Roadmap for Success: Increasing Diversity in the Biological Sciences

Dr Fern Tsien

Scientia

ROADMAP FOR SUCCESS: INCREASING DIVERSITY IN THE BIOLOGICAL SCIENCES

Historically, there has been a disparity between the demographics found in the broader population and in academia. Women and many minority groups are underrepresented in science careers. **Dr Fern Tsien** at Louisiana State University is directing educational programs in the New Orleans area aimed at improving this disparity, supporting underrepresented groups throughout their education, from elementary school through to post-graduate training.

Despite pushes for diversity over the past two decades, women and minorities are still underrepresented in the sciences. Many factors contribute to this phenomenon, including historical disparity in career opportunities offered to minorities, lack of awareness of underrepresented minority science role models, and poor access to quality early science education in underprivileged schools and communities. Everyone benefits from diversity in science – modern science is a collaborative effort, and the most powerful scientific insights often arise from interactions between scientists with unique perspectives working together. Many of the challenges humanity will face over the coming decades will demand interdisciplinary teams of scientists with a mixture of backgrounds and viewpoints, each bringing new ideas to the table.

One of the foremost missions in modern education is finding ways to increase female and underrepresented minority inclusion, participation, and retention in the sciences. Dr Fern Tsien works with the faculty of Louisiana State University in New Orleans (LSUHSC-NO) and teachers in Louisiana schools to help bring more minorities to the table in biological and health sciences. She states that, 'my goal is to increase the number of underrepresented minorities pursuing careers in the health and basic sciences.'

Starting Early for Scientific Success

To increase science participation at the college level, it is critical that children are granted access to high quality science programs early in their education, to both spark interest and create awareness of science as a viable career path. In 2003, the Louisiana State University Health Sciences Center (LSUHSC) began the Science Youth Initiative (SYI) in New Orleans public schools. Today, the program continues with funding from local and federal agencies, including the Entergy Foundation and the National Science Foundation.

The program helps to increase diversity, interest, and involvement in basic biology and health science subjects at the elementary, middle, and high school levels (K-12) by introducing students to diverse female scientists and underrepresented minority role models. The program makes science easier to understand through hands on activities, helps students improve their academic achievements, increases awareness of and access to potential science careers, and engages in community science education. Dr Tsien began directing the program in 2009, and under her leadership it has extended to reach hundreds more students throughout New Orleans.

The SYI program has three components aimed at reaching students at different age levels and across multiple biology and health science tracts. Starting in the fourth grade, the LSUHSC/New Orleans Schools Science Partnership Program for Elementary Schools brings LSUHSC faculty and trainees into the classroom to engage students in curriculum related experiments, such as extracting genetic material from strawberries.

The program is currently active in eight New Orleans elementary schools, and has also produced educational videos of the material to help broaden the reach of their work. The group is working to translate these videos into Spanish to reach an even wider audience of young learners. Since the program's initiation in 2006, academic performance in the sciences and science standardised test scores have risen for over 700 SYI students and counting.

The next stage of the SYI program, The LSUHSC Hands-on Workshops for Middle and High Schools, was founded in 2009, and works to build on the foundation of the elementary

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school curriculum to continue to fuel student interest in science education and careers. The day-long workshops offer students in Advanced Placement and Honours Biology courses the opportunity to tour LSUHSC facilities, meet research scientists, and conduct experiments in exciting and relevant topics, such as forensics and cancer research.

The workshops introduce students to the wide variety of careers with a base in the biological and health sciences, ranging from medical practice, to basic research, to public health. Students are also given access to educational videos that reinforce and build upon the information they gained during their visit to LSUHSC. Over 2000 students have participated in workshops so far, and many continue on to participate in the final phase of the program.

