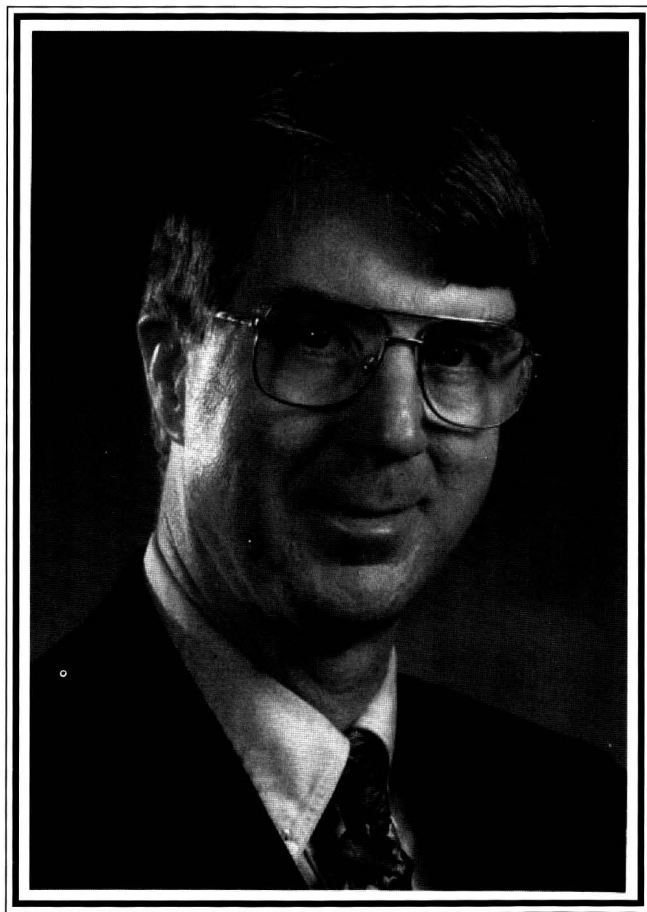


# Michael L. Shuler

of Cornell University



CLAUDE COHEN

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The School of Chemical (now Chemical and Biomolecular) Engineering at Cornell University is proud to have Michael L. Shuler, a true educator and a visionary, among its faculty members. Mike is a great example of what it means to be an educator. He is imaginative, creative, and prolific; most importantly, he is sincerely interested in the advancement of the field. He has a genuine curiosity and enthusiasm in guiding his students to become independent researchers, and he gives them the freedom to explore new research directions.

## BACKGROUND AND EDUCATION

Michael L. Shuler grew up in Joliet, Illinois, where as an 8<sup>th</sup> grader he had already decided to pursue biochemical engineering. All students were required to write a description of the career they wanted to pursue. Mike chose chemical engineering and wrote specifically about building processes to make antibiotics. He felt that making a life-saving drug in large enough quantities to really help people was a noble and ennobling enterprise. It combined his interests in science, society, and service.

Mike's choice of career path was a natural one given his family situation. His father Louis put himself through college (Bradley University) during the depression, majoring in chemistry, and began his worklife at the Army Ammunition Plant in Joliet before joining the Army Air Force in World War II. He spent his Army career as a civilian employee working as an industrial engineer, ultimately coordinating a production schedule of 700 different chemical plants. At the end of the war, Louis married Mary Boylan, who taught English to seventh graders in West Des Moines, Iowa. Not surprisingly, both Mike and his younger brother, Patrick, ended up being chemical engineers. Pat worked for Chevron prior to becoming manager of Oil Field Chemistry and Production Chemicals in the Petroleum Energy and Environmental Center administered by Caltech.

Growing up as a Roman Catholic, Mike's religious beliefs have always been an important part of his life and have greatly influenced his thoughts on service. He always had an interest in teaching, and while at the University of Notre Dame he became committed to the idea of teaching at the university level. Kramer Luks and Nick Sylvester were new, young faculty members there and they both strongly encouraged him to pursue graduate studies at the University of Minnesota.

When Mike graduated from Notre Dame in 1969, the Vietnam War was at its peak; Mike had participated in ROTC both in high school and at Notre Dame and graduated as a second lieutenant in the U.S. Army. He was able to obtain an educational delay to go to graduate school. At that time the only other male U.S. students who would enter graduate

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*Mike with Cornell faculty members at the 2002 annual AIChE meeting in Indianapolis, pictured at the NCAA Hall of Champions where Cornell's reception was held. Front row: Fernando Escobedo, Paulette Clancy. Back row: Matt DeLisa, Kelvin Lee, David Putnam, Bill Olbricht, Mike Shuler, Yong Joo, and Abe Stroock.*

school had either failed the Army's physical exam, were veterans, or had joined the U.S. National Guard or Reserves and had completed six months of training. While Mike had no interest in the Army as a career, he felt that the experience was useful in developing leadership and teaching skills (the only formal instruction he ever received in pedagogy).

