

Gateways to the Laboratory: How an MD–PhD Program Increased the Number of Minority Physician–Scientists

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Abstract

Traditional underrepresented minority (URM) groups (African Americans, Hispanic Americans, Native Americans) remain underrepresented among physician–scientists. To address the dearth of URM physician–scientists, in 1993 the Weill Cornell/Rockefeller/Sloan Kettering Tri-Institutional MD–PhD Program developed a pipeline program, Gateways to the Laboratory (Gateways), which focuses on increasing the breadth and depth of the URM physician–scientist

pipeline by offering an all-encompassing summer research training program which mirrors the life of a physician–scientist. This includes hypothesis-driven research and clinical shadowing opportunities, coupled with weekly career development workshops and extensive multitiered mentoring. Among the 245 alumni who had “graduated” from Gateways as of 2013, 88% have pursued or completed advanced degrees. Among these, 74% completed or are pursuing MD, PhD, or

MD–PhD degrees; and 17% completed or are pursuing combined MD–PhD degrees, over one-third of whom are enrolled in the Tri-Institutional MD–PhD Program. Gateways outcomes are compared to other programs with similar missions, which shows that Gateways has been successful at preparing URMs for MD–PhD Programs. The program serves as a model for how to increase the national pool of competitive URM MD–PhD applicants.

The lack of diversity in the physician–scientist workforce in the United States remains a serious concern.^{1–3} This pertains to both gender and ethnicity, and, despite a 30-year effort by the NIH,^{4–6} only about 5.3% of the U.S. medical school faculty with an MD–PhD or MD plus another higher degree are members of underrepresented minority (URM) groups.¹

To increase the number of URM physician–scientists, the number of URM MD–PhD trainees needs to increase. This continues to be a challenge because the applicant pool is small (between 2007 and 2013, the percentage of URMs in the national applicant pool averaged 15%),⁷ and many applicants lack the qualifications and research preparation to complete the training (between 2009 and 2015, the percentage of URM among MD–PhD matriculants averaged 10%);⁸ the total enrollment of URM students in

MD–PhD programs (2002–2013) averaged 12%.⁹ Moreover, once matriculated, URM students seem to graduate at lower rates than majority students.¹⁰ (The Association of American Medical Colleges has changed how it classifies individuals who are members of different ethnic groups, which complicates comparisons; the above numbers do not include students who declare “multiple race/ethnicity.”)

In 1993, the Weill Cornell/Rockefeller/Sloan Kettering Tri-Institutional MD–PhD Program became the first MD–PhD program to embrace the task of increasing the URM MD–PhD applicant and student pipeline. We developed a summer research training program for undergraduate students, Gateways to the Laboratory (Gateways), to provide everything we expected to see in a competitive MD–PhD applicant—strong academic performance and substantial research experience. To accomplish this, Gateways focuses on four elements: research experience that empowers the students; effective mentoring, focusing on the needs of the individual student; career development, where the students learn basic skills; and funding, so that students do not need to decide between supporting themselves and furthering their careers. These elements seem to be characteristic of summer programs that enhance students’ interest in pursuing a STEM (science, technology, engineering, and math) career.¹¹

Gateways is a 10-week summer program for URM, disadvantaged college students as well as those with disabilities who wish to become physician–scientists. Gateways incorporates a structure that mirrors the multiple responsibilities of a physician–scientist. It emphasizes hypothesis-driven research, clinical work, journal club, and multitiered mentoring.

We describe the structure of Gateways, report on the educational paths of students who participated in the program during its first 20 years, and summarize what we believe to be the most successful interventions we have made.

Program Organization and Culture

There are two distinct, valid approaches to foster the development of research trainees: to *grow* talent—that is, to support trainees who, without their participation in a mentoring and training program, may not have entered a STEM field; and to *harvest* talent—that is, to support trainees who for a variety of reasons were likely to have “made it” whether or not they participated in such a program.¹¹ Gateways both grows and harvests talent, as we aim to both increase the diameter of the pipeline and seal the leaks. To accomplish these goals, we strive to instill into enrolled students a commitment to excellence.