The third component of the SYI program, The Summer Internship Program for High School Students, began in 2003 and serves as the culmination of the SYI school-age biological sciences education progression. The program provides support for internships for high school students to work in laboratories with LSUHSC faculty members for eight weeks over the summer. Qualifying students earn stipends while they gain hands on experience with research and present their findings at a research symposium at the end of the summer. As part of their summer experience, the students participate in workshops to learn about topics such as laboratory safety, responsible research conduct, science communication, writing resumes, applying to college, networking with scientists, and science careers available to them.

Many continue working into the following school year and beyond with their mentors, attending scientific conferences or publishing in scientific journals. Students receive letters of recommendation and personalised support as they apply to universities to continue their science education. Over 160 high school students have been accepted into the program so far, and many alumni have continued on to university college study and graduate programs in the sciences.

Cultivating Diversity in Research

Dr Tsien’s work with underrepresented students extends to college undergraduates. In 2014 she secured a grant to direct a Research Experiences for Undergraduates (REU) program at LSUHSC, now part of a broad network of REU opportunities funded by the National Science Foundation in the United States. Like SYI’s summer opportunities for high school students, the REU provides funding and mentorship for undergraduates in science fields who are interested in gaining research experience that they can carry into graduate programs and research careers.

REU internships provide students with hard research skills, as well as structured professional development and science communication coaching. The program is designed to help prepare undergraduate students for the unique rigors of pursuing graduate education in the sciences, and provide a foundation of effective working skills that will benefit them throughout their careers. The overarching goal of the REU program is to build confidence and scientific skillsets, such that students who start the program as dependent apprentices leave as independent researchers, capable of forming their own hypotheses and carrying out their own research.

LSUHSC places a heavy emphasis on including historically underrepresented groups in their REU program, particularly African American/Black, Hispanic/Latino, and American Indian (Native American) students. In the United States, these three groups form approximately a third (29.8%) of the population, yet comprise less than 5% of the tenure-track professors in the biological sciences.

In LSUHSC’s immediate community of New Orleans, the population is 60.1% African American/Black, 5% Hispanic/Latino, and 0.3% American Indian, so the REU program

focuses efforts on recruiting local students, including those that have participated in the SYI before college. Further, Dr Tsien's program partners with Louisiana's Historically Black Colleges and Universities, along with other local colleges and universities. The program also leverages collaborative agreements with other universities around the United States and its territories to find diverse students at colleges around the nation with an interest in biological research. Along with underrepresented minorities, the program seeks to include women, non-traditional students, students from rural communities, and first-generation college students.

The Research Experiences for Undergraduates at LSUHSC focuses on genetic and biochemical mechanisms. Proficiency in genetics and biochemistry concepts and laboratory techniques are central to success in biological science research, and the program offers comprehensive training in current methodologies, hypothesis driven problem solving, data analysis, and communicating findings to the research community in a professional manner. In addition to these 'hard' science skills, students are provided guidance in 'soft' skills that are critical to success in the sciences, such as time management, teamwork, communicating science, and overcoming adversity in the scientific community.

While building critical professional skills is an important component of the REU, students' primary goal during their summer at LSUHSC is to contribute something new to our understanding of genetic and biochemical processes. Each student is partnered with an LSUHSC faculty member with whom they collaborate on a project for the summer. They learn how to design experiments using the scientific method, read and review current scientific literature on their project, and utilise the institution's extensive research facilities and equipment to apply state-of-the-art techniques to their experiments.

Students engage in cutting edge research, seminars, and workshops, as well as participating in community outreach education events. Through organised social events, students begin to build a network of scientific peers and mentors, forming supportive relationships that will bolster them throughout their scientific careers.

Finally, students are given personalised mentoring and professional development support, providing career counselling and advice, help with graduate school admissions, and recommendation letters. The program aims to recruit students early in their college careers so that the impact of academic and career counselling guidance the REU offers can be maximised through the course of their college education, setting them up for graduate success.

