Department of Chemical Engineering

In academic year 2005, the Department of Chemical Engineering maintained its leadership role in the profession, with high productivity and visibility in teaching and research. For the 16th consecutive year, both our graduate and undergraduate programs garnered number one rankings among the nation's chemical engineering departments by *US News and World Report*. Chemical Engineering faculty continue to realize tremendous research productivity, with sponsored research expenditures of over $20 million for FY2005.

Undergraduate Education

Undergraduate enrollment in the department stands at 205 students. Forty-eight SB degrees were conferred as of June 2005, with 60% awarded to women. Student quality remains excellent. The distribution of undergraduate students by class is shown in Table 1.

Table 1. Undergraduate Enrollment over the Last 12 Years

Class Level	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05
Sophomores	118	87	97	88	71	67	47	56	56	95
Juniors	101	121	90	90	85	76	66	49	43	55
Seniors	103	110	130	94	103	89	84	65	41	55
Total	**322**	**318**	**317**	**272**	**259**	**232**	**197**	**170**	**140**	**205**

The Department of Chemical Engineering offered for the first time in fall 2004 its new bachelor of science degree in chemical-biological engineering, MIT's first undergraduate engineering degree with modern molecular biology as its core science (Course 10B). The new degree reflects the long-standing importance of chemical engineering at MIT to biotechnological and biomedical fields, dating back 35 years to the early work and courses taught by Professor Edward W. Merrill. It is also responsive to recent trends among chemical engineering undergraduates to supplement the traditional chemical engineering education with a double major in biology or a minor in biomedical engineering. The new degree parallels the traditional SB degree in chemical engineering and is quintessential of modern chemical engineering. It includes a broad foundation in modern chemistry and especially biology; the three core chemical engineering sciences of thermodynamics, transport phenomena, and kinetics; and the development of engineering problem-solving skills through analysis and synthesis of solutions to complex problems that have social, economic, and global, as well as technical, dimensions. Revisions of content in the core chemical engineering courses such as 10.213 Chemical and Biological Thermodynamics and 10.37 Chemical and Biological Kinetics and Reactor Design were implemented to reflect the shifting emphasis to both chemistry and biology throughout chemical engineering. Two new lab courses, 10.28 Biological Engineering Laboratory and 10.29 Biological Engineering Projects Lab, as well as new modules in the capstone 10.492–10.494 Integrated Chemical Engineering design courses, covering such topics as biocatalysis, Molecular bioseparations, and controlled drug release, provide the specialized training for the new chemical-biological engineers. In its first year offered, Course 10B drew 23 students, comprising 27% of the Class of 2007 in the Department of Chemical Engineering. In the Class of 2008, 68 students, two-thirds of the rising sophomore class in the department for fall 2005, have declared majors in Course 10B.

Graduate Education

Graduate student enrollment is stable at 235 students, with 216 in the doctoral program and 19 master's-level degree candidates. The graduate programs include 86 foreign, 63 female, 31 Asian American, and eight self-identified minority students. The distribution of graduate students by degree is shown in Table 2. During the academic year, 43 doctoral degrees (PhD and ScD) were awarded, along with 31 SM and/or other master's-level degrees, yielding a total of 74 advanced degrees conferred. Forty-five students passed the doctoral qualifying exams and were promoted to candidacy for the PhD/ScD. The department received 276 applications for admission to the doctoral program, offered admission to 51 individuals, and received 36 acceptances of offers. Among the incoming class for 2005 are nine females and nine minority or Asian American students. The incoming graduate class had an average undergraduate GPA of 4.95 (out of 5.0).

Table 2. Graduate Enrollment over the Last 11 Years

Degree Level	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05
Master's	56	64	51	59	54	40	38	36	26	19
Doctoral	169	162	167	140	145	166	209	245	232	216
Total	**225**	**226**	**218**	**199**	**199**	**206**	**247**	**281**	**258**	**235**

Space Changes

Following the completion of earlier renovations of the undergraduate labs in the Ralph Landau Building (Building 66), the Department of Chemical Engineering renovated its lab space in Building 31 this year. The new lab provides the department with the facilities to offer 10.702 Introduction to Experimental Biology and Communication, an expansion of 7.02 Introductory Experimental Biology and Communication (a lab subject offered by the Department of Biology), in order to accommodate the growing interest among chemical engineering students in methods of modern biology. The department also completed renovation of its 4th floor research space in Building 66 to meet the needs of its newest faculty member, Professor Kristala Jones Prather. Following the recommendations of an external feasibility study completed in January 2004, whose purpose was to identify the facilities needs of the department and options for addressing them, the department continues to advocate the construction of a new facility to serve as the "home" of chemical engineering at MIT. Due to the deteriorating infrastructure in Building 66 and the changing nature of chemical engineering to encompass more diverse teaching and research involving modern biology, materials, and computational sciences, construction of a new building was identified as the option that best meets the constraints of time, money, and program requirements.

