

ARTICLE

Centering Diversity, Equity, and Inclusion in Graduate Admissions

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Many undergraduate neuroscience trainees aspire to earn a PhD. In recent years the number, demographics, and previous experiences of PhD applicants in neuroscience has changed. This has necessitated both a reconsideration of admissions processes to ensure equity for an increasingly diverse applicant pool as well as renewed efforts to expand access to the training and research experiences required for admission to graduate programs. Here, we describe both facets of graduate school admissions by demystifying the process and providing faculty with tools and resources to help undergraduate students successfully navigate it. We discuss admissions requirements and processes at two graduate institutions, highlighting holistic approaches to evaluating students, the ever-increasing research experience expectations, and the decreasing reliance on the GRE. With a particular focus on improving equity, diversity,

inclusion and belonging, we discuss resources for applying to graduate school that are available for students from underrepresented populations, including summer institutes and fellowship programs and intentional relationships with minority serving institutions (MSIs) to foster bi-directional engagement between undergraduate programs at MSIs and graduate institutions. With diverse perspectives as faculty involved in undergraduate education, graduate programs, and post-baccalaureate training programs, we provide recommendations and resources for how to help all trainees – especially those from populations underrepresented in the STEM workforce – succeed in the current graduate education admissions landscape.

Key words: graduate programs, equity, diversity, inclusion

Equity and inclusion efforts in graduate education are at an impasse. While many educators would like to level the playing field for historically and currently excluded populations of students, the current political landscape in the United States is making such efforts more and more difficult. In June 2023, the United States Supreme Court struck down affirmative action with its decision in *Students For Fair Admissions (SFFA) vs. Harvard* and *SFFA vs. UNC*, effectively undermining all efforts to have race-conscious admissions (Supreme Court of the United States, 2023). Meanwhile, many other states — currently 40 — are entertaining legislation that would challenge diversity, equity, and inclusion (DEI) efforts in a broad range of ways, from diversity statements to training, as well as programs intended to broaden participation (Lu et al., 2023). Such legislation is a direct affront to the work of many educators who wish to reverse decades of race discrimination.

This wave of anti-DEI legislation is particularly disheartening because we have been seeing slow but steady positive changes in the participation rates in science and engineering PhD programs (National Center for Science and Engineering Statistics, 2021). In neuroscience in particular, there are numerous efforts to broaden participation and dismantle historical structures that have blocked the participation of many groups. For example, the National Institutes of Health (NIH)'s National Institute of Neurological Disorders and Stroke Office of Programs to Enhance Neuroscience Workforce Diversity has been steadily building a robust pipeline to support

underrepresented researchers, beginning with Enhancing Neuroscience Diversity through Undergraduate Research Education experiences (ENDURE) programs for undergraduates, to neuroscience-specific post-baccalaureate programs, to a Diversity Specialized Predoctoral to Postdoctoral Neuroscience (D-SPAN) program for postdoctoral fellows (Jones-London, 2020). Structural changes, such as removal of the GRE and more holistic graduate admissions processes, have also been implemented with the goal of improving diversity in graduate programs.

The question at hand, therefore, is how do we protect this progress amidst the current backdrop of anti-DEI legislation? One first step is to make visible current graduate admissions processes so that we, as educators, can strategize ways to center diversity, equity, and inclusion efforts. Our goal in this piece is to therefore demystify the PhD admissions process and illustrate best practices to support our students, even in the wake of anti-DEI sentiment. We begin with a broad look at PhD admissions, and then focus on two specific programs as case studies. We then highlight general strategies to prepare students to be competitive applicants for graduate school, including programs to broaden participation in STEM.

Positionality statement

Each of the authors contributes first-hand experience as participants in graduate admissions and/or as directors of programs to prepare diverse trainees to enter graduate

programs: Dr. Tan serves on the admissions committee for the Harvard PhD Program in Neuroscience, co-directs the Harvard Program in Neuroscience Post-Baccalaureate (PiNBAC) training program, and co-leads the Morehouse and Harvard Partnership in Neuroscience Growth (MAHPING); Dr. Tomaszycski serves on the admissions committee and is the Program Coordinator for the Neuroscience Program at Illinois; Dr. Juavinett leads the BP-ENDURE STARTneuro training program for undergraduates at University of California, San Diego; and Dr. Martinez Acosta co-directs a Louis Stokes Alliances for Minority Participation (LSAMP) program PUI-SATX-LSAMP and serves on the leadership team for the ENGAGE-bio post-baccalaureate training program at the Marine Biological Laboratory.

Current state of PhD admissions

An in-depth 2016 report by the Society for Neuroscience indicated that neuroscience graduate programs in the United States received anywhere between 5 and 875 program applicants, with 170 on average (SfN, 2017). We used Next Generation for Life Science (NGLS) data to assess whether this held true in more recent years (Coalition for Next Generation Life Science, 2023). Indeed, there is still a wide range of graduate program sizes, but the number of applicants for most programs is still in this range (Table 1). Averaging across 15 different programs with data from admit years 2018 to 2023, the average number of applicants rose slightly, from 352 to 427. The percent admit rate averaged across the programs declined from 11.27% to 10.83% (Figure 1). The relative stability of admission rates observed for many of the programs included in this analysis may reflect the opposing forces of a global pandemic, which may have decreased students' access to research opportunities and therefore PhD applications, with the overall increase in PhD applications over the past two decades (Akil et al., 2016).

A related question is how competitive neuroscience graduate programs are. There is quite a bit of variability in admissions rates in neuroscience PhD programs, ranging from ~4-25% in recent years (Table 1; Figure 1). The public availability of these data can empower students and advisors to strategically select programs based on how competitive an applicant may be.

TYPICAL APPLICATION COMPONENTS

While each PhD program independently determines their admissions process, there are several common components and similarly shared attributes of competitive applicants. An application package for PhD programs in neuroscience typically consists of student essays to share applicants' previous research experiences and motivations for pursuing a graduate degree, academic transcripts, letters of recommendation, and a curriculum vitae (CV). First and foremost, competitive applicants have significant (at least one year, often more) independent research experience. Competitive applicants typically have a strong GPA, but this varies quite a bit across programs — in 2016, the average for all applicants was 3.56 (SfN, 2017). Strong letters of recommendation are those that can speak to the applicant's

