

Chico

S T A T E M E N T S



Students Michael Choy and Matt Vakili load a fermentation sample on a high-performance liquid chromatography device.

The Next Generation of Scientists

Chico State is attracting math and science majors in record numbers

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Research opportunities at CSU, Chico are attracting math and science majors in record numbers by Anna Harris

Most Chico alums and residents have a sense of home-town pride about Sierra Nevada Brewing Co. without knowing much about the intricacies of making beer. Even those who wax rhapsodic about the level of “hoppiness” or understand the distinction between top-fermenting and bottom-fermenting yeasts don’t usually think about the sheer amount of waste generated by the brewing process. For example, five gallons of home-brewed beer requires 10 pounds of grain, several ounces of hops, and an ounce of yeast, nearly all of which are discarded at the end of the process—and the amount of waste generated by a large-scale brewery can be mind-boggling.

Much of Sierra Nevada Brewing Co.’s waste feeds local dairy and beef cows, becoming cheese and milk and the burgers served in the brewery’s restaurant. The rest of it may soon become eco-friendly plastic cups and forks. To effect this alchemical change—turning yeast into plastic—Sierra Nevada founder, owner, and president Ken Grossman turned to students and faculty at his alma mater.

CSU, Chico students Paul Morris (BS, Biological Sciences, '08) and Kevin Parsons (BS, Biological Sciences, '08) spent their senior year experimenting with Sierra Nevada’s brewery waste—and

winning awards for doing so. They looked at the possibility of using spent yeast or other agricultural waste such as rice hulls as a medium for growing bacteria that produce lactic acid, which can then be made into biodegradable plastics.

Their research project, called “Use of Brewery Waste for the Microbial Conversion of Carbohydrates to Lactic Acid,” was supervised by professors Larry Kirk, Chemistry, and Larry Hanne, Biological Sciences. Professor Joe Greene, Mechanical Engineering, collaborated on the project and obtained funding from Sierra Nevada Brewing Co. and the California Rice Research Board. The project won first place in the 22nd Annual CSU Student Research Competition, held at CSU, East Bay in May 2008.

When asked what made this project stand out, Hanne points to what he calls a “perfect storm” of factors: two excellent students working on a “sexy project” that has the potential to revolutionize the way we deal with agricultural and industrial waste. “This project is one of those projects that just makes sense,” says Morris. “It is a brilliantly simple solution to two distinct environmental problems—industrial waste and non-biodegradable plastic.”



Biological Sciences majors Kevin Parsons and Kyle Arnet test the purity of bacterial cultures.

The opportunity to experiment

Morris is one of a growing number of students who have chosen CSU, Chico’s College of Natural Sciences for the chance to work closely with faculty on a wide range of projects as undergraduates—an opportunity virtually unheard of at the larger research institutions, where undergrad programs are largely theoretical.

“I was accepted to a larger university with a pretty hefty scholarship before I decided to go to Chico State,” says Morris, who initially thought a large research institution could best prepare him for medical school or a PhD program. Then, at a Shasta College presentation, he heard Chris Nichols and Dan Edwards, Chemistry, talk about their research at CSU, Chico. “After that, I knew that I could get the education I needed at Chico State,” he says. Morris has since entered an MD/PhD program

at Uniformed Services University of the Health Sciences, the military’s medical school.

These research opportunities are attracting math and science majors to CSU, Chico in record numbers. Dean of Natural Sciences James Houpis says the college has nearly doubled the number of majors since he became dean in 2001. Each semester, more than 25 percent of undergraduate students in the college are involved in research lab work, field research, internships, and service learning.

College faculty and staff directed research projects worth more than \$11 million last year. The funding sources for these projects range from small grants from local entities to large chunks of money from federal sources such as the National Institutes of Health and the U.S. Forest Service.

Natural Sciences majors can work on

just about anything that sparks their interest. Each student is given a list of faculty members and their research interests, and encouraged to contact those doing projects that interest them. They can get units for their work through an independent study course. Opportunities abound: Last year Natural Sciences faculty published more than 85 articles, proceedings, and abstracts and made nearly 200 professional presentations—and they involved students in nearly all of this work.

On any given day, students may be clustered in labs working on projects related to potential drug treatments for Alzheimer’s disease with Jonathan Day, Biological Sciences. Or monitoring volcanic activity in Lassen Volcanic National Park with Rachael Teasdale and Dave Brown, Geological and Environmental Sciences. Or synthesizing natural compounds called neolignans

with antibacterial and antiviral properties with Jinsong Zhang, Chemistry.

The “quiet crisis”

The College of Natural Sciences is making a concerted effort to attract students like Morris, considering it of crucial importance to foster an interest in science among young people, says Houpis. This is in response to what has been called the “Quiet Crisis,” the widening gap between the U.S. need for experts in science and technology and the country’s ability to produce them.

“I pursued a career in science, and when I look back, there’s no one behind me to work in our jet propulsion labs, our national labs, to replace a workforce of scientists and mathematicians and engineers close to retirement,” says Houpis. “We are coming near the edge. Is the educational system going to wake up before it’s too late?”