Faculty Notes

Professor Robert Armstrong continued to serve as department head. He currently serves as chair of the Council for Chemical Research, and is very active in leading a series of discipline-wide discussions on "Frontiers in Chemical Engineering Education." This educational activity has as its goal the first major revision in chemical engineering undergraduate curriculum in over 45 years. He serves as an assistant editor for the *Journal of Rheology*. During this past academic year, he gave invited lectures at the University of Washington, the University of Colorado, the University of Missouri, and Washington University. He serves on the advisory boards of chemical engineering departments at Georgia Tech, Northwestern University, Virginia Tech, the University of Wisconsin, and Stanford University. He is very enthusiastic about cochairing MIT's new Energy Research Council with Professor Ernest Moniz of the Department of Physics.

Professor Daniel Blankschtein continued to serve as graduate officer, and is responsible for the educational and social well-being of the graduate students in the department. His research group conducts fundamental theoretical and experimental research in the area of colloid and surfactant science, with emphasis on practical and biomedical applications. Professor Blankschtein's teaching responsibility included the core graduate course 10.40 Chemical Engineering Thermodynamics. Professor Blankschtein and his students presented papers and posters at meetings of the American Institute of Chemical Engineers (AIChE) , the Society of Cosmetic Chemists, and at the International Symposium on Surfactants in Solution, held in Brazil. Professor Blankschtein served as a member of the Scientific Committee for the International Conference on Biopartitioning and Purification, held in the Netherlands, and continues to serve on the editorial board of Marcel Dekker's Surfactant Science Series. Professor Blankschtein received the 2005 Outstanding Faculty Award from the graduate students in the Department of Chemical Engineering.

Professor Howard Brenner continued the thrust of his recent theoretical work aimed at modifying the Navier-Stokes equations based on the use of volume transport in place of mass transport, and delivered several seminars and lectures on the topic. A biographical sketch of him appeared in the book, *Giants of Engineering Science* (by Anwar Beg, Troubadour Publishing, Ltd., 2003) described as "a biographical monograph examining the life and works of ten of the world's leading engineering scientists." He continued to serve as a member of the Committee on Membership of the National Academy of Engineering.

Professor Robert E. Cohen was named fellow of the American Physical Society (APS) in 2004, and received his citation in a ceremony at the March 2005 APS meeting in Los Angeles. He also received a 30-year service and activity recognition from the Division of Polymer Chemistry of the American Chemical Society. Cohen and his students were active participants in seven professional society meetings in the past year, presenting papers and posters. Professor Cohen delivered an invited lecture on crystallization in block copolymers at the ACS 228th fall National Meeting in a symposium honoring the late John D. Hoffman. Cohen's continued codirection of the DuPont-MIT Alliance helped to secure a five-year, $25 million renewal of this combined research and education enterprise at MIT. In spring 2004, he was named chair of MIT's Committee on Nominations, a body that is central to the operation of the committee structure that underpins faculty governance at the Institute.

Professor Charles L. Cooney continued as the faculty director of the Deshpande Center for Technological Innovation and as codirector of the Program on the Pharmaceutical Industry. He was the co-lead, representing the School of Engineering, in developing the MIT BP Projects Academy in partnership with the MIT Sloan School of Management. The Projects Academy won this year's prestigious Helios Award from BP in London. Dr. Cooney was appointed to a three-year term as chair of the Food and Drug Administration (FDA) Advisory Panel for Pharmaceutical Sciences. He delivered keynote addresses to the FDA/Drug Information Association Conference on Follow-on Protein Pharmaceuticals and the IBC Life Sciences 2nd Annual Asia-Pacific Event in Mumbai. He is a member of the MIT Community Service Fund Board, the Lemelson-MIT Screening Committee and the MIT Committee on Intellectual Property.

Professor William H. Green Jr. received the American Chemical Society Fuel Division's Richard A. Glenn Award at the ACS National Meeting in August 2004, and presented the E.W. Thiele Lecture at the University of Notre Dame in September. He was a visiting fellow at Churchill College, Cambridge, UK, for most of his sabbatical year, where he researched the formation of nanoparticles in high-temperature environments.