Program	Year	# of Applicants	# (%) Admitted
Case Western University Neuroscience	2022	696	99 (14.2%)
Duke Neurobiology	2017	196	23 (11.7%)
Emory BBS Neuroscience	2023	341	56 (16.4%)
Harvard Program in Neuroscience	2023	845	35 (4.4%)
Johns Hopkins Neuroscience	2023	425	42 (9.9%)
MIT Brain & Cognitive Sciences	2023	800	29 (3.6%)
Northwestern Interdepartmental Neuroscience Program	2022	343	57 (16.6%)
NYU Neural Science	2020	445	18 (4.0%)
Stony Brook University Neuroscience	2023	95	24 (25.3%)
UCLA Neuroscience	2023	527	30 (5.7%)
UC San Diego Neurosciences	2022	650	52 (8.0%)
UCSF Neuroscience	2023	362	47 (13.0%)
University of Chicago Neurobiology	2023	216	22 (10.2%)
University of Illinois Neuroscience	2023	108	16 (14.8%)
University of Michigan Neuroscience	2018	285	52 (18.0%)
University of Minnesota Neuroscience	2020-2022	231	40 (17.3%)
University of Pennsylvania Neuroscience	2023	521	53 (10.2%)
University of Wisconsin Neuroscience	2022	177	24 (13.6%)

Table 1. Number of applicants and admission percentages from the most recently reported year for 17 different programs. Years reported refers to the year of matriculation (intended entry year), not application year. Note that University of Minnesota numbers are an average across three admissions cycles; all other numbers represent a single admissions cycle. All data gathered as a part of the NGLS Coalition or directly provided by the authors of this manuscript. Programs were included in this table if they provided admissions data and were a neuroscience-specific program.

motivation for graduate school as well as their research experience and academic performance. Letters of recommendation from primary research advisors are particularly impactful. During any research experience, trainees should communicate with their research advisors early and often about the contributions and skill development that are expected to warrant a strong letter of recommendation. As the application cycle approaches, applicants should ask potential letter writers for strong letters well in advance of the application deadlines. There is some variability in the specific student essay prompts and structures among PhD programs, with some schools requiring a single “statement of purpose” and others requiring separate “personal statements” and “statements of previous research experience.” As of 2022, almost all neuroscience programs have dropped the Graduate Record Examination (GRE) requirement (Langin, 2022). Submitted GRE scores may or may not be considered in an application package. Students are advised to look up whether the programs to which they hope to apply require the GRE before spending the time and money to prepare for and take the exam. In recent years, the “diversity statement” - an essay to determine an applicant’s contributions and commitment to advancing DEI - has also been incorporated into some applications. Diversity statements or other additional essays to assess candidates’ contributions in support of program or university mission statements (inclusive of promoting DEI) may become more common following the abolition of affirmative action by the Supreme Court (Students for Fair Admissions, 2023).

In addition to the written application materials, many PhD programs hold interviews for a subset of competitive applicants before final offers of admission are given. Programs differ in their requirements for if and when

prospective applicants should contact potential faculty advisors, so students are advised to reach out to individual programs to inquire whether individual faculty-student matches are considered during the admissions process. Regardless of whether contacting program faculty is expected or beneficial for the admissions process, prospective applicants are always encouraged to contact directors or administrators within the graduate school and/or specific graduate programs with any questions about the specific program or broader university landscape. Administrators can also direct applicants to program- or university-wide resources such as those related to student support and equity, diversity, and inclusion efforts.

Holistic Review

The movement to eliminate the GRE requirement was motivated in part by equity concerns, given that the cost of preparing for, and taking, the exam disadvantages applicants from low socioeconomic backgrounds (Langin, 2022). Additionally, the GRE provides little-to-none predictive value (Feldon et al. 2023) or correlation with graduate student success (Weiner, 2014; Hall et al. 2017; Moneta-Koehler et al. 2017); however, GRE quantitative scores do correlate with gender and ethnicity (Miller and Stassun, 2014). Yet, beyond the GRE, it is increasingly appreciated that each of the individual components of graduate applications has flaws, and that the overall PhD admissions process warrants further revision to promote equitable outcomes (Posselt, 2018; De Los Reyes and Uddin, 2021;). Increasingly, “holistic review” is gaining traction for PhD admissions as an approach to overcome the biases and barriers inherent in academic admissions processes that perpetuate inequalities (Kent and McCarthy, 2016; De Los Reyes and Uddin, 2021). Holistic review of

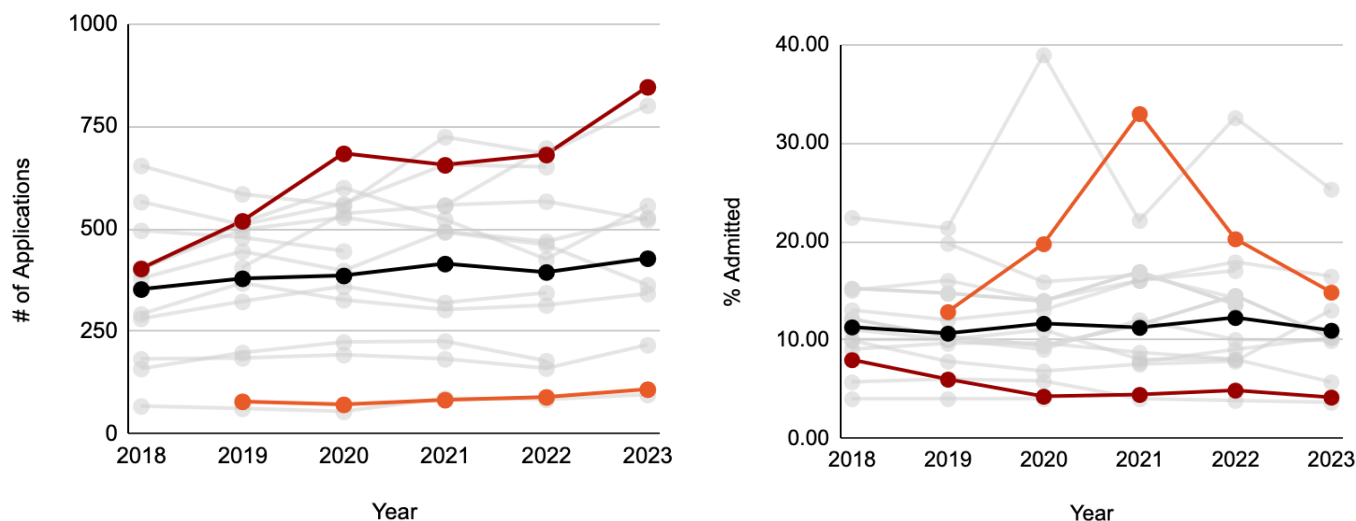


Figure 1. Number of applicants and admission percentages for 15 different programs from 2018-2023. All data were gathered as a part of the NGLS Coalition or directly provided by the authors of this manuscript. Programs were included in this table if they provided admissions data, were a neuroscience-specific program, and included multiple years of data. The average for both # of applicants and % admitted is shown as the thick black line; individual programs are in light gray. Harvard Program in Neuroscience and University of Illinois Neuroscience Program, both described in depth in this manuscript, are in crimson and orange, respectively. A complete table of data can be found in Appendix A.

