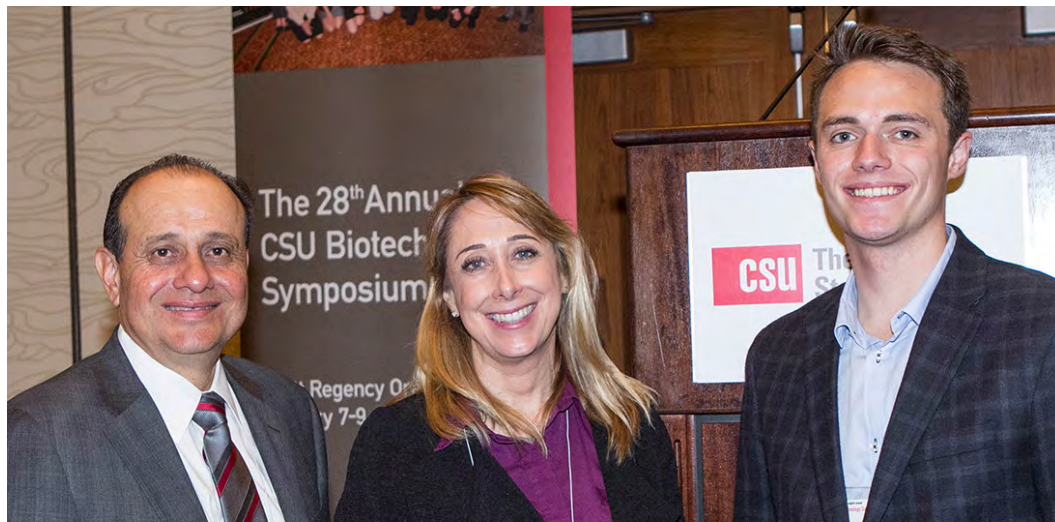




CSUPERB's mission is to develop a professional biotechnology workforce by mobilizing and supporting collaborative CSU student and faculty research, innovating educational practices, and partnering with the life sciences industry.



Above (left to right): CSU alums Willie Zuniga (CSU Los Angeles & President, Grifols Biologicals Inc.), Christina Waters (San Diego State University & CEO, Rare Science, Inc.) and Luke Sophinos (SDSU & CEO, CourseKey) were featured speakers at the 28th Annual CSU Biotechnology Symposium in Anaheim, California. **Below** (left to right): Rolando Ruiz (CSU Fullerton graduate), Jeffrey Jackson (CSU Fresno graduate), Joanne Nguyen (CSU Los Angeles graduate) and Lisa Sherman (Cal Poly San Luis Obispo graduate) talk about their education, jobs and careers with students during the symposium.

CSUPERB has keen interest in recruiting CSU alumni as participants and partners in our entrepreneurship programs, research efforts and symposia. Alumni working in biotechnology companies are particularly effective at building awareness around commercial product development and describing skills needed in today's world of work. Twenty-two of the 55 speakers and mentors attending the 28th Annual CSU Biotechnology Symposium this year are CSU alumni. They represent the wide range of biotechnology career options CSU students have after graduation. Rolando Ruiz, a Ph.D. candidate at UC Irvine, talked with students about his graduate school experiences. Joanne Nguyen, a medical science liaison at Boehringer Ingelheim, outlined the life decisions she's made while navigating a career. Luke Sophinos, the co-founder of a software company, described his willingness to take risks and desire to build something of lasting value. Students consistently report that the career advice and inspiration gained from alumni were unexpected benefits of the symposium. It's clear that sometimes the best mentors are the 'future selves' represented by alumni at the event!

2015/16 Program Highlights

- CSUPERB reauthorized as a system-wide program under CSU Executive Order 1103 through April 2021.
- The 28th Annual CSU Biotechnology Symposium at the Hyatt Regency Orange County drew 630 participants and featured 262 posters from 21 CSU universities – representing work from 168 CSU labs and 59 external partners.
- CSUPERB made 122 individual grants and awards (totaling \$826,897) to 58 faculty and 67 students at 20 CSU campuses.
- To date 202 students and faculty members from 20 CSU campuses participated in CSU Innovation Corps (I-Corps™) experiential entrepreneurship courses and workshops to learn how biotechnology research-based ideas might answer market needs or societal problems.



2015 - 2016 CSUPERB Leadership

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Sonoma State University

California State University
Program for Education and Research
in Biotechnology (CSUPERB)
www.calstate.edu/csuperb
www.csuperb.org/csuicorps
www.csuperb.org/blog

Susan M. Baxter (Executive Director)

Letter from the Executive Director

"CSUPERB invests in the idea that a modern biotechnology education requires an integration of coursework, hands-on practice, and participation in team-based research and entrepreneurship projects."

— 2015-2018 CSUPERB Strategic Plan

Dear Colleagues and Friends:

The start of the academic year is typically accompanied by a spate of publications and reports on science, technology, engineering and math (STEM) education and workforce development from think tanks, professional societies and federal agencies. This fall is no exception; recently it seems like I've been posting two to three must-reads a week on the CSUPERB LinkedIn Group page.

CSUPERB leadership pours over these reports to make sure we're keeping up with promising practices and remain strategically aligned with agency recommendations. This year we sponsored the 2016 *Talent Integration* report,¹ compiled by the state's biotechnology industry associations Biocom Institute and California Life Sciences Institute. For years the CSUPERB Presidents' Commission and others have prioritized regional reporting "that includes multiple sources of labor market data and local employers' assessment of the current and future workforce needs...with the dual goals of enhancing the local economy and strengthening student preparation for success in the regional workforce."² The *Talent Integration* findings echo those from other reports published recently. Employers and policy leaders alike think universities are "doing a good job providing...subject matter training," but new graduates also need cross-disciplinary communication, teamwork, critical thinking and collaboration skills. Undergraduate and graduate students are guaranteed to develop these skills while working on well-designed, authentic research and entrepreneurship projects.