Professor Paula T. Hammond was the recipient of the 2004 Bayer Distinguished Lecturer Award, which was presented to her by Bayer Chemicals at the University of Southern Mississippi; at this event, she spoke on the "Controlled Construction of Thin Film Nano-Assemblies for Power, Display and Bioapplications." She was also the ACS Scholars lecturer at Iowa State University and an invited lecturer at the International Self-Assembled Materials Conference in Tsukuba, Japan. She spoke at the Gordon Conference on Polymers in Ventura, CA, and at the Gordon Conference on Ion-containing Polymers in Il Ciocco, Italy, where she was elected to cochair the upcoming 2009 meeting. Dr. Hammond was also an invited speaker at several other companies and universities.

A new approach to the delivery of single or multiple drugs from an ultrathin degradable conformal coating has led to an Ignition Grant Award from the Deshpande Center for Technological Innovation for conformable, tunable, layer-by-layer drug delivery systems. Research developments in flexible thin-film solid-state electrolytes and related energy applications have also led to a new grant from the DuPont-MIT Alliance, and opportunities in fuel cells and battery applications.

Professor Hammond has just completed her first year as the new chair of graduate admissions for the Department of Chemical Engineering. Finally, Professor Hammond has also been involved in a number of institutional efforts. She was a member of the Faculty Advisory Committee for the recent MIT Presidential Search and a member of the ongoing Undergraduate Task Force on Educational Commons. She is also cochairing the Faculty Advisory Committee for the Office of Minority Education, which is tasked by the chancellor with refining the mission of the office, and the Committee on the Redesign of the MIT Summer Research Program, a committee that was tasked by the provost to ultimately increase the number of highly qualified underrepresented minority undergraduate students who engage in research and apply to MIT's graduate programs.

Professor Robert S. Langer's recent achievements include his appointment as an Institute Professor at MIT. He also received the 2005 Albany Medical Center Prize in Medicine and Biomedical Research—the United States' largest medical prize, the 2005 Dan David Prize in Materials Science, the 2005 Society of Biomaterials Technology Innovation and Development Award, the 2005 Western Society of Engineer's Washington Award, the McMaster University Hodgins Lectureship, Duke University's Keewaunee Lectureship and Harvard Medical School's Talamo Lectureship. He also received honorary doctorates from Pennsylvania State University (commencement speaker); University of Nottingham, UK; and Uppsala University, Sweden.

Professor Gregory C. Rutledge is currently the executive officer of the Department of Chemical Engineering. He serves on the editorial board of *Polymer* and as guest editor on several special issues of the journal. He also served as an editor of the Polymer and Soft Matter section of the *Handbook on Materials Modeling*. He delivered invited seminars at numerous conferences and academic institutions, including the World Polymer Congress (Paris, France) and Polymer Fibers 2004 (Manchester, UK), SoftExtrusion (Alvor, Portugal) and the ACS Special Symposium on Polymer Crystallization, in honor of the late John D. Hoffman. His research entails the molecular engineering of soft matter through the development of molecular simulations, materials characterization, and electrospinning of nanofibers.

Professor Jefferson W. Tester continues to expand his research program in the alternative energy area with new research thrusts in biomass conversion in hydrothermal media and advanced drilling technology using spallation and fusion methods. This past year, he continued to serve as chair of the National Advisory Council of the US Department of Energy's National Renewable Energy Laboratory and as cochair of the Governor's Advisory Committee of the Massachusetts Renewable Energy Trust. He also served on advisory boards for Los Alamos National Laboratory, Idaho National Laboratory, and the Paul Scherrer Institute of the Swiss Federal Institute of Technology (ETH). He gave invited lectures at several universities and industrial research laboratories worldwide on a number of energy and environmental topics. At MIT, Professor Tester continued his involvement with MIT's multidisciplinary energy subject, finalizing a new textbook, *Sustainable Energy—Choosing Among Options*, and worked with professors Ghoniem and Shao-Horn of the Department of Mechanical Engineering and Professor Kazimi of the Department of Nuclear Science and Engineering to develop a new subject, Fundamentals of Advanced Energy Conversion Systems.

Professor Bernhardt L. Trout has been making major contributions to the areas of molecular modeling of transformations in complex systems, engineering of phase transitions in pharmaceuticals and clathrate-hydrates, and stabilization of therapeutic proteins. He has been invited to speak at the European Center of Atomic and Molecular Computations, the Protein Stabilization Conference, and the 5th International Conference on Gas Hydrates. His work is fundamental, yet primarily with industrial sponsorship, including that of Merck, Amgen, DuPont, and Novartis. He is an officer of the Transport and Thermodynamics Division of the American Institute of Chemical Engineers and is the program chair for the fall 2006 conference (for which preparation has already begun). This year, he has taught or cotaught 10.675J Computational Quantum Mechanics of Molecular and Extended Systems, 10.37 Chemical Kinetics and Reactor Design, 10.333J Introduction to Modeling and Simulation, and 10.541 Kinetics of Biological and Chemical Systems, in addition to a Freshman Advising Seminar and being a Next House fellow.