applications - which is already widely implemented for undergraduate and medical school admissions - is an evidence-based practice that considers the “whole applicant.” Personal attributes and experiences, as well as applicants’ individual contexts, are considered alongside academic performance and applicants are evaluated on the strength of their entire application package (Kent and McCarthy, 2016; Coleman and Keith, 2018; Association of American Medical Colleges, 2023). Holistic review provides a framework for admissions committees to better assess applicant attributes such as grit, which positively impacts students’ graduate school experience (Sanchez et al. 2023). While the specific implementation of holistic review will vary across institutions, holistic review is, critically, still permissible in the current legal landscape following the abolition of affirmative action for admissions. As stated in the guidance published by the Department of Justice and Department of Education following the Supreme Court’s decision:

“Universities may continue to embrace appropriate considerations through holistic application-review processes and (for example) provide opportunities to assess how applicants’ individual backgrounds and attributes—including those related to their race, experiences of racial discrimination, or the racial composition of their neighborhoods and schools—position them to contribute to campus in unique ways. For example, a university could consider an applicant’s explanation about what it means to him to be the first Black violinist in his city’s youth orchestra or an applicant’s account of overcoming prejudice when she transferred to a rural high school where she was the only student of South Asian descent. An institution could likewise consider a guidance counselor or other recommender’s description of how an applicant conquered her feelings of isolation as a Latina student at an overwhelmingly white high school to join the debate team” (Department of Justice and Department of Education, 2023).

Advisors should work directly with students to determine which aspects of their personal identity and trajectory they feel comfortable disclosing in an application, while also paying attention to the specific prompts provided by graduate programs.

As noted above, graduate programs differ in their specific requirements. Below, and in Table 2, we describe the admissions landscape and processes for two graduate neuroscience programs to illustrate commonalities and variations between programs. Our hope is that these case studies will help to demystify the graduate admissions landscape for educators and mentors of aspiring applicants, empowering them to better prepare their students to be competitive applicants. Aspiring graduate students themselves should also leverage this article and other available resources to learn about the neuroscience graduate admissions landscape.

CASE STUDY #1: THE NEUROSCIENCE PROGRAM AT ILLINOIS

The Neuroscience PhD program (NSP) has a long history at the University of Illinois Urbana-Champaign (UIUC), beginning in 1971. The program is well known for being one of the most interdisciplinary programs in the country, spanning 7 colleges and 25 academic departments within the college, with breadth from Psychology to Engineering. The engineering focus allows students from varied backgrounds access to developing technologies to probe the nervous system, as well as to retain, repair, and even recreate it. Over 100 faculty participate in the program, and collaborative efforts among these colleagues are one of the program’s core strengths. The NSP typically has approximately 60 graduate students, with almost 20% of students from groups historically under-represented in STEM.

Admissions Process

The application consists of all the components listed above. There is a single personal statement and an optional DEI statement. The GRE is not required, but the Admissions

	GRE	Statements	Contacting Faculty
“Typical” neuroscience program	Not required, may or may not be considered	One combined personal/research statement or separate statements, sometimes optional DEI statement	Varies but is usually not required, ask individual programs.
University of Illinois Neuroscience PhD Program	Not required, admissions committee has access but scores are not formally reviewed	Personal statement and optional DEI statement	Faculty recruit somewhat directly; lab rotations are offered in special circumstances. Students should contact faculty before applications are due
Harvard University Program in Neuroscience	Not required, evaluated, or visible to admissions committee	Statement of purpose and (new for 2024) personal statement	No need for students to contact faculty

Table 2. Illustration of variation across graduate programs for GRE, statements, and procedures around contacting faculty.

Committee has access to the scores if they are submitted. GRE scores, however, are not formally considered in the admissions rubric. The admissions committee at Illinois uses a holistic rubric in which applicants are ranked on 3 dimensions and a 15 point scale (see next section). After reading all applications, admissions committee members agree on a cutoff—students below the point cutoff are not considered competitive and offers of admission cannot be made to these students. Once the cutoff is established, the remaining applications are released to recruiting faculty, and these faculty ultimately decide which applicants to interview. The NSP at UIUC receives over 100 applications per year and admits approximately 10%.

Because recruiting faculty play a direct role in admissions (rotations are offered in special circumstances), it is to an applicant's advantage to reach out to faculty they are interested in at Illinois before applications are due (typically December 1). It is suggested that students reach out directly to faculty via email. In that email, they should include a short paragraph about their research interests and experiences, highlighting the hypotheses tested, the techniques employed, and any results that emerged. Plans to present or publish such research should also be highlighted. Another paragraph should explicitly explain why they are interested in the faculty member's research. The applicant should also attach a CV and ask if the faculty member intends to recruit during the upcoming admissions cycle. Meeting with the faculty member prior to the application deadline is also highly encouraged. Another rather unique feature of the NSP at Illinois admissions process is that we technically have rolling admissions, which means that, in special circumstances when a prospective student and faculty member match outside of the typical admissions cycle, we can still admit the student.

Currently, a virtual open house is held in January, in which recruiting faculty and admissions committee members interview prospective students. After the virtual interviews, some prospective students are eliminated from further consideration. This is most often because recruiting faculty are more interested in other candidates. Faculty members select their top 1-3 candidates to attend an in-person open house in mid-February.

Holistic Admissions Rubric

All applications are reviewed using a standardized rubric that emphasizes improvement, leadership, and grit, and deemphasizes numerical metrics like GPA. The holistic admissions rubric does not consider race and ethnicity and requires that the admissions committee evaluate each student on each of three categories using multiple pieces of evidence (CV, personal statement, transcripts, letters of recommendation). Although race and ethnicity are not considered in the rubric, this information was previously available in the applicant's file. Because of the recent Supreme Court decision, the admissions committee will no longer have access to this information. The three domains are: Academic Performance, Research Potential, and Leadership/Service. Improvement and grit are embedded in each of the three categories. The first two components are

weighted more heavily than the third, and there are four categories within each domain (poor, fair, good, excellent) that are assigned point values.

Academic Performance requires strong grades in neuroscience-related courses, a solid GPA, and letters that speak highly of the individual's performance in courses, as well as their academic potential. The minimum GPA for Illinois is a 3.0, but a 2.75 GPA is acceptable if the student has significant post-bac experience or showed improvement over the course of their four years in college.

Research Potential requires 1-2 years of solid, in person, research experiences. Many successful applicants have a master's degree. Publications and/or presentations also lead to a high ranking in this domain. Letters of recommendation (at least 3) must convey aptitude for neuroscientific research and research potential, and the personal statement must convey clear and specific research interests, as well as enthusiasm for research.

The final category, Leadership and Service, focuses not only on performance in these categories, but also includes overcoming obstacles and grit. Letters of recommendation must speak to the student's leadership ability or distance traveled in order for students to be given the highest rating in this category. There is no specific amount of leadership or service required.

