

STEM Summer Program:

Inspiring the next generation of scientists

More students in the United States are studying STEM (Science, Technology, Engineering, and Mathematics) majors at university. However, there is a notable discrepancy in underrepresented students choosing STEM, including racial minorities and those first in their family to attend college. Research internships, such as the CHORI Summer Student Research Program, provide the much-needed boost in scientific research knowledge and confidence for underrepresented students to study and pursue careers in STEM. Co-directors of the program, Drs Bertram Lubin and Ellen Fung, firmly believe programs such as these can change the statistics behind underrepresented students pursuing STEM futures and bring greater diversity to science.

The number of students enrolling to study STEM (Science, Technology, Engineering, and Mathematics) subjects at university in the United States has progressively increased over the last few decades. However, more than half of students that enrol in a STEM subject will change their major during their time at university. The decrease in STEM enrolment and graduation is most notable in 'underrepresented' students. Underrepresented students include ethnic and racial minorities and women. They constitute 68% of all university students in the States but remain underrepresented in STEM careers. Providing encouragement for students to consider STEM careers before and during university can change these statistics and increase diversity in STEM fields.

A student's self-confidence and motivation are some of the greatest factors that influence their pursuit of a subject through university into a career. Research experience, "active learning" (problem-solving), and being

part of a community of students with shared interests have all been shown to increase students' persistence with STEM subjects. Summer internships, such as the Children's Hospital Oakland Research Institute (CHORI) Summer Student Research Program (SSRP), offer effective interventions within a student's academic trajectory to develop their confidence in STEM through one-on-one mentorship and broadening their scientific community.

The CHORI SSRP was initiated in 1981, the brain child of Dr Bertram Lubin, now an internationally recognised paediatric haematologist. He was first in his family to attend college and therefore fully aware of the challenges present when negotiating the university system with minimal support. Almost 40 years later, Dr Lubin continues to Co-Direct the program along with Associate Scientist, Dr Ellen Fung. In a highly competitive selection process, CHORI SSRP selects underrepresented students from both high schools and universities. Real world research experiences are provided with practising medical and scientific professionals. CHORI SSRP interns develop their confidence in science, inspiring them to pursue futures in STEM subjects, and encouraging greater diversity in STEM fields.

CHORI is the renowned biomedical research institute of the University of California San Francisco (UCSF) Benioff Children's Hospital Oakland. Students participating in the CHORI summer program have access to clinical research in close to 35 sub-specialty areas including but not limited to, haematology, oncology, endocrinology and orthopaedics. Over 200 basic scientists, post-doctoral fellows, and laboratory staff guide students interested in basic science in stem cell therapies, immunobiology, infectious disease prevention, nutrition and genomics. With funding from a variety of foundations and government

sources, including the NIH (National Institutes of Health), the CHORI summer program offers in-depth research opportunities in any of these fields. "I have the privilege to work directly with these incredibly gifted young students. They are the future face of science, and they inspire me," says Co-Director, Dr Ellen Fung.

CHORI SUMMER STUDENT RESEARCH PROGRAM

Over nine weeks, CHORI summer students: are paired with a mentor who educates and empowers them in a medical research field; attend weekly seminars and discussion forums to learn about contemporary scientific research; design, carry out, and present their own research project; join a community of like-minded peers and CHORI alumni. Some summer students have presented their work at national scientific conferences, and even co-authored published papers with their CHORI SSRP mentors.

Studies have shown that summer research programs increase the likelihood of underrepresented students pursuing careers in STEM. Furthermore, programs that include mentorship increase the likelihood of these students pursuing postgraduate education. Compared to 2014 US census data, CHORI summer program alumni are: 3.5 times more likely to pursue postgraduate studies than the US average for Asian or Pacific Islander students; over 6 times more likely than average for Hispanic/Latino students; and almost 9 times more likely than average for Black/African American students.

The CHORI Summer Student Research Program provides students not only with skills and knowledge to make them attractive candidates for future research work as a professional, but with the confidence needed to pursue a STEM career. Furthermore, the CHORI Summer Program aims to provide students from disadvantaged backgrounds, racial and ethnic minorities, and students with disabilities, the opportunity to engage with and be inspired by STEM research. Greater diversity within STEM gives rise to greater creativity and innovation – key characteristics needed to solve today's challenging scientific problems.



Bonny Alvarenga, Chloe Ghent (fore), Nicolas Nido and Lara Ramirez (background) discuss the challenges and occasional surprises in medical ethics during a weekly lecture.

