IU•CHEMISTRY

Association of Indiana University Chemists Alumni Journal

Vol. 62 • College of Arts and Sciences • Fall 2017

In this issue:

IU •Chemistry

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College of Arts and Sciences

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Cover photo: **John Hayes** (left) and **Dennis Peters**, outside of John's backyard home office in Berkeley, California. On May 24, 2009, Dennis and four of his students (who were attending and presenting papers at the 215th meeting of The Electrochemical Society in San Francisco) visited John and Janice Hayes at their home. Denizens of the 1930 portion of the IU Chemistry Building, before it was remodeled in the late 1980s, just might recognize the sign in the photograph between John and Dennis. For many years, the sign was in the hallway of the "old" chemistry building to indicate the location of the Main Office complex, which combined all the functions now found in the modern and separate Chairman's and Business Offices. During the remodeling, John happened to be walking down the old hallway and noticed that the sign had been detached from the wall and tossed into a trash bin for disposal. John rescued the sign, kept it when he moved his office and research group to the IU Geology Building on 10th Street, held on to the sign when he moved from IU to the Woods Hole Oceanographic Institute (WHOI) in Massachusetts. Finally, John took the sign to Berkeley when he retired from WHOI.

This magazine is published annually for graduates of the IU Department of Chemistry by the Department of Chemistry to encourage alumni interest in and support for IU.

Any questions regarding the content of this publication may be directed to the editor at creck@indiana.edu. The department may be contacted at cemchair@indiana.edu.

Contents

Dear IU Chemistry Colleagues and Alumni,

I am delighted to share some of the achievements and highlights from the Department of Chemistry in 2017.

This past year, we celebrated a number of promotions. Prof. **Kevin Brown** is now an associate professor with tenure, Prof. **Sara Skrabalak** achieved full professor, and Dr. **Laura Brown** earned senior lecturer. In addition, Drs. **Piotr Mroz** and **Yuriy Sereda** were promoted to the rank of assistant scientist, and Dr. **Hongwei Wu** is now an associate scientist.

In January 2017, Prof. **Xingchen Xe** joined our department in the area of materials chemistry. His research program is primarily directed toward the precision synthesis of colloidal nanocrystals and their integration into mesoscale assemblies for energy conversion.

Our faculty continue to garner top awards locally and at the national and international levels. Prof. **Sara Skrabalak** won the FRED Award (Frontiers in Research Excellence and Discovery) from the Research Corporation for Science Advancement to further her studies in nanomaterials synthesis. She was also selected to receive a Fulbright Award to Spain to pursue research in nanomaterial assembly and chemical sensing and a Guggenheim Memorial Foundation Fellowship to investigate phase transformations in nanomaterials. Prof. **David Williams** is the recipient of the ACS Ernest Guenther Award in the Chemistry of Natural Products for his outstanding contributions in the area of total synthesis of natural products. Prof. **Dennis Peters** was elected as a Fellow of the American Chemical Society for his outstanding mentorship and classroom teaching of graduate and undergraduate students and for his excellence in research involving organic electrochemistry. Prof. **Yan Yu** received a Sloan Research Fellowship in Chemistry to continue development of quantitative approaches to understand dynamics and interactions in cellular processes. Prof. **Jeffrey Zaleski** was named an IU Provost Professor, Prof. **Jonathan Schlebach** won the JBC Herb Taylor Young Investigator Award, Prof. **Milos Novotny** received the Memorial Medal of the Pardubice University (Czech Republic), and Prof. **Nicola Pohl** was selected as a Radcliffe Fellow at Harvard University. Drs. **Lane Baker, Yan Yu,** and **Jill Robinson** are our most recent winners of the IU Trustee Teaching Award, which highlights their efforts in the classroom. For the staff, Ms. **Judi Roberts** won the IU Staff Merit Award for Support Staff for her outstanding service and contributions to our department.

Over the past year, our endowed lecture series continued to support visits by a number of prominent scientists. The spring series featured the Raymond Siedle Distinguished Lecturer, Prof. Gerard Parkin from Columbia University; the Frank C. Mathers

Distinguished Lecturer, Catherine J. Murphy from the University of Illinois at Urbana–Champagne; and the Ernest Campaigne Distinguished Lecturer, Prof. Steven V. Ley from the University of Cambridge. The fall series included the V.J. Shiner Distinguished Lecturer, Prof. Amir H. Hoveyda from Boston College, and the Frank T. Gucker Distinguished Lecturer, Prof. Cynthia M. Friend from Harvard University.

Chemistry also hosted a number of outstanding speakers in two symposia this past fall. The 27th Inorganic Alumni Symposium was held on Friday, September 29, and included invited speakers Dr. **David Dye**, scientist at NSWC Crane Division; Prof. **Skye Fortier**, assistant professor at the University of Texas, El Paso; Dr. **Linfeng Gou**, associate scientist at Quaker Chemical Corp.; and Dr. **Roger Kuhlman**, scientist at Dow Chemical Co. The 8th Annual Watanabe Symposium in Chemical Biology was held on Saturday, September 30 and, this year, had the theme of biomolecular machines. Guest speakers included Prof. Angela Gronenborn from the University of Pittsburgh, Prof. Taekjip Ha from Johns Hopkins University and the Howard Hughes Medical Institute, Prof. Jody Puglisi from Stanford University, and Prof. Robert Sauer from the Massachusetts Institute of Technology. Lectures from these distinguished speakers were augmented by excellent presentations from our own Profs. **Stephen Bell** and **Michael VanNieuwenhze**.

Through the National Science Foundation Major Research Instrumentation Program, we were fortunate to receive two awards this year to acquire new instruments for Chemistry. Prof. **Lane Baker** spearheaded a proposal for a nanoimprint lithography instrument, and Dr. **Jonathan Karty** led a successful effort for a high resolution gas chromatograph–mass spectrometry instrument. Our *Research Experience for Undergraduates* (REU) *Program* also sponsored by NSF continued in summer 2017. Ten undergraduates from across the United States participated in this highly competitive 9-week program, focused on nanoscale assembly of molecules and materials. The REU students along with graduate students and postdoctoral fellows from the department presented their research at the 4th Annual Symposium on Materials Research. The Symposium was highlighted by a keynote lecture given by Dr. Nelson M. Felix from the IBM Corporation.

The College of Arts and Sciences at IU has developed a strategic plan to guide and direct research and teaching over the next decade. The College is now working on an implementation plan to set into motion what is outlined in the strategic plan. We hope the combination of the strategic and implementation plans will bring new research and instructional opportunities to Chemistry. In parallel, the department underwent an external review in spring 2017. Prof. **Lane Baker** did an outstanding job of coordinating the external review and devoted an inordinate amount of time preparing the review and response documents. Overall, the review was a positive experience and provided a chance for us to reflect on the state of the department and to receive feedback from the external review committee on what we do well and on areas we need to improve. We have now begun to work on many of the suggestion made during the review.

As many of you know, fluctuations in funding from the university, state, and federal agencies continue to impact our ability to educate the next generation of chemists and keep our department at the forefront of research. The entire department and I are extremely grateful for your continued and generous support. Without the contributions of our alumni, friends, and colleagues, we would certainly struggle to meet our research and educational goals.

This fall, we launched a new website for Chemistry, so please check out the latest news and information about the department at http://www.chem.indiana.edu/.

Please stop by and visit us!

Stephen Jacobson

IU chemist could reduce nuclear waste with chemically-engineered molecules

Indiana University scientists report new, highly accurate method to predict effectiveness of molecules that extract toxic elements from the environment

A discovery by Indiana University researchers could advance the long-term storage of nuclear waste, an increasingly burdensome and costly task for the public and private agencies that protect people from these harmful chemicals.

In a recent study, the scientists report they have developed a new chemical principle with the potential to revolutionize the creation of specially engineered molecules that extract radioactive elements from nuclear waste, significantly reducing the volume of these dangerous materials. The method is also applicable to molecules created to extract chemical pollutants from water and soil.

"*This work represents a major step forward in the effort to engineer specially designed nanostructures by providing a new, highly accurate method to predict how these molecules will behave in solution*," said lead author **Amar Flood**, a professor in the IU Bloomington College of Arts and Sciences' Department of Chemistry.

The breakthrough is reported in a cover article in the journal CHEM [DOI.org/10.1016/j.chempr.2017.08.003].

Flood said the study addresses the fact that it is nearly impossible to predict how efficiently an engineered molecule will perform in the real world. This is because chemists can currently only design molecules to function in isolation, despite the fact that molecules exist in combination – or "in solution" – with other molecules. Salt water, for example, is a solution of salt in water.

He compared the situation to designing a machine in outer space and then placing it at the bottom of the ocean. The waterlogged device will not function the same as the original design.

This is especially serious because creating artificial molecules to serve a specific function requires extremely precise design – like building a lock to fit a key. For example, a special molecule developed by Flood's lab, called a cyanostar, consists of a five-sided star-shaped lattice of carbon and nitrogen atoms with an empty center – the "lock" – whose specific shape causes negatively charged molecules such as phosphates and nitrates – the "key" – to catch in the center and break off from their previous host. If the solution fills up or warps the lock, the key might no longer work.

Structures such as the cyanostar are also known as "*receptor molecules*" because they are specially designed to receive specific molecules. In addition to accomplishing nuclear waste reduction, this technology may be used to remove chloride from

Professor Amar Flood

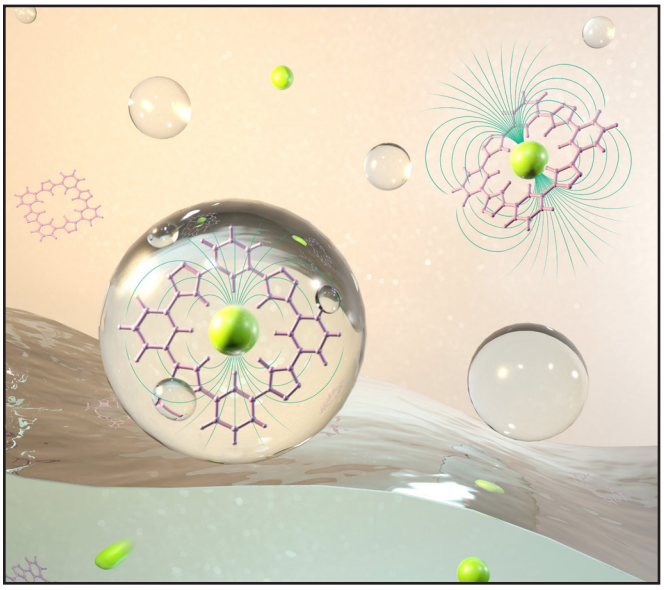
water – a part of the process used to convert seawater into freshwater – to eliminate excess chemical fertilizers from soil, or to gather lithium ions used in renewable power.

With the methods reported in the paper, Flood said, chemists can start to design new molecular reactions with the end goal in mind. Specifically, the new principle finds that the attraction between receptor molecules and negatively charged ion molecules is based on the dielectric constant of the solvent in which they're combined. A dielectric constant is a measurement of a substance's ability to stabilize electrical charge.

To test their method, the IU team applied their newly developed chemical principle to triazolophane – a molecule designed to extract chloride from surrounding molecules – in combination with chemical solvents commonly used in reactions to remove unwanted ions from other liquids. In each case, the principles discovered by Flood's group accurately predicted the molecules' effectiveness.

The primary researcher responsible for the method is **Yun Liu**, a Ph.D. student in Flood's lab.

"*The current paradigm only works for molecular designs on the drawing board, in theory*, " Liu said. "*But we want to make*



A triazolophane molecule with chloride in the center suspended inside a liquid solution. A similar image appears on the cover of the Sept. 14 issue of the journal CHEM.

Graphic by Yun Liu and Danny McMurray, Indiana University

molecules that will work in practice to help solve problems in the real world." The team also noted that the ability to accurately predict how a molecule will function in solution will assist in the development of highly accurate computer simulations to rapidly test chemically engineered molecules designed to achieve specific effects.

Additional authors on the paper were Professor **Krishnan Raghavachari** and Ph.D. student **Arkajyoti Sengupta**, both in the IU Bloomington Department of Chemistry, who were responsible for the study's computational component.

This research was supported by the U.S. Department of Energy.

This story was written by **Kevin Fryling** and is reprinted by permission.

Judi Roberts honored with Staff Merit Award for dedication to university

Judi Roberts has been employed at IU for more than 24 years, and nearly 19 of those have been spent in her current position as the secretary to the chair of the Department of Chemistry. Her nominators unanimously agree that Roberts truly embodies the values of Indiana University.

"*In a department where there is never a shortage of work or the urgency for completing it, Judi maintains a professional civility and personal confidence that lead us to collectively exceed expectations*," wrote **Richard DiMarchi**, Distinguished Professor of Chemistry and the Linda and Jack Gill Chair in Biomolecular Sciences. "*She is exceptionally loyal, trustworthy and most importantly caring for the goodwill of the department and its faculty, staff and students*."

Judi Roberts. *Photo by Eric Rudd, IU Communications*

Roberts' nominators said she is always doing small things to make others feel valued and welcome, like sending candidates handwritten thank-you letters and delivering cards to employees on their birthdays.

"*Judi not only executes her job to the best of her ability but also cares about the people she works with, always treating them with kindness and respect*," wrote **Stephen Jacobson**, a professor and Bair Chair in the Department of Chemistry. "*Her compassion for others is unprecedented, and she is a wonderful advocate for the department*."

Creating a CURE for Chemistry Students

Teaching faculty creates research experience in lab courses

For the past several semesters, **Laura Brown**, Senior Lecturer, in the Department of Chemistry, has informally surveyed students of her upper level Organic Chemistry laboratory course on their participation in research. Through these surveys, Brown found that a sizable portion of students were missing out on gaining valuable research experience.

Sixty percent of students are NOT involved in any form of research. Of those that are participating, half are in a department other than Chemistry. In the chemistry department, we are providing research experience for 20% of our majors.

A traditional research experience would have students working closely with faculty or AI's in their lab. Despite the impracticality of getting Chemistry's 400-some majors into labs, Brown wondered what factors were causing so many students to miss these opportunities. The surveys shed light on two major reasons:

Senior Lecturer Laura Brown

1. First generation students are unaware of the informal process of getting involved, which requires knowing what they want to do and approaching a faculty member about it.

2. Students who work part-time jobs while in school are often unable to take time beyond their class schedule for research experience.

A solution to both issues, Brown thought, would be to provide these experiences as a course where all students would have the opportunity to participate. This is where CURE comes into play. Brown noted that studies on Course-based Undergraduate Research Experience, or CURE for short, report the same types of gains as traditional experience. One of these benefits is retaining students in their particular degree, which is accomplished by increasing their self-identification as a scientist.

Students sign up for a CURE as they would any other course in a list of offerings. In return, they receive course credit and have built-in lab time in their schedules for running experiments. These time restrictions, however, present their own set of difficulties when developing a CURE:

1. Labs typically meet 4-5 hours once per week and few experiments require a week for incubation.

2. Ensuring the research project is not so complex that inexperienced students cannot participate.

These limitations meant that students would be creating a small library of compounds, catalysts, or molecules and setting up reactions to occur until the next lab session. Brown then went to colleague and biologist **Julia van Kessel** whose complimentary skillset would aid in developing a CURE within these confines.

The collaboration yielded a way for students to systematically test for certain proteins. These proteins are telltale signs that may lead to discovering a way to inhibit certain bacteria from communicating with one another, essentially causing them to lay dormant and thereby preventing virulence.

For assessment, Brown used the CURE Survey which was produced by collaborative efforts from professors at Grinnell College, Hope College, Harvey Mudd College, and Wellesley College. Students took this self-reporting survey as both pre-course and post-course surveys.

What did these surveys reveal?

Students reported improvements in skills such as reading the primary literature. However, the percent of students interested in pursuing a graduate degree had more than doubled in between surveys.

That's pretty good evidence that they identify as a scientist more at the end of the class than they did at the beginning.

Last semester, student experiments found a compound which showed a viable response. Now that they have found something that works, future CUREs can direct their modifications to incrementally build off of those findings. In the future, Brown hopes to find a project to accommodate much larger class sizes.

This story was written by **Matthew Barton** and is reprinted by permission.

IU Chemistry graduate students help prepare local teens for STEM career paths

Gabby Norris (sophomore at Bloomington High School North) and Alyssa Gilliland (sophomore at Edgewood High School), participates in a chemistry is one of the courses offered through the Foundations in Science and Mathematics program. *Photo by James Brosher, IU Communications*

For two weeks during the summer, local high school students can come to campus to take science and mathematics courses taught by Indiana University Bloomington graduate students.

When the program started in 2010, its focus was on physics and math. Now in its eighth year, the *Foundations in Science and Mathematics Program* offers 16 science- and math-related courses. Algebra, chemistry and biology are a few of the foundational courses offered, but options such as environmental science, zoology and forensic science were added this year.

