# UWYO

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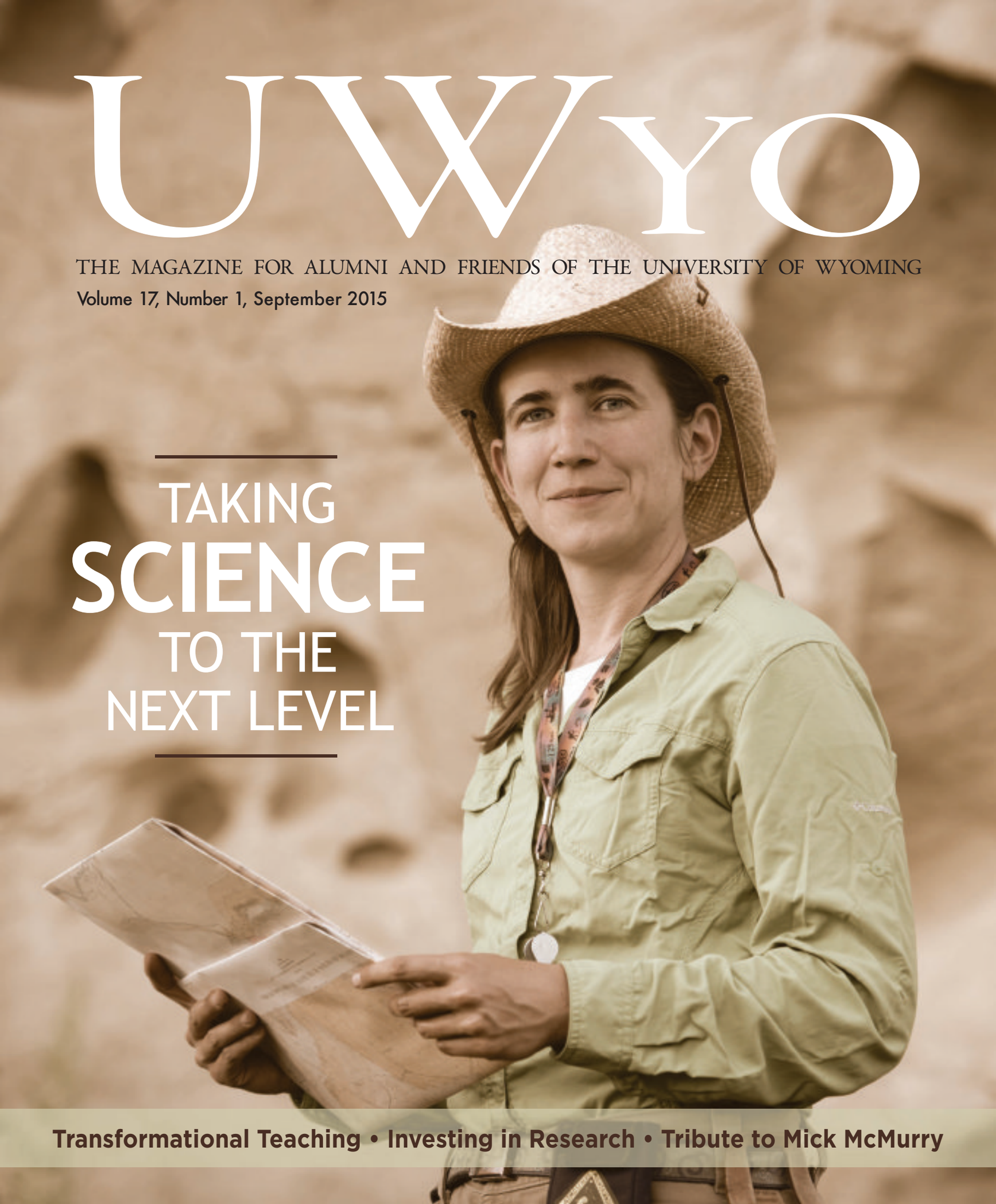


