Professor Wayland Noland retires after 64 years of service

KIND, FRIENDLY, COMMITTED, GENEROUS, AND SMART are just a few of the adjectives that describe Professor Wayland Evan Noland. But, perhaps, the one that describes him best is venerable; he is, indeed, accorded the utmost respect because of his wisdom, character, and age by all who are privileged to know him.

Professor Noland marks more than one milestone this fall. He celebrates his 90th birthday on Dec. 8, 2016, and retires from the Department of Chemistry on Saturday, Dec. 31, 2016, marking 64 years of service to the department and University. This makes him one of the longest tenured active faculty members at the University of Minnesota. As Professor Emeritus, Noland plans to continue his research and publishing for as long as possible, and to continue helping with alumni relations.

continued on page 4
Working together to enhance learning and address important scientific problems

ONE OF THE HALLMARKS of our department is a prevailing ethos of collaboration. Our faculty and students have a powerful appetite for working together to enhance learning and address the most important scientific problems through interdisciplinary research. This attitude is expressed in many ways. We recently removed departmental divisions, enabling graduate students to choose freely from all of our course offerings, and supporting our longstanding emphasis on “open” searches for new faculty who, as a result, tend to work in multiple research areas. Indeed, we foster research overlapping and at the cusps of multiple traditional research areas, which, in turn, has led to new collaborative projects and the growth of federally funded interdisciplinary centers. This collaborative ethos also extends to curriculum development, where faculty members are working in teams to implement new learning methods and course sequences.

In this issue, we highlight a number of the efforts that express our desire to make the whole of the department superior to the sum of its parts.

The exciting work being done in the broad area of chemical biology is illustrative. Our researchers use wide-ranging and cutting-edge theoretical and experimental methods to address diverse problems in pharmacology, cell biology, structural biology, and medicine from a chemistry-centered molecular viewpoint. A particular highlight is the National Institutes of Health Chemical Biology Interface Training Grant, administered by Professor Mark Distefano, which helps students become proficient in both their main areas of interest and in complementary areas through cross-discipline interactions.

The recent major increase in center activities in the department is exemplified by the Inorganometallic Catalyst Design Center (ICDC), directed by Professor Laura Gagliardi. An Energy Frontier Research Center funded by the Department of Energy, the ICDC brings together researchers from our department and from other universities, government laboratories, and industry to discover new catalysts that functionalize hydrocarbons derived from natural gas as part of an overall focus on developing new methods to address societal energy needs.

With respect to education, a team of faculty from our department and the College of Biological Sciences has developed a new curriculum aimed at serving the needs of students in the life sciences. This new set of courses integrates key aspects of traditional general and organic chemistry courses in a three-semester sequence, which more efficiently prepares students for their life sciences major.

Aimed at serving thousands of students from the entire University, the planned Teaching Laboratory Building remains on the University’s six-year capital plan for consideration by the Minnesota Legislature for funding in 2018. Funds for pre-design have been committed by the department and the College of Science & Engineering for what will be a state-of-the-art facility for experiential learning in chemistry. With about one-third of the estimated $60 million project coming from the University, we are actively engaged in fund-raising activities with our newly established external advisory board. We’d value your support of this important project! Donations should be directed to the new “Chemistry Building the Future” fund at http://z.umn.edu/buildingthefuture. We are driven to excellence, and value your interest and support! Thanks for reading.
In the building phase of Master of Filtering, gamers design Metal-Organic Frameworks that block or adsorb as much CO₂ as possible.

Trap nasty carbon dioxide, save the world, and become a Master of Filtering

New interactive game allows users to build and test Metal-Organic Frameworks.

YOUR MISSION: save the world from carbon dioxide gas (CO₂). YOUR TASK: build nano-materials that will successfully trap those nasty carbon dioxide molecules while allowing life-giving molecules through to save your world. LOSE: your world dies. SUCCEED: you become a Master of Filtering.

THE CHALLENGE: create a game that will teach young people about nano-technology, engage them in working on a real-world problem and possibly, just possibly, spark their creativity to build structures that will help solve a troublesome real-world environmental issue.

For more than a year, researchers in the Nanoporous Materials Genome Center (NMGC), based in the College of Science & Engineering’s (CSE) Department of Chemistry, and in the CSE’s Department of Computer Science & Engineering have worked to create a game, Master of Filtering, that lets players design and test brand new Metal Organic Frameworks (MOFs) within an interactive game center.

After watching her beloved nephew play computer games for hours on end, Chemistry Professor Laura Gagliardi thought “that it would be nice if he and other kids could do something more educational while having fun. And at the same time, they could help us make progress in science while playing.”

In addition to Gagliardi, chemists working on creating the game were Professor Christopher Cramer, Hakan Demir, Ph.D. and Xiangyun Lei (B.S. 2016). Computer scientists and engineers were Professor Stephen Guy and graduate student Tiannan Chen. Daniel Olson, a Computer Science & Engineering undergraduate, has also joined the project.

“Working on this project has been very fun,” said Guy. “Trying to understand and capture the underlying chemistry forces you to invent new styles of game play that are different from anything else out there right now. I think the work has a lot of potential to attract gamers who will be excited about the fact that playing the game can contribute directly to science.”

Metal-organic frameworks are a new class of nano-materials that are useful for a variety of safety, filtering, and manufacturing tasks. They are porous crystalline materials made by inorganic and organic units linked together by strong bonds. Because they have high levels of thermal and chemical stability, MOFs have important applications such as gas storage, catalysis of organic reactions, activation of small molecules, gas adsorption and separation (air purification), biomedical imaging, and proton, electron and ion conduction.

In phase one, the building phase of the game, each player is tasked with designing MOFs that block or adsorb as much harmful gas—carbon dioxide (CO₂)—as possible, while allowing harmless or even helpful gases—nitrogen (N₂)—to pass through as freely as possible. Each player is given a canvas of 3 by 3 unit cells, and can use the game’s building block library and available budget to buy different building blocks to create structures that will help solve a troublesome real-world environmental issue.

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— Professor Stephen Guy

“Trying to understand and capture the underlying chemistry forces you to invent new styles of game play that are different from anything else out there right now.”

— Professor Stephen Guy
A native of Wisconsin, Noland grew up with a strong interest in science. His parents met in graduate school at Wisconsin and were zoologists. He hoped to follow in the footsteps of his father, who was a noted professor at the University of Wisconsin and an outstanding teacher who always tried to be as helpful as possible to his students. The University of Wisconsin’s Noland Hall of Zoology is named after him.

In the midst of World War II and while finishing his fall term as an undergraduate, Noland was drafted into the Army in 1945. He served 11 months in training as an army medic and surgical technician. “My time in the military showed me that Americans are good people,” he said.

Noland earned his bachelor’s degree with high honors—first in his class with a 4.0 GPA—from the University of Wisconsin-Madison in 1948. He then went on to earn his master’s degree (1950) and doctorate in chemistry (1952) from Harvard University, specializing in physical organic chemistry. His roots at the University of Minnesota are deep, starting with his research as a DuPont post-doctoral fellow working with Professor Walter M. Lauer in 1951-52. He joined the faculty in the Department of Chemistry in 1952, which has included serving as its interim chair from 1967-1969.

His research focus has shifted over the years to synthetic and mechanistic organic chemistry, which he enjoys more because of its descriptive logic. Throughout the years, he has made more than 7,000 chemical compounds, seeking to create one that can be used as a pharmaceutical to combat disease. His research has been in heterocyclic chemistry with a focus on indoles and other nitrogen-containing ring systems. Currently, his research is concentrated on heterocyclic nitrogen and/or sulfur chemistry, including the chemistry of nitro compounds, with emphasis on synthesis, mechanisms, and submission of compounds for testing for medicinal activity. To date, activity has been found against cancer in two classes of compounds, HIV, and tuberculosis. Currently, emphasis is being placed on the synthesis of benzofuran oxides, nitriles, isonitriles, and their analogs, to observe interactions, especially with halogens, in the crystalline state. Noland is building on the work of the late-Professor Emeritus Doyle Britton.

Noland is self-effacing, but he has touched thousands of students. It is estimated that he has taught more than 14,000 students over the years, mentored more than 350 undergraduate students, 43 master and 46 doctoral graduate students, and about 30 post-doctoral fellows. He loved teaching and was honored in 1964 with the Institute of Technology Distinguished Teaching Award and in 2006 with the Charles E. Bowers Faculty Teaching Award. He taught his last class, “Advanced Organic Chemistry: Heterocycles,” in the spring of 2016.

He is also deeply committed to providing research opportunities to undergraduate students, supporting undergraduate researchers in his lab along with Project SEED students and fellowships in the summer. He was director of the department’s National Science Foundation (NSF)-Undergraduate Research Program for 11 straight years, including 11 summers and four academic years from 1959 to 1970, and the NSF-Research Experiences for Undergraduates program from 1987 to 1993, including six summers with 193 summer and 35 academic-year participants.

He works hard at keeping in touch with many of his former students and others in the Department of Chemistry. Noland is often a first-point of contact if anyone needs to know the history of something in the department, or its alumni, and he works closely on alumni...
relations with the College of Science & Engineering’s Kim Dockter, external relations director, and Kathy Peters-Martell, senior external relations officer, who works with the Department of Chemistry.

“Way has had a positive impact on the lives of thousands of students,” said William Tolman, department chair. “Indeed, when interacting with alumni, they often ask about him because of the role he played in their life decisions. We very much appreciate everything that he has contributed to our department.”

