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Stoking a passion for science

High school interns seek hands-on experience beyond the classroom

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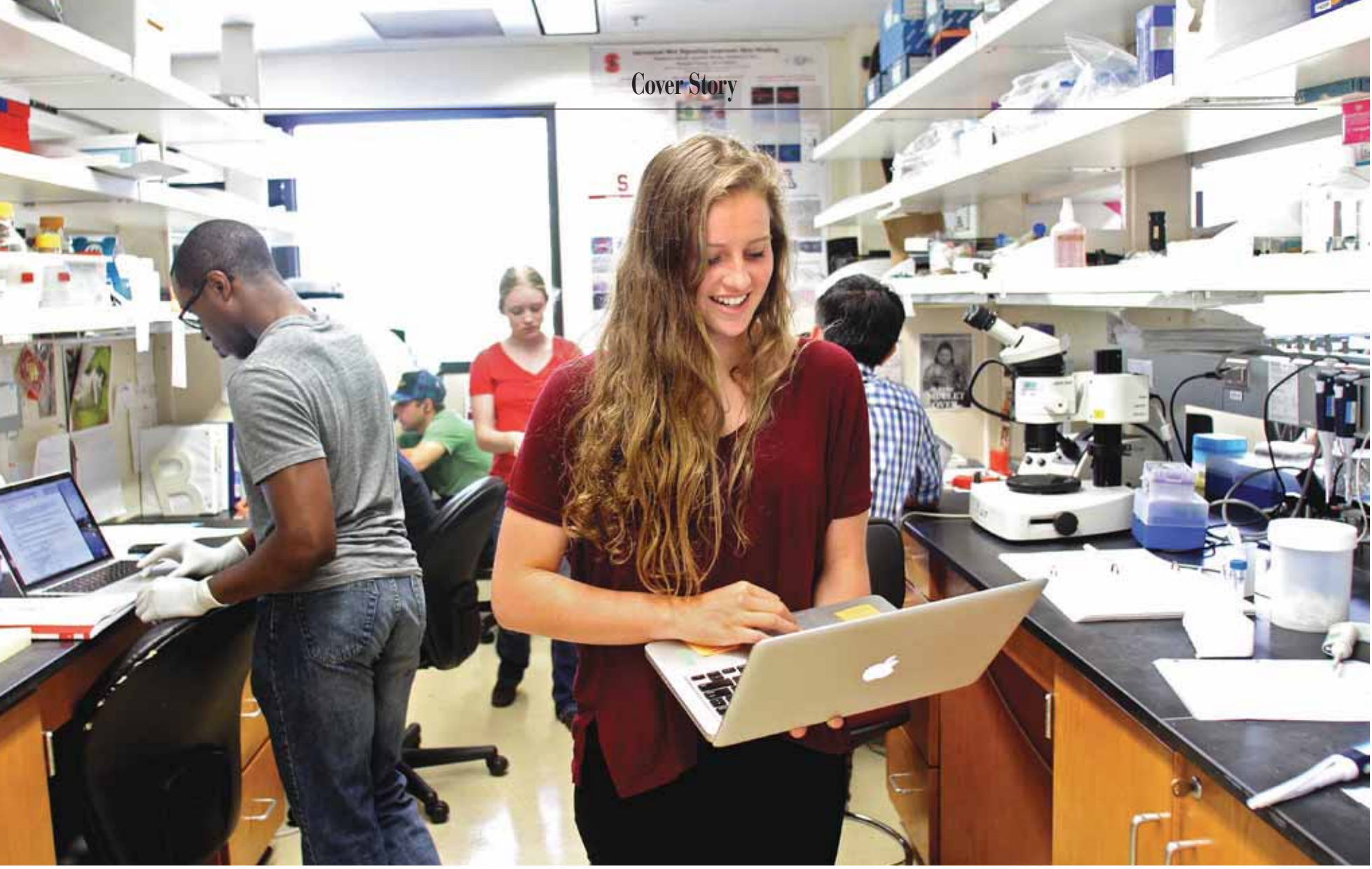


Castilleja graduate Stephanie Flamen researches how hair follicle stem cells might be stimulated by a signaling pathway to regenerate hair growth while interning in Jill Helms' laboratory at Stanford University.