## TAKING SCIENCE TO THE NEXT LEVEL

**Transformational Teaching • Investing in Research • Tribute to Mick McMurry**

# INVESTING IN RESEARCH

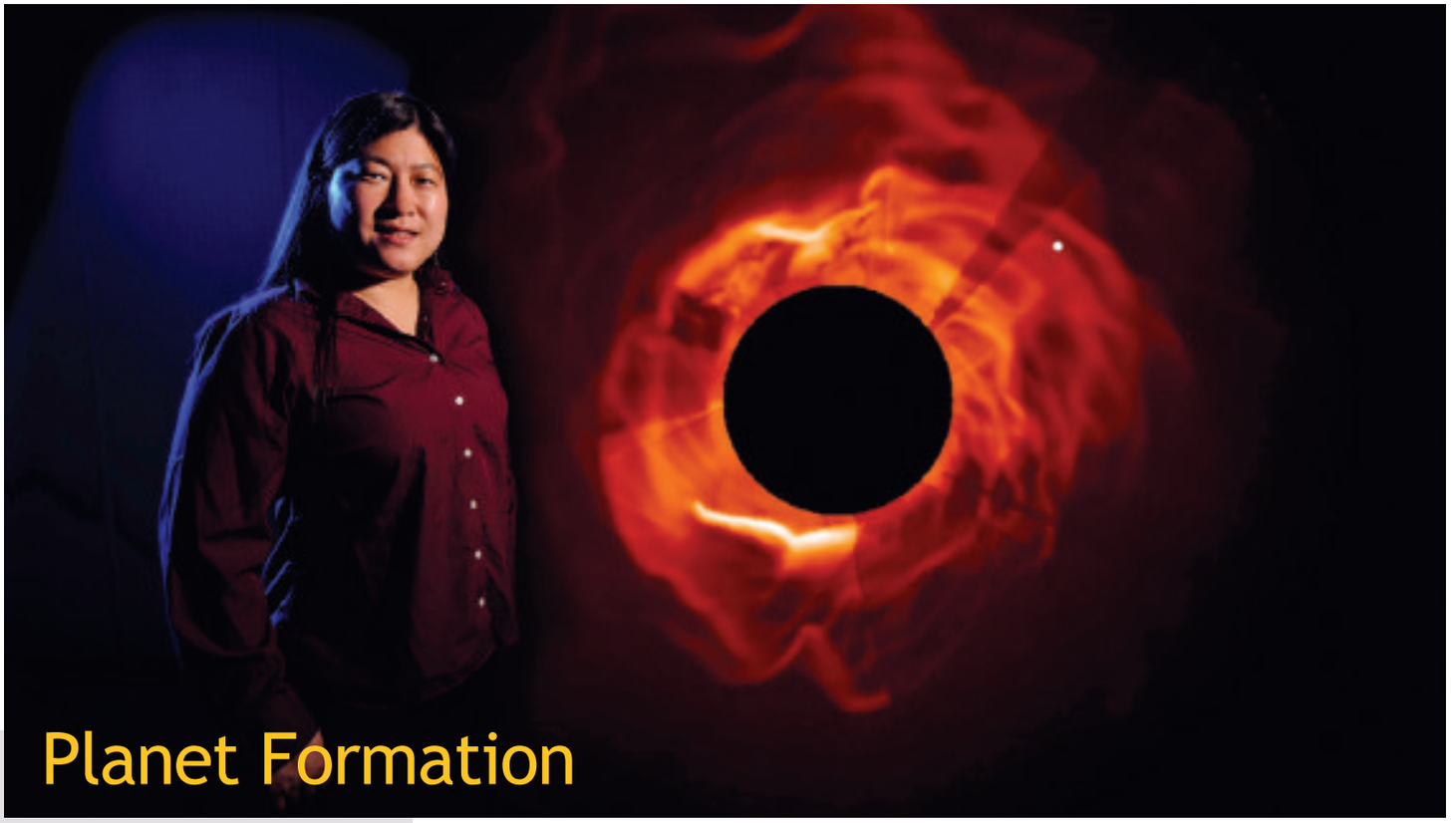
***The UW Science Initiative's innovative programs will stimulate research, leading to fundamental discoveries.***

**By Micaela Myers**

Gravity, electricity, transistor theory, penicillin, the structure of DNA, X-rays, vaccines, communication via satellites—all these discoveries and countless others came about through the hard work and research of scientists.

The core sciences at the University of Wyoming—including botany, chemistry, molecular biology, physics and astronomy, and zoology and physiology—study what exists in nature and how it works. The fundamental discoveries emerging from physical and biological sciences become the foundations of future technology, engineering and medicine. Recognizing this, UW's Science Initiative provides support for scientific research.