At the University of Minnesota he decided to work with Professors Rutherford "Gus" Aris and Henry Tsuchiya. Gus was a theoretician with exceptional mathematical skills and Henry was a bacteriologist. Mike soon realized that he knew more math than Henry and more biology than Gus, and that part of his role was to help bridge the interdisciplinary divide. This experience prepared Mike well for conducting and leading interdisciplinary research teams as he advanced along his career path. Mike also completed a minor (supporting program of courses) in mathematics, biochemistry, and microbiology and was only one course short of fulfilling the requirements for a Masters of Science in microbiology. A strong, formal background in biology was unusual for a chemical engineering student of that day and time and it provided Mike with an advantage that proved to be important to his early academic success.

When the time came to interview for an academic job, Neal Amundson, head of Minnesota's Chemical Engineering Department, took a great deal of interest in helping Mike (along with Gus and Henry). His perspective and insight were crucial; Amundson thought that chemical engineering at Cornell had great potential and that the faculty there would welcome someone with Mike's talents. The department at Cornell at that time was in transition from a department with a focus on undergraduate education to one that was developing a top-rated research department.

Mike's selection of Cornell was based not only on the advice of the faculty at Minnesota, but also on the supportive environment he found when he visited there. In particular, he found that Bob Finn (a founding father of biochemical engineering) had a well-established laboratory with the entire infrastructure necessary for biochemical engineering. During those days, academic offers did not include start-up packages and none of Mike's three academics offers had included any money for equipment or supplies.

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and  
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most  
importantly,  
he is  
sincerely  
interested  
in the  
advancement  
of the  
field.*

Even more important, Bob was by nature a very generous person and was a natural mentor for Mike. When I interviewed at Cornell three years later, I remember visiting with Bob and Mike in Bob's office. Mike remained rather quiet during my visit, and his boyish looks (he is a few years younger than I) led me to the mistaken conclusion that he was one of Bob's students—Julian Smith corrected my erroneous impression later in the day.

When Mike arrived at Cornell, Jim Stevenson and John Anderson were young assistant professors, and their presence and active support helped make Cornell an attractive and stimulating place. Mike was also happy to have the able administrative assistance of Bonnie Sisco right from the beginning.

## LEADERSHIP IN BIOCHEMICAL ENGINEERING

Mike has been a leader in biochemical engineering since joining Cornell thirty years ago and he continues in that role today. His work has had an extraordinary influence on academic research, on teaching and curriculum development, and on the industrial development of biotechnology.

Early on, Mike undertook the ambitious and challenging work of building comprehensive mathematical models for the kinetics of metabolic and synthetic pathways in single cells. He and his students integrated a large amount of information from microbiology and cell biology into a theoretical and computational framework to predict cell growth and how the formation of products depends on bioreactor variables. His paper with Mike Domach on single-cell mathematical models for the bacterium, *Escherichia coli*, published in 1984, was recognized as one of the twenty most influential papers published in *Biotechnology and Bioengineering* in the 40<sup>th</sup> anniversary issue of that journal. Over the years, Mike has been a leader in developing quantitative, numerical models of cellular functions and applying those models to the design and scale-up of biochemical processes. The computer models have been used successfully in identifying conditions that enhance production of desirable compounds while minimizing formation of undesirable byproducts. Gene Network Sciences (Ithaca, NY) uses Cornell's single-cell model as the base for



**Research Group – The Shuler research group at a 2003 holiday party in the Shuler home. Each year Karen and Mike host a party for his research group.**

bacterial models. The company is developing these models to find and evaluate new antimicrobial drugs.

The area of plant cell culture for the production of bio-chemicals was pioneered in the U. S. by Mike. His group was the first to explicitly demonstrate that the response of cell cultures containing cell aggregates depends on the interplay between mass transfer and chemical reactions in the culture. By combining immobilization, medium optimization,

and *in situ* product extraction, the group was able to obtain significant extracellular production of ajmalicine, a compound previously thought to be constrained to the intracellular compartment. This work opened the door for others to produce a variety of compounds.