Finally, applications are awarded an additional point if the admissions committee member feels strongly that the student is worthy of a graduate college fellowship nomination. Each applicant's scores are summed across the 3 categories, for a possible total of 15 points plus an additional point for being fellowship worthy.

Resources for Applying and Studying at Illinois

Application fee waivers are offered for students from Big 10 Alliance universities (<https://grad.illinois.edu/freeapp>) and for McNair Scholars. Prospective students from diverse educational, sociocultural, geographic, and familial backgrounds can apply for the ASPIRE program (<https://grad.illinois.edu/diversity/aspire>), which provides help with preparing application materials through a series of webinars, access to an early application process, and funding to visit campus and the NSP before the traditional December 1 application deadline. ASPIRE students are also eligible for ASPIRE fellowships upon admission into the program. For more information on resources available to admitted students, please see <https://grad.illinois.edu/diversity/about>.

CASE STUDY #2: THE PROGRAM IN NEUROSCIENCE AT HARVARD

The PhD Program in Neuroscience (PiN) at Harvard University is a highly interdisciplinary program that spans the Faculty of Arts and Sciences in Cambridge, Harvard Medical School in Boston, and Harvard's various affiliated hospitals. The program is centered within the Department of Neurobiology at Harvard Medical School, which was founded in 1966 as the first department dedicated to the cross-disciplinary study of the brain. PiN has over 150 participating faculty and a total student body of

approximately 150 students, corresponding to an incoming class size of approximately 25 students. 20.7% of currently enrolled students in PiN belong to populations underrepresented in STEM.

In contrast to the overall trends observed in the graduate admissions data collected by the NGLS Coalition reported above, application numbers and admissions rates for PiN have shown less stability in recent years. For the most recently matriculated class (admissions cycle admit year 2023, depicted in Table 1; Figure 1) PiN received 845 applications, more than double the number from five years prior (2018, 402 applications). The admissions rate for admit year 2023 was 4.1% (corresponding to 35 offers of admission), compared to an admissions rate of 8.0% in 2018 (32 offers given). The increase in applications to PiN continued with the recently completed 2024 admissions cycle. PiN received 945 applications and made 29 offers, yielding a record-low admissions rate of 3.1%.

Application Components and Attributes of Strong Applicants

The PiN application consists of a single “statement of purpose” essay, three required letters of recommendation (with the ability to submit an optional fourth letter), academic transcripts, the applicant’s CV, and additional demographic information collected through the application such as the number of months of previous research experience. The GRE is not required or evaluated (scores are not visible to the admissions committee even if submitted). A modified application was released for the Academic Year 2024 admissions cycle in response to the Supreme Court’s ruling (see section below), though we limit this discussion to our previously executed admissions processes.

The goal of the statement of purpose is to evaluate a candidate’s motivations for graduate study and their preparation to embark on independent research, as evidenced by their ability to “think like a scientist.” The prompt for the statement of purpose essay, which is shared across Harvard PhD programs, reads:

Describe your reasons and motivations for pursuing a graduate degree in your chosen degree program, noting the experiences that shaped your research ambitions, indicate briefly your career objectives, and concisely stating your past work in your intended field of study and in related fields. (1000 word limit)

In this essay, strong applicants are able to describe how their scientific interests and experiences have been shaped by their personal backgrounds and are also able to clearly describe their previous research experiences in terms of the research question and importance of that question, their hypotheses and how they tested them, the possible outcomes and what they found, and their interpretations of the observed and possible results. Less competitive applicants omit some or many of these components, or may emphasize the techniques and skills that they learned over discussing the science and their intellectual contributions to the project.

Letters of recommendation are used as additional sources of evidence of applicants’ scientific contributions and potential for success in the lab. Strong letters describe applicants as scientists who have made meaningful intellectual contributions, whereas weaker letters focus on applicants’ technical abilities and cast them as technicians. Applicants are encouraged to solicit letters from faculty who know them well, and especially from previous research advisors. While letters from course instructors can be useful, they are not as impactful as letters from research advisors. Additionally, students are oftentimes unaware of the impact of a missing letter of recommendation. If students have had a substantive research experience and do not include a letter of recommendation from their advisor, this is viewed as problematic unless it is addressed in other parts of the application.

There are no specific course prerequisites for PiN. Rather, the committee assesses the overall strength of the candidate’s academic preparation, especially their science and math coursework. In evaluating academic transcripts, the admissions committee does not apply GPA cutoffs, instead evaluating academic performance holistically. Strong applicants demonstrate that they are able to perform well in rigorous scientific coursework (mostly A’s and B’s), with later coursework considered more than earlier classes (i.e., the committee seeks evidence of an “upward trajectory” if there were lower grades early on). If applicants endured extenuating personal circumstances that made it difficult to maintain a strong GPA, they are encouraged to discuss this in other parts of the application. The overall goal of assessing prior academic performance is to determine whether there is confidence that the applicant will be able to successfully complete the required graduate curriculum.

Finally, the CV is a useful document to provide a summary of, and additional context for, the applicant’s prior experiences and accomplishments. It also provides an opportunity to share other information that could not fit within the essay or other parts of the application. Prospective applicants often worry that scientific publications are a requirement for admission, but that is not the case. Many admitted students do not have prior publications but significant previous research experience is a requirement for admission. Competitive applicants have at least 1-2 full years of research experience, often acquired through a combination of full-time summer undergraduate research and part-time research during the academic year, and/or through full-time post-baccalaureate research for 1-2 years as a research technician or participant in a formal post-baccalaureate training program. Only 30% of matriculating students in the most recent (AY23) PiN class entered PiN directly from their undergraduate studies. For the AY22 class this number was only slightly higher at 33.3% of the matriculating class.

Regardless of whether they acquire their research experience during their undergraduate years or as full-time research assistants or post-baccalaureate researchers, applicants should seek opportunities through which they can

make intellectual contributions to a research project - reading articles, designing experiments, thinking like a

scientist - rather than being just a “pair of hands” in the laboratory. Developing such expertise (and garnering a strong letter of recommendation from the research advisor) often necessitates at least one longitudinal research experience beyond a single summer or semester. While course-based undergraduate research experiences (CUREs) can be valuable, they are insufficient as the sole previous research experience. Some specific opportunities for students to acquire essential research experience are described below.

Admissions Process and Holistic Review Practices

PiN admissions is conducted by a committee of approximately 28 program-affiliated faculty spanning diverse research areas. Students are admitted to the program, not to individual laboratories; as such, applicants do not need to contact faculty of interest before or during the admissions process. The application opens early fall and is due December 1. Late applications are not accepted due to the short timeline for application review. The admissions committee reviews applications using an equity-based holistic review, as described above. Specifically, applicants are evaluated based on their entire application, and committee members value and take into account applicants' diverse backgrounds and experiences. Applicants are not admitted or rejected on the basis of one single part of the application, and no threshold criteria are applied (e.g., for GPA, number of months of research experience, etc.). The Chair of the admissions committee convenes a committee meeting before applications are received to review the process, to describe key features of equity-based holistic review, and to make reviewers aware of potential sources of inequity and bias that can arise during review so as to minimize any potential impact.