"*We continue this program with the goal of helping students prepare for high school*," said **Kate Hummels**, this year's program administrator and a graduate student in the Department of Microbiology. "*We hope the program will help expand their knowledge, encourage interest in STEM fields and spark exploration into specific areas*."

Programs like this are important for children to succeed, said **Sophia Vinci-Booher**, a math instructor in the program and a graduate student in the Department of Psychological and Brain Sciences. The difficult subject matter and the large amount of content being taught in high school are compounded by the fact that science and math concepts build off one another, and some students can get left behind quickly, she said.

The program isn't just a learning opportunity for the high school students, however. The graduate students, who do everything from applying for funding to designing the curriculum to teaching the courses, are expanding their knowledge as well.

"*The Foundations in Science and Mathematics program is a way to gain hands-on experience and to broaden my teaching experience to high school students*," Vinci-Booher said. "*Although the preparation we are receiving through our individual programs at IU Bloomington is superb, I feel that it is important to gain as much hands-on teaching experience as possible. The more hands-on teaching experiences I can have, the better able I will be to serve a university and my future students as a professor*."

With nearly 140 students enrolling each summer, the program caters to a wide range of learning abilities. They see students who need additional help in specific academic areas as well as students who are passionate about a subject and looking for ways to learn more, Hummels said.

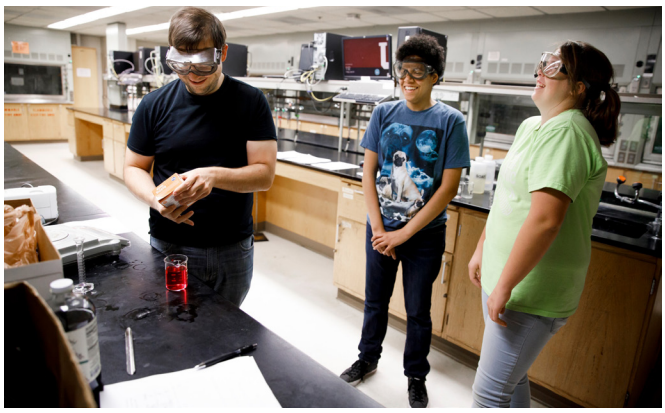
Because of this, the instructors make a point of actively engaging the students rather than lecturing the full two hours, and class sizes are capped at 15 students.

"*Because the class sizes are small, students get lots of one-on-one time with the teachers*," Vinci-Booher said. "*They are encouraged to ask questions and, because there are no formal grades given, they are free to experience learning without the pressure of a grade. This makes for a very different learning experience than is typical and gives them a bit more autonomy over what they are learning*."

For Vinci-Booher, this means helping her trigonometry students see the subject in a way that directly relates to the world rather than as a bunch of formulas out of context.

"*If they leave with a small piece of this knowledge, then I feel that will help instill in them a desire to know more about science and mathematics*," she said.

This story was written by **Bailey Briscoe** and is reprinted by permission.



IU Bloomington chemistry graduate student **Adam Kinne,** left, works with Gabby Norris, center, a sophomore at Bloomington High School North, and Alyssa Gilliland, a sophomore at Edgewood High School, during the chemistry class. *Photo by James Brosher, IU Communications*

Figure 1. Bronstein's group after the Chemistry Honors Banquet Poster Session, April, 2017.

Lyuda Bronstein's group provides undergraduates a meaningful research experience

Research in the Bronstein group is focused on magnetic nanoparticle based materials in two major thrusts: (i) the development of magnetically recoverable catalysts to obtain value-added chemicals and fuels from biomass and biooil, and (ii) development of magnetic bioprobes for magnetic resonance imaging, hyperthermia and drug delivery.

In general, this work is largely collaborative. They have collaborators in the U.S. and all over the world including Greece, Germany, Russia, and the UK. Collaborations allow Senior scientist **Lyuda Bronstein** to branch out and to leave her comfort zone, while allowing students to learn collaborative environments, obligations associated with them, and to perform science to which they would typically not be exposed. At Indiana University, Bronstein has ongoing collaborations with Prof. **Bogdan Dragnea** in the Department of Chemistry and Prof. **Aaron Ermel** at the IU Medical School.

Interestingly, almost all research in the Bronstein group is performed solely by undergraduate students.

Because of the nature of the Senior Scientist position, Bronstein can only co-chair graduate students when another faculty is willing to share a graduate student. For her entire 18 years at Indiana University, this has happened only three times. The last graduate student jointly shared with Prof. Bogdan Dragnea graduated in 2014 (accepting a position at Caltech) and undergraduate students become the main driving force for scientific progress. This means that undergraduates learn to do everything, every step of the way. Bronstein is available to help, both hands-on in the lab and discussing results in group meeting and personal meetings in the office.

But this environment also creates a unique pressure on the undergraduates: they are not merely helpers, they need to "own" their projects more than many students do in the research groups. This makes them strive for research progress, leading to publications, often resulting in a good recommendation letter for an admittance to a professional or graduate school (although this is not a major motivation). Many of them just get a "bug": they strive for progress, they want to succeed because it brings them satisfaction. They want to conquer obstacles and solve problems they encountered. *They learn to enjoy it!*

Methanol synthesis from syngas

One recent project deals with the catalyst development for the methanol synthesis from syngas – one of the important sustainable processes

which connects an environmentally significant sequence between biomass or biooil (sources of syngas), methanol, and value-added chemicals such as hydrocarbons or fuels (obtained from methanol). For methanol synthesis, they've developed a new family of Ni-, Co-, and Cr-doped Zn-containing magnetic oxide nanoparticles stabilized by two thermally stable polymers, one of which is linear polyphenylquinoxaline (PPQ) and the other is hyperbranched, rigid pyridylphenylene polymer (PPP).

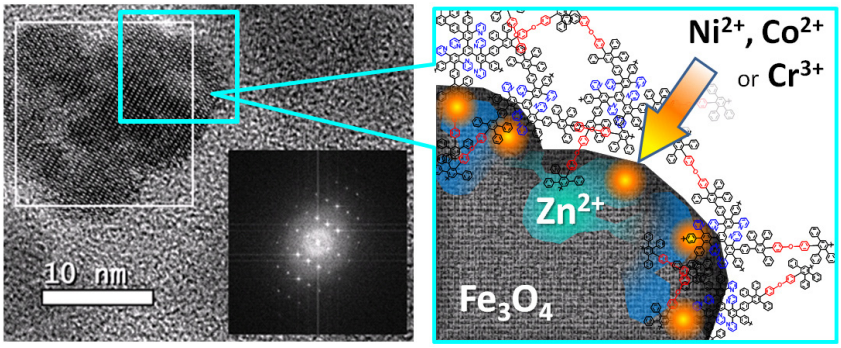


Figure 2. High resolution transmission electron microscopy image (left) and schematic representation (right) of doped Zn-containing magnetic oxide nanoparticles stabilized by PPP.

The Zn-containing magnetic oxide nanoparticles (Figure 2) have been synthesized in a one-pot procedure by thermal decomposition of Zn and doping metal acetylacetonates in the reaction solution of preformed magnetite nanoparticles. Using microscopic capabilities of the departmental nanocharacterization facility, they have demonstrated that all three types of metal species (Fe, Zn, and a doping metal) reside within the same nanoparticles, the surface of which is enriched with Zn and a doping metal, while the deeper layers are enriched with Fe, making it preferable for catalysis.

This mixed oxide structure furnished unique catalytic properties in syngas conversion to methanol. Moreover, it was demonstrated that catalytic activities are dependent on the doping metal content and on the stabilizing polymer. The PPP stabilization allows for better access to the catalytic species due to the open and rigid polymer architecture (Figure 2) and most likely optimized distribution of doping species than in the case of PPQ stabilization. Excellent activity and stability of these catalysts make them promising for practical applications. Two undergraduates, **Nicholas Baird** and **Jasper Dittmar,** appeared as first and second authors for this project in collaboration from two universities in Russia.

Magnetite-zeolite catalysts

Another project deals with the development of magnetite-zeolite catalysts for the methanol-to-hydrocarbon (MTH) reaction to obtain chemicals and fuels from renewable sources. They have developed hierarchical zeolites (ZSM-5) containing both iron oxide and nickel oxide nanoparticles. Modifying the iron oxide (magnetite, Fe_3O_4) amounts, they were able to control the catalyst activity and the product distribution in the MTH process. At medium Fe_3O_4 loading, the major fraction is composed of the C_9-C_{11} hydrocarbons (gasoline fraction). At the higher Fe_3O_4 loading, the C_1-C_4 hydrocarbons prevail in the reaction mixture, while at the lowest magnetite loading the major component is C_5-C_8 hydrocarbons.

Addition of Ni species to Fe_3O_4-ZSM-5 leads to the formation of mixed Ni oxides (NiO/Ni_2O_3) positioned either on top of or next to Fe_3O_4 nanoparticles (Figure 3). This modification allowed them to significantly improve the catalyst stability due to diminishing coke formation and disordering of the resulting coke. The incorporation of Ni oxide species also leads to a higher catalyst activity and an improved selectivity, making these zeolites highly promising for industrial applications. This work was a joint effort between Bronstein's group and collaborators from the Tver State Technical University, Russia, and University of Warwick, UK. Former group member, **Joshua Mann**, is a first author on the published paper.

Since 2014 , her group has published 14 papers and the majority of them had undergraduate students as first authors. There are numerous other projects for undergraduates, but probably the most unique feature of working in the Bronstein lab is how she interacts with these undergraduates when they join her group.

Typically, the first semester is spent in training under supervision of more experienced students in lab. In this semester new students learn procedures pertinent to their future projects. At the same time, Bronstein gives them some relevant literature to read, meeting with them weekly or biweekly (depending on the student availability)

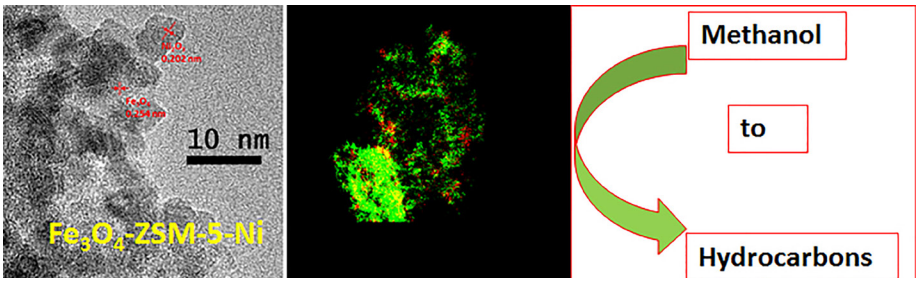


Figure 3. HRTEM image (left) and superposition of energy dispersive spectroscopy Fe (red) and Ni (green) maps (center) of the magnetite-zeolite catalyst modified with Ni species. Right image shows schematic of the catalytic reaction.

to discuss their questions and to enhance their understanding. If students are confused, Bronstein might discuss the same paper 2 – 3 times until they understand it well.

After their training is complete, they begin their own project. Considering that many projects have external collaborators, often students have obligations to provide materials for testing. Hence, there is not time for procrastination. These collaborations help students to be motivated and build team efforts on a number of projects.

Major research progress is done by students during summer research.

Although mentor-mentee teams work well, surprisingly, team work is really difficult skill for students to develop. While these students are friendly, help each other, and socialize well, it is difficult to make them work in teams as equal partners. They often do not talk to each other about their work, and do not discuss their science. Because in the real world team work is an important part of any work place, Bronstein pushes them to learn how they can benefit from a team environment.

Weekly group meetings are crucial. From Prof. **Steve Tait's** group experience, they adopted weekly research updates by each student at the beginning of the group meeting. These do not go into much detail (individual meetings are scheduled with each student for detailed discussions), but it stimulates students to think about what they accomplished for the past week. They are quite eager to talk about these accomplishments. It also gives them better awareness about work of their group colleagues. After research updates, students present either their work or a literature paper which is relevant to their research.

During a semester, each student presents their work at least once and receives questions and comments from the group. Students find these experiences invaluable as they have very few opportunities to make presentations in their core courses. If students have to present their work at conferences or at the departmental poster sessions, they first present their draft posters at group meetings and get suggestions from group members on how to improve their posters. This is also a valuable experience for improving their skills in presenting their data.

A major portion of Brontein's interactions with students is "career counseling".

Last year thanks to the IU Hutton Honors College Travel Grants, two undergraduates, **Joshua Mann** and **Jasper Dittmar**, presented at the fall American Chemical Society (ACS) meeting in Philadelphia. This year two more students, **Paige Price** and **Stanley Bram**, will present posters at the fall ACS meeting in Washington, DC. Students feel that it is an awesome experience.

Students are strongly encouraged to participate at national meetings on two conditions: (i) they need to have some results by the abstract submission time and (ii) they need to do research in summer to make sure that there will be more progress by the meeting time.

Major research progress is done by students during summer research. In this respect, the students and Bronstein owes a great deal of gratitude to the Department of Chemistry and the Hutton Honors College for summer scholarships. Without this funding, their research would be completely impeded as the Bronstein group operates without any external funding. Buying chemicals and paying instrumentation fees is a significant part of their budget and during fall and spring semesters their group enjoys some financial support from the Department of Chemistry for those items.

A major portion of Brontein's interactions with students is "*career counseling*". Often, merely doing research helps them to choose between pursuing graduate studies and becoming a health professional. Furthermore, Bronsein takes time to talk to her students about differences in such careers and about their opportunities if they choose one over the other. Although not all of these undergraduate students will become chemistry professionals, she boasts success if they become better researchers when they graduate than when they joined her group.

Students in the Bronstein group are strongly encouraged when they join the group to stay until graduation and to take the capstone course, *X499: Chemical Research Capstone*, which includes writing a senior thesis and presenting a poster at the at the annual Chemistry Honors Banquet (Figure 1). The poster session allows them to demonstrate to the department and their peers what they accomplished. Writing a senior thesis affords them a first experience of writing a scientific paper. Both experiences teach them how to focus on the problem to be solved, to talk about the work of others, to write up the experimental part and the most challenging, the Results and Discussion session, where the students have to not only describe their observations but also make sense of them.

Due to a well-structured X499 syllabus, students start working on their thesis early and all spring semester. Bronstein's job is to teach them to write up scientific results. Normally, it takes several iterations between students and Bronstein to move from the first draft to the final version. Students work hard on their writing, complying with the group requirement of using EndNote for their thesis referencing, and learning an important skill which should be useful in their future

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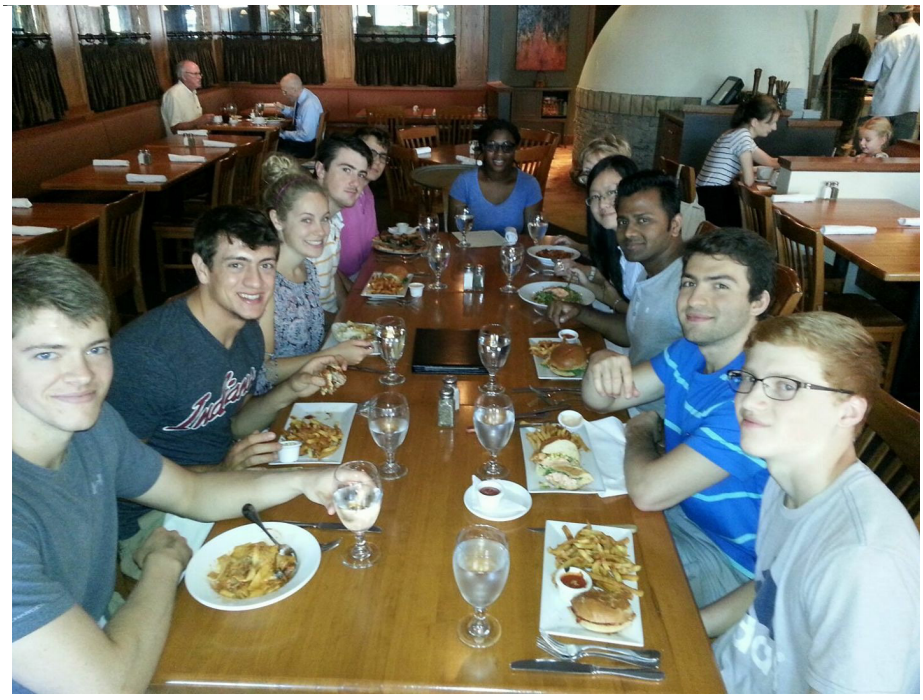
careers. In the end, the students' research experience greatly enhances their education and future career prospects.

Although students' progress can be slow when they are too busy with classes or other student activities, Bronstein finds it extremely satisfying to be their mentor and to see them grow.

Figure 4. Bronstein's group at Materials Symposium Poster Session, July 17, 2017.

Organized by graduate students and faculty each summer, the IU Materials Symposium provides younger students the opportunity to present their research. This year one of the students gave an oral presentation, while seven other students presented posters.