Here, we introduce you to five researchers from the core science departments, and we share the new research support programs aimed at promoting research for undergraduates, graduate students and faculty members.



# Planet Formation

**Hannah Jang-Condell,** assistant professor in the Department of Physics and Astronomy

**Background:** B.S. Massachusetts Institute of Technology (MIT); Ph.D. Harvard University; postdoctoral fellowships at Carnegie Institution for Science, NASA's Goddard Space Flight Center, the University of Maryland and the Space Telescope Science Institute; joined UW in 2011.

**Why UW?** "I do computational astrophysics, so the big attraction for me was the NCAR-Wyoming Supercomputing Center."

**Research:** "I study how planets form around other stars and around our own sun."

Planets that orbit a star other than the sun are called exoplanets, and close to 2,000 exoplanets have been discovered so far.

"They're very different from our solar system. You'll have planets that are two or three times Jupiter's mass that are closer to their star than Mercury is to the sun."

Jang-Condell and her team study how these gas giant planets can be so close to a star's heat, and they study why some planets have eccentric orbits.

"I hope my research will lead to a better understanding of our place in the universe because I feel like one of the fundamental questions humanity has is, 'Are we alone in the universe?' "

By finding out how common habitable planets like ours are—planets that have a rocky body and are the right distance from a star to have liquid water—researchers can better determine if any are inhabited.

Jang-Condell and her team were recently tapped to take part in NASA's Nexus for Exoplanet System Science initiative, an interdisciplinary project that connects top research teams for a synthesized approach in the search for planets with the greatest potential for signs of life.

"If we can learn more about what life is like on other planets, I think that would be extremely exciting."

**About the Science Initiative:** "I think the Science Initiative will bring better students to our university and improve the education we can provide to those students.

"I'm excited about drawing more students into physics and astronomy. One of the things that we have high hopes for are upgrades to the Wyoming Infrared Observatory (see page 27). Wyoming used to be a major power in research astronomy in decades past, but since that time, bigger and better telescopes have been built. If we can make an investment in our current assets and really develop them, we can still be a player."

# Cell Nuclear Size

**Daniel Levy,** assistant professor in the Department of Molecular Biology

**Background:** B.S. California Institute of Technology; Ph.D. University of California, San Francisco; American Cancer Society Postdoctoral Fellow at University of California, Berkeley; joined UW in 2011.

**Why UW?** "I was immediately excited about the research going on." Levy uses frogs as the model organism for his research, as does fellow UW molecular biologist Jay Gatlin, so Levy knew he could hit the ground running with his own research projects.

**Research:** Inside each cell is a nucleus—a compartment that contains the genetic information directing how the cell grows and behaves. Large cells generally have large nuclei, while smaller cells have smaller nuclei, but little is known about how cells regulate their nuclear size. This is where Levy's research comes in.

"It turns out there are some really interesting disease implications when it comes to nuclear size regulation because in cancer cells, the nucleus is usually much larger. The real goal of my lab is to try to understand the basic mechanisms that control the size of the nucleus with the hope that when we have that basic cell biological understanding, we might apply it to cancer diagnosis or treatment."

Levy and his team have already identified specific proteins that are important for controlling nuclear size in frog cells, and these same proteins also seem to be important for controlling nuclear size in humans.

"This change in nuclear size is certainly used diagnostically, but in terms of treatment approaches for cancer, no one has really targeted nuclear size. If these cells are really dependent on these larger nuclei for their cancerous growth, and we could specifically target that, we might be able to knock out the cancer cells but not affect the normal cells."

**About the Science Initiative:** "I'm really excited about having a new building and new lab space. One of the big issues with molecular biology is that we're split up right now, which is not ideal for collaboration."

# Plant Growth

**Cynthia Weinig,** professor in the Department of Botany and Department of Molecular Biology

**Background:** B.S. Brown University; Fulbright fellowship at University of Minnesota; Ph.D. Indiana University; postdoctoral fellowship at Brown University; faculty member at University of Minnesota; joined UW in 2007.

**Why UW?** "I was intrigued that the position was split between botany and molecular biology, which I thought would offer a lot of opportunities. Wyoming also offers a wonderful quality of life."

**Research:** Weinig studies the traits and genes that enhance performance of plants in variable settings. This research includes both wild and crop species.

