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STEM: Science, Technology, Engineering and Math

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FOCUS ON STEM: Science, Technol



Susan Agre-Kippenhan
Vice President for Academic Affairs
Dean of Faculty

Science is on our minds here at Linfield.

In August, I joined 350 innovative leaders in biological research and education from 178 colleges and universities at the Vision and Change in Biology Undergraduate Education conference in Washington, D.C.

I accompanied Linfield biology Professors Anne Kruchten and Catherine Reinke, who had been invited to participate in this conference, co-hosted by the leading science foundations in the country. I was delighted to be party to this impressive group but also interested to learn how our work at Linfield fits into this national conversation. I was very pleased to find that the ideas at the heart of the conference are already embedded into Linfield's academic philosophy and practice.

The conference focused on the mandate for the future of undergraduate teaching and research in the sciences, an imperative not just for biology, but for the STEM disciplines (Science, Technology, Engineering and Math). In the broadest of terms, we need science education for every student. We must prepare future scientists, physicians, engineers and computer scientists. In addition, we are called to educate all students. As informed citizens they can participate in an increasingly complex world where scientific understanding is at the core of many, many issues.

At Linfield, our faculty have already taken to heart the themes that permeated this conference:

- Science education is about doing science, not just learning about science.
- Collaboration is critical to address issues that do not neatly fit into any single discipline.
- Critical thinking, data analysis and communication are essential scientific skills for scientists and non-scientists alike.
- The ability to communicate science to the general public is crucial.

All of these themes are found at Linfield: articulated in our strategic plan, demonstrated in our engaged teaching and evident in our student-faculty collaborative research. They are critical to the rich conversation about the future of science at Linfield, initiated by faculty, that includes professors from STEM disciplines and many other departments as well as trustees of the college, and friends in the community.

In the pages that follow, you will learn about our students, faculty and alumni. As President Hellie discusses in A View from Melrose (page 2), science is very much on our minds.



Opposite: Amanda Dorman '14, led by Professor Stephen Bricher '86, took a mathematical look at terrorists during her summer research project. Her work culminated in a paper, which she hopes to submit to an undergraduate journal and present findings at a math conference in the spring.

ogy, Engineering and Math

Mathematical look at terrorists



Amanda Dorman '14 spent her summer pondering terrorists – from a mathematical perspective.

She and Stephen Bricher '86, professor of mathematics, investigated the population dynamics of terrorist organizations, specifically Al-Qaeda. To answer their ultimate question – How to prevent terrorists from taking over the world? – Dorman examined recruitment rates of potential terrorists and martyrs and identified relevant questions that could motivate future research in the social sciences.

As a math major and psychology minor, Dorman designed

“It’s amazing to me that you can do this – use mathematics to take a real-world situation and understand how a terrorist organization evolves and works. I love it.”

– Professor Stephen Bricher '86

the project to meld her two interests.

“The model is a four-dimensional system of nonlinear differential equations, which is crazy hard to analyze,” said Bricher, who recommended Dorman read published math papers and problems with similar models. “We started with a basic form





Students used syringes to collect water samples while scuba diving. This photo is an example of how to collect a sample of exhalant water, or water that is being exhaled by the sponge. The sample measures the nitrogen concentrations leaving the sponge, which are then compared to the concentrations entering the sponge to determine the effect on the nitrogen in the water.

from other research and then made it our own."

Dorman was able to find data to estimate some of the parameters in their model. For other parameters that couldn't be estimated with known data, they applied different examples across a wide range of realistic values to see how they would affect the solution.

It is this trial and error, this asking and answering, that prompts additional questions. Dorman and Bricher discuss, analyze and repeat the same questions from new angles. They work in a classroom diagramming equations on the white board, then move to the computer lab where they write computer code and graph solutions to their mathematical models using the software program Mathematica.

From time to time, they stumble upon a breakthrough.

"At one point, Mandy brought up a big point," Bricher said. "What is the rate at which a potential terrorist becomes a terrorist based on an interaction with a terrorist? That data doesn't exist and would provide motivation for a psychological study."

