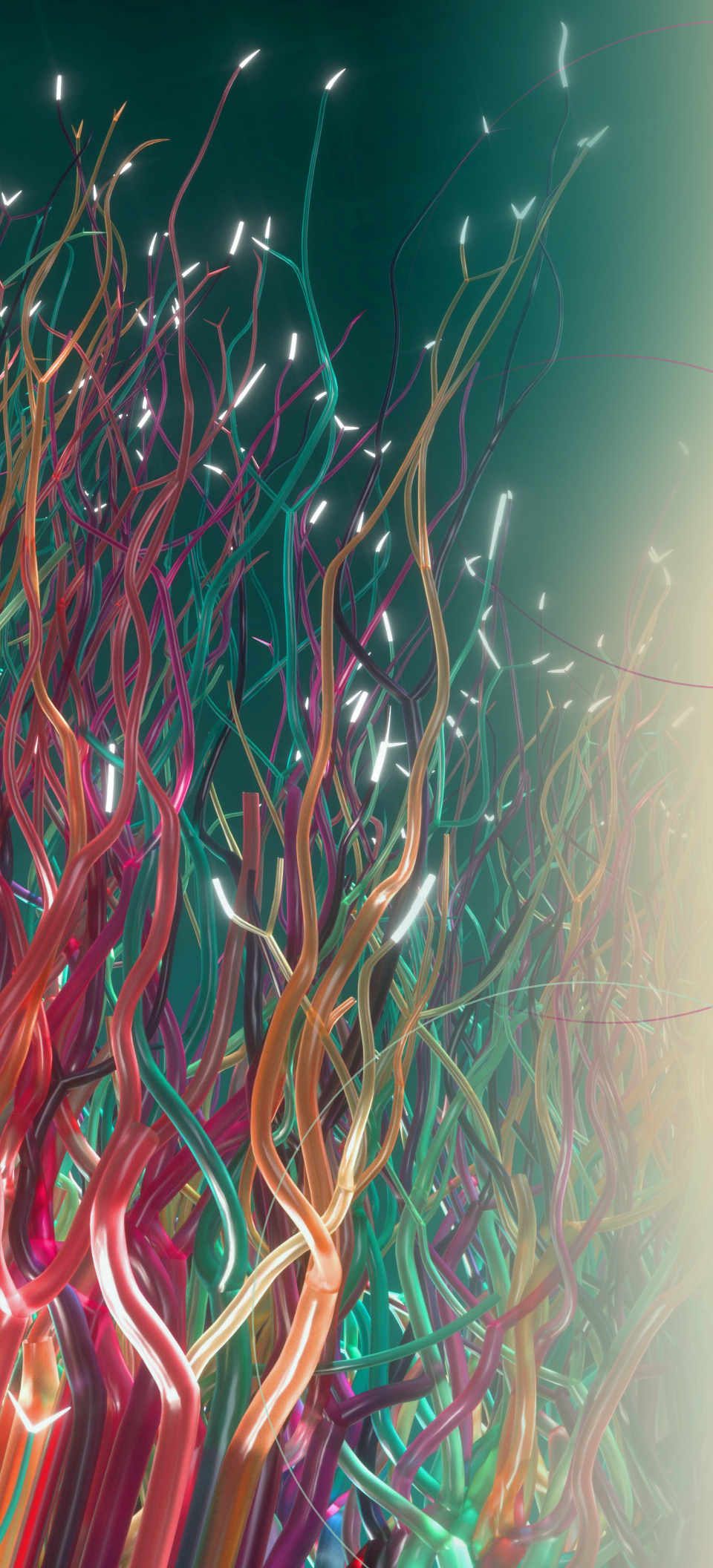




FOCUS ON: UNDERGRADUATE STUDENT RESEARCH



Many freshman students arrive at UC Santa Barbara with only a vague idea, if any, of where they want to go in life, much less with a plan for how to get there. Especially for first-generation college students and those from underrepresented or otherwise disadvantaged groups, a big university like UCSB can feel intimidating and hard to navigate. Even for students who take a more “traditional” path to college, words like *research*, *graduate school*, and *PhD* can seem almost mystically remote, with the professional pathways they offer lying nearly beyond imagination. Fortunately, UCSB is full of resources, including the Faculty Research Assistance Program (see page 33 for a list of others), that can help students transform the mystical into the immediate by providing keys to doors of opportunity. Undergraduate research (UGR) is one time-honored way that happens.

Not every undergraduate who works in a lab on campus will become a researcher. At the very least, however, as is clear from the students and faculty profiled in this edition of FOCUS ON:, undergraduate research provides students with valuable skills and knowledge and makes them more engaged, more satisfied, and more successful students. It can also, as you’ll read here, enable students to discover the passion that defines their professional future.

GABRIELLE HAMMERSLEY

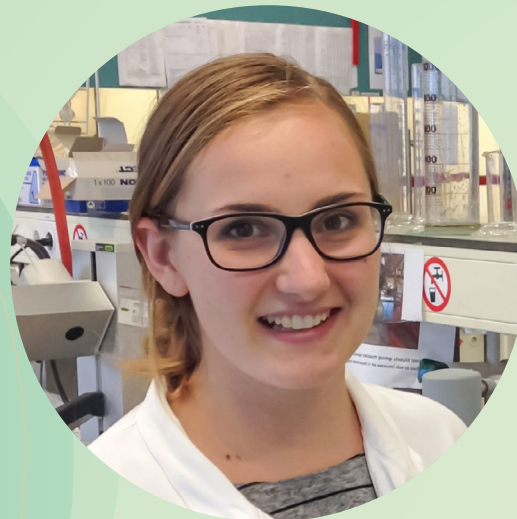
Being raised by her single mother in a small town in Wisconsin, **Gabrielle "Gabby" Hammersley** (BS '17) recalls, "Our resources were very limited.