Noland is eclectic. He has a natural curiosity about what things are for and how they work. He is a long-time collector, including wastebasket looking and dumpster diving for interesting things. He is always on the lookout for things that can be recycled, which is one of his passions and teaching interests. “I have learned a lot that way, figuring out how the things that I find work,” he said. Admittedly, he has had some interesting experiences while collecting, including having to do a backflip out of a dumpster, which tilted on a slope toward him. He didn’t get caught under it when it tipped over, but he did get a compression fracture of the spine. He can’t count the number of times he has been offered money, which he declines with thanks, when people see him looking in the garbage, thinking he is poor, which he is not.

He walks a lot, on average five to 10 blocks daily to the nearest bus stop, where many of the drivers and passengers know him by name. One of those bus drivers became his friend, often inviting Noland to his home for dinner at Thanksgiving, Christmas, and Easter. “I enjoy riding the buses and meeting people from different lines of work, and then discovering our shared interests,” he said.

In Noland’s younger days, he also rode his bike a lot because it meant being outdoors and was a great way to get to work. He enjoys the outdoors, watching birds and being able to identify many by their birdsong, watching animals, walking by the river, and appreciating and watching violent storms. He has long been interested in the weather. As a high school student, Noland was one of 40 winners in the 1944 Westinghouse National Science Search, honored for his research on “Amateur Weather Forecasting.” Winners received an expense-paid trip to a national meeting in Washington, D.C., where they met Eleanor Roosevelt on the steps of the White House for a photo, and Vice President Henry Agard Wallace. They also toured the FBI Laboratory, where they were all fingerprinted.

Noland loves to fish and one weekend each summer he takes his research group to Lake Bertha near Pequot Lakes, MN. He is also a cat lover and always seems to have at least one in his home. Currently, he owns Scarlett, a dwarf tuxedo cat now at least 16 years old, that he obtained from Letitia Yao. It has been love and affection ever since.

Noland believes in service. “I have always believed that my purpose in life is to do good in many ways,” he said, “particularly, if that is creating something useful for the future, or leaving something behind like the recollections that people, including my students, may have of me, my inventions, or my many scientific papers.”

One of Noland’s major, long-time hobbies, starting when he was a graduate student, is investing. He took six semesters of economics as an undergraduate student, which gave him a theoretical understanding of investing. He gives away what he makes through investing to charitable causes, including supporting the University of Minnesota Foundation, sponsoring student scholarships and fellowships, and supporting his research program and researchers.

One of Noland’s long-time service commitments was to Organic Syntheses Inc., a non-profit that publishes organic chemistry books and information on an open access website. Organic Syntheses is a source of reliable, tested step-by-step procedures for organic chemists. Noland has been involved with this organization since 1969, serving as secretary, vice president, and editor of Collective Volume 6, which is about 1,200 pages. He has served on its board of directors continuously since 1969, and worked on its publications for 10 years.

He was also active with the Minnesota Section of the American Chemical Society (ACS) for 48 years, serving as its chair in 1970, and as a councilor for 21 years or alternate councilor for 11 years, which meant being a delegate to the ACS Council and attending its national meetings. He worked on local elections (1990-2004), serving as an election judge for one year and chair for 13 years in his neighborhoods of Prospect Park and Seward. He also served on the East River Gorge Citizens Advisory Committee (1990-1994), working to make improvements and preserve the river area so others can enjoy its amenities. He was a consultant in petroleum technology and heterocyclic chemistry for the Sun Oil Co. in Marcus Hook, PA, for 11 years (1958-1970).

If the venerable Dr. Noland had advice for students it would be to “make up your mind what you want to do, pursue it with vigor, and try to do public service on the outside.” And for his colleagues, “Be friendly, stop by each other’s office and say ‘Hi’ if the door is open, and take an interest in each other’s activities as widely as possible.”

“Way has had a positive impact on the lives of thousands of students. . . when interacting with alumni, they often ask about him because of the role he played in their life decisions. We very much appreciate everything that he has contributed to our department.” — William Tolman, department chair
AFTER YEARS OF DISCUSSION and four years of hard work, this fall, the Department of Chemistry created and launched a new sequence of lectures and laboratories entitled, Chemistry for Life Sciences. This sequence is designed for students enrolled in the College of Biological Sciences who are interested in life science subjects, majors, or careers. It may be extended to students in other colleges in the future.

Professor David Blank, director of Undergraduate Studies, worked with Professor Paul Silicano, director of Undergraduate Studies in the Department of Biochemistry, Molecular Biology and Physics, and a group of faculty members in the Department of Chemistry and College of Biological Sciences (CBS) to design the all-new, three-semester chemistry sequence of lectures and laboratories. The sequence includes seven introductory and sophomore-level chemistry courses, of which three are laboratory courses. These lectures and laboratories are specifically tailored and required for students interested in life sciences, and focus on reactions that take place in living cells. This was one of the Department of Chemistry's largest curriculum development projects.

The need for this new curriculum was originally identified in CBS, where students were struggling to find enough space in their major programs for advanced course work. This led to a discussion of how they could complete their chemistry preparation a semester earlier, and complete their required biochemistry course in four rather than five semesters.

With this as the original driver, evaluation of the content also provided a tremendous opportunity to reevaluate the chemistry needs of students planning to pursue careers in the life sciences that may not be chemistry intensive. Thus, the new curriculum provides a solid grounding in chemistry to students who may not, in the end, become chemistry majors.

“Although redesigning a sequence that currently serves roughly 2,000 students is a very large and complicated undertaking, this has offered us the opportunity to really examine and improve how to best serve one of the largest student populations that rely on a strong foundation in chemistry for their future studies.” — Professor David Blank

“Although redesigning a sequence that currently serves roughly 2,000 students is a very large and complicated undertaking,” said Blank, “this has offered us the opportunity to really examine and improve how to best serve one of the largest student populations that rely on a strong foundation in chemistry for their future studies.”

The new curriculum, which is being implemented by Professor Angela Perkins, encompasses an integration of topics from general and organic chemistry courses alongside biological applications, and is designed to help students see the connections between chemistry and biology. The first semester starts by following an atoms-first general chemistry class structure, but introduces topics related to the structure of organic and biological molecules. The second semester incorporates more general and organic chemistry topics with discussion of acid-base chemistry, kinetics, and free radicals presented in the context of organic/biological chemistry. The third semester is similar to traditional organic chemistry-based content with discussion of organic reactions, but includes topics related to the chemistry of biological molecules such as carbohydrates, DNA and lipids.

Students also have an associated laboratory each semester, giving them enhanced learning opportunities to develop problem-solving, effective communication, and critical-thinking skills in a hands-on setting. In their first semester, students are taking the traditional first-semester general chemistry laboratory. Two new laboratory courses are in development for the second and third-semesters, which will incorporate general, organic, and biological chemistry techniques.

Over the last 18 months, intensive discussions were held related to material content as well as space requirements for lecture and labs. Lab space has been a particularly difficult hurdle, focused on the challenge of how to use chemistry's existing organic lab space and squeeze in new labs to accommodate the 320 students in the life sciences program. The plan for spring and fall 2017 has labs running two to three times per day, including into the evening four nights a week.
“I have immensely enjoyed the opportunity to participate in the design of this new curriculum sequence, and I am glad that we are finally at the stage where it is being implemented,” said Perkins. “It was an immense task, but it is exciting to see it finally come together. I hope that the students complete this sequence with an appreciation of chemistry principles and how they relate to their majors and future careers.”

Chemistry is a required class for incoming CBS students and 320 are currently enrolled in this new life sciences sequence for fall 2016. While these students have not officially declared majors within CBS, their expressed interests are spread over all majors within that college. In an informal survey, a majority of the students indicated that they are considering professional school such as medical, dental or pharmacy after graduation.

Master of Filtering

continued from page 3

During the action phase of the game, a wave of asteroids (CO₂ molecules) and supplies (N₂ molecules) drops from the sky and hits the defense matrix. While the objects are in the matrix, a real-time simulation of the underlying chemical structures is used to determine whether the supplies and asteroids are destroyed or pass through the defense matrix. The asteroids and supplies that pass through land on the player’s world unless destroyed by the player’s-controlled laser cannon. Each asteroid (CO₂ molecule) that lands decreases the player’s health and each successful supply drop (N₂ molecule) increases it. The player must remain healthy and save his or her world. The higher the player’s score, the better the chemical properties and filtering aspect of the created MOF. If successful, the player moves on to the next wave.

One of the NMGC’s important concentrations of research is discovering and exploring MOFs that can be used to capture and separate harmful CO₂ molecules from less environmentally harmful gas molecules such as N₂. From a real-world perspective, it is possible, said Gagliardi, that players may create new materials with enhanced filtering properties that could be useful in separating CO₂ from N₂.

The game’s creators are continuing to refine the game to make it more user friendly and simpler for non experts, to make it available on different platforms, and to extend the building blocks with which the users can build MOFs.

The game can be found at http://www.chem.umn.edu/nmnc/mof. Send comments on the game to chemmofg@umn.edu.
David Blank
Professor David Blank was awarded the 2016 President’s Award for Outstanding Service and the 2016 George W. Taylor Award for Distinguished Service by the College of Science and Engineering. He was honored for his leadership of Energy and U, his work as the Department of Chemistry’s Director of Undergraduate Studies, including the creation of a new life sciences curriculum, and his work as a professor and researcher. He was also named the department’s 3M Alumni Professor.

