2018 - 2021 CSUPERB Strategic Plan

About CSUPERB: The California State University Program for Education and Research in Biotechnology

CSUPERB believes that the best way to engage and help students embark on life sciences careers is to invest in and provide access to experiential learning opportunities in biotechnology research and entrepreneurship. CSUPERB recognizes that biotechnology preparation requires integration of disciplinary knowledge, hands-on practice, and collaborative, team-based projects. We know that these experiences are particularly effective at engaging and retaining students who are the first in their families to attend college or are from communities underrepresented in the life sciences. By working on solutions for real-world problems with CSU faculty teacher-scholars in the classroom and on research teams, all students can build a solid foundation for successful biotechnology careers. CSUPERB partners with industry professionals, alumni, and organizations to support the always-evolving life sciences industry and California's regional economies. The California State University plays a critical role in California's biotechnology ecosystem by providing not only a professional workforce but also innovative ideas that drive the growth and evolution of the entire industry.

Contents

Executive Director:
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http://www.calstate.edu/csuperb

Approved by Chancellor White, July 17, 2018

Executive Summary

Since 2009 CSUPERB has developed three-year strategic plans to articulate the CSU's biotechnology community's purpose, values and goals, to prioritize investments, to develop programming, and to frame annual operational plans. In Spring 2017 the CSUPERB Presidents' Commission decided to continue the practice, which was also adopted by Executive Order (EO) 1103, the CSU's new policy governing system-wide affinity groups.

During the Fall 2017 and Winter 2018, members of the CSUPERB Faculty Consensus Group (FCG), the Strategic Planning Council (SPC), and the Presidents' Commission (PC) collaborated on a strategic planning process that involved:

- Surveys (September - October 2017), to gather detailed feedback from 162 individuals, including FCG members, campus administrators, grantees, program participants, external partners, and biotechnology industry leaders;
- A one-day retreat (November 2017), involving SPC members, students, faculty, and administrators, to synthesize the stakeholder feedback and industry trends; and
- PC (November 2017 and April 2018) and SPC (April 2018) meetings to review and respond to ideas and strategic plan drafts.

The CSUPERB community overwhelmingly decided the program should continue to operate with three broad strategies: Expand Experiential Biotechnology Learning Opportunities, Innovate Biotechnology Education, and Partner with Industry. Priorities and cross-cutting themes for 2018-2021 are: 1) raising the visibility of the CSU's impactful biotechnology community, 2) deepening efforts to improve undergraduate biotechnology-related education, and 3) providing biotechnology career resources to faculty mentors and students. The Presidents' Commission especially encouraged CSUPERB to 4) lead boldly in advancing integrative, inter-disciplinary education, and team research.

CSUPERB remains focused on improving student success in biotechnology. We define student success not only as the completion of a biotechnology-relevant degree, but also the acquisition of abilities needed to chart a successful life science career. The latter is increasingly tied to the need to integrate, "make sense," and make decisions based on disparate sources of knowledge, data, or content. As a result, partnerships with the individuals and organizations that make up the life science industry – companies, universities, non-profit research institutions, industry associations, business incubators, and government laboratories – are key not only to our success as a community, but also our graduates' successes.

A community like CSUPERB needs to remain vibrant, maintain its intellectual focus and energy, and have access to and remain aligned with system-wide CSU decision-making.[1] CSUPERB's impact will depend on collaborative partnerships, alumni networks, faculty volunteerism, administrative support, and campus engagement. Over the next three years, CSUPERB will continue to champion experiential education, make seed investments in faculty-driven academic programs and research projects, and remain open to new ways of thinking within the university and the surrounding life sciences ecosystem.

CSUPERB Mission & History

CSUPERB was organized between 1985 and 1987 by faculty across the CSU and led by Joe Bragin (CSU Los Angeles, Chair, Governing Board and Executive Committee), Steve Dahms (SDSU, Co-Director), and Crellin Pauling (SFSU, Co-Director). President Thomas B. Day (San Diego State University) championed the organization and in 1987 CSU Chancellor W. Ann Reynolds approved and chartered CSUPERB. During this time, CSUPERB focused on acquiring resources and equipment necessary to incorporate molecular biology and genetic engineering techniques and concepts into the CSU curriculum, core facilities, and research laboratories. In 1988 a travel grant program was established and CSUPERB began hosting annual CSU Biotechnology Symposia.