Applications are reviewed in two rounds. In the first round, all applications are read by two reviewers who are assessing whether a candidate will be competitive for an interview and/or offer of admission. Approximately 150 applications progress to the second round of review, during which each application is read by an additional four reviewers and detailed comment sheets are collected. In addition to evaluating the strength of applicant's academic preparation, statement of purpose, letters of recommendation, and quality of research experience, reviewers are also asked to score applicants based on their grit and perseverance, their trajectory and potential, the extent to which they have taken advantage of opportunities and exhibited initiative, and their potential contributions to our community. A rubric for all eight criteria is provided to reviewers as a resource. These criteria have been modified from those used by the Fisk-Vanderbilt Bridge Program and reflect attributes that are important for success in research (Stroud et al., 2022).

The admissions committee convenes after the second round of review to discuss candidates and to select approximately 55 applicants to be invited for on-campus interviews in late January. During the interview/recruitment weekend visit to Harvard, applicants have a total of six, 30-minute interviews, five with PiN faculty and one interview with a PiN student. A second admissions committee meeting

is used to determine the approximately 30 candidates who will be offered admission to the program, as well as 10 applicants who will be given a position on the waitlist. Both the applicants' interviews and paper applications are considered in the final admissions decisions.

Changes Following the Supreme Court decision

For the 2024 admissions cycle (open in fall 2023) the application for PhD programs at Harvard was amended to include an additional “personal statement” essay with the following prompt:

A core part of the Harvard Griffin GSAS mission is to identify and attract the most promising students to form a dynamic and diverse community. We are committed to educating individuals who reflect the growing diversity of perspectives and life experiences represented in society today and who will contribute to our commitment to sustain a welcoming, supportive and inclusive environment. Please share how your experiences or activities will advance our mission and commitment. (No longer than 500 words)

While applicants were required to submit answers to the prompt, individual admissions committees had the option to determine whether to consider this additional essay in their admissions review process.

Additionally, while the PiN holistic review rubric does not consider race or ethnicity, the admissions committee previously had access to applicant demographic information (including race and ethnicity) that was collected as part of the application. In response to the Supreme Court decision, race/ethnicity data is now withheld from graduate programs and admissions committees during the review process.

Resources for Applying to and Studying at Harvard

PiN has added an “admissions demystified” section to the program website to help potential applicants navigate and understand the admissions process for the program. The PiN Chair of Admissions and members of the PiN leadership team host PiN-specific virtual open houses for potential applicants to explain the application process and selection criteria, and also participate in larger virtual open houses hosted by the Harvard Integrated Life Sciences consortium that span multiple graduate programs. Another general resource offered by the Harvard Griffin Graduate School of Arts and Sciences' Office of Equity, Diversity, Inclusion and Belonging is the brochure, “Perspective: Resources for Diverse Applicants,” which also demystifies the components of the PhD application and offers advice to applicants.

Applicants can request application fee waivers within the application itself. Participation in one of a number of listed conferences or programs to broaden participation in STEM within the application grants automatic approval of the fee waiver. If an applicant has not participated in any of the programs listed in the application portal, they can select “other” and provide details for any similar programs to request the fee waiver. Additionally, fee waivers may be automatically granted based on applicants' responses to the

questions in the application that probe “disadvantaged status”.

An additional benefit to students admitted to the Harvard Integrated Life Sciences PhD programs (including the neuroscience program) is the Life Sciences Summer Institute. The Life Sciences Summer Institute is a three-week program held before the start of the fall semester that is designed to build community and to support the personal, professional, and scientific development of incoming PhD students. It consists of networking events, panel discussions, academic bootcamp courses, social outings, and professional development workshops.

PREPARING COMPETITIVE APPLICANTS

Despite the fact that collaborative teams comprising a diversity of membership and perspectives unequivocally lead to better scientific outcomes, there are still far too few Black, Latinx, and Indigenous peoples advancing into the STEM workforce and leadership (Whittaker et al., 2015; Layton et al., 2016; Martinez-Acosta and Favero, 2018; Clark and Hurd, 2020). Creating stronger pathways of entry and supporting them in a sustained way is therefore not only desirable, but essential. While there are multiple factors that contribute to retention in STEM, the following continue to be identified as the most impactful, especially on individuals who are underrepresented in STEM: 1) fostering and shaping scientific identity (Espinosa, 2011; Puritty et al., 2017; O'Brien et al., 2020); 2) addressing socio-economic factors that impair retention (Cole and Espinoza, 2008; Asai and Bauerle, 2016; Hurtado et al., 2017); 3) developing an understanding of the scientific climate (Garibay et al., 2013; National Academy of Sciences, Engineering, and Medicine [NASEM], 2020a; Cronin et al., 2021); 4) providing transparency regarding the level of commitment to completing preparation for a STEM career (i.e., time to degree); 5) providing a research environment that is supportive/encouraging while offering sponsorship into scientific networks (Crisp and Cruz, 2009; NASEM, 2020b); and 6) offering high quality faculty mentorship in research while also encouraging professional growth and development within the culture of the discipline (Perna, 2004; Fries-Britt et al., 2010; Museus and Liverman, 2010; Stanton-Salazar, 2010; Hurtado et al., 2017; NASEM 2020b).

Thus, graduate research institutes can leverage the transformative nature of an intensive research training-professional development program, empowering participating scholars to successfully navigate challenges they encounter and equip them with the skills and confidence to succeed within the scientific community (Kindead, 2003; Lopatto, 2004; Hurtado et al., 2017). Undergraduate or postbaccalaureate research experiences that have mentoring as their core value offer a guided approach to navigating a field which has long been competitive, increasing the development of a stronger sense of scientific identity and self-efficacy through the offering of one-on-one interactions with research faculty/scientists who are committed to offering an open, inclusive, and supportive research experience, an approach which has been shown to directly enhance graduate school/professional school

degree aspirations of STEM students (Lopatto, 2007; NASEM, 2019a; Peters et al., 2019; Louten, 2022).

Partnerships with Minority-Serving Institutions (MSIs)

Economists argue that continuing to produce adequate numbers of doctoral recipients is vital to growth. A graduate degree will become the new bachelor's degree, as a highly skilled workforce will be vital to our technological and economic growth as a nation. Graduate education then is a strategic national asset. At the same time, demographics in the US are changing, with 50.5% women in population currently and a projection that, in 40 years, the US will become more racially and ethnically diverse; these demographics are underrepresented in most STEM disciplines. We are challenged to develop the workforce needed for technological advances. There remains an urgent need to build, maintain the pipeline, attract, retain, educate, and graduate underrepresented graduate students. Some of the major barriers that stop the “upward flow” of students from underrepresented backgrounds through the academic pipeline are: unwelcoming research environments, poor or insufficient mentorships, and uninspiring introductory courses.