Erin Carlson
Professor Erin Carlson was named a recipient of the Presidential Early Career Awards for Scientists and Engineers. She was nominated for this award by the National Science Foundation for her discovery of novel chemistry underlying a new approach to treat antibiotic-resistant infections, for leadership in the chemistry and women-chemists communities, and for developing new hands-on laboratory activities to engage K-12 students in natural product chemistry. She also has been selected to receive a 2017 Rising Star Award from the American Chemical Society Women Chemists Committee. This award recognizes up to 10 early- to mid-career women chemists annually who have demonstrated exceptional promise for contributions to their fields.

Laura Gagliardi
Professor Laura Gagliardi received the Bourke Award from the Royal Society of Chemistry, honored for her contributions to quantum chemistry focused on predicting new materials for catalysis, gas separation, and excited state phenomena. She was invited to become a Fellow of the Royal Society of Chemistry through its “Leaders in the Field” program, which honors outstanding individuals in the chemical science community. She was also elected a Fellow of the American Physical Society, honored for her seminal contributions to the development of electronic-structure methods and their application to the understanding of complex chemical systems, including the prediction of new materials and associated properties. She was named an associate editor of the Journal of Chemical Theory and Computation, bringing her expertise in quantum mechanics, inorganic, nanoscience, and materials science to that leading American Chemical Society publication.

Jiali Gao
Professor Jiali Gao was elected to one of quantum science's most exclusive academic societies, the International Academy of Quantum Molecular Science in Menton, France. Gao is recognized for seminal theoretical and practical developments in the combined quantum mechanical and molecular mechanical (QM/MM) method, and applications of this method in organic chemistry and biochemistry.

Christy Haynes
Professor Christy Haynes was named an associate editor of Analytical Chemistry, bringing her myriad expertise in analytical chemistry to that leading scientific journal. She was also selected as one of the top 50 women in analytical science and featured in The Analytical Scientist’s 2016 Power List of talented scientists who brilliantly represent the scope and impact of the analytical sciences.

Thomas Hoye
Professor Thomas Hoye was named the 2016 Royal Society of Chemistry’s Robert Robinson Award winner, honored for his contributions to organic chemistry. Hoye and his research group explore synthetic organic chemistry. He also will receive a 2017 American Chemical Society (ACS) Arthur C. Cope Scholar Award, recognized for his excellence in organic chemistry. He will be honored at a day-long Cope Symposium at the fall 2017 ACS National Meeting in Washington, D.C.

Timothy Lodge
Regents Professor Timothy Lodge was elected a Fellow of the American Academy of Arts and Sciences, which honors leaders in the academic disciplines, the arts, business, and public affairs. He was also named a 2016 Fellow of the Neutron Scattering Society of America. He was honored for the creative use of SANS to achieve groundbreaking insights into the structure and dynamics of a range of complex polymer systems, in particular, multi-block copolymers in the bulk and in selective solvents.

Lee Penn
Professor Lee Penn’s passion and commitment for diversity and equity earned her the prestigious Charlotte Striebel Equity Award for 2016-17. This award from the University’s Office for Equity and Diversity’s Women’s Center recognizes people who go above and beyond daily responsibilities to promote access for the common good, to undo bias and discrimination, and to build capacity for diverse and equitable campus communities.

William Pomerantz
Professor William Pomerantz was named a 2016 Cottrell Scholar by the Research Corporation for Science Advancement. He is using this award for an initiative entitled, “Fluorinated Peptides and Proteins for 19F MRI and Integrated Research Experiences in an Organic Chemistry Lab Course.” He was also selected as a recipient of the University of Minnesota McKnight Land-Grant Professorship, which will aid Pomerantz in his research into, “Innovation from Fluorination: Teflon Proteins for Protein-Protein Interaction Drug Discovery.” He plans to extend his applications of fluorinated biopolymers to use its unique bioorthogonality of fluorine for imaging cancer biomarkers by 19F MRI. In addition, he was selected as a 2016 Rising Star in Chemical Biology by the International Chemical Biology Society.

Lawrence Que Jr.
Regents Professor Lawrence “Larry” Que Jr. will receive the 2017 American Chemical Society Award in Inorganic Chemistry. Recognized for his many contributions to the field of inorganic chemistry that have profoundly impacted the understanding of the nature and reactivity of high-valent iron centers, he will be honored, Tuesday, April 4, 2017, at the ACS National Meeting in San Francisco.

Theresa Reineke
Professor Theresa Reineke received the prestigious 2017 Carl S. Marvel Creative
Polymer Chemistry Award from the American Chemical Society Division of Polymer Chemistry, which recognizes accomplishments and innovations of unusual merit in the field of basic or applied polymer science. She was inducted into the American Institute for Medical and Biological Engineering College of Fellows, honored for her outstanding and creative contributions to the design and discovery of synthetic polymers for drug and gene delivery. From the University of Minnesota, Reineke received the 2016 George W. Taylor Award for Distinguished Research from the College of Science & Engineering for her outstanding research. She was also selected to receive a 2016 Sara Evans Faculty Woman Scholar/Leader Award, recognized for her transformative research contributions to the field of polymeric materials chemistry; leadership of innovative and collaborative research teams across the University of Minnesota campus that have garnered large government and industrial support; excellent track record of entrepreneurship and technology licensing; and service to societies and organizations in her research field, the College of Science and Engineering, and the Department of Chemistry.

William Tolman

Professor William B. Tolman, chair of the Department of Chemistry, will receive the 2017 American Chemical Society Award for Distinguished Service in the Advancement of Inorganic Chemistry. He is honored for his research accomplishments, excellent teaching and mentorship of students and post-doctoral researchers, and outstanding leadership and service in the inorganic chemistry community. He will be honored, Tuesday, April 4, 2017, at the ACS National Meeting in San Francisco.

Donald Truhlar

Regents Professor Donald Truhlar was awarded the prestigious 2016 Earle K. Plyler Prize for Molecular Spectroscopy and Dynamics, honored for his outstanding work and accomplishments in dynamics, which span a range of theoretical and computational chemical physics. For the third consecutive year, he received an Outstanding Advising and Mentoring Award from the Council of Graduate Students, Professional Student Government, and Student Conflict Resolution Center.

Promotions

Michelle Driessen

Michelle Driessen, the Department of Chemistry’s general chemistry director, was promoted to professor. Driessen is interested in the development of new teaching methods to improve educational outcomes for undergraduates and educational materials for use in general chemistry. Her work has included implementation of a problem- and team-based laboratory curriculum, an online course for introductory chemistry, a reduced-seat-time, flipped, general chemistry curriculum, and a peer-led workshop program to support students in general chemistry. She is co-author of a textbook on introductory chemistry, *Introductory Chemistry: An Atoms First Approach*. This textbook, written with co-author Julia Burdge, uses an atoms first approach specific to introductory and general chemistry.

Driessen earned her bachelor’s degree from Minnesota State University, Mankato, and her doctorate from the University of Iowa. She started working in the Department of Chemistry in 2002, has been the department’s general chemistry director since 2007, and was promoted to associate professor in 2012.

Jane Wissinger

Jane Wissinger, director of the Department of Chemistry’s organic chemistry laboratory, was promoted to professor. She teaches more than 1,100 students per year, developing the course curriculum, publishing the course manual, and training and supervising the approximately 45 teaching assistants who are involved. Her research group focuses on the development of laboratory experiments that model green chemistry principles and guide-inquiry pedagogy.

As a senior principal investigator in the Center for Sustainable Polymers, Wissinger also works to develop experiments for the college and high school level, which share innovative technologies in renewable and degradable plastics. These experiments are meant to engage students and inspire them to pursue careers in the science technology, engineering, and math fields. Wissinger shares her green chemistry expertise with educators and professors in workshops and seminars on a national level and is involved in the American Chemical Society-Green Chemistry Institute project to develop a Green Chemistry Education Roadmap.

Wissinger has been working with the Department of Chemistry since 1992, first serving as an adjunct instructor for organic and general chemistry. She became the organic chemistry laboratory director in 1998, and was promoted to associate professor in 2011. She earned her bachelor’s degree from Susquehanna University, and her doctorate in organic chemistry from Northwestern University in 1987. Her teaching accomplishments were recognized in 2014 with a Horace T. Morse-University of Minnesota Alumni Association Award for Outstanding Contributions to Undergraduate Education.
We are grateful to the generosity of the donors who are supporting talented and deserving chemistry students through scholarships and fellowships.