STOKING A PASSION FOR SCIENCE

Interns seek hands-on, real-world experience beyond the classroom

Story and photos by Veronica Weber

In Jill Helms' laboratory at Stanford University — past a glass case filled with skulls of mice, ducks and a two-headed pig and shelves stocked with glass beakers and rows of chemicals — a group of high school interns are gathered around a lab work space feverishly working on a set of experiments.

As one intern gently applies a piece of transparent film onto a slide of a mouse tibia sliced as thin as tissue paper, recent Castilleja graduate Stephanie Flamen consults with research assistant Andrew Smith regarding the section of human DNA sequence displayed on her laptop. The sequence has not mutated the way she had hoped.

In her third summer working at the lab, Flamen is helping a group of researchers who are studying the stem cells of hair follicles and how certain proteins in the cells can be stimulated to trigger hair growth and potentially treat baldness, aid cancer patients who have lost hair or help individuals with alopecia.

"When you're bald you are still harboring stem cells, but the hair is in its resting phase. They've lost some signaling that would control the hair to keep growing," Flamen says as she excitedly explained her team's work. "We found a certain protein that could (give signals to cells) and could make hair grow longer, which was so cool because we're like, 'Oh, my God, we found the solution to Rogaine' — or a better version of it."

Flamen is just one of the many young students passionate about science who choose to spend their summers doing internships working directly with graduate and doctoral students, postdoctoral scholars and faculty who lead publicly and privately funded science research at institutions like Stanford University, University of California, Santa Cruz, Stanford School of Medicine, NASA Ames and Lockheed Martin.

Far from washing glassware and fetching coffee, interns are given the responsibility to directly help with the research, involved in tasks like pipetting bimolecular samples, using high-tech lab equipment, analyzing vast amounts of data and programming. Oftentimes the work is later included in the research's findings in scientific papers.

In their 30 to 40 hours per week for eight to 10 weeks, interns may want to explore a future career; others are curious about the real-world applications of the science they study in school. Some seek job experience and a boost for college applications or the chance to enter their work in national competitions like the Siemens Competition in Math, Science & Technology or the Intel Science Talent Search.

And many of their mentors say the internships not only directly provide more manpower towards their research but give them a chance to inspire the next generation to pursue science and show them that research is far from the stereotype of the "old guy sitting behind a microscope all day."

One of the most vocal proponents of expanding science, technology, engineering and mathematics (STEM) education has been President Barack Obama. In his 2011 State of the Union address, President Obama stated, "Maintaining our leadership in research and technology is crucial to America's success."

He outlined a vision to train 100,000 new STEM teachers by 2021, increase students' science and math proficiency and prepare graduates for the rising demand for STEM-based occupations.

A 2011 brief from the Economics and Statistics Administration reported that from 2000 to 2010, growth in U.S. STEM jobs, at 7.9 percent, was three times as fast as the 2.6 percent employment growth in non-STEM jobs. A 2010 report from the Center on Education and the Workforce at Georgetown University projected that STEM-based occupations would account for 8.6 million jobs in 2018 — the second fastest sector growth behind health care.

One way local researchers and teachers believe they can inspire an influx of young scientists and innovators is to get them beyond the classroom and show them how tasks like memorizing the periodic table and the molecular structure of amino acids are directly applied to research in the real world.

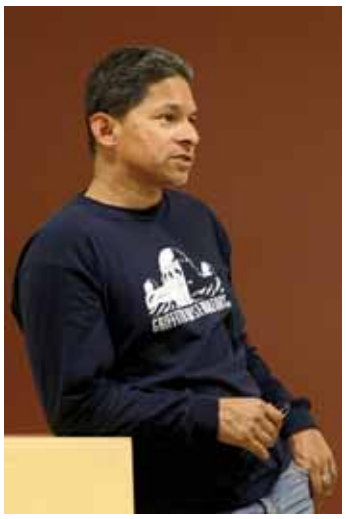
Erik Ortega, 18, a recent graduate of Eastside Preparatory School in East Palo Alto and intern at Stanford's Raising Interest in Science and Engineering (RISE) program, has learned how seemingly unrelated sciences can converge in his work over the past two summers at the Camarillo Lab.