If we are going to successfully train the next generation of scientists, which will largely be from underrepresented backgrounds, then we must develop strategic initiatives for recruiting and training these students. HBCUs and MSIs have enrolled over 20 percent of all college students in the United States, and for decades they have been doing the majority of the work of educating and empowering minority and low-income students. HBCUs and MSIs are institutions that offer learning environments which are supportive and culturally responsive to students who are from marginalized backgrounds. So, it makes sense that these institutions should be places of recruitment efforts for graduate institutions who would like to diversify their student body – through early identification programs, which identify talented undergraduates for participation in undergraduate research programs, post-baccalaureate programs, and ultimately graduate programs.

While these recruitment partnerships have offered opportunities to students attending HBCUs/MSIs, the relationships between the HBCU/MSI and the research institute are often broken or loosely coupled (Posselt et al., 2021). It has been demonstrated that when a true alliance is formed between institutions with larger resources to support research training and institutions with limited resources, the outcomes are far reaching. Instead of offering support to one individual at a time, the support of the low resourced institution grows through synergistic interactions and collaborations between faculty, increased access to equipment and data analysis support, potential for curricular support, and opportunities for graduate students or post-docs to train as lecturers, just to name a few. This bi-directional approach to sharing of resources and mentoring needs, ultimately builds more intentional relationships between institutions with the ultimate goal of breaking down barriers so that students from marginalized populations have a deeper sense of belonging in the research environment. Indeed, a recent report from the National

Academies highlights MSIs as a critical, yet under-resourced, mechanism to strengthen the STEM workforce (NASEM, 2019b).

The Morehouse And Harvard Partnership In Neuroscience Growth (MAHPING, <https://projects.iq.harvard.edu/mahping/>) is an example of a cross-institutional partnership - between Harvard Medical School (HMS) and Morehouse School of Medicine (MSM) - that consciously prioritizes bi-directionality in its research and education programming. Current MAHPING initiatives include collaborative educational programming between the BS/MS Program in Neuroscience at MSM (<https://www.msm.edu/Education/neurobiology/BSMSprogram/>) and the Harvard PiN and PiNBAC programs; a cross-institutional, team-taught "Explorations in Neuroscience" course for undergraduates at Spelman College, Morehouse College, and Clark Atlanta University; and a Pedagogy Fellows program to train graduate and postdoctoral trainees at HMS, MSM, and Emory University in inclusive teaching practices. In recent years MAHPING has hosted cross-institutional science programming including a virtual symposium on circadian neurobiology and sleep. The program also seeks to catalyze exchange and establish cross-institution research collaborations through travel funds that enable HMS and MSM faculty to visit the partner campus. MAHPING activities have been made possible through funding by the NIH, the Simons Foundation, and an institutional award at HMS. We encourage academic institutions, federal funding agencies, and private foundations to continue to offer funding mechanisms that enable the creation and sustained success of partnerships with HBCUs/MSIs.

Louis Stokes for Minority Participation Alliances

The National Science Foundation's Louis Stokes Alliance for Minority Participation (LSAMP, <https://new.nsf.gov/funding/opportunities/louis-stokes-alliances-minority-participation>) offers funding to colleges and universities for the support of students who are historically underrepresented in STEM. LSAMP alliances offer curriculum-based interventions and research experiences, based on the Tinto model for student retention (Tinto, 2005). The LSAMP model offers multiple pathways of support, at the community college level, LSAMP Bridges to Baccalaureate programs provide mentorship and training to students receiving associates degrees so they successfully transition to four-year colleges/universities. The sharing of resources between the four year and two year institutions provides an opportunity for students to develop a sense of belonging in a space that will offer their next level of training. LSAMP Implementation Only Alliances and Research Alliances offer support to students at four year colleges either through early career curricular interventions or through immersion in rich research opportunities at one of the institutions held within the alliance. Thus, LSAMPs offer a model for the pooling of resources between institutions for the broadening participation of students who are underrepresented in STEM. In 2021, the LSAMP program celebrated 30yrs of support offered to students who have been historically

underrepresented in STEM across the country.

Industry and Foundation Partnerships

With a growing number of students from historically underrepresented cultural backgrounds choosing to attend Minority Serving Institutions and Historically Black Colleges and Universities, it seems appropriate that industry partners and foundations invest resources in STEM programs and departments at HBCUs and MSIs to aid in the development of the next generation of scientists. One example of this investment is the support offered by the Grass Foundation to fund outreach programs at the K-12/undergraduate levels as well as workshops for faculty teaching physiology at minority serving institutions. Programs supported by the Grass Foundation have offered hands-on science experiences to students in Puerto Rico and in Arizona using Backyard Brains human physiology and animal physiology recording devices to get students excited about STEM (Bravo-Rivera, 2018; Ramadan and Ricoy, 2023). Taking science to the students while also teaching the teachers ensures that the impact of the investment will continue beyond the one class of students participating in the workshop. Likewise, the ADInstruments corporation has long offered a workshop to college educators that inspires creativity in the physiology classroom. CrawFly is an international teaching workshop that is sponsored by Cornell University and ADInstruments which offers instruction to neuroscience educators for teaching basic physiological recording techniques using invertebrates. ADInstruments has most recently made efforts to bring the CrawFly team to San Antonio, TX which is situated in close proximity to multiple minority serving institutions in central Texas where faculty are eligible to receive competitive scholarships to attend. Meeting educators in their geographic region to offer guidance on teaching strategies broadens the support needed to increase the likelihood that students in lower resourced schools will have meaningful experiences in the laboratory that support skill development and sense of belonging within the field of neuroscience.

Undergraduate Broadening Participation Programs

One significant way to promote paths into PhD programs is by structured broadening participation programs, such as the NINDS Blueprint ENDURE programs (<https://neuroscienceblueprint.nih.gov/training/endure-undergraduate-education>). These programs are specifically designed to provide underrepresented students with "training at the undergraduate level, so that they are prepared to enter and successfully complete neuroscience Ph.D. programs." Most of these programs are centered around a summer REU, in which students conduct research at their home university or a partner university. Several programs focus on transfer students at large universities, who experience additional significant barriers to STEM careers (Townsend, 2008; Jackson and Laanan, 2015; Zuckerman and Lo, 2021). Importantly, the ENDURE programs are focused on long-term growth of students — generally over two years, and include significant mentorship components.

One of the BP-ENDURE programs, STARTneuro

(<http://startneuro.ucsd.edu>), began in 2020 with the goal of serving diverse transfer students at UC San Diego who were interested in neuroscience research. Each year, a cohort of 10 students begins the program with an 8-10 week summer research experience to provide them with the technical skills and cultural capital to both make headway into research and to adapt to life on campus. While this program is still underway, several students who have completed the program are on their way into PhD career paths in neuroscience and other fields, demonstrating the power of such programs to open up doors for underserved students. A previous version of this program (separate from ENDURE but with a similar structure), showed substantial gains in students' research self-efficacy and knowledge of scientific career pathways (Zuckerman et al., 2022).