Because more than 80% of the >280,000 professionals working in the California life sciences industry have an education at or below the master's degree level,[2,3] a special legislative line item (AB 968, Ducheny, 1999) provides ongoing support for CSUPERB to "maintain and enhance its role in the preparation of the biotechnology workforce." The increased financial support allowed CSUPERB to broaden its focus and create additional grant programs. At the same time a shared leadership structure was organized to include a Presidents' Commission (PC), a Strategic Planning Council (SPC), and a Faculty Consensus Group (FCG). A CSUPERB Operations Committee, including the Executive Director, program staff, SPC Chairs, and taskforce chairs, manages and administers program operations.

In 2008 CSUPERB developed its first three-year strategic plan, approved by the CSU Chancellor. This effort matured the system-wide program and it began operating intentionally as a community of practice to "create, expand, exchange knowledge and to develop individual capabilities."[1] CSUPERB uses strategic plans to articulate the community's purpose, values, and goals, while also framing annual operations. In March 2016 CSUPERB was authorized by Executive Vice Chancellor Loren J. Blanchard to continue operations as a system-wide affinity group under EO 1103.

CSUPERB strategically partners with biotechnology employers and industry associations[4] on curriculum and workforce development initiatives. In 2008 CSUPERB

(continued)

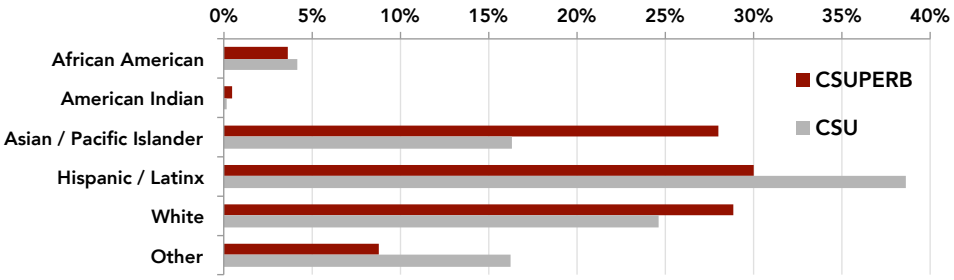
CSUPERB seeds biotechnology innovation and cultivates a diverse, professional workforce for California and the global economy.

Mission

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

Theory of change

We can make a difference by ensuring all CSU biotechnology students have access to an education that integrates experiential learning, especially team-based research or entrepreneurial projects.



Self-reported ethnicity of research-active students supported by CSUPERB (Fall 2017), compared to overall CSU student demographics.[5] Responses came from the 397 CSU students who attended the 30th Annual CSU Biotechnology to present research posters in Santa Clara, California. The biotechnology industry overall does not reflect California's demographics; many of our communities remain underrepresented in biotechnology-related degree programs and career paths.

provided initial support, bolstered by funding from the Alfred P. Sloan Foundation, for the development of biotechnology-related Professional Science Master's degree programs. CSUPERB served as a catalyst to make California Institute for Regenerative Medicine (CIRM) funding available to CSU students interested in stem cell research. Fourteen CSU campuses now have Bridges to Stem Cell Research programs that, as of 2018, have received over $82 million in CIRM funding. CSUPERB built public-private partnerships to increase the number of clinical laboratory scientists and other skilled professionals in California; as a result, in 2010 two CSU-led teams won $10 million in Department of Labor funding. In 2014 CSUPERB seeded partnerships and the community contributed data that led to major funding to the CSU from The Leona M. and Harry B. Helmsley Trust for the STEM Collaboratives project and the National Institutes of Health to fund BUILD programs. The CSUPERB community's efforts to adopt *Vision and Change* principles in biology courses system-wide were featured in a 2015 AAAS report.[6] In 2014 CSUPERB won a National Science Foundation (NSF) grant to establish CSU Innovation Corps (I-Corps™) and offer experiential entrepreneurship education to faculty and student researchers system-wide. NSF renewed the CSU I-Corps grant in 2018, based in part on our success including a discipline-, gender- and ethnically-diverse set of researchers from campuses system-wide. To define strategies, priorities and tactics for each of these initiatives, CSUPERB collaborated across academic divisions, with multiple campuses, and external biotechnology industry partners.

The graduation rate of CSUPERB-supported students is greater than 90%, roughly double the averaged CSU STEM six-year graduation rates.