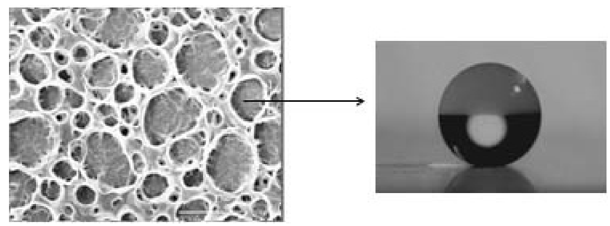
Professor Daniel I.C. Wang was appointed the distinguished Temasek Professor in 2004 in the Department of Chemical and Biomolecular Engineering at the National University of Singapore. He was also bestowed the honorary professor recognition at the Peking Union Medical College in Beijing, China, in 2004. He was the keynote lecturer at the Singapore Biological Manufacturing Conference in 2004 and at the International Biological and Bioprocess Engineering Conference in 2004, in Shanghai, China. His PhD student, Brian Baynes (coadvised by Professor Bernhardt L. Trout) was awarded the W.H. Peterson Award for the best student paper presented at the Biochemical Technology Division of the American Chemical Society in Anaheim, CA, in 2004.

Professor Jackie Y. Ying was selected as a Global Young Leader by the World Economic Forum in October 2004. She was elected a member of the German Academy of Natural Scientists, Leopoldina, in April 2005, and is currently the youngest member of the academy. She delivered 15 invited lectures at various international conferences and national meetings during the past year, including keynote lectures at the 7th International Conference on Nanostructured Materials, 1st Nano-Engineering and Nano-Science Congress, 2nd International Conference on Technological Advances of Thin Films and Surface Coatings, 1st International Bioengineering Conference, Institute of Electrical and Electronics Engineers International Workshop on Biomedical Circuits and Systems, 19th North American Catalysis Society Meeting, and 76th American Chemical Society Colloid Symposium. Professor Ying was the conference chair of the 1st Society for Bioengineering International Conference on Bioengineering and Nanotechnology held in Singapore, September 2004. She serves on the editorial boards of seven journals/book series, as well as on the advisory boards of the Leibniz Institue for Solid State and Materials Research Dresden (Germany), the University of Queensland Nanomaterials Centre (Australia), the National Research Council Steacie Institute for Molecular Sciences (Canada), and the Institute of Materials Research and Engineering (Singapore). Professor Ying is an honorary professor of chemistry of Jilin University (China), and served on the panel of judges for the 2004 *Technology Review* TR100 Awards and the Singapore National Academy of Science Young Scientist Award. She was on professional leave in Singapore, where she is currently the executive director of the Institute of Bioengineering and Nanotechnology.

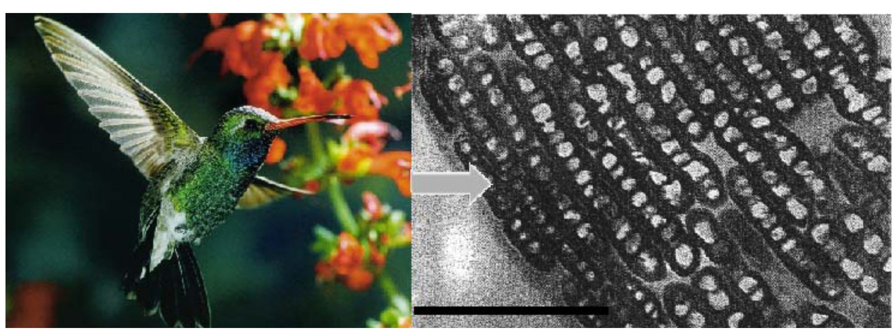
Research Highlights

Novel and Useful Surface/Thin-film Phenomena Found in Nature (Robert E. Cohen)