"You start to see the connections between biology and mechanical engineering — at a young age what everyone thinks is so separate. In reality they're very much connected," he says.

The engineering student has assembled about 200 to 300 mouth guards that house tiny electronic sensors to study the physical forces and impact on Stanford football players' brains as they get hit during practice and endure concussions.

"The real-world relevance of why a particular equation fits a particular curve in mathematics ... is often lost in the high school classroom," says Puragra (Raja) GuhaThakurta, a professor of astronomy and astrophysics at UC Santa Cruz and director of the Science Internship Program hosted at the university. "This is what turns kids off science very often: They feel they're doing something that's difficult, but they don't see any connections between what they're doing in that classroom beyond performance on a test or getting into a college. They don't see a real-world relevance for that."

"You don't get this hands-on research (in school)," says Lau-



Raja GuhaThakurta is director of the Science Internship Program at UC Santa Cruz.

ren Nolen, 14, a rising sophomore at Palo Alto High School who is working on cataloging thousands of prehistoric crustacean fossils as part of the History of Life program at the Stanford School of Earth Sciences. "You get: Here's a book, here's the information you need to know for the test and what not. But for this (internship) not only are you learning the information, but you're actually contributing. ... It's a different feeling; it feels more important."

Private schools such as Castilleja have started to take notice and begun adjusting their traditional curriculum to encourage students to explore science more independently in class.

In fall 2012, the school dropped its AP science program to focus on a more hands-on and analytical approach. A key component was the forming of annual after-school and weekend "Science Research Methods Modules," in which parents and volunteer scientists lead three-week-long courses as an introduction to their fields of study and research methods.

Teachers at the school say the modules and internships can provide a supplementary experience for students who might be curious about science but not inclined to pursue the more advanced and rigorous classes.

"Traditional faculty like myself used to think that the only way you're going to learn science is in the classroom," Castilleja chemistry teacher Doris Mourad says. Mourad expressed concern that they were testing only for students who could excel in a fast-paced, very science- and math-oriented curriculum but were missing those that did not think of themselves as scientists.

One parent who leads the astrophysics module is GuhaThakurta who took his experiences in mentoring and formed the Science Internship Program at UC Santa Cruz, which pairs high school students with researchers to assist them in their projects in a variety of fields from astronomy to evolutionary biology and biomolecular engineering.

GuhaThakurta has watched the program grow from three students in 2009 to 68 this year, explaining that his biggest sense of pride comes from teaching students the nature of research and how the process is a constant "journey into the unknown," including methodical practice in creativity, critical thinking and perseverance.

"As a kid you believe, 'I'm going to do science and I'm going to solve some big problem,' but all you do at the end is you put a few pieces into some giant jigsaw puzzle," GuhaThakurta says. "Research involves a healthy mix of these things that don't have easy or well-defined solutions. ... It's a way to find meaning in the information we have access to."