**Scholarships**

**Peteris Auzins Memorial Scholarship**
Fiona Armstrong-Pavlik, Kaitlin Landy, Danica Maile, and Rachel Staebell

**George B. and Mary Ann Bodem Scholarship Fund**
Spenser Marting

**Stanley G. Bonnema Scholarship Fund**
Andrew Diep-Nguyen

**Robert C. Brasted Memorial Fellowship**
Marquel Dresel

**Churchill Scholar/Winston Churchill Foundation of the United States**
Sammy Shaker

**Thomas DuBruil Memorial Award**
Molly Anderson, Jiaxin Duan, and Kyle Johnson

**Lloyd W. Goerke Scholarship**
Soñia Maltseva

**Goldwater Scholar**
Stephanie Hart

**Dr. Paul F. and Patricia Guehler Chemistry Scholarship**
Eric Kalkman and Stephanie Hart

**Hach Chemistry Teacher Scholarship Fund**
Anthony Kort

**Sally Herz Memorial Scholarship**
Kathryn Almquist and Karina Lin

**David A. and Merece H. Johnson Scholarship**
Francisco Gomez, David Kraus, Patricia Maglalang, Jonathan Schultz, and Kindra Sullivan

**Betty A. Lewis Scholarship**
Caitlin Puro

**J. Lewis Maynard Memorial Prize in Advanced Inorganic Chemistry**
Bret Andersen, Olivia Chase, Ed Koleski, Merrick Pierson Smela, and Megan Stevens

**Wayland E. Noland Award For Academic Excellence in Chemistry**
John Rosenow

**Wayland E. Noland Scholarship Fund**
Myles Golden, Julie Normandreau, and Joshua Witt

**Wayland E. Noland Second Scholarship Fund**
Katherine Grondahl and Ryan Thill

**Kenneth E. and Marion S. Owens Scholarship**
Hien Pham

**M. Cannon Sneed Memorial Fund**
Rami Shaker

**Jane B. Spence Scholarship**
Christopher Chao and Jinbin Chen

**John Wertz Fellowship in Chemistry**
David Bergs

**Chemistry Summer Research Program**

**Heisig Endowment, Graham N. Gleysteen Scholarship Fund in Chemistry, the Andrews Endowment, and the Walker Endowment**

**Fellowships**

**3M Fellowship**
Peter Clement

**Richard D. Amelar and Arthur S. Lodge Fellowship for Outstanding Collaborative Research in Materials**
Pragya Verma

**Newman and Lillian Bortnick Fellowship**
Kiall Francis Suarez

**Camille and Henry Dreyfus Environmental Chemistry Fellowship**
Madalyn Radlauer, Ph.D.

**Department of Energy Office of Science Graduate Student Research Program grant**
Lafe Purvis

**Robert and Jill DeMaster Fellowship**
Samuel Stoneburner

**Diversity of Views and Experiences (DOVE) Fellowship**
Derek Batiste

**Fulbright Scholarship for International Students**
Anna Abfalterer

Fellowship recipients for 2016-17 are Evan Anderson, Lester C. and Joan M. Krogh Endowed Fellowship; Kiall Francis Suarez, Newman and Lillian Bortnick Fellowship; Jamie Brooks, Phillips 66, Kelsey Parker, Kenneth E. & Marion S. Owens Fellowship; Fazel Zare Bidok, Jane B. Spence Fellowship; and Shu Xu, Wayland Noland Fellowship.
Alumnus Gary Brudvig honored with Outstanding Achievement Award

Benefitting greater community through his research, service, outreach, and mentoring.

ALUMNUS GARY W. BRUDVIG, PH.D., received an Outstanding Achievement Award (OAA) from the University of Minnesota. This award honors alumni for unusual distinction in their chosen professions or in public service, and who have demonstrated outstanding achievement and leadership on a community, state, national, or international level.

He was honored for the impact of his many scientific contributions to the field of energy conversion both in biological and abiological systems, his extensive service contributions to his field, his outreach to the science education community in New Haven, and his effective mentoring of coworkers.

Professor Brudvig is chair of the Department of Chemistry at Yale University, and the department’s Benjamin Silliman Professor.

He has a joint appointment in the Department of Molecular Biophysics and Biochemistry, and is director of the Yale Energy Sciences Institute. He earned his Bachelor of Science degree in chemistry from the University of Minnesota in 1976, graduating with high distinction. He went on to earn his doctorate in chemistry from the California Institute of Technology in 1981, and conducted post-doctoral research at the University of California, Berkeley. He began his career in academia at Yale University in 1982.

He is an outstanding researcher, focusing on solar energy conversion. One area of his research encompasses understanding the chemical mechanism by which oxygen is formed from two water molecules in photosynthesis.

Many of Brudvig’s more than 300 publications detail the structure of the intermediates and the complex step-by-step events involved in the reactions of photosystem II, where oxygen formation occurs. His work is shedding light on manganese’s role as an essential element in the formation of oxygen. His significant findings are important to understanding the biological production of oxygen necessary for sustaining life on the planet.

Professor Brudvig is also making an important impact on developing man-made catalysts.
Chemical biology one of the department’s research strengths

Researchers cross chemistry boundaries to address myriad biological problems

CHEMICAL BIOLOGY is one of the Department of Chemistry’s strengths, encompassing the expertise of researchers who are interested in studying biological problems using the tools of chemistry. From theoretical chemists to chemists interested in organic, inorganic, analytical or physical chemistry, they are crossing traditional chemistry boundaries to address myriad problems in pharmacology, cell biology, structural biology, and medicine.

“Chemical biology is critical because it brings the breadth of chemical tools, both synthetic and analytical, to bear on the complexity of biological systems,” said Professor Christy Haynes.

Chemical biology can be distinguished from biochemistry. Chemical biology focuses on how chemistry, chemistry techniques and chemical tools can be applied to solve complex biological problems with a major focus on small molecules, said Professor Mark Distefano. For example, chemical biologists add a chemical or specifically designed molecule to a tissue or cell, and see what the reaction is or how the interaction works. Although the definition of “small” is always changing, chemistry continually pushes the limit of what can be made, Distefano noted. Developing new methods for measuring things in the context of biological systems with better precision or higher structural resolution is also a major dimension to chemical biology research.

“When chemists talk about a biological problem, they start drawing chemical structures and speaking about the problem in chemical terms,” said Distefano. “Biochemists, on the other hand, are more focused on the biological aspects of the problem as a whole, thinking and viewing the biological system in more global terms.”

The department’s chemical biologists are working on a variety of issues. For example, Haynes’ research group approaches chemical biology from an analytical perspective, often with a focus on developing measurement tools or platforms to characterize cell-to-cell communication. One specific example of her research group’s work is its extensive use of microfluidic platforms to explore neutrophil/endothelial cell chemical interactions where the researchers can control the chemokines presented and even study how the presence of cancerous cells influence the critical process of neutrophil migration.

The central focus of research in Professor Will Pomerantz’ laboratory is on understanding the details of molecular recognition processes that affect biological outcomes. His researchers accomplish this from both the fundamental study of new non-covalent interactions such as the newly investigated sulfoxide-aromatic interaction, to applied studies in medicinal chemistry, focusing on disrupting protein-protein interactions using small molecules and peptidomimetics. To accomplish these goals, they have pioneered a metabolic labeling approach of proteins using fluorinated amino acids for highly sensitive small molecule screening by 19F NMR, called PrOF NMR. They use this method to find new inhibitors of proteins that control the epigenome for studying their role in various disease states, including cancer and heart disease. These studies are highly interdisciplinary, engaging faculty in the departments of Medicinal Chemistry and Biomedical Engineering, the Medical School, and industrial partners such as Eli Lilly.

Distefano said that chemical biology is ever changing, aided by advances in technology that enable scientists to tackle more complicated and larger biological problems at greater levels of detail. For example, with today’s mass spectrometry instruments, chemists have the ability to look at an entire protein or virus. The Department of Chemistry and the University of Minnesota have state-of-the-art facilities that aid scientists in their work, including the department’s Magnetic Resonance Imaging (MRI) laboratory and the University’s Magnetic Resonance Imaging Center, the University Imaging Centers with their high-powered imaging microscopes that have been designated as a Nikon Center of Excellence, and the Medical School.

With diverse collaborations among researchers, expanding knowledge about biological issues, and technological advances, the goal posts in the chemical biology field are ever changing. “It really is exciting to use our chemical tools to solve problems in biology,” Distefano said.

Because of this there is a high demand for educated chemists to work on biological, pharmacology, biotechnology, and medical device issues, said Distefano. The Department of Chemistry is meeting that challenge through such things as its chemical biology laboratory, Chemical Biology Discussion Group, and
Professor Erin Carlson, who has expertise in organic synthesis, mass spectrometry and other methods critical for mapping biological interactions, developed a chemical biology laboratory course—the first of its kind for the Department of Chemistry. The goals of the course are to expose students to the application of modern chemical concepts and techniques to biological problems, and for students to understand how chemistry and biology are related, and why that interdisciplinary focus is important to the study of human biology and therapeutic development.

She also spearheaded the organization of a Chemical Biology Discussion Group, which meets once a month to discuss cutting-edge techniques, upcoming speakers, and ongoing research from chemical biology groups across campus.

Professor Carlson’s research group is working to develop new antibiotics by the identification of strategies that evade current drug-resistance mechanisms. Although the 20th century was marked by a significant reduction in global infectious disease burden, rapidly increasing drug resistance combined with the prevalence of emerging diseases are raising the specter of a coming "post-antibiotic era." To address this mounting challenge, Carlson unites tools from chemistry and biology such as organic synthesis, metabolomics, proteomics, and molecular and cellular biology to explore and exploit the master regulators of microbial behavior. This strategy is in direct contrast to traditional antimicrobial discovery efforts that have depended upon the identification of compounds that simply kill bacteria, which results in the rapid evolution of resistance. Instead, her research program focuses on the identification of proteins and small molecules that are required for microbial “conversations,” with the goal of developing new methods to blind silence and eliminate bacteria.

The Chemical Biology Interface Training Grant, administered by Professor Distefano, allows first-rate students to grow into accomplished professionals both in their primary areas of interest (e.g., synthetic/mechanistic organic and inorganic chemistry, molecular biology, mechanistic enzymology, medicinal chemistry) and in their secondary areas of interest (e.g., synthetic/mechanistic inorganic chemistry, mass spectrometry, organic synthesis).

“Chemical biology is critical because it brings the breadth of chemical tools, both synthetic and analytical, to bear on the complexity of biological systems.”

