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A Science Pipeline Pathway for Training Underrepresented Stduents in the Biomedical Sciences

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If the U.S. is to maintain its current level of worldwide competitiveness in science and technology, underrepresented minority students in the science education pipeline represent an essential source of talent for the STEM workforce of the future. A number of factors can account for the success of underrepresented minority students that persist in the science pipeline. Several of these factors include a strong development in high school math and science (George et al. 2001), peer and faculty mentoring in college, economic support, and participation in faculty research projects (Lopez and Alfred, 2003). In the referenced study (Alfred et al., 2005), we focused on the importance of academic workshops and continuous mentoring, but particularly on the participation of minority students in faculty-mentored research projects, and the overall research environment that motivates students to pursue research careers.

In our article “A Science Pipeline Pathway for Training Underrepresented Students in the Biomedical Sciences” (Lawrence J. Alfred, Cathie Atkins, Michelle Lopez, Thelma Chavez, Vernon Avila and Paul Paolini) we focused on undergraduates in several minority research support programs, and on data showing the award of degrees to students in two major programs, the Minority Access to Research Careers (MARC) Honors program and the Minority Biomedical Research Support (MBRS) program. The overall ethnic distribution of students in these programs consisted of 28.4% African American, 51.5% Hispanic, 2.5% Native American, 14% Pacific Islanders, and 3% undeclared. The basic hypothesis of our study was that students in the pipeline who participated in faculty-mentored research, and who were managed and tracked by program staff, would show higher rates of retention, graduation and entry into graduate programs than non-participants.

Concurrent with our SDSU study, the California State University System-wide Alliance for Minority Participation (AMP) program assessed the retention rates, graduation rates and GPAs of more than 13,000 minority and non-minority undergraduates between 1995 and 2001 (Garcia, 2002). Students in the AMP program major in engineering, computer science or the biomedical sciences.

Students move through the science pipeline from high school into the freshman year and subsequent years in college during which the curriculum is enriched in biology, chemistry, mathematics and physics through the AMP program, Bridges to the Future program, and the

Student Support Services program. An important source of competitive minority students for science careers is found at the community college level. A U. S. Department of Education report in 1996 showed that 42 % of African American, 51% of American Indians, 56% of Hispanics, and 39% of Asian Americans in higher education were enrolled in two-year colleges (Opp, 2002). These programs welcome all minority students interested in biological or physical sciences, mathematics, and engineering.

Students in the Bridges program, for example, take several preparatory courses including one or two semesters of “Laboratory Skills” classes (learning to use laboratory apparatus and instrumentation) while in community college. Enrichment course work taken at SDSU, while the Bridges students are still enrolled at community college, includes an Introduction to Research class (examining experiment design, data analysis, experimental errors, etc.). First exposure to hands-on research comes through a summer “mini-internship” consisting of half-day participation for six weeks, not with “cook-book” style lab course exercises, but actual immersion in an on-going team research project coordinated by the staff scientist managing the research laboratory.

A full summer research internship of 10 week duration, 40 hours per week, is a feature of both the McNair Scholars and the second summer Bridges programs. The student is mentored by a participating faculty member and interacts with graduate and upper division undergraduate students and technical staff members in the laboratory, and often as well with postdoctoral fellows. The students showing best laboratory and academic course performance are then linked to the MARC or MBRS program that offers up to two year long research experiences and financial support. Both MARC and MBRS students are required to present their research findings in local symposia twice each year, and attend national research conferences at which they might also present posters or make oral presentations.

What are the consequences of this early immersion in a research laboratory environment? Early on, students are made aware of the importance of research productivity to their future research careers. Currently, a number of the College of Sciences’ minority students are in doctoral degree programs at some of the most prestigious institutions in the nation. During the past five years, six SDSU students have been selected for the highly competitive NIH Undergraduate Scholarship Program (UGSP).

MARC and MBRS students participating in faculty research projects showed a significant increase in the number that entered master's degree programs (28), Ph.D. programs (32), and M.D. programs (8) over a 10-year period. The number that earned graduate degrees during this period included 28 master's degrees, 15 Ph.D. degrees, nine M.D. degrees and one M.D./Ph.D. degree. A number of MARC, MBRS and REU students co-authored papers in peer-reviewed journals. Publications in science journals (n=46) and presentations of research at national and international meetings (n=458) were major factors in subsequently obtaining undergraduate fellowships (n=14), pre-doctoral fellowships (n=38), and postdoctoral fellowships (n=5).

The most difficult goal to achieve is at the end of the science pipeline; that, of course, is a faculty appointment for the holder of a Ph.D. degree. Five of the Ph.D. graduates from our MARC and MBRS programs have obtained tenure-track appointments and several are in

postdoctoral positions or carrying out research in industry. One of our MARC graduates recently graduated from MIT and completed two years of postdoctoral studies before accepting a faculty position at the community college he attended before coming to San Diego State University through our Bridges to the Future research experience. Minority Ph.D. degrees recipients seeking an academic position may be compelled to remain in postdoctoral training appointments longer than they may desire because of discrimination barriers in receiving tenure-track appointment offers. In efforts to enhance the rate of faculty appointments, we communicate with former students and their mentors and provide assistance to then in their applications for faculty positions. Yet, despite such barriers we believe that the science pipeline pathway we have described serves as a viable approach to increasing the number of underrepresented minorities in science, mathematics and engineering careers. We believe that the model for pipeline training described in our report can be duplicated at other institutions that serve ethnically diverse student populations. The science pipeline pathway can be highly successful when it links students to committed faculty mentors within a motivating research environment.

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