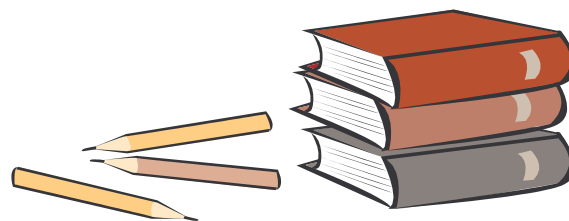


DIVERSITY

Preparing Minority Scientists and Engineers

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An undergraduate program involving mentorship, summer and other workshops, and targeting high-achieving high school students improves participation of underrepresented minorities in science.

As international participation in advanced science and engineering (S&E) increases, and as national populations become more diverse (1–3) it becomes even more important to provide quality science education to all children, including those from racially diverse groups (2, 3). Despite several decades of federally supported programs, Americans from these groups continue to be underrepresented among Ph.D. recipients and in the S&E workforce (4–6).

Contrary to popular belief (7), many well-prepared underrepresented minority students (URMs)—including men and women of Latino, Native-American, Pacific Island, and African-American descent—are interested in pursuing scientific or engineering careers. In 2005, the same percentage (44%) of African-American and Caucasian college-bound high school students indicated their intent to major in S&E fields (8). Many students with strong SAT scores, impressive grades, and success in high school honors math and science courses leave the college science pipeline, but the loss is disproportionately among women and minorities (9, 10). Thus, factors other than school preparation, science aptitude, and interest must be responsible for the low achievement and low persistence in these subgroups of undergraduate and graduate S&E students. Identifying these negative factors and retaining well-educated students with S&E interests would improve the United States' ability to compete in today's global scientific community.

Factors that keep URMs from persisting with science include academic and cultural isolation, motivation and performance vulnerability in the face of low expectations, peers who are not supportive of academic success, and discrimination, whether perceived or actual (10–15). These factors can have a stronger

effect at institutions with predominantly majority populations. Such institutions award about 75% of all bachelor's degrees earned by African Americans (16). To address these particular factors, we developed the Meyerhoff Scholars Program in 1989 at the University of Maryland, Baltimore County (UMBC). At that time, the university was graduating fewer than 18 African-American S&E majors per year (see graph below). Typically, fewer than five of these students graduated with a grade point average above 3.0 (on a 1 to 4 scale), consistent with achievement levels observed at other institutions (17, 18).

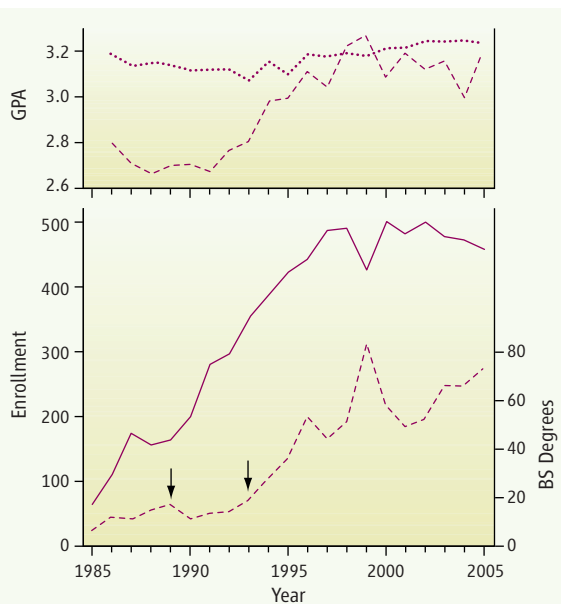
The Meyerhoff Scholars Program (named after its founders, Baltimore philanthropists Robert and Jane Meyerhoff) focuses on producing bachelor's degree recipients, particularly African Americans, who go on to doctoral programs in science and engineering. Since 2000, an average of 1900 candidates have been nominated each year by high school teachers and counselors. Of those nominated, the 80% who are from Maryland (~1500) represent about 2% of graduating high school students in Maryland. We typically invite about 180 students and their parents to UMBC for interviews, and offer 4-year scholarships to about 100 of them. About half accept. Most students who decline the Meyerhoff program accept other scholarships at UMBC or other institutions. Transfer students, typically not more than two per year, can join the program later.

The program has supported 768 students, 260 of whom are currently undergraduates. Most of the Meyerhoff graduates (435 of 508 students, 86%) earned science or engineering bachelor's degrees (students in good academic standing who leave S&E fields before graduation become supported by other UMBC scholarship programs). Most of the S&E graduates (379 students, 87%) went on to graduate or profes-

sional programs (41% to Ph.D. or M.D.-Ph.D., 22% to master's, 24% to medical or other professional programs, and 13% employed). Meyerhoff students with completed advanced degrees now number 44 with Ph.D.'s or M.D.-Ph.D.'s (most earned in the past 2 years), 72 with master's degrees, and 32 with medical degrees.

The effectiveness of the Meyerhoff program is highlighted by comparing students who entered the Meyerhoff program with those who were invited but declined and attended other institutions (9, 19, 20). Both groups earned similar grades and graduated at similar rates. But students who entered the Meyerhoff program were twice as likely to earn a science or engineering bachelor's degree (9) and 5.3 times more likely to enroll in post-college graduate study (19, 20). In addition, Meyerhoff students were about twice as likely to earn S&E B.S. degrees as Asian, Caucasian, and non-Meyerhoff African-American students with similar preparation and interests (9).