We know the same percentage of CSUPERB-supported students (~90%) continue on in life sciences career paths, whether accepting jobs in the life science industry or entering professional, graduate or medical school programs.

CSUPERB supported 642 CSU students and faculty in Academic Year (AY) 2016-2017. From 2006-2017, CSUPERB made grants or provided funding to 6084 CSU students and faculty. AY 2016-2017 was notable, because CSUPERB supported faculty and students on all 23 campuses for the first time. Additional metrics further describe the vibrancy and growth of the CSUPERB community system-wide. The applicant pool continues to expand across campuses and disciplines. On average 43% of grant proposals (2000-2017) were submitted by first-time applicants; 35% of CSUPERB grants have been made to first-time applicants. The seed grant programs average 14.5-fold fiscal returns (or 1451%), based on CSUPERB dollars awarded in the last decade (2005-2015) compared to follow-on funding received by CSUPERB-supported faculty. On average 30% of CSUPERB Principal Investigators (PIs, 2010-2015) report receiving >$100,000 in external grant funding within 2.5 years of completing work on CSUPERB seed grants. These data strongly suggest that our coordinated seed grant investments, coupled with a competitive peer review system and professional development opportunities, identify promising research and innovations across the CSU that are competitive at the national level. Follow-on funding to CSUPERB-supported faculty represents an expansion of student research and experiential learning opportunities on campuses system-wide.

Final reports from undergraduates supported by CSUPERB seed grants (2007-2017, n = 583) highlight even greater, transformative impacts. The graduation rates of CSUPERB-supported students are greater than 90%, roughly double the averaged CSU six-year graduation rates of students declaring STEM majors at entry.[7] Students supported by CSUPERB funding are ethnically diverse (chart above), but don't yet mirror the CSU's overall enrollment,

reminding us that more work is needed to include students underrepresented in the biotechnology ecosystem. Over 90% of the undergraduate and master's students participating in CSUPERB programs and symposia report they do not have family or friends working as researchers, clinicians or professionals in the life sciences industry. However - against this backdrop - we know that 90% of CSUPERB-supported students continue in life sciences career paths, whether accepting jobs in the life sciences industry or entering graduate or medical school programs.

Importantly, these student outcomes hold across all CSUPERB programs – amongst Howell Scholars, who are academically accomplished juniors and seniors, or Presidents' Commission Scholars, who are lower-division students recruited into faculty-led research groups. As many other education researchers nationwide have found, discovery-based STEM learning coupled with teamwork is a high-impact practice.[8] While many of these "signature" [8] experiences may not yet show up on transcripts, they are the number one workforce need articulated by alumni and employers in the biotechnology industry.[3]

Programs and activities inspired by previous CSUPERB strategic plans are bolstered and amplified by other system-wide and campus-driven projects and strategies. In Fall 2017 we attempted to assess not only the "aliveness"[1] and culture of the CSUPERB community, but also its impact on campuses, the faculty, and the student experience.

The majority of faculty members, CSUPERB PIs, and administrators surveyed during the Fall of 2017 observed that greater numbers of CSU faculty and students were involved in biotechnology research, partnerships and collaborations compared to three years ago. The majority of students and faculty surveyed reported increased opportunities within the CSU to learn about entrepreneurship and biotechnology commercialization. Faculty reported that campuses now place increased value on course-based active learning and innovative educational experiences for CSU students, building on positive outcomes reported by STEM Collaboratives projects.[9] The majority also reported unmet student needs for inter-disciplinary, biotechnology-related courses and course-based research opportunities. Concomitantly, they see unmet faculty professional development needs in curriculum redesign. Students, in particular, asked for more networking and connections with alumni and biotechnology professionals. The majority of respondents viewed CSUPERB as a supporter, investor, and convener around these system-wide issues.

Survey respondents and stakeholders agreed that CSUPERB's culture fosters communication, collaboration and trust, while also welcoming a variety of participation levels and fostering a collective sense of purpose, professionalism, or intentionality. All groups surveyed and stakeholders alike agreed that CSUPERB doesn't need better communication within the community. Instead, it should raise the visibility of the CSU's biotechnology community, its workforce development work, and accomplishments of faculty, students and alumni within and beyond the CSU's campuses.