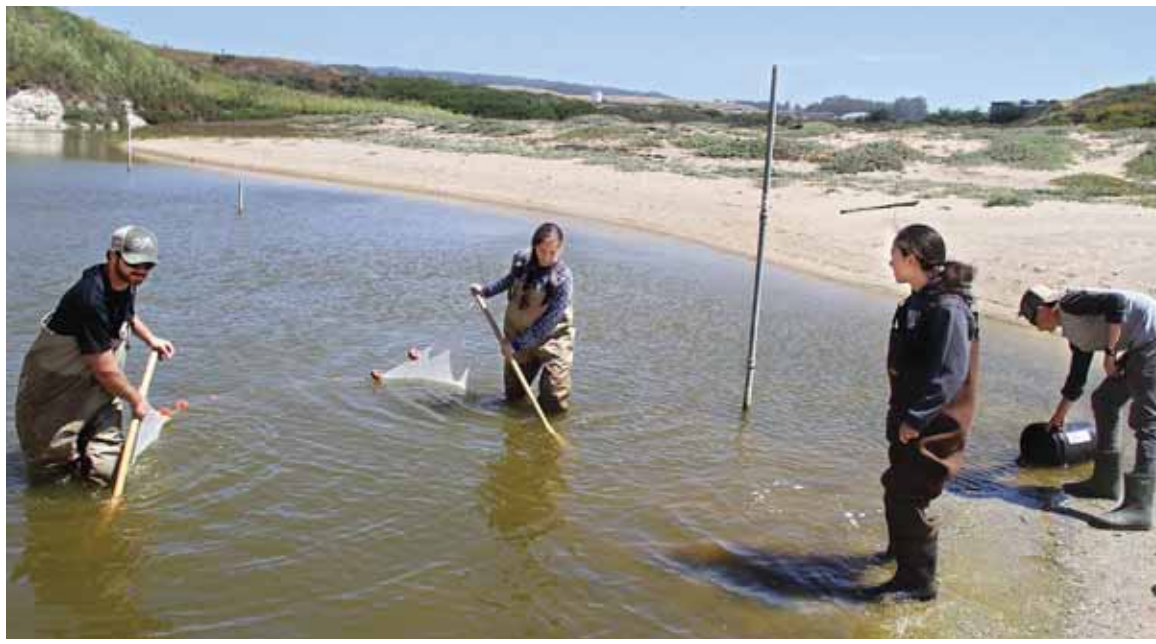
Stephanie Flamen knows this well. She describes her team's work in the lab as less about profound scientific discoveries and more about the "mini victories" that slowly lead them closer to better answers about how information is carried across stem cells.

"I think some people might hate being in a place where you might work there for 10 years and not really discover anything supermomentous," she says. "You have to be ready to know that you're not going to cure cancer and maybe you won't cure it in 10 years, or maybe someone else will cure it before you, but it's all part of a process."

In quite a contrast to expectations in the classrooms, many interns say that one of the most striking things they learn from their experience is how failures are embraced and encouraged in the field.

"If you fail at something at least you know out of all the possibilities out there, that won't work so you have all the other ones to explore. It's not a negative thing," says Pawanjot Kaur, 17, a recent graduate of Kennedy High School in Fremont working in the RISE program at Stanford.

Kaur, who is helping researchers study how certain types of fungus and fir trees fertilize one another, says, "I love that they promote that kind of nature. There's no such thing as failing in science."



Research technician Travis Apgar, left, and intern Danielle Jacobsen use a net to catch three-spined stickleback fish in an estuary adjacent to the Joseph M. Long Marine Laboratory at University of California, Santa Cruz, while fellow intern Rosie Crisman and doctoral student David Fryxell look on.

Meri Gyves, who runs Gunn High School's exploratory program that places students in internships and work experience during the school year, likens the real-world education to a kind of career test trial.

"A lot of kids start out and say, 'I want to be a vet, I want to be a vet, I want to be a vet.' So you work in a veterinarian's office and you love everything about it except for the blood. Well, that's a problem," she says. "You saved yourself a lot of time in veterinarian school."

For Sherry Zhou, 16, a rising junior at Gunn, the decision to intern at the Canary Center at Stanford for Early Cancer Detection was personal. Zhou lost her grandfather to pancreatic cancer and was interested in getting first-hand experience in the center's work on blood-based and imaging tests for earlier cancer detection.

"I think that if we can find something that can detect cancer early enough, then we can have a high chance of people living longer and curing cancer," she says. "I thought that there's probably some better way to find a cure or detect cancer earlier."

Zhou is working with postdoctoral scholar Fatih Inci on nanotechnology capturing cancerous cells as they bind to different antibodies.

Nitya Katsuri saw an internship as a way to escape the boredom of sitting around the house but also was attracted to the thrill of working in a social tech-focused environment similar to her experiences on Gunn's robotics' team.

