solutions.

What a great real-world lesson for students to learn before beginning their own professional careers.

Professor Ken Smith Retires



In January 2010, Professor Kenneth A. Smith retired after sixty years as a member of the MIT community. Smith received an SB degree in chemical engineering from MIT in 1958. An SM and an ScD followed in 1959 and 1962. He was an NSF Postdoctoral Fellow in the Cavendish Laboratory, Cambridge University, in 1964-65.

Smith has been a member of the MIT faculty since 1961. During that time, he has held a number of important administrative posts, including that of Vice President for Research (1981–1991). Upon retirement, he was the Edwin R. Gilliland Professor of Chemical Engineering.

Professor Smith's research has been centered on fluid mechanics and on heat and mass transfer. The specific applications have varied over a wide range which includes turbulent drag reduction, facilitated transport in membranes, transport in artificial organs, cardiovascular transport in the context of atherogenesis, and micellar dynamics. His achievements have been recognized by the Professional Progress Award of the AIChE (1981) and by election to the U.S. National Academy of Engineering (1983). He has also thrice (1993, 2000, 2008) been an Overseas Fellow at Churchill College (Cambridge, England).

When writing the 2007 ACS festschrift to honor Professor Smith's seventieth birthday, Jerry Meldon (PhD '73) expressed it best:

"Ken's numerous research collaborators and advisees have benefited from his remarkable abilities to (1) identify the fundamental physicochemical mechanisms underlying observable phenomena, (2) formulate appropriate mathematical models, and (3) employ such models to identify important dimensionless parameter groups, elucidate asymptotic behavior, design key experiments, and interpret experimental data. The result is a large and distinguished body of scholarly production in the areas of transport phenomena, drag reduction, atherogenesis, membrane transport, supercritical fluids, surfactant dynamics, and aerosols.

His sizable professional contributions notwithstanding, firsthand experience and numerous discussions with his other students and advisees have convinced this writer that Ken's greatest and most enduring impacts have been on our lives. All of us recall fondly the sound of Ken's hearty and heartfelt laugh. His mentoring, both professional and personal, has been priceless. We consider ourselves most fortunate indeed."

The Chemical Engineering Department is grateful for Ken's contributions to the Department and field of chemical engineering and will miss his wise counsel, engaging camaraderie and that infamous infectious laugh. We wish the best to Ken and his wife Ambia.

Course X Awards Day 2010

Jeffrey Mo
Course X Graduate Student, Green and Prather Labs

This year's Awards Day ceremony and reception took place on the afternoon of May 10, 2010. Undergraduates, graduate students, and staff members were recognized for their achievements and contributions to the Department over the past year.

A variety of organizations outside of MIT have, often in consultation with the Department, donated prizes and scholarships to students in chemical engineering. The following students were so honored:

• **Grace Liao '11**, recipient of the Merck Fellowshipfor scholastic excellence.

• **Rachel Licht '10**, recipient of the Fulbright Scholarship, an international exchange program sponsored by the U.S. Department of State. She will research cellulosic ethanol production in France.

• **Timothy Humpton '10**, recipient of the Gates Cambridge Scholarship. He will pursue a Ph.D. in oncology at the University of Cambridge in September.

• **Allen Lin '11**, recipient of the Barry M. Goldwater Scholarship. Established in 1986, this is a highly competitive program that supports sophomores and juniors intending to pursue a career in the sciences, mathematics, and engineering.

• **Amrita Karambelkar '11**, recipient of the Genentech Scholar Award for outstanding achievement in disciplines related to production and development.

In addition, the Malcolm J. Kispert Award is given to an outstanding male and female scholar-athlete. This year, the recipient of the men's prize is **Jeffrey Zhou '10**, a member of the MIT swimming team.

Two scholastic achievement prizes are presented by the Department to graduating seniors every year. This year, the recipients are:

• **Gregory Johnson '10**, winner of the Robert T. Haslam Cup for outstanding professional promise in chemical engineering

• **Mary Jane Tsang Mui Ching '10**, winner of the Roger de Friez Hunneman Prize for outstanding scholarship and research. First awarded in 1927, this is the oldest prize in the department.

Academic Administrator Suzanne Easterly Maguire and Department Head Klavs Jensen prepare to commence the 2010 Ceremony, which includes awarding of the 2010 iteration of the ChemE "Rock" Award at left.

Graduate students are recognized for their achievements in research, teaching, and on the sports field:

• **Chris Marton** and **Stephen Chapin** received the Outstanding Seminar Presentation prize in Fall 2009 and Spring 2010, respectively, for their Monday afternoon research talks. These prizes are awarded by their fellow graduate students.

• **Vikramaditya Yadav** received the Edward W. Merrill Outstanding Teaching Award, as judged by the undergraduate students, for his role as a TA in 10.37, Chemical and Biological Reaction Engineering, during Spring 2010.

• **Diwakar Shukla** received the Outstanding Graduate Teaching Assistant Award, as judged by the graduate students, for his role as a TA in 10.50, Analysis of Transport Phenomena, during Fall 2009.

Several awards were also handed out for leadership and service to the Department:

• **Katrina Westerhof '10** was awarded the Special Service Award in recognition of her year as the president of the student chapter of AIChE.

• **Matthew Blackburn, Caroline Chopko, Rachel Howden, Jen Lee, Cheri Li, Kevin Lin, Jeffrey Mo, Asha Parekh, Christy Petruczok, Armon Sharei, Karthik Shekhar, Mike Stern, Spencer Schaber**, and **Achim Wechsung** were also awarded the Special Service Award, in recognition of their work on the Departmental Graduate Student Council.

• **Joshua Allen** was awarded the Rock Award for outstanding leadership in Departmental athletics. He played on, and captained several of, the soccer, basketball, ice hockey, unihoc, ultimate frisbee, softball, and octathon teams in the 2009-2010 academic year.

• **Christine Preston**, administrative assistant to Professor Paula Hammond, and **Teri Chung**, financial coordinator, were awarded the Outstanding Employee Award. Christine liaises between many different offices both throughout and beyond MIT, largely supporting Professor Hammond's administrative role as the Executive Officer of the department, while Teri handles many of the budgetary concerns of the department. Both women have worked tirelessly over the past year to keep the Department operating smoothly.

Finally, teaching by faculty and staff members was recognized by the undergraduate and graduate students:

• The undergraduates voted to give **Dr. Barry Johnston** the C. Michael Mohr Outstanding Faculty Award for his efforts in 10.10, Introduction to Chemical Engineering and 10.490, Integrated Chemical Engineering I, during Fall 2009; and 10.26/29, Biological Engineering Projects Laboratory, and 10.450, Process Dynamics, Operations, and Control, during Winter 2010.

• The graduate students voted to give **Professor William Deen** the Graduate Student Council Outstanding Faculty Award for his efforts in 10.50, Analysis of Transport Phenomena, during Fall 2009. ◊

Professors Daniel Blankschtein, Paula Hammond'84, Pat Doyle and Bill Deen await the start of the Award Ceremony.

2010 Award Winners Share their favorite Course X memories:

My favorite ChemE memory has been this past semester with 10.29, where I learned a lot about pretreatment of sugarcane bagasse (a lignocellulosic biomass) for ethanol production - it was a great hands-on laboratory course.

*Barry M. Goldwater Scholar **Allen Lin**, Holmdel, NJ*

All of us (ChemE'10) stuck in the bunker, working on ICE psets - rough but fun times.

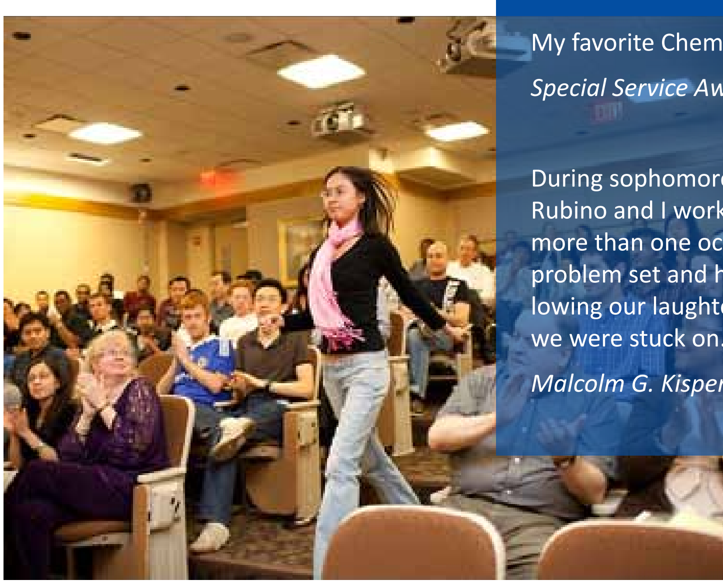
*Roger de Friez Hunneman Prize Winner **Mary-Jane Tsang Mui Ching**, Rose-Hill, Mauritius*

My favorite ChemE memory is of bonding over late-night ICE projects in the bunker.

*Special Service Award Winner **Katrina Westerhof**, Algonquin, IL*

During sophomore year I balanced swimming with Course X and 10.301. My friend Alex Rubino and I worked late in the reading room just about every night of the week. On more than one occasion after midnight we would start to have fits of laughter over the problem set and how ridiculously difficult it was. More often than not, immediately following our laughter someone would in our words "strike it rich" and solve the problem we were stuck on.

*Malcolm G. Kispert Award Winner **Jeffrey Zhou**, Getzville, NY*



Mary Jane Tsang Mui Ching '10 wins the Roger de Friez Hunneman Prize.

Faculty News

The Department Welcomes Four New Professors

Allan S. Myerson

Allan Myerson is no stranger to MIT – he has spent the past two years working with the Institute's new Novartis Center for Continuous Manufacturing. His previous position was with the Illinois Institute of Technology in Chicago, where, since 2000, he had served as dean of engineering and science, provost, and senior vice president, before returning to full time research and teaching in 2008. He joins the Department as a professor of the practice.

Myerson's research focuses on crystallization from solution with an emphasis on nucleation, polymorphism, and industrial applications of crystallization. He has published five books including the "Handbook of Industrial Crystallization," 150 papers, and 31 patents on crystallization and related areas. He also worked with the American Chemical Society (ACS) to develop the Journal "Crystal Growth and Design" and has served as an associate editor. Myerson has consulted for approximately 70 companies in the chemical and pharmaceutical industry around the world.His research was recognized by the ACS's 2008 Award in Separation Science and Technology.

Daniel G. Anderson

Dan Anderson, who has a dual appointment with the Harvard-MIT Division of Health Sciences and Technology, has been at MIT since 1999, when he came here to start his postdoctoral work with Institute Professor Bob Langer. He became a research associate in 2003, continuing his work on RNAi and NDA delivery, polymeric arrays, and cell encapsulation for regenerative medicine.

The primary goal of Anderson's research is to advance medicine through the study and development of advanced biomaterials and drug delivery systems. He is particularly interested in fully-automated, combinatorial methods to develop therapeutically useful biomaterials and nanoparticulate systems, including libraries of biodegradable polymers and lipid-like materials for intracellular drug delivery, synthetic polymer surfaces for stem cell manipulation, and new materials for macroscopic devices and tissue engineering.