I always felt like we had less than most people." And though Hammersley was her high school class's senior valedictorian, her circumstances made her unsure whether she would go to college. She applied quite late, and only then because one of her teachers encouraged her to.

Arriving at UCSB with a vague notion of perhaps aiming for medical school, she began as a biology major, then switched to chemistry. In her junior year, she wanted to do research to build up her resume to apply for med school. Now, she is working as a medicinal chemist at Vividion Therapeutics, a drug-development startup company that was recently purchased by Bayer Pharmaceuticals, earning Hammersley a payout big enough to retire all her student loans.

"Before doing research, I didn't have any sense of direction or purpose for my life," she says. "Research was the beginning of my evolution. It gave me challenges, pushed me out of my comfort zone, and put me in a place that was kind of scary but gave me a space to grow."

"It's a success story of her undergraduate research opening up multiple different avenues of opportunity for her," says chemistry professor **Javier Read de Alaniz**, Hammersley's faculty mentor, who is also associate director of the California NanoSystems Institute (CNSI) and director of the NSF-funded BioPACIFIC MIP.



ANGEL OKORO

Like many science-minded freshmen, **Angel Okoro** (BS '20) entered UCSB under pre-med, not knowing what a PhD really was or why or how one would go about getting one, intending to major in biochemistry and become a pharmacist. She eventually graduated with a BS in biology and a minor in Black Studies and is now in her second year of PhD work at Brown University, where she studies the nervous system of *Drosophila*, aka "the fruit fly," in a supportive lab that she loves while working toward her still-forming goal of entering the medical industry, but now via the research route rather than medical school.

She traces her current trajectory directly to her UG research experience in the lab of her mentor, **Julie Simpson**, a professor in the Department of Molecular, Cellular, and Developmental Biology (MCDB). "It's so rare to find a faculty member who can see you as an individual, as a student with goals, desires, promise, and potential, and when you do find someone who reaches out and treats you like a person who has promise — well, it changed a lot of things for me," Okoro says. "Julie's lab environment made me feel I could be somebody, which wasn't something I had experienced before. I wouldn't be here without her."



Photograph by Cristina Soto Balderas

MARIANN GUZMAN- ESPINOZA



Mariann Guzman

Espinoza was born in Oaxaca, Mexico. Her parents are both artists, and neither went to college. Her father is Zapotec, and his parents spoke only that language. The family moved to San Francisco when Mariann was three. She arrived at UCSB “set on going to med school” but also “really scared of going to college,” not sure how she would do academically, and “not knowing where to start” her journey. Now preparing to graduate in June, having spent three years in the lab of **Craig Montell**, a neurobiologist in MCDB, she was accepted into a STEM cell master’s program at San Francisco State University and has also been offered a position as a junior specialist researcher in a lab at UC San Francisco. She is considering pursuing an MD/PhD down the road.

“There are lots of possibilities, and my future plans are really open,” she says.



HENRY MOISE

Henry Moise (BS

’21) was an average high school student in the San Francisco Bay Area and wasn’t thinking about going to college. He did attend community college, and then transferred to UCSB, where he found the transition challenging during his first two quarters as a chemical engineering major. Then, he found that he could put his experience working with tools in a hardware store to good use in chemical engineering professor **Eric McFarland**’s lab. Moise is spending the current year as an employee in McFarland’s startup company, C-Zero, Inc., before beginning a PhD program at Stanford, where he has already been accepted.

“I would never have thought I’d be so excited reading science papers by other groups about methane pyrolysis,” he says. “It’s a cool feeling to be excited about things like that, and grad school will allow me to take that further.”

THESE FOUR STORIES AND THOSE THAT FOLLOW DEMONSTRATE

with compelling consistency the transformative effects that can flow from undergraduate research (UGR) experiences for students and, some years ago, for many whose own transformative journeys were instrumental in their leading labs and mentoring UG researchers today.

By one estimate, approximately half of all undergraduates at UCSB participate in UGR, but the figure is unreliable, because students come and go from labs, and there is no central campus body to register or track them. Whatever the percentage, it is clear that as many students who can do UGR *should* do UGR.

Read de Alaniz vividly recalls his own transformation as an undergraduate researcher. At the time, he was an academically strong student at Fort Lewis College, in Durango,

Colorado, running cross country and majoring in environmental science but without a focus on graduate school. “I had no understanding of what a PhD even was,” he remembers. “I didn’t know it was an option.”

Then, because it paid the same as a construction summer job would, he spent three months working on a project in a professor’s lab. He recalls the science being less important than “the environment, the investigation, the camaraderie.” He then did undergraduate summer research at Purdue University, where he worked with graduate students, an experience he describes as “the stepping stone” that allowed him to think he, too, should go to grad school. “Undergraduate research was what got me kicked off in science and STEM,” he says. “It changed my trajectory.”

THE UG TRIAD



Javier Read de Alaniz

"Science courses generally do not actually teach science. Rather, they teach the resultant product that arose over centuries of science" says **Joel Rothman**, a professor in MCDB, the Wilcox Family Chair in Biotechnology, and the director of the Biomolecular Science and Engineering Doctoral Program at UCSB.

is the act of striving to make new discoveries, of working at the moving edge of knowledge. To experience science, one must engage in the rich discovery process known as research and, ideally, do so within a community of other scientists."

Over the past decade, Rothman and MCDB teaching professor **Rolf Christoffersen** ran a program funded by the Howard Hughes Medical Institute called the Large-Scale Undergraduate Research Experience, an immersive six-week, 24-hours-per-week summer course taught by postdocs who would bring their lab's research into the course. "It was good for the postdocs, who got to design the curriculum and mentor the undergraduates," says Christoffersen, "and the students got a much better feel for what research is about, and the opportunity to experience how it feels to work as a scientist."

"We based our efforts on hard data that's been published, demonstrating that students who do research perform better academically," says Rothman. "It remains an open question as to what are the most important factors in research experiences that result in these positive outcomes, but there are likely three major ones."