— Professor Christy Haynes

Some of the chemical biology research being explored in the Department of Chemistry includes:

- synthesizing potent bioactive molecules including anti-cancer compounds and natural products
- developing chemical methods for synthesis of small molecules, peptides and small proteins, engineering designer proteins,
- mimicking metalloprotein active sites and examining reactivity of model complexes
- using a combination of biochemical, inorganic, and synthetic organic chemistry to study how these fascinating catalysts function at the molecular level
- conducting single cell, organelle, and molecule analysis
- studying the redox properties of enzymes
- designing novel bioactive nanomaterials
- conducting in-situ neurochemistry
- performing theoretical and computational studies of the structure, reactivity, and dynamics of biomolecules in solution
- modeling enzymatic catalysis
- using fluorescence, IR, Raman, EPR, and NMR spectroscopies to study exciting problems and protein-RNA interactions, HIV, membrane-bound proteins, and metalloproteins
- conducting in vitro selection (SELEX) to obtain new diagnostic and therapeutic agents
- developing and using new methods for proteomic analysis
- determining the structure of proteins via NMR methods
- studying the mechanisms of DNA damage and repair
- creating new protein-based therapeutics
- developing new methods for super resolution microscopy

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THE EMERGENCE OF SHALE GAS as a “new” energy source poses challenges of enormous economic significance. The Department of Chemistry-led Inorganometallic Catalyst Design Center (ICDC), directed by Professor Laura Gagliardi, is at the forefront in addressing this opportunity. The ICDC is an Energy Frontier Research Center funded in 2014 with $12 million over four years.

In addition to Gagliardi, six other faculty members from the Department of Chemistry are involved in the center, including Christopher Cramer, Connie Lu, Lee Penn, Andreas Stein, Ian Tonks, and Donald Truhlar. These researchers are all leaders in theoretical chemistry, inorganic chemistry, and materials science—each a field in which the University of Minnesota excels. Other critical partners include Northwestern University, University of Washington, University of California-Davis, Clemson University, Argonne National Laboratory, Pacific Northwest National Laboratory, NuMat Technologies, and Dow Chemical Company.

A bright and energetic team of about 50 junior investigators, ranging from undergraduate interns to graduate students and post-doctoral research scholars, advances the day-to-day research.

The ICDC aims to discover new catalysts that functionalize hydrocarbons derived from natural gas by using a combination of theory and experiment operating in synergy. Its researchers are developing new theoretical and experimental models and methodologies to address critical technologies relevant to the energy needs of modern society.

“Our research could lead to new opportunities for energy efficiency and resource conservation,” Gagliardi says. “Our ultimate goal is to design and produce catalysts for reactions that will yield significant energy savings and environmental benefits compared to existing alternatives. A more immediate outcome of the research will be what we learn about structure–function relationships for new catalysts in a size range spanning the nano- to the mesoscales.”

A major hurdle in the race to energy efficiency is the liquefaction of natural gas, a mixture of light hydrocarbons. Finding inexpensive means to convert natural gas to more readily stored and transported liquid fuels would greatly enhance its value, and address environmental concerns arising from flaring it into the air or injecting it into the ground. Suitable targets are the catalytic conversion of shale-oil gases either to alcohols, via partial oxidation, or to longer-chain hydrocarbons, via oligomerization or metathesis reactions.

How is the ICDC tackling these challenging transformations? The center spotlights a new and versatile family of materials named Metal–Organic Frameworks (MOFs). MOFs are three-dimensional, porous structures with metal oxide nodes connected by organic linkers; they are similar to children’s Tinker Toys®, with the nodes like the toy’s wooden disks and the linkers like the colored sticks permitting the nodes to be built into networks of various shapes and sizes. Among them, a MOF known as NU-1000 has the potential to be an ideal support for the installation of a variety of metals with potential catalytic activity. Such sophisticated materials can potentially provide unique environments with uniform, well-defined structures that are amenable to high-throughput computational and experimental screenings.

Like a jigsaw puzzle, all the pieces need to be matched in order to get the entire picture. The ICDC precisely combines four essential pieces of chemistry: synthesis, characterization, quantum chemical simulations, and catalysis.

Synthesis involves the creation of new MOFs and their further modification with different catalytic species (generally metals) using a variety of techniques, such as atomic layer deposition or solution-phase exchange.

Characterization, a key early goal, entails structural determinations of the as-synthesized MOFs and their metal-decorated derivatives, from the molecular level to the nanoscale.

Quantum chemical simulations model these materials to gain further insight at the atomic level of detail and drive experimental efforts. Theoreticians utilize density functional theory and wave function-based methods to help with structural and spectral characterization as well as to understand and predict reactivity through assessment of chemical descriptors and structure–function relationships. In addition, they invest in the development of new computational methods to accurately describe these unique species.
Catalysis studies are the capstone efforts of the ICDC. Synthesized and characterized materials are put to work for natural gas transformations with the guidance of quantum simulations. The center focuses on the

1. selective oxidation of light alkanes to alcohols, especially methane to methanol;
2. dehydrogenation/hydrogenation of light alkanes/alkenes; and
3. manipulation of C–C bonds—their formation and cleavage in selective oligomerization.

Over the past two years, the team has had particular success in the installation of transition-metal catalysts in MOFs having nodes acting as supports, which are effective in catalytic reactions involving the manipulation of C–C bonds.

In a recent paper in the *Journal of the American Chemical Society*, some IDCC researchers published a study in which nickel ions were precisely placed into a zirconium-based MOF called NU-1000 by using a method called atomic layer deposition in MOFs (AIM). The resulting material is a stable, active catalyst for ethylene dimerization and hydrogenation. In a subsequent study, ICDC researchers devised a strategy to install two different metals, aluminum and cobalt, thereby significantly expanding the palette of choices for catalyst design by confirming the viability of heterobimetallic installations.

Even in the presence of a catalyst, some challenging reactions (e.g., dehydrogenation of alkanes) may not be thermodynamically favored at low temperatures but, instead, require rather high temperatures—at which the organic linkers of the MOF start to decompose—to proceed. Importantly, the ICDC turned this problem into an opportunity. The team designed a technique to stabilize the material; it used the porous MOF as a template into and around which to build a robust silica structure—a process known as “nanocasting.” When subjected to high temperatures (calcination), the organic linkers burn away, but the metal oxide nodes and the silica remain, thus retaining the structure and catalytic activity of the original MOF. One such nanocast material has been shown to isomerize glucose, thus proving that catalytically reactive metallic clusters are still available for catalysis after calcination.

Researchers have had success in the installation of transition-metal catalysts in MOFs having nodes acting as supports, which are effective in catalytic reactions involving the manipulation of C–C bonds.
Chemists invent paper-based, low-cost, portable ion-selective detector

Could be used for in-home blood testing or in developing countries.

It started with a problem poised at a student research presentation, grew into a conversation, resulted in an interdisciplinary collaboration between two professors and their students, and now has led to an invention that may make blood testing more affordable, portable, and easy.

Professor Philippe Buhlmann, an expert in electrochemistry, and Professor Andreas Stein, an expert in materials chemistry, along with their graduate student Jinbo Hu, have created a simple ion-selective detector built on paper with the potential to replace costly and maintenance intensive laboratory equipment.

Ion-selective detectors are chemical sensors that provide information on the presence of ions—electrically charged atoms or molecules—in the samples being tested. The detectors convert chemical information into electrical or optical signals, detecting atypical deviations from what would normally be found. These detectors are used in laboratory analysis, blood and other physiological measurements, and environmental monitoring for a total of several billion measurements annually.

As an example, ion-selective detectors are used to determine the levels of potassium in the blood stream. Too little potassium causes weak muscles and abnormal heart rhythms. Too much potassium can cause abnormal and dangerous heart rhythms and have a negative impact on kidney function.

In a miniaturized sensor, the ion-selective polymeric membranes need to interface with a porous carbon electrode material in order to make the electrochemical measurement possible. Hu, a 5th-year graduate student, created nanoporous carbon ink that can be used to paint the electrodes onto paper, followed by the application of the ion-selective membrane. Working with Buhlmann and Stein, he developed a low-cost system that includes a printed polyurethane microfluidics channel, an ion-selective membrane, a reference membrane, and stencil-printed silver/silver chloride (Ag/AgCl) electrodes. A simple voltmeter serves as a read-out device.

Careful calibration of conventional ion-selective sensing equipment is important for accurate results, and is usually done in laboratories by trained technicians. The new detector is cheap and flexible, and has the advantages of not requiring careful assembly, pretreatment, or calibration. With a precision in the range of one millivolt, the University’s researchers are close to making their device calibration-free. For example, their testing of small amounts of blood serum has given them accurate and reproducible measurements of chloride and potassium levels.

“I was really fascinated by this project, not only because of its unique chemistry, but also because I see a great potential for the devices eventually being commercialized and used as low-cost, point-of-care diagnostic devices,” said Hu.

This research has already opened doors for Hu. A presentation of this project at an Industrial Partnership for Research in Interfacial Materials & Engineering meeting connected him to Medtronic, and he spent a summer as an intern, working on implantable...
medical devices. This experience reinforced Hu’s commitment to service, and helped him realize that he wants to pursue a professional career in the medical device industry.

“The feeling of being able to serve people by developing more affordable and accessible medical devices causes me to wake up early in the morning, and provides extra satisfaction whenever I reflect on the possibilities,” Hu said.

Hu also said that being co-advised by two professors who are experts in two different chemistry areas was a rewarding experience.

“I very much appreciate the opportunities for exposure to interdisciplinary research, and to develop a variety of technical skills, and to learn diverse ways to problem-solve from my advisers,” said Hu. “I have also enjoyed serving as a ‘hub’ to connect my two research groups, from sharing instruments and resources to connecting people with different expertise for possible collaborations.”