Richard D. Braatz
Edwin R. Gilliland Professor of Chemical Engineering

Before coming to MIT, Richard Braatz was the Millennium Chair and Professor of Chemical and Biomolecular Engineering, Electrical and Computer Engineering, Mechanical Science and Engineering, and Bioengineering at the University of Illinois at Urbana-Champaign. He has been recognized internationally as a leader in systems engineering. He brings to MIT a unique blend of fundamental controls theory, multiscale modeling, and challenging applications.

Braatz received a BS in chemical engineering at Oregon State and completed his PhD with Professor Manfred Morari at the California Institute of Technology. At the University of lllinois, he built an internationally recognized program in process systems engineering. At MIT, Braatz plans to focus on multiscale processes that arise in pharmaceuticals, materials, and energy systems.

Yuriy Román

Yuriy Román received his PhD in chemical and biological engineering from the University of Wisconsin-Madison in 2008. He then went on to the California Institute of Technology to pursue postdoctoral research in the synthesis and characterization of microporous and mesoporous materials in the group of Professor Mark E. Davis. His research there involved studying structure-function relations in zeolites in applications related to the isomerization of carbohydrates and the carbonylation of dimethylether.

Working under the supervision of Professor James A. Dumesic at Wisconsin, Román's thesis work involved the catalytic conversion of carbohydrates obtained from lignocellulosic biomass into chemical intermediates used for the production of biofuels and biomaterials.

During the course of his PhD studies, Román helped develop new catalytic systems to convert sugars into furan derivatives such as 5-hydroxymethylfurfural (HMF) and furfural. In addition, he helped design a catalytic process for the production of 2.5-dimethylfuran from HMF for use as a biomass derived fuel. These breakthroughs were published in the journals *Science* and *Nature*, respectively. His research interests include biorefining, catalysis, reaction kinetics, and nanomaterials. As a faculty member, he will continue developing catalytic processes and novel materials applied to renewable energy, including the conversion of biomass into fuels and chemicals and CO_2 activation.

Bob Cohen Elected to NAE and MRS

In the spring of 2010, Bob Cohen received two honors: he was named a fellow of the Materials Research Society (MRS) and elected to the National Academy of Engineering (NAE) "for research on polymer morphology and surfaces, commercial products and processes, successful entrepreneurship, and novel educational programs."

Election to the NAE is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made outstanding contributions to "engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature," and to the "pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

MRS recognizes as "MRS Fellow" outstanding members whose sustained and distinguished contributions to the advancement of materials research are internationally recognized. Through excellence in science and engineering and dedication to the advancement of materials research, MRS Fellows represent the highest ideals of accomplishment and service in the MRS mission.

Paula Hammond Honored as 2010 Scientist of the Year by the Harvard Foundation

The Harvard Foundation presented the 2010 Scientist of the Year Award to Paula Hammond as part of its annual Albert Einstein Science Conference: Advancing Minorities and Women in Science, Engineering, and Mathematics, in April 2010. Hammond was honored for her outstanding scientific contributions in macromolecular design and synthesis of biomaterials. She was also a fellow at the Radcliffe Institute for Advanced Study in 2004.

During the April conference, Hammond discussed her materials science research with hundreds of elementary school students. She spoke about the many potential applications of her research on directed assembly of polymers, including fabricating remotely-controlled drug chips to treat diseases.

Hammond commented to the Harvard Crimson newspaper on how being both a minority and a woman scientist has affected her work. "This is one of those things that you carry with you, and you really just make it a point not to [let it] be a barrier," she said.

Hammond also said her progression through science was guided largely by the mentors she found, from her high school chemistry teacher to some of her college professors. She said she is glad to both have an impact on the children she met, as well as to be a role model for them.

BIO Presents Gregory Stephanopoulos with the 2010 George Washington Carver Award

The Biotechnology Industry Organization (BIO) presented the annual George Washington Carver Award for Innovation in Industrial Biotechnology to Greg Stephanopoulos, recognizing his pioneering work in the field of industrial biotechnology and in particular metabolic engineering and its practical application to industrial processes. The award was presented at a plenary session during the 2010 World Congress on Industrial Biotechnology and Bioprocessing, in Washington, D.C.

Stephanopoulos is a pioneer in the field of metabolic engineering and co-author of the seminal textbook that laid the educational and engineering foundations of this new field. He has also actively transferred laboratory developed technologies to important industrial processes, co-founding start-up companies to produce antimicrobial peptides and biofuels. He has developed processes integrating highly engineered microbes in industrial settings to produce amino acids, such as lysine and isoleucine; indandiol, an essential precursor of the AIDS drug Crixivan; and important diterpenes, such as lycopene and taxadiene, a precursor to the cancer drug taxol. His current work focuses on engineering a microbe for cost-effective production of oil and biodiesel.

Stephanopoulos said, "I am truly honored to receive the George Washington Carver Award. Our work has emphasized the importance of engineering microbes not for the production of token amounts of bioproducts, but for the cost effective conversion of renewable resources to useful bioproducts and biofuels. This is the essence of a biobased economy and it is for this reason that this award is particularly important to me, representing the industries that epitomize this bio-based economy. Manufacturing from renewable resources will grow steadily as more processes are developed, and since it cannot be done offshore its contribution to the national welfare will also increase. This suggests a bright future for industrial biotechnology and the technologies that enable it, such as metabolic engineering." ◊

Research Focus: Biomedicine

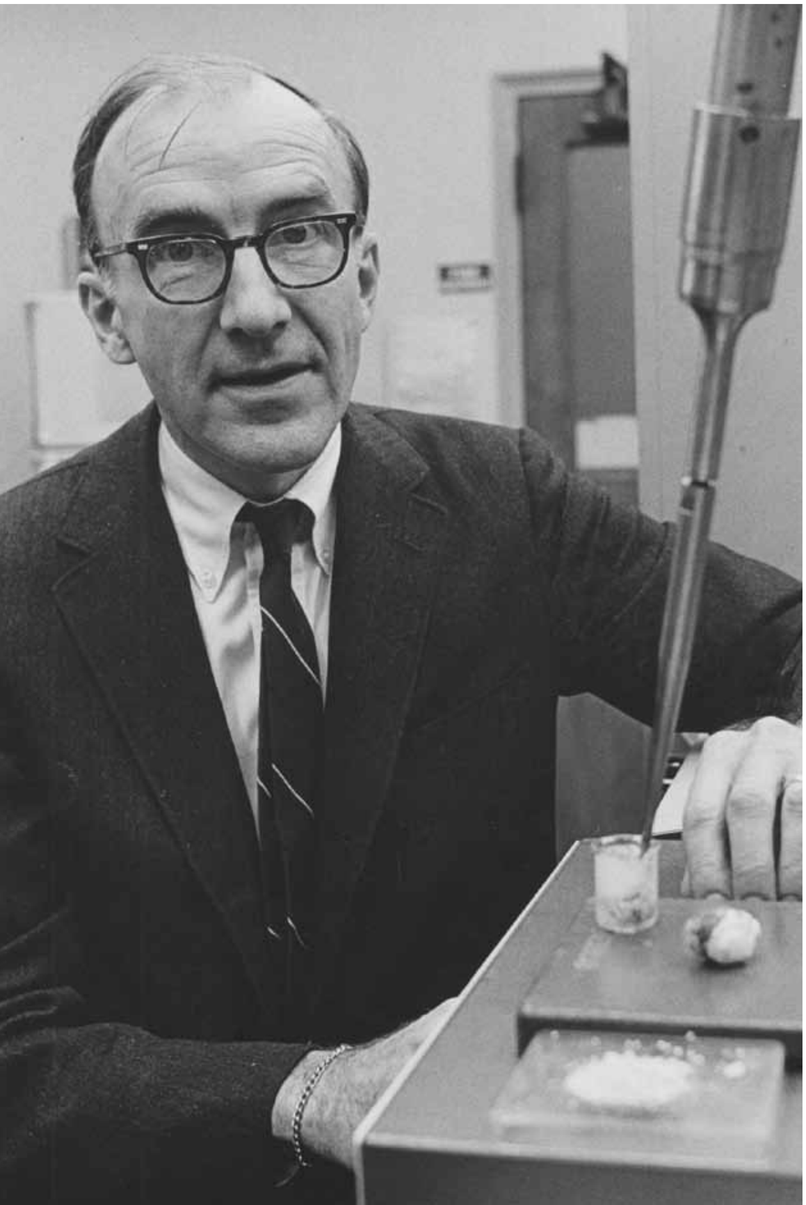
When MIT chemical engineering professor Paula Hammond cleans out her lab every few years, her students occasionally find bottles of the chemical polyethylene oxide that date back to the 1980s. The bottles are relics of the previous lab occupant, Professor Emeritus Edward Merrill, and a reminder of his legacy in developing polymers for biomedical uses.

Engineering a New Path

How Ed Merrill helped steer his field toward biomedicine

Anne Trafton, MIT News Office

Merrill, one of a handful of researchers who pioneered the field of biomedical engineering in the 1960s and 70s, showed that polyethylene oxide, a polymer (long chain) of repeating units called ethers, is remarkably inert when in contact with blood, whereas most other materials cause blood to clot upon contact. He suspected this quality would make it ideal for biomedical applications such as drug delivery.



Today, polyethylene oxide is ubiquitous in the biomedical and pharmaceutical industries, and Hammond and others are developing the polymer into nanoparticles for cancer-drug delivery. Hammond's "time bomb" nanoparticles can flow through the bloodstream without being absorbed by cells, until they reach a tumor and release their chemotherapy payload.

Polyethylene oxide, also known as polyethylene glycol (PEG), "turns out to be one of the most important, critical elements of designing the polymeric systems we believe can help us in targeting drugs for cancer," says Hammond, the Bayer Professor of Chemical Engineering.

During his 60-year career at MIT, Merrill also used his expertise in polymer chemistry, especially the study of membranes, to make major contributions to the development of the artificial kidney and oxygenation of the blood during open-heart surgery.

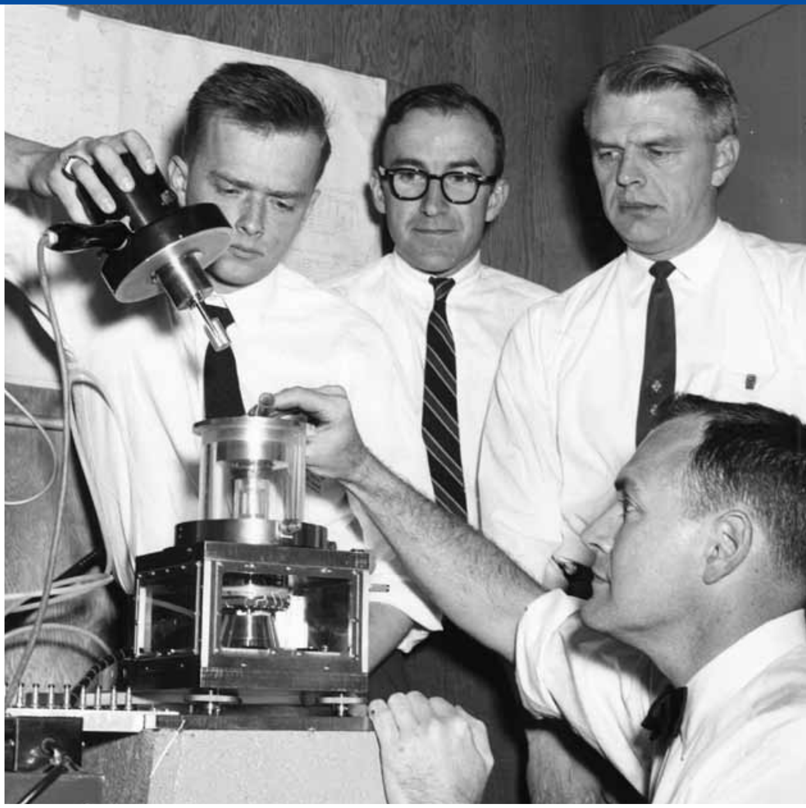
'Sticky stuff'

Although Merrill's father was a chemical engineer, he was at first reluctant to follow in his father's footsteps. At Harvard, he majored in chemistry and classics. His senior year, he planned to take a course in advanced physical chemistry, but wandered into the wrong classroom and ended up in a chemical engineering course taught by MIT Professor William Henry McAdams. "It kind of intrigued me, so instead of going to the correct classroom, I stayed on with it and did reasonably well in it," recalls Merrill, now 86.

