MIT ChemE

Massachusetts
Institute of
Technology

Graduate Studies

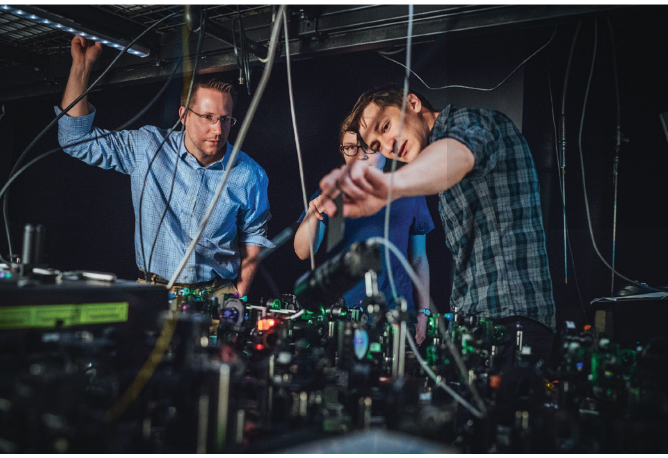
Massachusetts Institute of Technology

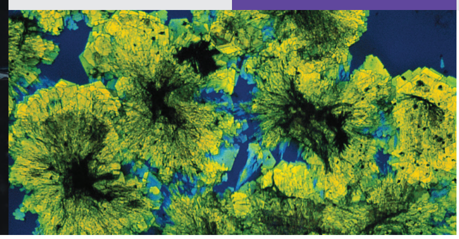
"Chemical engineering prepares you for solving big picture problems while still being aware of what's happening on the molecular scale."

Kristala L. J. Prather
Department Head
Arthur D. Little Professor
Professor of Chemical Engineering

Why come to MIT ChemE?

The world today faces many challenges. Even when it comes to our most basic needs – from the foods we eat to the medicines we take, the clothes we wear, and the energy we use – the world is ready and waiting for new ideas.





Chemical engineers are uniquely prepared not only to come up with new ideas, but also to turn them into real solutions.

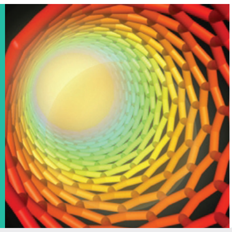
Chemical Engineers solve problems at the most fundamental levels. And at MIT, chemical engineers are solving a wide range of problems with great depth. With 40 professors with expertise in energy and sustainability, materials, polymers, biotechnology and manufacturing. Each of our labs runs multiple well-funded research projects giving our graduate students incomparable opportunities to immerse themselves in the research programs they are most interested in.

No matter which path you follow, MIT chemical engineering will give you ample time and the financial support to make the right choice. Whether your dream is to work in academia, industry or to create your own company, MIT chemical engineering has the people, the resources and the path to get you there.

Want to learn more?
Turn the pages and explore our world of chemical engineering.

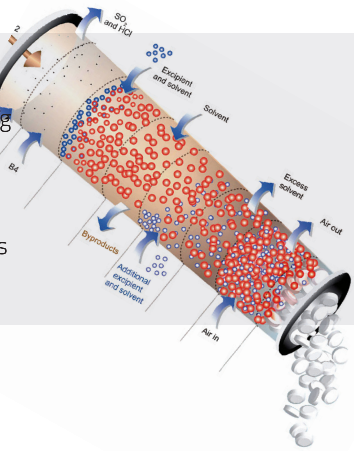
MIT Chemical Engineering.
We put molecules to work.

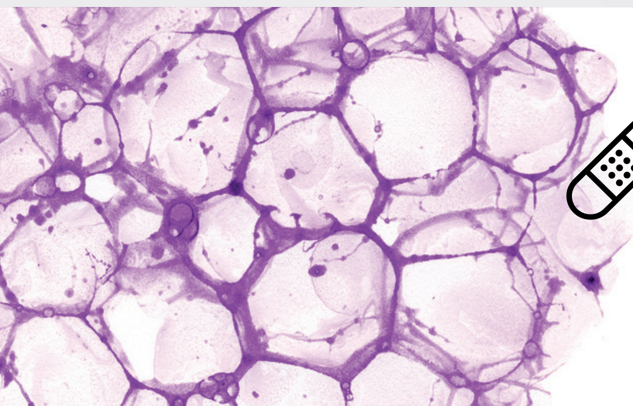
Types of Research



Live wire.
Professor Michael Strano discovered a previously unknown phenomenon that can cause powerful waves of energy to shoot through minuscule wires known as carbon nanotubes. The discovery could lead to a new way of producing electricity.