He adds that many students have the wrong impression about science, thinking it boring or purely about memorizing facts. “But really, science is akin to art,” says Houpis. “It’s creative. Every day there’s a new problem you need to solve. That is what we want to get across to students: a real scientific job is creative, is different, is exciting.”

“[Students at CSU, Chico] get to see what doing research is really like,” says Gordon Wolfe, Biological Sciences, who was named the 2007–2008 Outstanding

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Professor for his efforts in mentoring student researchers. “You don’t really understand what goes into day-in-and-day-out research until you’ve done it. For a lot of them, it’s a great way to find out that they have an aptitude for it and want to go to graduate school. Other students I’ve had avoided spending five years of their life in grad school discovering that they hated research.”

Kirk and Hanne estimate that, of the more than 100 student researchers they have mentored over the last 10 years, 42 percent have gone to professional schools to get a PhD, MS, MD, DDS, or other degree, and 44 percent have gone directly to a job in biotechnology or industry.

Solidifying a passion for science

Physics students at CSU, Chico have been “playing around in the lab” with non-Newtonian fluids for three years, says Eric Ayars, Physics. A cutting-edge experiment has grown out of this free-form experimentation, “Investigation of Viscosity Transitions in Non-Newtonian Fluids,” which looks at the way these fluids change from liquids to solids. Ayars is the research advisor to Society of Physics Students chapter mem-

bers who won a 2008 Sigma Pi Sigma Undergraduate Research Award to support this project.

The U.S. slalom ski team used a non-Newtonian fluid in their body armor during the last Winter Olympics, says Ayars. They used packets of this fluid, similar to gel packs, worn over vulnerable areas like the shins. The liquid moved with the skiers, conforming to their bodies, until they hit a gate. At the moment of impact, the liquid turned solid—forming shin guards as protective as the hard plastic kind. Other potential applications include protective gear for sports or bulletproof vests.

The Society of Physics students are looking at how non-Newtonian fluids become solid under pressure. “This is stuff nobody knows,” notes Ayars. “Nobody really understands it completely, and we are trying to figure it out. How does it change from liquid to solid? Does it change smoothly, like it gets thicker and thicker and eventually turns into a solid? Or is it thin, thin—BAM—solid, all of a sudden? Is it a phase transition or is it a continuous transition?” Ayars spends countless extra hours in the lab helping his students investigate these questions.

When Natural Science professors are asked why they spend so much of their free time and resources to create these opportunities for student research, especially for undergraduates, they each give a similar response: “That’s what we do here” or “That’s why I’m here.” For these professors, undergraduate education and training is the foundation of what they do.

“If you don’t like teaching, you don’t stay here long,” jokes Ayars. “That is part of why I chose to come here to Chico State. I appreciate being somewhere that values the educational aspect as much as the research.”

Collaborative learning

Natural Sciences majors are encouraged to find the area that really excites them and to get involved with work in that field, whether it is research with a professor or in the wide variety of other hands-on learning opportunities offered by the college (see sidebar, back page).

Kirk and Hanne have taken undergraduate research a step further,



Michael Choy, Larry Hanne, Kevin Parsons, and Larry Kirk discuss rice waste as a medium for growing lactic acid bacteria.

running a weekly, multidisciplinary research group since 1984. At this Microbial Biochemistry Group, students and faculty from the Departments of Biological Sciences and Chemistry and Biochemistry discuss their research, present findings and scientific papers, or learn research techniques. Current faculty participants include Kirk and Hanne as well as biochemists Dan Clark and Dan Edwards and biologist Andrea White.

“This group is unique,” says Kirk. “Even at a major [research] university, people work individually or in a specific graduate group working on one project, but we have all these different projects that we work on. And we talk about them at our weekly meetings, so the students are exposed to research ideas and methods that are different from their individual research project.”

The Microbial Biochemistry Group helped Morris and Parsons perfect their brewery waste project, says Morris. “The formalized group meeting was great because it gave the students a chance to present their research and then defend the analysis of their results. Many times, someone in the group would ask a

question, and I would realize that we had to run another experiment because we hadn’t addressed that issue.”

Chemistry students have another opportunity to refine their research in a group setting. The Chemistry Summer Research Institute (CSRI), begun four years ago by David Ball, Chemistry, brings together students, professors, and industry leaders to work on the leading edge of chemical and biochemical research. This summer, five research teams made up of 16 students, four professors, and industry scientists made independent discoveries and met once a week to discuss their work, methodology, and findings with the other teams.

Students Garrett Parker, Brandon Fragoso, Kevin Parsons, Allen Mull, and Justin Petrovic experimented with applications of laser technology to specific cancer cells with Brian Pierce, the CEO of Chico-based Advanced Light Technologies. Student Minh Uyen Huynh analyzed lyngbyatoxin, the cause of swimmer’s itch, with Dan Edwards, Chemistry. Three other teams created biologically active compounds with potential use to treat HIV, synthesized neolignans with potential antibacterial

and antiviral properties, and synthesized compounds to use in research at the Stanford Synchrotron Radiation Laboratory.

The student researchers are paid—\$3,500 for 10 weeks of work—by the professors’ research grants, the College of Natural Sciences, alumni donations, and grants from private industry.