But do our students use those learned skills in their lives post-graduation? With the help of two CSU STEM VISTA summer associates we worked to compile post-graduation status of 705 students supported by CSUPERB grants (2007 to the present). The 'last known status' data on our CSUPERB alumni are inspiring (dryly summarized on page 10 of this report). 79% of the CSUPERB-supported graduates are working or studying in biotechnology fields. Alumni feedback this summer convinced us yet again that discovery and risk-taking opportunities are worth supporting. In aggregate alumni stories are in line with new evidence demonstrating the value of hands-on, team-based projects embedded within the curriculum³ and offered as co-curricular activities.

Carpi and coworkers⁴ lament, "while the trend toward undergraduate participation in research may benefit the state of science education nationally, there is an inherent danger of exacerbating current disparities in minority representation if care is not taken to support these experiences at institutions that may not presently be able to afford them." Continuing institutional will and leadership is needed to scaffold team-based discovery opportunities across the CSU curriculum. CSUPERB, with new authorization to operate as a system-wide program through April 2021 under EO 1103, will continue to impact nearly 500 CSU students annually and provide thought leadership on these issues.

We've compiled only a small number of voices here in this annual report. Thankfully our newly redesigned website has room to feature new profiles and expand on the ones in this report going forward! I encourage you to take a moment as you read to extrapolate and imagine the scale of discoveries, talent and promise found in the CSU's biotechnology community.



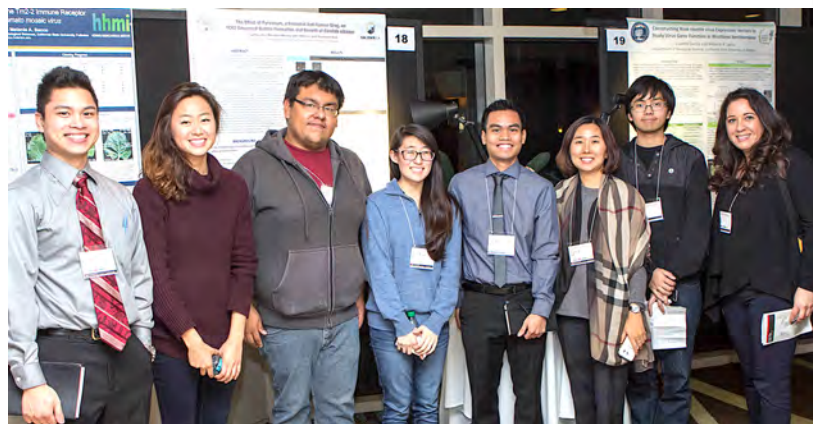
Articles Cited: 1. 2016 Talent Integration: California Workforce Trends in the Life Science Industry, califescienceworkforcetrends.org
2. Promising Practices for Strengthening the Regional STEM Workforce Development Ecosystem (2016) National Academies Press, doi: 10.17226/21894. 3. Mervis, J. (2016) *Science* 352 doi: 10.1126/science.352.6291.1266 4. Anthony Carpi, A., Ronan, D.M., Falconer, H.M., Lents, N.H. (2016) *Journal of Research in Science Teaching*. doi:10.1002/tea.21341

Summary: 28th Annual CSU Biotechnology Symposium

A recent National Academies Press (NAP) report* encouraged universities to provide students opportunities to "interact with STEM professionals and learn about employers and career opportunities" and "to meet role models and mentors who look like the students." The report also pointed out the need "to facilitate connections between [faculty] and STEM professionals who wish to function as volunteer speakers and/or mentors." The annual CSU Biotechnology Symposium is a working example of a "larger-scale, convening event" called for in the NAP report.

CSUPERB designs the event each January to broaden exposure to cutting-edge biotechnologies, product-focused innovation and the spectrum of career paths available in the life sciences. Faculty and administrators system-wide use the event to catch up, initiate collaborations, share ideas and swap lessons learned. The 28th annual CSU Biotechnology symposium (January 5-7, 2016) brought together 630 students, faculty members, administrators, industry professionals, alumni and government officials. The symposium is open to CSU students and faculty whether they are funded by CSUPERB or not.

The symposium program showcases the high level of hands-on, project-based research and entrepreneurial projects the CSU's students take on. The 262 posters and 13 CSU I-Corps team presentations at the event featured collaborative faculty-student research projects from 168 labs across the CSU, many of which are supported by the National Institutes of Health, National Science Foundation, Howard Hughes Medical Institute and other funding organizations. Interestingly 59 of the posters included authors from partnering institutions external to the CSU, highlighting the connections needed to advance biotechnology research. CSUPERB also made nine system-wide biotechnology awards to outstanding CSU students and faculty during the event (see page 8).



*<https://www.nap.edu/catalog/21894/promising-practices-for-strengthening-the-regional-stem-workforce-development-ecosystem>

Find more photos from the 28th Annual CSU Biotechnology Symposium at our Facebook page: <https://www.facebook.com/csuperb/>

Find out more about the students who attended the 28th Annual CSU Biotechnology Symposium: <https://magic.piktochart.com/output/11020572-csuperb-supported-students>

Anonymous Student Voices from the Post-Symposium Survey

What will you remember?

"I am going to remember the most from the graduate school information session. It was really helpful to ask professors first-hand what it is that they expect from potential graduate students."

"There were many interesting people I was able to meet and I learned a great deal through the I-Corps presentation process and working with some of the panel from the initial presentations."

"I'll most certainly remember Dr. Kelly Doran's talk about Group B Streptococcus and the blood-brain barrier."

"It was really interesting to see student works during the poster sessions. I was incredibly interested in the posters that had a social twist to them. For example, there were a few posters that focused on differences between males and females. Another combined music and protein sequencing..."