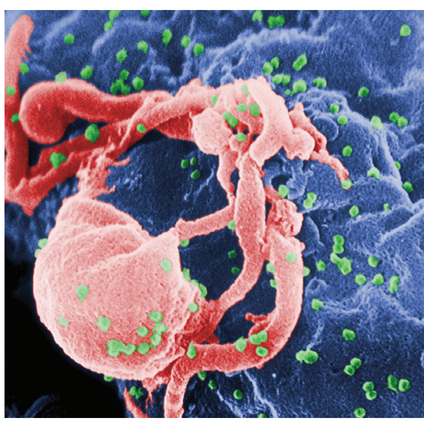
Go with the flow.
The Novartis-MIT Center for Continuous Manufacturing is creating a continuous manufacturing process for pharmaceuticals. Key to the continuous system is the development of chemical reactions that can take place as the reactants flow through tubes, as opposed to the huge vats in which most pharmaceutical reactions now take place.





Wound, heal thyself.
Associate professor Bradley Olsen is developing smart bandages that stop bleeding instantly and use bio-inspired materials that help the body heal itself.

Understanding HIV.
MIT chemical engineers have made breakthroughs in the study of the HIV virus. Novel monitoring techniques for cell response to HIV and the new identification of some of the virus's vulnerabilities could help AIDS researchers develop new vaccines.

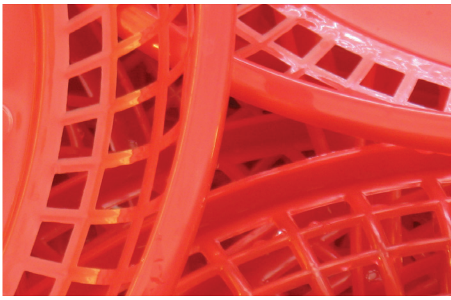


"The future is bright for chemical engineers. Think about the world today. We need to feed and clothe billions of people, we have to find new energy sources, and we want to help people live longer and healthier. These are all things chemical engineers are involved in. Molecular interactions are the root of everything. In chemical engineering, we teach our students to translate these molecular interactions into everyday – and not so everyday – products and processes. As a result, they go off in many directions, creating and improving pharmaceuticals, fuels, polymers, plastics, cosmetics, cereals and more."

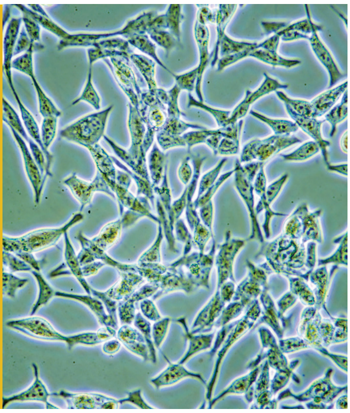
Klavs Jensen, Warren K. Lewis Professor of Chemical Engineering
On Being a Chemical Engineer

Nature's chemical factory.
Professor Kristala Prather is turning single-celled organisms into miniature chemical plants by embedding multiple enzymatic pathways inside the bacteria cell walls.

Plastics.
Chemical engineers are finding ways to harvest biodegradable plastics from bacterial strains that store excess energy in the form of polymers instead of fats.