CSUPERB continues to mature and evolve with the dynamic, cutting-edge ecosystem it inhabits. The CSUPERB community and its network of external partners change as new biotechnologies evolve to solve problems in our communities and regions. The SPC and the Presidents' Commission recognize the strategic value of system-wide, disciplinary-diverse faculty participation in CSUPERB. Looking forward we see an increased need for inter-disciplinary partnerships to tackle complex problems from sustainable crop production to human diseases. Indeed, employers and graduate school admissions committees seek scientists and engineers capable of integrating knowledge from disparate sources.[3] The 2018-2021 strategic plan is crafted to steward an adaptive, responsive community supporting excellence in biotechnology education and research across the CSU system.

"I learned and GREW so much by attending CSUPERB for the first time…[I] was INSPIRED by professionals and realizing that I can make a difference in the world by pursuing research. I'll also remember the people I met and how amazing everyone's research work was (and how incredibly knowledgeable the students are!) I'll remember this was the weekend I began to fall in love with research and truly be exposed to this world with opened eyes."

– Student who attended the 30th Annual CSU Biotechnology Symposium

2018 - 2021 Goals and Strategies

This 2018-2021 CSUPERB strategic plan identifies three priorities for the program: 1) expand experiential biotechnology learning opportunities across the CSU; 2) innovate biotechnology education; and 3) partner with the life science industry. To address these priorities simultaneously over the next three years, CSUPERB will need support, advocacy and resources from the CSU, external partners, and policy makers.

The four cross-cutting programmatic themes for 2018-2021 are Career/Professional Development for Students and Faculty, Communication Efforts, Inter-Disciplinary Education and Team Science, and Operational Capacity and Effectiveness. Program priorities include efforts to 1) raise the visibility of the CSU biotechnology community's impact, 2) deepen efforts to improve undergraduate biotechnology-related education to engage students and close opportunity gaps, and 3) provide trusted biotechnology career resources to faculty mentors and students. The Presidents' Commission especially encouraged CSUPERB 4) to lead boldly to advance integrative, inter-disciplinary education and team science, a theme ratified by the Faculty Consensus Group in January 2018.

At this stage in CSUPERB's evolution, we think capacity-building activities should include expanded efforts to track student career trajectories, to support faculty leadership development, to champion quality, high-impact practices for student learning and success, and to measure CSUPERB programs' impact on student success and their value to the CSU system. CSUPERB must pay continued attention to collaborations, communications, and outreach to CSU administrators, faculty, students and alumni to align our efforts with the overall strategic directions of this great public higher education system.

Strategic Goal #1: Expand Experiential Biotechnology Learning Opportunities

Based on feedback from life science industry employers[3] and graduate school admissions advisors, CSUPERB will invest in disciplinary-diverse, team-based experiential learning opportunities. Well-implemented research opportunities, project-based internships, and evidence-based entrepreneurship programs allow students access to cutting-edge science and technology and opportunities to think like scientists, engineers, and entrepreneurs. These student research experiences – whether in campus laboratories, companies, innovation centers, or

"I learned about what a research career is really like from people who are passionate about it and do it everyday. I was also exposed to so many new ideas from fellow undergraduate students whose research opened my eyes to broaden my horizon and not to limit myself to just conquer the 'easy' things but to shoot for the stars."

– Student who attended the 30th Annual CSU Biotechnology Symposium

classrooms – create opportunities to explore and discover, knit together multi-disciplinary concepts, collect disparate data for evidence-based investigation, and synthesize and communicate findings. These are critically important modes of learning required to prepare graduates for biotechnology industry careers.[3]

Financial support for experiential learning experiences is particularly impactful for students not supported by other training or scholarship programs. CSUPERB seed grants provide faculty with the resources to successfully compete for follow-on, externally funded grants. External grant support for CSU biotechnology faculty increases the number of students involved in faculty-led scholarship, creative activities, and research programs in classrooms, laboratories, and the field.

During these next three years, CSUPERB will invest in and nurture partnerships (intra-campus, cross-divisional, and inter-campus) aimed at expanding experiential learning opportunities for all CSU biotechnology students. Complex biotechnology-related problems require diverse perspectives and techniques, bringing together life, physical, clinical, computer sciences, business, engineering, public health and mathematics expertise. Professional development workshops, incorporating design thinking, team-building, and project management, for both students and faculty will cultivate diverse teams capable of identifying and addressing problems worth solving. CSUPERB leadership will advocate within the CSU and in Sacramento for infrastructure, building maintenance, and architectural designs needed to unlock creativity and support experiential learning.