"My friend winning her Nagel award in a pikachu beanie."

"I was surprised to find members of my field - community college biology education - actively participating and willing to share their insight. I was also impressed that issues of access and equity made an appearance in the closing banquet (Pauling Scholarship)...People [were] willing to share their experiments and provide constructive feedback...being the only member of my lab using molecular methodology, this is invaluable."

"The networking sessions allowed me to explore the many career opportunities in the science field and to listen to the different career paths taken by many professionals."

"Listening to Dr. Waters was very impressive and touched my heart. I made a bunch of friends and got a chance to talk to Profs from various CSU campuses."

"I really enjoyed the Friday activities; the graduate school sessions and the job networking. It CHANGED my strategy to the PhD program! VERY IMPORTANT!!!!"

"I'll remember the career networking session and how helpful it was and also an idea from the elevator speeches that I should be willing to be uncomfortable if it's necessary."

"I learned that it isn't necessary to have a business degree to start your own company and that there are many ways to arrive at your final destination. Therefore, it wouldn't be the 'end of the world' if the plan doesn't go as planned."

"How it's actually possible for me to succeed and pursue my dreams."

SAVE THE DATE! The 29th Annual CSU Biotechnology Symposium will be held January 5-7, 2017, at the Santa Clara Marriott!

Student Researcher Voices

Charles Wingert (San Francisco State University & Spring 2016 CSUPERB Travel Grant recipient) is a Marine Biology master's student working at the Romberg Tiburon Center for Environmental Studies. Mr. Wingert studies the effects of ocean acidification on the problematic toxin-producing diatom *P. australis*, responsible for closing shellfish and crab fisheries along the United States' west coast in 2015. Working with NOAA collaborators in Seattle, he used competitive enzyme-linked immunosorbent assays (cELISA) to monitor *P. australis* growth rates. He was invited to the 4th International Symposium on the Ocean in a High-CO₂ World in Tasmania, Australia (May 2016). In his final report Mr. Wingert writes, "Before attending this conference, I was fairly certain that I was done with school and would not pursue a PhD, as I had originally planned. However, the encouragement, feedback and ideas I received while attending this symposium have got me thinking that I may wish to continue with my education after all. Now I feel recharged, inspired, and ready to tackle the grueling task of completing my written thesis. Lastly I would like to express my sincerest gratitude to the people who make the CSUPERB travel grant available to students like me. If it were not for this generous funding source, attending the International High-CO₂ conference in Tasmania would not have been financially feasible and I would have missed out on one of the best professional experiences of my life. Thank you!"

Nadja El-Mecharrafie (San Diego State University & Spring 2015 Travel Grant recipient) is a masters' student in Cell and Molecular Biology and works with Dr. Kristin Baldwin and Dr. Richard Lerner at The Scripps Research Institute as part of the CIRM-funded Bridges to Stem Cell Research program. She presented her work at the annual meeting of the International Society for Stem Cell Research in Stockholm, Sweden. In her final report Ms. El-Mecharrafie described the experience: "...after my mentor gave a talk about our project, many attendees came to see and talk about my poster long before the poster session and showed great interest in what we do. I got to discuss [the project] with scientists of various backgrounds who found the idea of reprogramming with antibodies very out of the box and offered new points of view on the subject. Due to the extent of the [work] some asked if I was a post-doc, and I appreciated being taken seriously as a scientist. We were also approached by a company who was interested in our screening platform technology and antibody libraries."

Faculty Researcher Voices

Karin Crowhurst (CSU Northridge; Fall 2015 Travel Grant recipient) used a sabbatical to take a short-term visiting professorship at the University of Toronto. In her final report Dr. Crowhurst explained what happened next: "First, I was given the opportunity to perform uninterrupted research (which was not even possible during the period of my sabbatical spent on the CSUN campus)...[An] important component of the visit included learning some new NMR techniques which can be applied to several of the ongoing research projects in my group; this included both techniques I specifically travelled to Toronto to learn, as well as new cutting edge techniques of which I had not previously been aware...Overall, I was grateful to have had this opportunity for new learning, new scientific interactions, and overall rejuvenation."

Greg Holland (San Diego State University; Spring 2015 Travel Grant recipient) joined SDSU's faculty in January 2015 and started setting up his research group right away. He used a CSUPERB travel grant to collect data at Arizona State University (ASU) while he waited for delivery of a new solid state Nuclear Magnetic Resonance (NMR) spectrometer at SDSU. He writes, "...this visit to the MMRC [Magnetic Resonance Research Center at ASU] provided invaluable training for the three graduate students accompanying [me]...new SDSU graduate students were trained in solid-state NMR techniques by not only senior graduate students at ASU, but also senior PhD NMR spectroscopists. This provided the new graduate students the training they needed to hit the ground running when the new solid-state NMR equipment was installed at SDSU at the end of 2015."

Vasanthi Narayanaswami (CSU Long Beach; Fall 2015 Travel Grant recipient) presented results from a collaborative research project at the 2nd Barriers of the Central Nervous System conference in Parador de Oropesa, Spain. She writes, "The conference attracted numerous stakeholders from academic, industry and biotechnology backgrounds, which was an ideal venue for obtaining feedback and...information. [The presentation] laid the groundwork for establishing the collaboration with Prof. Hagen von Briesen, my CSUPERB Joint Venture Program external partner, whom I met in-person for the first time. We were able to discuss a great deal of the project during the meeting and worked out the rationale and strategies for experimental approaches. I also met with his colleague, Dr. Sylvia Wagner, who is the project leader for the nanoparticle work in his group. The three of us are planning to move forward with a grant proposal submission..."