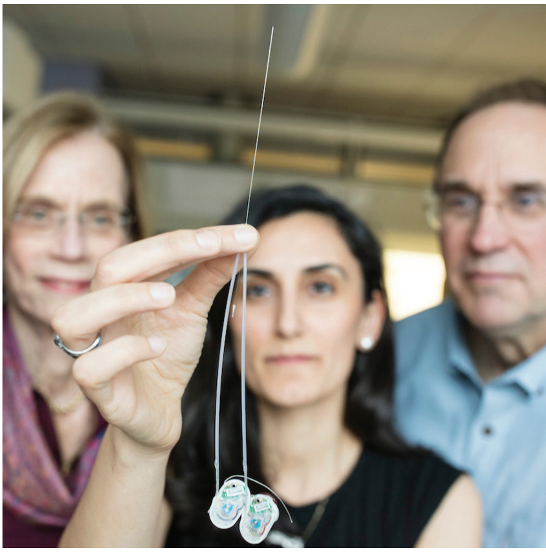
Wear your Metabolism on Your Sleeve.
MIT chemical engineering professors are developing tattoos made of fluorescent, glucose-detecting nanoparticles that may soon help diabetics monitor blood-sugar levels.



Cancer-seeking Missiles.
Institute professor Robert Langer's lab helped create drug-carrying nanoparticles designed to specifically seek out prostate tumor cells and destroy them.

Wrap it Up.
Novel plastic bags, envisioned by professor Paula Hammond, may help preserve the casava harvest in Africa by blocking out oxygen, a food spoiler, and consuming the oxygen already inside the bag.

DIY Energy.
Think like a chemical engineer and imagine a world with self-powered iPads, spray-on virus-based batteries, and self-healing solar cells.



Cutting-Edge Research

"In many ways MIT was the birthplace of the discipline of chemical engineering," says Bernat Olle PhD '05, "And still today the department continues to set the standard for the discipline and lead the way in opening new research directions for the field."

Heather Kulik
Lammot DuPont Professor of Chemical Engineering

Machine Learning

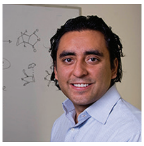
Machine learning is a valuable tool for identifying new materials with properties optimized for specific applications. Working with large, well-defined data sets, computers learn to perform an analytical task to generate a correct answer and then use the same technique on an unknown data set.

This approach has primarily focused on organic compounds, notes Kulik. She focuses instead on inorganic compounds, in particular, those based on transition metals. Transition metal complexes already play important roles in energy storage, pharmaceutical manufacturing, and catalysis, but Kulik thinks that machine learning could further expand their use. Her group is working to make predictions on compounds that haven't been seen before, says Kulik.

"Chemical engineering enables me to design molecules atom-by-atom from first-principles," she explains. "It inspires me not just to understand enzymes but to unearth mechanisms that we may leverage from some of the fastest known catalysts."

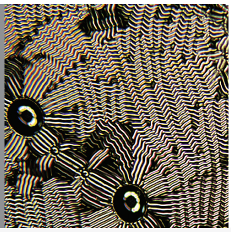
Yuriy Román
Robert T. Haslam (1911) Professor of Chemical Engineering

Catalyzing Greener Products



With a changing climate and shifting fossil fuel economics, there's a burning need to change the way the world makes and uses catalysts: the materials that induce or accelerate chemical reactions and are often the key to making chemical processes industrially viable. The drive to use plants rather than fossil fuels as feedstock means the catalytic materials used to process petrochemicals need to be adapted — or entirely new ones developed — to work with biomass.

Roman's lab is working on the catalytic conversion of the inedible parts of plant matter, such as cellulose and lignin, into chemicals useful for making fuels and substances like plastics, adhesives, lubricants, detergents, fertilizer, and pharmaceuticals. "Boundaries between the different fields are really fading, and I think this is something that's really important to embrace," says Román. "As we start working at the interfaces of fields, we should begin to see new game-changing discoveries."



Areas of Focus:

- New energy technologies, including photovoltaics, fuel cells, biofuel refinement, and gas to liquid transformations.
- Biomedical devices and methods including cancer and AIDS research.
- Materials for electronic, optical, medical, and energy-conversion devices.
- Biotechnology for therapeutics and biofuels.
- New approaches to pharmaceutical manufacturing.
- Process design and control for chemical, energy-conversion and materials processes.