One of Weinig's projects, done in conjunction with researchers at other institutions, examines how plants interact with organisms below ground, called the rhizosphere microbiome. This community of microorganisms exists around plant roots.

"While we largely know what plants and animals exist in a certain habitat, what's below the ground is more of a mystery. If you look below ground, you can find thousands of microorganisms.

"As part of a new project, we will use DNA sequencing to understand the taxonomic composition of the microbiome—what species are there, as well as a functional analysis to tell us what function those microbes are performing, such as improving nitrogen accessibility and water availability. It turns out that if you grow plants in the absence of a complete and complex microbiome, they have reduced performance.

"We're also going to grow plants in the presence and absence of their natural rhizosphere microbiome and ask how that changes plant gene expression. That should give us very good clues as to why the presence of microbes in soil affects plant performance."

**About the Science Initiative:** "It's really an exceptional opportunity. We're fortunate the Legislature appreciates the university and realizes it's truly a training ground for the citizens—a place where we can provide research to benefit the state, educate our students and also raise the profile of the state in many ways."

# Nanomaterials in the Catalytic Processes

**Jing Zhou,** associate professor in the Department of Chemistry

**Background:** B.S. Xiamen University; Ph.D. University of South Carolina; postdoctoral researcher at Oak Ridge National Laboratory; joined UW in 2007.

**Why UW?** "I really liked the chemistry department and the opportunity to be able to do research and teach."

**Research:** Think tiny. Zhou and her team work with nanomaterials, which are partially characterized by tiny size, measured in nanometers. A nanometer is one millionth of a millimeter, or about 100,000 times smaller than the diameter of a human hair.

"I'm working on understanding nanomaterials and how they work for energy conversion and the industrial catalytic process."

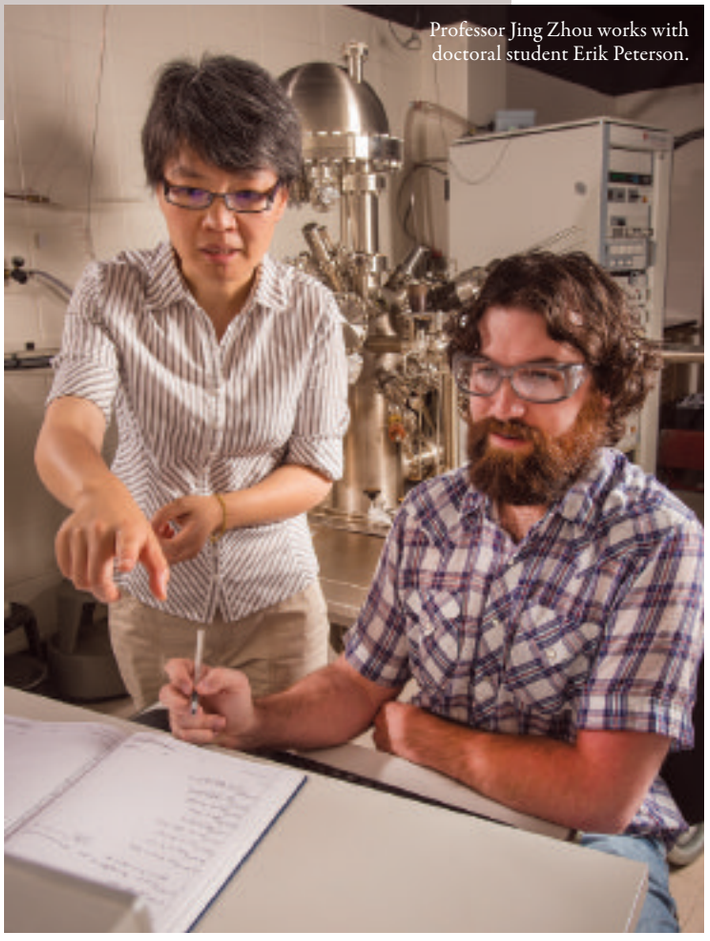
For example, they're studying what are called "oxide-supported metal nanoparticles" like nickel and gold. "We use the nickel as a reforming catalyst for methane natural gases and ethanol to produce hydrogen. We use the gold as a good material for oxidation to convert the harmful carbon monoxide into carbon dioxide.

"We use state-of-the-art instrumentation to understand the science at the atomic and molecular level to see how the materials work.