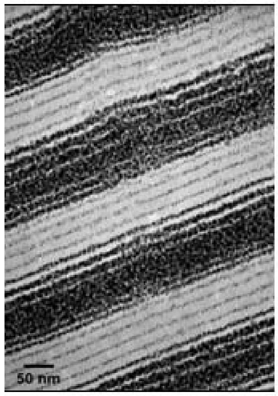
Professor Robert E. Cohen, in collaboration with Professor Michael F. Rubner of the Department of Materials Science and Engineering, has been directing his attention to novel and useful surface/thin-film phenomena that are found in nature. In one example, their discovery of a successful synthetic route to robust superhydrophobic surfaces led to a patent application, and a communication in *Nano Letters* that was flagged by the press in a June 7, 2004, *Chemical and Engineering News* feature "Lessons from Lotus Leaves." Quoting the latter, "A surface of micrometer-sized hills and valleys dotted with waxy nanoparticles gives the lotus leaf its superhydrophobic self cleaning properties. Water droplets bead up and roll off the rough surface, taking dirt and debris with them. Using a simple, water-based process, researchers from MIT have created a polyelectrolyte multilayer coating that mimics the leaf's tidy topography [*Nano Lett*, published online May 18, 2004, http://dx.doi.org/10.1021/nl049463j]. The group, led by Robert E. Cohen and Michael F. Rubner, first creates micrometer-sized pores in a polyelectrolyte surface (shown) via multiple low-pH treatments. They then add nanoscale texture by depositing silica nanoparticles onto the material, followed by a semifluorinated silane coating. The material retains its superhydrophobic character even after being immersed in water for a week. By eliminating the semi-fluorinated silane coating step, the team can make the material superhydrophilic."

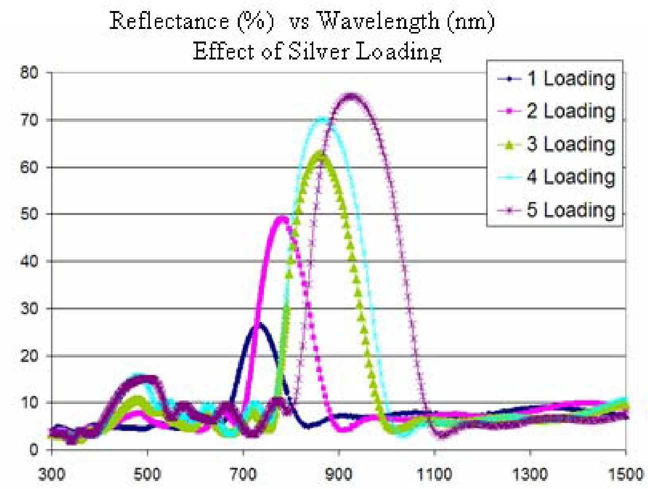


Cohen, Rubner, and their postdoctoral associate Dr. Lei Zhai, have been similarly motivated by optical properties of hummingbird wings which demonstrate magnificent changes in color as the angle of observation varies. In this case, spatially controlled variations in porosity in ultrathin films are responsible for the photonic mirror effects. Using the same aqueous-based layering techniques mentioned above, the team has produced lamellar structures that mimic the wing's alternating nanoporous/fully dense ultrastructure. The tunable Bragg reflectors, based on the step changes in refractive index that result from the porous to dense excursions, were first disclosed in a patent application and then published in the ACS journal, *Macromolecules*, (2004) Vol. 37, No. 16, 6113–6123.



In a further improvement aimed at eliminating unwanted side bands in the reflection spectra of the photonic films, Cohen used his well-known in-situ "nanoreactor chemistry" techniques, (*Supramolecular Science*, [1994] Vol. 1, No. 2, 117–122), to generate, with nanometer length-scale precision, arrays of high-index silver nanoparticles inside the ultrastructure. The challenge (described in a publication in *Langmuir*, (2004) Vol. 20, No. 8, 3304–3310), was to generate a sinusoidally varying





refractive index gradient in the film (known as a Rugate structure) to suppress the side bands. As shown in the figure above, this strategy produced remarkable nanocomposite structures comprised of as many as 1,500 polylectrolyte layers with appropriately embedded silver nanoparticles. The locations and magnitudes of the narrow, nearly side-band-free, reflectance peaks depend on the predetermined density of the silver nanoparticles in the high-index regions of the designed heterostructure.

Attention is now focused on two other natural phenomena: water gathering/channeling properties of the surface of the Namid desert beetle and antireflectivity of moth eyes. The former is based on juxtaposed patchy regions of superhydrophilic and superhydrophobic character on the back of the beetle, a structure that Cohen and Rubner have already reproduced successfully in their laboratories. Tiny droplets of water accumulate on the superhydrophilic regions, grow in size and eventually roll freely along superhydrophobic zones to a pre-determined location; in the beetle's case, the water is directed to its mouth thereby directly linking this novel surface physics to its survivability in arid circumstances. The moth eye provides inspiration for synthetic antireflection coatings that are again based on combinations of polyelectrolyte multilayers and inorganic nanoparticles. Working with a design team from Rockwell International under Defense Advanced Research Projects Agency funding, the MIT group is currently addressing the challenge of producing antireflection coatings on flexible, fluid-filled lenses for use in lightweight zoom optical systems for deployment on drone surveillance aircraft.