Sydney Johnson, Current PhD Student

Graduate Research: Moving Past the Iron Age

A fourth-year dual degree MBA and PhD candidate in chemical engineering and a graduate research assistant with the MIT Energy Initiative (MITEI), Sydney Johnson looks at ways to reduce carbon dioxide (CO_2) emissions generated by industrial processes in hard-to-abate industries. Those include steel.

"I optimize steel production pathways using emission goals, industry commitments, and cost," she says. Based on the projected growth of India's steel industry, she applies this approach to case studies that predict outcomes for some of the country's thousand-plus factories, which together have a production capacity of 154 million metric tons of steel.

"Energy applications affect every field. My goal as a chemical engineer is to have a broad perspective on problem-solving and to find solutions that benefit as many people, especially those under-resourced, as possible," says Johnson.

David Kastner, Current PhD Student

Graduate Research: The Art of the Enzyme

For as long as he can remember, scientific curiosity has been a key part of David Kastner's life.

"I remember being fascinated by how complex the universe is and how little people know about it," recalls Kastner, now a fourth-year PhD student in biological engineering. "I always wanted to uncover new truths about the universe."

Nearly two decades later, Kastner is now at MIT studying a challenging subset of proteins known as metalloenzymes, in the lab of Heather Kulik, a professor of chemical engineering, and Forest White, a professor of biological engineering. With the same curiosity that sparked those on-the-road discussions with his father, Kastner is motivated by a desire to harness the chemical and medical potential of enzymes through computational and mechanistic approaches.

Kastner's research aims to uncover the fundamental blueprints of reactivity for enzymes using state-of-the-art computational methods.

"MIT offers two things that are hard to find anywhere else in the country. First, the faculty size is large and many of the faculty are running large groups. As a result, the range of research topics is very wide," says Kevin Dorfman PhD '01, "Second, the entrepreneurial spirit at MIT is astonishing."

Practice School

It started out over a century ago, in 1916, when MIT chemical engineering alumnus Dr. Arthur D. Little and professor William Walker wanted to add a practical component to education in chemistry. They founded, with $300 thousand of funding from George Eastman, of Eastman Kodak, the School of Chemical Engineering Practice. Just five sites participated at first – all in the Northeast, all traditional chemical industries working on dyes, abrasives, solvents and fuels. Today, Practice School students consult with companies all over the world to help them solve their toughest chemical engineering challenges, from food to pharmaceuticals to finance, in what is still the only academic program of its kind.

"In this profession, more truly than any other, one needs to get into the water to learn to swim."
Arthur D. Little,
Practice School Founder

Practice School Site:
Corning, Inc., Corning, New York
Station director Bob Hanlon found it a tremendous opportunity to engage with a Fortune 500 company focused on innovation. Corning's selected projects provide a great mix of theory and experimentation, of fundamentals and applications, and of technologies and chemical engineering concepts, ranging, for example, from Corning® Gorrilla® Glass and Celcor® substrates (used in catalytic converters) to mol-sieve drying, surface energy characterization, ion-exchange, and photo-catalysis.

The students' hosts also introduced them to Niagara Falls, a bus tour of the Finger Lakes Wine Region, and excursions to NYC's Broadway and Chinatown.

Practice School Site:
Novartis, Basel, Switzerland
The Practice School has had stations at several Novartis locations, including France, California, Italy, and its headquarters in Switzerland. MIT students have helped the healthcare company on several projects, including optimizing existing processes, using near infrared spectroscopy for analysis and control, and dealing with the

"Practice school was obviously a once in a lifetime experience. You enter these companies and are exposed to people in very influential roles within those organizations. You work closely with them everyday, and make connections that will be invaluable throughout your career."

Christine Ensley '14,
Practice School alumna

optimization of a ultrafiltration/diafiltration operation. Students also found time to take part in Basel's "Fasnacht," the city's ancient three-day carnival, and see the countryside, including visits to Colmar and Strasbourg, in Alsace, France.