Post-Baccalaureate Training Programs

Another valuable pathway into graduate study is post-baccalaureate research experience. While several PhD applicants attain this experience through employment as research assistants, structured post-baccalaureate training programs supplement the intensive research experience with additional professional development programming, mentorship structures, and sometimes formal coursework. The NIGMS Postbaccalaureate Research Education Program (PREP, <https://nigms.nih.gov/training/PREP>) funding mechanism has supported a number of programs to develop a diverse pool of trainees who will transition to doctoral degree programs (including PhD and MD/PhD) in the biomedical sciences (Remich et al., 2016; Schwartz et al., 2020). One such program is the Research Scholar Initiative (RSI, <https://gsas.harvard.edu/program/research-scholar-initiative>) at Harvard University, which has a very successful track record of preparing trainees for graduate school, including in the neurosciences. More recently, NINDS created funding for Neuroscience Doctoral Readiness (DR.) programs, two-year postbaccalaureate training programs specifically in the neurosciences to train a diverse cadre of trainees who graduated from undergraduate institutions with limited research opportunities (<https://www.ninds.nih.gov/funding/training-career-development/diversity-awards/nih-neuroscience-doctoral-readiness-program-dr-program>).

One of the six currently funded NINDS programs through the DR. mechanism is the Program in Neuroscience Post-Baccalaureate program (PiNBAC, <https://www.pinbac.org/>) at Harvard Medical School. Alumni from the program thus far have successfully matriculated to top neuroscience PhD programs across the country. The current program is anchored by a weekly core course that features a mix of four types of complementary sessions: a Neuroscience Spotlight session that features research and researchers in the field, a Paper Discussion class to dissect primary literature, an "In the Lab" session to discuss concepts related to experimental rigor and skills to successfully navigate the lab environment, and a Professional and Career Development session to provide critical career development, especially as pertaining to the graduate program application process. Additional programmatic components include mentorship "pods" consisting of a PiN faculty member and PiN graduate

students, semiannual research presentations to program leadership and their pods, the opportunity to present to the Harvard neuroscience community at a public symposium, participation in a peer-mentoring program to prepare their applications for the National Science Foundation Graduate Research Fellowship Program (NSF GRFP), and cohort-building activities. Building on previous research and similar efforts to broaden participation in STEM (e.g., Maton et al. 2016, Zuckerman et al. 2022), programmatic elements have been designed to increase students' research self-efficacy, scientific identity, and sense of belonging within the scientific community.

The structure and goals of PiNBAC are similar to other programs that are more broadly situated in biology. For example, "Empowering New Graduates to Access Graduate Education in Biology," or ENGAGE-Bio (<https://www.mbl.edu/education/postbaccalaureate-program>), is a post-baccalaureate program that has recently been developed at the Marine Biological Laboratory with a grant from the Sloan Foundation. It is designed to support underrepresented post-baccalaureate scholars' full immersion in a year-long intensive independent research experience at the MBL in Woods Hole, Massachusetts. While enrolled in the program, scholars will also engage in leadership training and career development opportunities with the goal of successfully advancing to graduate programs in STEM sciences. One of the hallmarks of the program is the recruitment of individuals from minority serving institutions (MSIs) from specific geographic hubs - Boston, Atlanta, San Antonio, Puerto Rico, and San Diego to the MBL. An assembled Advisory Committee, composed of STEM faculty from minority serving institutions (MSIs) within the target hubs, will offer guidance for interactions with hub institutions that foster partnerships between faculty at the target hubs and faculty at the MBL. These partnerships will support scholars recruited to the postbac program as they take steps toward graduate careers. ENGAGE-Bio is a year-long, scholar-centered program founded on four pillars identified as interventions to increase representation in STEM: research experience, mentoring, professional development, and student support. As an institution, the MBL remains an ideal setting to accomplish these goals. Leveraging its core scientific resources with its year-round research programs in areas such as ecosystems science, regenerative biology, microbiology, neuroscience, and optical physics/imaging, the MBL is well positioned to offer an array of mentored, hands-on research experiences for the ENGAGE-Bio scholars. The MBL uniquely offers opportunities to conduct research in these areas while living in a marine and coastal environment, taking advantage of emerging and existing marine and aquatic organisms for biological research, in a highly collaborative and entrepreneurial environment where an array of innovative technologies is being developed at an ever-increasing pace.

CLOSING THOUGHTS AND ADVICE FOR UNDERGRADUATE EDUCATORS

Undergraduate educators play a critical role in preparing the next generation of neuroscientists and can empower their trainees to successfully navigate a changing graduate

admissions landscape in a number of ways. By familiarizing themselves with trends and processes in graduate admissions (such as those described here), they can help students realistically assess their preparation and competitiveness for graduate school and provide guidance on the specific programs to which students should apply. We have compiled additional resources on the topic of graduate admissions in Appendix B. We also encourage undergraduate educators to connect with colleagues in the graduate education space to learn the nuances of specific PhD programs and institutional environments, as well as to learn about institution-specific resources such as virtual open houses and application assistance programs. Drs. Tan and Tomaszewski welcome these connections. Undergraduate educators should connect students to the broader collection of wonderful resources and programs (including those in Appendix B) designed to help applicants navigate the graduate admissions process, and should demystify the process of graduate admissions for mentees.

Educators and mentors of undergraduates should continue to teach critical scientific thinking and emphasize scientific independence in the laboratory wherever possible. CUREs remain a powerful educational tool to excite trainees about science and to engage them in the research process, even if they may be insufficient as the sole research experience for admission to PhD programs. Fortunately, a variety of high-quality training programs to provide additional research experience to students exist, and faculty at primarily undergraduate institutions are important partners in identifying students who would be good candidates for the wide array of training programs to broaden participation in STEM, including those mentioned in this article. We encourage undergraduate educators to identify and connect with the directors of such programs, and to help advertise these training opportunities to their students. As described above, the changing legal landscape around admissions underscores the importance of recruiting diverse applicant pools for both pre-PhD and graduate training programs. Undergraduate educators and professional networks like Faculty for Undergraduate Neuroscience (FUN) will continue to be critical in those efforts.