The scientists are pursuing patents for their device and possible commercialization. It is possible that such devices can be used by individuals who need to monitor their electrolyte levels in their homes, or by people in developing countries to test and monitor health and environmental issues.

This disposable selective ion detector (schematic, top; photo of device, bottom) consists of printed Ag/AgCl electrodes, microfluidic channels (dashed lines), and inexpensive membranes embedded in a piece of filter paper. Credit: Andreas Stein.

A challenge for scientists doing chemical biology is the vast body of knowledge that makes it impossible for them to know everything. They must be experts in both chemistry and biology.

—Professor Mark Distefano
Science Mentors brings hands-on science lessons to the adult-learning community

Helping students relate science to their everyday lives

THE DEPARTMENT OF CHEMISTRY fosters and cultivates an environment of volunteerism and giving back and being actively engaged with outreach into the community. Graduate students and post-doctorate researchers are often at the forefront of such engagement. One such group is the student-created Science Mentors “SciMentors.”

Science Mentors is an active group of graduate students and post-doctorates that are teaching science to adult community learners who are preparing for their general educational development (GED) degrees. Leading this outreach initiative are graduate students Anna Komor and Nicole Gagnon. Gagnon was interested in starting a long-term mentoring outreach program that differed from traditional science show or one-time outreach efforts. Komor mentioned that adult learners were an underserved population by university-based outreach efforts, and a partnership was born.

As a former high school chemistry teacher, Komor loves teaching and enjoys working with older students. About five years ago, she became a volunteer teacher for Open Door Learning Centers and the Franklin Learning Center, which offer daytime and evening classes for adult English-language learners, GED preparation, and adults interested in improving their job skills. The student populations are diverse, composed of adults ranging in age from their early 20s to 60s. About half are recent immigrants or refugees, more than 70 percent are English Language Learners, and more than 50 percent are parents.

SciMentors was initially started through the Department of Chemistry’s Women in Science and Engineering, but morphed off onto its own as more and more people from the Department of Chemistry stepped forward to volunteer, and male volunteers were recruited. Under Gagnon and Komor’s tutelage and leadership, these volunteers create and deliver hands-on science lessons that last 1 to 1.5 hours. They teach in each classroom two to three times a month, year round.

Some of the skill-based lessons encompass ecosystems for earth and space science, compounds and solutions for physical sciences, and cells and cell division for life science. Komor said that they try to create experiments using materials that the students may find or use in their everyday lives such as DNA extraction from strawberries to learn about genetics. They actively engage students in the discussions, asking them to write what they know about strawberries, what they know about their DNA, and questions that they have about DNA.

The experiments and demonstrations use household materials and, if possible, plants that they would grow in their gardens or that might be native to their countries of origin. “This helps the students relate science to their everyday lives and gain confidence in their own observation skills,” said Gagnon.

A technically simple experiment to determine how many drops of water fit on a penny engages students in learning a number of science GED skills such as basic math, reading and generating graphs, designing an experiment using the scientific method, interpreting data and identifying logical fallacies, and writing summaries and conclusions.

Experiments use household items such as eggs and toilet-paper rolls

SciMentors is led by Nicole Gagnon and Anna Komor.
The volunteers also have a number of interactive demonstrations used to teach students about a variety of topics that are difficult to demonstrate via hands-on experiments, such as the conservation of energy. These demonstrations walk students through discussions about making observations and connections between the physical world and fundamental scientific topics.

The students delight in successfully working their way through an hour-long experiment and obtaining the desired results, said Gagnon. “They realize that science can be fun and they cheer, for example, when the light goes on at the end of the potato battery experiment.”

Komor said that she is continually impressed by the commitment of the students. “These students are inspiring,” she said. “It is hard to go back to school as an adult. Most of them work, many have kids; yet, here they are in class, learning. That’s what makes teaching so rewarding, and I am so thankful to have these opportunities and experiences.”

SciMentors continues to attract volunteers from the Department of Chemistry. Currently, there are about 25 to 30 volunteers in two different Minneapolis schools. Gagnon and Komor recognize the volunteers that have been part of the advisory board for their work designing experiments, maintaining the website, and helping to grow the program: Courtney Elwell, Solaire Finkenstaedt-Quinn, Scott Kleespies, Sadie Otte, Bianca Ramirez, and Waqas Rasheed. The program is currently funded by the UMN Women’s Center, with administrative and grant writing support from Letitia Yao.

While there are many benefits to the students who are being taught, Gagnon said that the volunteers gain skills as well for their careers and professions such as self-confidence, leadership, working with diverse groups of students, and communication. Chemistry community members interested in learning more about the program or in volunteering can visit the program website at scimentors.chem.umn.edu.

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**in Memoriam**

**Professor Emeritus**

Stephen Prager

Department of Chemistry Professor Emeritus Stephen Prager died, Saturday, January 2, 2016, at the age of 87, in Saint Paul, MN. He was a professor of physical chemistry in the Department of Chemistry at the University of Minnesota for more than 40 years, 1952 to 1990.

Prager was born on July 20, 1928, in Darmstadt, Germany. During the Nazi period, he emigrated with his family to Turkey and then to the United States. He earned his bachelor’s degree in 1947 from Brown University in Providence, RI, and his doctorate in physical chemistry from Cornell University in 1951. He spent a post-doctoral year as a Jewett Fellow at the University of Utah from 1951 to 1952, before joining the faculty at the U of M as an assistant professor. He was promoted to associate professor in 1956, and to full professor in 1962.

Prager was a Guggenheim Fellow and Fulbright Scholar at the University of Brussels from 1958 to 1959, where he worked with Nobel Laureate Ilya Prigogine. Later, he was a Guggenheim Fellow and Fulbright Lecturer from 1966 to 1967 at the University of Erlangen, Germany, where he also served as a visiting professor.

His research was in the area of the physical chemistry of macromolecules, particularly, in the application of mathematics to rheology. His colleague C. Alden Mead wrote a tribute about Prager that was published in the *Theoretic Chimica Acta* in 1992. Mead noted that Prager was the founder of the Theoretical Chemistry Group at Minnesota, which, in 1952, was not only unusual, but also not necessarily desirable in a chemistry department. Today, the Department of Chemistry’s Chemical Theory Center is one of the most renowned in the country.

“Steve’s early and continuing achievements certainly have done much to pave the way for the growth and prosperity of that discipline at Minnesota and elsewhere,” wrote Mead. He also wrote that Prager made many important contributions to theoretical chemistry, particularly, in various areas of statistical mechanics and in molecular quantum mechanics. He also pioneered teaching techniques that combined both classical and statistical thermodynamics.

Prager served as assistant editor of the *Transactions of the Society of Rheology* and as associate editor of the *Journal of Physical Chemistry*. He also was a Fellow of the American Physical Society. He retired in 1990, and was honored with a two-day special symposium on polymer theory and related topics, called Pragerfest, in October 1990.

Stephen met his wife Julianne while at Cornell University. She, too, graduated from Brown University, and earned her doctorate in organic chemistry from Cornell University. She worked as a synthetic polymer chemist and fluoroxy chemist at 3M. She worked at 3M for more than 37 years, ending her career serving as 3M’s executive director of Corporate Technical Planning and Coordination.

The Pragers have supported the Department of Chemistry for many years. They established the Chemistry Faculty Support Fund and have made a bequest that will create the Prager Chair in Macromolecular Science through their estate plans.
GRADUATE STUDENTS in the Department of Chemistry are empowered to create a learning environment and community that helps them thrive in graduate school. One of the department’s successful student-led groups is the Community of Chemistry Graduate Students (CCGS).

Formed in the fall of 2012, after a Boynton Health stress and mental health workshop specifically for the Department of Chemistry, the Community of Chemistry Graduate Students is a support network with a three-fold mission of improving the mental, physical, and social health of graduate students. It regularly hosts workshops in these areas and plans a variety of activities and events.

One of CCGS’ largest undertakings was partnering with Boynton Health, University of Minnesota Counseling & Consulting Services, and Professor Philippe Buhlmann, chemistry’s director of Graduate Studies, to develop a survey for assessing mental health and to help understand the cause of stress and anxiety among chemistry graduate students.

The first of these surveys, conducted in 2013, identified that among the main sources of stress for students were their relationships with advisers, oral and written exams, progress toward degree, and need to publish research articles.

One of the survey’s findings suggested that providing more specific feedback to students might help facilitate their progress toward their degrees. To address this issue, the graduate student annual review form was revised with the help of Professor Buhlmann and Professor Aaron Massari, director of Graduate Studies for Chemical Physics. The revised section in the form now asks students to evaluate themselves in 13 different categories, including writing and presentation skills, independent problem solving, and career planning. Faculty advisers evaluate the students against the same categories. Students and their advisers meet to discuss any discrepancies between the evaluations.

A second survey was distributed in the spring of 2016. The results of this survey and the past survey are being combined and prepared for publication. The second survey is expected to lead to a new plan of action on how to further promote the health and success of chemistry graduate students.

To clarify elements for success in graduate studies, the CCGS offers workshops called, “How to succeed in graduate school.” These workshops are panel discussions with faculty members and successful researchers from industry. They address the tips and tricks of surviving and thriving in graduate school and preparing for a successful career afterward.

The Community of Chemistry Graduate Students has also partnered with chemistry professors to prepare short how-to videos. Some topics include how to write a paper, with advice from Professor Peter Carr, and how to give a good talk, with advice from Professor William Tolman.