Strategic Goal #2: Innovate Biotechnology Education

The CSU has a strong record of preparing and graduating students into jobs, graduate and medical school programs. Our alumni provide the high-level talent for basic discovery programs and clinical research in the biotechnology industry. However, the

More than 80% of the professionals working in the life science industry have an education at or below the master's degree level

"The first student who worked on the project is in the PhD program at UC Riverside. The second student who worked on the project just started a research associate job at Medtronics in Irvine, CA… The CSUPERB research development grant allowed gap money to produce preliminary data that was used in my funded SC3 [NIH] grant."

– Judy Brusslan (CSU Long Beach, 2014 Research Development grant recipient)

"It was so great to see all the amazing and diverse research that is going on in the CSU system. Going through the posters I got to see a lot of interesting research, and compared to other conferences that are solely student focused (like SACNAS) people were genuinely interested in MY RESEARCH and that was really great."

– Student who attended the 30th Annual CSU Biotechnology Symposium

biotechnology industry overall does not reflect California's demographics; many of our communities remain underrepresented in biotechnology-related degree programs and career paths.

CSUPERB knows that intentionally designed and well-implemented experiential learning opportunities engage all students. Students learn knowledge needed to persist toward STEM degrees and skills to navigate degree-relevant careers post-graduation. CSUPERB will work to increase adoption of well-designed, high-impact practices, collaborative projects, experiential learning, and course-based research at all levels of biotechnology-related curricula. We know there is more to meeting the needs of students than merely offering experiential learning opportunities. Lessons learned from the STEM Collaboratives projects raised the importance of effective early interventions, faculty and peer mentoring, and the unified campus community of support needed to ensure success across all student demographics.

Strategic Goal #3: Partner with the Life Science Industry

The Life Sciences Industry is an ecosystem - defined as networked organizations including companies, universities, non-profit research institutions, industry associations, business incubators, hospitals, and government laboratories. CSU biotechnology faculty and students report increased interest in learning from and working with entrepreneurs, community partners, small business development centers, regional innovation hubs, and companies. They want to learn how to translate science into something tangible or impactful. On the academic side, we need to find ways to make campuses more porous and open to external partnerships with other universities, companies, and communities. To this end there is keen interest in recruiting CSU alumni to serve as mentors, advisors and partners in career mentoring, entrepreneurship education, and inter-disciplinary research efforts. Our stakeholders recognize that alumni and industry professionals can be particularly effective partners in aligning educational programs with workforce realities, as well as building student awareness of career options, biotechnology-relevant product development, and skills needed beyond the university.

Success Indicators

- Renewing numbers of CSU students and faculty involved in biotechnology research, discovery, and evidence-based entrepreneurship
- Evidence of effective and engaging biotechnology-related courses across the CSU, especially those that integrate course-based research
- Seminars and workshops successful at building integrated, inter-disciplinary partnerships, with a special emphasis on identifying problems worth solving and knowledge translation[10]
- Industry and alumni participation in CSUPERB programs, especially the Annual Biotechnology Symposium, career mentoring programs, entrepreneurship programs, and collaborative projects

"This CSUPERB grant program is invaluable to the success in redesigning and implementing our new BIO 2 (Cells, Molecules, and Genes) laboratory course. The course redesign would not have been possible without the funding for new equipment and supplies. The course implementation would not have been possible without the help of our two Graduate Teaching Assistants, whose salaries were provided by this grant."

– Hao Nguyen (CSU Sacramento, 2014 Curriculum Development grant recipient)

- Continued compliance with EO 1103, including timely annual reports, impact reporting (student outcomes, follow-on funding, etc.), and workforce demand data
- Internal and external awareness of the CSUPERB community's excellence, its collective impact on the CSU's biotechnology-related research enterprise, effective educational practices, and CSUPERB-supported students' success on campus and beyond the university
- Board level involvement of CSUPERB leadership with biotechnology industry associations and in higher education-related policy discussions

"The a-ha moment was when we interviewed a doctor… He gave us the picture - the way vital signs are measured in hospitals or health care facilities. It totally changed the way we think and it gave us the idea and potential scope of our work. And because of that interview we have a potential partner to help conduct the validation test of our technology."