Sociologists or social psychologists might research the inner cells of a terrorist organization to see what would serve as incentive to quit, said Dorman.

"This could result in developing more effective governmental policies to control a terrorist organization's population size," she added.

Using math to understand and explain real-world phenomena drew Bricher to the subject more than two decades ago, while a student at Linfield.

"It's amazing to me that you can do this – use mathematics to take a real-world situation and understand how a terrorist organization evolves and works," Bricher said. "I love it."

Are sponges bioindicators?



Imagine diving into 30 feet of murky water, tides pulling and pushing as you try to collect water samples and pull sponges clinging tightly to rocks on the seabed.

That's how three Linfield students spent part of their summer, clad in wet suits, air tanks and thick gloves. Their excitement is palpable as they describe being tossed by tides, clinging to rocks and sometimes barely able to see inches in front of their faces.

Matt Creech '14, Amy Hammerquist '14 and Mariah Denhart '15 worked alongside Jeremy Weisz, assistant professor of biology, investigating whether sponges can serve as bioindicators of pollution. Weisz is researching how sponges, which filter huge volumes of water, respond to changing nitrogen levels. They might indicate if an estuary is clean or if it is being impacted by pollution.

The students spent about three weeks diving in Netarts Bay, and in between returned to the lab at Linfield to analyze their samples. They learned basic and advanced lab techniques and were trained to use a scanning electronic microscope. The knowledge will help them as they pursue graduate studies and is also filtering back into their classes.

"It's been fantastic because for every biology or chemistry-related class I have, everything makes more sense when you learn how to apply it. It keeps me thinking about science when school's out and keeps your brain figuring out different ways that biologists have of solving problems." – Matt Creech '14



Matt Creech '14, Mariah Denhart '15 and Amy Hammerquist '14 spent the summer scuba diving and collecting samples and then analyzing them in the lab. They agreed that working with Professor Jeremy Weisz has been their best college experience, saying he allowed them freedom to work alone, but was always available to help when needed. "He's patient and relaxed and never got excited when we made mistakes," Hammerquist said. Creech added, "We have to be serious in the field, but his relaxed attitude made us more creative. You think of different things, you work in different ways."

"It's been fantastic because for every biology or chemistry-related class I have, everything makes more sense when you learn how to apply it," Creech said. "It keeps me thinking about science when school's out and keeps your brain figuring out different ways that biologists have of solving problems."

Students honed critical thinking skills daily. "There are plenty of things that can go wrong in the field that you have to deal with on the fly," Hammerquist said. "You learn how to keep calm under pressure and deal with challenges that come up."

All three students will present their findings at the Murdock College Science Research conference this fall and they will attend the American Society of Microbiology conference in the spring. Hammerquist will present her work there as part of the undergraduate research fellowship she was awarded for her work with Weisz during the summer.

Molecular biology of HIV

Jasper Erickson '13 didn't just spend the summer studying the molecular biology of HIV – he did it in Germany while immersing himself in another culture.

He merged his love of biology and German into a research internship at the Federal Institute for Vaccines and Biomedicines, near Frankfurt.

A semester studying in Vienna, Austria, fueled Erickson's interest in returning to a German-speaking country. His earlier research at Oregon Health and Sciences University and with Catherine Reinke, assistant professor of biology at Linfield, prompted his search for opportunities in Germany.

Erickson studied the molecular biology and biochemistry of HIV as part of the German lab's work identifying mechanisms by which HIV hijacks host cells. The work could eventually lead to better therapies and treatments for HIV.

Erickson was no stranger to research into infectious disease. He completed an independent project with Reinke on HIV and worked in her lab his senior year, dissecting the microRNA pathway in fruit flies. At OHSU, he studied the Dengue virus, the agent responsible for Dengue fever, which affects millions and for which there is no vaccine or cure.