"What I'm doing right now is using a model system. We're hoping that by understanding those simple systems, the next stage will be to bridge the model to the real-world application and give insight into the development of new nanomaterials."

**About the Science Initiative:** "A centralized imaging facility with scientists who can help the students better use that instrumentation for their research will be a huge plus. It also helps UW in the long run to better maintain and use those instruments."

Zhou is also excited for a centralized location for students and faculty to meet and collaborate. "Working in the nanomaterial field, I could see the students in chemistry, chemical engineering and physics mingling together and sitting down to chat."



Professor Jing Zhou works with doctoral student Erik Peterson.

# Skin's Senses

**C. Jeffery Woodbury,** associate professor in the Department of Zoology and Physiology

**Background:** B.S. Arizona State University; Ph.D. Stony Brook University (SUNY Stony Brook); assistant research professor at University of Pittsburgh; joined UW in 2003.

**Why UW?** "What drew me was the locale—and especially the sense that the people here were a community that really loved Laramie."

**Research:** Woodbury and his team study the senses of the skin at a very detailed, single-cell level. "All of our work is in mice, so everything is extremely specialized and miniaturized to allow us to do this work."

Skin contains many types of sensory neurons. "Each of these sensory neurons is tuned to extract only a small amount of information from the environment. Some are specialized to respond only to the movement of hairs. Some are specialized to respond only to constant indentation of the skin, some to light touch, others to heavier pressure and others to pinch. Some only respond to slight changes in temperature, whereas others only respond to temperature extremes."

Woodbury is especially interested in how this diversity is organized, how it develops and how it changes after injury or disease. He also studies the interaction and transition between touch, which is a pleasant feeling, and pain, which is very unpleasant.

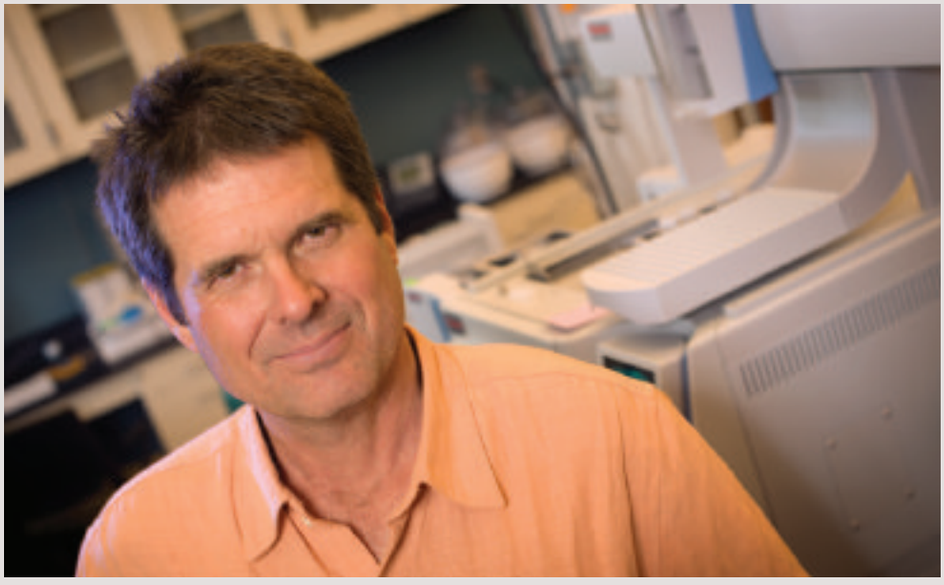
"We know there are a number of chronic pain syndromes where the distinction between those two extremes—from touch to pain—becomes blurred and even reversed. What we hope to do is examine the changes that are taking place not only in the skin but also the spinal cord, which receives all this information. We hope we can get a better understanding of what causes pain and how touch fibers can produce it."

**About the Science Initiative:** "I'm most excited about modernized facilities, especially the imaging facilities. There's also a potential for cross-fertilization by bringing all biologists together."

# New Programs, New Support

## Wyoming Research Scholars Program

The Science Initiative includes several programs to promote research, starting with undergraduates. "The Wyoming Research Scholars Program is our effort to bring a hands-on research experience to qualified students," says David Williams, head of the Department of Botany. "We believe the skills they will learn can take their fundamental education to the next level and make them competitive internationally for the next stage in their life."