First, he says, "Students involved in research feel part of the scientific enterprise as members of a lab group, which

provides a strong sense of community. That's particularly important at a large campus like UCSB."

"Being in a lab with grad students from all over the world and seeing the freedom and opportunities they have really opens the eyes of first-gen students and others from underrepresented groups," says Read de Alaniz, expanding on Rothman's point. "They get to see themselves as part of a bigger community beyond just UCSB, and where they fit into that structure."

That observation rings true for **Ricardo Espinosa Lima**, a first-generation student who was born in Mexico City and moved to the U.S. when he was fourteen, and whose family qualifies as low-income. He says that doing research in the lab of **Angela Pitenis**, a professor in the UCSB Materials Department who studies soft, biological, and bio-inspired materials, he discovered that he likes being in a group, especially one that crosses disciplines.

"One of the biggest challenges for me is communicating science to an engineer, because the focus of a question shifts a lot depending on the lens through which we approach it," he explains. "The Pitenis lab is dominated by materials scientists, chemists, and mechanical engineers, who have very different approaches than I do as a biologist. It's been fulfilling to be in interdisciplinary spaces where I get to be challenged and to think in ways I probably wouldn't have."

Rothman says that the second element of UG research that enhances success is "the hands-on research experience — students' direct contributions through experiments that may lead to new discoveries."

"Being in Eric [McFarland's] group made me fall in love with research and see the opportunities you get from it," says Henry Moise.

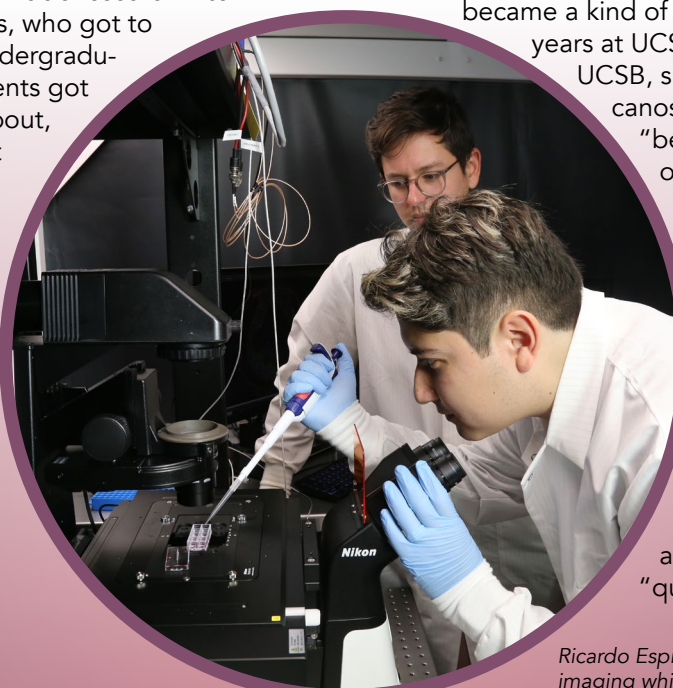
For Mariann Guzman Espinoza, her UG research experience became a kind of hub around which her highly successful four years at UCSB have revolved. Initially feeling intimidated at UCSB, she joined the Society for Advancement of Chicanos and Native Americans in Science (SACNAS), "because I wanted that sort of space where I saw other people, also first-generation who came from similar backgrounds."

At the suggestion of SACNAS upper classmen, she sought out a UG research position, finding one doing experiments in the Montell lab, where she worked closely with her PhD student mentor, **Angela Morales**. When COVID forced her to work remotely, Guzman Espinoza took the time to learn various types of software used to analyze images and experimental data.

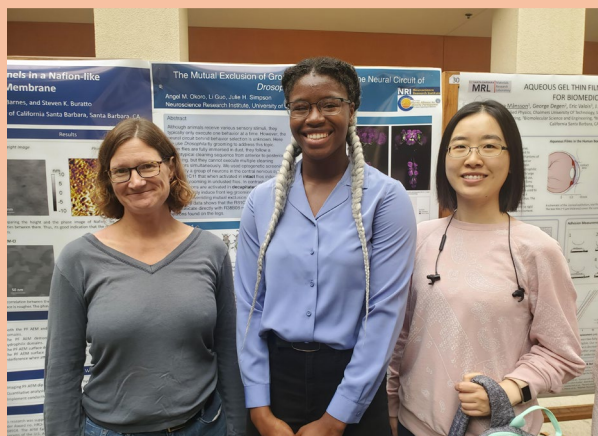
After experiencing impostor syndrome in a way that could make her feel as though her "questions weren't good enough" or she didn't



Mariann Guzman Espinoza (center) and her mentors, Craig Montell and Angela Morales.



Ricardo Espinosa Lima prepares organoid cultures for fluorescent imaging while his mentor, third-year PhD student Jona Rosas, looks on.



Angel Okoro (center) at a CAMP research poster session with Julie Simpson (left) and Li Guo, a graduate student in Simpson's lab who served as Okoro's mentor.

"belong in research" or "belong in my major," things started to shift while she was working as part of a research cohort during a third-year internship. She realized that she wasn't alone, that other people have impostor syndrome, and that they also make mistakes while they're learning new techniques.

From there, one thing led to another. She fell in love with research, gained confidence and participated more in her classes, became a better lab partner, spent hours in the lab, and experienced the excitement of discovery and what she describes as "such a nice feeling after struggling to master a technique and then leaving the lab after doing an experiment successfully for the first time."

She was also hired as a SIMS peer mentor for incoming freshmen. In that role, she says, "I was able to interact with new students who are low-income and first-generation, like me. I was able to share my story with them and offer some advice that I wish I had when I first arrived. I tell them that that if they want to do research, they can. It's really important to me to be able to say that, because I've always wanted to be a mentor, and I really appreciated the mentoring I got from my research experience."