"Over the summers I need to keep my mind busy. Honestly if I were home right now I'd be freaking out about colleges," the 16-year-old, rising senior says. "I wanted to do something that's educational and informative and also fun. I really enjoy work environments."

Katsuri is also interning at the Canary Center and is working on designing a computer model that will map how pancreatic cancer proteins change over time.

Rebekah Sousae, a molecular biology graduate student at UC Santa Cruz and Science Internship Program mentor, says an important takeaway from these internships is that students discover that science research isn't always for them.

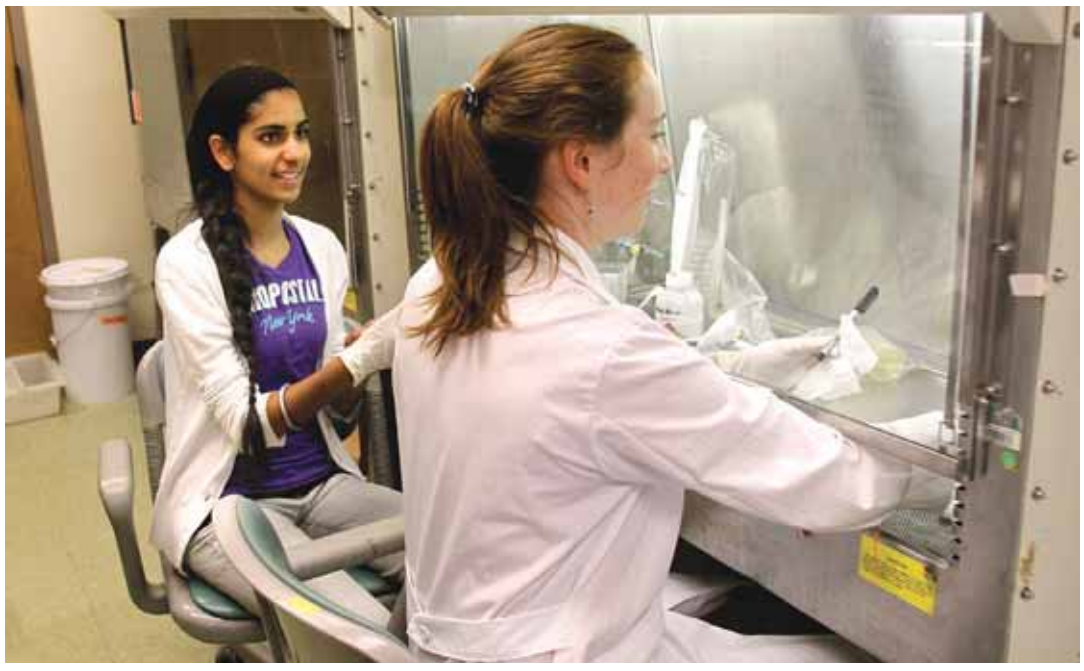
"It's good to just get in there and get experience, to shadow people and figure out if it's for you or not," she says. "Because academia science is only for a small number of people, you know you really have to really like it and want to be there for lots of hours. It's a lot. ... In this field you can work really hard for 10 weeks and not generate a single data point."

Still, the interest in gaining experience working in research institutions seems to be growing, especially since they tend to boost college applications and provide students the space to develop their own side research to enter into the prestigious Siemens and Intel competitions.

Coordinators often have to sift through hundreds of applications from students applying from all over the country and internationally. One of the most sought after is the Stanford Institutes of Medicine Summer Research Program, which alone received about 1,400 applications this year to fill about 70 to 75 openings. Decisions are based on academic grounds to help narrow down the number of prospective candidates — a tough task in a pool of extremely well-educated candidates.

But coordinators also recognize the need to provide opportunities for students who don't have the chance to join accelerated science programs and express that oftentimes the most important quality of an applicant is a passion for science.

Kaye Storm, director of the RISE internship program, talks about its mission to recruit students who are generally the first in their family to go to college or are from a low-income background and how they might not have the same opportunities from the onset.