McAdams encouraged Merrill to come to MIT for graduate school, where he earned his PhD in chemical engineering in 1947. He did his thesis in polymer chemistry, an area he hadn't encountered at Harvard. "It was an ignominious pursuit. Pure chemists would not touch it. It was sticky stuff, gooey stuff," Merrill says.

Merrill then spent three years working at the Dewey & Almy Chemical Company, where he studied rheology — the flow of polymer materials, such as rubber cement. He returned to MIT for good in 1950, joining the faculty as an assistant professor.

Because of his experience in rheology, researchers at Brigham and Women's Hospital asked him to help them measure the viscosity



Merrill (center) with students. Courtesy MIT Museum.

of blood, which is how he got into biomedical engineering, around 1960. That work led him to devise a better way to oxygenate blood during open-heart surgery, using membranes permeable to oxygen and carbon dioxide. He also developed membranes to filter blood for artificial kidney machines.

At the time, only a handful of engineers around the United States were delving into biomedicine. Merrill's colleagues told him that his work in blood rheology might undermine his shot at tenure. But the risk paid off, and Merrill went on to launch biomedical engineering as a major focus of MIT's chemical engineering department, influencing hundreds if not thousands of MIT students.

"While it may be common to have a medical focus in chemical engineering curricula now, it sure wasn't in 1957, or even when I came to MIT in 1970," Robert Langer, MIT Institute Professor, said at a May 14 symposium honoring Merrill's 60 years on the MIT faculty. "When you look at the people he's touched and the people they've touched, it's truly remarkable. It's hard for me to think of anyone who's had a greater impact."

The Cheshire Cat

Hammond first met Merrill as a senior at MIT in 1983, when she took his class in polymer chemistry. She appreciated Merrill's focus on chemistry at the molecular level, which was a change from the usual chemical engineering focus on materials as a continuum.

"As an undergrad, the reason I wanted to become a chemical engineer was because I loved chemistry," Hammond recalls. "When I started to take my chemical engineering courses I missed the sense that something molecular was going on. I loved chemistry and I wanted to see it again. So I took as an elective one of Professor Merrill's classes in polymers and just got fascinated."

In 1988, Hammond returned to MIT to get her PhD in chemical engineering and took two more polymer chemistry classes with Merrill. "Physical chemistry of polymers can be particularly difficult to conceptualize but he was able to make these concepts incredibly clear and fascinating at the same time," she says.

Paula Hammond discusses Ed Merrill's influence on her work during the May 14 symposium in his honor.

Recognizing the difficulty of the material he was teaching, especially thermodynamics of polymers, Merrill often used an analogy from one of his favorite works, "Alice in Wonderland," to hearten his students. In the story, the Cheshire Cat often climbs up a tree and then slowly disappears, leaving only the grinning mouth.

"Some of these things are very difficult concepts. It takes a lot of thinking, a lot of soaking in, before you can get it," Merrill says. "I said to the students, this is going to be like the Cheshire Cat's grin. You're going to go out of the room and you'll have this vague idea that you saw something, but the rest of the idea will be gone."

The students eventually got it, though, says Hammond, who co-taught two courses with Merrill in the late 1990s, soon after she joined the MIT faculty. "It was really amazing to be in the classroom with him and to learn how he engages the students," she says. When they began teaching together, Hammond asked Merrill for his course notes, which turned out to be three or four sheets stapled together. "I remember thinking, 'Oh my God, he does all of this just streaming from his head,'" says Hammond. "It amazed me."

Throughout his career, Merrill, who officially retired from MIT in 2001, made it a point to keep up with what was happening in industrial chemical engineering, and to convey that aspect of the field to his students. He often designed his labs to incorporate biomaterials such as bone cement, used to anchor artificial joints. Because of that exposure to real-world applications, "we end up with chemical engineers coming out of our department with this perspective that I think is unique," says Hammond. ◊

Research Focus: Biomedicine

On Friday, May 14, 2010, the Chemical Engineering Department hosted a Symposium to Honor Professor Emeritus Edward W. Merrill '47, for his six decades of research and teaching excellence at MIT. In this issue we highlight some of the current work within the Department that continues to build upon Merrill's legacy of work in polymer synthesis, biomaterials and biomedical engineering.

Professor Bradley Olsen's current research focus continues Professor Merrill's focus on polymer chemistry and its implications for biomaterials and drug delivery.

Protein Polymer Physics

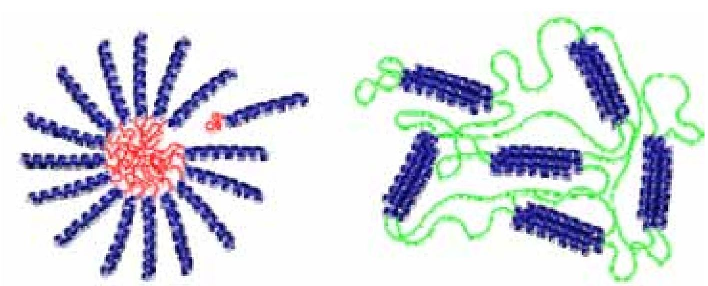
Olsen Lab

Jeffrey Mo

Professor Bradley Olsen received his Bachelor's degree in Course X from MIT in 2003. While an undergraduate here, he pursued research projects, as a UROP, in two different labs. As a freshman, Olsen UROPed for Professor Ronald Prinn in the Department of Earth, Atmospheric, and Planetary Sciences (EAPS, Course XII), performing analytical chromatography method development for atmospheric hydrocarbons – a project similar to an internship experience he had held at General Mills in Minneapolis prior to arriving at MIT. After a year in Professor Prinn's group, he spent the next three years with ChemE's own Professor Karen Gleason, studying the chemical vapor deposition (CVD) of fluorocarbon-siloxane copolymers. His efforts led to a method for making previously-intractable Kevlar® surfaces waterproof, and were eventually reported in five separate journal papers. Olsen received the Alpha Chi Sigma Award, given for achievement and interest in chemistry and related fields, and the Barry M. Goldwater Scholarship, a national scholarship program for students with demonstrated excellence and potential in science and engineering.

It was in high school that Olsen's interest in polymers first developed; they represented a tangible combination of basic scientific principles and practical, product-based applications. He completed almost all of the courses in the Program for Polymer Science and Technology (PPST) graduate curriculum, including some taught by Professors Bob Cohen and Paula Hammond. In particular, he was interested in block copolymers, and pursued this topic in graduate school with Professor Rachel Segalman at the University of California, Berkeley.

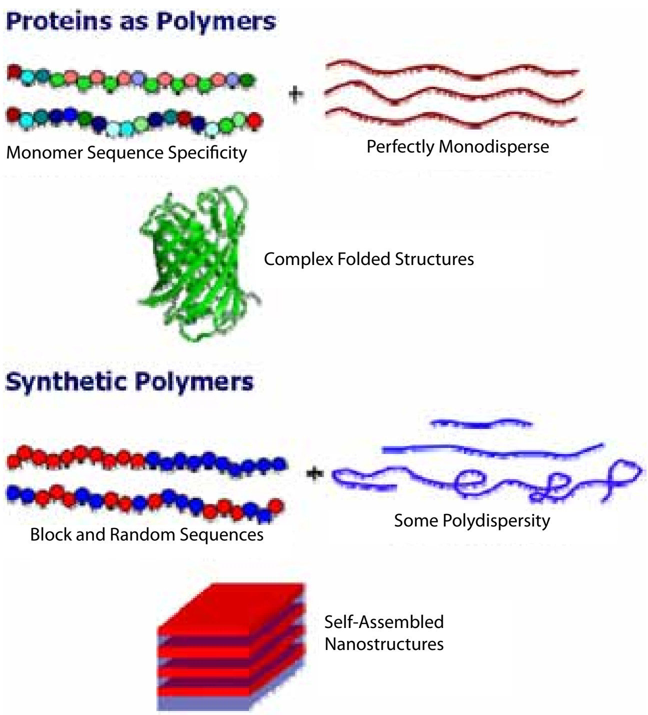
Each half of a block copolymer is chemically different – each half is comprised of distinct monomers – so they want to phase-separate from one another, much like oil and water do. However, they are chemically linked together, so they can only get so far apart. As a result, an interface forms and each half of the molecule partitions to one side of the interface. This interface can be tuned based on the geometry of the monomers and the strength of the interactions involved. In the end, block copolymers resemble crystals – they self-assemble and have well-defined lattice parameters. However, instead of being 2-4 Å in size, as in a typical atomic crystal, block copolymers form crystals of 15-100 nm in size.



Helix-coil proteins forming a micelle and a gel from telechelic proteins.

Two companies have taken the lead in commercializing block copolymers. Pluronic® products, sold by BASF, are copolymers of ethylene oxide and propylene oxide that self-assemble into micelles when placed in water; they are used as active, non-toxic, non-ionic surfactants. Kraton sells a variety of styrene-based block copolymers (i.e. block copolymers with styrene or a styrene derivative as one monomer) for use in footwear, adhesives, and the modification of asphalt. Both of these commodity block copolymers are comprised of flexible monomers, so that the overall polymer resembles a limpid piece of spaghetti. This is referred to as a Gaussian coil, as the distance between the ends of the polymer take on a Gaussian distribution. A collection of polymer molecules is likewise intertwined like a plate of spaghetti noodles.

Olsen's doctoral work investigated the properties of more rigid, non-Gaussian chain block copolymers. Such block copolymers find applications as semiconducting polymers for photovoltaic cells or organic light-emitting diodes (LEDs); health-related materials including tissue-engineering and drug-delivery scaffolds; and very rigid, liquid-crystalline polymers for use as high-strength resin materials. Olsen focused on semiconducting block copolymers, which are comprised of a very long, rigid, and highly-conjugated rod section attached to a more flexible, Gaussian-like coil section. The spacing between interfaces in such a system facilitates and makes efficient the dissociation of excitons (an electron and the electron hole to which it is bound) and the subsequent transfer and capture of charge through the polymer. The core of Olsen's thesis studied the fundamental physics behind the self-assembly of these rod-coil block copolymers. This self-assembly could be affected by a variety of parameters, including interactions between rod domains and containment into a thin film (as is used in photovoltaics). On the grand scheme, Olsen created the first universal phase diagram for block copolymers. Much like the law of corresponding states for gases, the principle behind a universal



phase diagram is that if one chooses the correct non-dimensional parameters to characterize the polymer/monomers, the phase behavior of polymer systems can be generalized and predicted.