Figure 5. Group lunch at Finch's, July, 2017.



Bronstein comments, "*Besides being businesslike with my students all the time, I am also trying to build in some social events to show my appreciation of their hard work. Normally, these events include a group lunch every semester, often associated with a general lab cleanup, and a group dinner at my place once a year. The students enjoy these events, and I only regret that I cannot invite their significant others because of the size of my group (I normally have 10-12 undergraduate students per semester).*"

IU chemists create molecular 'leaf' that collects and stores solar power without solar panels

This new molecule harvests sunlight to create useable material from carbon dioxide in the atmosphere

An international team of scientists led by **Liang-shi Li** at Indiana University has achieved a new milestone in the quest to recycle carbon dioxide in the Earth's atmosphere into carbon-neutral fuels and others materials.

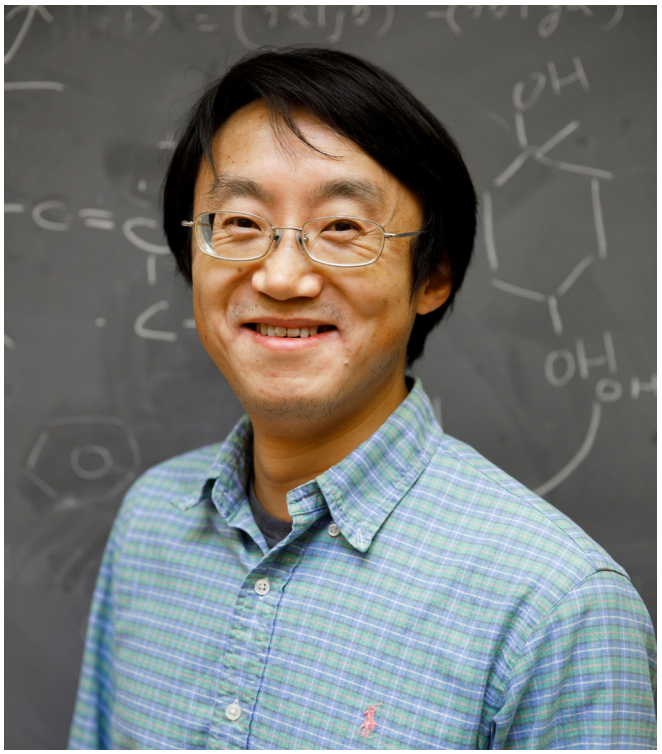
The chemists have engineered a molecule that uses light or electricity to convert the greenhouse gas carbon dioxide into carbon monoxide – a carbon-neutral fuel source – more efficiently than any other method of "carbon reduction."

The process is reported today in the Journal of the American Chemical Society.

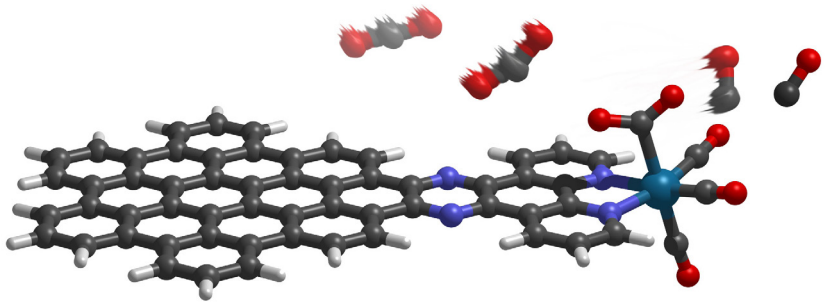
"*If you can create an efficient enough molecule for this reaction, it will produce energy that is free and storable in the form of fuels*," said Li, associate professor in the IU Bloomington College of Arts and Sciences' Department of Chemistry. "*This study is a major leap in that direction*."

Burning fuel – such as carbon monoxide – produces carbon dioxide and releases energy. Turning carbon dioxide back into fuel requires at least the same amount of energy. A major goal among scientists has been decreasing the excess energy needed.

This is exactly what Li's molecule achieves: requiring the least amount of energy reported thus far to drive the formation of carbon monoxide. The molecule – a nanographene-rhenium complex connected via an organic compound known as bipyridine – triggers a highly efficient reaction that converts carbon dioxide to carbon monoxide.



Professor Liang-shi Li

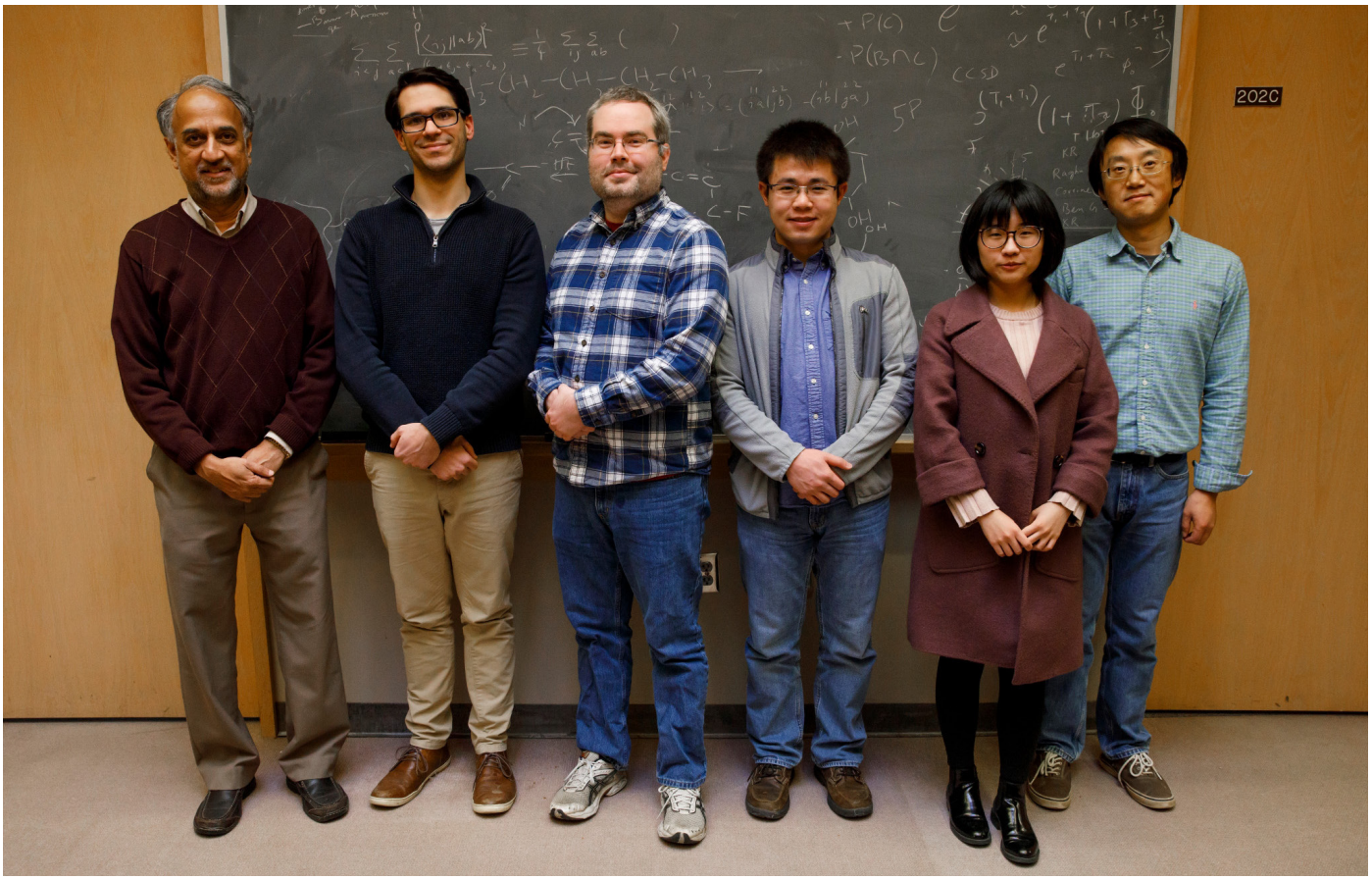


The new molecule employs a nanographene complex (on left) to absorb light and drive the conversion of carbon dioxide (upper center) to carbon monoxide (on right).
Photo by Ben Noffke and Richard Schaugaard

The ability to efficiently and exclusively create carbon monoxide is significant due to the molecule's versatility.

"*Carbon monoxide is an important raw material in a lot of industrial processes*," Li said. "*It's also a way to store energy as a carbon-neutral fuel since you're not putting any more carbon back into the atmosphere than you already removed. You're simply re-releasing the solar power you used to make it*."

The secret to the molecule's efficiency is nanographene – a nanometer-scale piece of graphite, a common form of carbon (i.e. the black "lead" in pencils) – because the material's dark color absorbs a large amount of sunlight.



From left, Krishnan Raghavachari, Benjamin W. Noffke, Richard N. Schaugaard, Yijun Liu, Lu Liu and Liang-shi Li
Photo courtesy of Indiana University

Li said that bipyridine-metal complexes have long been studied to reduce carbon dioxide to carbon monoxide with sunlight. But these molecules can use only a tiny sliver of the light in sunlight, primarily in the ultraviolet range, which is invisible to the naked eye. In contrast, the molecule developed at IU takes advantage of the light-absorbing power of nanographene to create a reaction that uses sunlight in the wavelength up to 600 nanometers – a large portion of the visible light spectrum.

Essentially, Li said, the molecule acts as a two-part system: a nanographene "energy collector" that absorbs energy from sunlight and an atomic rhenium "engine" that produces carbon monoxide. The energy collector drives a flow of electrons to the rhenium atom, which repeatedly binds and converts the normally stable carbon dioxide to carbon monoxide.

The idea to link nanographene to the metal arose from Li's earlier efforts to create a more efficient solar cell with the carbon-based material. "*We asked ourselves: Could we cut out the middle man – solar cells – and use the light-absorbing quality of nanographene alone to drive the reaction?*" he said.

Next, Li plans to make the molecule more powerful, including making it last longer and survive in a non-liquid form, since solid catalysts are easier to use in the real world. He is also working to replace the rhenium atom in the molecule – a rare element – with manganese, a more common and less expensive metal.

All of the research on the study was conducted at IU. The first authors on the paper are **Xiaoxiao Qiao** and **Qiqi Li**, former graduate students at IU. Additional authors are professor **Krishnan Raghavachari** and graduate students **Richard N. Schaugaard**, **Benjamin W. Noffke** and **Yijun Liu**, all of the Department of Chemistry; **Dongping Li**, a visiting professor from Nanchang University; and **Lu Liu**, a visiting undergraduate from the University of Science and Technology of China.

This study was supported by IU Office of the Vice Provost for Research and the National Science Foundation.

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2017 Conferences, Special Lectures and Symposia

December 6, 2016, *ACS Student Selected Speaker*: Eric N. Jacobsen, Sheldon Emery Professor of Chemistry, Department of Chemistry, Harvard University (Cambridge, Massachusetts), "*Anion-Binding Catalysis.*"

February 22, 2017, *Frank C. Mathers Distinguished Lecture*: Catherine Murphy, Professor, Department of Chemistry, University of Illinois at Urbana-Champaign (Champaign-Urbana, Illinois), "*Gold Nanocrystals: Physics, Chemistry, Biology, Ecology.*"

April 11, 2017, *ACS Student Selected Speaker*: Sharon Glotzer, Department of Chemical Engineering, University of Michigan (Ann Arbor, Michigan), "*Self Assembly, Shape and the Entropic Bond.*"

April 19, 2017, *Ernest E. Campaigne Lecture in Organic Chemistry*: Steven V. Ley, CBE FRS, Professor, Department of Chemistry, University of Cambridge (Cambridge, United Kingdom), "*Challenges and Opportunities in Natural Product Synthesis.*"

April 26, 2017, *Raymond Siedle Distinguished Lecture*: Gerard Parkin, Professor, Department of Chemistry, Columbia University (New York, New York), "*Tetradentate and Tridentate Tripodal Ligands in Bioinorganic and Organometallic Chemistry: Carbon Dioxide Functionalization, Mercury Detoxification, and New Classes of Atranes.*"

July 17, 2017, *4th Annual IU Symposium on Materials Research* to be held Monday, Indiana Memorial Union. The symposium included a keynote address by Dr. Nelson Felix of IBM and materials research presentations by IU students and postdocs.

September 27, 2017**,** *Frank T. Gucker Lecture in Physical Chemistry*: Cynthia Friend, T.W. Richards Professor of Chemistry, Professor of Materials Science, Dept. of Chemistry & Chemical Biology and School of Engineering & Applied Sciences, Harvard University (Cambridge, Massachusetts), "*The Role of Chemistry in Meeting Global Challenges: Catalysis Science Perspective.*"

September 27, 2017, *2017 Gill Symposium*

- Dr. Clifford J. Woolf, Boston Children's Hospital and Harvard Medical School, was honored as the 2017 Gill Distinguished Scientist, "*Unraveling pain one millisecond at a time*".
- Diana Bautista, Associate Professor of Cell and Developmental Biology, University of California, Berkeley, was honored as the 2017 Gill Transformative Investigator, "*Neural control of chronic itch and inflammation in atopic disease*".
- Xinzhong Dong, Professor in the Department of Neuroscience at the Johns Hopkins University School of Medicine, "*The Mechanisms of Itch and Inflammation*."
- Wenqin Luo, Assistant Professor in the Department of Neuroscience at the University of Pennsylvania, "*Somatotropic Organization and Functions of Mammalian Non-peptidergic Nociceptors.*"
- Michael Salter, Chief of Research at the Hospital for Sick Children and Professor of Physiology at the University of Toronto, "*Sex, Pain and Microglia*."

September 29, 2017, *27th Annual Inorganic Alumni Mini-Symposium*

- Dr. **David Dye**, Scientist at NSWC Crane Division, "*Pyrotechnic Chemistry and Spectroscopy in the Navy.*"
- Prof. **Skye Fortier**, Assistant Professor at the University of Texas, El Paso, "*Adventures in Actinides and Academics.*"
- Dr. **Linfeng Gou**, Associate Scientist at Quaker Chemical Corp., "*Corrosion Protection: Closing the Gap between Lab and Industrial Applications.*"
- Dr. **Roger Kuhlman**, Scientist at Dow Chemical Co., "*Complex Polyethylene Compositions from Molecular Catalyst.*"

September 30, 2017, *8th Annual Watanabe Symposium in Chemical Biology: Biomolecular Machines*

- **Stephen Bell**, Indiana University
- Taekjip Ha, Johns Hopkins University School of Medicine
- Angela Gronenborn, University of Pittsburgh
- Jody Puglisi, Stanford University Medical School
- Robert Sauer, Massachusetts Institute of Technology (MIT)
- **Michael VanNieuwenhze**, Indiana University

Paul Bosland and IU Professor **Jeremy Smith** tasting chile peppers after the ACS Chemistry of Everyday Life seminar.

October 18, 2017, *ACS Chemistry of Everyday Life***:** Paul Bosland, New Mexico State University (New Mexico), "*Chile Pepper Chemistry: Color, Flavor, and Heat.*"

In Memoriam: John M. Hayes 1940-2017

Father of isotopes in modern and ancient biogeochemical processes, biosynthetic carbon and hydrogen isotope fractionation and compound specific isotope analytical techniques.

Professor Emeritus John Hayes

John Michael Hayes, Professor of chemistry and geology for 26 years at Indiana University (Bloomington) until 1996, then director of the National Ocean Sciences Accelerator Mass Spectrometry facility at Woods Hole Oceanographic Institution and adjunct professor at Harvard University until 2007, died peacefully at his home in Berkeley, California, on February 3rd, 2017.

John was born in Seattle, Washington and grew up in Montana and Iowa. He attended thirteen schools as his family moved along with his father's job for the Chicago, Milwaukee, St. Paul and Pacific Railroad. He graduated from High School in Perry, Iowa and enrolled at Iowa State University, where he graduated with a B.Sc. in Chemistry in 1962. The same year he married Janice Maria (Boeke) Hayes of Hubbard, Iowa, whom he met at Iowa State University. He was awarded a Ph.D. from Massachusetts Institute of Technology in 1966 for thesis work (Hayes, 1966) performed on the organic constituents of meteorites (Hayes, 1967; Hayes et al. 1968) under the supervision of Klaus Biemann.

After spending 3 months in 1966 as a Postdoctoral Research Associate at the Enrico Fermi Institute, University of Chicago, John undertook three month of military training to then spend another 21 months of military duty as Captain in the Medical Service Corps of the U.S. Army, specifically in the Chemical Evolution Branch at NASA Ames Research Center in Moffett Field, California. He subsequently went abroad as a NATO-NSF Postdoctoral Fellow in the Organic Geochemistry Unit at The University of Bristol, UK, where he worked with Geoff Eglinton and others on the carbon chemistry of lunar samples brought back to Earth by Apollo 11 and 15 missions (Hayes et al., 1970; Abell et al., 1970 a,b).