The program strives for diversity and is committed to changing the statistics behind underrepresented students studying STEM.

TESTIMONIALS FROM CHORI ALUMNI

Student testimonials speak volumes about the CHORI Summer Student Research

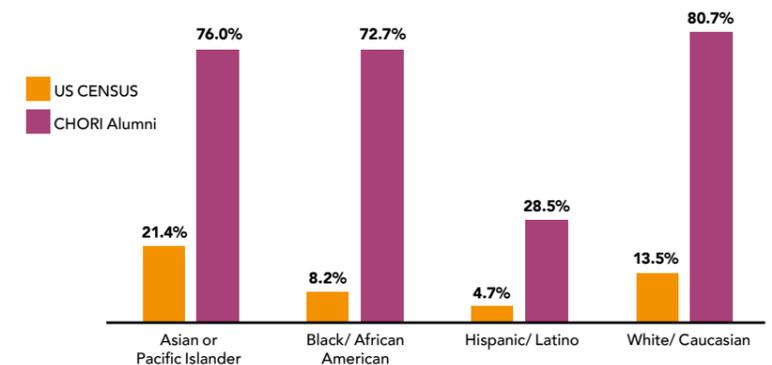
individuals. It is about making new, valuable connections with my fellow CIRM [California Institute for Regenerative Medicine] friends, my mentors, and other students and scientists involved in the program. It is about getting inspired by the talks given by prominent scientific figures and the touching stories

CHORI summer program alumni are ... more likely to pursue postgraduate education than the US average.

Program. Julia Nguyen, who took part in the program in the summer of 2017, says: "...this internship is about more than just lab work. It is about joining a community of curious, intelligent, and like-minded

of bone marrow transplant pen pals. And it is about learning the true ways of science and getting the opportunity to contribute to humanity's growing pool of knowledge."

Percentage of CHORI SSRP Alumni who pursue graduate education*



*Of those respondents who have completed a minimum of undergraduate education.



High school junior, Chima Ezeh, in his first basic laboratory experience, studied the colonisation of *Neisseria Meningitidis* in the laboratory of Dr Gregory Moe at CHORI.

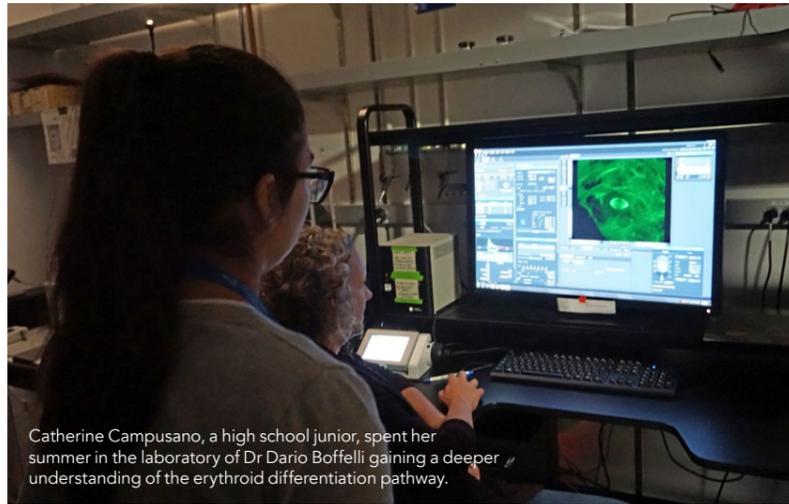


The CHORI Summer Student Research Program has been training underrepresented students in STEM for nearly 40 years.

These feelings are echoed by other students, including the 2018 CHORI Summer Program participant, Chima Ezeh: "During this program, I have been fortunate to integrate myself into such a diverse community of students who share an ever-growing passion to further the field of science and medicine."

Students from the 2016 cohort are excited about the future opportunities available to them after the CHORI program: "...I am happy to say that this summer full of discovery has been of large growth to me, and has brought to light unforgettable opportunities I thought were once far from my grasp. May this be the beginning of many adventures to come!" says Anna Victoria Serbin.

"Working next to highly educated scientists who are passionate about their research has allowed me to imagine myself in their shoes. It has led me to ask myself questions like "Can I do this



Catherine Campusano, a high school junior, spent her summer in the laboratory of Dr Dario Boffelli gaining a deeper understanding of the erythroid differentiation pathway.

in the future?", "Would I enjoy waking up every day to know I will be working in a lab?", "Can I imagine myself eventually publishing a scientific paper?",

The program strives for diversity within STEM and is committed to changing the statistics behind underrepresented students studying science.