Erickson's German internship was sponsored through the Research Internship in Science and Engineering (RISE), a program



Jasper Erickson '13 conducted research alongside Catherine Reinke, assistant professor of biology. He said many Linfield professors were influential throughout his education including Peter Richardson, professor of German, who encouraged him to study abroad, and Bob Wolcott, professor emeritus of chemistry, who also conducted research in Germany as a student and provided support and inspiration to Erickson.

"The translation of findings in the lab to treatments for patients in the clinic is of the utmost importance for the advancement of medicine." – Jasper Erickson '13

of DAAD (the German Academic Exchange Service). While expanding his knowledge about immunology, he also learned how much is yet to be discovered in the fields of HIV and immunology.

Erickson plans to apply to medical school and his research experiences provide a good perspective for that career.

"The translation of findings in the lab to treatments for patients in the clinic is of the utmost importance for the advancement of medicine," he said. "The communication and understanding between researchers in academia and clinicians in the hospital is essential for the success of biomedical science and clinical therapy. Through these experiences I will try to tie in what I'm doing in the lab to the potential effect the research might have in a clinical setting."

Computer science, web design

Nate Mills '14 has immersed himself in learning languages, without conjugating a single verb.

Over the summer, Mills honed skills in computer languages such as Javascript during an internship with Lvsys, a web design company based in McMinnville. The Lvsys content management system enables customers to design their own websites. Mills, who has continued his work this fall, helps with technical support, investigates system bugs and works with clients on individual projects.

The personalized internship is comparable to work towards a master's degree, according to Dan Ford, assistant professor of computer science and Mills' advisor.

"The amount of experience he's gained is the equivalent to an extra year of study," said Ford. "It's huge."

Along with learning a new language is learning *how* to learn a new language. Mills learned Javascript, the computer code that makes web pages come to life.

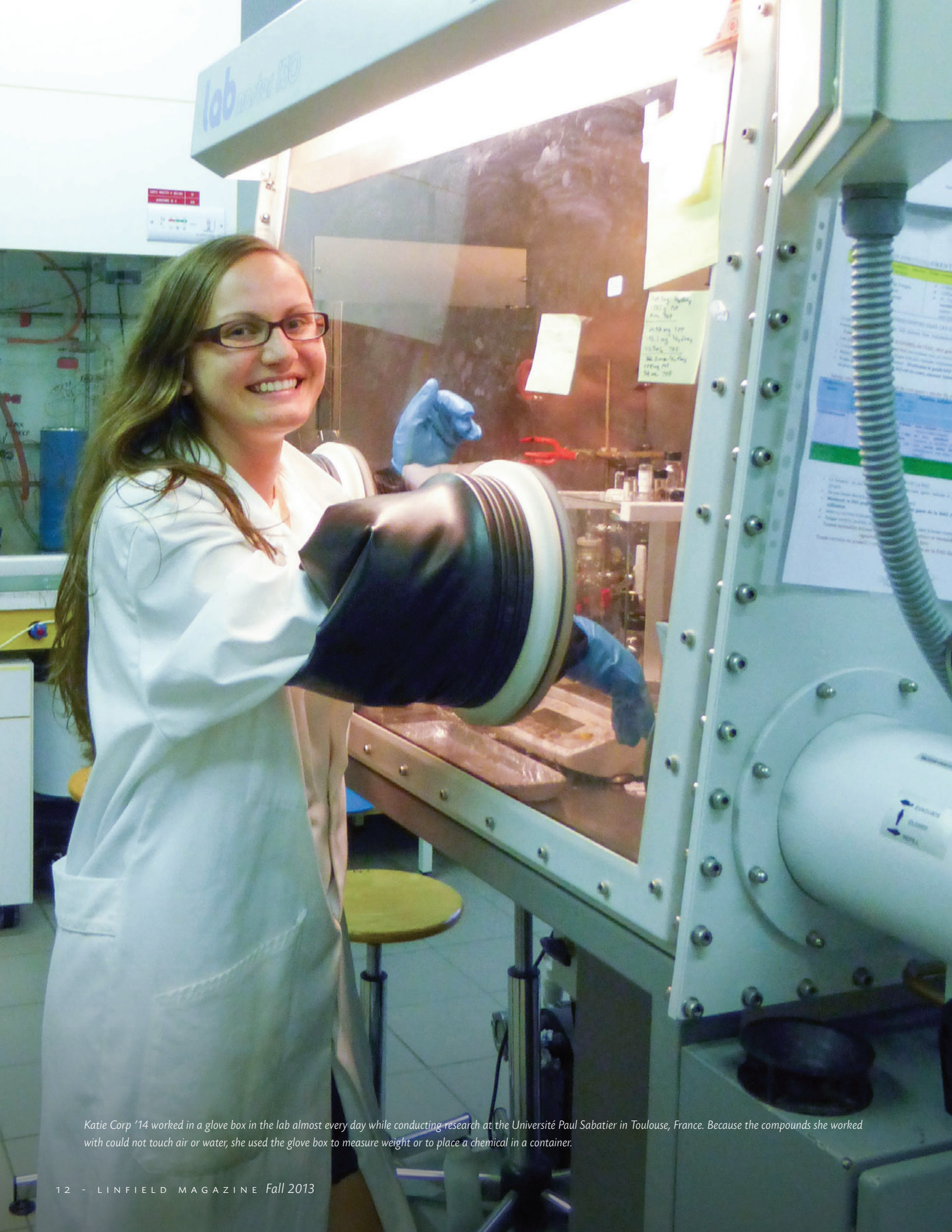
"In a classroom, I can talk with the professor, ask questions and get answers," said Mills, a computer science and math double major. "But in the workforce, there are fewer direct answers. Learning where to go online and what resources are best for particular situations is important. With computer languages, there are large online forums to go to, but learning how to find those is important."