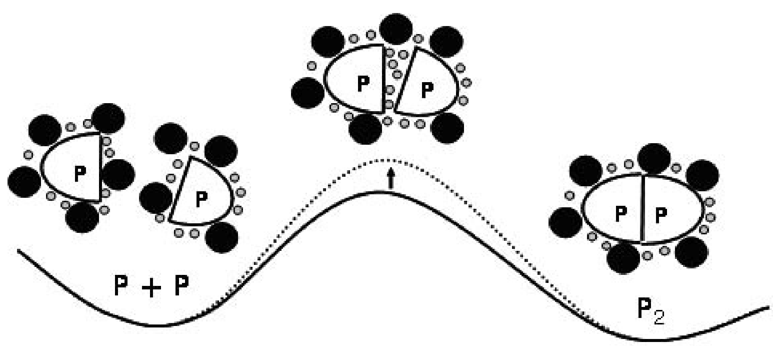
Molecular Engineering of Stabilizers of Therapeutic Proteins and Antibodies (Bernhardt L. Trout)

Proteins (including antibodies) are only marginally stable and degrade by a variety of chemical and physical routes, the most common of which is aggregation. The impacts of aggregation range from the onset of human diseases, such as Alzheimer's, to significant productivity losses in the pharmaceutical industry. Because of the vital role played by proteins in industry and biology in general, significant work has been directed toward understanding aggregation mechanisms. A general solution to this problem would be of great benefit in industrial applications where aggregation is prevalent, such as cell-based and cell-free protein synthesis, protein purification, and protein formulation. Protein formulation is the development of aqueous solutions of very expensive therapeutic proteins that are stable enough to be marketed. In addition to protein formulation, a manufacturing process that is often plagued by aggregation is that of protein refolding. Empirically, it has been found that solution additives such as arginine often deter aggregation and result in a higher yield of properly refolded, active protein.

Before Trout's group began working in this field three years ago, the level of theory was heuristic and driven by phenomenological approaches, which need a large amount of empirical input. Trout and coworkers have developed a molecular modeling approach that allows the computation of free energies of interaction from first principles (no ad hoc fitting parameters) with experimental accuracy. Furthermore, they used this approach to obtain details of the interactions of each chemical group with other groups, thus both generalizing and quantifying the concepts of hydrophobicity and hydrophilicity. Finally, they have used their approach to develop a new concept for the stabilization of proteins. This new concept is based on new molecules, called "neutral crowders." The neutral crowder concept has the potential to be the first new approach to stabilizing proteins in 30 years and to be an enabling technology for new pharmaceutical products.

Neutral crowders deter protein-protein association. Because these additives reduce protein-protein interactions, they address the prevention of aggregation phenomena, which exhibit second- or higher-order kinetics, such as aggregation during refolding and some cases of aggregation from the native state (all aggregation events can be made to be second order, if the barrier to protein-protein aggregation can be selectively increased).

The action of neutral crowders is based on a new theory developed in Trout's group about how additives could affect protein association reactions. This idea, called "gap effect theory", demonstrates that it is possible for an additive to exert a purely kinetic effect on protein association reactions. Specifically, it is possible for a large additive that does not affect the free energy of isolated protein molecules to increase significantly the free energy barrier for association. Such additives are called neutral crowders, because their



The gap effect. A free energy-reaction coordinate diagram for protein-protein association in a mixed solvent is shown. In the dissociated (P+P) and associated (P2) states, the large additive (black circles) and water (grey circles) can both solvate the protein equally, and there is no thermodynamic effect. At intermediate separations (center), there will be a separation distance where the gap between the protein molecules excludes the large additive for steric reasons, but water can still solvate the gap. This results in a net preferential exclusion of the additive, and a selective free energy increase in the encounter complex. This effect slows protein association reactions exponentially with an increase in the barrier.