To support students in their physical health, CCGS implemented a weekly riverside running and walking party, provided information on making good nutritional choices,

Members of the Community of Chemistry Graduate Students are (front row, from left) Xin Chen, Mammad Nasiri, Sadie Otte, Amanda Maxwell, and Zahra Sohrabpour; (back row, from left) Fazel Zare Bidoky, Yuanxian Wang, Waqas Rasheed, and Evan Anderson. Not pictured: Suyue Chen.
...the CCGS is helping the department to not only improve itself, but is setting an example for student involvement in addressing stress and mental health across campus and beyond.”

—Professor Philippe Buhlmann

offered free yoga sessions, and provided an information session on the opportunities available at the Recreation Center. In the mental health area, CCGS has worked with Center of Spirituality and Health to offer stress management information sessions, and worked with Paws for Learning to offer pet away stress relief during exam time. Graduate students also need opportunities to have fun and build community, and the CCGS offers biweekly coffee hours, movie nights, yogurt labs, and barbecues/picnics.

Buhlmann emphasizes how excited he is about the success of the CCGS: “We all seem to agree that some causes of stress in graduate school are unavoidable; the need to publish is the perfect example. However, avoidable causes of stress distract us and make all unhappy and less productive. The CCGS has done an outstanding job at helping us to identify how we can improve our department. With its involvement in the stress and mental health surveys and the systemic effort to identify and execute action items, the CCGS is helping the department to not only improve itself, but is setting an example for student involvement in addressing stress and mental health across campus and beyond.”

The current leader of the CCGS is Evan Anderson, and recent leaders were Maral Mousavi and Zahra Sohrabpour. Other members of the CCGS team are Fazel Zare Bidoky, Suyue Chen, Xin Sean Chen, Amanda Maxwell, Mammad Nasiri, Sadie Otte, Waqas Rasheed, and Yuanxian Wang. For additional information, visit the Community of Chemistry Graduate Students’ website at http://ccgs.chem.umn.edu or send an email to ccgs@umn.edu.

Rising star, undergraduate Stephanie Hart excels in the classroom and laboratory

Research hones her interest in renewable energy

STEPHANIE HART is an honor student, a researcher, a double major, a recipient of scholarships, and an athlete. She is a rising star with a bright future.

A senior undergraduate pursuing dual degrees in chemistry and chemical engineering, Stephanie excels in her academic studies and in the research laboratory.

With two bachelor’s degrees in hand in May 2017, she hopes to pursue earning a doctorate in physical chemistry with an emphasis on renewable energy research. A native of Grand Rapids, MN, Stephanie traces her interest in solving environmental challenges to her childhood experiences camping, hiking, and skiing in northern Minnesota.

Despite not having a particularly strong background in math and science when she entered the University, Stephanie discovered a passion for chemistry in her first-year courses. She credits Professor David Blank, director of Undergraduate Studies, for urging students in her general chemistry class to get involved in research and outreach while they were at the University. Stephanie has done both.

Through the University’s Undergraduate Research Opportunity Program, Stephanie began working with Professor Renee Frontiera, where she has used ultrafast Raman spectroscopy to study charge transfer in organic semiconductors. This research may lead to solar cells that are substantially more efficient than silicon based systems currently being used, said Stephanie, and was instrumental in honing her interests in working on renewable energy development and other green chemistry issues.

The past two summers, Stephanie has participated in research programs at other universities. In 2015, she conducted research using fluorescence resonance energy transfer, total internal reflection fluorescence, and epifluorescence microscopy to track kinetics of DNA stand displacement at liquid crystal interfaces in the Chemical Engineering Department at the University of Colorado-Boulder. As an Amgen Scholar, she worked on the construction of a single molecule microscope in the Department of Chemistry at the Massachusetts Institute of Technology this past summer.

Stephanie is an outstanding student and has received prestigious honors for her hard work in the classroom and laboratory. In 2015, she received the Department of Chemistry’s Thomas DuBrui1 Memorial Award for Outstanding Achievement in Undergraduate Research and, this year, she received the Dr. Paul F. and Patricia Guehler Chemistry Scholarship. She was also one of two University of Minnesota students named a 2016 Goldwater Scholar. The prestigious, competitive scholarship is awarded annually to outstanding sophomores and juniors who intend to pursue research-oriented careers in mathematics, the natural sciences, and engineering.

An athlete, Stephanie is a member of the cycling and Nordic skiing clubs at the University. She also is involved in outreach, volunteering with the Chemists in the Library and the Energy and U programs.

If she had advice for new undergraduate students, it would be to get involved, talk to professors about research, get involved in research, accept the challenges, work hard, and enjoy.

www.chem.umn.edu 21
EVAN ANDERSON’S INTERESTS in research and teaching are converging in the Department of Chemistry. He is an award-winning student, receiving accolades for his work in the classroom and the research laboratory. He is a 3rd-year graduate student working with Professor Philippe Buhlmann, and a leader of the student-led Community of Chemistry Graduate Students. The 2016 recipient of the Lester C. and Joan M. Krogh Endowed Fellowship, Evan also received a departmental fellowship from 2014-16.

Evan has always been an outstanding academic student, taking all of the honors classes offered in college, including those in chemistry, biology, and biochemistry. He credits his high school adviser for encouraging him to attend the University of Minnesota-Duluth. At first, Evan thought that he might pursue a career in medicine, until Professor John Evans, director of Undergraduate Studies in the Department of Chemistry & Biochemistry at the University of Minnesota, Duluth, ignited an interest in analytical chemistry. Professor Evans guided Evan through four years of undergraduate studies and research, and he encouraged Evan to continue his education in graduate school.

“I had to think about that decision,” said Evan. “I didn’t know anything about it or anyone who attended graduate school when I started college.” A native of Mountain Lake, MN, a small community of about 2,100 people located in southwestern Minnesota, Evan is a first-generation college student.

Evan stayed at the University of Minnesota-Duluth to complete a Master of Science in chemistry before applying to the graduate program at the Twin Cities campus. Teaching assistant experiences at Duluth and in the Twin Cities have generated a strong interest in teaching. He is taking Preparing Future Faculty courses through the Center for Educational Innovation. He hopes to participate in the Mentorship Program for Aspiring Chemistry Teachers starting next fall, which provides additional teaching experience and guidance for graduate students and post-doctoral researchers who are interested in an academic career at the college or university level. Evan would like to work with Professor Buhlmann, who is the Department of Chemistry’s director of Graduate Studies, and learn first-hand about curriculum development and teaching methods, and present a minimum of two guest lectures during Buhlmann’s electrochemistry course.

Buhlmann is an expert in electrochemistry and chemical sensors, and Evan said that he finds the research that is taking place in his laboratory extremely interesting, especially, their recent work on ion-transfer stripping voltammetry. After only two years of research in the Buhlmann group, Evan is already co-author of two journal publications and...
first author of another two publications. The latter two focus on ion pair formation in fluorous media and on electrochemical impedance spectroscopy and have been published in the in the *Journal of Physical Chemistry* and in *Analytical Chemistry*, respectively.

Buhlmann said that it is fun to work with Evan, and highlighted that Evan is the single student author of the *Analytical Chemistry* article. Until this article was published, the scientific literature contained no appropriate description of instrumental artifacts in the characterization of highly resistive sensing membranes with impedance spectroscopy. Buhlmann says that Evan’s publication will prevent others from making mistakes that he has, unfortunately, seen all too often in the published literature.

Evan has also enjoyed a number of research collaboratives, including one working with Professor Marc Hillmyer’s research group on nanoporous materials for reference electrodes in wearable sensors. “It’s fun working with different research groups that are not in your specialty and making a lot of progress,” said Evan.

In addition to research and academics, Evan is also a student leader, working with the Community of Chemistry Graduate Students (CCGS). The CCGS is a student-driven group that promotes a healthy academic environment for all graduate students in the department. It connects students with existing University resources and refines and/or develops new resources aimed at increasing graduate student health, happiness and productivity. It also facilitates communication between faculty and staff and graduate students.

“Being involved with the CCGS is a good way to work with other people in the department on improving the climate for graduate students,” said Evan. He is also a volunteer with the Chemists in the Library program helping young people and adults with chemistry experiments at community libraries. The Minnesota Local Section of the American Chemical Society organizes this program, and Buhlmann coordinates it.

For the future, Evan hopes to be a university faculty member where he can teach and conduct meaningful research.

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**An example of Evan Anderson’s research**

**Possible quick measurement of compounds suspected in leading to chronic kidney disease**

PERFLUOROOCTANESULFONIC ACID (PFOS) and perfluorooctanoic acid (PFOA), two of the most prevalent perfluorinated compounds in the environment, have been found in the blood of the general public at ng/mL concentrations and are suspected to lead to an increase in chronic kidney disease. Currently, solid-phase extraction with liquid chromatography/tandem mass spectrometry is the detection recommendation for PFOS and PFOA. While this technique is applicable for sampling of environmental contaminations (requires sample preparation), a more cost-effective and time-efficient technique that can be used for detection in small volumes typical of clinical samples is needed. To achieve this goal, solid-contact electrodes with a fluorophilic membrane for ion-transfer stripping voltammetry are being developed. Using this technique, ultralow detection limits are made possible by preconcentration of the analyte in the fluorophilic membrane at an applied voltage prior to detection of the large current when the analyte is quickly released back into the sample (i.e., stripping voltammetry). This process takes advantage of the high selectivity of fluorous ion-selective electrodes, while allowing for lower detection limits. Also, it allows for the detection of non-redox active species, which is not possible for conventional stripping techniques. If successful, this technique will not only allow for the quick measurement of PFOS and PFOA concentrations, but can be combined with fluorophilic ionophores to lower detection limits for a large number of ionic analytes.
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WORKING WITH the Department of Chemistry is a great experience. Our students, who are so focused, driven, and confident about the future, always amaze me. This is due, in part, to our dedicated and talented faculty who are teaching them in the classrooms and the laboratories. The Department of Chemistry represents excellence, not just in many areas of research, but also for having the most faculty members with teaching awards in the University.