While at Berkeley, Olsen was inspired by the advances in protein expression techniques and biotechnology that could be used to develop new polymer materials – after all, a protein is a polymer of amino acids. Very few people at the time were exploiting such techniques in polymer science. After graduating from Berkeley in 2007, the newly-minted Dr. Olsen headed to CalTech to work with Professors David Tirrell (himself a Course X undergraduate in 1976), Julia Kornfield, and Zhen-Gang Wang on novel biosynthetic hydrogels for tissue-engineering applications. These hydrogels were also, in a way, block copolymers. More specifically, Dr. Olsen constructed telehelic triblock copolymers, comprised of a very flexible, repetitive, Gaussian-coil like midblock flanked at both ends by a leucine zipper. The specific association of the endblocks and the biological interactions between the Gaussian coil sections provide a controlled way to synthesize gels – much more control than the non-specific hydrophilic/hydrophobic interactions in a traditional block copolymer would allow.

Professor Olsen draws from both of his California research stints in his current position as an MIT chemical engineering professor. Using a variety of polymer/protein hybrids as model systems, Professor Olsen is trying to delve deeper into fundamental polymer physics and develop new nanostructured biomaterials and, perhaps somewhat surprisingly, energy-related materials. Biological systems perform energy conversion in ways that have been, to date, very difficult to replicate non-biologically. One example of such a process is photosynthesis, which Dr. Shuguang Zhang (of the Centre for Biomedical Engineering) and Professor Marc Baldo (of EECS) have pioneered. Professor Olsen is particularly interested in reduction reactions. In biological systems, reduction reactions are typically energy-storage reactions, and therefore are the equivalent of chemical batteries or fuel-synthesizing reactions. Enzymatic processes may offer some efficiency advantages over purely synthetic approaches. The Olsen group is interested in the controlled design of the interface between the natural and the synthetic parts of such a reduction system – in other words, incorporating the enzyme into a nanomaterial scaffold while preserving the functionality of the enzyme. As an end goal, they would like to see this project to commercialization through mass-production in a chemical reactor.

Primarily a physical sciences lab that draws heavily on tools from biology, Professor Olsen's research group regards proteins as highly-functional polymers that have novel properties from a materials standpoint. Through predominantly experimental means, with a fundamental bent towards the physical sciences, Professor Olsen is poised to push the boundaries of polymer knowledge – both in terms of basic knowledge about soft materials and in new applications aimed at some of the world's most pressing needs. ◊

Other Spring 2010 Research News

-- Professor Paula Hammond & Post-doc Avni Argun produce new ways to build membranes for fuel cells

-- Professor Narendra Maheshri's & grad student T. L. To's work on bimodal gene expression published in Science

-- Professor Michael Strano finds carbon nanotubes could create electriciy

-- Professor Dane Wittrup explains the phenomonenon of directed evolution

-- Grad student Deepak Dugar helps apply ranking algorithms to pharmaceutical research and development

-- Professor Paula Hammond and team use carbon nanotubes to improve battery capacity

For more information on these and other Departmental news, go to

web.mit.edu/cheme/news/

Research Focus: Biomedicine

Articles by Anne Trafton, courtesy of the MIT News Office. For more information, go to *web.mit.edu/cheme/news/*

Listening in on Single Cells

A novel sensor array is the first to detect single molecules in living cells

MIT researchers have built the first sensor array that can detect single molecules emitted by a living cell. Their sensor targets hydrogen peroxide and could help scientists learn more about that molecule's role in cancer.

Hydrogen peroxide has long been known to damage cells and their DNA, but scientists have recently uncovered evidence that points to a more beneficial role: it appears to act as a signaling molecule in a critical cell pathway that stimulates cell growth, among other functions.

When that pathway goes awry, cells can grow out of control and become cancerous, so understanding hydrogen peroxide's role could lead to new targets for potential cancer drugs, says Michael Strano (below), MIT associate professor of chemical engineering and leader of the research team. Strano and his colleagues describe their new sensor array, which is made of carbon nanotubes, in the March 7, 2010 online edition of Nature Nanotechnology.

Strano's team is also working on carbon nanotube sensors for other molecules, and within the past year has successfully tested and published sensors for nitric oxide and ATP (the molecule that carries energy within a cell).

"The list of biomolecules that we can now detect very specifically and selectively is growing rapidly," says Strano, who also points out that the ability to detect and count single molecules sets carbon nanotubes apart from many other nanosensor platforms, including electrochemical, electromechanical cantilevers and surface acoustic wave sensors.

Nanotube array

In the new study, Strano's team used the carbon nanotube array to study the flux of hydrogen peroxide that occurs when a common growth factor called EGF activates its target, a receptor known as EGFR, which is located on cell surfaces. For the first time, the team showed that hydrogen peroxide levels more than double when EGFR is activated.

EGF and other growth factors induce cells to grow or divide through a complex cascade of reactions inside the cell. It's still unclear exactly how hydrogen peroxide affects this process, but Strano speculates that it may somehow amplify the EGFR signal, reinforcing the message to the cell. Because hydrogen peroxide is a small molecule that doesn't diffuse far, the signal would be limited to the cell where it was produced.

The team also found that in skin cancer cells, believed to have overactive EGFR activity, the hydrogen peroxide flux was 10 times greater than in normal cells. Because of that dramatic difference, Strano believes this technology could be useful in building diagnostic devices for some types of cancer.

"You could envision a small handheld device, for example, which your doctor could use to assay tissue in a minimally invasive manner and tell if this pathway is corrupted," he says.

The new sensor represents "an excellent example of the application of nanotechnology to address fundamental questions in biology," says Ravi Kane, professor of chemical and biological engineering at Rensselaer Polytechnic Institute. ◊

"At any given time, there's a large fraction of the culture that does not contribute to the overall yield," - Kerry Routenberg Love, lead author of the paper.

Slackers & Superstars of the Microbial Workplace

Researchers find yeast engineered to make drugs vary widely in their productivity

Drug companies often use yeast to manufacture drugs, especially proteins such as antibodies and enzymes. It has been assumed that a batch of genetically identical yeast will secrete such drugs at uniform rates, but MIT chemical engineers have made the surprising discovery that drug productivity varies greatly among individual yeast cells.

The research team, led by J. Christopher Love (below), assistant professor of chemical engineering, found that while a small subset of yeast is highly productive, a significant minority of the population releases nothing at all. The finding, reported in the journal Biotechnology and Bioengineering, could give drug companies new targets to maximize yeast productivity.

"This is clearly a very powerful tool for selecting cells based on their rate of synthesis, which has a number of applications, including the obvious ability to pick out high-producing cell lines," says Barry Buckland, a former research and development executive at Merck Research Laboratories, who was not involved in the research.

Love and his colleagues studied a strain of yeast known as Pichia pastoris, which can be used to manufacture proteins including antibodies, growth factors, enzymes and erythropoietin (a hormone that controls red blood cell production). There are now 151 such proteins approved for therapeutic use in the United States or Europe. In 2008, sales of these biopharmaceuticals in the United States exceeded $45 billion, with nearly half of them produced by microbes, including yeast.

To measure yeast productivity, the researchers used a technique that Love had previously developed and used to study immune cells, specifically B cells, called microengraving. The technique allows researchers to look at the quantities of proteins released by single cells.

The yeast in the study were engineered to produce a fragment of a human antibody molecule, but the researchers were surprised to find that a subset of the yeast population (about 35 percent) did not secrete measureable amounts of protein.

"At any given time, there's a large fraction of the culture that does not contribute to the overall yield," says Kerry Routenberg Love, a postdoctoral associate in chemical engineering and lead author of the paper.

Intrigued, the researchers ran a longer study, over an eight-hour period, and identified three subpopulations among the cells: those that secrete very little protein over this time, those that secrete consistently high quantities, and those that fluctuate between states of high and low productivity.

Because the yeast used in the study (and in drug manufacturing) are genetically identical, genetic differences cannot account for the discrepancies in productivity. Instead, the difference appears to be epigenetic — meaning that it involves differences in the processing that the proteins undergo after they are assembled, such as protein folding and secretion from the cell.

In future work, the researchers hope to discover more about why there is such variability in yeast productivity, which could lead to new ways to improve drug yields by enhancing productivity in low-producing cells. ◊

Research Focus: Biomedicine

Articles by Anne Trafton, courtesy of the MIT News Office. For more information, go to *web.mit.edu/cheme/news/*

New Insights into the Mystery of Natural HIV Immunity

New findings have implications for designing an effective AIDS vaccine.

When people become infected by HIV, it's usually only a matter of time, barring drug intervention, until they develop full-blown AIDS. However, a small number of people exposed to the virus progress very slowly to AIDS — and some never develop the disease at all.

In the late 1990s, researchers showed that a very high percentage of those naturally HIV-immune people, who represent about one in 200 infected individuals, carry a gene called HLA B57. Now a team of researchers from the Ragon Institute of Massachusetts General Hospital, MIT and Harvard has revealed a new effect that contributes to this gene's ability to confer immunity.

The research team, led by MIT Professor Arup Chakraborty (below) and Harvard Professor Bruce Walker of MGH, found that the HLA B57 gene causes the body to make more potent killer T cells — white blood cells that help defend the body from infectious invaders. Patients with the gene have a larger number of T cells that bind strongly to more pieces of HIV protein than people who do not have the gene. This makes the T cells more likely to recognize cells that express HIV proteins, including mutated versions that arise during infection. This effect contributes to superior control of HIV infection (and any other virus that evolves rapidly), but it also makes those people more susceptible to autoimmune diseases, in which T cells attack the body's own cells.

This new knowledge, described in the May 5, 2010 online edition of Nature, could help researchers develop vaccines that provoke the same response to HIV that individuals with HLA B57 muster on their own, says Walker, who is director of the Ragon Institute and a professor at Harvard Medical School.

"HIV is slowly revealing itself," says Walker. "This is another point in our favor in the fight against the virus, but we have a long way to go."

Natural resistance

MIT Chemical Engineering Professor Chakraborty, who specializes in theoretical and computational studies of the immune system, undertook this study after Walker told him about the phenomenon of HLA B57-induced immunity. Chakraborty was also intrigued by the fact that people who carry the HLA B57 gene also are more likely to develop autoimmune disorders.

Chakraborty, Walker and their colleagues focused on killer T cells, one of two types of T cells that play an important role in the immune response. Most killer T cells are genetically unique and recognize different pieces of foreign proteins, known as epitopes, attached to the surface of cells that have been infected by viruses or bacteria.

After a killer T cell grabs hold of such a protein, it becomes activated and starts sweeping the body for more cells that express the same protein, so it can kill them. It also clones itself to produce an army of T cells targeting the invader.

The new Ragon Institute study shows that individuals with the HLA B57 gene produce larger numbers of killer T cells that are cross-reactive, meaning they can attack more than one epitope associated with HIV, including mutants that arise to escape activated killer T cells.

The finding offers hope that researchers could design a vaccine to help draw out cross-reactive T cells in people who don't have the HLA B57 gene. "It's not that they don't have cross-reactive T cells," says Chakraborty. "They do have them, but they're much rarer, and we think they might be coaxed into action with the right vaccine."

The work is a valuable contribution to scientists' understanding of HIV, says David Baltimore, professor of biology and former president of Caltech.