In 1970 John was one of the attendees of the first Gordon Research Conference on Organic Geochemistry in New Hampshire, which he regularly attended throughout his career. In 2010, celebrating the 40th anniversary of this conference, he and six other first attendees shared their views and scientific career experiences with the audience and specifically the Gordon Research Seminar young graduate attendees in a truly inspirational session.

Also in 1970 he was appointed Assistant Professor at the Department of Geological Sciences, Indiana University, Bloomington, becoming Associate Professor in 1974 and Full Professor in 1977. As of 1984, he held Professorships in the Department of Geological Sciences and in the Department of Chemistry. In 1990 he became Distinguished Professor of Biogeochemistry. While at Indiana University he also was Visiting Research Geochemist at the University of California, Los Angeles in 1979 and 1980 and Visiting Scientist at the Bureau of Mineral Resources, Geology and Geophysics, Canberra, Australia in 1988.

During the 1970s at IU John continued studying the fate of carbon in lunar samples (DesMarais et al., 1973), advanced studies of carbon isotope fractionation in biogeochemical processes, including bacterially produced acetic acid (Meinschein et al., 1974, Rinaldi et al., 1974 a,b), carbon isotope analysis of aquatic samples, and high resolution mass spectrometric techniques (DesMarais and Hayes, 1976; Hayes and Schoeller, 1977; Hayes et al., 1978; Matthews et al., 1978) and working with NASA (Novotny et al., 1975). During this period of remarkable productivity, his first co-authored book (Peters et al.,1974) was soon followed by a second (Peters et al., 1976). During this time, he also made the first measurements of the distribution of the isotopes of carbon within biolipids (Meinschein et al., (1974a), thereby providing a foundation for new studies on the pathways of carbon in natural environments, both modern and ancient.

In the late 1970s and early 1980s, Hayes continued to push forward the use of stable isotopes as a tracer of biochemistry, working on the carbon isotopic composition of synthesized carboxylic acids, biosynthesized fatty acid fractions and decarboxylation pathways and their isotopic fractionation (Games et al., 1978; Vogler et al., 1979). With David Monson, he produced the first evidence of isotopic ordering in fatty acids, a pattern now widely recognized as characteristic of terrestrial life, and simultaneously proved that distribution of carbon isotopes in organic matter was not an equilibrium phenomenon (Monson and Hayes, 1980, 1982). Continuing his longstanding interests in early Earth biogeochemistry, he was also an active member of the Paleoproterozoic Research Group (PPRG) organized by Bill Schopf at UCLA. This group produced groundbreaking research into the Earth's Earliest Biosphere (Schopf, 1983) and laid the groundwork for future isotopic studies of ancient life. During this same time, he was also beginning to explore what would become one of the seminal contributions of his career: the development of methods for

measuring the isotopic compositions of individual organic molecules, a technique he initially called isotope-ratio-monitoring GC/MS (Matthews and Hayes, 1978) and is now more widely known as compound-specific isotope analysis (CSIA). As part of this work he forged a strong collaboration with Finnigan MAT (now part of ThermoFisher Scientific) to develop the first generations of mass spectrometers for the new compound-specific analyses (Hayes at al., 1978). That collaboration on isotope instrumentation was to continue for the rest of his career.

Throughout the 1980s, Hayes – together with his skilled technician Steve Studley, programmer Margaret Ricci (on loan from Finnigan), and numerous graduate students and postdocs, particularly Dawn Merritt and Kate Freeman – continued to refine and perfect methods for compound-specific carbon isotope analyses. These analytical developments would not be recognized in print for almost a decade (Hayes et al., 1989; Merrit and Hayes, 1994; Merrit et al., 1995; Ricci et al., 1994), but in the meantime their application lead to a series of groundbreaking papers (Hayes, 1984, 1991; Knoll et al., 1986; Hayes et al., 1987; Freeman et al., 1990; Jasper and Hayes, 1990; DesMarais et al., 1992; Kohnen et al., 1992; Freeman and Hayes, 1992; Zaback et al., 1993) on subjects ranging from the biogeochemistry and oxygenation of the Archaean earth, to isotopic records of PCO2 in the Cenozoic, to isotopic characteristics of phytoplankton lipids and pigments, and others.

By the early 1990s John's compound-specific analyses had expanded to include nitrogen isotopes (Merritt and Hayes, 1994), and by the late 90s to include hydrogen isotopes (Burgoyne and Hayes, 1998; Sessions et al., 1999). His research interests in Precambrian biogeochemistry continued, including the role of active methane cycling in early climate (Hayes et al., 1992), and previously unnoticed shifts in the isotopic ordering of n-alkyl and isoprenoid carbon skeletons during the precambrian (Logan et al., 1995). They also expanded to include the origins and history of hydrocarbon biomarkers, with relevance both to the history of life and to the energy industry (Sinninghe Damsté et al., 1993; Jasper and Hayes, 1993; Hayes, 1993; Hartgers et al., 1994; Hayes 1996). With Kai Hinrichs, he helped to discover the long-sought organisms responsible for anaerobic oxidation of methane (Hinrichs et al., 1999).

In 1996 he moved to the Woods Hole Oceanographic Institution (WHOI) for the purpose of – as he put it in his typically modest way– "advancing and disseminating some experience to the next generation." There he undertook a new position as Director of the National Ocean Sciences Accelerator Mass Spectrometry facility, and national facility dedicated to radiocarbon dating for all of science, but for oceanographic research in particular. He also maintained a separate lab where research continued on hydrogen isotopes in lipids (Sessions et al., 2002; 2004) and plant leaf waxes (Sauer et al., 2001), and on anaerobic methanotrophy (Hinrichs et al., 2000; Orphan et al., 2001). With his new colleague Tim Eglinton and graduate student Ann Pearson, they began to employ compound-specific radiocarbon as an isotopic tool for distinguishing the origins of organic molecules (Pearson et al., 2001; 2004). Using similar techniques, John, Tim, and postdocs Nao Okhouchi and Gesine Mollenhauer first showed us that organic biomarkers like alkenones can be thousands of years older than the sediments in which they are buried (Okhouchi et al., 2002; Mollenhauer et al, 2005), a finding whose implications continue to ripple today.

At NOSAMs, Hayes continued his longstanding interest in analytical development. Working with physicists Bob Schneider, Karl von Raden, and Mark Robers, they built the first routine continuous-flow ion source for accelerator mass spectrometry (Schneider et al, 2004; Roberts et al, 2007). They also constructed the first continuous-flow sample introduction system for AMS using pyrolysis of organic matter. Now known as 'ramped pyrolysis' (Rosenheim et al., 2008), it was affectionately known as the 'dirt burner' in the lab, a term coined by John's longstanding technician Sean Sylva. Recognizing the shift in analytical organic chemistry away from GC and hydrocarbons and towards LC and biolipids, John also worked again with Finnigan to help develop the prototype moving-wire combustion system for measuring 13C in nonvolatile molecules, including DNA (Pearson et al., 2004; Sessions et al., 2004).

During his time at WHOI, John was appointed as an adjunct faculty at Harvard, where he taught his biogeochemistry class and continued to collaborate with colleagues at Harvard and MIT. Notable among the output from this time was the hypothesis that the huge Neoproterozoic 13C excursions that had puzzled biogeochemists for so long were in fact the signature of a disappearing dissolved organic carbon pool (Rothman et al, 2003).

After his retirement in 2006, John and Janice moved to Berkeley, California, which was conveniently near the geographic center of their children and grandchildren. In total John published more than 200 research papers, two textbooks and four book chapters. He is widely credited with inventing compound-specific isotope analyses, which utterly transformed the use of stable isotopes as tracers in organic molecules. He performed field work around the globe, including on the R/V Atlantis and in the submersible Alvin, and in Western Australia, South Africa, and the Canadian Arctic. He was a member of the American Geophysical Union, the American Society for Mass Spectrometry, and the European Association of Organic Geochemists. He was elected to the US National Academy of Sciences in 1998 and The Royal Society in 2016. He was a recipient of the Treibs, Goldschmidt, and Urey medals, collectively the three highest honors in his field. He received an exceptional number of honors and awards, a fact that both honored and humbled him, served as editor, associate editor and editorial board member and served the geochemical discipline in multiple honorary roles:

2016	The Royal Society, elected Foreign Member
2003	Geochemistry Division Medal, American Chemical Society
2002	Goldschmidt Medal, The Geochemical Society
2001	Fellow, American Geophysical Union
1998	National Academy of Sciences, elected Member
1998	American Academy of Arts and Science, elected Fellow
1998	Treibs Medal, The Geochemical Society
1997	Urey Medal (with G. Eglinton), European Association for Geochemistry
1996	Geochemical Fellow, Geochemical Society and European Association for Geochemistry
1996-1998	Associated Director, Canadian Institute for Advanced Research

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1995 H. Burr Steinbach Scholar, WHOI

1995 Krumbein Lecturer, University of Chicago, Northwestern University, Field Museum

1994 Ingerson Lecturer, The Geochemical Society

1987-1989 Chair, Organic Geochem. Division, Geochemical Society

1987-1988 Fellow, John Simon Guggenheim Memorial Foundation

1986-1988 Chairman, Gordon Conference on Organic Geochemistry

1986 Fellow, American Association for the Advancement of Science

1984-1986 Chairman, Publications Committee, The Geochemical Society

1983-1989 Member, Publications Committee, The Geochemical Society

1981-1983 Chairman, Gordon Conference on Chemistry and Physics of Isotopes

1977-1998 Member, Editorial Board, Precambrian Research

1975-1983 Member, Editorial Board, Biomedical Mass Spectrometry

1971-1975 Associate Editor, Geochimica et Cosmochimica Acta

1964-1966 NSF Cooperative Graduate Fellow, MIT.

1962 Eastman Prize for outstanding graduate student in chemistry, MIT.

In his personal life John was a determined and skilled photographer (a hobby that began with his use of photographic plates as MS detectors during his PhD thesis), an accomplished flutist and lover of classical music. He never minded lending his car to his postgraduate students, as long as they were fine with him having a selection of classical CDs in the player and in the glovebox compartment. Remembered will be in-depth discussions we had about Brahms' Requiem performed by Kurt Masur and the New York Philharmonics vs. the recording of Karajan with the Berlin Philharmonics. Unforgettable remain the evenings at his houses in Bloomington and Woods Hole, enjoying spectacular home-cooked meals, fine wine, and listening to classical music.

After retirement, John continued to regularly attend conferences in the geochemical domain and the Royal Society elected him Foreign Member. He was the John we all got to know and appreciate so much, the same modest, sometimes withholding and gentle person. Those of us, who had the privilege to work with him and enjoy his leadership, will always remember him and he has become part of our own thought processes and nature. We all sadly heard in 2013 about his wife, Janice, passing away, and who we also always remember as John's inspiration - a gentle, welcoming and truly warm partner of his. When John joined her, dying of idiopathic pulmonary fibrosis, or as his daughter Anne Hayes Hartman called it, "rejoined the carbon cycle", his children, James T. Hayes of Honolulu, Hawaii, Anne Hayes Hartman of Oakland, California, and Rachel M. Hayes of Nashville, Tennessee, and his grandchildren were with him.

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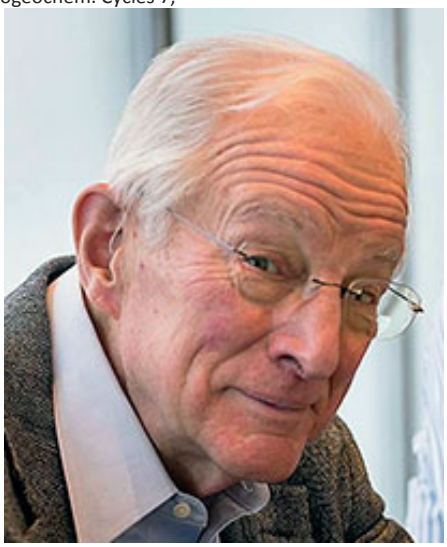

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2017 Faculty News

Flood Laboratory

Nobel Prizes and new chemistry of star-shaped macrocycles, called cyanostars, have marked a productive and rewarding year in the **Flood Group**. The 2016 Nobel Prize went to Professor Flood's former advisor and the research group's academic grandfather, Sir Fraser Stoddart, for "*the design and synthesis of molecular machines*". Professor Amar Flood was one of 15 people invited to participate in the Nobel week in Stockholm, Sweden in December 2016. Highlights include the paparazzi that hounded the Laureates, people stopping them on the street for autographs, and the Laureates getting a standing ovation at the end of their Nobel lectures. Keeping with the theme of the Nobel Prize, molecular switches and machines were made in the Flood Group in new works by **Chris Benson** and by **Bo Qiao**. The first made use of redox chemistry to switch a small organic radical in and out of the centers of the cyanostar macrocycles. The second made use of acid-base to drive movements of the macrocycles along an axle in rotaxanes – a class of mechanically active molecules whose name is derived from the Latin for wheel (rota) and axle (axis). These studies lay an exciting foundation for making molecular machines capable of moving down molecular tracks in the future.

Amar Flood, left, with his wife, Michiko Owaki, and Fraser Stoddart
Photo courtesy of Nobel Foundation.

Peters Laboratory

At the 231st meeting of The Electrochemical Society (ECS), held in New Orleans from May 28 – June 1, 2017, a two-day symposium was held by the Organic and Biological Electrochemistry (O&BE) Division of ECS to honor and celebrate the 80th birthdays of Professors Albert Fry (Wesleyan University, Connecticut), Jean Lessard (University of Sherbrooke, Canada), and **Dennis Peters** (Indiana University, Bloomington), all three long-time members, contributors, good friends, and former officers of the O&BE Division. At a reception on Tuesday evening of the week, each celebrant received a special plaque, bearing the inscription "*The Organic and Biological Electrochemistry (OBE) Division of ECS presents: The Career Excellence Award to Dr. Dennis G. Peters, in recognition of his significant achievements in the field and contributions to advancing the mission of the OBE Division and ECS, May 30, 2017.*"

At the same ECS meeting, Dennis also received another plaque to recognize his recently ended five-year term as an associate editor for the Journal of The Electrochemical

At the meeting of The Electrochemical Society (May 28–June 1, 2017 in New Orleans), **Dennis Peters** (left) receives a plaque from Dr. Mekki Bayachou (right), Chair of the Organic and Biological Electrochemistry Division, to commemorate Dennis' 80th birthday and his many years of service to that division and to The Electrochemical Society as a whole.

At the meeting of The Electrochemical Society (May 28–June 1, 2017), **Dennis Peters** (third from left) in the company of (left to right) **Michael A. Pence** (Indiana University sophomore chemistry major in the Peters group), **Benjamin H. R. Gerroll** (second-year graduate student in the Peters group), and **Gregory A. Bishop** (former undergraduate member of the Peters group and now Assistant Professor of Chemistry at East Tennessee State University). Photos courtesy of The Electrochemical Society.

Society. Accompanying Dennis to the meeting were two of his present students, shown in the second photograph on page 19. At the left of that picture is **Michael A. Pence**, who just completed his sophomore year at Indiana University; Michael gave an oral paper entitled "Electrochemical Reduction of Bromobenzenes at Silver Cathodes", a collaboration with Adjunct Professor **Mohammad Mubarak** (in Bloomington from May to December, 2017), **Brett Walker** (who just received his B.S. degree in chemistry from Indiana University), and Dennis. **Benjamin H. R. Gerroll** (second from the left, and a second-year graduate student) presented an oral paper on "Electrodeposited Cadmium Oxide Semiconductor Electrodes for Protein Redox Characterization", in collaboration with Dennis. On the far right of the second photograph is **Dr. Gregory A. Bishop**, who received a B.S. degree in chemistry from Indiana University under Dennis, earned a Ph.D. degree from the University of Florida, did postdoctoral work at the University of Connecticut, and who is now Assistant Professor of Chemistry at East Tennesee State University.

Skrabalak Laboratory

2016-17 saw the promotion of Professor **Sara Skrabalak** to the rank of full professor. She also began as an Associate Editor for *Nanoscale*, a journal of the Royal Society of Chemistry that publishes research across nanoscience and nanotechnology. Her group continues to develop new ways of making nanoscale materials with structural precision. This work produced a manuscript in *Nanoscale* (DOI: 10.1039/C6NR04085C) which reports the highest refractive index sensitivity for gold-based nanomaterials which scatter and absorb light in the visible region. This enhancement was achieved by incorporating palladium into gold nanomaterials with the appropriate shape, and these structures could bring improvements to colorimetric sensing applications.