Michael Gordon, the Robert G. Rinker Founder's Chair in Chemical Engineering, says he sees it as a victory that roughly half of his UG researchers have gone on to grad school. "I did undergraduate research myself and found it immensely enlightening and motivating, and if I can transfer that experience to undergrads in our lab, so that they want to go further and have a deeper experience of why the world is so cool, then I've done my job," he says. And, like Espinosa Lima, many of Gordon's students who have gone on to pursue advance degrees did not remotely consider that possibility as freshmen.

Pitenis discovered undergraduate research in her last semester at the University of Florida after being encouraged by a professor. "A ten-minute lab tour turned into a PhD and completely changed my

career trajectory," she says. "I encourage my undergraduate students to get involved in research so they can gain additional skills outside of the classroom, build up their confidence, and become more competitive applicants for scholarships, industry, graduate school, or beyond."

The third important piece in the UG research experience, Rothman says, is "the enduring support students receive from an engaged and nurturing mentor, someone who looks out for them and can provide guidance, support, and validation. In large courses on a large campus like UCSB, students can feel anonymous. This direct mentoring can provide undergraduate researchers with the first truly personalized science experience."

The mentorship that Angel Okoro received as a UG researcher in the lab of Julie Simpson proved pivotal. "I wanted to do research in a lab. I didn't know what kind of research I wanted to do or what lab I wanted to be in," Okoro recalls. "I just wanted to get my foot in the door and get started."

Frustrated after contacting some 25 faculty members without success, Okoro finally was invited to what she thought would be a sit-down interview with Simpson. But after giving Okoro a tour of the lab, Simpson told her she could start to work whenever she was ready. Okoro, who had no experience at the time, recalls vividly what happened next: "I asked her about my lack of qualifications, and Julie looked me straight in the eyes and said, 'I looked at your resume, and I think you are qualified. I have full faith in you.'"

THE THIRD IMPORTANT PIECE IS THE MECHANISM OF HAVING A GUARANTEED MENTOR, SOMEONE WHO LOOKS OUT FOR YOU AND WITH WHOM YOU CAN INTERACT AND FEEL VALIDATED BY AND GET REAL HELP FROM INSTEAD OF BEING AN ANONYMOUS BIT IN A LARGE UNIVERSITY,



Materials professor Angela Pitenis describes undergraduate researchers as "the backbone of our lab."

WHAT UGR'S ADD IN THE LAB



Galan Moody finds that undergraduate researchers help graduate students "more deeply understand what they're doing."

It would be easy, and incorrect, to suppose that undergraduates might not have enough knowledge or experience to contribute much in the lab. In interviews for this piece, however, one professor after another indicated the diverse ways that those students bring value to the lab.

Michael Gordon says that multiple undergrads in his lab have been listed as co-authors on journal papers, and one did most of the work that resulted in a recent intellectual-property (IP) application. He says that getting to that level requires the UGRs in his lab to do more than busy work; it requires them to have enough autonomy and responsibility to take real ownership of their projects. "It's tremendously empowering to take ownership and make progress and see those milestones that you reached through your own accomplishments," he says.

Although undergraduates are usually, indeed, the least knowledgeable people in a lab, their relative "greenness" can enable them to ask simple questions that are trenchant and useful.

"On long-term projects, it's easy to get stuck in the details, and sometimes we need to take a step back and ask these more basic questions, the kinds of things that undergrads ask when first starting their research projects," says **Galan Moody**, professor in the Department of Electrical and Computer Engineering who currently has major projects in quantum photonics. "Answering the undergraduates' questions is a good way for our grad students to more deeply understand what they're doing, at a basic level, and to learn how to communicate the science."

Undergraduate contributions come in many forms. One of Moody's UG researchers, **Quynh Dang**, left her family in Vietnam when she was 16 to attend community college in Washington state, then transferred to UCSB to study electrical and computer engineering, graduated a year and a half later, and is now a first-year PhD student at UC Irvine.

When COVID protocols kept undergraduates out of the lab, Dang worked remotely to develop and construct experimental modules for a graduate course Moody was teaching. "She came to our group and, with very little experience, helped me put together the tutorials for the quantum photonic teaching labs for my courses," Moody says. "She was amazing," adding that she also contributed significantly to his research on quantum light sources, resulting in co-authorship on a paper published in *PRX Quantum*.

Eric McFarland says that while undergraduates generally contribute little to forwarding his research, he finds it rewarding to see students evolve from when they start in the lab and "know really nothing to becoming someone who can see how what they're doing makes a little bit of a difference and are excited about it and want to go to grad school."

For Read de Alaniz, even the students' youthful enthusiasm is a benefit. "One of the best parts about working with undergrads is that they have this curiosity that, I think, reminds a lot of us why we got interested in science in the first place," he says.

Angela Pitenis considers her undergraduate researchers "the backbone of our lab," and says that during the COVID closures, "Our research was severely impacted by our undergrads' not being there. And they weren't missed just in the day-to-day running of the lab, but also in serving as kind of sounding boards for ideas that the grad students and I have. Sometimes, it takes a simpler question from an undergrad to really probe the depth of a question and to encourage graduate students and me to think about the problem in a deeper and more fundamental way."

SOMETIMES, IT TAKES A SIMPLER QUESTION FROM AN UNDERGRAD TO REALLY PROBE THE DEPTH OF A QUESTION AND TO ENCOURAGE GRADUATE STUDENTS AND ME TO THINK ABOUT THE PROBLEM IN A DEEPER AND MORE FUNDAMENTAL WAY."

Julie Simpson maintains a small army of about forty undergraduate researchers in a group established during COVID restrictions to trace neurons in large electron microscopy (EM) data sets. Recently they found some surprising types of sensory inputs to one of the neurons of interest. "The undergraduate students arrive without preconceived ideas, which is helpful, because if I or the grad students or postdocs had seen those inputs, we might have dismissed them; we might have said, 'No, that can't be right,'" Simpson explains. "But they traced it, and it is right. People bring different past experiences and talents to this work, and the undergraduates are contributing to real scientific discoveries."