Pawanjot Kaur, left, and graduate student Laura Bogar plate cuttings of Suillus brevipes fungus onto feeder plates to be used in a future experiment on how the fungus fertilizes jack pines and affects decomposition of organic matter at Stanford University.

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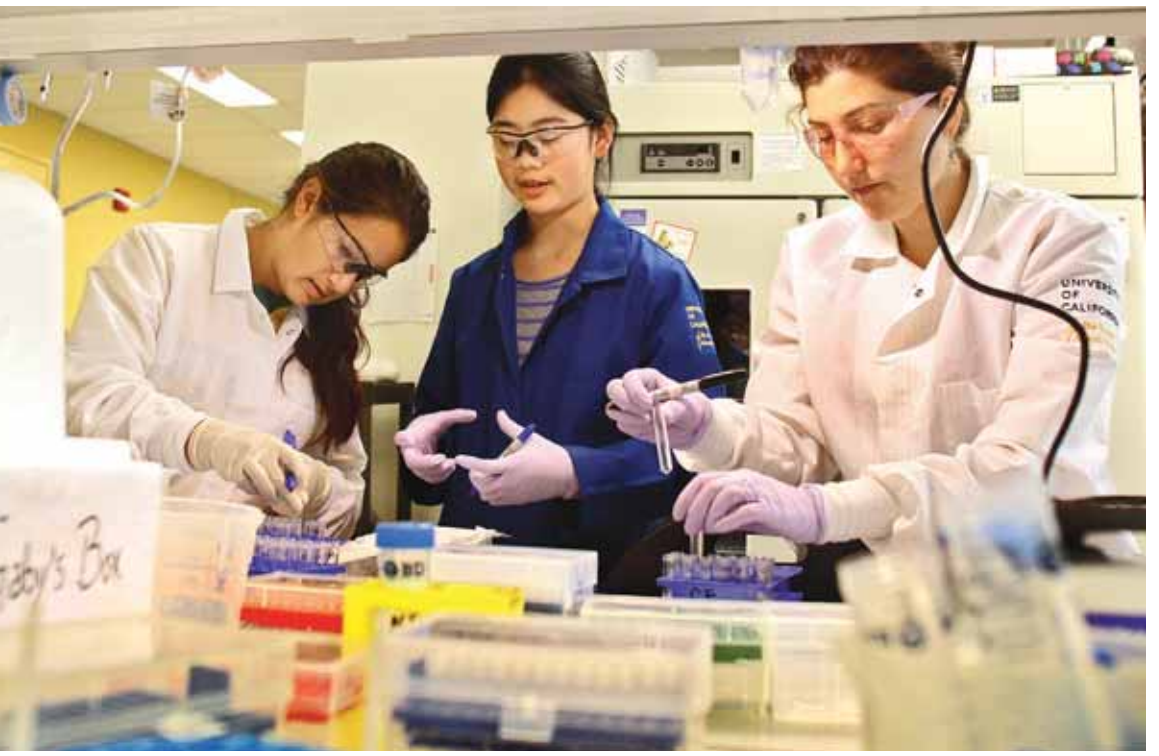

Interns Tara Thakurta, left, and Hannah Zhang help UC Santa Cruz graduate student Rebekah Sousae prepare cell well plates for Sousae's research on how a type of protein may inhibit changes to the DNA structure of blood stem cells.

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As an example, Storm refers to the "ad hoc" internships in which students find labs on their own or with the help of a family member or friend.

"Typically those are kids with very educated parents who speak fluent English and who are comfortable poking around Stanford a little bit ... or have a network and know somebody who works in a lab here. The RISE students typically just don't have family members that can help them in that way," she says. "I think it's important to serve all students, not just the privileged gifted students who are going to thrive and do well no matter what because they've got the backing of their school and parents and siblings."

Jennifer Saltzman, director of outreach education at the Stanford School of Earth Sciences, echoes that sentiment. The Earth Sciences program offers a "diversity honorarium" to a select group: students who are the first in their families to go to college, a minority underrepresented in the STEM fields or low-income.