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Acad Med. XXXX;XX:00–00.

First published online

doi: 10.1097/ACM.0000000000001478

Supplemental digital content for this article is available at <http://links.lww.com/ACADMED/A406>.

Here we describe the current program; Supplemental Digital Appendix 1 at <http://links.lww.com/ACADMED/A406> shows the evolution of Gateways, and Supplemental Appendix 2 at <http://links.lww.com/ACADMED/A406> provides additional information.

Creating a culture of excellence

To create and nurture a culture of excellence, a mentoring and training program must set clear and constructive expectations, so that students develop an intrinsic drive toward excellence, which in turn empowers them. This process, which the laboratory helps enforce, commences before matriculation, when the students begin to make decisions about their laboratory and research project.

Similar to other summer programs, Gateways students conduct independent, hypothesis-driven research and participate in journal clubs. Additional features include the active involvement of the program leadership; career development workshops; three presentations of their research (written, oral, and poster); and several formal and informal weekly meetings where all students are together, thereby creating cohesion and a culture that emphasizes excellence. A unique feature is the Big Siblings (Big Sib) program (described below), in which a current MD–PhD student serves as mentor for each Gateways student. In addition to the Gateways students, the program thus consists of three pillars: laboratory; current students in the Tri-Institutional MD–PhD Program; and program administration. To function efficiently and to minimize the leaks in the pipeline, these pillars must work in unison and deal proactively with the predictable stressors that arise.

Addressing potential barriers to success

It is not enough to provide the laboratory research experience; it is necessary to provide encouragement and advice at critical junctures in the students' training. To do so, we focus on four recurring issues faced by many URM students: low expectations; lack of information about career opportunities; lack of role models; and inadequate family and community support.

Low expectations. Minority students often lack the knowledge, or self-confidence, to pursue physician–scientist careers. Gateways strives to instill into the

students a drive to excel. The program structure is designed to empower the students such that they are prepared for the unique rigors of combined MD–PhD training, as opposed to the more familiar and singular MD or PhD degree training. The guiding principle is that “good enough is not good enough.” The program structure helps the student learn how to set and meet goals and deadlines (underscoring that deadlines are not recommendations). They have milestones to meet throughout the program, and there is regular follow-up to make sure they are on target to meet, if not exceed, our (and their) expectations.

Lack of information about training and careers.

Gateways educates its students about what training MD–PhD programs provide, what types of interests compel people to pursue this training, and what MD–PhD graduates do once they complete their training—knowledge that is critical if the students are to become informed and competitive MD–PhD applicants and successful MD–PhD students. This is done both formally and organically—the students are continuously exposed to people who are enrolled in, are graduates of, or lead MD–PhD programs. By the end of the summer, the challenges of applying to and getting accepted into an MD–PhD program no longer seem insurmountable. Importantly, however, the focus is on making informed decisions—whether it be to pursue an MD, PhD, or MD–PhD. Therefore, to give the students opportunities to compare their performance with that of students in other summer programs, they all give an oral presentation at the annual Leadership Alliance National Symposium, a national scientific symposium bringing together a diverse group of faculty and students who are participating in the Leadership Alliance's Summer Research Early Identification Program (SR-EIP).¹²

Lack of role models. Undergraduates view positive mentoring as among the most valuable features of a training program, second only to significant research experiences.¹¹ Gateways provides positive, consistent mentoring by a multitude of individuals with different life experiences: program director, administrative director, principal investigators, members of the lab, Big Sibs, recent alumni of the Tri-Institutional MD–PhD Program, journal club leaders and moderators, mock

MD–PhD interviewers, oral presentation reviewers, and other students in the MD–PhD program (see also Supplemental Digital Appendix 3 at <http://links.lww.com/ACADMED/A406>).