This dedication to teaching is at the core of everything that happens in the department. The other vital piece in sustaining an energetic and productive environment for learning is the support we receive from our alumni and friends. We are so grateful to the many donors who support our students, research, and the department. The impact of this support cannot be overstated. Last year, we were able to award more than 50 scholarships and fellowships to help support our students. This was in addition to the support we receive from individuals and corporations for research and centers within the department. The impact of this support cannot be overstated.

If you have questions or need assistance in making a gift to the department, please contact Kathy Peters-Martell at kpeters@umn.edu or 612-626-8282 in the College of Science and Engineering Dean’s Office.

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Contrary to what many would expect, for alumnus Edward “Ted” Ulrich (B.S. ’92) it wasn’t a big leap to go from being an undergraduate majoring in chemistry to earning a doctorate in religious studies and becoming a professor of theology.

Ulrich was an undergraduate student in chemistry from 1987-1992. He brought to the University a strong interest in science and chemistry in particular. He grew up in a science household with a father who was a dentist with a laboratory in the basement, and an older brother and older sister who were engineering students at the University of Minnesota.

From an early age, Ulrich loved and collected chemistry sets. In grade school and high school, he was known as the science guy and had a full-blown chemistry laboratory in his basement. “I just always have had a natural curiosity about the world,” Ulrich said.

Within just a few weeks of starting work on his undergraduate degree in the Department of Chemistry, Ulrich learned about the Undergraduate Research Opportunities Program, pursued it, and started working with Professor Peter Carr. Their relationship has blossomed into a close friendship.

Ulrich conducted research with Professor Carr for three years, studying solute-solvent interactions in order to develop more effective approaches to chromatography. His first peer-reviewed paper came from this work. He then became an undergraduate research assistant for the late-Professor Margaret Etter.

As he drew closer to graduating with his bachelor’s degree, Ulrich felt drawn toward another strong interest that he had for a long time—the humanities and religion. He wrestled with what to pursue for graduate school, and spent a lot of time during his last semester reading and talking with people to get their advice.

“A professor of theology at the University of St. Thomas since 2001, Ulrich earned his master’s degree from St. John’s University in theology, and his doctorate in comparative religion from The Catholic University of America. He teaches courses in world religions, Hinduism and Buddhism, and Christian theology. He also brings students on a study abroad course that focuses on rural life in south India and the Hindu, Muslim, and Syriac Christian religions.

Ulrich says that his time spent studying chemistry and working in laboratories was a fantastic preparation for theology. “Chemistry requires incredible mental discipline, helps you think about things in an abstract way, and takes a no-nonsense approach to the topic at hand. It requires intense focus on details,” said Ulrich. This discipline really helped him with his theology studies, and taking students on month-long study experiences in India where there are so many details to keep track of in terms of travel, the experiences of the students, and study arrangements. In retrospect, he said, he wouldn’t have pursued his post-secondary education in any other way.

Ulrich says that people often consider religion and science as two homogenous blocks that are intrinsically in conflict with each other. However, there are a variety of scientific and religious worldviews, and there is a robust, academic dialogue today between science and religion. Ulrich’s grounding in
What he cherishes most, however, is his friendship with Professor Carr, “I have always known him as a dedicated mentor,” said Ulrich. “No matter what, it seemed like he always had time for me. If I had trouble understanding something, he would walk me through the problem until he knew specifically what I didn’t understand and then correct it. He continued to be a supportive mentor after I went into theology. For instance, I practiced my first academic presentations in front of him. His curiosity about my career track and the sense of belonging that I felt as a student in the Chemistry Department fostered what became a close and lasting friendship.” Also, they’ve enjoyed many hours fishing together on Lake Minnetonka and the Mississippi River.

Both areas have helped to shape and hone his interests in different worldviews. Those worldviews have led Ulrich to different parts of the world, and one particularly favorite spot, India, where he studies, in-depth, the interactions between Hinduism, Islam, and Christianity.

One thing Ulrich carries close to him from his time at the University of Minnesota is the feeling of belonging that he had in the Department of Chemistry. “Here I was, a freshman undergraduate, with my own key and my own desk in the chemistry building,” he said.

Kevin Kreevoy

Professor Emeritus Maurice Kreevoy

PROFESSOR EMERITUS MAURICE KREEVOY died, Sunday, March 20, 2016, at the age of 87, from pneumonia and complications from Parkinson’s Disease. He was born in Boston on August 28, 1928.

Kreevoy earned his bachelor’s degree in 1950 from the University of California in Los Angeles, and his doctorate from the Massachusetts Institute of Technology in 1954. He spent his entire career in academia with the Department of Chemistry, joining the faculty in 1956 as an assistant professor, promoted to associate professor in 1959, and to full professor in 1964. He retired in 1994.

He was a distinguished physical organic chemist. Kreevoy’s seminal contributions included fundamental studies on the mechanism of acid-catalyzed acetal hydrolysis, the chemistry of sodium borohydride and sodium cyanoborohydride, the activity of the hydronium ion in organic solvents and in D2O, the use of isotope effects for elucidation of reaction mechanisms, the application of Marcus theory to hydride transfer mechanisms, and the concept of short, strong hydrogen bonds.

His work is featured on the University’s Wall of Discovery, mentioned with collaborator Marvin Bacaner. The inscription reads: “Lab notes from the development of the drug bretylium tosylate in the 1960s, which has been used to save countless heart attack victims. Bretylium, patented in 1978, has become a widely prescribed drug for preventing heart disease and life-threatening arrhythmias. Dr. Bacaner, in collaboration with retired chemistry professor, Dr. Maurice Kreevoy, has developed an oral form of Bretylium, previously only available as an injectable.”

Professor Steven Kass was one of Kreevoy’s colleagues and close friends in the Department of Chemistry. Kass said that Maury was his mentor and guide when he first came to the University, taking him under his wings, and this mentorship blossomed into a close friendship.

“He was a terrific scientist and scholar in the best sense of the word,” said Kass, “but he was also a real gentleman—a gentle man, very kind. Whenever people asked me about Maury, they would comment about what a kind man he was.”

He was preceded in death by his parents, Edward and Jennie Kreevoy, and his wife of many years, Raye S. Kreevoy. He is survived by two children, a daughter Edith Pang (Gary) and a son William Kreevoy, both of Minneapolis, as well as his two grandchildren, Raymond and Helen Pang.

In Memoriam

Alumnus Gary Brudvig honored with Outstanding Achievement Award

for using solar energy to generate fuels that can be stored and used in place of the dwindling supply of fossil fuels. His primary focus is on the water-splitting reaction (artificial photosynthesis), which uses sunlight to convert water into oxygen and hydrogen.

Throughout his life, Brudvig has consistently sought out venues to use his talents to benefit the greater community. His service contributions are extensive, notes University of Minnesota Professor John Lipscomb, one of Brudvig’s long-time friends. At Yale, Brudvig has twice served as chair of its Department of Chemistry. Since 2000, he has been an associate editor of Biochemistry, the leading journal in the field. He has organized numerous conferences and symposia, including a Gordon Conference on the Biophysical Aspects of Photosynthesis. Recently, he was elected to chair the 2018 Gordon Conference on Solar Fuels.

Brudvig’s outreach efforts demonstrate his enthusiasm for fostering science education in high schools. He regularly has taught a two-week seminar course at the New Haven Teachers Institute, and developed new teaching units on topics, including “Chemistry of Photosynthesis,” “Renewable Energy,” “Green Chemistry,” “Energy Sciences,” and “The Chemistry of Everyday Things.”

Among Brudvig’s numerous honors and awards are the Distinguished Alumni Award from Mounds View High School in Minnesota, election as a Fellow of the American Association for the Advancement of Science, and selection as an Alfred P. Sloan Research Fellow, Camille and Henry Dreyfus Teacher-Scholar, and Searle Scholar.

Another of his long-time friends, Professor William Tolman, chair of the UMN Department of Chemistry, said: “Gary is an exceptional scholar who has made highly significant contributions to understanding the molecular details of photosynthesis and the development of new oxygen-evolving catalysts. An esteemed alumni of our department, he has made key impacts in research, mentoring, teaching, and outreach that make us very proud.”
Flames, explosions, music, and screaming gummy bears—they’re all part of the fun and high-energy University of Minnesota College of Science and Engineering outreach program Energy and U, which aims to interest young people in science. The College of Science and Engineering invites you and your family to join us for a special all-ages, public show, Saturday, Jan. 7. Bring your kids and grandchildren!

About Energy and U
Everybody is talking about energy: What is it? Where do I get it? Can I convert it? Where can I put it? What happens when I let it out? Energy and U literally blows the lid off these questions and highlights the many science and technology challenges that energy presents. Learn about energy during this 50-minute interactive show that includes demonstrations, dancing, bright flashes, and flames! You might even be chosen as a volunteer from the audience to help with one of the demonstrations.

About the presenters
Energy and U is a specialized outreach program of the University of Minnesota’s College of Science and Engineering (CSE) and its departments of Chemistry and Chemical Engineering and Materials Science. Working in partnership with the University’s Department of Theatre Arts and Dance, faculty and staff from the College of Science and Engineering present this show to more than 14,000 elementary students each year.

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