In fact, graduate student **Josh Smith** is collaborating with former graduate student, and current scientist at the Naval Surface Warfare Center Crane Division, **Alison Smith** to use these nanomaterials in anti-tamper and anti-counterfeit applications for secured electronics. The idea of using nanomaterials in these applications was highlighted in a 2017 manuscript from the Skrabalak group in *Journal of Materials Chemistry C* (DOI: 10.1039/C7TC00080D). Finally, if you want to learn a bit about Professor Skrabalak's journey to becoming a scientist, check out her interview for "*People behind the Science*" at http://www.peoplebehindthescience.com/dr-sara-skrabalak/.

Yu Laboratory

The **Yu Group** has had a very exciting and productive year in 2016-2017. Professor Yan Yu was named a Sloan Fellow in Chemistry (among a total of twenty three nation-wide) by the Alfred P. Sloan Foundation. The Sloan fellowship recognizes the "*most promising scientific researchers working today*" in the U.S. and Canada. She also received the Trustee Teaching Award from Indiana University to recognize her dedication and innovation in undergraduate education. Graduate students in the Yu group have received multiple awards and fellowships to recognize their diligent work. Those include a travel award from the Biophysical Society and a President Diversity Dissertation Fellowship from Indiana University to **Lucy Sanchez**, an E. Campaigne C500 Introduction to Research Award from the Chemistry Department to **Yanqi Yu**, and a travel award from the College of Arts and Sciences to **Yuan Gao**.

The Yu group received a research grant from the *National Institute of Allergy and Infectious Diseases*, part of the National Institutes of Health, to spearhead a new research project designed to understand the physical mechanisms of microbial infections. Former undergraduate student, **Mariah Chambers**, who had done research in the Yu group for three years and graduated in 2016 has published her first-author paper in Soft Matter, a top journal published by the Royal Society of Chemistry. Graduate students, Lucy Sanchez and **Kwahun Lee**, have also each published a first-author paper in top chemistry journals. Graduate students, Yuan Gao and Lucy Sanchez, and Professor Yan Yu gave multiple research presentations at the annual Biophysical Society Meeting in February 2017 and the National American Chemical Society Meeting in April 2017.

Provost Professor Jeffrey Zaleski

Jeff Zaleski is a professor of chemistry with extremely broad expertise in the field, including bioinorganic chemistry, synthetic chemistry, material chemistry and metals in medicine. His research has applications toward topics as diverse as human disease – including Alzheimer's disease, cancer and atherosclerosis – and harvesting energy from sunlight.

His ability to translate research into discovery has garnered him U.S. patents, a role as a consulting scientist with the DuPont Corp. and past service as a member the board of directors of the IU Research and Technology Corp. His skill as an educator has also made him a two-time recipient of both the IU Teaching Excellence Recognition Award and Trustees Teaching Award. He is also a two-time Department of Chemistry commencement speaker chosen by the graduating seniors.

In Memoriam: Malcolm Chisholm 1945-2015

Father of isotopes in modern and ancient biogeochemical processes, biosynthetic carbon and hydrogen isotope fractionation and compound specific isotope analytical techniques.

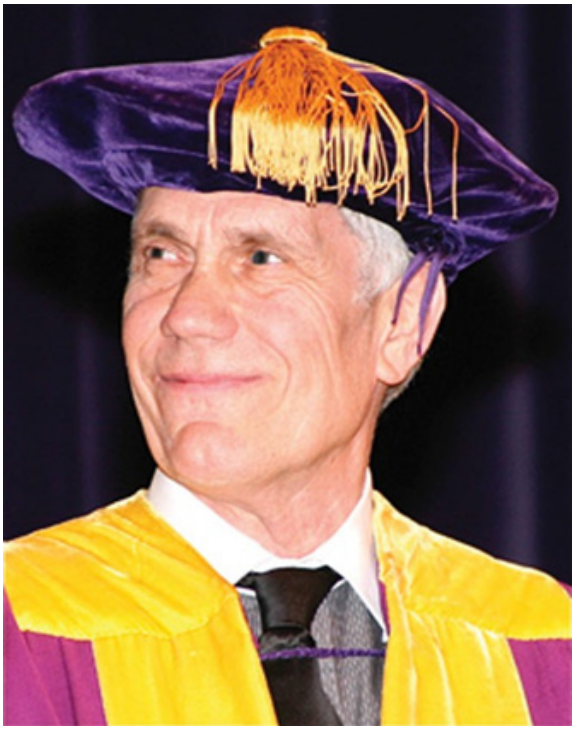
We observe the passing of someone who had a tremendous impact on the chemistry department at Indiana. **Malcolm Harold Chisholm** passed away in late 2015 after a long bout with colon cancer. The story of his life and the lives he touched is worth recounting.

Malcolm was born in 1945 in Bombay (now Mumbai), India, to Scottish parents, at the end of the Second World War. After the war, the family moved back to their ancestral home in Inverness, Scotland, when Malcolm was six months old and then to Dorset, in the south of England, when Malcolm was aged three. It was there that he spent his formative years, though a slight Scottish burr could always be detected in his English accent and he always cherished his Scottish heritage. He was a lifelong vegetarian. He remembers being captivated by science even at the young age of four and, in the late 1950s, Malcolm was given a chemistry set, which evolved into homemade rockets, until a particular incident drew the local fire brigade.

Malcolm was admitted to Queen Mary College (QMC), London, in 1963. He settled on chemistry as his degree, but threw himself into the social life of the university and spent much of his undergraduate years booking and promoting rock concerts by rising stars from the 1960s London music scene. Remarkably, his undergraduate research earned him his first publication, a brief communication in Nature. It was then that he discovered his love of curiosity-driven research and that he had a natural talent for synthetic chemistry, enabled by his association with Prof. Don Bradley who had discovered that volatile molecular alkoxides of several transition metals could be obtained if bulky alkyl groups were used, to prevent oligomerization through the formation of alkoxide bridging groups. However, these molecules were very easily hydrolyzed or oxidized, and, in the absence of needed dry boxes, the students used vacuum lines and did most of their own glass blowing. Characterization of new compounds was challenging. X-ray crystallography was very slow then and, because most of the compounds were paramagnetic, the developing technique of nuclear magnetic resonance (NMR) spectroscopy was not usually helpful. Malcolm was fascinated by the structures, colors and magnetic properties and he taught himself ligand field theory to account for the unusual physical properties. Among his many initiatives was to introduce research group meetings at the local pub. Bradley noted that the level of excitement, both inside and outside the lab, decreased markedly after Malcolm graduated in 1969. Malcolm moved to the University of Western Ontario, 1969–1972, for postdoctoral studies with Howard Clark focusing on the cationic carbonyl complex, $[PtCl(CO)(PR_3)_2]^+$, for which NMR spectroscopy was the routine characterization tool. Shortly after Malcolm started at UWO, a young graduate student, Leo Manzer, joined the group. Leo went on to a distinguished career in industry at DuPont, later leading their efforts to develop environmentally benign aerosols and refrigerant gases. Leo Manzer relates of a simpler time: "*On one particular occasion Malcolm wanted to go and see the Ford museum near Detroit. I was designated to drive so Malcolm, Trevor Appleton, Hideo Kurosawa, Kenji Ito and I hopped in the car and headed for the tunnel from Ontario to Detroit. Back then we did not need passports so the border agent just asked where we were all born. The answers were from Malcolm (India), Trevor (Australia), Hideo (Japan), Kenji (Japan) and me (Canada). The agent laughed and said this was the most internationally diverse group he had ever seen. He looked at me and said 'Keep an eye on these characters and have fun'.*"

The most important concept to emerge from Malcolm's time at UWO was that cationic complexes of platinum with alkenes and alkynes could be considered as metal-stabilized carbocations and that their high reactivity could be interpreted in these terms. Malcolm and Howard Clark published 19 papers together, and Malcolm valued his time at UWO and especially the mentorship and support of Howard Clark.

Dick Puddephatt was a postdoc with Malcolm at UWO and comments on Malcolm's "*amazing energy, friendliness and joie de vivre. That energy allowed him to work hard at his*



Malcolm Chisholm in faculty regalia

chemistry, to support his family and students, and also to enjoy himself and to maintain a wide circle of friends. A few years later, we now had a young son and Malcolm was again visiting England. One day, he drove up to Liverpool, bubbled into our home with a toy train in hand, and quickly made a new, very young friend as they happily played on the floor together. Stuffy he definitely was not!"

When Malcolm was seeking his first faculty position in 1972, there were few openings in either Canada or the UK, so he sought opportunities in the US. Having arranged a second postdoctoral position with F. Albert Cotton, at MIT, Malcolm was offered a faculty position at Princeton University. Cotton generously advised him to take the Princeton appointment, thus beginning a close friendship. Malcolm was initially interested in both organoplatinum chemistry and metal amide and alkoxide chemistry, but the granting agencies made the decision for him and he soon focused his efforts on alkoxides and amides of molybdenum and tungsten in their lower oxidation states. Because Princeton lacked an X-ray structure determination facility and because his new compounds contained metal–metal bonds, a long and fruitful collaboration began in which Malcolm pursued the synthesis and reactivity of metal–metal bonded dialkylamides and alkoxides of molybdenum and tungsten, and Al Cotton supplied the single crystal structure determinations; they combined expertise in interpreting the bonding properties. Subsequent student exchanges included Carlos Murillo who moved from the Cotton group to become Malcolm's first postdoctoral fellow. The Chisholm–Cotton collaboration led to over 40 papers. Although Malcolm moved to the Indiana University in 1978, he acknowledged his gratitude to Princeton by endowing a scholarship there, the *Malcolm H. Chisholm Thesis Award*, for outstanding undergraduate senior achievement in inorganic chemistry.

Malcolm and (retired) chemistry administrative assistant, **Anne Martin**, at an inorganic alumni picnic

Malcolm was attracted to a faculty position at Indiana from his then faculty position at Princeton University. Strengths that he saw at Indiana included exceptional infrastructure and talented specialists in mass spectrometry, crystallography and computational chemistry, and he was influential, subsequent to his arrival, in faculty hiring in a number of areas. Indeed it was Malcolm's vision for chemistry in its broadest forms that is the origin of his impact here. Malcom's personality was exceptionally outgoing and welcoming, he was an exceptional host in his home just south of campus, and he was always open for developing a new collaboration involving his broad palette of newly synthesized molecules. Malcolm was central to bringing many outstanding lecturers to our campus, including Patten Lecturer John Thomas. Malcolm developed overtures to IU physics faculty at a time when chemical vapor deposition, forming surface layers valued either for their electronic properties or for their strength, was a developing theme.

Following his move in 1978 to IU, new inorganic hires at Indiana included **George Christou** and **Jeff Zaleski**. Malcolm was full of innovative ideas and generally created a stimulating and collaborative environment for research in inorganic chemistry. He was responsible for initiating an annual fall meeting of inorganic research presentations by students from Indiana, Notre Dame and Purdue, the PINDU conference, which continues to rotate among the three locations.

Malcolm was very active in promoting the careers of both colleagues and students, and a number of his research group members went on to independent research positions, in industry, in national labs and in academia. Malcolm was exceptionally proud that his IU PhD student **David Clark** was the first winner of the ACS Nobel Laureate Signature Award, and Clark subsequently won the ACS award in Nuclear Chemistry in 2017, for his long career and leadership at Los Alamos National lab, which place became home for a number of talented IU PhD graduates.

Malcolm was a great host to all friends and quickly converted new acquaintances into friends. In May 1982, Malcolm and Cynthia (Cyndy) Truax were married. Their Christmas parties at their home featured *Malcolm's Artillery Punch*, a highly alcoholic concoction, and visits to his home were also times to sniff his beloved cigars. He introduced darts into his research group meetings. He was an avid gardener, and he also loved the entire festival nature of another event for four legged creatures: the Kentucky Derby. It was here too that Bloomington learned of his love of Jaguar cars.

Malcolm spent a considerable time every summer at his second home in Cambridge, England, sharing views there with Jack Lewis, whose fame evolved around osmium carbonyl clusters. Malcolm was delighted by his election as FRS in 1990, at the age of 44, and by the later award of the Davy Medal by the Royal Society. Malcolm created many dimetal M_2 compounds, and he was always ready for a joke, in this case titling some research lectures "*Anything One Can Do, Two Can Do Better…and it's More Fun*." It was therefore a special fascination when he and his wife Cyndy became

continued on page 23

parents of ….twins. Malcolm also often acknowledged funding of his work by the National Science Foundation (NSF), but joked that the initials stood for Not Sufficient Funds.

Jeff Zaleski remembers many mid-day walks to play squash together on campus and the career-crafting conversations that occurred then. Malcolm offered tidbidts to help increase productivity, and, when Jeff began to worry that this was eating too much of his work day, Malcolm countered: "*this is a time when we can talk about collaborations, make plans for the future of Inorganic Chemistry within the department, and make sure you are on track for tenure, all while getting exercise to stay healthy*." Jeff realizes how important those discussions were to him personally, to his research program, and to setting the culture that the division worked together for the betterment of the whole. That set the political perspective for the next generation of Inorganic Chemistry at IU. Jeff says: "*As years go by, I realize more and more how much I valued those squash walks and how critical Malcolm was to setting that tone in the department*."

"Mister Butters" riding in Malcolm's Jag roadster

Dave Clark refers to Malcolm's challenging, encouraging and supporting his students and considers Malcolm as his surrogate father. Dave writes of receiving, in his Los Alamos office, a phone call from Malcolm who asked, " 'What can I do for you?' as illustrative of Malcom's "*generosity and graciousness as a role model and as a person. He cared deeply and genuinely for everyone around him*."

In spite of his success Malcolm was realistic and not loathe to accept responsibility for …disappointing referee opinions! He once told me that a communication manuscript of his which was panned by referees simply meant that he did not write the results sufficiently forcefully.

While at IU Malcolm became interested in the use of metal alkoxides for ring opening polymerization of cyclic esters to biodegradable polyesters, using the "simpler" (now called "earth-abundant") metals magnesium, calcium, or zinc. One molecule synthesized in his Princeton times, $W_2(O_2CNMe_2)_4$, contains a metal–metal quadruple bond, and the communication between these two metals, as well as between nearby W_2 units, by electron and energy transfer became a fascination for Malcolm. He saw this and related compounds as potential electronic and optical materials, and it was with a desire to interact locally with more materials chemists and physical chemists that caused Malcolm to move to Ohio State University in 2000. There he served as department chair from 2007 to 2011 and as associate director of Ohio State's Institute for Materials Research. Malcolm's second major theme at OSU was in the general area of green chemistry, in particular in the synthesis of oxygen-containing, biodegradable polymers from sustainable sources. His main emphasis was on the polymerization of corn-derived dilactide, to make polyesters, but he also worked on polymerization of epoxides to polyethers and copolymerization of epoxides with carbon dioxide to make polycarbonates.

OSU colleague and former ACS president Bruce Bursten comments on "*the Chisholm graciousness. It was genuine, it was palpable, and it was part of what made him beloved by so many*." Bursten notes that Malcolm dispelled Bruce's self-doubt as a young assistant professor and comments "*…with Malcolm's passing, we lost a giant in the world of science and an even bigger gentleman and friend. His warmth, his generosity toward others, his brilliance, and his love of family and of life are models of how the rest of us should be*."

Sadly, at about the same time, both Malcolm and his wife were diagnosed with different illnesses and Cyndy passed away in August, 2012. Malcolm underwent repeated cancer therapies for the last five years of his life. Malcolm grew a beard, refused to quit, and continued with his teaching, research and social life, including hosting a Christmas party in 2013, inviting his research group, family and friends.

Still travelling extensively, he treated himself to a new Jaguar sports coupe that year, to encourage him to take road trips to see old friends, including in Bloomington. Dave Clark writes: "*one of my fond memories is a road trip we took from Columbus to Bloomington in his Jaguar Roadster to participate in the 2014 Fall IU Inorganic Alumni symposium and picnic. We spent four memorable days together reminiscing, telling stories, joking around, listening to music, discussing chemistry, and visiting our favorite eating and drinking establishments. Being back in Bloomington with Malcolm brought home the central role that both Malcolm and IU played not only in launching my career, but welcoming me into larger family of friends and colleagues all over the world*." Malcolm passed away at home at age 70, on November 20, 2015. He was unique, he was gregarious, he was affable, he was inspiring, he was visionary, and he touched the lives of those around him.

Major acknowledgment is made to Malcolm's friends, and special thanks to Dick Puddephatt, whose affectionate memorial article can be found at http://rsbm.royalsocietypublishing.org/cgi/content/abstract/rsbm.2016.0025

Staff News

by Cheryl Johnson

Alita Hornick was hired as the Director of Business (replacing **Amy VanPelt**) for the Department of Chemistry. She has been an IU employee since September 1993. Alita's previous experience includes the positions of the Director of Financial Operations and the Fiscal Officer at the College of Arts and Sciences, IU Bloomington.

Daniel Hosler was hired as an Accounting Representative (replacing **William Unrue**) in the Research Support Group. Daniel has a BA in History and a BA in Anthropology, with high distinction, from Indiana University. His prior experience includes invoice processing at IU Financial Management Services and working at the Monroe County Public Library.