SCIENCE FOR CHANGE



Then-PhD student Sammy Davis (second from left) with undergraduate researchers.

For all of their varied contributions to the labs where they work, the students themselves benefit in ways that, often, permanently change them, helping them to grow academically and personally while pointing the way to previously unimagined careers.

Ricardo Espinosa Lima will graduate from UCSB this June and was, at press time, waiting to hear from graduate programs at UCLA, UC Berkeley, and UC San Francisco, with the intention of pursuing a PhD in stem cell biology or bioengineering. He says that his UGR experience, which included participating in the STEP and EUREKA programs, was decisive. "Those programs helped me realize what I'm capable of and what being a biologist is," he says. "The support was so good. Ofi [**M. Ofelia Aguirre Paden**, Director of the Center for Science and Education Partnerships (CSEP)] and Sammy [CSEP Undergraduate Research Programs Coordinator **Sammy Davis**] were always asking, 'Is there any way we can support you?' Their support launched me into the science world."

Galan Moody makes an often-repeated point when he says, "Undergraduate research is often more open-ended than what students encounter in coursework labs. You don't have a lab manual telling you the steps. You don't know exactly what you're doing until you start, and you have to figure out what to do on your own. So, developing those skills as an undergrad is important. It's the real world of engineering."

Research can be tremendously impactful in undergraduates' becoming more academically interested, engaged, and successful. "I have countless examples of students who were below a 3.0 GPA and probably wouldn't have made it through their major without the research experience that kept them engaged," says Read de Alaniz. "They realized that to keep doing this thing they discovered they like doing, they have to keep their grades up. It helps them to balance the two and to see why it matters to excel. They think, *That career could allow me to do things I want to do*. That's an eye-opener for many of my first-generation students or students from underrepresented groups. Maybe for the first time, they see a future."

Eric McFarland refers to himself as "hard-nosed" about his requirement for UG researchers in his lab. "They have to raise their GPA every quarter. If they don't, they have to leave," he says. "It's gratifying to see a student who comes in and is not in the top ten percent of their class and by the time they leave me, they are. Frankly, those are the students I want, the ones who have the potential to be a lot better."

"The [McFarland] lab was very demanding, and I needed to spend a lot of time there, and that forced me to focus even more on my courses, because there just wasn't time to fool around," Moise remembers. "You have to get good grades to keep working in the group, and that was a really good motivator for me."

For Moise, lab work proved to be the key to real learning. "I'm much more of a hands-on learner, and there were so many vocabulary words, concepts, and ideas that kind of



M. Ofelia Aguirre Paden (left) and Dotti Pak have supported hundreds of undergraduate researchers.



Allison Koopman with lab colleagues during her CISEI summer internship in Japan.

escaped me just reading them in a textbook,” he says. “It was kind of embarrassing that a simple concept like vapor pressure escaped me. I knew what it was, but I got a really solid grasp of it only after I worked in Eric’s lab and saw the consequences of what it does. There are so many things you learn being in a group, like showing you can take a project and run it. You get to take ownership. You get to say, ‘These are my results, and I can defend them.’”

Allison Koopman (BA ‘19), who graduated from a public high school in San Jose, California, and is now pursuing a PhD in materials science at the University of Delaware, describes herself as “a low-achieving high achiever.”

She took ownership almost from the moment she arrived at UCSB, participating in summer research every year she was here. She began with the two-week SIMS program the summer before her freshman year, then spent eight weeks the following summer at the University of Texas El Paso (UTEP) as part of the PREM program. She participated in the CAMP program the summer before her sophomore year, and conducted research at the Tokyo Institute of Technology as part of the CISEI program. During her sophomore and junior years, she also worked in the labs of UCSB materials professors **Craig Hawker** and **Chris Bates**, where she, says, “I gained a love for polymer science that I’m still pursuing into my PhD. They’re crazy smart, and it was interesting to see the gears whirring in their heads.”

Enrolled in UCSB’s highly competitive College of Creative Studies (CCS), where she majored in chemistry and biochemistry, Koopman discovered the importance of trying to do undergraduate research via a post on a Facebook group for incoming CCS freshmen, where she learned about the SIMS program from one of her future dorm mates.

“That post was very important,” Koopman says, “because without it, I wouldn’t have done SIMS, and without SIMS, I wouldn’t have known to apply in February for summer internships after my freshman year. I wouldn’t have had the momentum to go to UTEP that summer, and it was UTEP that led directly to me getting a place in the other labs where I’ve worked.”

Koopman’s experience underscores the importance for undergraduates of being attentive to opportunities — whether they show up as a social media post, a university email, a workshop, or a notice on a club bulletin board — and taking action when they appear. While various programs and offices in the COE and elsewhere in STEM disciplines at UCSB do an outstanding job of informing students about the value of pursuing UGR opportunities, it’s easy enough for a student to miss class on the day of a research presentation or to fail to read an email about research opportunities that could change their lives.

Like many UG researchers, Koopman says she “became hooked” on lab work right away, and when she was introduced to polymers in the Hawker and Bates labs, she found the path to her future while doing challenging work that dramatically increased her confidence.

“I was working with [project scientist] **Morgan Bates**, who had me do a lot of the physical chemistry. I would ask for help only if I was having a big problem; otherwise, I had to figure out stuff myself,” she says. “It was fun, even if it was kind of panic-inducing at the time. Now, I find I’m quite confident doing all this chemistry and setting up polymerizations. I am confident that I can do research, that I can do my own research, and that I can get my PhD.”

Having recently bought a house in Delaware, Koopman says that she might like to work eventually at one of the several national labs nearby or in industry — both DuPont and W. L. Gore & Associates (makers of Gore Tex) have campuses near her.