The best example of how Mike strives to convert new discoveries into large-scale production of compounds that will benefit people and society is the story of Phyton, Inc., a company founded by two of Mike's former PhD students, Bobby Bringi and Chris Prince. Mike headed an industrial and academic collaboration aimed at understanding the factors that would allow the effective production of the important anti-cancer compound Taxol using plant cell culture techniques. Phyton, Inc., was one of two industrial collaborators. At Phyton, Bobby and Chris applied the principles developed in their theses and described in a joint monograph with Mike, *Plant Cell Tissue Culture in Liquid Systems*,<sup>11</sup> to the successful, large-scale commercial production of Taxol from *Taxus sp.* The company has grown in ten years from three to approximately a hundred employees and boasts the world's largest dedicated plant-cell-culture facility with bioreactors of up to 75,000 liters in capacity. Mike's ten-year service on Phyton's Board of Directors has been an important factor in the company's growth. The company has recently been acquired by DFP Pharmaceuticals, Inc.

A major issue in bioprocess engineering has been the production of proteins, particularly therapeutic proteins, using recombinant DNA technology. Mike's group has worked extensively on a variety of host cells to make various proteins: bacterial, yeast, insect, plant, and mammalian. Mike's breadth of experience with this wide-range of host cells is unique. This work not only has increased our fundamental understand-

ing of protein expression, but it has also led to new approaches that enhance productivity and product quality. Working with Al Wood and Bob Granados of Boyce Thompson Institute, Mike developed an insect cell line that is widely used and sold commercially by Invitrogen as the “High Five” cell line. Working with Dave Wilson, Mike demonstrated the possibility of producing large amounts of a desired protein that could unexpectedly be released by the commonly used bacterium, *Escherichia coli*, into the extracellular medium where recovery or purification is relatively inexpensive.

In another area of innovative research, Mike has proposed cell culture analog (or CCA) models that combine detailed cellular/molecular models with traditional physiology-based pharmacokinetic models (PBPK) to guide the construction of a physical analog of the PBPK. The physical analogs can act as human or animal surrogates for estimating the response of an organism to challenges by pharmaceuticals or potentially toxic chemicals. Mike’s group is currently constructing microscale devices with four compartments: “liver-lung-fat-other tissue” and other microscale models of the blood-brain-barrier and of the gastrointestinal tract. The expectation is that these devices will facilitate evaluation of new drugs prior to animal studies and/or human clinical trials. HmREL™, a company cofounded by Greg Baxter (who collaborated with Mike’s group), has licensed patents developed in Mike’s group to commercialize these concepts.

Mike’s research work has been well recognized by numerous awards: the Marvin J. Johnson Award of the Microbial and Biochemical Technology Division of the ACS in 1986; the AIChE Food, Pharmaceutical, & Bioengineering Division Award in 1989; the AIChE Professional Progress Award in 1991; the Amgen Award in Biochemical Engineering in 1997; and the Warren K. Lewis Award in 2003. Besides being elected fellow of the AIChE in 1997, Mike has been honored by election to the National Academy of Engineering in 1989 and to the American Academy of Arts and Sciences in 1996.

Mike has had a lasting educational influence in the field of biochemical engineering. His textbook, *Bioprocess Engineering: Basic Concepts* (with F. Kargi, a former student), has been extremely successful, by any measure, and is now the textbook-of-choice for a course in biochemical or bioprocess engineering. The second edition of the book was published in 2002.<sup>[2]</sup> Mike is also very keen on integrating research into undergraduate courses or laboratories<sup>[3,4]</sup> and strongly encourages his graduate students to work with undergraduate students on their research.

Mike has been actively involved with the AIChE since his

student days. He was chair of the Food Pharmaceutical and Bioengineering Division in 1994. He has been a member of the publications committee for about 15 years and was founding editor for *Biotechnology Progress*. In addition to serving on numerous AIChE committees and task forces, Mike was a member of the Board of Directors for the last three years (2000-2003). As many readers are aware, the last three years have been a tumultuous period for AIChE, making board membership a very intense experience. The evolution of AIChE in the last three years has been remarkable, and Mike hopes that his work as part of a large team effort will serve the profession well.

Mike is currently serving on a Formation Committee for a new “Society for Biological Engineering” (announced at the November, 2003, AIChE meeting). It is being formed through AIChE but will seek partner organizations. The expectation is that AIChE’s leadership in establishing SBE will result in a clearer understanding of chemical engineering contributions to biotechnology and bioengineering and better link the profession to new opportunities at the interface of biology and engineering.

## ROLE IN THE DEPARTMENT AND THE COLLEGE

To be a successful teacher, one should have an excellent command of the subject matter, an ability to inspire students to high achievement, and generosity with one’s time—Mike possesses all these qualities. His success as a teacher has been recognized by several teaching and advising awards at Cornell. He was awarded the prestigious College of Engineering’s Tau Beta Pi Award early in his career, an award given to the best teacher in the college (of 200 faculty members). More recently (1996), he received the Richard F. Tucker award for outstanding teaching from the college, and this past year he received the James M. and Marsha D. McCormick award from the college in recognition of his sustained contributions to freshmen academic advising.