"We want to have a diverse community of scientists; people from many different backgrounds bring many new ideas," she says. "Just because we think in different ways based on where we grew up and how we grew up, we may not think that those differences impact how we think and how we would do science, but it does. And so with more ideas, the better chance and the better opportunity for us to be successful in understanding how the earth works."

The RISE program also tries to place students in labs run by researchers and faculty who come from similar backgrounds. Storm explains that it conveys a subconscious and subtle message in which students can envision themselves in similar roles.

"What it does is it shows that all kinds of people belong in science labs, and they too could belong in a science lab if they wanted to. The power of role models is really strong," she says.

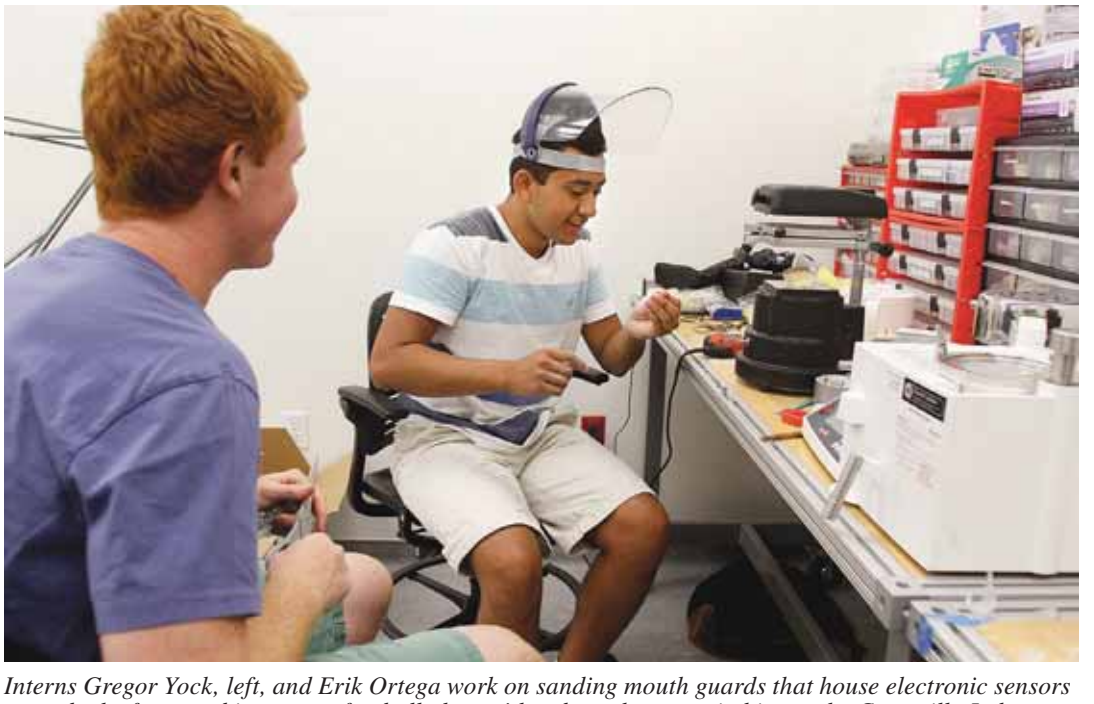
These types of opportunities are important to start curbing the racial disparities that exist in STEM occupations. Roughly 70 percent of the people in STEM occupations were Caucasian, 14 percent Asian, 6.5 percent Hispanic and 6.4 percent African American, according to an American Community Survey Report from the U.S. Census Bureau in 2011. Since 2008, Storm says about 80 percent of RISE graduates have gone on to major in math, engineering or science in college.

Researchers are also passionate about increasing the number of girls in labs since women are also largely underrepresented in STEM fields. The same 2011 U.S. Census Bureau report stated that roughly 25.8 percent of those in STEM occupations are women, compared to 45.7 percent of all jobs.

GuhaThakurta beams when he points out that of the 68 interns in the Science Internship Program, about two-thirds are girls, a statistic that made Castilleja student Rosie Chrisman, 15, "do a silent cheer" during the program's orientation.

