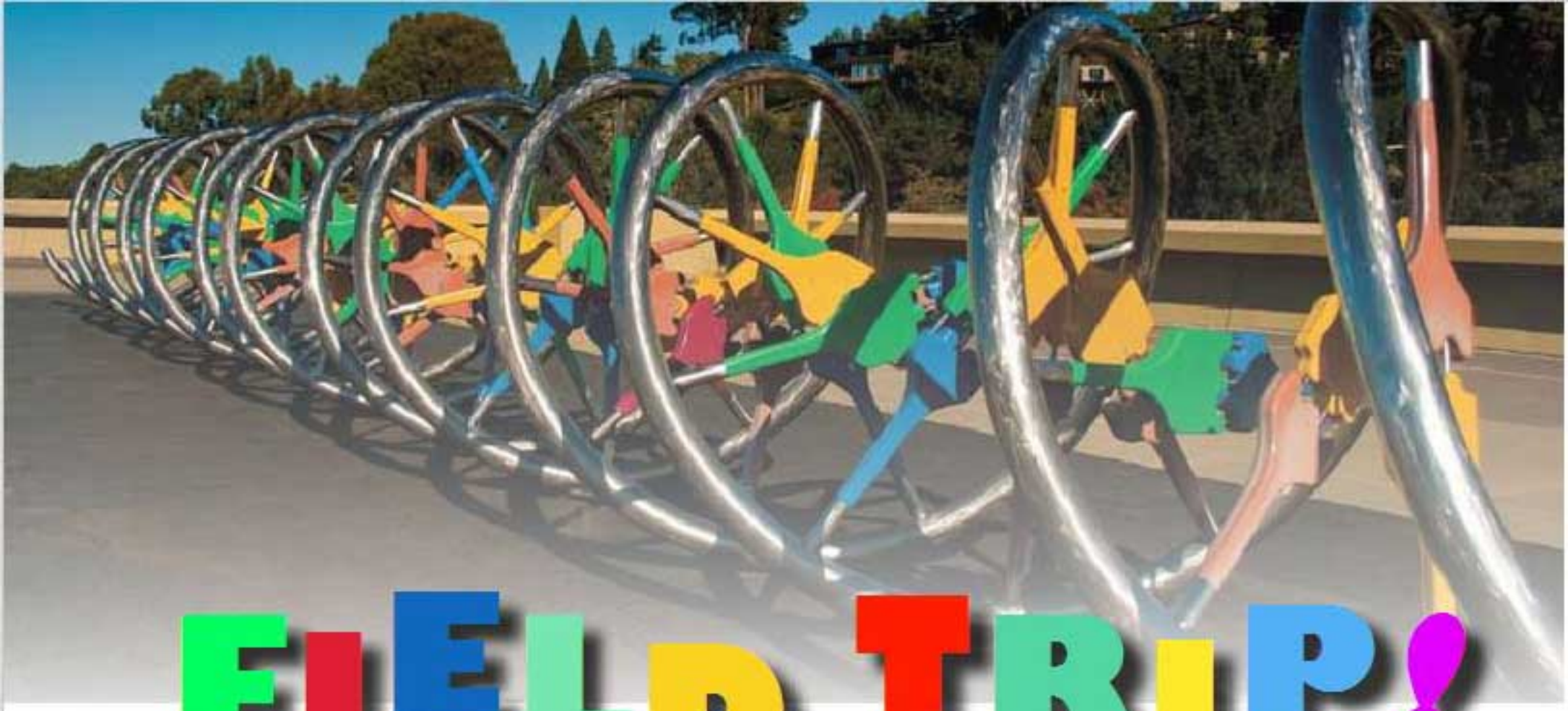

FIELD TRIP!

Scientists inspire the public

by Alec Sexton and Seychelle Vos

In a 2007 survey, UC Berkeley's Lawrence Hall of Science found that 80% of Bay Area elementary school teachers spent less than one hour per week on science education and fewer than half of Bay Area fifth graders met state standards for science. Results like this show that scientific illiteracy is an enormous problem, especially in our increasingly technological world. In response to the clear need for improved scientific communication and outreach, a number of UC Berkeley institutions are coming up with innovative solutions that bring the expertise—and excitement—of Berkeley scientists to the public.

Museums lead the way

Lawrence Hall of Science (LHS) may be the most well known museum affiliated with UC Berkeley, but there's another institution that has been a pioneer in science outreach: Cal's Museum of Paleontology. The museum was one of the first in the world to create its own website, and, following in this tradition, it continues to develop innovative methods to disseminate science to a broad audience throughout the world. Websites such as the *Paleontology Portal*, *Understanding Evolution*, and *Understanding Science* give educators, students, and the general public access to interactive materials aimed at a broad range of age groups, from kindergarten to undergrad levels. "They're extremely popular because they're robust, they're accurate, they're current, and they're also engaging," says Judy Scotchmoor, the museum's director of education and public programs. In fact, demand for the websites is so high that Understanding Evolution has been translated into Turkish, with German, Spanish, French, Portuguese, and Tibetan versions coming soon.