Mike has also been an extraordinarily effective mentor of students at the graduate education level. According to many of his former students (see Table 1), most of whom have gone on to successful careers in academia and in industry, he has always been approachable, kind, and encouraging. Under his guidance, students are given the freedom to take their research in new directions and to act as research mentors to undergraduate students—both of these opportunities have prepared many for academic positions.

Mike served as director of the School of Chemical and Biomolecular Engineering from 1998 to 2002. He demonstrated excellent leadership throughout his tenure, as reflected

***His work [in biochemical engineering] has had an extraordinary influence on academic research, on teaching and curriculum development, and on the industrial development of biotechnology.***



by curriculum development and resolution of difficult personnel issues during that time. He was successful in encouraging faculty to develop focal areas of research and instruction, and he constantly strived to keep the morale of the faculty, staff, and students high.

Mike was also successful in the hiring, development, and retention of faculty during his tenure as director. He played a valuable role in supporting young faculty (Kelvin Lee and Fernando Escobedo) and in hiring new faculty (Lynden Archer, Yong Joo, David Putnam, Abraham Stroock, and Matthew DeLisa). Besides serving as acting director for one year in 1986 and for one semester in 1993, Mike repeatedly resisted serving as director of the school on a more continuous basis before 1998. Having served as director of the school from 1990 to 1993, I understood his earlier reluctance, but applauded his eventual decision to accept the position when he considered that the time was right to take on the challenge. He subsequently earned the admiration of his colleagues and students for his ability to successfully juggle his large research group, the administration of the department, and his family obligations.

In 1993, the Dean of Engineering asked Mike to head a college-wide committee to develop a plan for intensifying the college's investment in bioengineering. The charge and vision have evolved over the last decade, but Mike has always played a leadership role. He led the development of a new bioengineering curriculum—a long-standing college goal. At the undergraduate level, the new curriculum comprises several series of courses that have been tailored to accommodate students from any engineering major. Students who complete the bioengineering option receive recognition on their transcripts. Early on, Mike recognized the importance of advising, and he developed a system where each student participating in this option is assigned a bioengineering faculty who oversees that part of the student's curriculum. Thus, the students not only receive formal recognition for completing the option but they also obtain sound advice on planning a career in bioengineering. Mike was also instrumental in designing a new Bioengineering Seminar for juniors and seniors that gives students from different engineering disciplines a venue for interaction. The seminar provides students from different engineering disciplines with a venue for interactions and illustrates the inter-

**TABLE 1**  
**Mike's PhD Students**

David W. Mitchell  
Dennis J. Kubek  
Fikret Kargi  
Michael M. Domach  
Om P. Sahai  
G. Anders Hallaby  
Mohammad Ataai  
Sooyoung S. Lee  
George Georgiou  
Toohyon Cho  
Ke Ming Hsieh  
Jeffrey Chalmers  
Jen Shu  
Byung Gee Kim  
Lisa A. Laffend  
David E. Steinmeyer  
Jeffrey Fu  
A. Paul Togna  
Christopher L. Prince  
V. "Bobby" Bringi  
Thomas J. Wickham  
Peng "Paul" Wu  
Olotu W. Ogonah  
Lisa M. Sweeney  
Naheed "Nina" Mufti  
Ronald A. Taticek  
Carolyn M. Acheson  
Carolyn W-T Lee  
Yousuf M. Al-Roumi  
Kennie U. Dee  
Michael S. Donaldson  
Amyl Ghanem  
Susan C. Roberts  
Ik-Sung Ahn  
Patricia Kuo Haller\*  
Brian A. Wright  
Melissa J. Mahoney\*  
Kathryn Hollar  
Mark L. Smith  
Aaron Sin  
Christoph E. Joosten  
Chien-Kuo Wang  
Itzcoatl A. Pla  
Kwan Viravaidya

*\*Primary thesis work done in the laboratory of W. Mark Saltzman*

disciplinary nature of the bioengineering field.

The college and university have asked Mike to play important roles in leading university-wide efforts in developing bioengineering and the role of engineering in the university's "New Life Sciences Initiative." Currently Mike is director of the Biomedical Engineering Program (BMEP). The BMEP is responsible for an undergraduate minor in BME available to all engineering students. The BMEP is also the home for an interdisciplinary graduate field in BME. This field draws upon approximately 30 faculty members from 12 different departments including seven faculty from Cornell's Weill Medical College in New York City. Four of the Chemical and Biomolecular Engineering faculty currently belong to the BME field and two new faculty are in the process of election—with six faculty as members, Chemical and Biomolecular Engineering will have the greatest concentration on BME. Such a complicated program is an administrative challenge, but one that is being well met by Mike and his colleagues.