Sophia Uemura (BS ‘20) knows what it’s like to get in a bit over her head. Now pursuing a PhD in materials chemistry at UCLA, Uemura, who double-majored in chemistry and biochemistry, used tenacity to get her UG position in the lab of chemistry professor **Lior Sepunaru**. She says, “I approached him in his office, but he didn’t have a spot, so I went back every day, saying ‘I would love to be in a lab; I would love to get research experience.’” Sepunaru told her that he didn’t have a graduate student to mentor her at the time but did have an idea of a project she could take on and asked if that was OK.

She said yes, she recalls, “not knowing at the time that, traditionally, as an undergrad, I would be working under a graduate student. But I took on a project related to silver nanoparticles on my own, under Lior’s supervision. While I had a lot of responsibility beyond what an undergrad usually has, it was important in helping me understand that I would like to continue doing this in the long term.”

Tenacity earned Sophia Uemura a position in chemistry professor Lior Sepunaru’s lab. She is now pursuing her PhD at UCLA.



DIVERSE SUCCESSES

Students who do UGR vary widely, and faculty have a range of criteria for selecting them. Read de Alaniz says he is not particular about the kind of experience students have when they apply to work in his lab, because he sees hosting undergraduate students, especially those from underrepresented groups, as “a way to expand the STEM pipeline,” adding, “My ultimate goal is to expose students to real research and see if they like it as much as I did. I usually try to identify a few students who are coming from a nontraditional pathway and don’t know what UGR is or what a science degree might enable them to do, because they’re not exposed to the role models who can show them.”

For Gabby Hammersley, her “trajectory-changing” research experience in the Read de Alaniz lab catapulted her to one success after another. “From Javier’s lab, I was included in two research papers, one of which was a first-author paper, which is kind of unheard of for an undergraduate, I think,” she says. “That research got me into CISEI, which allowed me to study abroad for a summer in the Netherlands, where I did more research. After that, Javier introduced me to an opportunity to do a two-year post-baccalaureate program known as CRTA (Cancer

Research Training Award), doing organic synthesis under a professor at the National Cancer Center at the National Institutes of Health, which resulted in two

more publications, another of which was a first-author paper. So, that little bit of chemistry I learned in his lab took me so far.”

Angel Okoro, too, saw her UG research experience yield a cascade of opportunities. It’s one reason, she says, “I’m constantly on the UCSB subreddit page advocating for people to do more research, because there are a lot of benefits that people don’t consider, like getting course credits for being a UG researcher. And I got the Lewis Stokes Alliance Fellowship because I was doing research, which also funded part of my research hours the next quarter, which helped me afford grad

here?” he says. “Every year, at least five or six students write to me after they complete the program and say, ‘This program gave me confidence to know that I can do this work at this level.’”

“A lot of the students I meet have no research experience, and first-generation students, especially, have limited role models in research,” says CSEP’s Davis. “It’s cool to witness it when a student sees a new door open, and then to see them going for things they’re excited and qualified to do and couldn’t have imagined going for previously.”

Mario Castellanos, executive director of the UCSB Office of Education Partnerships (OEP), coordinates a number of experiential programs aimed at diversifying students in the STEM pipeline and overcoming achievement gaps experienced disproportionately by

students who take non-traditional paths to UCSB. In one such project in the UCSB-Smithsonian Scholars Program, community college students are working to develop an algorithm to optimize the sorting and counting of wildlife images from remote cameras on Santa Cruz Island. Working there, students have to combine GIS and field-based data points, such as road locations and vegetation, as well as a sampling

protocol and instructions for handing off the work to other students.

“They had to do it all from the ground up,” says Castellanos, who is an ecologist and mentors students in the field for the program. “Our network provided equipment, transportation, training, and safety. They had to develop a research design and be able to communicate about it, which required a range of skills that are not normally taught but that resonate with industry professionals.

“It’s transformational for the students who come to us having no access to such experiences and not knowing how to take the first steps,” Castellanos adds. “I see huge changes after that direct experience. Literally getting their hands dirty in an outside environment, they get inspired and start to tune in to things that they didn’t learn in class.”

Diego Lopez, a first-generation senior in chemical engineering who works in Michael Gordon’s lab, says, “I had tons of impostor syndrome. It was something I dealt with until probably junior year.”

Emily Lopez (no relation to Diego), is a first-generation student who says that growing

FIRST-GENERATION STUDENTS, ESPECIALLY, HAVE LIMITED ROLE MODELS IN RESEARCH. IT’S COOL WHEN A STUDENT SEES A NEW DOOR OPEN, AND THEN TO SEE THEM GOING FOR THINGS THEY’RE EXCITED AND QUALIFIED TO DO AND COULDN’T HAVE IMAGINED GOING FOR PREVIOUSLY.”