"This is a remarkable paper because it starts from a clinical observation, integrates it with experimental observations, generates a valuable model and derives from the model a deep understanding of the behavior of the human immune system. Rarely does one read a paper that stretches the mind so surprisingly far," says Baltimore, a Nobel laureate in physiology or medicine who now studies HIV and human T cell interactions.

Weeding out

Chakraborty and colleagues had previously developed computational models of T-cell development in the thymus, an organ located behind the breastbone through which T cells must pass in order to become mature killers. There they undergo a selection process designed to weed out cells that might attack the body's own cells (which display pieces of human proteins on their surface). T cells must also demonstrate that they can bind weakly to some human protein fragments. Only a tiny percentage of T cells pass these tests and are allowed to leave the thymus and circulate in the body to defend against viruses, other diseases, and cancerous cells.

Inside the thymus, T cells are exposed to "self-peptides" — small human protein fragments — bound to HLA proteins. Chakraborty and co-workers had previously shown that the diversity of self-peptide fragments presented in the thymus influences the kinds of T cells a person can produce. The type and number of self-peptides expressed are determined by the HLA genes, which have hundreds of distinct forms, including HLA B57. Each person carries up to six of them (three inherited from each parent).

Using data from previous studies, the Ragon team found that HLA B57 protein presents fewer types of self-peptides than most other HLA proteins. (HLA B27 is another protein that presents few types of self-peptides and also appears to protect against HIV and promote autoimmune disorders.) In this study, Chakraborty and postdoctoral fellow Elizabeth Read and graduate student Andrej Kosmrlj, lead authors of the paper, used their computer model to study what happens when maturing T cells are exposed to only a small diversity of self-peptides in the thymus.

T cells with receptors that bind strongly to any of the self-peptides in the thymus are forced to undergo cell suicide, because of their potential to attack the body's own cells. Chakraborty and co-workers showed that this means that, for most individuals, most of the body's T cells have receptors that bind to targeted viral proteins via a number of weak interactions, with each interaction making a significant contribution to the binding. Thus, a single mutation to an HIV peptide can potentially evade the immune response.

(image courtesy of Christine Daniloff, MIT)

A different scenario unfolds in people who have the HLA B57 gene. Using their computer model, Chakraborty and colleagues showed that, because those individuals' T cells are exposed to fewer self-peptides in the thymus, T cells with receptors that mediate strong binding to viral proteins via just a few important contacts are more likely to escape the thymus. This makes these T cells more cross-reactive to targeted HIV peptide mutants, because as long as those points in the viral proteins don't mutate, the T cells are still effective. The model also showed that once those T cells are released into the bloodstream, they can effectively attack HIV proteins, even when the virus mutates.

This model also explains why people with the HLA B57 gene have autoimmune problems: Their T cells are more likely to bind strongly to human peptides not encountered in the thymus.

The computational studies explained many puzzles, but also made a prediction: Individuals with HLA genes that result in a display of fewer self-peptides should control HIV (and other viruses like hepatitis C virus) better. To test this prediction, the researchers studied nearly 2,000 patients — 1,100 "HIV controllers" and 800 who progressed normally to AIDS, and confirmed that this appears to be true. ◊

Research Focus: Biomedicine

Articles by Anne Trafton, courtesy of the MIT News Office. For more information, go to *web.mit.edu/cheme/news/*

More Precise Food-Allergy Diagnoses

Many people mistakenly think they have food allergies. A new technology aims to erase all doubt.

About 30 percent of Americans believe they have food allergies. However, the actual number is far smaller, closer to 5 percent, according to a recent study commissioned by the National Institute of Allergy and Infectious Diseases (NIAID). That's due in large part to the unreliability of the skin test that doctors commonly use to test for food allergies.

Professor Christopher Love believes he has a better way to diagnose such allergies. His new technology, described in the June 7 issue of the journal Lab on a Chip, can analyze individual immune cells taken from patients, allowing for precise measurement of the cells' response to allergens such as milk and peanuts.

Using this technology, doctors could one day diagnose food allergies with a simple blood test that would be faster and more reliable than current tests, says Love. "With a large number of diagnoses, it's ambiguous," he says. "A lot of times it's almost circumstantial whether you're allergic to one thing or another."

Measuring single cells

Food allergies occur when the body's immune system mistakes a protein in food for something harmful. This triggers an allergic response that can include rashes, hives, difficulty breathing or gastrointestinal distress. Some allergies can provoke life-threatening anaphylactic shock, which requires immediate treatment.

Patients suspected of having food allergies usually undergo a skin test, which involves placing small quantities of potential allergens under the skin of the patient's arm. If the patient's blood has antibodies specific to that allergen, immune cells will release histamines that cause itching and redness in the spot where the allergen was placed.

Doctors can also perform blood tests that directly measure the presence of particular antibodies in the patients' blood. However, one drawback to both of these tests is that the presence of antibodies to a particular allergen does not necessarily mean that the patient is allergic to that substance, leading to false positive results.

Love's new technology, developed with funding from the Deshpande Center for Technological Innovation, the Dana Foundation and the NIAID, takes a different approach. Instead of detecting antibodies, his system screens the patient's immune cells for small proteins known as cytokines. Immune cells such as T cells produce cytokines when an allergic response is initiated, attracting other cells to join in the response.

To perform the test, blood must be drawn from the patient, and white blood cells (which include T cells) are isolated from the sample.

The cells are exposed to a potential allergen and then placed into about 100,000 individual wells arranged in a lattice pattern on a soft rubber surface. Using a technique known as microengraving, the researchers make "prints" of the cytokines produced by each cell onto the surface of a glass slide. The amount of cytokine secreted by each individual cell can be precisely measured.

Testing allergic reactions

The ability to measure individual immune cells' cytokine production represents "a great advance," says Amal Assa'ad, professor of pediatric immunology and allergy at the University of Cincinnati College of Medicine, who was not involved in the research. She adds, however, that clinical studies will be needed to demonstrate the ability to accurately diagnose food allergies. "Any test will have to be tested on multiple patients to see that it truly correlates with clinical allergy," she says.

Love is now working with Dale Umetsu, professor of pediatric immunology at Children's Hospital Boston, on a project they hope will pinpoint the relationship between cytokine activity and allergic reactions. In that study, children with milk allergies are being given small amounts of milk to desensitize their immune systems to the milk. Using the new technology, the team is tracking how the responses of the patients' cells change as the patients undergo treatment. ◊

“The most problematic consequences of diabetes result from relatively short excursions of a person’s blood sugar outside of the normal physiological range...If we can detect and prevent these, we can go a long way toward reducing the devastating impact of this disease.”

- Michael Strano

‘Tattoo’ May Help Diabetics Track Blood Sugar

Carbon nanotubes injected under the skin reveal blood glucose levels

Paul Barone, a postdoctoral researcher, and Professor Michael Strano are working on a new type of blood glucose monitor that could not only eliminate the need for finger pricks but also offer more accurate readings.

“Diabetes is an enormous problem, global in scope, and despite decades of engineering advances, our ability to accurately measure glucose in the human body still remains quite primitive,” says Strano, the Charles and Hilda Roddey Associate Professor of Chemical Engineering. “It is a life-and-death issue for a growing number of people.”

Strano and Barone’s sensing system consists of a “tattoo” of nanoparticles designed to detect glucose, injected below the skin. A device similar to a wristwatch would be worn over the tattoo, displaying the patient’s glucose levels.

Continuous glucose detection

“The most problematic consequences of diabetes result from relatively short excursions of a person’s blood sugar outside of the normal physiological range, following meals, for example,” says Strano. “If we can detect and prevent these, we can go a long way toward reducing the devastating impact of this disease.”

Most existing continuous glucose sensors work via an injection of an enzyme called glucose oxidase, which breaks down glucose. An electrode placed on the skin interacts with a by-product of that reaction, hydrogen peroxide, allowing glucose levels to be indirectly measured. However, none of those sensors have been approved for use longer than seven days at a time.

Taking advantage of nanotubes

The technology behind the MIT sensor, described in a December 2009 issue of ACS Nano, is fundamentally different from existing sensors, says Strano. The sensor is based on carbon nanotubes wrapped in a polymer that is sensitive to glucose concentrations. When this sensor encounters glucose, the nanotubes fluoresce, which can be detected by shining near-infrared light on them. Measuring the amount of fluorescence reveals the concentration of glucose.

The researchers plan to create an “ink” of these nanoparticles suspended in a saline solution that could be injected under the skin like a tattoo. The “tattoo” would last for a specified length of time, probably six months, before needing to be refreshed.

To get glucose readings, the patient would wear a monitor that shines near-infrared light on the tattoo and detects the resulting fluorescence. One advantage of this type of sensor is that, unlike some fluorescent molecules, carbon nanotubes aren’t destroyed by light exposure. “You can shine the light as long as you want, and the intensity won’t change,” says Barone. Because of this, the sensor can give continuous readings.

Development of the nanoparticles and the wearable monitor is being funded by MIT’s Deshpande Center for Technological Innovation.

Barone and Strano are now working to improve the accuracy of their sensor. Any glucose monitor must pass a test known as the Clarke Error Grid, the gold standard for glucose-sensor accuracy. The test, which compares sensor results to results from a lab-based glucose meter, needs to be very stringent, since mistakes in glucose detection can be fatal. ◊

(image courtesy of Christine Daniloff, MIT)

Alumnus Highlight

Professor Bradley Olsen '03 is one of ChemE's newest faculty members, having officially started in the department January of this year. One of our graduate students had the opportunity to sit down and ask him a few questions about his career path, research, and life outside of MIT.

Professor Bradley Olsen '03

Graduate student Jeffrey Mo discusses MIT, UROP and the Jetsons with one of Course X's newest professors.

Before you were a professor here, you were an MIT undergrad. What was it like, applying to MIT the first time?

I grew up in Minneapolis, and most people that I went to high school with didn't really leave the area – I think 2 people out of my graduating class of 600 ended up leaving the Midwest for school. At the time, it was a pretty big adventure. I was the first person from my school to come to MIT.

Have you always been interested in a career in academia?

No, not so much. Starting out, chemical engineering was pretty cool for the same reasons as the freshmen in 10.10 tell me today – you're really interested in chemistry and in engineering, and chemical engineering is supposedly the combination of both. I thought that I was going to stop after my Bachelor's degree and become an engineer in industry. I'd always had a strong interest in internships and started, two weeks after I turned 18, in a science lab in General Mills. But through my experiences at MIT, I became interested in graduate school and went out to Berkeley, and during that process decided that I wanted to do research in an academic career.

Do you attribute that to some of your UROP experiences here?

I really think so. I don't know if there's a biggest fan contest for UROP, but I would enter it. One of the things I was absolutely excited about in coming back to MIT was the strength of the UROP program and being able to take part in that. I think that the opportunities that MIT gives younger students to get involved are priceless.

I UROPed mainly during the school years, all eight semesters on campus. I had one summer of UROP while at the same time working at an internship, so I'd get up really early and start my internship at 7, finish my eight hours there at 3, and then I could come to MIT and UROP for several hours. That was the only summer I UROPed; otherwise I spent it all in industry. That summer was exhausting, but I would say that working two jobs is still easier than being an MIT undergrad during the term!

Why did you choose to go to Berkeley for grad school?

There's a pretty good tradition of sending MIT undergrads to the Bay Area. Certainly my advisors here thought very highly of it. At the time, Berkeley had been making a real effort to expand its research in the polymer area, the area that I was interested in. It was also great for my wife Catie and me because it was easy to find a two-body solution in that area.