David Williams, faculty director for the Stable Isotope Facility and a member of the Science Initiative Leadership Team, says undergraduate research will help attract top students to UW.

Applicants must be science majors, and scholars will be chosen from a wide spectrum—from top students, to transfer students, to students with the potential for growth. Once fully implemented, the program will fund 25 students in each year of school for a total of 100 students at any given time. Students will be paired with faculty mentors who can model the scholarship, teaching, service and outreach activities of a professional scientist. Stipends will include funds to enable students to work in labs and to attend and present their work at conferences. The program cohort will participate in a one-credit seminar class each year to learn about scientific process, ethics, public speaking and writing. Junior and senior students will also collaborate with the Science Initiative Ph.D. fellows and faculty mentors in research and spend one semester as a peer instructor in active-learning classrooms.

"I think it will help keep the best students in Wyoming and also attract top students from around the region because they see these great opportunities," says Williams, adding that his undergraduate experience was key for him going on to graduate school. "The marketplace is getting much more competitive, and students graduating with a four-year degree need to show more than just coursework."

## Ph.D. Fellowship Program

In order to attract more high-quality graduate students to UW, the Science Initiative includes the Ph.D. Fellowship Program.

"Successful Ph.D. students bring a lot to a university," says botany and molecular biology Professor Cynthia Weinig. "They contribute to ongoing research and develop novel research avenues themselves, and they contribute to the vibrancy of the educational experience for our undergraduates."

"My doctoral students play a huge role in my research," says Jing Zhou, associate professor in the Department of Chemistry. "They are the driving force."

Once fully implemented, the Ph.D. Fellowship Program will provide funding for 20 prestigious Ph.D. fellowships within the core five science departments. These fellows will undergo training and demonstrate competency in outreach, as well as perform one semester of active learning classroom teaching and/or undergraduate research mentorship via the Wyoming Research Scholars Program, in addition to performing doctoral research.

Fellowships will be awarded on

Graduate student Kristen Smith works in Associate Professor C. Jeffrey Woodbury's lab. The Science Initiative created a new Ph.D. Fellowship Program to increase the number of Ph.D. students graduating from UW.

a competitive basis to the most outstanding graduate applicants and will last for up to five years with stipends competitive with highly selective nationwide fellowships awarded through the National Science Foundation and the National Institutes of Health. This competitive package, along with UW's new planned facilities, will help attract top graduate students. The program also aims to increase the number and quality of Ph.D. students graduating from UW to bring programs to top-quartile status; to train the next generations of leading scientists with skills to address challenging and relevant interdisciplinary problems, and to pursue successful careers and conduct effective outreach; to stimulate an increase in successful research grant proposals from interdisciplinary researchers; and to reduce average time-to-degree for a UW Ph.D.

## Competitive Research Innovation Program

The Science Initiative's Competitive Research Innovation Program (CRIP) aims to elevate STEM—science, technology, engineering and mathematics—research at UW by providing infrastructure and increasing grant funding for principal investigator-initiated research projects.

These days, hiring top-tier faculty members in the sciences requires providing those researchers with significant startup funding. The CRIP program will provide funds to supplement available startup funding in the five core sciences. In addition, major pieces of equipment required for modern-day scientific research can cost $500,000 to $1 million and have a lifespan of eight to 12 years. CRIP will provide additional funds to help replace instruments that have reached the end of their functional lives.

"Since I've been chairman of the Department of Molecular Biology, we've hired four faculty members," says Associate Professor Mark Stayton. "We've had multiple candidates turn us down in this process. We had one failed search, and it was because there wasn't the right instrumentation on campus. The Science Initiative offers us a way to cover part of the needed startup costs for new hires and therefore make us competitive for these elite new faculty members."

Another major aspect of the CRIP program is seed grants—one to two years of funding at $30,000–$60,000 in order to allow faculty to jumpstart new or innovative research streams that are not yet mature enough to win extramural funding. Recipients will be expected to submit competitive full multiyear proposals to the National Science Foundation, Department of Energy, National Institutes of Health or similar federal agencies within two years of receiving seed grants.

"CRIP helps encourage competitive proposals from faculty members with seed funding," Stayton says. This funding is all the more important given the increasingly competitive nature of federal funding, he adds. "We're going to enable faculty members to get the preliminary data they need for a grant."