The Big Sibs, an initiative created in 1998, provides key mentors/role models to Gateways students. Big Sibs mentor Gateways students in overcoming small and large challenges, such as learning laboratory skills, critically reading articles for journal club, answering scientific and career-related questions, enforcing a culture of excellence, and professionalism.¹³ These mentors were initially selected from the Tri-Institutional URM MD–PhD students. But, as Gateways grew (and we learned from our experiences), we realized that it would be important to broaden the group of mentors to fully integrate the Gateways students into the MD–PhD community. Beginning in 2006, majority MD–PhD students also became Big Sibs—a natural progression as the majority students already were involved in other Gateways activities. This was an impactful change because it emphasized that Gateways is a priority of the whole MD–PhD program, irrespective of the mentors and mentees background, and the Gateways students continue to have numerous interactions (both formal and informal) with URM MD–PhD students. Among the MD–PhD students involved in Gateways, about one-third are URM and two-thirds are majority students (about 25% of the students in the MD–PhD Program are URM; see Outcomes).

Family and community. Many Gateways students are the first in their families to attend college, and it is critical to educate the parents so that they understand their children's career aspirations. We therefore invite parents to the final Research Day (graduation), which allows the families to meet the program's leadership and get answers to questions they have about the pursuit of the combined degree (compared with MD) training. The program provides travel support and housing, and all students have family members present. Inviting the parents is likely underlying much of the change that occurred between the early (1993–1999) and later cohorts (Figure 1).

Life After Gateways

Mentoring must be an integral part of any outreach program's culture but does not

end with graduation from Gateways or matriculation into an MD–PhD program. We keep in touch with and continue to mentor the students, who need realistic advice about their chances of admission when they are contemplating whether or not to apply to an MD–PhD or some other program (including postgraduate training). This is no small undertaking, but it is essential for achieving what we set out to accomplish. Gateways alumni are part of an active alumni listserv that we use monthly to distribute career-related information; they also are invited to Gateways and MD–PhD program events, as well as the alumni dinners the program director hosts in different cities. At scientific conferences, Gateways alumni wear a logo lapel pin, which allows them to identify each other across years. (Supplemental Digital Appendix 4 at <http://links.lww.com/ACADMED/A406> has testimonials from Gateways alumni.)

Recruitment and matriculation

Gateways aims to increase the participation of URMs, as well as other underrepresented groups (e.g., students with disabilities or from socioeconomically disadvantaged backgrounds) in MD–PhD programs. The focus is on college freshmen and sophomores, to enable the students to get additional research experience *after* their “graduation” from Gateways. Recruitment into Gateways therefore is multifaceted, with extensive, ongoing communication with prehealth advisors via their listserv and annual meetings, booths at national conferences, participation in the Leadership Alliance, social media marketing, and word of mouth from our alumni.

About 200 applicants from all over the continental United States, Puerto Rico, and Guam, from varying economic backgrounds and colleges ranging from community colleges to Ivy League schools, including Historically Black College and Universities, apply to the program. The majority come from undergraduate research universities. An admissions committee, consisting of current MD–PhD students who have been involved in Gateways plus the program and administrative directors, reviews the applications with a focus on perceived drive, motivation, resiliency, and potential as future physician–scientists. Grades, particularly in math

and science (reflecting the increasing importance of quantitative reasoning in biomedical science), are considered in the selection. Students who apply to participate for a second year are evaluated also on the basis of their performance during the first year (and we make clear to those who matriculate that we expect them to set a high standard and example for their fellow students).

To pair each Gateways student with a Tri-Institutional faculty research mentor, we solicit faculty members to serve as lab mentors five months prior to the start of Gateways. Potential advisors are selected on the basis of their proposed projects and mentoring experience, and the students choose laboratories on the basis of their research interests. The projects are vetted by the program director on the basis of an abstract, due the first week of the program, which ensures that the student, mentor, and program leadership all agree on the project.