- 2017 CSU I-Corps Participant

References

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(5) 2017 CSU Fact Book https://www2.calstate.edu/csu-system/about-the-csu/facts-about-the-csu/documents/facts2017.pdf

(6) Vision and Change in Undergraduate Biology Education: Chronicling Change, Inspiring the Future (2015). AAAS. http://visionandchange.org/files/2015/07/VISchange2015_webFin.pdf

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(8) Kuh, O'Donnell & Schneider (2017) HIPs at Ten. *Change*, 49:5, 8-16. http://dx.doi.org/10.1080/00091383.2017.1366805

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(10) Lane & Flagg (2010) Translating three states of knowledge – discovery, invention, and innovation. *Implementation Science*, 5:9. https://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-5-9

Photos

Page 1: Student researchers from San Diego State University at the 30th Annual Biotechnology Symposium. Left to right: Paul Smith (MS student), Kevin Walsworth (PhD student), Amy Jackson (undergrad), Sean Maddox (PhD student), Andrew Dinh (PhD student), Greg Dawson (undergrad) & Susan Andersen (undergrad).

Page 2: Members of the CSUPERB Faculty Consensus Group (FCG) at the end of the 30th Annual Biotechnology Symposium. FCG members design, organize, and manage the symposium program each year.

Page 3: Don Eden Graduate Student Research Award Finalists at the 30th Annual CSU Symposium. Left to Right: Rafael Sandoval (CSU Los Angeles), Roger Berton (CSU Los Angeles), Hansini Vitharanage (Cal Poly Pomona), Anastasia Martinez (CSU Fullerton), Clariss Limso (CSU Long Beach; 2018 Awardee) and Matt Escobar (CSU San Marcos, 2018 Eden Award Selection Committee Chair).

Page 5: Audience at the 30th Annual CSU Biotechnology Symposium, Santa Clara, CA.

Page 6: CSU Alumni Speakers at the 30th Annual CSU Biotechnology Symposium. Left to right: Mitch Lucas (Breeding Project Lead, Syngenta & CSU Fresno alum), Stacy Markison (Senior Director of Pharmacology and Toxicology, Crinetics Pharmaceuticals & San Diego State University alum), and Avery August (Professor of Immunology, Chair of the Department of Microbiology and Immunology in the College of Veterinary Medicine & Vice Provost for Academic Affairs, Cornell University & CSU Los Angeles alum).

Page 7: Chemistry researchers from CSU Fresno at the 30th Annual CSU Biotechnology Symposium. Left to right: Undergraduates Maizie Lee, Pravien Rajaram, Ziran Jiang & Graduate Student Kevin Muthima.

Page 8: Maricruz Macz De La Torre (CSU Dominguez Hills) accepts the 2018 Crellin Pauling Student Teaching Award during the 30th Annual CSU Biotechnology Symposium. Also pictured, left to right, Dr. Kay Pauling, Aparna Sreenivasan (CSU Monterey Bay & 2018 Pauling Award Selection Committee Chair), and David Pauling.

Page 9: Students and faculty from Cal Poly San Luis Obispo at the 30th Annual CSU Biotechnology Symposium.

Page 10: Students and faculty from Stanislaus State University at the 30th Annual CSU Biotechnology Symposium.

What capabilities will we need?

Biotechnology student success depends on a faculty and administrator community well-versed in discipline-based education research and familiar with the literature on undergraduate STEM learning. We need committed partners and alumni from the life sciences industry to ground our work in relevant workforce needs.

Where will we work?

Our strategic roles are catalyst, persuader, investor, and convener. We will seed faculty-driven projects, support preliminary data collection, provide a competitive peer review framework, and offer faculty and student professional development opportunities. As a result, we can scale up faculty success in winning external grants, follow-on funding, and institutional support. In turn greater numbers of CSU students are impacted and continue in biotechnology careers. CSUPERB-supported students will have experiences and skills of interest to employers and graduate schools.

How will we succeed?

The rate and scale at which we work depends on our budget, the size and vibrancy of our community, and the quality of the collaborations we catalyze. We hope to see CSU faculty, administrators, departments, and campuses design effective ways to incorporate experiential learning for *all* STEM students across the curriculum. This will require learning by discovery, scientific teaching practices, and collaboration with intra-campus, inter-campus, and industry partners.

Program Home Page:
www.calstate.edu/csuperb

CSUPERB Grants and Awards Database (1999- present):
csuperb.org/grants/database/

CSUPERB Events:
www.csuperb.org/symposium

CSUPERB Entrepreneurship (@csu_icorps)
www.csuperb.org/csuicorps

CSUPERB Student and Alumni Outreach:
www.facebook.com/csuperb