Kimberly Jones was hired as an Accounting Associate (replacing **Susie DuMond**) in the Chemistry Business Office. Kim transferred from IU School of Public and Environmental Affairs where she was the HR/Payroll Transaction Associate.

Danny McMurray was hired as the Web Design Media Specialist in the Department of Chemistry. Danny is studying Computer IT at Ivy Tech and expects to earn his degree in 2018. He has experience as a freelance web designer at Indiana University.

Kristin Ousley was hired as an Administrative Assistant (replacing **Colleen McConahay**) in the Research Support Group. Kristin has a BA in Graphic Design from Indiana University. Her prior position was a Production Assistant at the Indiana University Press.

Maria Sievers Perotti was hired as the Compliance & Reporting Manager for Chemistry grant activities (new position). Maria has a BS in Biochemistry from Indiana University. Her prior experience includes Proposal & Administrative Coordinator in the department and bookkeeping experience in a local small business.

Mary Skinner was hired as the Office Services Assistant Sr. in the Chair's Office (replacing **Tania Osborn**). Mary worked previously as an administrative assistant at THT Presses, Inc. Mary received certification as a dental assistant from the Aristotle College of Medical and Dental Technology in 1986.

Misty Theodore was hired as the Assistant Director of Business (replacing **Erin Edwards**). Misty received a BGS with high distinction from Indiana University in 2013. She previously served as the Cognitive Science Program Fiscal Officer/Analyst and as the Gill Center Program Manager.

Caitlin Watkins was hired as the Grants Manager (replacing **Kristina McReynolds**) in the Chemistry Department. Caitlin will receive her Master's in Public Affairs in December 2017. She has experience as a Grant Writer for First Book Monroe County.

2017 Retirements

Toni Lady leaves the Chemistry Department after 32 years of service to IU. Toni was hired in 1985 by the College of Arts and Sciences to maintain student records and certify undergraduate degrees. In 1997, she went on to work as an assistant recorder for the University Division before joining the Chemistry Department in 2001. Toni provided secretarial assistance to Drs. **Burke**, **Oakley**, **Richardson**, and **Stone** from 2001 until 2002 when she then became the Administrative Assistant for graduate affairs with the Chemistry Graduate Program. She was instrumental in helping numerous graduate students obtain their graduate degrees. Toni and her husband, Danny, retired to St. Petersburg, Florida where they look forward to enjoying the sunshine and lazy days on the beach.

Service Recognition

10 years – **Dalane Anderson, James Clark**

15 years – **Rose Burchfield, Scott Harrington**

20 years – **Angela Hansen**

30 years – **Andy Alexander**

2017 Staff Award Recipients

Rose Burchfield (Electronic Technician Senior)

In Memoriam: Bruce Frye 1951 – 2017
Chemistry Machinist, Pioneer and Mentor

"*Never underestimate the impact you have on the lives of others*" is a quote that **Bruce Frye** shared years ago after I helped someone which seemed very minimal, but later I found out it helped them tremendously. Bruce was a talented, knowledgeable, big hearted, fun- loving man that was always willing to help while making an impact on many people.

Bruce was born in Bloomington, Indiana on May 25, 1951; his family lived at the corner of 12th and Indiana. He began delivering newspapers at age 8 in his neighborhood. Later he talked about how much he enjoyed watching the sunrise each morning and drinking a cold Mountain Dew after walking his newspaper route. This strong work ethic continued throughout his life and at the age of 14, he bought his first stick welder with the money he saved from his newspaper route.

After graduating high school in 1969, he went to work for Pritchard's Service Station in Bloomington and worked there for almost 20 years as a mechanic which was another one of his many talents. After earning a degree in computer-aided drafting and becoming a certified welder, Bruce went to work for Cook, Inc. as a welder and fabricator and eventually became the machine shop supervisor at the Ellettsville West Plant.

In 2004 he began working at IU Chemistry Department as a machinist. Bruce was the true definition of one and didn't need the latest version of a computer drafting program, new machines, or specialized tooling to do the job. He made some of the finest parts with old, half worn-out equipment and could do everything from blacksmithing to small high-precision scientific pieces. The parts were always within tolerance, had the finest finish and if Bruce could improve the design, he did. All that he needed to start a project was an idea, a piece of paper and pencil. Bruce greatly enjoyed taking raw material and machining it into finished parts that many times could be classified as artwork. He was also a genius and pioneer in the "green" recycling movement of today. He often took things that had been discarded or deemed as worn out and restored/rebuilt them into working masterpieces that would be returned to service for decades to come.

Bruce was a man that description doesn't do justice. He could tell you about history, United States, other countries, wars, mechanical things, railroading, farming, tractors, livestock, equipment, politics, machining, welding, medicine, music, aircraft, guns and the list goes on. His broad range of knowledge, humor, and professional attitude made him a joy to work with and many times he was specifically requested by students and faculty for projects.

Away from IU, Bruce enjoyed several hobbies on the Unionville farm with his wife Barbara and son John. They loved doing many things together — raising animals, farming, restoring old farm equipment, and railroading were stories that he would share about the good times. The Frye family also enjoyed volunteering at nearby railroad museums, doing track repair, and riding their restored railroad track maintenance car (motorcar). They went on several trips to ride the rails, enjoy the scenery, and meet with friends. He always had a story about a little "Mom & Pop" restaurant where they stopped and had delicious food. Railroading was often a topic of discussion where he appreciated watching the trains come through Unionville.

Bruce was a lover of all creatures — large and small. He raised farm animals and even a few wild ones. Many of the dogs in Unionville also knew Bruce well, as he always kept some dog biscuits in his vehicle and would stop to give them one. His own dogs were either riding or running alongside of his golf cart.

His grandson, Samuel, was born in 2016 to his son, John, and daughter in-law, Hillary, and was a source of great pride and joy. He was also close to his three brothers Mark, Perry, Kent, their wives and children; family was important to Bruce.

He was a great friend and mentor. The things that Bruce built and repaired in his life particularly for others are innumerable. His quote "*Never underestimate the impact you have on the lives of others*" truly describes the amazing man we knew.

Jeremy Boshears
Lifelong friend and Manager of Mechanical Instrument Services
Department of Chemistry
Indiana University

CHEMISTRY GRADUATE NEWS

by Dalane Anderson

During the 2016-2017 school year, Professor **Amar Flood**, was the Director of Graduate Studies. Serving with him on the Graduate Standards Committee were Professors **Lane Baker**, **Kenneth Caulton**, **Srinivasan Iyengar**, **Liang-shi Li**, **Martha Oakley**, and **Michael Van Nieuwenhze**.

Steven Tait chaired the Graduate Admissions Committee. Evaluating the hundreds of dossiers submitted to the department were Professors **Kevin Brown**, **Charles Dann III**, **Krishnan Raghavachari**, **Jonathan Schlebach**, **Jeremy Smith**, **Thomas Snaddon**, **Megan Thielges**, and **Yan Yu**.

Graduate Student	Graduate Fellowship(s) & Award(s)	Research Lab
Riyadh Alshammari	Kingdom of Saudi Arabia Fellowship	Jeff Zaleski
Sandra Atehortua Bueno	NSF Graduate Research Fellowship	Sara Skrabalak
Madeline Beatty	Associate Instructor Award	Jeff Zaleski
Daniel Beckett	Raymond Siedle Materials Fellowship	Krishnan Raghavachari
Greg Bukowski	Associate Instructor Award	Megan Thielges
Alyssa Cabelof	Associate Instructor Award	Ken Caulton
Henry Castillo	Arts and Sciences Presidential Diversity Fellowship	Steven Tait
Laura Chamness	Deans Allocation Award	Jonathan Schlebach
Linxiao Chen	Robert & Marjorie Mann Fellowship	Steven Tait
Nicholas Daanen	NSF Graduate Research Fellowship	Sara Skrabalak
Ashley DeYong	Deans Allocation Award	Nikki Pohl
Tarick El-Baba	Robert & Marjorie Mann Fellowship	David Clemmer
John Espinosa-Duran	ACS Graduate Student Poster Award	Peter Ortoleva
Jocelyn Gamler	Chester E. Davis Recruiting Fellowship	Sara Skrabalak
Yuan Gao	Arts & Sciences Travel Fellowship	Yan Yu

Sandra Atehortua Bueno

Madeleine Beatty

Greg Bukowski

Alyssa Cabelof

Linxaio Chen

Tarick El-Baba

JB Holmes

Panagiotis Kondylis


Katie Logan


Corinne Lutomski


Nick Maciulus


Sashary Ramos


Rush Scaggs


Josey Topolski


Brenna Walsh


Lushan Zhou

Graduate Student	Graduate Fellowship(s) & Award(s)	Research Lab
Cody Haycraft	Kraft Fellowship David A. Rothrock Award	Srini Iyengar
JB Holmes	QCB Fellowship	Bogdan Dragnea
Alexander Jacobs	Briscoe Teaching Scholar Fellowship	David Clemmer
Neelam Khanal	Provost's Travel Award	David Clenmmer
Panagiotis Kondylis	Robert & Marjorie Mann Fellowship Felix Haurowitz Award	Stephen Jacobson
Sarah Lindahl	Briscoe Teaching Scholar Fellowship	Jeff Zaleski
Yun Liu	ACS Organic Travel Award	Liang-shi Li
Katie Logan	Chester Davis Organic Fellowship Jack K. Crandall Award	Kevin Brown
Corinne Lutomski	E.M. Kratz Fellowship Provost's Travel Award	Martin Jarrold
Nick Maciulis	Raymond Siedle Inorganic Fellowship William H. Nebergall Memorial Award	Ken Caulton
Eric McKenzie	Mays Fellowship	Dennis Peters
Ben Noffke	Lynne L. Merritt Award	Krishnan Raghavachari and Liang-shi Li
Bo Qiao	Wendell P. Metzner Memorial Award Lynn L. Merritt Award	Amar Flood
Sashary Ramos	QCB Fellowship Associate Instructor Award	Megan Thielges
Stephen Ratvasky	QCB Fellowship	Jeff Zaleski
Manisha Ray	Keijzer Award	Caroline Jarrold
Frank Roushar	QCB Fellowship	Jonathon Schlebach
Rush Scaggs	Chester Davis Organic Fellowship	Tom Snaddon
Arkajyoti Sengupta	ChemGRC Travel Grant Verne L & Paula A. Trinoskey Award	Krishnan Raghavachari
Kevin Schwarz	Associate Instructor Award	Tom Snaddon

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Graduate Student	Graduate Fellowship(s) & Award(s)	Research Lab
Teddy Sheetz	Bernard Berk Recruiting Fellowship	David Williams
Levi Sigua	Deans Allocation	Yan Yu
Josey Topolski	Chester Davis Inorganic Fellowship	Caroline Jarrold
	ChemGRC Travel Grant	
	McKenzie Award	
Brenna Walsh	QCB Fellowship	David Giedroc
David Wisman	Crane PhD Fellowship	Steven Tait
Justin Vadas	NSF Graduate Research Fellowship	Romualdo deSouza
Yanqi Yu	E. Campaigne C500 Award	Yan Yu
Elizabeth Yuill	Carroll Family Fellowship	Lane Baker
Lushan Zhou	Henry Mahler Award	Lane Baker

Ph.D. Degree Recipients

Staci Anthony – Analytical, August 2016, Dr. Martin Jarrold
Edward Basom – Analytical, July 2017, Dr. Megan Thielges
Christopher Benson – Materials, February 2017, Dr. Amar Flood
Brian Cook – Inorganic, October 2016, Dr. Ken Caulton
John Espinosa-Duran – Chemical Physics, June 2017, Dr. Peter Ortoleva
Erin Fruchey – Organic, August 2016, Dr. Silas Cook
Yuan Gao – Analytical, July 2017, Dr. Yan Yu
Daniel Haywood – Analytical, October 2016, Dr. Stephen Jacobson
Anne Hickey – Inorganic, June 2017, Dr. Jeremy Smith
Alexander Jacobs – Analytical, July 2017, Dr. David Clemmer
Jared Kafader – Materials, July 2017, Dr. Caroline Jarrold
Eun Koh – Physical, September 2016, Dr. Bogdan Dragnea
Amanda Le Sueur – Inorganic, December 2016, Dr. Megan Thielges
Yijun Liu – Materials, June 2017, Dr. Liang-shi Li
Gavril Nagy – Analytical, July 2017, Dr. Nikki Pohl
Benjamin Noffke – Physical, July 2017, Drs. Krishnan Raghavachari and Liang-shi Li
Alysa Pirinelli – Organic, February 2017, Dr. Nikki Pohl
XiaoXiao Qiao – Organic, December 2016, Dr. Liang-shi Li
Manisha Ray – Physical, June 2017, Drs. Caroline Jarrold and Krishnan Raghavachari
Jonathan Rittichier – Organic, September 2016, Dr. Mike Van Nieuwenhze
Anumita Saha – Materials, January 2017, Dr. Lane Baker
Andrew Schwartz – Analytical, August 2016, Dr. Gary Heiftje
Wenqing Shi – Analytical, April 2017, Dr. Lane Baker
Virginia Smith – Biochemistry, June 2017, Dr. Bogdan Dragnea
Alison Smith – Materials, September 2016, Dr. Sara Skrabalak
Christa Snyder – Analytical, September 2016, Dr. Stephen Jacobson
Mark Sprowl – Inorganic, November 2016, Dr. Mookie Baik
Andrew Storey – Analytical, August 2016, Dr. Gary Hieftje
Fangzhou Wu – Chemical Biology, October 2016, Dr. Richard DiMarchi
Xu Yang – Chemical Biology, June 2017, Dr. Richard DiMarchi
Cheng Zeng – Physical, February 2017, Dr. Bogdan Dragnea
Zhimeng Zhu – Chemical Biology, December 2016, Dr. Richard DiMarchi

MS Degree Recipients

Jessica Amos – Organic, July 2017, Dr. Tom Snaddon
Scott Curtis – Inorganic, January 2016, Dr. Ken Caulton
Xiao Dong – Chemical Biology, October 2016, Dr. Charles Dann
Stephanie Hagan – Physical, October 2016, Dr. Jonathan Raff
Jordan Harrington – Inorganic, February 2017, Dr. Jeff Zaleski
Omaru Kabia – Organic, July 2017, Dr. Tom Snaddon
Meredith Kunz – Materials, May 2017, Dr. Sara Skrabalak
Jennifer Sandahl – Materials, August 2016, Dr. Steven Tait
Anna Weber – Analytical, January 2017, Dr. Lane Baker
Sean White – Organic, June 2017, Dr. Kevin Brown
Yuhan Zeng – Analytical, July 2017, Dr. Lane Baker

MS/MSES Recipients

Katie McKinley – Analytical, May 2015, Dr. Jonathan Raff

Dr. Kevin Schwartz, Dr. Michael Connor and Dr. Thomas Atack

Dr. Bo Qiao and Professor Amar Flood

Dr. Josh Baker, Dr. Chris Kneller, and Professor Stephen Jacobson

Dr. Christopher Wiliams, Professor Steven Tait, and Dr. Christopher Tempas

Dr. Jared Kafader, Dr. Manisha Ray and Professor Caroline Jarrold

Dr. Sylvie Hudan, Dr. Blake Wiggins and Professor Romualdo DeSouza

Professor James Reilly, Dr. Dennis Chen, Dr. John Espinosa-Duran and Professor Sara Skrabalak

Dr. Sarah Lindahl and Professor Jeffrey Zaleski

UNDERGRADUATE NEWS by Carly Friedman

We added 93 new alumni to the IU Chemistry family after 2016-2017 fall and spring graduations. The Department of Chemistry conferred 25 Chemistry BS degrees, 27 Biochemistry BS degrees, 25 Chemistry BA degrees, and 16 Biochemistry BA degrees to our students.

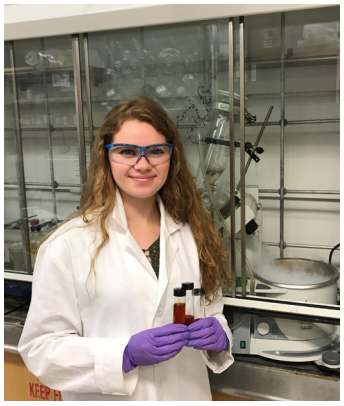
We are extremely proud of our recent graduates as they embark on the next chapter of their lives. We are equally excited for the new students that come into our department to study chemistry or biochemistry. Students can enter the department in one of three ways: by direct admission into the College of Arts and Sciences, by certification through the University Division, and by transfer or intercampus transfer admission from another college or university.

Current Direct Admit Program standards include earning an ACT composite score of 28 or an SAT score of 1320, plus a high school GPA of at least a 3.7. We accepted 94 Direct Admit Program students for the fall 2017 semester. Students can be certified into the College of Arts and Sciences and the Department of Chemistry three time each year if they have completed the English Composition requirement and have a College and in-major GPA of 2.0. We admitted 74 students during the 2016-2017 certification cycle. Lastly, we welcomed five transfer students last academic year.