"I think it's really great that more girls are just loving science and they'll probably pursue science later on. ... It's great that we're kind of fostering that for the future," she says.

"Oftentimes girls will be underestimated when they're pursuing a career in science," says fellow Castilleja classmate Danielle Jacobsen, 17, a rising senior. She is working in the Science Internship Program helping to collect data on the body sizes of three-spined stickleback fish in estuaries around Santa Cruz and the Central Coast.



Interns Gregor Yock, left, and Erik Ortega work on sanding mouth guards that house electronic sensors to study the force and impact on football players' heads as they sustain hits, at the Camarillo Lab at Stanford University.

Jacobsen says the internship experience is helping to break down any preconceptions she had that a position in academia is out of reach, notably since many researchers leading internships are fairly young. Her mentors, research technician Travis Apgar, 26, and doctoral student Dave Fryxell, 23, laugh while telling a story how Fryxell was recently carded for trying to buy dry ice.

"It makes it easier to see myself doing something like this in the future. There's less of an age gap, like, 'Oh, in eight years I could be doing that' as opposed to 'Oh, in 40 years I could be doing that,' and it just makes it more tangible," she says.

Making research accessible is a main reason why many scientists are drawn to becoming mentors.

"To see that people make entire livelihoods out of this and they derive tremendous job satisfaction by being immersed in these fields is probably the most important human element of the whole thing," GuhaThakurta says.

Mentors see it as a way to pay it forward, citing how a lot of their own success early on in their careers was due to help from their mentors.

"A lot of people think science is so hard, and they don't feel like (they) can do it. (We are) just making them realize that pretty much anyone can do it who really wants to put their mind to it," says Shellie Bench, a Stanford postdoctoral scholar whose interns research the phytoplankton community of the West Antarctic Peninsula. "There's nothing special about scientists, except that they're more determined than other people. It did take me over six years to get my Ph.D."

Rebekah Sousae, who has a background in leadership training for high school students and young adults, says that having a role model and someone readily available to consult with is a key reason why students become successful.

"When you look at success rates of students or really anybody and take into consideration their economic background, their experiences, their natural talents — all of these different things — the one thing that they actually find that is the most important for people's future success is how much mentorship they received."

GuhaThakurta explains that the internships also provide a way to show students how labs are universal social settings and everyone, from high school students to seasoned faculty, plays a role in advancing the research forward.

"Seeing scientists and engineers as human and not on an ivory tower somewhere is a very important part of a kid's aspirations towards becoming a scientist," he says.

Flamen has seen this firsthand since her beginnings at the Helms lab. When she first started working with a mentor three summers ago, she was handed complex scientific papers to read and says she couldn't even understand the title.

"I just remember thinking, 'I'm going to die here,'" she laughs. After Flamen passed the initial learning curve, she says the lab's researchers have always sought out her help and creativity when stumped with a problem.

"What's so great about this lab is everyone really values interns, and they want other people to learn. It's not just like, 'Oh, they're just here for the summer, (so) give them a little bit of stuff'; it's really like, 'Treat them as if they're going to be your lab partner for life,'" she says.

Researchers say that providing these kinds of hands-on experiences, mentorships and scientific nurturing is integral in getting more and more young people to think about the growing demand for STEM careers and lead the way of future scientific research.

Students like Flamen say they have developed a newfound excitement about science from their experience.

"If you look at a science textbook from 100 years ago versus one today there's been huge leaps. ... I think that science is just something that's never going to be finished. ... It's something we're continuing on, and I think that's what's really cool about it — not knowing what the future of it is. And I think it's really cool to be a part of something that, who knows, could one day cure a disease or something like that," she says. ■

Staff Photographer Veronica Weber can be emailed at vweber@paweekly.com.

On the cover: *Gunn High School student Sherry Zhou prepares a cell culture plate to be used in an experiment to test how cancer cells can be captured using different antibodies that bind to the cells, at the Canary Center at Stanford. Photo by Veronica Weber.*