Practice School Site:
General Mills, Minneapolis, Minnesota
One of the world's most iconic food companies, General Mills manages a myriad of top food brands. Our students have helped it keep its standing by applying their chemical engineering skills to real-world applications. Recently, students have focused on modeling product quality metrics in dough by describing the leavening reaction kinetics, thermodynamics, and constituent transport phenomena in the system. Another project focused on designing a process and corresponding control system to be used with new packaging for an existing product. And they still found time to catch a Red Sox-Twins game, hike, and sample several great restaurants in the area.

Christine Ensley MSCEP '14
Sustainable Energy and Skills

When nearing the end of her undergraduate work, Christine Ensley knew she wanted to enter industry with "(a) the strongest foundation in ChemE fundamental principles possible and (b) the skills and confidence to apply this knowledge base to whatever my career could throw at me." A Practice School degree was a perfect fit.

Ensley is now in Chicago working for method, a sustainable home and personal care products company. "There is no way I would have been given this opportunity without my MSCEP degree," She says. "method is a very lean, fast-paced company that typically only recruits experienced candidates. My experience at Practice School helped give them the confidence to bring me in as a part of their Process Engineering team."

MIT and Cambridge/Boston

The Massachusetts Institute of Technology stands among the world's preeminent research universities and is home to one of the broadest and most advanced arrays of technical facilities anywhere in the world. We seek to develop in each member of the MIT community the ability and passion to work wisely, creatively, and effectively for the betterment of humankind.

- Ninety-five present and former members of the MIT community have won the Nobel Prize. Eleven current faculty members are Nobel laureates.

- Coeducational and privately endowed, MIT includes over 1,000 faculty and approximately 4,500 undergraduate and 6,700 graduate students. The university's research sponsorship for fiscal year 2013 was $675.3 million. The 154-acre campus stretches more than a mile along the leafy Cambridge banks of the Charles River, just a bridge away from the lively heart of Boston.

- Boston, one of America's oldest cities, has evolved into a center for social and political change, the economic and cultural hub of New England, as well as a home to world-class shopping and exciting sports teams: the world champion Celtics, New England Patriots, Red Sox, and Bruins. Easily accessible from the city are opportunities to hike, bike, ski, sail, and rock-climb. From Cambridge and Boston, it is an easy drive to the mountains of Vermont, the woods of Maine, or the beaches of Cape Cod.

- The MIT campus is just a short walk or T (subway) ride from downtown Boston. Transportation is available on foot or bicycle, on a city bus, or on an MIT SafeRide shuttle. Our students get free admission and discounts to places like the Museum of Science, the Museum of Fine Arts, the Boston Symphony Orchestra, and the Boston Ballet. Tickets for Bruins, Celtics, and Red Sox games are available, and a bus runs to Gillette Stadium, for those who want to attend Patriots games.

- The MIT Campus also offers opportunities to relax, one being the Intramural (IM) Sports Program, a time-honored tradition of the Institute. Chemical Engineering graduate students have historically been strong participants in the IM program, from badminton to ice hockey to bowling to flag football.

Be it academics, research, or IM dodgeball, you can find your path at MIT.

Degree Requirements/Options

Graduate study at MIT offers students the opportunity to do important, leading-edge research in any of a broad range of innovative areas and to work alongside our distinguished faculty, each a leader in his or her chosen specialty. Our students also take advantage of the extensive resources within the department, throughout MIT and in the intellectually and culturally rich Greater Boston area.

MIT Chemical Engineering offers three distinct graduate programs:

PhD/ScD Degree

The Doctor of Philosophy and Doctor of Science degrees in Chemical Engineering are identical. Students may choose the appellation they prefer. This traditional, research-based doctoral degree program provides a thorough grounding in the fundamental principles of chemical engineering as well as an intensive research experience.

MSCEP Degree

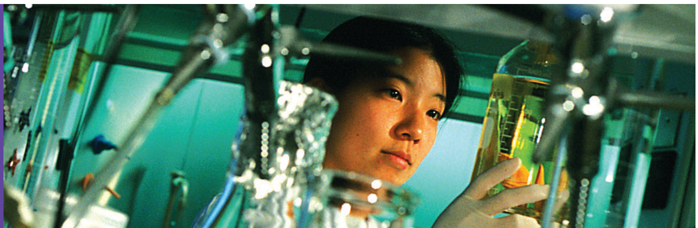
Also unique to MIT, the Master of Science in Chemical Engineering Practice degree program provides hands-on, real-world experience in industrial settings. Students complete two semesters of graduate-level courses at MIT (core plus electives), followed by one semester at industrial sites of the Practice School under the direction of resident MIT staff. Credit for the Practice School semester is accepted in lieu of a Master's thesis.