Students can succeed no matter how they enter the department. We would like to highlight three of our summer research scholarship recipients: **Riley Mortensen**, Direct Admit Program student; **Caitlyn Mulcahey**, Direct Admit Program student; and **Stanley Bram**, transfer student.

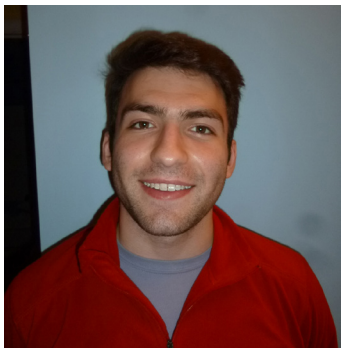
Riley Mortensen, recipient of the *Harry G. Day Summer Research Scholarship*, is a sophomore working toward a Chemistry BS. Riley explains that his first-year experiences as a Direct Admit student have provided him with a solid foundation in the department. His classes all had fewer than 50 people and he has already worked in the Tait Lab for over a semester. He found his honors courses, especially Honors Organic Chemistry with Dr. **Thomas Snaddon**, to be rigorous and immensely rewarding, as the smaller class size allows a pace that moves quickly but leaves nobody behind. Riley's involvement in the **Tait Lab** has already developed his knowledge and skills much more than he would have imagined. He found the group to be immediately inclusive and eager to help him acclimate to the laboratory setting. In the lab, Riley enjoys studying the spontaneous self-assembly of molecules into highly ordered materials, and he has become proficient in scanning tunneling microscopy, which is an advanced, state of the art research instrument that allows imaging of molecular architectures with atomic resolution.

In his first year, Riley has experienced advantages of his direct admission into the College of Arts and Sciences and the Department of Chemistry. He feels immediately invested in his major and included in the program, due to his relationships with faculty as well as departmental academic advising. He predicts that opportunities will continue into the future.



Caitlyn Mulcahey is a recipient of the *Earl G. Sturdevant Summer Research Scholarship*. She is a sophomore pursuing a Biochemistry BA with minors in English and History. She chose a Biochemistry major as a way to apply chemistry and biology to medicine with the goal of pursuing medical school.

Furthermore, Caitlyn was very excited to begin researching as an undergraduate, specifically looking to research medically-oriented scientific questions in organic chemistry. She was able to explore research before her summer prior to colllege through the *Integrated Freshman Learning Experience* (IFLE). This allowed her to transition to her more permanent research position through the *Science, Technology and Research Scholars* (STARS) program. She currently works in the **VanNieuwenhze** Lab, working on projects that aim to combat the growing antimicrobial resistant bacteria problem. One of the most appealing aspects of IU for Caitlyn was being accepted into the Direct Admit Program so that she could begin pursuing her passions immediately. She enjoys her honors chemistry courses because she is required to go beyond memorizing concepts to reaching critical conclusions independently.



Stanley Bram received a *Harry G. Day Summer Research Scholarship*. He is a senior pursuing a Chemistry BS. Stanley began his undergraduate career at IUPUI because the Indianapolis branch of IU awarded him with a presidential scholarship that covered tuition. Though he had a great experience at IUPUI, Stanley realized he did not want to continue studying there. Therefore, he decided to contact Dr. **Lyuda Bronstein** to ask about potential summer research positions. He was particularly interested in her electrochemical research. Stanley is grateful to Dr. Bronstein and the entire chemistry faculty for how welcoming they have been to him as a transfer student. He didn't expect the challenges that come from transferring schools, but the academics and mentoring he has received have made it all worthwhile to him. The Bronstein lab was Stanley's first independent research opportunity and has paved the way for his science career.

Goldwater Scholar LeeAnn Sager

The Goldwater Scholarship recognizes outstanding college sophomores and juniors who have shown great promise in math, science or engineering.

Chemistry major, **LeeAnn Sager**, is among 240 scholars selected by the Barry Goldwater Scholarship and Excellence in Education Foundation, a federally-endowed agency that awards the scholarships. The scholars were selected from a field of 1,286 students nominated by 2,000 colleges and universities. The one- and two-year scholarships cover the cost of tuition, fees, books, and room and board up to a maximum of $7,500 per year.

Sager is a junior from LaPorte, Indiana, who is pursuing a degree in chemistry in the Department of Chemistry. She has conducted research in the labs of IU faculty members **Mu-Hyun "Mookie" Baik** and **Srinivasan Iyengar**, who is her current and primary mentor. Sager's nominators describe her as a "fearless" student who "eagerly approaches the most challenging subjects." Her long-term career goals include earning a Ph.D. in theoretical chemistry and teaching at the university level.

Logan Hille of Fort Wayne, Indiana, a junior chemistry major at IU Bloomington was also recognized as honorable mentions by the Goldwater Foundation.

The Goldwater Foundation was established by Congress in 1986 to honor the late Sen. Barry Goldwater and to foster and encourage outstanding students to pursue careers in mathematics, science and engineering. Since it was established, the foundation has bestowed 7,680 scholarships worth about $48 million. Goldwater Scholars have been awarded 86 Rhodes Scholarships, 125 Marshall Awards, 134 Churchill Scholarships and many other fellowships and awards.

Chemistry Honor Roll

The following chemistry and biochemistry majors attained an overall and in-major grade point average of 3.75 or better through the fall 2016 semester.

Senior Honor Roll: **Alec Bell, David Burke, Liza Burns, Megan Coghlan, Daniel Cox, Arthur Cross-Najafi, Laura Daily, Christopher Dietrich, Jasper Dittmar, Alexander Duckworth, Antonio Garcia, Parker Gill, Hendrik Glauninger, Mitchell Gray, Lennon Gregor, Sara Hardman, Rachel Hartman, Mark Hazelbaker, Logan Hille, Michael Hinton, Miriam Hu, Oluwagbemisola Ibikunle, Alexandra Jostes, Corrine Kumar, Zachary Lee, Peter Leonard, Samantha Lisy, Harrison Love, Bryce Manifold, Joshua Mann, Sophia McClain, Molly McFadden, Catherine Morgan, Adam Nan, Matthew Pappas, Minal Patel, Michael Peng, Arden Piepho, Kyle Prisby, Gene Qian, Wednesday Rees, Andrew Rejer, Mitchell Rice, Gina Roesch, Lucas Rowe, Alaina Roy, LeeAnn Sager, Eda Shi, Jay Shukla, Connor Singrey, Hajeung Song, Theresa Spech, Andrew Stark, Cody Tragesser, Albin Vleck, Brett Walker, Alexander West, Wyatt Wright, Sen Xiong, Christine Yang**

Junior Honor Roll: **Robert Brenner, Meredith Campbell, Jessica Collins, Jonathan Dietrich, Emily Ellinger, Eric Fleck, George Hutchins, Evan Keiser, Haley Klimaszewski, Sterling Manka, Brendan Martin, Michaela Pettit, Jacob Pottratz, Austin Reilly, Casandra Pamela Sandoval Hurtado, Laura Scanameo, Joseph Stembel, Nicholas Watkins, Jonathan Watson, YoungJun Woo, Ejun Yun**

Sophomore Honor Roll: **Iyad Ali, Kaeli Bryant, Lydia Byers, Natalie Cox, Tin Duong, Lauren Granskog, Spencer Irick, Sarah Johnson, Carsyn Kranz, Yuhan Lu, Riley Mortensen, Sara Okeley, Tristin Phegley, Adam Shatique, Abigail Thompson,Bailey Trinkino, Aubrey Whiteman, Amna Yaqub**

Freshman Honor Roll: **Madison Hershberger, Austin Miller, Jon-Luc Poirier**

Departmental Scholarships and Awards

C117 General Chemistry Award	**Neev Kadakia**, **Kaleb McCarter**, **Elle McFarlane**
S117 General Chemistry Award	**Sartak Agarwal**, **Damon Pham**, **Tiffany Xie**
Organic Chemistry	**Allyson Hamilton**
American Chemical Society Award	**Robert Satterthwaite**
Keith Ault Scholarship	**Wyatt Wright**
William H Bell Award	**Stephen Feldhake III**, **Anne Lietzke**, **Samantha Lisy**
John H. Billman Summer Scholarship	**Evan Keiser**
Harry G. Day Summer Research Scholarship	**Stanley Bram**, **Riley Mortensen**, **Gene Qian**, **Jay Shukla**
Leroy Dugan Scholarship	**Daniel Cox**
Dr. & Mrs. Harlan English Scholarship	**Gursimran Kaur**, **Caitlyn Mulcahey**
Courson Greeves Scholarship	**Camille Allison**
R.J. Grim Memorial Scholarship	**Jessica Collins**, **Zachary Lee**, **Casandra Pamela Sandoval Hurtado**, **Jay Shukla**, **Andrew Stark**, **Christine Yang**
John R. & Wendy L. Kindig Scholarship	**Sara Hardman**, **Logan Hille**, **Jacob Huston**, **Gene Qian**
Russell Leo & Trula Sidwell Hardy Scholarship	**Alan Trinh**
Ira E. Lee Summer Research Scholarship	**Megan Coghlan**, **LeeAnn Sager**
John R. & Wendy L. Kindig Scholarship	**Sara Hardman**, **Logan Hille**, **Jacob Huston**, **Gene Qian**
Margaret C. & Anne Marie Kuzmitz Scholarship	**Zitong Song** Andrew
Loh Scholarship	**Gina Roesch**
Robert & Marjorie Mann Scholarship	**Connor Bunch**, **Huidi Chen**, **Emily Ellinger**, **Timothy Gruenhagen**, **Jacob Huston**, **Catherine Morgan**, **Matthew Pappas**, **EJun Yun**
Frank Mathers Undergraduate Summer Research Scholarship	**Bret Lawson**, **Paige Price**
Dennis Peters Scholarship	**Lennon Gregor**, **Christine Hustmyer**, **Ashley Nguyen**, **Drew Wawrzyszuk**
William G. Roessler Scholarship	**Timothy Gruenhagen**
Joseph B. Schwartzkopf Award	**Hendrik Glauninger**
Raymond Siedle Scholarship	**Austin Reilly**, **Regine Vincent**
Earl G. Sturdevant Summer Scholarship	**Caitlyn Mulcahey**, **Zitong Song**
Lee J. Todd Chemistry Memorial Scholarship	**Lennon Gregor**
John R. & Wendy L. Kindig Scholarship	**Sara Hardman**, **Logan Hille**, **Jacob Huston**, **Gene Qian**
Margaret C. & Anne Marie Kuzmitz Scholarship	**Zitong Song**
Votaw Undergraduate Summer Research Scholarship	**Joshua Ewigleben**
Forrest L. Warner Scholarship	**Yuhan Lu**, **Riley Mortensen**
Francis & Mildred (Eckerty) Whitacre Scholarship	**Brendan Martin**, **Eda Shi**
James C. White Memorial Chemistry Scholarship	**Christopher Dietrich**
Mary Frechtling White Memorial Chemistry Scholarship	**Molly McFadden**

Chemistry Honors Program

The following students are BS majors in chemistry or biochemistry, have maintained a minimum grade point average of 3.3, and have completed a research project and thesis.

Haider Al-Awadi (Hundley Group), **David Burke** (Flood Group), **Chrisptopher Dietrich** (Giedroc Group), **Jasper Ditmar** (Bronstein Group), **Alexander Duckworth** (Oakley Group), **Jackson Fessenden** (Dann Group), **Hendrick Glauninger** (Giedroc Group), **Michael Glennon** (Skrabalak Group), **Austin Goodson** (Peters Group), **Bryce Manifold** (Peters Group), **Joshua Mann** (Bronstein Group), **Adrianna Masterson** (Dann Group), **Molly McFadden** (L. Brown Group), **Troy Oracko** (Bronstein Group), **Samuel Paterson** (Bronstein Group), **Luke Schkeryantz** (Bronstein Group), **Jonathan Specker** (Thielges Group), **Brett Walker** (Peters Group), **Alexander West** (Williams Group)

2017 Graduation Names

1. Professor Stephen Jacobson, 2. Andrew Copeland, 3. Madeline Poteet, 4. Andrew England, 5. Professor Bogdan Dragnea, 6. Professor Dennis Peters, 7. Hailey Meyer, 8. Abby Lichlyter, 9. Brett Walker, 10. Paige Dausinas, 11. Dr. Lyuda Brontein, 12. Professor Meghan Porter, 13. Professor Jill Robinson, 14. Austin Goodson, 15. Trent Wagoner, 16. Jordan Graff, 17. Ashley Cohen, 18. Theresa Spech, 19. Kyle Miller, 20. Alexander Beer, 21. Shine Duncan, 22. Professor Sara Skrabalak, 23. Professor Martha Oakley, 24. Alex West, 25. Luke Schkeryantz , 26. Conner Singrey, 27. Alexander Duckworth, 28. Joseph Sakowski, 29. Alexandra Jostes, 30. Adriana Masterson , 31. Eleni Salyers, 32. Michaela Colestock, 33. Kelsie Zawada, 35. Alec Bell, 36. Ahmed Rozani, 37. Professor Steven Tait, 38. Professor Norman Dean, 39. Professor Kenneth Caulton, 40. Professor Laura Brown, 41. Professor David Giedroc, 42. Michael Peng, 43. Molly McFadden, 44. Bryce Manifold, 45. David Burke, 46. Samuel Paterson, 47. Kyle Prisby, 48. Alaina Roy, 49. Wednesday Rees, 50. Sydney Lehman, 51. Tatiana Knox, 52. Haider Al-Awadi, 53. Mark Hazelbaker, 54. Albin Vleck, 55. Will Wurster, 56. Andrew Rejer, 57. Professor Theodore Widlanski, 58. Professor Cathrine Reck, 59. Michael Gleeson, 60. Eric Regele, 61. Natan Sojko, 62. Jasper Dittmar, 63. Jay Morrison, 64. Curtis Green, 65. Hendrik Glauninger, 66. Daniel Cox, 67. Adam Oldham, 68. John Bruhn, 69. Wyatt Wright, 70. Connor Braeger, 71. Christopher Dietrich, 72. Albert Cross-Najafi, 73. Johnathon Specker, 74. Professor Charles Dann III

2017 Phi Beta Kappa Fall and Spring Inductees

Connor Braeger, Megan Ariel Coghlan, Arthur Albert Mohammed Cross-Najafi, Jasper Dittmar, Alexander Todd Duckworth, Eric James Fleck, Hendrik Glauninger, Mitchell Thomas Gray, Lennon Wallace Gregor, Mark Hazelbaker, Logan Thomas Hille, Michael S Hinton, Corrine Anne Kumar, Zachary William Lee, Peter Manuel Leonard, Bryce Adrian Manifold, Joshua John Mann, Adam Edward Nan, Matthew Alexander Pappas, Michael Peng, Wednesday Dean Rees, Andrew Emery Rejer, Mitchell Alexander Rice, Michael Jay Riddle, Lucas William Rowe, Alaina Michael Roy, LeeAnn Marie Sager, Paige Ann Schultheis, Eda Shi, Leo Song, Alexander Vincent West, Wyatt Hunter Wright

2017 Alumni News

In 2016, **Bryan R. Brown**, BA'78, completed the first ever source-to-mouth descent of Canada's MacKenzie River watershed, roughly 2,300 miles in total. During the challenging trek, which took place above the Arctic Circle, Brown faced blizzards, bears, and lightning strikes. Cataloguing the highlights and dangers of the trip, Brown writes: "*Number of point-to-point paddlers I met between the Canadian Rockies and the Beaufort Sea? Zero. Bear incidents? Three (one predatory). Number of times I was mistaken for Bigfoot? One. Number of times I saw Bigfoot? Zero. Number of roasted beaver feet I was offered to eat? Too many. Number I ate? None.*" The MacKenzie River watershed is the third largest on earth after the Nile and the Amazon, and is the last of the 10 largest watersheds on the planet to be successfully navigated from source to mouth. In 2014, Brown traveled to Alaska, where he completed the first source-to-mouth solo kayak descent of the Yukon River in history. Brown adds, "*The effort took 57 days, covered some 2,300 miles, started at the foot of the Llewellyn Glacier near Atlin, B.C., and ended about 72 miles from Russia in the Bering Sea*." Brown is a Wall Street market strategist who lives in Beverly Hills, Calif.

William F. Carroll Jr., PhD'78, retired from Occidental Chemical Corporation in 2015 after 36 years, and now heads his own company, Carroll Applied Science, in Dallas, Texas. He is a member of the board of directors of the world's largest scientific society, the American Chemical Society, having served as chair between 2012 and 2014. He is also a past president, one of three living members to hold both offices. Carroll is a fellow of the AAAS and the Royal Society of Chemistry. In 2009, he was chair of the Council of Scientific Society Presidents. Carroll is an adjunct industrial professor of chemistry at IU Bloomington.