## FAMILY AND AVOCATION

While at the University of Minnesota, Mike met Karen Beck, a physical therapy student from Springfield, Minnesota. They married in June of 1972. Mike considers this decision to be the best and most important one he has ever made. During the final year of Mike's PhD thesis, Karen worked at a local hospital, and after defending his PhD thesis in September of 1973, the two of them headed to Aberdeen Proving Grounds in Maryland. There, Mike spent three months in the Army at the Ordinance Officers Basic School (where he graduated at the top of his class).

Mike and Karen then migrated to Ithaca, arriving on January 17, 1974. In those days, wives were not invited to visit during the recruitment process, so Karen had not had the opportunity to see Ithaca before Mike accepted the Cornell offer. They both fell in love with the hills, lakes, woods, and the small city of Ithaca, however. While that area of the country is often considered extremely cold, Karen and Mike had left Minnesota when it was 25 below—so when they arrived in Ithaca and heard a radio announcer say "12 degrees Fahrenheit and bitterly cold," they knew they would be right at home with the weather there.

Mike and Karen have four children (Andy, Kristin, Eric, and Kathy) and one very new grand-

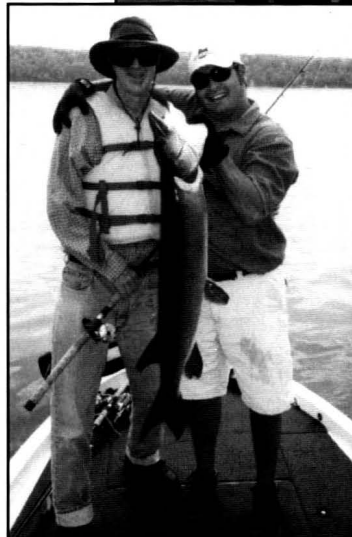


◀ *Mike and Karen relax in front of a quilt made by Karen.*

*The Shuler family in Arizona's White Mountains in 2001. Left to right: (first row): Harrey (Andy's wife), Kathy, and Kristin; (second row): Eric, Mike, Louis (Mike's Dad), Andy, and Karen. ▼*



*Mike (with guide, Mike Williams) and a 45-inch muskie caught on the Kawartha Lakes in Canada. The fish was released. ▼*



child (Jeremy). Andy graduated from Cornell in Mechanical and Aerospace Engineering and is currently a PhD student in Aerospace Engineering at the University of Texas, Austin. Andy married a fellow PhD student (Harrey Jeong) from Korea in 2001 and Jeremy was born last December. Having a grandchild is a newfound source of great joy for both Mike and Karen.

Kristin, who has Down syndrome and lives at home with Mike and Karen, works at Cornell in two part-time office jobs. Both Mike and Karen have been active in various community groups supporting developmentally delayed persons.

Eric, who graduated from Cornell with a BA in Religious Studies and History has begun PhD studies in Medieval Studies at the University of Notre Dame. He completed a year of service with Francis Corps between his BS studies and PhD program. Mike is pleased to have one of his children decide to attend his *alma mater*.

The youngest child, Kathy, was adopted from Korea. Kathy arrived in Ithaca when she was only 4 months old. Mike and his family are strongly connected to Korea, both through his family members and through the Korean alumni of the Shuler group. Kathy, a senior in high school, has decided to attend the University of Dayton, where she intends to study psychology with a minor in biology and to focus on animal behavior (especially marine mammals). She is active in dance and the retreat program of the Diocese of Rochester and expects to continue similar activities in college.

Mike's family has always been a source of strength and comfort to him. As is true with any faculty member, his big-

gest challenge has been to balance professional and family activities through the years, and since family and professional obligations are dynamic, the balance has had to be continuously reconfigured.

Mike loves the outdoors in general and fishing in particular. He has successfully passed this interest on to his children. While he enjoys all types of fishing, he particularly likes the challenge of muskie fishing, with fly fishing for trout or smallmouth bass running a close second. Mike got his biggest muskie in Canada last year while fishing with his son Eric and a guide—the fish was just shy of 45 inches.

Mike's advice is that everyone should have a second favorite job as a "fall back" position in case they get discouraged with what they are doing. For Mike, his fantasy job is to be a guide for people who enjoy fishing as a hobby. For now, however, teaching at Cornell is still his "dream" job come true.

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