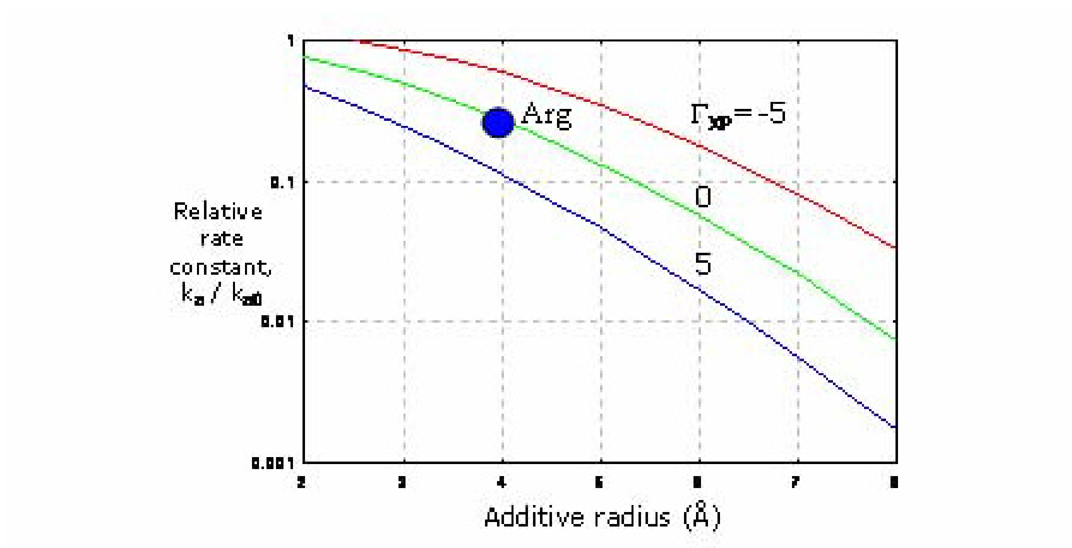
interaction is neutral with respect to reactants and products; and they crowd the protein association complex, making it less stable. This effect arises because the large additive is preferentially excluded from the protein-protein encounter complex, as seen in Figure 4.

Gap effect theory suggests that large solution additives that do not affect the free energy of isolated protein molecules will still slow protein-protein association reactions. Such molecules are rare, because as additive size is increased, the preferential binding coefficient and hence protein transfer free energy falls off as the third power of the additive radius due to an excluded volume effect.

However, Trout's group has discovered one natural molecule whose effects on association reactions are consistent with the assertion that it is a neutral crowder: the amino acid arginine. Specifically, they have shown that arginine decreases the rate of association of globular proteins, as measured by surface plasmon resonance (BIAcore); and that arginine decreases the rate of association of unfolded and partially unfolded intermediates in the folding pathway during refolding, as measured by native protein activity and size exclusion HPLC.

The magnitudes of these effects are consistent with their gap effect theory.

As seen in the figure below, if a neutral crowder larger than arginine can be synthesized, it has the potential to depress protein association rates tremendously. Arginine decreases the rate of association by a factor of three or so, but for an 8 Å additive, the rate of association may be depressed by 2–3 orders of magnitude.



Association rate depression with increasing additive size as predicted by gap effect theory. The relative association rate constant (ka/ka0), comparing the rate in the presence of an additive to the rate in its absence, is plotted as a function of additive radius and additive-protein preferential binding coefficient. The binding coefficient, XP, is the computed preferential binding. To suppress association, an additive should be large and as attractive to proteins as possible.

There are a few existing molecules that are putative neutral crowders. One class is dendrimers with the right termination. Another is small molecules which are like arginine, but which have multiple guanidine residues. Trout's group is currently obtaining these molecules and testing their ability to hinder aggregation of real therapeutic proteins, including antibodies.

Annual Lectures, Seminars, and Symposium

The department once again hosted a very successful series of four annual major lectures: the 6th Frontiers in Biotechnology Lecture, delivered by Douglas S. Cameron, director of biotechnology, Biotechnology Development Center, Cargill, Inc.; the 19th Hoyt C. Hottel Lecture, delivered by Adel S. Sarofim, presidential professor, University of Utah; the 11th Alan S. Michael Lecture, delivered by Kristi S. Anseth, University of Colorado-Boulder; and the 27th Warren K. Lewis Lecture, delivered by Lynn Laverty Elsenhans, executive vice president of global manufacturing, Shell Downstream, Inc.

Our departmental Seminar Series featured academic leaders from University of Texas at Austin; Swiss Federal Institute of Technology–Zurich ; University of California, Berkeley; Northwestern University; University of California, Los Angeles; Rensselaer Polytechnic Institute; University of Wisconsin–Madison; Princeton University; California Institute of Technology; and University of Minnesota.

This year also marked the 25th annual Department Information Conference. To celebrate the occasion, we hosted an event to honor and connect with those corporations and individuals who help to sustain us and to make possible the cutting-edge education and research that is core to our mission. Our past Information Conferences consistently provided a venue to discuss new developments in education and research, and we used this opportunity to address not only our history, but future issues that will define and drive our work. The dynamic schedule included industrial and academic experts who discussed our discipline's four crucial areas for the future: materials, health, security, and energy. Our speakers in these areas were

- Health: Andreas Rummelt, head of Global Technical Operations, Novartis, and Professor Robert Langer
- Security: Miriam John, vice president of Sandia National Laboratories, and Professor Alice Gast
- Materials: Tom Connelly, senior vice president and chief science and technology officer, DuPont, and Professor Paula Hammond
- Energy: Emil Jacobs, vice president of research, ExxonMobil, and Professor Greg McRae.