Joseph Ross (CSU Fresno; Spring 2015 Travel Grant recipient) traveled to Dr. Julin Maloof's UC Davis lab to learn a new computational technique. He writes, the bioinformatic pipeline was "developed to perform specific genome sequence analyses of nematode strains my laboratory generated...Over the course of my visit, [Dr. Maloof] did mentor me in the entire process, using a deep sequence dataset from one of our samples, and now I am independently continuing to apply the same bioinformatic workflow to the additional samples...this effort should pay additional dividends in allowing me to train my students to perform this workflow." Dr. Ross' next goal is to incorporate the pipeline tools into an upper-division genetics course.

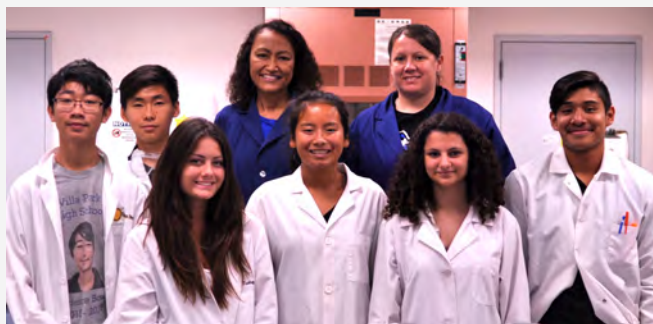
CSUPERB is: Researchers, Educators & Mentors

Troy Cline (2014 New Investigator Award recipient) joined CSU Chico as an Assistant Professor in the Department of Biological Sciences, after completing doctoral studies at Ohio State University and a postdoc at St. Jude Children's Research Hospital. Dr. Cline's research group is trying to understand the mechanisms by which H5N1 influenza viruses cause greater illness and mortality relative to seasonal strains of the flu virus. Like many new professors nationwide, his first grant proposal to NIH was not funded so he turned to CSUPERB for funding to generate more data to address reviewers' concerns. He explains, "I had proposed experiments only in mouse cells and they wanted to see my results confirmed using human cells as well." The CSUPERB grant also made it possible to recruit Keerthana Sekar, a master's student, to the project. Together they found that a change in interferon signaling was involved in the aggressive H5N1 immune response. The result "changed the direction of that aim of the project. Initially, I had proposed to look at several broad aspects of macrophage function but the recent result gives us something more focused to investigate; something a bit more mechanistic." The reviewers of the resubmitted proposal were supportive of the new direction, awarding the lab a 3-year NIH R15 grant (\$334,656) to support the research program. Meanwhile Ms. Sekar defended her thesis and landed a job in an immuno-oncology research group at Amgen in South San Francisco. With NIH funding the Cline research group can grow, adding 2 undergrads and 2 graduate students. Dr. Cline says, "My decision to take a job in the CSU was based on my desire to work closely with students in the classroom and the lab...So far I've been immensely pleased with the motivation and quality of our students in the CSU!" In turn we are pleased that Dr. Cline has found his research footing at CSU Chico!



The Cline lab (CSU Chico) hard at work uncovering mechanisms of influenza virus pathogenesis this summer. Clockwise from bottom left: Donald Beck (seated), Ana Barragan-Trejo, Dr. Troy Cline, and Elizabeth Bianchini.

Madeline Rasche (2014 Research Development Grant recipient) is a Professor in the Biological Sciences department at CSU Fullerton (CSUF). The lab uses molecular biology and X-ray crystallography methods to characterize proteins involved in the biosynthesis of tetrahydromethanopterin, a cofactor required for the microbial production of methane. The lab's long-term aim is to discover ways to reduce greenhouse gas production by methane-producing microorganisms. But a reorganization at NSF moved her competitive grant renewal from the Biology Directorate to the "Chemistry of Life Processes" program and it was not funded. She explains, "Reviewers were very specific that an in-depth kinetic and mechanistic analysis of a single protein in the nine-step pathway was needed." So Dr. Rasche applied for CSUPERB funding to focus in and get the data requested. On resubmission she was awarded a two-year grant from NSF and then things really took off. The \$200,000 NSF grant allowed her to integrate her research program into four different upper division courses and involve 30 students in research data collection, analysis and discovery. The research project caught the attention of Kristy Clarke, a high school teacher in CSUF's Howard Hughes Medical Institute program. Ms. Clarke proposed adapting the methanopterin biosynthesis project used in Dr. Rasche's college-level course for high school students. During the regular academic year, students in Ms. Clarke's Dana Hills High School class learn the biotechnology tools needed to carry out an original research project. This summer Ms. Clarke and three high school students joined the Rasche lab for a 4-week summer internship to take the project to the next level and make proteins suitable for crystallography studies. Dr. Rasche sums it all up, "The CSUPERB program is a godsend...Without a doubt, the grant saved my career as a professor by contributing to one publication, six undergraduate and one graduate poster presentations, and setting the stage for the successful 2015 NSF RUI grant."



Top: Ms. Kristy Clarke and Jose Moscaira from Dana Hills High School coach Robert Kim from Sunny Hills High School. **Bottom:** 2016 Methanopterin Biosynthesis High School Research Experience. Back row from left: Robert Kim (Sunny Hills High School), Madeline Rasche, Kristy Clarke (Dana Hills High School, DHHS). Front row: Terrence Lee (Villa Park High School), Grace Touhey (DHHS), Lily Nguyen (Villa Park High School), Camille Damore (DHHS), Jose Moscaira (DHHS).