Mills now knows more than 10 computer languages, and that number continues to grow – including coding languages such as Java, C++, PHP; and web-based languages such as Javascript, HTML and jQuery.

According to Ford, the summer internship is crucial to providing real-world experience for students, and provides a transition into the professional world. But more than that, it has reinvigorated Mills' interest in programming.



Nate Mills' internship, focusing on web design, has reinvigorated his interest in computer science. The hands-on experience of developing projects and presenting to clients is invaluable to Mills as he looks ahead to next year when he will join the workforce.



Katie Corp '14 worked in a glove box in the lab almost every day while conducting research at the Université Paul Sabatier in Toulouse, France. Because the compounds she worked with could not touch air or water, she used the glove box to measure weight or to place a chemical in a container.

"Once students understand how to learn and test things on their own, their learning accelerates dramatically," Ford said.

After graduating from Linfield, Mills hopes to continue working with Lvsys and might eventually pursue video game creation.

Nanoparticle research in France

A presentation at a national leadership conference helped Katie Corp '14 secure a research internship in France last summer. Corp, a chemistry and math major, applied for a research internship through the National Science Foundation Research Experiences for Undergraduates (NSF-REU) program seeking an opportunity to combine her passion for chemistry and math with her love of all things French.

Corp spoke at the American Chemical Society conference last year offering tips and suggestions on how professors should communicate with undergraduate students. That presentation led to an encounter with a professor with ties to the NSF-REU program and an endorsement for her acceptance into the program.

Corp spent the summer at the Université Paul Sabatier in Toulouse, France, where she worked with nanoparticles that could eventually be used for developing tiny electronic circuits. She expanded not only her chemistry knowledge, she also worked alongside people from around the world.

As a freshman, Corp began working on nanoparticle research with Brian Gilbert, associate professor of chemistry. Over the next three years, she learned how to use a Raman spectrometer and other lab equipment and techniques. In France, she had access to state-of-the-art instruments and was trained on a nuclear magnetic resonance machine, a transmission electron microscope, glove box and vacuum lines.

Working in a large research lab with 250 people was overwhelming at first, after conducting research at Linfield with anywhere from four to 12 students, Corp said. However, researchers were split into smaller teams, which more closely resembled her Linfield research experience.