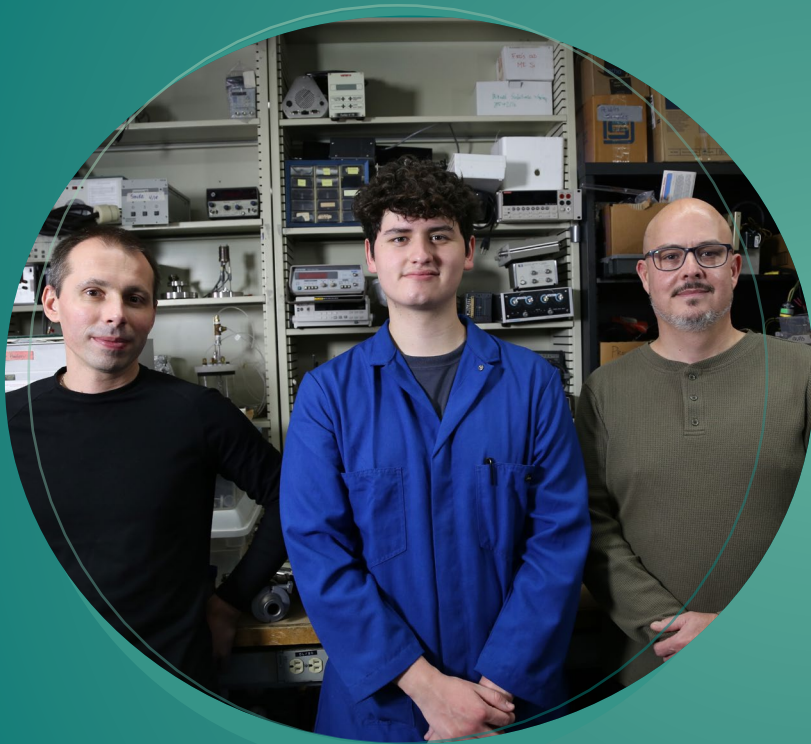
school applications, take my GRE classes, etc. They also paid for me to fly to Hawaii for a research conference, and that helped me get into several graduate school programs, because I was able to talk personally to recruiters. Research opened so many doors that I didn’t know existed.”

Walter Boggan works on the front lines in supporting students from diverse backgrounds find their way to research. As director of Admissions, Outreach, and Diversity Initiatives for UCSB Graduate Division, Boggan oversees the Academic Research Consortium. The summer pipeline program, which is open to students from underrepresented groups attending colleges from Bakersfield to San Diego, he says, “gives students from diverse backgrounds who might not otherwise have them opportunities to get experience at an R1 Institution.”

Boggan says that he sees a big increase in confidence among students in the program, many of whom experience impostor syndrome. “I like to ask the question: *Do you feel like you belong*

For her CISEI summer, Gabby Hammersley did organic synthetic chemistry research in the Netherlands.





Diego Lopez (center) with Michael Gordon (right) and postdoctoral researcher and mentor, Oleksandr Polonsky.



Junior environmental engineering major Ricardo Estrada visits a camera trap site on Santa Cruz Island.

up, "I didn't have academics in my life." Now, as a McNair Scholar and a senior mathematics major in CCS who does UGR in the lab of mathematics professor **Katie Craig**, she does do research — so effectively, that, just before spring quarter, she was trying to decide among offers she had received from UC Davis, UC San Diego, Cornell University, and the University of Colorado Boulder, all of which had accepted her into their doctoral programs.

Getting to this point required Lopez to overcome impostor syndrome, which, for her, shows up as anxiety. "Even though I'm in the honors college, mathematics is a very homogeneous, male-dominated field with not many female-identifying students," she says. "It often felt like a boy's club, and I'd sometimes feel excluded and wonder if I was smart enough. Doing my grad school applications, I wondered if I was qualified to pursue it. But, yes, I am."

UG research played a central role in her coming to that self-affirmation. "It was all the programs I did," she says. "First, it was, *Am I qualified enough to get into the SIMS research program?* Yes, I am. Then, *Am I qualified enough to get into a more involved research project in EUREKA?* And I found that yes, I could do that. And then, *Could I do a math-specific project with the SMALL Math Research Experience for Undergrads?* And I found that I can do that, too. Now, it's, *Can I actually apply my math in the machine-learning realm?* And the answer to that is also, yes, I can."

Despite her many successes, Gabby Hammersley says that she still struggles with impostor syndrome. "I have to hype myself up in a sense, remind myself of what I've accomplished." But even then, she adds, "Occasionally, I'll think, *Do I really deserve to be here?* The

other students might have worked harder, which can make me think that maybe I wasn't supposed to be where I am now."

But there she is, prospering amid her lingering, clearly unfounded doubts, succeeding by a combination of ability, effort, opportunity, and something she likely shares with a lot of the undergraduate researchers profiled in this piece. "I think my strongest quality is probably having grit and perseverance," she says. "Just coming from where I did and not knowing anything about research and begging Javier to get me into the lab and just making the best out of every situation. If something goes negative in the lab, I don't let it affect me. You have to just roll with the punches and keep thinking and be innovative."

Having worked through her own obstacles, Emily Lopez is now helping to build the confidence and make opportunities available to others, especially students from underrepresented groups. She says that her arc in SIMS — she participated before her freshman year and served as the SIMS student coordinator in 2021 — "goes to show, I

"I HAVE PURPOSEFULLY OR ACCIDENTALLY SURROUNDED MYSELF WITH PEOPLE WHO INSTILL CONFIDENCE IN ME, SO THAT I CAN WALK ON MY OWN TWO FEET. THERE ARE A LOT OF SOCIALLY MINDED EXTROVERTS AT UCSB WHO HELP PULL YOU OUT OF YOUR SHELL."

think, that by investing in undergraduates, you are also creating leaders who can spark systemic change for the better in the STEM field.

"There's this intellectual curiosity I have for the research," she adds, "but also a social aspect, a desire to try to create spaces, role models, and an environment I wish I'd had starting out as an undergraduate. That's what I'd like to do in the future: create spaces where people can be their authentic selves and reach their highest potential."

Increased confidence is clearly a major and widely noticed benefit that students derive from their UG research experiences.

"I think one of the most amazing things that I see in this work is students' expanded view of what is possible and what they are capable of achieving," says **Julie Standish**, who as intern coordinator for the MRL, provides multiple forms of support to propel students toward their academic goals while expanding the limits of what they might have thought was possible. "It is wonderful to witness their transition to being more confident in themselves and to realizing that their career and academic goals are obtainable."

"I've worked with several students in these programs who, before they began UGR, were extremely shy and lacked confidence," says Davis. "When you interviewed them, they were overcome with nerves and couldn't finish a sentence. After one summer of research, they're giving fifteen-minute research talks to a group, cracking jokes, relaxed and full of confidence. Their whole demeanor and personality change, and then they get into really competitive, top-level programs at UCs and elsewhere. It's a great achievement."