CSUPERB is: Researchers, Educators & Mentors

Andrew Kinziger (2014 Research Development Grant recipient) is professor and chair of Fisheries Biology at Humboldt State University. The CSUPERB funding portfolio includes a growing number of environmental monitoring projects as



Modern fisheries monitoring – no nets or traps! Humboldt State University Fisheries Biology graduate student Michael Sutter (left) and undergraduate student Chad Martel (right) collecting water samples for environmental DNA analysis at Devereux Slough, Santa Barbara County, California. (Photograph by Lisa Stratton.)

investigators learn and adapt cutting-edge DNA-based methods. Dr. Kinziger writes, “Monitoring fish populations using environmental DNA in water samples represents a revolutionary approach for fisheries management, which has traditionally relied upon fish monitoring with traps and nets. Environmental DNA techniques have been shown to be more sensitive than traditional monitoring techniques, detecting species presence at low levels of abundance.” But in 2014 Kinziger still faced “skepticism from the fisheries community that eDNA (environmental DNA analysis) could be applied to real field situations” and he was unable to renew his US Fish and Wildlife Service (USFWS) funding. Kinziger turned to CSUPERB for proof-of-concept funding. The project focused on the tidewater goby, a fish listed as endangered under the US Endangered Species Act, and found in lagoons and estuaries along the entire coast of California. State agencies like CALTRANS are “interested in improved [goby] survey techniques, such as eDNA monitoring, because it can be used to ...save money and avoid delays during maintenance and construction.” Kinziger and Molly Schmelzle, a master’s student, developed “eDNA protocols for water sample collection, DNA extraction and qPCR detection of tidewater goby...The work showed the eDNA approach has nearly double the detection probability of traditional approaches.” As a result the Kinziger lab won two new contracts from USFWS and CALTRANS, opening up research opportunities for two more graduate students. Meanwhile, after completing her degree, Ms. Schmelzle took a job with the USFWS in Ashland, Oregon, advancing the use of molecular techniques in fisheries management.

Clinton Francis (2014 New Investigator Grant recipient) became an assistant professor in the Biological Sciences department at Cal Poly San Luis Obispo in 2013 after completing doctoral studies at University of Colorado and a postdoc at the National Evolutionary Synthesis Center in North Carolina. Signal detection and analysis is a big part of biotechnologies developed and used in the medical imaging and scientific instrumentation sectors. The Francis group analyzes noise (sound signals) to better “understand phenomena through the lens of sensory ecology.” He writes, “Health experts have long known that exposure to noise has negative physiological effects in humans...Because of their reliance on acoustic communications, birds have been viewed as especially sensitive to noise pollution.” Francis proposed developing state-of-the-art monitoring devices, along with signal mixing and deconvolution techniques, to determine whether reproductive success in nesting boxes might correlate with noise exposure. They faced technical hurdles right away; the lab-tested playback systems failed in the field. They “bought systems off the shelf so that we could have new units in the field in less than 48 hours. For our ongoing work, we rely on lots of consumer electronics that we modify with added microphones, solar power or custom windscreens.” The technical pivot paid off with compelling preliminary data that led to a \$481,000, 3-year NSF grant to the Francis group. Francis says the CSUPERB funding allowed them “to trial field playback systems and identify key improvements needed for scaling acoustic manipulations to a much larger study.” Further the CSUPERB grant “provided important research experiences for six undergraduate students...” One of those students, Connor Shanahan is now an Agricultural Biologist with Santa Barbara County Agricultural Commissioner’s Office. Dr. Francis reports Mr. Shanahan got the job because “he had over a year and a half of doing research...He worked on several different projects in my lab and, with each, had to go through the process of problem-solving stumbling blocks that are inherent to almost any field biology project...he got to practice ‘doing science’...[and it] gave him a lot of critical thinking skills and practice that helped him get the position.”



Francis group student researchers in action: Graduate student Tracy Mulholland (right) and undergraduate Kat Ivey (left) banding a bluebird nestling.

CSUPERB is: Researchers, Educators & Mentors

Katherine McReynolds, a chemistry professor at CSU Sacramento, faced a gap in funding when attempts to renew her NIH research grant were unsuccessful. She turned to CSUPERB's Research Development grant program to keep her lab afloat financially; she won a CSUPERB grant in the Spring 2013 round of seed grant awards. Dr. McReynolds explains, "...the CSUPERB proposal focused on synthetic method development using green chemistry coupled with microwave chemistry." She also made sure she had the right collaborators. "We perform an in-house competitive binding assay to determine at the most basic level if our molecules have the ability to bind to HIV-1 gp120 [the therapeutic target]. If they do, we then send the samples forward to Duke University

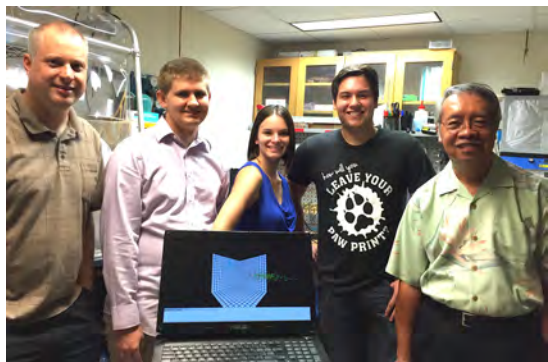


Dustin Dimas, CSU Sacramento Master's candidate, and Dr. Katherine McReynolds discuss new conditions for a protection reaction, part of a glycodendrimer synthetic design strategy.

and my collaborator, Dr. Celia LaBranche, who performs both an inhibition of infectivity assay with different pseudovirus strains of HIV-1, followed by cytotoxicity assays. "The team was able to gather additional "anti-HIV data that showed that we were on the right track" designing active molecules. She explains what happened next: "We were very happy to have the first SCORE submission from our campus funded [by NIH] on the first try. This opens the door for other faculty on the CSUS campus to apply to this great program, which provides excellent opportunities for

students and faculty alike to participate in important biomedical research". This summer, three graduate students and six undergraduates worked with Dr. McReynolds to keep the science moving forward.