"How rewarding will it actually be to pursue a PhD?" says Raymundo Sanchez.

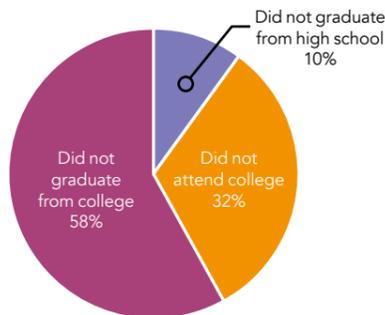
"Entering college with the experience and knowledge I have gained from this internship will undoubtedly prepare me for my coursework and allow me to earn even more prestigious opportunities. I feel extremely well equipped for the future in science and medicine that I want to pursue. My experience as a CIRM SPARK [Summer

Program to Accelerate Regenerative Medicine Knowledge] Award intern has given me the confidence that I could not only do research like this, but excel

in research like this. From here, I see no other direction for me to go but up," says Ava Daniel.

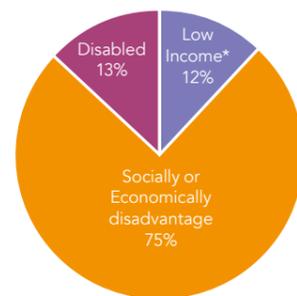
And whilst all the students developed confidence and knowledge in scientific research, some students also learned a sense of humour is often needed. Recounting his summer spent performing qPCRs (quantitative Polymerase Chain Reactions), 2018 CHORI Program participant Jonathon Luo says: "It is often said that baking is a science, but you rarely hear anyone saying science is like baking... Day after day, I laboured to pipette drop after drop into their appropriate wells, bent over and fatigued... the strain of pipetting started to set in, reminding me that my right thumb was still getting a pretty hardcore workout... I've learned countless new skills, gained a great amount of knowledge in the field of molecular biology, and of course, had lots of fun... But perhaps most importantly, I will leave this experience with extreme respect for laboratory scientists all over the world, who inarguably have the strongest thumbs on the planet."

Educational Background of Parents of Students Served



Includes data from recent CHORI student interns: 2012-2018.

Social & Economic Background of Students Served



*In 2018, low income defined as family of 4 with income <\$44,000

Behind the Research



Dr Bertram Lubin



Dr Ellen Fung

E: ssrp@chori.org T: +1 510-450-7604 W: www.chori.org/ssrp f www.facebook.com/CHORISummerResearch/

Research Objectives

The Children's Hospital Oakland Research Institute (CHORI) Summer Student Research Program aims to increase the number of students from underrepresented backgrounds pursuing and graduating with a STEM major.

Detail

CHORI (Children's Hospital Oakland Research Institute) Summer Student Research Program
5700 Martin Luther King Jr Way
Oakland CA 94609, USA

Bio

Bertram Lubin MD, Internationally recognised Haematologist and Associate Dean Children's Health at UCSF, and Ellen Fung, PhD Associate Scientist at CHORI, Co-Direct the Summer Student Research Program. With the same focus for nearly four decades, the SSRP has trained well over 1000 underserved students interested in STEM, many of whom are now practising physicians and basic scientists.

Funding

- NIH (National Institutes of Health)
- DDCF (Doris Duke Charitable Foundation)
- CIRM (California Institute for Regenerative Medicine)
- ACHPP (Alameda County Health Pathway Partnership)

Collaborators

- Biology Scholars Program at UC Berkeley
- CHAMPS (Community Health & Adolescent Mentoring Program for Success) at UCSF Benioff Children's Hospital Oakland
- Students Rising Above, Achieve Scholars, Biotech Partners



References

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Personal Response

What do you think student's benefit from most by taking part in something like CHORI Summer Student Research Program?

Dr Ellen Fung: As many of our students come from households with little to no science background and minimal experience with US secondary education, what our students gain from just nine weeks in the SSRP is often immeasurable. In addition to practical laboratory and clinical skill development, experience with hypothesis and protocol generation, statistical analysis and presentation practice: CHORI SSRP students broaden their scientific network. Their new scientific community is invaluable to opening doors and improving opportunity for acceptance into university, graduate school and future participation in other highly competitive internships.