During the conference, we also held our annual Practice School Awards Banquet, which honored students who had participated in the Practice School in the past year. The banquet speaker was Course 10 alumnus and author Peter Spitz, who discussed the outlook for the chemical industry in the 21st century.

Departmental Awards

The Department Awards Ceremony took place on May 9, 2005, in the Gilliland Auditorium of the Ralph Landau Building. We are pleased to recognize this year's recipients of the Outstanding Faculty Awards—Professor Daniel Blankschtein (the graduate students' choice) and Jean-Francois P. Hamel (the undergraduate students' choice for the second year running).

The Edward W. Merrill Outstanding Teaching Assistant Award was presented to Harpreet Singh for his work in the undergraduate subject 10.213 Chemical and Biological Engineering Thermodynamics.

Chemical Engineering Special Service Awards were conferred to the members of the Graduate Student Council: Curt Fisher, Michelle Hardiman, Christopher Loose, Kristin Mattern, Brian Mickus, Andrew Miller, Daniel Pregibon, Earl Solis, Lily Tong, Ryan Waletzko and Anna Wilkins. In addition, Daniel Pregibon was awarded the Chemical Engineering Rock for outstanding athleticism; and Jorge Nobel, was recognized for his year as president of the Student Chapter of AIChE. All third-year graduate students are required to present a seminar on the progress of their research and the two recipients of the Award for Outstanding Seminar were Ramin Haghgooie and Daryl Powers.

Our undergraduates also earned numerous accolades over the course of the year. The Merck Fellowship Award was presented to Robert Batten in recognition of scholastic excellence. The Robert T. Haslam Cup, which recognizes outstanding professional promise in chemical engineering, went to Peter Miller. The Roger de Friez Hunneman Prize—the oldest prize in the department, awarded to the undergraduate who has demonstrated outstanding achievement in both scholarship and research—went to Pryia Shah. The Omnova Early Achievement Award went to Mr. Daeyeon Lee for excellence in polymer research, sponsored by MIT and OMNOVA Solutions, Inc. The Outstanding Graduate Teaching Assistant Award went to Srivnivas Moorkanikkara for his work in the graduate subject, 10.40 Chemical Engineering Thermodynamics.

The department is quite pleased to recognize Alina Haverty, assistant to Professor Gregory C. Rutledge, as the department's Outstanding Employee of the Year for her dedication and outstanding service to faculty, staff, and students. The Infinite Mile Award designed to recognize those individuals or teams who have made extraordinary contributions within their own organizations to help the Institute carry out its mission went to Melanie Miller from the Headquarters Office and Esther Estwick from the Administrative Services Office. The Individual Accomplishments Citation went to James Hardsog for his outstanding academic, social, and personal performance in the past year.

Personnel

We are proud to announce the promotion of Professor Paul I. Barton to full professor and the tenure of Professor Bernhardt L. Trout, as well as the promotion of Esther Estwick to personnel administrator.

Professor Robert A. Brown continued to serve MIT in his role as provost. Professor Alice P. Gast serves as MIT's vice president of research and associate provost. As an Institute Professor, MIT's highest academic distinction, Professor Daniel I.C. Wang was joined this year by Professor Robert S. Langer, in recognition of Langer's contributions at the interface of chemical engineering and life sciences. Professor Robert C. Armstrong is the head of the Department of Chemical Engineering, while Professor Douglass A. Lauffenberger is codirector of the Division of Biological Engineering. In 2004, Professor Gregory C. Rutledge assumed the role of executive officer of the Department of Chemical Engineering and Professor Paula Hammond became graduate admissions officer. Professor Daniel Blankschtein continues his role as graduate officer.

The department welcomes Professor Kristala Jones-Prather to the faculty, Mary Renard as graduate student coordinator; Iris Chang as undergraduate student coordinator, and Carrie Casado as administrative assistant to professors Kenneth J. Beers and Robert E. Cohen. Also, we have two new additions in our Administrative Services Organization: fiscal officer Amanda Tat and financial assistant Richard Lay.

The Department of Chemical Engineering at MIT has certainly had a very fruitful and rewarding year in 2004–2005 and is poised for even bigger and greater successes for the upcoming year.

Robert C. Armstrong,
Chevron Professor and Department Head

Gregory C. Rutledge
Professor and Executive Officer

More information about the Department of Chemical Engineering can be found online at http://web.mit.edu/cheme/index.html.