LSUHSC offers nearly numerous research possibilities, with labs working with organisms ranging from single celled bacteria to mammalian cells and tissues from organisms including humans and non-human primates. While in pursuit of their research questions, REU students learn cutting-edge methods, such as bioinformatics, genome editing, microscopy, histology, and advanced genetic protocols. Further, they learn how to analyse the data they collect and distil it into meaningful knowledge.

As a final step, at the end of the summer students present their findings at a scientist-reviewed conference, honing the skill of professional science communication that is so critical to long term academic success. Program alumni have received additional NSF funding to support their presentation of their research at the NSF Council of Undergraduate Research Conference in the Washington, DC area, and other scientific meetings.

From Strength to Strength

More than 379 college students have participated in the LSUHSC Summer Research Internship thus far since 2003. Since the debut of the LSUHSC-REU program three years ago, 41 underrepresented minority undergraduate students have completed the summer program. The program has offered many students from underrepresented groups the opportunity to take the first steps into blossoming research careers, supported by a team of dedicated mentors and enthusiastic peers. Of the first 41 students, 74% were African American/Black and 23% Hispanic/Latino, 64% female, with 20 first-generation college students, one non-traditional student in their 50s, and a student with a disability.

These students represent great strides in increasing diversity in the biology workforce, as alumni from the program have already begun to be admitted into graduate schools, along with presenting their work at national science conferences and submitting manuscripts for publication for peer-reviewed journals. During this short time, applications to the program have roughly doubled each year. Dr Tsien has also been granted supplemental funding from the NSF, which has allowed the REU program to take on an additional college student each summer, as well as additional SYI high school students. This grant also provides for the training of high school science teachers to serve in New Orleans school districts.

Beyond touching the lives of students in the SYI and REU programs, numerous community outreach events hosted by LSUHSC in collaboration with program students have occurred, bringing science education outside the classroom and benefiting the broader population. 'Medical and graduate students, residents, and post-doctoral fellows learn how to teach health sciences to the community through these programs,' says Dr Tsien. 'Teaching to the lay public is a necessary skill for future health care professionals and research scientists.'

Continuing Opportunity

The next logical step in the educational roadmap is increasing opportunities for students following college graduation, particularly students that are not immediately accepted into graduate programs. Dr Tsien explains that, 'not all college graduates are immediately accepted into graduate or medical school and may need additional resources to make them more competitive when applying to advanced academic programs.'

Recently, Dr Tsien and her colleagues at LSUHSC and Moffitt Cancer Centre in Tampa, Florida have received funding from the National Institutes of Health's (NIH) National Cancer Institute (NCI) for cancer research opportunities for underrepresented minority undergraduates, medical students, and junior faculty. Also she and her LSUHSC colleagues have received for the Post-Baccalaureate Research Education Program (PREP) for underrepresented minority students to work on professional and academic development during a gap year between undergraduate and graduate studies. Dr Tsien hopes the PREP will help enhance these students' opportunities for success in the sciences, and help prepare them for the rigors of graduate school.

Meet the researcher

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Dr Fern Tsien is an Asian/Hispanic/Latina American researcher and educator who began her educational career at Tulane University, New Orleans, LA, graduating with a double major in Biology and Studio Arts in 1989. She earned her PhD in Human Genetics from Tulane in 2002, specialising in epigenetics and cytogenetics. She joined the faculty of Louisiana State University Health Sciences Center in New Orleans in 2003, where she currently serves as a Tenured Associate Professor in the Department of Genetics. Her research illuminates the genetics of chromatin instability in cancer and congenital hearing loss in founder populations. She is dedicated to increasing diversity in the sciences, and currently serves as the Director of the New Orleans Schools Partnership, Hands-on Genetics and Health Education Workshop, Science Youth Initiative, and Research Experiences for Undergraduates (REU) Programs, and as Co-Director of the Summer Research Internship Program, and Postbaccalaureate Research Education Program (PREP). These programs work to make science education and careers more accessible to minority and disadvantaged students of all ages, both in New Orleans and throughout the United States.

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