Arturo Concepcion, a computer science professor at CSU San Bernardino (CSUSB), received a 2011 CSUPERB Curriculum Development grant. Bioinformaticians and data scientists typically fill knowledge gaps by taking individual, but uncoupled courses. The CSUSB faculty saw the need for and an opportunity to intentionally integrate biology, chemistry, computer science, and mathematics content to educate next generation bioinformaticians. The CSUPERB grant supported the development of a new bioinformatics course based on real-world research problems. To provide course-based research experience and internships, faculty partnered with researchers at the Center



The CSU San Bernardino Tetranucleotide Frequency viewer project team. From left, Dr. Jeremy Dodsworth (biology), Aaron Chamberlain (computer science), Kathleen Conner (bioinformatics), Christian Torres (bioinformatics) and Dr. Arturo Concepcion (computer science). Not pictured is team member Michael Morikone, who spent the summer doing research at Cornell University.

for Bio-Image Informatics at UC Santa Barbara, Loma Linda University Medical Center, and the City of Hope. CSUSB faculty also began new collaborative research projects. Dr. Concepcion is working with Jeremy Dodsworth, an assistant professor of biology, to develop a web-based, mobile application to visualize very large metagenomic datasets. The project requirements led the team to cloud-based computing and distributed processing solutions. As a result another new course on Big Data was developed; the first course taught in Computer Science and Engineering at CSUSB is now "Cloud Computing." Dr. Concepcion writes, "I am pleased to report that the B.S. Bioinformatics degree program at

CSUSB has been approved for permanent status...I firmly believe that this is due to the offering of the new bioinformatics courses...the high-quality internship programs that our majors undertake, and the success of our graduates in finding meaningful and appropriate careers in bioinformatics."

Student Researcher Voices

Sa La Kim (CSU Northridge & Fall 2015 CSUPERB Travel Grant recipient) is an undergraduate biology student working in Dr. Jonathan Kelber's developmental oncology lab. Working with other Kelber group members, Ms. Kim discovered that integrin alpha 1, a cell-surface receptor, works in concert with other proteins to keep pancreatic cancer cells alive and promotes tumor growth. As a result of this work, Ms. Kim was invited to present her work at the annual meeting of the American Association for Cancer Research in April 2016 in New Orleans. In her final report Ms. Kim explains, "One of the most surprising [things] was that I understood much more than I anticipated. During many of the mini-symposium talks...delivered by Ph.D.s and postdocs...I understood the reasoning behind the work, the reason for their work, and could think of multiple follow-up experiments for their hypotheses. This also made me realize that the level of work Dr. Kelber's students engage in is phenomenal. This level of research is the push that I believe prepares students for a higher level of education."

Anastasia Ennis (San Francisco State University & Fall 2015 CSUPERB Travel Grant recipient) is a master's student in the Ecology, Evolution and Conservation program working with Dr. C. Sarah Cohen. Ms. Ennis' work uses population genetics and phylogeography methods to understand how salt marsh harvest mice adapt to a rapidly changing environment. She writes, "While my abstract was originally accepted as a poster, a spot for a talk opened up in my session, so I was able to [give] a formal presentation" in Portland, Oregon, at the Coastal and Estuarine Research Federation (CERF). The "...plenary talks at this conference [focused] on making the case for the validity and importance of ecological research to all people: minorities and those from different countries and socio-economic strata. While I have heard before about how to reach out to non-scientists from all walks of life to get them to care about what we do, the panels at CERF included differing perspectives on how best to do this - very thought-provoking. This conference galvanized and recharged my passion for and interest in ecosystem conservation and restoration."

2016 CSU Biotechnology Symposium Awards



2016 ANDREOLI FACULTY SERVICE AWARD: Dr. Amybeth Cohen, Professor & Director, Department of Biological Science, College of Natural Sciences and Mathematics, CSU Fullerton. Dr. Cohen was recognized for her leadership in promoting student success in biotechnology at CSU Fullerton (CSUF). Dr. Cohen was group leader during the development of the Concentration in Molecular Biology and Biotechnology, now the second largest concentration in the Department of Biological Science, serving more than 500 students annually. Since 2005 Dr. Cohen has served as the Director of the NIH-funded Minority Access to Research Careers (MARC) Scholars Program. Pictured here (left to right): David Bowman (Interim Dean, College of Natural Sciences and Mathematics, CSUF), Robert Koch (Special Assistant to the Provost and Professor of Cell Biology, CSUF), Dr. Cohen, Laura Arce (MARC Program Assistant Director, CSUF) & Michael Goldman (Chair, CSUPERB Faculty Consensus Group, Professor of Biology at San Francisco State University & Chair, 2016 Andreoli Award Selection Committee).

2016 CSUPERB FACULTY RESEARCH AWARD: Dr. Kelly Doran, Professor, Department of Biology, San Diego State University. Dr. Doran was recognized not only for her "outstanding research productivity and her dedication to students," but also her ability to bring the excitement of research into the classroom. Dr. Doran's research program at San Diego State University (SDSU) studies the host-pathogen interactions of gram-positive bacterial pathogens. Her group has published over 50 peer-reviewed manuscripts since the opening of her SDSU lab, 20 of which were co-authored with students. Her research program has been continuously funded by NIH R01 grants, in addition to grants from the Burroughs Wellcome Fund and others. Pictured here (left to right): Stanley Maloy (Dean, College of Sciences, SDSU), Dr. Doran & Frank Gomez (CSU Los Angeles, 2007 Faculty Research Awardee & Chair, 2016 Faculty Research Award Selection Committee).



2016 CRELLIN PAULING STUDENT TEACHING AWARDS: Mr. Kevin Chiem, Master's degree candidate, Department of Biological Science, CSU Fullerton, taught Evolution and Biodiversity for three years as an undergraduate Supplemental Instruction (SI) leader. Starting in Fall 2013 he served as a teaching assistant for General Microbiology. Mr. Chiem writes, "I initially came from an artistic background and later transitioned to science, which aided me in seeing the benefits of creative thinking when it comes to teaching and learning science." The selection committee was impressed with the examples he included of his creative approaches to teaching and assessment, and applauds his "tireless efforts to improve the course curriculum."