Okoro, whom Simpson describes as "a force to be reckoned with," says of her success to this point: "I think it's because I have either

purposefully or accidentally surrounded myself with people who instill confidence in me, so that I can walk on my own two feet. There are a lot of socially minded extroverts at UCSB who help pull you out of your shell. I don't know if that's the case everywhere. I have friends at other schools who have not had that kind of experience."

The rewards flow in both directions. "I got my start in research through undergraduate lab experience," Simpson says. "I discovered that I loved research science, so it's an honor to be able to give that opportunity to other people. I'm delighted that Angel enjoyed what she did in the lab enough to want to keep doing it on her next educational step."

Pitenis echoes that, saying, "I am motivated knowing that I can facilitate my students' journeys by having a lab that is accessible to them and comes with a built-in community of students and faculty to support them along the way."

The seed of Diego Lopez's undergraduate research was planted early but was reflected in a self-admittedly naïve notion. "I always thought the clean room was so cool and that the people in there were the ones doing all the cool research you hear about on the news. I wanted to experience it," he says, recalling that, on the other hand, "Research was always intimidating to me. I had no idea how to find those opportunities."

He also faced a central fear that stopped him for some time. "I thought the last thing a professor would want is a freshman with no experience to get in the way or mess up the lab or take up time," he says. "I think I was worried about being told no. You just have to ask, but I didn't know that as a freshman, or even as a sophomore."



Walter Boggan has seen a big increase in students' confidence after their undergraduate research experiences.



Emily Lopez (center) with her mathematics mentors, professor Katie Craig and assistant teaching professor Karel Casteels.

“

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After hearing MRL Education Director **Dotti Pak** explain the RISE program at a career services event, Lopez started trying to find professors whose research interested him. Michael Gordon rose to the top of his list, and with persistence, Lopez got in.

He says his confidence grew by having to speak in front of the group nearly every day in the RISE program. That continued in Gordon's lab, where, he says, “My mentor, [postdoctoral researcher] **Oleksandr Polonsky**, had this attitude ‘to just go for it.’ Before, I wasn’t that kind of person. I was too afraid of doing something wrong. But Oleksandr’s attitude kind of rubbed off on me to try it out and see what happens. Now, I use that outside of research, too.”

Gabby Hammersley, too, says that her confidence is growing: “I can see now that I really did accomplish a lot. I validated myself in a sense, and proved that I was capable of doing things I never would have thought of to begin with. It has a lot to do with Javier being an advocate, seeing something in me that I didn’t see in myself, and pushing me.”

Ironically, she adds, having started with an ill-formed notion of being a doctor, “It was great to find by doing research that I could be in medicine, actually making medicine like I am now, without being in medical school. I’m using all the same skills.”

Still, there are more students who could benefit from doing UG research than there are positions for them in labs, and, observes Sammy Davis, circumstances arise that can prevent first-generation and low-income students, especially, from taking advantage of the opportunities that do exist. “We have many students from working-class families who have to pay their way and have two or more jobs,” she says. “The challenge for them is that, to get a good UGR experience, they need to devote five to ten hours a week to research, and many of them just can’t do that. A big challenge at UCSB is to ensure that UG research is inclusive and available to the entire student body.”

Providing funding to broaden the pipeline is therefore critical, because, as mechanical engineering professor and the College of Engineering’s Associate Dean for Undergraduate Studies, **Glenn Beltz**, says, “It happens all the time that a student takes advantage of an undergraduate research opportunity and then flourishes.”



MANY STUDENTS TAKE THEIR FIRST STEP TOWARD RESEARCH EXPERIENCES THAT CAN LEAD TO UNFORESEEN SUCCESSES IN UNIMAGINED CAREERS BY ATTENDING AN OPEN HOUSE FOR ACCEPTED STUDENTS DURING SPRING QUARTER, WHERE THEY CAN GATHER INFORMATION ABOUT PROGRAMS TO SUPPORT UNDERGRADUATES, LIKE THOSE ON THE OPPOSITE PAGE.

A PARTIAL LIST OF RESEARCH-FOCUSED PROGRAMS FOR UCSB UNDERGRADUATES

CISEI

CISEI (Cooperative International Science and Engineering Internships)

Another MRL program, CISEI sends UC science and engineering undergraduates to international partner institutions for a ten-week summer research experience.

CSEP

Center for Science and Engineering Partnerships (CSEP)

Based in the California NanoScience Institute at UCSB and offering diverse research programs for undergraduates.

EUREKA!

EUREKA!: An enrichment program focused on introducing first-year STEM students to the broader science community on campus and providing exposure to research through academic-year internships.

CAMP

CAMP (California Alliance for Minority Participation) One of an array of programs administered by the UCSB Materials Research Laboratory (MRL), CAMP provides resources and opportunities to students from underrepresented groups (URGs) in STEM fields.

MARC U*STAR

MARC U*STAR (Maximizing Access to Research Careers - Undergraduate Student Training in Academic Research)

A two-year research program aimed especially at students from URGs who are interested in biomedical research, leadership development, and graduate school preparation.

PREM

PREM (Partnership for Research and Education in Materials)

The MRL-run program affords students from UCSB, the University of Texas, El Paso, and Jackson State University in Mississippi the opportunity to do a ten-week summer research exchange at another participating school.

RISE

RISE (Research Internships in Science and Engineering)

Sponsored by the MRL, the program provides research internship opportunities in a variety of fields.

SIMS

SIMS (Summer Institute in Mathematics and Science)

Administered by CSEP, a three-week program offering admitted students academic preparation and an introduction to research during the summer before their freshman year.

UC LEADS

UC LEADS (Leadership Excellence through Advanced Degrees)

Administered by the Graduate Division at UCSB, the UC-wide program is designed to identify upper-division UCSB STEM students who have the potential to succeed but who have experienced situations or conditions that have adversely impacted their advancement.