Outcomes

From 1993 to 2013, 245 students completed the Gateways program. During the summers of 2010 to 2013, we contacted each of them by phone, e-mail, and/or social media. Alumni were asked to complete a survey that elicited demographic information and updates about career and educational achievements. We organized response data using Microsoft Excel and Origin. The study was approved by the Weill Cornell Medical College institutional review board with a waiver of informed consent.

Among the 245 alumni, 152 (62%) were women and 93 (38%) were men. Self-reported minority categories were URM (209; 85%), economic or socially disadvantaged (59; 24%), and disabled (2; 0.8%). Some listed more than one category. Two hundred twenty-five (92%) participated in Gateways for one summer; 20 (8%) participated for two summers (8 before 2000 and 12 in 2001–2013). The alumni represented 113 undergraduate institutions, with 100 (40%) from 11 schools. The year of college completed at time of first participation was freshman (108; 44%), sophomore (136; 56%), junior (20; 8%), and senior (1; 0.4%).

Of responding alumni, 211 alumni completed college; to our knowledge, only

1 did not complete college education; we have follow-up information for 207 (98%). Of these, 182/207 (88%) had received (133) or were pursuing (54) advanced degrees (Table 1), including 5 students who pursued a second advanced degree after receiving the first. The graduates’ educational paths are summarized in Figure 2.

One hundred thirty-three alumni received advanced degrees: 64 MDs, 14 PhDs, 11 MD–PhDs, and 17 dual MD/other (with MD–MPH being the most common, 8)—for a total of 106 (or 80% of this group)—plus 27 other advanced degrees (18 were health related). Fifty-four alumni, including 5 who already received one advanced degree, were pursuing advanced degrees: 16 MDs, 7 PhDs, 25 MD–PhDs, and 2 dual MD/other—for a total of 50 (or 93% of this group)—plus 4 other advanced degrees (3 were health related). One hundred fifty-one alumni had completed or were pursuing MD, PhD, or MD–PhD degrees (including 3 who received or were pursuing both an MD and a PhD). All the PhDs were in biomedical sciences; those who pursued an MD, and all but 1 who pursued a PhD, completed their training; of the 41 who embarked on MD–PhD training, 5 did not complete the dual degree and were awarded either an MD (4) or a PhD (1). The advanced degrees (completed or pursued) by Gateways alumni for three time periods, 1993–1999, 2000–2004, and 2005–2013, are summarized in Figure 1. There has been a pronounced shift from alumni enrolling in MD-only programs toward MD–PhD and PhD-only programs (Figure 1; see also Supplemental Digital Appendix 5 at <http://links.lww.com/ACADMED/A406>).

Among the 8 alumni who participated twice before 2000, 7 received MDs and 1 an MBA. Among the 12 who participated twice during 2001–2013, 7 have received or are pursuing MD–PhDs, including 1 who received separate MD and PhD degrees, 1 PhD, 1 MD, 1 DO, and 2 who were applying to graduate or medical school.

On completion of their terminal degrees, Gateways alumni pursued residency, fellowship, or postdoctoral training (in the case of the PhDs); and 8 alumni (4 MDs, 1 PhD, 1 MD–MPH–MBA, 1 PharmD, and 1 MD–PhD) already hold faculty positions. Many who pursued MD training conducted research during medical school, and

Table 1
Outcomes for Different Undergraduate Outreach Programs for Physician-Scientists in Training, 1993 to 2003