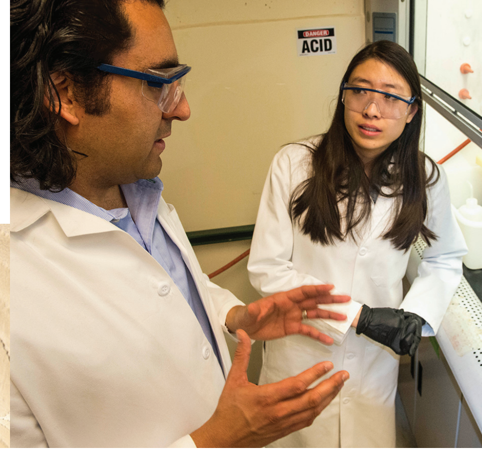
PhDCEP Degree

Offered nowhere else but MIT, the Doctor of Philosophy in Chemical Engineering Practice degree program enhances a traditional doctoral program by leveraging the unique resources of MIT's David H. Koch School of Chemical Engineering Practice (Practice School) and the world-class leadership instruction of MIT's Sloan School of Management while still allowing students to complete the program in approximately 5 years. The PhDCEP program builds a solid foundation of industrial experience, research and business, preparing students for a quick launch into leadership.

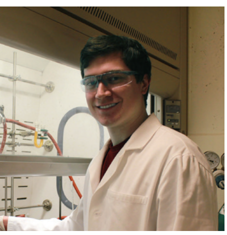
"The reason I chose MIT was due in large part to the variety of research areas offered by the faculty and the rich tradition of preparing future faculty members as well as successful entrepreneurs. Given that I was uncertain about my desired research area and whether I would pursue a tenure track position or an entrepreneurial endeavor, I knew MIT had me covered."

Todd Zion PhD '04, president of 454, LLC, and founder of SmartCells, winner of MIT's $50K Entrepreneurship Competition and now owned by Merck.





Where our PhDs go



Sean Hunt, PhD '16
Co-founder, Solugen

As companies pump oil and gas out of the ground, they generate large amounts of contaminated salt water that needs to be treated or disposed of. Hydrogen peroxide can be used in the treatment process, but Sean Hunt says the traditional methods for creating hydrogen peroxide leave a large carbon footprint associated with the constant venting of the working solution.

"What I really love about this is it's a true environmental crisis that I think we're making a big difference on," Hunt says, noting other chemicals used to treat wastewater are extremely toxic.

Solugen's current production facilities ship concentrated forms of hydrogen peroxide, but the founders plan on building "minimills" next to oil and gas plants that don't require concentration and dilution to further reduce costs and improve sustainability.

Looking forward, Hunt says Solugen's infrastructure could be used to co-produce hundreds of different organic acids by changing the enzymes and compounds being mixed.

Entrepreneurs
Just some of the companies founded by graduates and faculty

Abcor Industries
Acusphere
Adimab
Advanced Inhalation Research
Alkermes
Alnylam Pharmaceuticals
Amgen
Arsenal Medical
Aspen Technologies
BIND Biosciences
Biogen Idec
BioProcessors Corp.
BioScale
Echo Pharmaceuticals
Enumeral Biomedical
Focal
Genzyme
GVD Corp.
Intelligen
Ionics
Living Proof
MatTek Corp.
MicroCHIPS, Inc.
Mitra Biotech
mNEMOSCIENCE GmbH
Moderna
Momenta
Nano-C
NewcoGen
Optifood
PerSpective Biosystems
Pervasis
Promethegen
Pulmatrix Inc.
PureTech Ventures
Samply
Selecta Biosciences
Semprus Biosciences
Seventh Sense Biosystems
Solugen
T2 Biosystems
Transform Pharmaceuticals