“Although there are many great things about CSRI, including the dialogue, the camaraderie, and the shared research experience, the best part of the institute is the opportunities it affords the students,” says Randy Miller, chair, Chemistry and Biochemistry. “Most of these students go on to make presentations at national meetings for the American Chemical Society and other professional organizations. It connects them to the real world of chemistry, and it enhances their credentials for getting into top graduate programs or jobs in the field.”

Researching a sustainable future

A pit of boiling acid was the meeting place in July for Gordon Wolfe; students Billie Reeder, Rachel Eidman, and Marni Merrill (BS, Biological Sciences, ’08); and



Chemistry major Deepika Nayyar collaborates with Professor Jinsong Zhang during the Chemistry Summer Research Institute at CSU, Chico.

researchers and students from Humboldt State University and Portland State University. Teams from the three institutions are collaborating on a \$1.2 million, five-year National Science Foundation grant to study organisms living in the boiling acid pools and hot acidic lakes of Lassen Volcanic National Park.

Wolfe and his collaborators have established a microbial observatory at Boiling Springs Lake. The 52° Celsius (about 140–145°F) lake is the largest hot spring in North America. “The focus is really on basic science,” says Wolfe. “We want to know what organisms are in the lake, how they are interacting, how they are producing food. ... But this is a lake where there are no macroscopic organisms at all, no support to insects or fish or anything you can see with the naked eye.”

The lake does, however, contain microbes, and Wolfe and the other

researchers are studying those microbes to understand how this unique ecosystem works. Wolfe has taken his Microbial Ecology classes to Boiling Springs Lake every fall for five years. He sees it as an ideal place to teach the methods of research science.

Wolfe says student interest has prompted different types of “spin-off” projects not covered by the original National Science Foundation grant. And like Morris and Parsons’ brewery waste project—and much of the other research done in the College of Natural Sciences—these projects are related to sustainability.

Marni Merrill’s research interests lie in sustainability, especially using microbes to help solve environmental problems. She did a senior honors project studying fungi in Boiling Springs Lake, characterizing the enzymes produced by these unusual fungi. She hoped to discover

whether they could be used to clean up waste or create a sustainable source of energy.

“This work under high temperatures and acidic conditions might turn out to be useful for some industrial products,” says Wolfe. “A lot of companies are buying [enzyme-based] products, but these products started out when scientists asked basic questions about what organisms live in these environments and how they survive.”

These kinds of questions, driven by curiosity and developed with the help of faculty mentors, are giving students in the College of Natural Sciences exciting opportunities to participate in important real-world research projects. They are also instilling a lifelong love of science in these students, many of whom will join the ranks of the much-needed new generation of scientists. 🍷

Learning by Doing

“Science, by its very nature, is hands on,” says College of Natural Sciences Dean James Houpis, who points out that science learning outside of the classroom isn’t limited to student research projects. Other opportunities include the following:

Each year the **Hands-On Lab** gives 250 future elementary school teachers the chance to teach discovery math and science lessons to local fourth through sixth-grade students. The lab is offered through the college’s Center for Mathematics and Science Education, which provides support for the University’s goal of doubling the number of math and science teachers.

About 60 undergraduate and graduate students work in paid and unpaid service-learning positions each semester through the **Center for Nutrition and Activity Promotion**. They participate in program design, implementation, management, and evaluation. The center’s programs serve high-risk populations in the North State.

Nursing students test their ability to respond to medical situations under pressure in the **Clinical Simulation Center**, located on the Cohasset campus of Enloe Medical Center. The center includes simulated “patients” of various ages, a birthing simulator, and an infant simulator. The “patients” can be programmed for various medical scenarios so future nurses can practice techniques including intubation procedures, inserting chest tubes, and managing critical-care scenarios in a risk-free environment.

The 4,000-acre **Big Chico Creek Ecological Reserve** provides biology, geology, geosciences, and environmental sciences majors projects for field observation and research in a wide variety of habitats. The reserve supports more than 600 plant species and 140 animal species. Many projects at the reserve are through the college’s Center for Ecosystem Research, which expands opportunities for faculty studying ecosystems.

The **Northern California Natural History Museum**, currently under construction, will open up new opportunities in science education anchored in the familiar landscape of the North State.

Courses in biology, geology, chemistry, soil science, zooarchaeology, and more are offered at the **Eagle Lake Field Station** in Lassen County. The 80-acre site is located at the second largest freshwater lake entirely within California and is being upgraded with the help of a recent National Science Foundation grant. The station, managed by CSU, Chico and the CSU, Chico Foundation, is also a satellite-based seismic facility managed by the Seismic Lab at UC Berkeley.

Math students work in teams and show their skills at various state- and nationwide competitions. In 2008, the CSU, Chico **Mathletics team** won first place in the college calculus competition at the 40th Annual Statewide Mathletics Competition.

For students interested in the local flora, the **Herbarium** is a valuable resource. This warehouse of about 98,000 native plants is part of the Consortium of California Herbaria, a group of 17 collections with a database containing information on more than 959,000 specimens.



Nursing students gain clinical experience in CSU, Chico’s Clinical Simulation Center