Program ^a	MD/DO ^b			PhD			MD-PhD		
	Received	Pursuing	Received	Received	Pursuing	Received	Received	Pursuing	Other ^c
Gateways (211 graduates)^d									
Total graduates by advanced degree, no. (%)	107/211 (51)	50/211 (24) ^e	82/211 (39)	18/211 (9)	7/211 (3)	14/211 (7)	11/21 (5)	25/211 (12)	59/211 (28)
Subset of graduates by advanced degree, ^b no. (%)			82/107 (77)	18/50 (36)	7/50 (14)	14/107 (13)	11/107 (10)	25/50 (50)	
The Leadership Alliance (3,182 graduates)^f									
Total graduates by advanced degree, no. (%)	862/3,182 (27)	505/3,182 (16)	337/3,182 (11)	126/3,182 (4)	352/3,182 (11)	475/3,182 (15)	50/3,182 (2)	27/3,182 (1)	1,815/3,182 (57)
Subset of graduates by advanced degree, ^b no. (%)			337/862 (39)	126/505 (25)	358/505 (70)	475/862 (55)	50/862 (6)	27/505 (5)	
Meyerhoff Scholars Program (1,004 graduates)^g									
Total graduates by advanced degree, no. (%)	338/1,004 (34)	204/1,004 (20)	107/1,004 (11)	21/1,004 (2)	147/1,004 (15)	186/1,004 (19)	45/1,004 (4)	36/1,004 (4)	462/1,004 (46)
Subset of graduates by advanced degree, ^b no. (%)			107/338 (32)	21/204 (10)	147/204 (72)	186/338 (55)	45/338 (13)	36/204 (18)	
MARC U-STAR (1,739 graduates)^h									
Total graduates by advanced degree, no. (%)	741/1,739 (43)	101/1,739 (6)	212/1,739 (12)	NA	101/1,739 (6)	504/1,739 (29)	251/739 (1)	NA	897/1,739 (52)
Subset of graduates by advanced degree, ^b no. (%)			212/741 (29)	NA	101/101 (100)	504/741 (68)	25/741 (3)	NA	

Abbreviation: NA indicates not available.
^aData for this column are program alumni who have completed their undergraduate training. ^bIncludes alumni who had received, or were pursuing, dual MD-other degrees, such as MD-MPH.
^cGraduates who had neither received nor were pursuing MD (or DO), science PhD, or MD-PhD degrees; some in this group may have received master's or other doctoral degrees.
^dThis study; the one who received a DO is included in the MD category.
^eIncludes five who were pursuing a second advanced degree.
^fFrom the Leadership Alliance Web site¹⁷ with updates from Collins.¹⁸
^gFrom the Meyerhoff Scholars Program Web site¹⁹ with updates from Harmon.²⁰
^hFrom Figure 4 in Hall et al.⁶

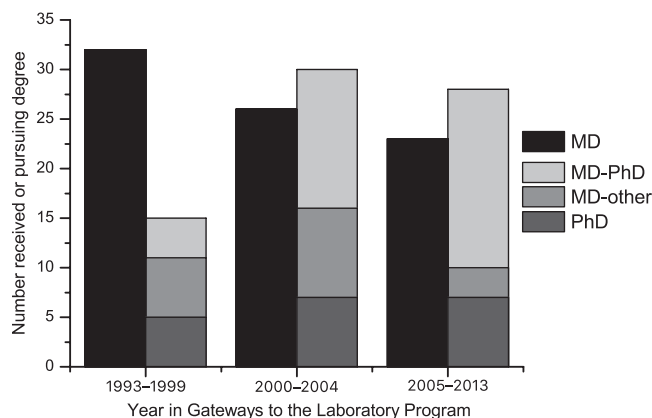


Figure 1 Evolution of the educational paths of Gateways to the Laboratory alumni (1993–2013). The 1993–1999 cohort participated in an 8-week program; the 2000–2004 cohort participated in a 10-week program, and we invited the parents to the final “graduation” day; the 2005–2013 cohort included students who were socioeconomically disadvantaged or disabled, in addition to the traditional URM students, and the composition of the admissions committee was changed to be current MD–PhD students who were involved in Gateways. Abbreviation: URM indicates underrepresented minority.

some alumni with MD or DVM degrees are pursuing physician–scientist careers.