How would you compare MIT to Berkeley? What did you miss about MIT when you left?

I missed things about both the institution and the city, so I'll say the best about each one. The thing about MIT is that this place, more than any other, has a culture of not saying "No!" to science. This is a place where people dream the impossible – and then they go and do it. The culture at MIT really encourages people to tackle very high-risk, yet very impactful things that others wouldn't necessarily dare to try. Boston as a city is pretty fantastic in terms of its culture and its concentration of walkable things to do: being able to go to the North End or take a stroll in the Back Bay or sit on a bench in the Public Garden…

You said that MIT has a culture of being very conducive to high-risk ideas. Is that one of the reasons you came back here?

Yeah, that's one of the big ones. The level of creativity that's present at MIT is just unmatched. The other thing is that the environment at MIT is consistent with the idea that when you bring a bunch of really talented people together, great things happen. MIT is a critical nucleus of talent in science and engineering, so it's exciting to come back and work with other intelligent people and have an opportunity to learn from some of the other faculty and from my students – to grow as a scientist and hopefully to do some great work.

What is it like interacting with the undergrads now?

I certainly have quite a bit of nostalgia about the place. The undergrads probably find me to be a less-desirable faculty member because I'm less sympathetic – I've been through it before, I know they're going to survive and I really expect them to rise up and perform their best.

I was happy to have an undergrad lab be the first class I had to teach: 10.10. It was pretty scary for me, because the undergrads here are a tough crowd. They're really, really bright and always on the ball. If you make a mistake, they're going to find it right away. It is a good experience in terms of making you a sharp teacher.

UROP is very important to me. Undergrads here have the opportunity to cultivate mentors who will really support them throughout their career. I was afforded that, and it's really important to me to return that opportunity and mentor young people, encouraging their scientific ambitions and their growth as people. From high-schoolers to independent adults and researchers … they're going to be the next generation doing what we're trying to do now.

How has MIT changed in the seven years since you've gone and come back?

It looks a lot more like it's out of the Jetsons now. The Stata Center is new since I left, as are Picower and McGovern. The white building over the train tracks – that looks very Space Age. When I came here, Central Square was gentrifying and MIT was acquiring land and expanding. Some of these expansions are done now, but at the time, it still had a light industrial vibe that, today, is disappearing all throughout Cambridge.

What has been the most exciting part of your job since you arrived at MIT?

I would have to say that it's working with the team of people who have joined the research group. It's a young group and everyone is so much fun to work with. They make research exciting every day – not just on the days when there's a big discovery. Coming back to the UROPs, they really have a level of excitement that's unparalleled in anyone else, and that's fantastic.

Did you meet your wife here at MIT?

Yes, I met Catie freshman year. We started dating before we took any ChemE classes, and we were dating all through our ChemE classes. I think most of the faculty didn't realize this! One of the funny moments was when we were partners in 10.493, the ICE module taught over IAP by Professor Sawin. We were partners, and won, in the paper airplane design contest, and as a prize, he took us on a flight in his airplane over to Nantucket or Martha's Vineyard for dinner. We were getting on the plane, and it was just then that he realized that we were actually engaged!

What advice do you have for students – both undergraduate and graduate – going through MIT ChemE today?

This is a great place to be. For the graduate students, you have the best advisors here. At the same time as you work hard and stay focused on your project, think big about where your research fits in and how you're making a contribution, both in terms of fundamental science and the impact of your research on society.

For the undergrads, realize that it's a pretty tough program and it's tough intentionally. You're learning how to think in new ways and how to challenge yourself. It isn't always a comfortable feeling, but when you're done, it pays dividends.

MIT is certainly a university, but in many ways, it's also a community and a family – so when you graduate, you're a member of that alumni club, a group of the smartest people in the world who are doing really important things. When you look back on your education – no matter how tough it is any one day a week before finals – you're going to feel grateful for being here. Most of the people I know from MIT have had some of the most transformative experiences here. They meet people who will affect them and help them throughout the rest of their lives.

Finally, what memory from being an MIT undergrad sticks out the most for you?

Well… I really liked sleeping in 26-100, in two separate instances. The first was during LSC movies – I would finish the week so exhausted that I couldn't stay awake during an LSC movie, no matter how good of a movie it was. It's like sacrilege to admit this at MIT, but I basically fell asleep 10 minutes into Monty Python and the Holy Grail and had to be woken up to get out. I was really passed out.

Then, for freshman year, I had Walter Lewin for the big physics lectures. He's awesome, so it didn't happen very often, but once in a while you were so tired from the P-Set the night before. So I guess the very fond memories are that you work really, really hard and then you take some nap time! ◊

Olsen (2nd from right) poses with Professor Karen Gleason and other graduates during Course X's 2003 Commencement Reception. Photo courtesy of Karen Gleason.

Commencement Alumni Reception

This year's Commencement Reception was on Friday, June 4, 2010. Graduates, families, faculty, friends and alumni mingled at the Chemical Engineering Tent on the McDermott Circle, and the Red Coats were in full force!

Alumnus Highlight

Bhavik Bakshi (PhD '92)

TERI (The Energy and Resources Institute) University has appointed Prof. Bhavik R Bakshi as Vice Chancellor. Prior to joining TERI University, Bakshi was a professor of chemical and biomolecular engineering at Ohio State University. He has also been a visiting professor of chemical engineering at Institute of Chemical Technology, Mumbai. In his new role at TERI, Bakshi will oversee all academic and research enterprises at the university.

Bakshi has a distinguished record of teaching and research extending over two decades in India and the US. He has written research papers in the areas of Sustainability Science and Engineering, Process Systems Engineering, Complex and Multiscale Systems, Industrial Ecology, and Applied Statistics and speaks regularly at international conferences.

Bakshi holds an MSCEP from MIT and a B Chem Eng from the University of Bombay. He was conferred the NSF Faculty Early Career Enhancement Award (CAREER) in 1998.

Dr R K Pachauri, Chancellor, TERI University and Director General, TERI, said, "Professor Bakshi is a dynamic and forward thinking individual with a wealth of experience. His dedication and commitment to education and research on sustainability science at the national and international levels is a great asset to our University, taking it closer to realizing our vision of a university of excellence for the entire region." ◊

Alumna Highlight

Stephanie Espy ’01

Stephanie Espy’s educational pedigree stands out on first look. It starts at Southwest DeKalb High School, where she graduated in 1997. She then moved to MIT where she received a bachelor’s in chemical engineering in 2001. From there she got her master’s in chemical engineering, followed by an MBA from Emory in 2008. It’s not the typical resume of your average, for-hire math tutor.

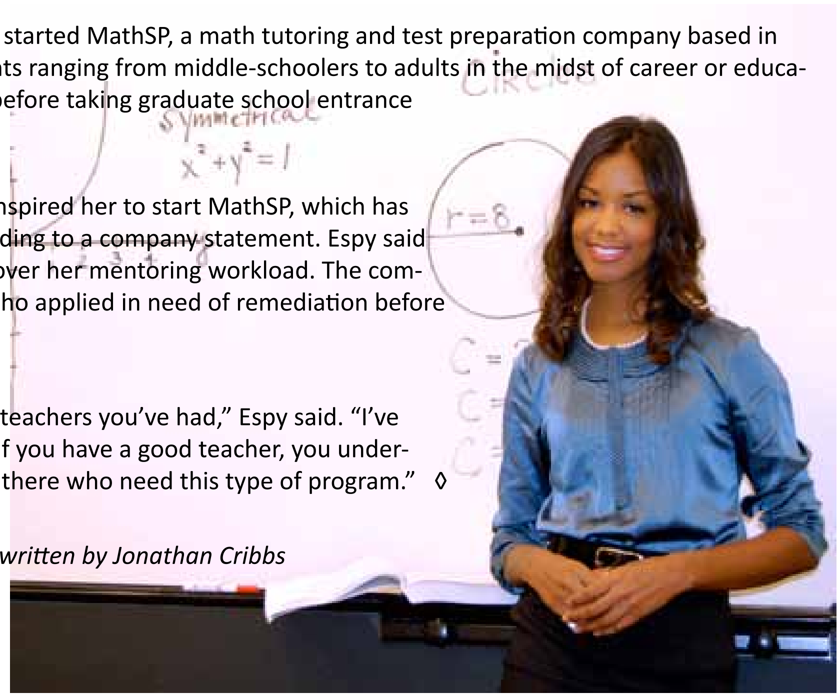
“So many careers these days require knowledge of mathematics,” she said. “Really, to be successful in your career or in general some basic level of math is important.”

With this sort of enthusiasm for numbers, Espy started MathSP, a math tutoring and test preparation company based in Atlanta. The service is designed to assist students ranging from middle-schoolers to adults in the midst of career or educational changes who feel they need a brush-up before taking graduate school entrance exams, etc.

Espy said her time at Emory’s business school inspired her to start MathSP, which has grown to include instructors in New York, according to a company statement. Espy said she plans to hire additional instructors to take over her mentoring workload. The company also offered free courses to 15 students who applied in need of remediation before the SAT, GRE and GMAT.

“Part of what makes math fun or not fun is the teachers you’ve had,” Espy said. “I’ve been fortunate… to have really good teachers. If you have a good teacher, you understand it better. There are so many students out there who need this type of program.” ◊

From the April 2010 article in the DeKalb News written by Jonathan Cribbs



We’ve been hacked!

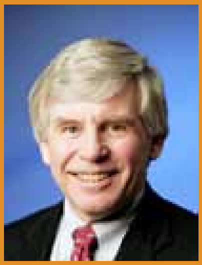
On Thursday, April 8, 2010, just in time for Campus Preview Weekend, an upside down living room, complete with wall art, sleeping cat and hacker’s map laid out on a pool table, appeared underneath the concrete arch outside the Media Lab and across the street from Building 66.

You can find more photos at www.ericschmiedl.com.

Spring 2010 Lectureships

During the 2010 spring semester, the Chemical Engineering Department hosted a distinguished group of academic and industry leaders; highlights are noted below.

Webcasts for all Chemical Engineering major lectures can be accessed at *web.mit.edu/cheme/news/webcast.html.*



16th Alan S. Michaels Lecture (April 2, 2010)

"Starting and Building Biotech Companies: From Sepracor to Selecta."

Robert L. Bratzler (PhD '75) is the executive chairman of Selecta Biosciences, a Watertown-based biotech company pioneering the development of targeted nanoparticle vaccines for treatment and prevention of diseases. Dr. Bratzler, an alumnus of the MIT Chemical Engineering Department, shared advice and anecdotes from his experience of starting several successful biotechnology companies.

32nd Warren K. Lewis Lecture (April 30, 2010)

"The Untold Story of Gluten:
Viscoelastic Wonder, Rat Poison, or Autoimmunity's Rosetta Stone?"

Chaitan Khosla of Stanford University presented issues surrounding the "fascinating material" gluten and celiac disease. Over the past two decades Professor Khosla has studied polyketide synthases as paradigms for modular catalysis, and has exploited their properties for engineering novel antibiotics. More recently, he has investigated celiac sprue pathogenesis with the goal of developing therapies for this widespread but overlooked disease.

"This is always a wonderful place for curious people to come because you feel the basic nature of what makes our profession so special. The imbalance between what you learn from [this] environment and what you have to share... is so large that there's no point in trying to do anything about it other than just enjoying it."