"This experience studying abroad and doing research in a different culture will strengthen my applications to graduate school," said Corp, who plans to pursue a Ph.D. in chemistry.

"I'm not set on a big-name school, but somewhere where I love the research and I can get a good adviser and a great education," she added.

Computational physics

Deep in the basement of Graf Hall, three Linfield College science students are running experiments using computers rather than test tubes.

Welcome to the world of computational physics. Arun Bajracharya '16, Tyler Schiewe '16 and Yura Sim '14 are combining their skills in physics, biology and computers to gain a more holistic understanding of proteins. Led by Joelle Murray, associate professor of physics, they are using computer simulations to study protein folding, the process by which a protein assumes its functional shape. Some diseases, such as Parkinson's and Alzheimer's, are the result of misfolded protein structures.

"If we can learn and understand how protein folding occurs,

scientists could possibly prevent the misfolding from occurring in the future," said Sim.

The students are studying protein folding under the framework of self-organized criticality, a physics concept useful in understanding forest fires and avalanches. In the same way that random movements of snow on a mountain can produce a complete avalanche, the students have tried to see if random folds in a protein can produce physically realistic protein structures.

The three are learning more than just physics. All distinct individuals with varied skill sets, they are learning to problem solve as a team while maintaining their own perspectives.

"The three of us have different backgrounds and know completely different things," said Sim, a biology and chemistry double major, as the others nod in agreement. "It's important to problem solve and communicate."

Schiewe, a math major, says merging the science fields – biology and physics – has given him a broad perspective.

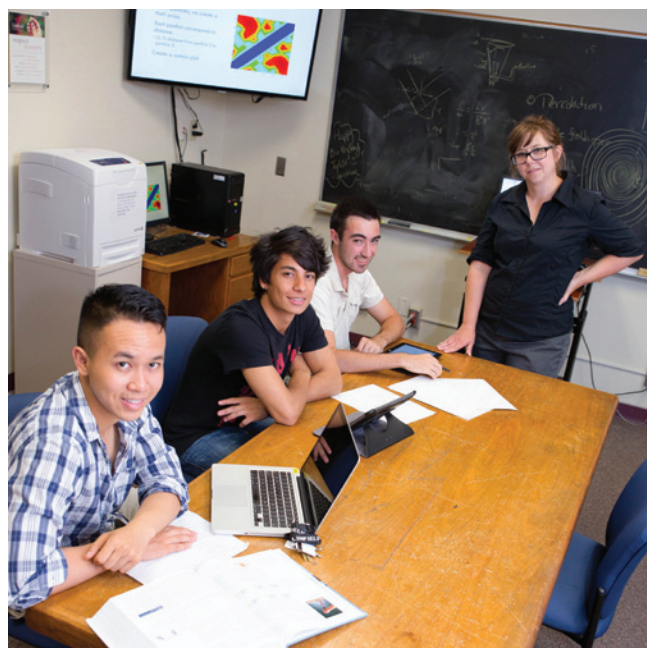
"Being able to look at different ideas and figure out how they relate is a valuable skill," he said. "If we can understand what we've learned from protein folding and apply that to other projects, that's extremely useful."

For Bajracharya, a physics major and math minor, the experience has spurred an interest in computer programming.

The research project, in its fourth year, resulted from class discussions between Murray and her students and centers on self-organized critical systems. This is the first research to look at protein folding from this perspective, Murray said, which makes it both challenging and exciting.

"The research we're doing is not well defined," Murray said. "There's no textbook to refer to. We are defining it and that's hard to do." 🌿

– Laura Davis, Mardi Mileham



From left, Yura Sim '14, Arun Bajracharya '16 and Tyler Schiewe '16 with Professor Joelle Murray, spent the summer studying protein folding with computers. In the simulation environment, proteins can be folded by assigning coordinates and moving them about. "The trick is writing code that mimics reality and makes predictions," Sim said.