Forty-one alumni matriculated in dual-degree programs; 36 completed or were pursuing MD–PhDs. Among the 36, 13 had graduated from (2) or were enrolled in (11) the Tri-Institutional MD–PhD Program. This evidence testifies to the notion that we have created our own pipeline.

Impact of the Tri-Institutional MD–PhD Program

The percentage of URM MD–PhD students matriculating in MD–PhD Programs nationally (2009–2015) averaged 10%,⁸ and the total URM student body (2002–2013) averaged

12% with no obvious trend.⁹ (There are 36% ethnic minorities in the U.S. population.^{11,14}) Following the inception of Gateways, the percentage of URM students in the Tri-Institutional MD–PhD Program has increased eightfold, from ~3% to ~25% (Figure 3), with a near-doubling since 2002, a period in which the percentage of URM applicants in the national applicant pool⁷ or URM students who matriculated in MD–PhD programs⁹ did not change; 30% of the URM students in the program are Gateways alumni.

Cost

The institutional cost per Gateways student is approximately \$7,000, not including staff efforts. The cost includes stipends, travel for both student and parents, Big Sib honoraria, poster

printing, travel to the Leadership Alliance National Symposium, and miscellaneous expenses including food. Faculty members do not get reimbursed for hosting a student.

Comparison to Other Programs

There is a paucity of outcomes data for summer outreach programs for undergraduate students.^{15,16} We compare in Table 1 our results with those for three programs with publicly accessible outcomes data: the Leadership Alliance’s cooperative SR-EIP,^{17,18} which includes Gateways; the Meyerhoff Scholars Program (MSP) at the University of Maryland Baltimore County^{19,20}; and the NIH Minority Access to Research Careers (MARC) Undergraduate Student Training in Academic Research (U-STAR) program.⁶ The MSP and MARC are full-time academic programs, while the SR-EIP and Gateways are summer programs.

The Leadership Alliance’s SR-EIP aims to develop URM students into outstanding leaders and role models in academia, business, and the public sector.¹⁷ The program caters to college students at any year of training.

The MSP at the University of Maryland Baltimore County is dedicated to increasing the representation of minorities in STEM¹⁹ and provides financial assistance, mentoring, advising, and research experience to undergraduate students committed to obtaining PhD degrees in science or engineering. The program caters to college students in any year of training.

The MARC U-STAR program is an institutional undergraduate research training program designed to prepare high-achieving URM students for doctoral programs in biomedical research.⁶ The program focuses on students in their last two years of college.

The outcomes in Table 1 reflect averages over many years and, as is the case for Gateways, may not reflect recent changes in program organization. Yet, compared with these benchmarks, Gateways has been successful, especially considering that the participants were selected during their freshman and sophomore years of college. We attribute our success to the program’s structure and to the culture it has created within our MD–PhD program, which has enabled us to

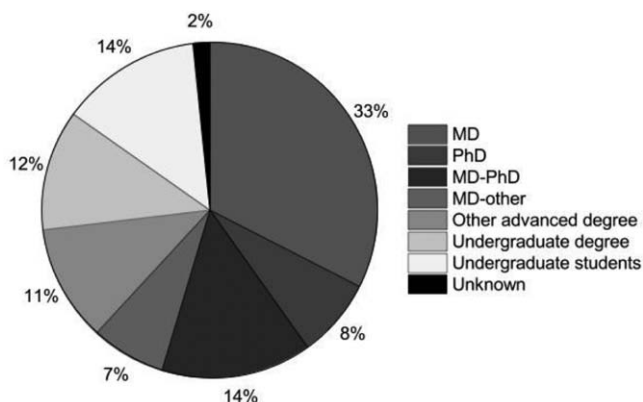


Figure 2 Educational paths of the 245 Gateways to the Laboratory alumni (1993–2013 graduates). Among the 211 alumni who had completed college, 182 (86%) had received or were pursuing advanced degrees, with 151 (72%) having received or pursuing MD, PhD, or MD–PhD degrees.