Ms. Kristine Teague, Biological Sciences master's candidate, Humboldt State University, taught sections in Cell and Molecular Biology at Humboldt State University. The selection committee was impressed by her thoughtful narrative in which she described the benefits to society of scientific understanding, including her recognition that "the goal of education should not only be to teach students a particular subject, but to engage their minds in a critical discussion and inspire true understanding and exploration." Pictured here (left to right): Mr. Chiem, Math Cuajungco (CSU Fullerton & Chair, 2016 Pauling Award Selection Committee).

2015 GLENN NAGEL UNDERGRADUATE STUDENT RESEARCH AWARD: Ms. Rachel Flores, CSU Long Beach, works with Brian Livingston in the Department of Biological Sciences. The NSF-supported lab studies the evolutionary biology and biochemistry underlying the formation of biomineralized skeletons found in sea creatures like sea urchins and brittle stars. Ms. Flores used biochemical and bioinformatic methods to identify proteins associated with biomineralization. Pictured here (left to right): Tom Savage (CSU Sacramento & Chair, 2016 Nagel Award Selection Committee), Ms. Flores & Dr. Livingston.



2015 DON EDEN GRADUATE STUDENT RESEARCH AWARD: Ms. Lace M. Riggs, CSU San Bernardino, works with Sergio Iniguez in the Department of Psychology. The NIH-supported lab is studying how stress works as a risk factor for the development of mood-related illnesses, including depression, anxiety, and posttraumatic stress disorder in women. Ms. Riggs examined the expression of signaling genes in the region of the brain associated with depression following stress. Pictured here (left to right): Dr. Iniguez, Ms. Riggs, Ms. Lisba Fowler (Eden Family Representative) and Kasuen Mauldin (San Jose State University & Chair, 2016 Eden Award Selection Committee).

California State University Program for Education and Research in Biotechnology (CSUPERB)

Annual Report
Academic Year
2015-2016

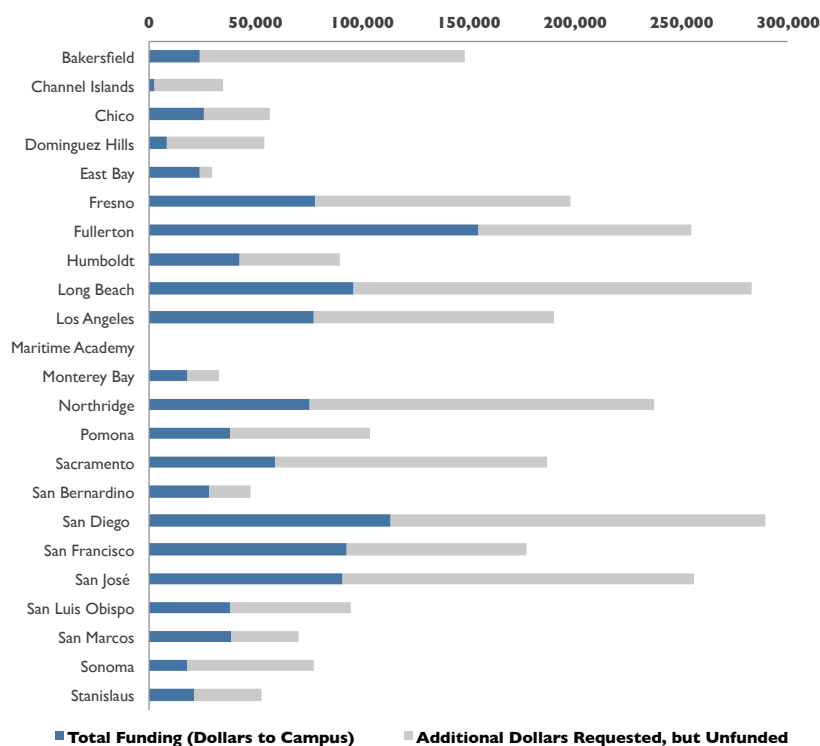
Annual Expenditures AY 15-16	Salaries & Office Operations	\$ 420,855
	Program Operations & Outreach	158,646
	Symposium (including Symposium Awards)	316,679
	Grants & Awards	751,965
	CSU I-Corps™ Grant (NSF)	52,182
Total Expenditures:		\$ 1,700,326

The last two years CSUPERB had significant help ramping up CSU I-Corps from 2 full-time VISTA members and 2 summer associates through the CSU STEM VISTA program.

Grants and Awards Issued by Program (Number of Awards & Total Award Dollars)	Faculty-Student Collaborative Research Grants	32 / \$ 479,495
	Entrepreneurial Joint Venture Matching Grant	3 / 75,000
	Curriculum Development Grants	2 / 30,000
	Travel Grants (Faculty & Student)	40 / 55,402
	Howell - CSUPERB & Presidents' Commission Research Scholar Awards	23 / 130,000
	Symposium Awards	6 / 9,500
	CSU I-Corps™ Microgrants	19 / 47,500
Total Number of Awards / Total Dollars:		125 / \$ 826,897

CSUPERB received 390 proposals, applications and nominations from 22 campuses this year; awards were made to 20. The CSU I-Corps microgrant program is made possible by a three-year grant from the National Science Foundation.