The Internet provides a great tool to help institutes like the Museum of Paleontology reach a broad audience, but simply making information available is not enough. The Museum of Paleontology website is an effective learning tool because it communicates science in a captivating and informative way—no small task, as any scientist will tell you. LHS, with its rich history of leading science education, has successfully achieved this balance as well. Aside from the 200,000 people who visit the museum every year, about 350,000 students across the country benefit from science curricula and programs developed at LHS, and an additional 22,000 science teachers attend LHS professional development workshops every year. The long hours spent putting these curricula together, as well as the countless exhibits the museum has hosted in its forty years of existence, mean that curators at LHS have some pretty good ideas about effective science communication. And in the past few years, they have started sharing this expertise with other scientists.

A scientist's training generally focuses on the complexities of the atom or the nuts and bolts of mouse metabolism rather than the skills to share scientific discovery with a non-specialist public. LHS is working to help bridge this gap through a partnership with UC Berkeley by hosting a course called Communicating Ocean Sciences to Informal Audiences (COSIA). This course uses ocean sciences as a model to teach aspiring scientists how to share their findings with the public. "I think scientists owe it to society to let them know, in language they can understand and relate to, what it is we do and why it is important," says UC Berkeley Professor of Earth and Planetary Sciences and COSIA instructor Lynn Ingram, explaining the motivation for the course. "We also have a vested interest in keeping our society literate in science, and that means we really need to be involved in science education at the K-12 level. This is the time that kids are still so excited and curious about the natural world. Kids need to be engaged by science, and feel that they too can think like a scientist—make hypotheses and test them—even if that isn't their profession."

Ocean sciences may seem like an odd topic for such a course, but increasing awareness of climate change and rapidly diminishing populations of ocean life have led people to care more about what is happening in the sea. Furthermore, "it is important to

know about the ocean and understand ocean concepts in order to be science literate," says Catherine Halversen, director of COSIA at LHS, "not just ocean science literate, but science literate. Ocean sciences are intrinsically important and highly relevant, especially to understanding climate change, and are a motivating and integrating context for learning biology, chemistry, physics and earth science. All the disciplines of geosciences (ocean, atmosphere and earth) are growing in importance at a rapid rate as research related to climate and climate change becomes increasingly prominent and critical."

In the course, about 40 UC Berkeley undergraduate students learn how to communicate science by focusing on science's experimental framework instead of fact memorization. In one experiment, for example, students must determine which of two unknown water samples is saltwater and which is fresh without tasting the water. One solution uses the different buoyancies of saltwater and fresh water: if something floats in the first sample but not the second, the first must be the saltwater. Then, in an important and recurring motif of the course, the students discuss what they learned and how they learned it to better understand the variety of learning styles that they may encounter on the floors of science centers.

Fifth graders at Bella Vista Elementary in Oakland eagerly dive into the CRS experiments brought to their classrooms.

"Reading and writing are not the only ways that people learn," says COSIA instructor and LHS research specialist Lynn Tran. "Talking is part of the learning process, engaging and interacting with their peers is part of the learning process, and this idea of people constructing knowledge of the natural world around them based on their experiences is a huge part of learning that is a revelation to the students." Activities in the COSIA course are meant to teach students about these multiple learning styles and prepare them for trips onto the floor at LHS, where they practice their newfound skills by talking with guests.

Chemistry graduate student Laura Miller explores states of matter with first graders at Berkeley Arts Magnet during a CRS visit. The students tested whether different solids floated or sank in water to determine their relative densities.

Museum visitors benefit from the skills COSIA students learn as much as the students do themselves. Having scientists, especially young ones, interact with visitors at science institutions is hugely effective. In a preliminary evaluation conducted for the COSIA program, responders said that their attitude towards science changed positively as a result of their interaction with COSIA students. According to Tran, "In interacting with these college students they realize, 'wait a minute, scientists actually care about me and will talk to me and teach me about work that they do.'"

The success of COSIA at LHS promises to extend well beyond Berkeley. Halversen reports that LHS has already received inquiries from other institutions that would like to be involved in the program. To meet this need, course organizers are developing a manual that can be used by other institutions to teach more future scientists about effective science communication, making portable the expertise of COSIA's course instructors. There is also a desire to expand the scope to teach established scientists how to convey their findings and to share the most recent scientific advances with science educators. The program appears poised to receive additional funding to create courses that would meet both of these aims and help further bridge the gap between educators and research scientists.

Taking it to the classroom

While Berkeley undergrads are making a splash at LHS, there is always a need for more involvement with young students in the classroom. "Science education needs to undergo a sea change, empowering children to learn through their own experiences of making observations, formulating and testing hypotheses by gathering evidence, and objective reasoning," says Ingram. Berkeley graduate students are answering this call to service in droves. Through a program called Community Resources for Science (CRS), every week they reach out to students in their own classrooms with science demonstrations meant to excite and stoke latent curiosity.