- Chaitan Khosla, on his short residency in the Department
as the 2010 Warren K. Lewis Lecturer

Of Note: Fall 2010 Hoyt C. Hottel Lecture

On September 22, 2010, Dr. Steven E. Koonin, the Department of Energy's Under Secretary for Science, gave the 25th Annual Hoyt C. Hottel Lecture, discussing "Energy Innovation at Scale." Full coverage of the lecture will be included in the next edition of *XCurrents*.

More information and a webcast of the Hottel Lecture can be found at *web.mit.edu/cheme/news/hottel.html.*

A Special Event

On May 14, 2010, researchers, colleagues and former students of Professor Merrill came from all over the world to celebrate his legacy in chemical engineering research and education. The day consisted of several talks by his former students, a luncheon and dinner that evening at the Charles Hotel.

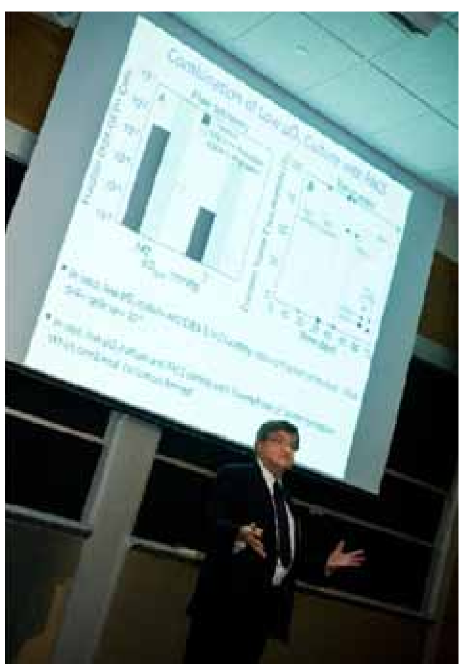
For more information and to view a webcast of the event, go to *web.mit.edu/cheme/news/merrill.html.*

Symposium to Honor Professor Emeritus Ed Merrill









Alumni News

Please direct news to: Melanie Miller, Editor, Email: melmils@mit.edu, Phone: 617-253-6500, Fax: 617-258-8992
We want to hear from you. Find the latest news at *web.mit.edu/cheme/alumni/.*

John Ross '56 has published the network administration "how-to" book *Network Know-How: An Essential Guide for the Accidental Admin,* available on amazon.com. After a short stint as an engineer, Ross became a high school science teacher in Princeton, N.J., where he taught physics and chemistry for twenty six years at Princeton Day School.

Bill Acorn (MS '60 ScD '65) has published a book of 48 personal essays with a section on consciousness studies. The title, *My Affair With S*, is available on amazon.com. Acorn specialized in the design of catalysts and catalytic processes, and wrote papers on batteries for electric cars and hydrocarbon fuel cells. He later became Technical Director at Harshaw Chemical and then Camet, a manufacturer of catalytic converters. He is active in a Unitarian-Universalist church and has served as board president. He is a trustee of a professional theater, a member of a 107-year-old philosophical club, and an amateur musician. Acorn and his wife reside in Cleveland, Ohio.

Peter Balbus '82 has been named Chairman of the MIT Enterprise Forum of Chicago. Balbus is founder and CEO of integrated business & IT strategy consultancy Pragmaxis. He was previously vice president and GM of Booz Allen & Hamilton's Chicago regional e-business strategy and implementation group. He was also formerly a vice president at eXperience, the "brick and mortar" strategy consulting group at Divine InterVentures, a principal at CSC Index and a senior manager at KPMG Strategic Services.

John J. Alam '82 has joined Inhibitex as its Senior Medical Advisor. Dr. Alam was formerly Executive Vice President, Medicines Development and Chief Medical Officer at Vertex Pharmaceuticals, Incorporated. Dr. Alam will be responsible for formulating and directing the clinical and regulatory strategies for Inhibitex's development programs, including FV-100, which is in Phase II clinical development for the treatment of shingles, and INX-189, a nucleotide polymerase inhibitor in development for the treatment of chronic hepatitis C infections (HCV).

Arunava Dutta (ScD '85) is currently Research and Development Manager for Osram Sylvania, a Siemens Company. His US office is in Beverly, Mass. He is responsible for development of UV products in Canada and for advanced photo-luminescent (phosphor) R&D for the NAFTA region. He presently has 19 US patents and several EU patents.

Dutta lives in Winchester, Mass, with wife Malini and two daughters Anashua and Anamika who are in the Winchester school system.

Noubar Afeyan (PhD '87)'s company Joule Biotechnologies was profiled in the May 2010 *Technology Review* as a company "to watch" because of its work to make the ideal renewable fuel. "What we wanted to know," Afeyan says, "is could we engineer a system that could convert carbon dioxide directly into any fuel that we wanted?"

The answer seems to be yes, according to Joule Biotechnologies, the company that Afeyan founded (also in Cambridge) to design this new fuel. By manipulating and designing genes, Joule has created photosynthetic microörganisms that use sunlight to efficiently convert carbon dioxide into ethanol or diesel--the first time this has ever been done, the company says. Joule grows the microbes in photobioreactors that need no fresh water and occupy only a fraction of the land needed for biomass-based approaches. The creatures secrete fuel continuously, so it's easy to collect. Lab tests and small trials lead Afeyan to estimate that the process will yield 100 times as much fuel per hectare as fermenting corn to produce ethanol, and 10 times as much as making it from sources such as agricultural waste. He says costs could be competitive with those of fossil fuels.

Beth Israel Deaconess has named **Elliot L. Chaikof (PhD '89)** new chief of surgery. Chaikof is the former chief of vascular surgery at Emory University in Atlanta. He is a leader in the development of minimally invasive endovascular therapies for aortic aneurysms, carotid disease and peripheral vascular disease. He earned his MIT degree while training as a surgeon at Massachusetts General Hospital.

In February 2010, **Mick Sawka (SM '91)** was named vice president of business development for biofuels company Qteros. Sawka joins Qteros from Microbia, Inc. where he led business development efforts for this developer of unique bio-based specialty chemicals directed at large-scale industrial applications. Sawka's 19-year experience in the specialty chemicals industry includes negotiating and leading numerous large-scale strategic partnerships, alliances, and acquisitions as well as complex product introductions throughout the world.

Randy Lewis (PhD '95) has become the new chair of chemical engineering at Brigham Young University (BYU). Lewis teaches upper-division classes including biochemical engineering, chemical reaction engineering and unit operations. Lewis has been acting as chair of the undergraduate committee for the department and as the co-advisor for Engineers Without Borders. He conducts research in biomaterials, sustainable energy and analysis of nitric oxide's effects on biological systems.

He has been a professor at BYU since August 2005. Before joining the BYU faculty, he taught at Oklahoma State University as the R.N. Maddox Professor in its School of Chemical Engineering. While at OSU, he was named Teacher of the Year in 1998. That same year, he was recognized with a fellowship from the Engineering Foundation in New York.

Patrick De Man (PhD '06) and his wife welcomed their first child, baby boy Masa on February 9, 2010.

Dhananjay Dendukuri (PhD '07), has been named Technology Review India's 2010 "Humanitarian of the Year" for offering cheaper, speedier medical tests for the developing world by using microfluidic chips.

Through his Bangalore-based Achira Labs, Dendukuri has developed a novel platform that allows samples of blood, urine, saliva, or other body fluids to be loaded directly on to a plastic microfluidic chip and tested for the presence of multiple analytes in a few minutes. The focus is on immunoassays (protein tests).

"This automated testing platform consists of a fluorescence-based, portable reader and reagent-loaded microfludic chips. The miniaturized assays allow for reduction in the volumes of expensive reagents used and hence their cost," says Dendukuri.

"The low development cost of the platform coupled with the sensitivity and reliability of expensive tests will enable a large number of people to have access to health-care tests in underdeveloped parts of India and other countries," he adds.

"Dhananjaya has innovated around microfluidics, focusing on lab-on-a-chip (LOC) for point of care in the diagnostics space which was a carry over from his doctoral dissertation at MIT. He has manufactured the LOC such that samples from multiple patients and multiple tests per patient could be done," says Rajesh Srivathsa, venture capitalist from Ojas Venture Partners who has invested in Dendukuri's Achira Labs in Bangalore.

"Given that in emerging markets, such as India, this testing is not available (with a reasonable turn around time and at a reasonable cost), it would go a long way in democratization of diagnostics," he added.

The exciting news is that Dendukuri believes such a manufacturing technology will have wide use beyond medical diagnostic testing in areas including defense, food, and environment testing and in new areas such as tissue engineering. ◊

Alumnus Highlight

James Wei (ScD '55)

Professor James Wei has retired from the Princeton University faculty as professor of chemical engineering, which he joined in 1991 and served as Dean of Engineering and Applied Science from 1991 to 2002. Previously to this, he was professor of chemical engineering at MIT from 1978, and department head for a decade, from 1978 to 1988. He is currently writing a book "Great Inventions that Changed the World", and hopes to have it in print before the end of 2010.

At Princeton, Wei taught a freshman seminar titled "Great Inventions That Changed the World." His research is in catalysis and zeolites as it relates to environmental problems. Wei has published more than 100 articles, and has been editor of several books and journals, including Advances in Chemical Engineering, a journal devoted to informing a general audience of major developments taking place in the field of chemical engineering. As an expert on the environmental impact of the chemical industry, he has participated in many governmental panels, such as the National Research Council. Wei has received numerous awards, and has been elected into the ranks of the National Academy of Engineering, American Academy of Arts and Sciences, and Academia Sinica.

Professor Wei notes that the Princeton Chemical Engineering Department has numerous MIT alumni on its faculty, including Pablo Debenedetti (PhD '85), Vice Dean of Engineering Rick Register '84, Department Chairman Thanos Panagiotopoulos (PhD '86), and Celeste Nelson '98. ◊

In Memoriam

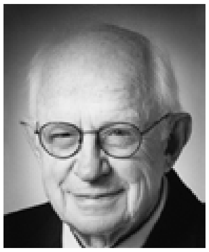
Edward A. Mason ’50
1924-2010

Edward A. Mason, a former head of the Department of Nuclear Engineering, died on June 23, 2010 at his home in Osterville, Mass. He was 85.

Mason joined the faculty of the department when it formed in the late 1950s, having previously served as an assistant professor in the Chemical Engineering Department. He served as Nuclear Engineering department head from 1971 to 1975. Mason was a U.S. Navy veteran, and received his master’s and doctorate degrees in chemical engineering from MIT after serving in World War II.

In 1974, President Gerald Ford appointed Mason as a commissioner on the first Nuclear Regulatory Commission. He began his government service in January 1975, when the commission was formally established. He subsequently served as vice president for research at Amoco Corporation. Mason was a member of the National Academy of Engineering and the New York Academy of Sciences; fellow of the American Academy of Arts and Sciences, American Nuclear Society, and the American Institute of Chemists; and member of the American Institute of Chemical Engineers, the American Chemical Society, and the American Association for the Advancement of Science.

Richard K. Lester, the current head of the Department of Nuclear Science and Engineering, noted the influential role played by Mason in the early years of the department. “Ed was an outstanding figure in the development of the nuclear engineering discipline. Together with Manson Benedict and their students he shaped the field of nuclear chemical engineering. And even after leaving the department, Ed continued over many years to provide valuable advice and counsel to us. He will be greatly missed.”