Competitive CSUPERB Funding by CSU Campus AY 15-16

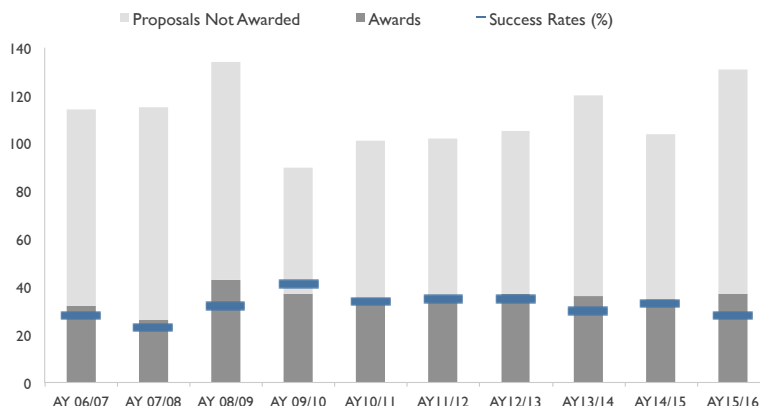


This chart summarizes CSUPERB financial support in the form of competitive grants, awards, and symposium expenses (in dollars, \$) by campus. 20 campuses won grants and awards this year; 22 campuses were represented at the 28th Annual CSU Biotechnology Symposium.

Additional dollars requested reflects campus applications and proposals that were not funded and symposium registrations that could not be accommodated. The grey bars indicate both campus and faculty interest in CSUPERB programs from biotechnology teams across the CSU system.

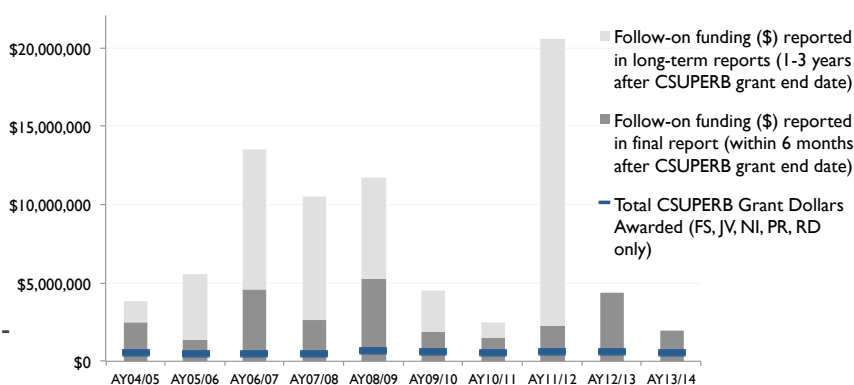
CSUPERB Program Trend Data - At a Glance

Competitive CSUPERB Grant Program Success Rates: Number (#) of proposals awarded, # of unfunded proposals and success rates (AY 06-07 through AY 15-16)



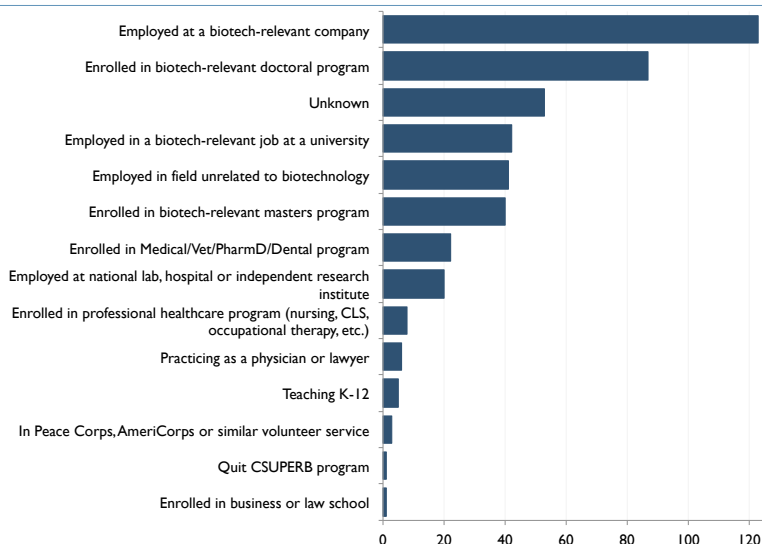
Overall success rates (number awards made ÷ number proposals received, reported as a percentage) are shown by academic year for the seed grant programs. For the last three years ~30% proposals were funded. Notably we saw a 33% increase in New Investigator applications this year compared to the 5-year average, correlated perhaps to new faculty hiring system-wide.

External, follow-on funding received by CSU faculty supported by CSUPERB seed grants (AY 04-05 through AY 13-14)



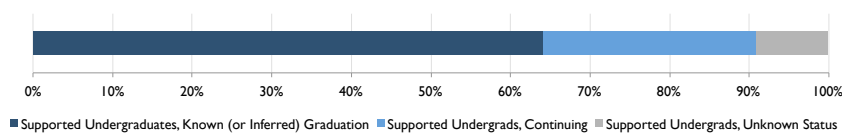
About 27% of CSUPERB seed-grant-funded faculty (2009-2014) are successful at winning external, follow-on funding. The averaged financial return-on-investment in PIs funded 2004-2014 is 1460%, based on reports received as of July 1, 2016. One of CSUPERB's strategic aims is to increase the number of funded biotech researchers system-wide. Follow-on funding represents an expansion of student research opportunities.

Where are they now? Last Known Status, CSUPERB-supported undergraduates & masters students (n = 452) post-graduation / degree completion (2007-2014)



This year 483 CSU students received financial support from CSUPERB as scholarships, symposium participation and research support. CSUPERB made 181 seed grants (2006-2014); 83% of them supported CSU student researchers. These seed grants resulted in 70 peer-reviewed publications; 23% of them included CSU student authors. Research experience sets CSU students up for success in a wide range of life science careers.

Last Known Status, Supported Undergraduates (2007-2014)



At least 91% of CSUPERB-funded undergraduates (2006-2014, n=478) graduated or continued in CSU life science or engineering degree programs.