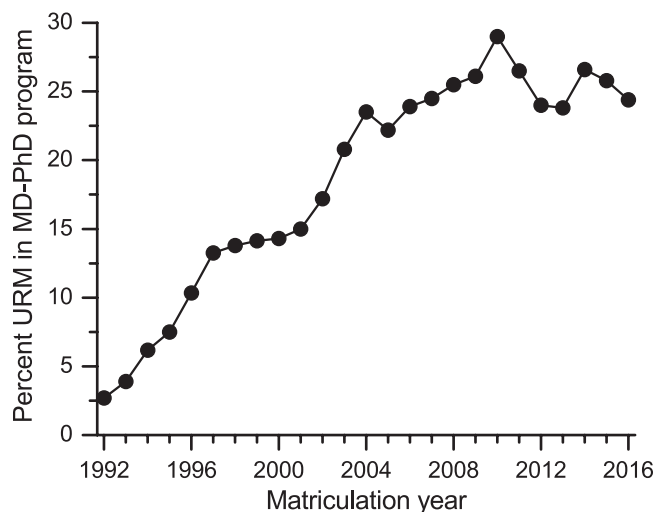


Figure 3 Percentage of URM students in the Tri-Institutional MD-PhD Program (1992–2015). Since 2003, the percentage of URM students in the program has ranged between 20% and 30%. Abbreviation: URM indicates underrepresented minority.

recruit and develop students who are excited about the challenges of careers as physician–scientists.

Comparing the outcomes of the four programs, it appears that if one wishes to increase the number of URM physician–scientists, there need to be more summer programs that focus on widening the URM MD-PhD applicant and student pipeline.

Conclusions and Future Directions

Since Gateways' inception in 1993, the number of URM MD-PhD students in the Tri-Institutional MD-PhD Program has increased 10-fold (Figure 3). We have created our own pipeline—and, in the process, developed an environment that is receptive to the training of URM students. We deem that the two most important elements that helped foster this were creating the Big Sibs element and inviting participants' parents to the final graduation. Currently, we are exploring novel, self-directed learning and mentoring initiatives.

Though an increasing number of MD-PhD programs have developed summer research programs, few focus on students who are members of underrepresented groups or who otherwise are underrepresented among physician–scientists. It is not difficult to mount an effective program—but it requires dedication, focus, and time to develop a robust culture and willingness to provide continued advice and mentoring after

completion of the program, as evident in the temporal shift in the Gateways students' career choices (Figure 1 and Supplemental Digital Appendix 5 at <http://links.lww.com/ACADMED/A406>). We provide information about Gateways, and its structure, to other MD-PhD programs, and some have adopted its structure (University of California, San Diego in 2001 and Ohio State University in 2012). To truly meet the demands for training and mentoring of students who are members of URM groups, or who otherwise are underrepresented among physician–scientists, there is a pressing need to replicate Gateways at a national scale. But it is important to be realistic—it took about 10 years to develop Gateways into the effective tool it has become.

Acknowledgments: The authors thank the Gateways alumni for providing the information underlying this study and the Gateways to the Laboratory Program Endowment donors: Abby Rockefeller Mauzé Charitable Trust, Andrew W. Mellon Foundation, Medtronic Foundation, Richard Lounsbery Foundation, and Drs. Martin and Sarah Leibowitz. The authors also thank Deborah Collins (the Leadership Alliance), Alison K. Hall, PhD (National Institute of General Medical Sciences), and Keith Harmon (University of Maryland Baltimore County) for information about their programs that was invaluable in preparing Table 1, and Caroline K. Fulford and Kenneth M. Javier for their assistance with the data collection and analysis.

Funding/Support: None reported.

Other disclosures: None reported.

Ethical approval: Reported as not applicable.

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