Thomas Pigford (SM ’48, ScD ’52)
1922-2010

Former MIT Professor Thomas Harrington Pigford (SM ’48, ScD ’52), who helped launch the Institute’s graduate program in nuclear engineering, died Sunday, Feb. 28, 2010, at his home in Oakland, Calif., from complications of Parkinson’s disease. He was 87.

Pigford’s five-decade career in nuclear engineering spanned nuclear reactor design, nuclear safety, nuclear fuel cycles and radioactive waste management. He championed nuclear power, but not at the expense of appropriate safeguards for health and the environment. He was respected among scientists and environmentalists alike for his technical expertise and objectivity, and was appointed to numerous advisory commissions on nuclear reactor safety, including the Expert Consultant Group to Evaluate the Chernobyl Accident and the President’s Commission on the Accident at Three Mile Island (TMI).

Pigford was born April 21, 1922, in Meridian, Miss., where he attended school before leaving for college. He received his bachelor’s degree in chemical engineering from the Georgia Institute of Technology, where he graduated magna cum laude in 1943. His graduate studies at MIT were interrupted when he joined the U.S. Navy, where he served in the Pacific during the last stages of World War II. He was discharged with the rank of lieutenant junior grade at the end of the war and returned to MIT to continue his studies.

While still completing his doctorate, Pigford was asked to join the MIT faculty — he became associate professor of nuclear and chemical engineering in 1955 — and his career here included a two-year stint as director of the MIT Graduate School of Engineering Practice at Oak Ridge, Tenn. Pigford transferred back to MIT from Oak Ridge in 1952, the same year he helped Benedict inaugurate MIT’s new graduate program in nuclear engineering.

At the Oak Ridge National Laboratory, Pigford also held a position as senior development engineer with the Aqueous Homogenous Nuclear Reactor Project. From 1957-1959, he was a founding staff member at General Atomic, now called General Atomics, at the time a nuclear technology research and development firm based in La Jolla, Calif.

In 1959, Pigford was recruited to the UC Berkeley faculty as a full professor by Nobel Laureate Glenn Seaborg, who was UC Berkeley chancellor at the time. Pigford became the first permanent chair of the nuclear engineering department, which had just been elevated to a full department from a graduate studies program. He also held a position as a senior scientist at the Lawrence Berkeley National Laboratory. Pigford retired from UC Berkeley in 1991 and became professor emeritus.

George W. Roberts '65
1939-2010

Dr. George W. Roberts, professor emeritus of North Carolina State University's chemical and biomolecular engineering and department head emeritus of chemical and biomolecular engineering, died April 5, 2010 in Raleigh at age 71 after succumbing to a short illness. He will be remembered for his 21 years of extraordinary service to the department as an excellent teacher, researcher and administrator.

Roberts received his bachelor's degree in chemical engineering from Cornell University in 1961 and his ScD degree from MIT in 1965. He began his professional career as an instructor in the Department of Chemical Engineering at MIT. After leaving MIT, he pursued a career that included positions of increasing responsibility at the Rohm and Haas Company, as a faculty member in the Department of Chemical Engineering at Washington University, Engelhard Minerals and Chemicals Corporation and Air Products and Chemicals, Inc. In 1989, he joined NC State as professor and head of the chemical engineering department.

As department head, his major accomplishments included initiating the departmental alumni relations program, restructuring the departmental corporate relations programs, recruiting four new faculty members, obtaining almost $500,000 in outside faculty recruitment/development grants, obtaining corporate grants totaling over $250,000 to support graduate education and facilities improvement, and obtaining over $1.2 million in outside grants and contracts for research on alternate fuels.

His teaching and research interests included chemical reaction engineering, applied catalysis, polymerization kinetics, polymer synthesis in supercritical carbon dioxide, synthesis of oxygenated fuels, automotive catalysts, environmentally benign chemical synthesis, multiphase reactors, and the development and commercialization of new technology.

Over the last 10 years of his career, Roberts was instrumental in the establishment of the $37 million National Science Foundation Science and Technology Center for Environmentally Responsible Solvents and Processes that was launched in 1999. He led research initiatives focused on the continuous polymerization of monomers in supercritical fluids, including the design of innovative reactor configurations that enabled environmentally responsible supercritical carbon dioxide based processes for the production of commercially important materials as poly(acrylic acid) and poly(vinylidine fluoride). From 2005 until 2009, Roberts was the co-director of this very successful NSF STC.

Roberts was faculty advisor to the NC State AIChE Student Chapter from 1993-2003. During his tenure as faculty advisor the chapter won the national AIChE Chapter of the Year Award nine times and the Marx Isaacs Award for the best Student Chapter Newsletter. Quite appropriately, in recognition of his unprecedented success as faculty advisor, Roberts was a recipient of the national Outstanding AIChE Student Chapter Advisor Award. His other awards include the NC State Alumni Association Outstanding Teacher Award, Alcoa Foundation Distinguished Engineering Research Award, the Ralph R. Teetor Award from the Society of Automotive Engineers and the Distinguished Faculty Award from Washington University. Roberts was also a Fellow of AIChE. He was co-inventor on 19 U.S. patents, author or co-author of more than 65 refereed technical publications, 11 book chapters, and 130 technical presentations, and his textbook, *Chemical Reactions and Chemical Reactors*, was published in 2008. The second printing of his text will be published shortly.

Blast from the Past

This edition's theme is "Party Time!" Below are new photos culled from the MIT Chemical Engineering archives. Are you or anyone you know in them? Or do you have a photo you'd like to share? Email *melmils@mit.edu*.

Seymour J. Sheinkopf '39 sent in a special treat: a photograph he took of his 1939 Course X-B Practice Group in Bethlehem Steel Station, Lackawanna, NY. He shares:

This photo was take by me in May 1939 in front of the Buffalo boarding house in which our group lived.

Of this group, I know that Hank Landwehr, Paul Comstock, Sig Oettinger, Julius Lucas, Leo Kiley and Doug Taylor are deceased. I do not know the condition of the others.

I believe the Assistant Director at this station was Ed Vivian. If I am wrong about that, then he was at our Eastern Paper Station in Bangor, Maine. I know Roy Whitney was the Director at the Bangor Station.

Please post this photo, which probably wins the "oldest prize," in the "Blast from the Past." Some of our survivors may be interested in renewing contact with each other.

In the photo, left to right: (rear row) Hank Landwehr, Norm Farquhar, Paul Comstock, Frank Bent, (middle row) Jack Wholey, Sig Oettinger, Julius Lucas, Seymour Sheinkopf, (front row) Leo Kiley, Bob Atwater, Doug Taylor, and Bob Arns.

Thank you to all the sharp-eyed alumni who recognized the photos from the Spring 2010 edition!

B.H. Wood (ScD'64) writes: The tall man at the righthand end of the line appears to be John Sherman, ScD around '64. John was a Practice School station director in New Jersey (I don't remember the site) in the mid 60's. The photo is most likely a Practice School team.

Eugene Grumer (SM'64) recognized himself! He writes: The picture is my practice school class, 1964 at Bayway in New Jersey. I am 2nd from left, next to me is Charles Warford who died in a tragic car accident I believe on his honeymoon after graduation, and 2nd from right is the chap from Australia. The lady of course is Helene Sevenier Blanc from France. The picture was published in The Flagstaff, p. 152.

David Sabo '61 helps with identification: I believe the fourth person from the left hand side in this picture is James Lin Go, SB, Class of 1963, my Phi Kappa Theta fraternity brother. I believe he went to Practice School the following year after graduation so the picture is probably from 1963-64.

For this photo, Adrain Johnson, Jr., emeritus professor from the Chemical Engineering Department at Louisiana State University shared memories:

I immediately identified the photo in the lower left corner of page 27 in the Spring 2010 MIT course X news. This photo was taken in late 1948 of some of the participants in the VERY FIRST!! Oak Ridge (XA-49) practice school.

Unfortunately, I cannot now remember many of the names (I of course recognize all of the faces), although we all had become good friends by the time the five months we spent in Oak Ridge was over.

At the extreme left (kneeling) is Ruffin G. Stirling, Jr., (XA SM '49). At left-most sitting position is Thomas A. Kirkham, Jr. (X SB '48, XA S.M. '49). I am in the topcoat facing away from the camera, Adrain E. Johnson, Jr., (XA SM '49).

Other names I remember, but can't match with faces in the photo are Thomas Cantwell, Jr., (X SB '48, XA SM '49, XII PhD '??) and James F. Sheehan, Jr., (X SB '48, XA SM '49)-- I think he is the student at the extreme right in the photo.

The graduation photo from the Fall 2010 edition of XCurrents is still getting responses. Maria Klapa (PhD '01), now associate researcher at the Institute of Chemical Engineering and High-Temperature Chemical Processes and Foundation for Research and Technology-Hellas, writes:

"I just saw myself in the graduation picture appearing in the Fall issue of the ChemE Alumni News!
It is a picture from the 2002 graduation. I can recognize Pat Walton (first on the right), David Quiram (second from right), Tom Wang (third from left) and Betty Yu (fourth from left). You can see my head (5th fully shown face from the right) on the left of the guy with the MIT gray-purple robe.

Thank You for Your Support

This honor roll is a special salute to those who have given over $100 to the MIT Chemical Engineering Department for the period of July 1, 2009, through June 30, 2010.

Thank you to everyone who has supported us throughout the year!

Every effort has been made to ensure the accuracy of this list.
Please direct corrections to: ***Melanie Miller, Editor,*** at melmils@mit.edu

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Fall 2010 Chemical Engineering Dept. Seminar Schedule

All Seminars are Fridays at 3pm in 66-110. Reception at 2:45pm.

9/10 Mathematical Models From Molecules To Life
Prof. Yiannis N. Kaznessis, University of Minnesota

9/17 Flame Aerosol Synthesis of Functional Nanoparticles and Devices: Non-toxic Nanosilver for Biosensors
Prof. Sotiris E. Pratsinis, ETH Zurich, Switzerland

9/22 HOYT C. HOTTEL LECTURE Energy Innovation at Scale
Dr. Steven E. Koonin, Under Secretary for Science, US DoE

9/24 Molecular Understanding, Design & Development of Ultra Low Fouling Zwitterionic-based Functional Materials
Prof. Shaoyi Jiang, University of Washington, Seattle

10/1 Bio-based Production of Polymers and Monomers from Renewable Sources
Prof. Sang Yup Lee, Dean, College of Life Science and Bioeng. Korea Advanced Institute of Science and Technology (KAIST)

10/8 Electrodes for Solid Oxide Fuel Cells and Electrolyzers
Prof. Raymond Gorte, University of Pennsylvania

10/15 Towards Sustainable Fuel Production: Nanostructured Materials and Devices
Prof. Levi T. Thompson, Jr., University of Michigan

10/22 Towards Non-flammable Polyolefins: Using Surface Chemistry and Catalysis to Design Composite Materials
Prof. Susannah L. Scott, UCSB

10/29 Electrokinetics of the wall/electrolyte interface in nanofluidics
Prof. Henrik Bruus, Tech. University of Denmark

11/05 Thermodynamics of Electrostatically Driven Viral Packaging
Prof. Zheng-Gang Wang, CalTech

Going to AIChE in SLC?

You are invited to attend the

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Monday, Nov. 8, 2010

7pm-9pm in Room 255 A/B

Salt Lake City Convention Center