Thought Leaders
Just some of the universities where graduates teach and do research

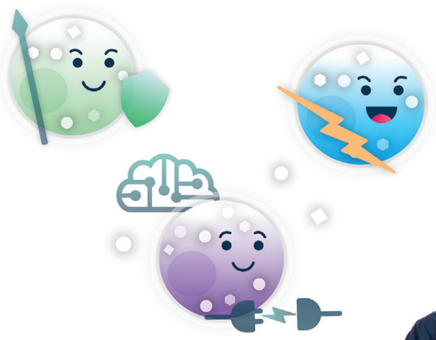
California Institute of Technology
Colorado School of Mines
Columbia University
Cornell University
Dartmouth College
Duke University
Emory University
Georgia Institute of Technology
Harvard University
Hong Kong University of Science and Technology
Imperial College London
Johns Hopkins University
KAIST
Michigan State University
National Univeristy of Singapore
Princeton University
Rensselaer Polytechnic Institute
Seoul National University
Stanford University
Tsinghua University
University of California at Davis
University of California at Berkeley
University of Colorado at Boulder
University of Illinois at Urbana-Champaign
University of Missouri
University of Pennsylvania
University of Texas at Austin
University of Wisconsin at Madison

Hal Alper PhD '06
Professor, University of Texas

Hal Alper's research focuses on biochemical engineering in the fields of metabolic engineering and synthetic biology. His work in the production of chemicals using microbial systems is not only sustainable and renewable but also scalable, and it is a competitive alternative to the existing petrochemicals widely used in manufacturing.

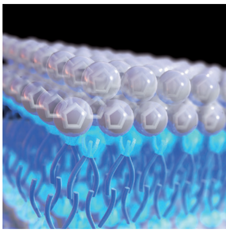
Alper's inventions have already enabled new technologies, leading to seven U.S.-issued patents, with six additional patents pending. In 2019, he was recognized for these accomplishments by being elected to the National Academy of Inventors.

"I'd say the most important characteristic of the inventor is being unaffected by failure," he said. "Ironically, failure is an integral part of success. And having that ambition and a desire to explore the unknown is crucial to gaining the perspective required to think about solving problems in new ways."



Let Us Wow You

You may have heard that Chemical Engineering at MIT has been ranked #1 by US News and World Report for over twenty-five years and counting, or that it is one of the largest chemical engineering departments in the country. No matter what you want to do in ChemE, we probably have someone here who is teaching it or researching it or, at the very least, wants to start it.

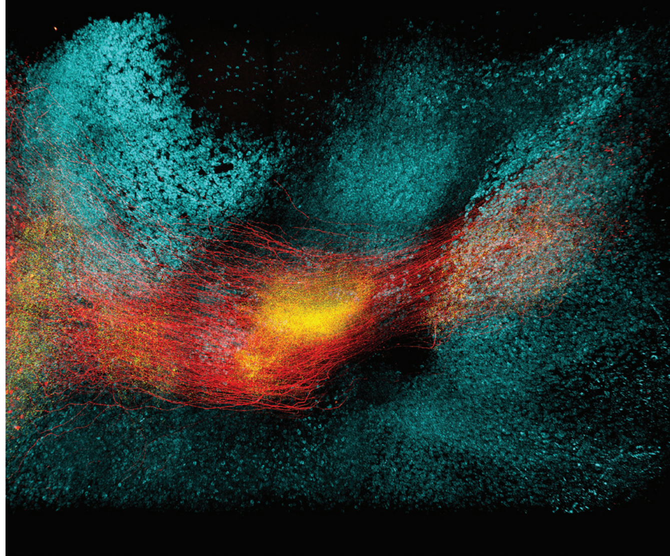


MIT attracts bright people who have a passion for turning ideas into reality. MIT is a place where students and professors are also innovators and life-long learners. It is a place where people are more interested in moving forward together than being competitive separately. It's a place where people love to learn and discover.

And MIT is a place where people have a lot of fun. Join us.

MIT Chemical Engineering. We put molecules to work.

For more information visit: http://cheme.mit.edu

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