In April 2016, **Gary M. Gaddis**, BA'79, PhD'84, MD'86, was named clinical professor of emergency medicine and resident research director of the Division of Emergency Medicine in the School of Medicine at Washington University in St. Louis. He previously served 17 years as an endowed chair in emergency medicine and faculty member in the Department of Emergency Medicine at the University Missouri–Kansas City School of Medicine. Gaddis was an "All-Star" rider for the 1979 Little 500 Race, and has continued to be an active cyclist and runner. He lives in St. Louis.

In August 2014, Indianapolis anesthesiologist **David E. Hoover**, BA'83, MD'87, and his wife, ophthalmologist **Sharon (Fulton)**, MD'87, proudly watched as their son, **John David "JD" Hoover**, received his white coat at a ceremony to honor the incoming IU School of Medicine class in Indianapolis. A member of the class of 2018, JD represents the fourth generation of his family to attend the IU School of Medicine. His great-grandfather, **John T. Emhardt**, BS'26, MD'28, practiced family medicine for over 50 years in Indianapolis and his grandfather, **William H. Fulton**, BA'55, MD'58, still practices neurology in Indianapolis.

Barbara J. Wagner, BS'84, was listed as a top-rated personal injury-products attorney in the 2016 edition of South Carolina Super Lawyers. She is special counsel at the law firm Barnwell Whaley in Charleston, S.C. Wagner advises and represents a broad range of clients primarily in the areas of construction law and products liability. An attorney, PhD chemist, former professor of chemistry at the College of Charleston, and holder of 20 U.S. patents, Wagner's law practice areas include business law and civil litigation, insurance, and intellectual property. She has represented chemical and drug manufacturers, tire and boat manufacturers, governmental entities and numerous construction trades, among others. Wagner lives in Charleston.

"*I was recently promoted to senior director of pharmaceutical market development at Waters Corporation, an analytical laboratory instrument and software company headquartered in Milford, Mass.*," writes **Diane M. Wagrowski-Diehl**, PhD'99. She adds, "*I have been at Waters for 16 years.*" Wagrowski-Diehl lives in Wilbraham, Mass.

In February, during the IUPUI Alumni Leaders Dinner, **George R. Zundo**, BA'76, DDS'80, of Danville, Ill., was presented with the *Maynard K. Hine Award* for his contributions in support of the IUPUI campus and its alumni programs. Zundo has given more than two decades of continuous service to the *IU School of Dentistry Alumni Association*, as an alumni board member and as the IUAA Executive Council representative. He is currently working on programs to connect out-of-state alumni to the *IUSD Alumni Association* and to assist dental graduates as they transition into dental practitioners.

Library News

by Jennifer Laherty

A 21st Century Library supports Chemistry by providing the following services:

- In-depth research consultation
- Instruction on searching for information and data in all formats
- Setting up research profiles on systems like Google Scholar, ResearchGate, etc.
- Editing to produce data management plans as required by federal funding agencies
- Publishing data in institutional repositories designed to curate and preserve such research outputs
- Managing citations for future theses and dissertations
- Purchasing, collecting, and cataloging information resources
- Course reserves
- Circulating books! Finding online articles!
- Quiet study space
- Help anytime you need it

The Chemistry library is happy to serve you if you're in the area and want to obtain a borrower's card for books or want to set up a guest account to use databases and online journals. At a distance, we can provide help via email or phone.

The Library may be reached at libchem@indiana.edu, 812-855-9452, or **Jennifer Laherty**, Librarian, jlaherty@indiana.edu, 812-855-5609. https://libraries.indiana.edu/chem

4th Annual IU Science Fest opens doors to world-class labs

Free, family-friendly event featured over 150 science-related activities from 17 scientific areas across campus

The *4th Annual IU Science Fest* took place from 9 am to 3 pm Oct. 21 on the IU Bloomington campus. This year's event attracted over 3,000 visitors to campus. A small sampling of this year's activities included a low-temperature physics demonstration; a volcano simulation; the chance to experiment with VR headsets, Snapchat glasses and 3-D printers; controlling electric cars with brain impulses; geode rock smashing; a guided trek through IU's beautiful campus woodlands; and tours of IU's world-class research spaces, including the IU greenhouse, solar observatory, electron microscope facility and scientific glassblower's studio.

Science Fest is hosted by the IU Bloomington College of Arts and Sciences and its Office of Science Outreach. This year's event included the largest number of participating departments and units, including Department of Anthropology, Department of Biology, Department of Chemistry, Department of Earth and Atmospheric Sciences, Department of History and Philosophy of Science, Department of Mathematics, Department of Physics, Department of Psychological and Brain Sciences, Department of Speech and Hearing Sciences and the IU School of Art, Architecture + Design, all in the College of Arts and Sciences, and the IU School of Informatics, Computing and Engineering.

Necrology:

*We remember those in the IU Chemistry family who have passed away during 2016 - 2017. Included here are deaths of which we learned this year (*degree year shown is deceased alumni preferred class year).*

John W. Sloan, BS 1939, January 5, 2016

Robert C. Wolfe, MAT 1963, January 22, 2016

James C. Bigelow, PhD 1985, January 31, 2016

Philip Ball, BA 1940|MD 1942, February 4, 2016

Paul W. Seidl, BA 1974, March 4, 2016

James P. Ferris, PhD 1958, March 4, 2016

James M. Mitchell, BA 1966, March 11, 2016

Jan Arvin Combs, BA 1984, March 6, 2016

Elizabeth L. Pruden, PhD 1976, March 29, 2016

Arthur C. Diesing, MS 1956, March 31, 2016

Ted J. Logan, BA 1953, April 10, 2016

Daniel D. Mark, BA 1986, March 20, 2016

Charles E. Streaty, Jr., BA 1959, April 20, 2016

Mary K. Johnson, BS 1944, April 22, 2016

Jesse E. White, PhD 1958, May 1, 2016

Sidney Fleischer, PhD 1958, May 27, 2016

Bruce C. Cook, BA 1947|DDS1951, June 1, 2016

William W. Bromer, PhD 1954, June 5, 2016

Mhrete-Ab Gebre-Selassie, BA 1955|MD 1959, June 7, 2016

Allan W. Stoner, BS 1953, June 10, 2016

Robert F. Acker, BA 1942|MA 1948, June 25, 2016

Edward W. Rutledge, BA 1972|MD 1975, June 29, 2016

Clyde G. Sussman, BA 1938|MD 1942, July 26, 2016

John T. Craig, BS 1948, August 1, 2016

Marc H. Anderson, BA 1976|MD 1980, August 20, 2016

Paul David Prather, BS 1961|MS 1962, August 25, 2016

Elaine K. Wong, BA 1946, September 2, 2016

Max M. Marsh, BS 1947|DSc 2003, September 17, 2016

Ahmad Rahbar, BA 1966, September 19, 2016

Craig A. Hollars, BS 2006, September 24, 2016

Robert D. McFarlin, BA 1937, September 26, 2016

Joseph M. O'Neal, BA 1940, October 22, 2016

Lenora O. Smith, BS 1949, November 15, 2016

Thomas J. Spahn, BA 1975|MD 1978, November 23, 2016

Dana W. Mayo, PhD 1959, November 26, 2016

Richard C. Combs, BA 1966|MD 1970, November 20, 2016

Donald W. Davies, BA 1945, December 1, 2016

Arnold W. Kunkler, BA 1942|MD 1949, December 25, 2016

James R. Kemper, BA 1956, December 30, 2016

Craig E. Booher, BA 1942, January 17, 2017

Harry W. O'Dell, BA 1942|MD 1942, January 20, 2017

Robert D. Dillard, BS 1957|MA 1959, January 21, 2017

Bruce W. Peavler, BS 1986, January 24, 2017

Albert L. Hensley, Jr., BS 1951, February 8, 2017

Nathan A. Long, BS 2001, February 12, 2017

Mark A. Muesing, BA 1976|PhD 1985, February 24, 2017

Irving Rosen, MA 1949|PhD 1951, March 4, 2017

Lettie K. Neff, MS1984, March 5, 2017

Richard R. Otter, PhD 1946, March 6, 2017

Roger E. Johnson, PhD 1966, March 13, 2017

Suraj P. Makhija, PhD 1967, April 4, 2017

Don F. Mitchell, BS 1960, April 8, 2017

David L. Leland, BS 1971|MS 1973, April 9, 2017

Charles W. Pearson, BS 1950, April 13, 2017

Donnell C. Marlin, BA 1952|DDS 1956, May 13, 2017

Michael P. Bubb, BA 1970|MD 1974, May 17, 2017

Robert J. Pursley, BA 1950, May 17, 2017

William B. Hendrey, BA 1962, May 22, 2017

Harold L. Fenimore, BS 1958, June 9, 2017

Lawrence Lumeng, MD 1964|MS 1969, June 21, 2017

Vernon D. Baiamonte, PhD 1966, June 26, 2017

Mark S. Grych, BA 1977, July 1, 2017

Bernard A. Holman, BA 1951, August 14, 2017

Joseph G. Moser, BS 1973, August 15, 2017

If you would like to submit an obituary to be included in the next issue, please send the information and/or a photo to chemalum@indiana.edu.

In Memorium: Richard Robert "Dick" Otter

May 17, 1920 - March 6, 2017

NOTRE DAME - **Richard Robert "Dick" Otter**, 96, died peacefully at 9:50 p.m. Monday, March 6th, at Dujarie House, Notre Dame. Born May 17, 1920, in Evanston, IL, to the late Irene (Farrell) and William Otter, Dick was a longtime South Bend resident.

After graduating from Dartmouth College, Dick earned a PhD in chemistry at Indiana University in Bloomington. There he fell in love with mathematics and with the woman whom he would later marry, Margot Weichert. After their wedding in 1949 Dick and Margot settled in South Bend, where Dick joined the mathematics faculty at Notre Dame. He taught there until his retirement in 1985.

Dick was an avid hockey player and competitive sailor. His love of sailing began as a teenager racing Star boats with his brother on Lake Michigan. Later he was instrumental in the growth and success of the Eagle Lake Sailing Club in Edwardsburg, MI. In 1969 Dick helped establish the Irish Youth Hockey League and was one of its first coaches. For many years he was a regular in the noontime hockey group at Notre Dame, and continued to play beyond the age of 80.

He was preceded in death by his loving wife Margot, as well as by a sister, Josephine Gerlin, and a brother, Bill Otter. He is survived by his children, Marlene Hubbard (Jon) of Bar Harbor, ME, and his son, Tim Otter (Lynn) of Caldwell, ID; two grandsons, Nick and Lucas Hubbard; and a sister, Margaret Street of Tucson, AZ.

Memorial contributions may be made to the Irish Youth Hockey League, 1421 S. Walnut St., South Bend, IN, 46619 (574-288-3300); or to the Center for Hospice Care, 501 Comfort Pl., Mishawaka, IN 46545. Welsheimer Family Funeral Home is assisting the family with arrangements. Family and friends may leave email condolences at www.welsheimer.com.

Published in South Bend Tribune on Mar. 9, 2017

See more at: http://www.legacy.com/obituaries/southbendtribune/obituary.aspx?n=richard-r-otter&pid=184413734#sthash.uaBeYa0f.dpuf

Dick Otter, ca. mid-1940s. His time at IU had a great influence on the course of his life, and I hope there are some who still remember him.

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Professor Tait congratulating Student-Selected Commencement Speaker, Professor Dragnea, at 2017 Chemistry Undergradaute Commencement

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A Well-Traveled Sign
by John Hayes

I arrived in Bloomington in 1970, fresh from a postdoctoral appointment in Bristol, England. I joined the faculty as a mass spectroscopist and analytical chemist, but my postdoc had been in organic geochemistry and much of my interest in chemistry developed from my parallel interests in earth science. The central problem in organic geochemistry is to understand the history of the molecules that can be extracted from sediments. *What organisms produced them? What do they tell us about the ancient environment? What has happened to them since their burial?* Dealing with those questions takes a lot of analytical chemistry. In my research, I hoped to develop techniques focused on the problems of organic geochemistry.

Years earlier, my biochemistry teacher had stressed isotopic tracing experiments as a means of dissecting metabolic pathways. In physical organic chemistry, I had heard about isotope effects in which the rate of a reaction or position of an equilibrium is affected by isotopic substitution. When I asked whether such phenomena could produce misleading results in tracing experiments, I was told, perfectly accurately, "The isotope effects can't be avoided but the isotopic separations that they produce are much smaller than the variations imposed by the tracers."

I kept thinking about that. The isotope effects associated with metabolic reactions would produce very subtle patterns of isotopic abundance in the products. Since natural carbon is comprised of 99% ^{12}C and 1% ^{13}C, some positions in a natural product would be slightly enriched in ^{13}C and others would be depleted. My students and I set out to measure those patterns. The plan was simple. First, learn what isotopic patterns are characteristic of primary biosynthetic products. Second, study sedimentary organic chemistry by examining the extent to which those patterns are preserved in the carbon skeletons of molecules extracted from rocks.

We found clear patterns of "intramolecular isotopic order" in fatty acids synthesized by bacteria and other unicellular organisms. At the same time, we developed new mass spectroscopic techniques that allowed us to determine the abundance of ^{13}C to within 0.0003 atom% in nanogram quantities of an organic compound. Together, these developments opened the door to measuring and understanding a host of isotopic signals in sedimentary organic molecules. For geochemistry, this was a breakthrough, but I don't think the work could have been done in a department of geology. The chemistry was too intricate.

But with that foundation laid, I began to be pulled strongly into the geosciences. I was given a half-time appointment in Geology, and we moved our labs to the Geology Building in 1984, being encouraged to do so because space was so tight in chemistry, in part due to a major remodeling project.

One day, as I was walking the hall on the main floor of the old Chemistry Building, I noticed that the construction crew had unceremoniously taken down and discarded the sign pointing to the departmental office. I pulled it out of the trash bin and have had it ever since. For some years it hung in our basement in Bloomington, pointing to my home office and defining my scientific roots.

By the 1990s, "isotopic biogeochemistry" (as I had taken to calling it) began to develop some real traction. We had a new tool and there was a lot of low-hanging fruit. Informative results kept appearing. The origins of most of the signals we were finding and interpreting were in the oceanic water column (where the producer organisms grew) and in ocean sediments (where a microbial community chewed on organic materials prior to their ultimate burial). In conversations with prospective graduate students, I used to tell them "I could die happy if, when a molecule of CO_2 dissolved in seawater was assimilated by an alga and used to produce organic matter, I could predict whether that carbon would be reoxidized or instead buried in the seafloor." We were getting close. I worked often with oceanographers and was a frequent visitor at Woods Hole Oceanographic Institution (WHOI) on Cape Cod.

In the ocean sciences, WHOI is a key center. It's a private research institution. The total head count, including double crews for three ships and a support staff for Alvin and other deep-diving submersibles, is about 900. The resident scientific staff is comprised of about 120 individuals organized into five departments. A doctoral program is shared with MIT. Remarkably, the whole thing runs on "soft money," with members of the staff writing proposals furiously to cover not only all the usual research expenses but also 100% of their annual salaries. You would think that wouldn't make it very attractive but, by providing a truly excellent research environment, the institution maintains a strong staff. Combined, they mount a broad and incisive attack on problems like the carbon cycle and its role in climate change.

And at the end of 1995 they called Bloomington to ask whether I might join them. By then I had become more of a natural scientist than physical scientist. In field studies, in particular, I had frequently encountered dramatic evidence of past global change. I was deeply convinced (and still am!) that our unchecked combustion of fossil fuels, and the resulting increases in concentrations of CO_2 in the atmosphere, were certain to have dire effects. As a result, I didn't hesitate and, in the summer of 1996, moved to Woods Hole.

The "**Chemistry Office**" (see cover photo) sign moved to our home on Cape Cod, continuing to serve as a reminder of my ever-more-cherished roots. The importance of the work we had done in Bloomington was increasingly recognized and honored. Unfortunately, as a result of my move, the celebrations were in Woods Hole. There, I found my work becoming more and more biological. Inspired by the intensively collaborative environment, we used our techniques to dissect the processes occurring in microbial communities, thus contributing to knowledge of processes occurring deep in seafloor sediments. It was, I have to say, enormous fun.

The constant search for funding was indeed a grind. As my 66th birthday approached, I decided that I could afford to retire, and that I would enjoy it. A year later, we moved to Berkeley, California. Our goals were to escape New England winter and to get closer to the center of our family. Of course, it's also the home of a fine university. The phone rang quite promptly and I wound up assisting in studies of the mechanisms by which bacteria assimilate inorganic nitrogen. In connection with that, I find myself appointed as a visiting scholar at UC/Berkeley in the Department of Integrative Biology. After a lifetime of multiple prefixes, I've now actually held appointments in departments of chemistry, geology, and biology. But the sign keeps reminding me of my roots and especially of the marvelous colleagues and support that I enjoyed in Bloomington.

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