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Effect of the Meyerhoff program on undergraduate studies. (Top) Average grades of Caucasian (dotted line) and African-American (dashed line) students at graduation in S&E fields (biology, biochemistry, chemistry, computer science, engineering, mathematics, and physics). **(Bottom)** African-American enrollment (solid line) and graduations (dashed line) at UMBC for S&E undergraduates. The Meyerhoff undergraduate program was initiated in 1989 and began graduating students in 1993 (arrows).

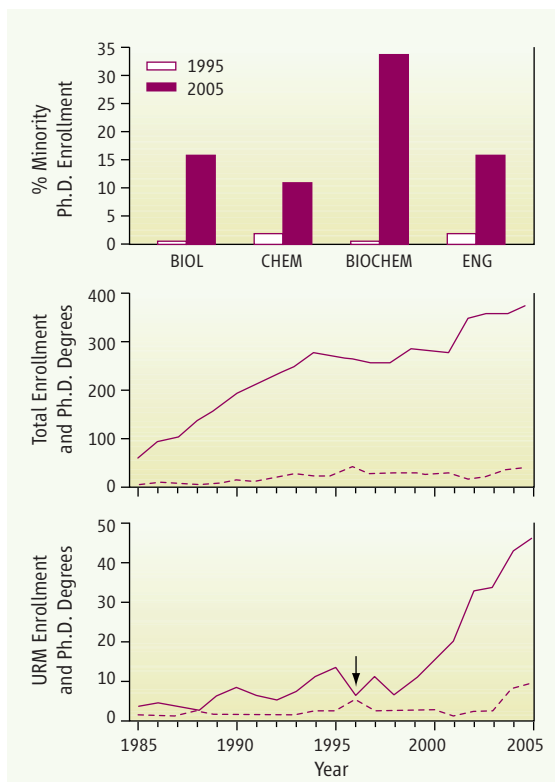
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The Meyerhoff model has four overarching objectives: (a) academic and social integration, (b) knowledge and skill development, (c) support and motivation, and (d) monitoring and advising (9, 19, 20). Our ongoing evaluation of outcomes leads us to identify five elements as most important for achieving these objectives: (i) recruiting a substantial pool of high-achieving minority students with interests in math and science who are most likely to be retained in the scientific pipeline, (ii) offering merit-based financial support, (iii) providing an orientation program for incoming freshmen, (iv) recruiting the most active research faculty to work with the students (our philosophy is that it takes a scientist to train a scientist), and (v) involving the students in scientific research projects as early as possible, so that they can engage in the excitement of discovery. Encouraging high academic performance in the first 2 years is critical. Students are encouraged to retake courses in which they earn a C in order to strengthen foundation knowledge before advancing to other courses.

The program encourages students to pursue academic goals, earn top grades, and prepare for graduate school. Students participate in study groups and use university resources for tutoring and counseling. Students also mentor and tutor other students on campus as well as children in inner city schools. Group activities such as monthly focus groups to discuss class and research experiences, receptions with mentors and parents, competitive team building events, and group travel and participation at scientific conferences encourage a sense of community among the students, faculty, and staff.

As participation in the Meyerhoff program has grown, we have observed a simultaneous increase in S&E participation among UMBC minority students who are not in the Meyerhoff program. The number of African-American undergraduates majoring in science and engineering has increased more than sevenfold since 1985 (see graph, bottom panel, on page 1870) whereas overall African-American enrollment increased 1.4-fold. Overall and S&E enrollments among Latino students have also grown (three- and fivefold, respectively) since 1985. The number of Caucasian S&E majors also increased during this time period (from 710 to 1287 students, 1.8-fold) at a rate greater than that of total undergraduate enrollment (from 7914 to 9406 students, 1.2-fold). The average GPA of all African-American S&E graduates



Effect of the Meyerhoff program on graduate studies. (Top) Effect of diversity efforts on minority S&E Ph.D. enrollment. **(Middle)** Total S&E Ph.D. enrollment (solid line) and degrees awarded (dashed line) at UMBC. **(Bottom)** Total African-American and Latino S&E Ph.D. enrollment (solid line) and degrees awarded (dashed line). The Meyerhoff graduate program was initiated in 1996 (arrow).

has increased from 2.70 in 1989 to 3.21 in 2005, due primarily to the high achievement of the Meyerhoff Scholars (average graduating GPA = 3.42 ± 0.12). The average GPA of Caucasian S&E graduates has remained relatively unchanged (3.17 ± 0.05) (see graph, top panel, on page 1870).

In the 1990s, participation of URM in graduate studies at UMBC continued to reflect low national averages (Meyerhoff undergraduates are encouraged to pursue graduate studies elsewhere). To address this, we began the Meyerhoff Graduate Biomedical Fellows Program in 1996. The program includes (i) a prematriculation orientation program; (ii) group social activities, including annual weekend retreats and picnics (with white-water rafting and hiking); (iii) monthly student seminars; (iv) instruction on technical writing and grantsmanship; and (v) financial support for student travel and minority-scientist seminars. Efforts to encourage student applications focused on predominantly minority-serving campuses. Research opportunities for summer students and undergraduate research symposia were available. Applications from African-American and Latino students went from about 2 per year in 1998 to about 50 per year since 2002, and URM participation has increased by an average of 18% (see graphs above).

Sustaining interest in a scientific career is

every bit as important in producing the scientific workforce as is generating the interest and knowledge in the first place. Retention of both undergraduate and graduate students can focus on specific populations. Success depends on addressing both academic and community issues. At the undergraduate level, administrative efforts and resources are needed to attract high-achieving minority S&E students and prepare them for the rigors of college courses. Research faculty are usually eager to mentor minority students who are academically successful. At the graduate level, departmental leadership is critical, since this is where admissions, mentoring, and candidacy decisions are made.

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