CRS is a non-profit organization founded by two parents in 1997 that brings hands-on science experiences into elementary school classrooms, mainly in Alameda County. The founders, Nicki Norman and Anne Jennings, created the organization in response to elementary school teachers' desire to teach science more effectively. With this in mind, they held town hall-like meetings to find out what teachers thought would make science more accessible in the classroom. As CRS Program Coordinator Heidi Williamson recounts, the

teachers responded, "What we really need are '-ologists.' We don't care what kind, we just want scientists to come in and talk to our kids to show them that we are not the only ones who find science exciting."

In 2003, CRS enlisted Professor Robert Bergman of the College of Chemistry, who became a key force for the development of Chemistry in the Classroom. From a small group of chemistry students, the program has mushroomed in the past six years to Community in the Classroom, with students from over 20 departments on campus, including Plant and Microbial Biology; Molecular and Cell Biology; and Environmental Science, Policy, and Management. Last year, approximately 150 UC Berkeley graduate students, with the help of about 30 outside volunteers, taught over 230 lessons. Interest has been so high that the program has expanded to include areas beyond its original reach in Alameda County. Local scientists working in government or industry also assist the organization, and the College of Chemistry now offers a graduate course affiliated with Community in the Classroom. In recognition of the impact the program has had on the local community, Bergman and CRS were awarded the UC Berkeley Chancellor's Public Service Award for Campus-Community Programs in

"A main goal of the program is to inspire kids from a young age to pursue science," says Stavroula Hatzios, a chemistry graduate student involved in Community in the Classroom. The tools for this inspiration: hands-on science lessons that give students the opportunity to play and to explore the excitement of discovery. Teams of graduate students teach one-hour lessons, developed with CRS assistance to ensure that they are age group appropriate and meet California State science standards, in different elementary school classrooms throughout the year. The lessons cover a broad range of scientific principles, ranging from proper controls to recognizing trends to forming hypotheses. In one of the fifth grade lessons, candy has been stolen from the classroom and the thief has left a ransom note. The students are asked to determine who stole the candy based on the note. Each student is given a different pen, and basic chromatographic techniques are used to determine which pen was used to write the note.

The materials are simple, affordable household products, and elementary school teachers can easily repeat the experiments. The lessons give teachers confidence that they too can perform simple yet interesting scientific experiments with their students, empowering the classroom for further scientific investigations. Perhaps most importantly, the kids really enjoy the lessons. "Overwhelmingly the kids are very excited," Hatzios says. "They are very easily engaged. new, a fresh face come into the classroom."

Thank you notes written to Community in the Classroom illustrate the program's effectiveness and the kids' enthusiasm. In one such note, a child drew a picture of herself with a pillow over her head and her sister standing beside her and titled the picture "potential energy." In the next frame, she drew the pillow hitting her sister and titled the picture "kinetic energy." This playful depiction of a scientific concept shows both the effectiveness of the teaching as well as the enthusiasm that graduate students are able to elicit in young students who otherwise might shy away from science, perhaps viewing it as too difficult or too boring.

"Grad students are fabulous," Williamson says. "They are really enthusiastic. They are really good at communicating at the level of the students and they are really excited to do something like this. They show the students that lots of different people are scientists. Graduate students really drive home that idea because they are so diverse, they are young, and they are usually hip. It is great for the students to be able to see people who they feel they would want to be like, who are scientists and who are excited about science." Bergman goes further, saying, "It's not just old people like me who are going in and doing these things, its people who are much closer in age to the students, and I think the kids relate to that. They have the sense that it won't be too long before they reach the age of the grad students and they have some chance of becoming a scientist too."

A sea change

According to the Pew Research Center, 84% of the public considers science to have a positive impact on society, yet a disappointingly small number of adults can be considered scientifically literate. Scientists themselves are partly to blame for this shortcoming, as they lack the skills or simply lack the energy to communicate complex ideas to a non-specialist audience. The Bay Area is in a singular position as one of the world's most dynamic scientific research hubs to overcome some of these hurdles and provide unique opportunities for interaction between scientists and the public. As the educator Francis Keppel put it, "education is too important to be left solely to educators." In some cases, the scientists themselves must become the educators, and programs like COSIA and Community in the Classroom are making promising headway toward this goal.

Alec Sexton *and* Seychelle Vos *are graduate students in molecular and cell biology.*

Aiming For The Stars

2009 was named the International Year of Astronomy in honor of the 400th anniversary of Galileo's first observations of the sky with his simple telescope, and groups across the world are celebrating, including UC Berkeley's Department of Astronomy. Berkeley's department arranged a special lecture series to take place over the year; talks ranged from astronomy professor Geoff Marcy's search for habitable planets to history professor Roger Hahn's discussion of Galileo to a joint talk between astronomy postdoctoral fellow Steve Croft and Integrative Biology Professor David Lindberg discussing the connections between astronomy and evolution. "As scientists," says Croft, "the public are paying our salaries and we need to do some outreach to make sure that people support funding what we are doing because they understand what we are doing. But I also think it is our duty simply to give back to some extent, to give back to society the fruits of our labor in terms of what we are learning." The lecture series aimed to do just that, highlighting current research and informing the public of many of the interesting faces of astronomy today.