REFERENCES

- Association of American Medical Colleges (2024) Professional Service – Holistic Review. Washington, DC: Association of American Medical Colleges Available at <https://www.aamc.org/services/member-capacity-building/holistic-review>.
- Akil H, Balice-Gordon R, Cardozo DLL, Koroshetz W, Posey Norris SMM, Sherer T, Sherman SM, Thiels E (2016) Neuroscience Training for the 21st Century. *Neuron* 90:917–926. doi: 10.1016/j.neuron.2016.05.030
- Asai D and Bauerle C (2016) From HHMI: doubling down on diversity. *CBE Life Sci Educ* 15(3):fe6,1-3. doi: 10.1187/cbe.16-01-0018
- Bravo-Rivera C, Díaz-Ríos M, Aldarondo-Hernández A, Santos-Vera B, Ramos-Medina L, De Jesús-Burgos, Bravo-Rivera H, Torrado A, Cabezas-Bou E, Cruz-Lopez F, Colón-Mercado J, Otero-Rivera J, Rolon-Reyes K, Mendez-Gonzalez M, Ferrer-Acosta Y, and Quintero-Martinez Z (2018) NeuroBoricuas: a novel approach for incorporating neuroscience education in schools of Puerto Rico. In: Proceedings of 4th International Conference on Higher Education Advances (HEAD'18), pp 1447-1455. Valencia, Spain: Universitat Politècnica de València. doi: 10.4995/HEAD18.2018.8223
- Clark US, Hurd YL (2020) Addressing racism and disparities in the biomedical sciences. *Nat Hum Behav* 4:774–777. doi: 10.1038/s41562-020-0917-7
- Coalition for Next Generation Life Science (2023) Data for a stronger workforce. Available at <https://nglcoalition.org/coalition-data/>.
- Cole D, Espinoza A (2008) Examining the Academic Success of Latino Students in Science Technology Engineering and Mathematics (STEM) Majors. *Journal of College Student Development*. 49. 285-300. doi: 10.1353/csd.0.0018
- Coleman AL, Keith JL (2018) Understanding Holistic Review in Higher Education Admissions: Guiding Principles and Model Illustrations. New York, NY: College Board. Available at <https://highereducationboard.org/media/pdf/understanding-holistic-review-he-admissions.pdf>.
- Crisp, G. and Cruz, I (2009) Mentoring College Students: A critical review of the literature between 1990 and 2007. *Research in Higher Education* 50:525-545. doi: 10.1007/s11162-009-9130-2
- Cronin, M.R., Alonzo, S.H., Adamczak, S.K. et al (2021) Anti-racist interventions to transform ecology, evolution, and conservation biology departments. *Nat Ecol Evol* 5:1213–1223. doi: 10.1038/s41559-021-01522-z
- De Los Reyes, A., Uddin, L.Q. Revising evaluation metrics for graduate admissions and faculty advancement to dismantle privilege (2021) *Nat Neurosci* 24:755–758. doi: 10.1038/s41593-021-00836-2
- Department of Justice and Department of Education (2023) Questions and answers regarding the supreme court's decision in Students for Fair Admission, Inc. v Harvard College and University of North Carolina. Available at https://www.justice.gov/d9/2023-08/post-sffa_resource_faq_final_508.pdf.
- Equity in Graduate Education Resource Center (n.d.) Los Angeles, CA" University of Southern California. Available at <https://equitygraded.org/>.
- Espinosa LL (2011) Pipelines and pathways: Women of color in undergraduate STEM 2011 majors and the college experiences that contribute to persistence. *Harvard Educational Review*, 81(2):209-240. doi: 10.17763/haer.81.2.92315ww157656k3u
- Feldon DF, Litson K, Cahoon B, Feng Z, Walker A and Tofel-Grehl C (2023) The Predictive Validity of the GRE Across Graduate Outcomes: A Meta-Analysis of Trends Over Time. *The Journal of Higher Education* 95:120-148. doi: 10.1080/00221546.2023.2187177
- Fries-Britt S, Younger T, and Hall W (2010) Underrepresented minorities in physics: How perceptions of race and campus climate affect student outcomes. In: *Managing diversity: (Re)visioning equity on college campuses* (Dancy TE ed), pp 181-198. New York, NY: Peter Lang Publishing.
- Garibay JC, Hughes BE, Eagan MK, Hurtado S (2013) Beyond the bachelor's: What influences STEM post-baccalaureate pathways. In: *Proceedings of Association for Institutional Research Annual Forum*, May 2012, Long Beach, CA. Tallahassee, FL: Association for Institutional Research.
- Hall JD, O'Connell AB, Cook JG (2017) Predictors of Student Productivity in Biomedical Graduate School Applications *PLoS ONE* 12:e0169121. doi: 10.1371/journal.pone.0169121
- Hurtado S, White-Lewis D, Norris K (2017) Advancing inclusive science and systemic change: the convergence of national aims and institutional goals in implementing and assessing biomedical science training. *BMC Proceedings* 11(Suppl 12):17. doi: 10.1186/S12919-017-0086-5
- Jackson DL, Laanan FS (2015) Desiring to Fit: Fostering the Success of Community College Transfer Students in STEM.

- Community College Journal of Research and Practice 39:132–149. doi: 10.1080/10668926.2012.762565
- Jones-London M (2020) NINDS strategies for enhancing the diversity of neuroscience researchers. *Neuron* 107:212–214. doi: 10.1016/j.neuron.2020.06.033
- Kent, J.D. and McCarthy, M.T (2016) Holistic Review in Graduate Admissions: A Report from the Council of Graduate Schools. Washington, DC: Council of Graduate Schools. Available at <https://cgsnet.org/report/innovation-in-graduate-admissions-through-holistic-review>.
- Kindead J (2003) Learning through inquiry: An overview of undergraduate research. *New Directions for Teaching and Learning* 2003(93):5–17. doi: 10.1002/tl.85
- Langin K (2022) 'GRExit' gains momentum as Ph.D. programs drop exam requirement. *Science* 378(6623): 936–937. doi: 10.1126/science.caredit.adg0534
- Layton RL, Brandt PD, Freeman AM, Harrell JR, Hall JD, Sinche M (2016) Diversity Exiting the Academy: Influential Factors for the Career Choice of Well-Represented and Underrepresented Minority Scientists. *CBE Life Sci Educ* 15(3):ar41. doi: 10.1187/cbe.16-01-0066
- Lopatto D (2004) Survey of undergraduate research experiences (SURE): First findings. *Cell Biology Education* 3(4):270–277. doi: 10.1187/cbe.04-07-0045
- Louten J (2022) Fostering Persistence in Science, Technology, Engineering, and Mathematics (STEM): creating an equitable environment that addresses the needs of undergraduate students. *J Coll Stud Retent Res Theory Pract* 26(1):1–20. doi: 10.1177/15210251211073574
- Lu A, Elias J, June AW, Charles JB, Hall E, Huiskes H, Marijolic K, Roberts-Grmela J, Schermele Z, and Surovell E (2023) DEI Legislation Tracker. The Chronicle of Higher Education, July 14. Available at https://www.chronicle.com/article/here-are-the-states-where-lawmakers-are-seeking-to-ban-colleges-dei-efforts?cid=gen_sign_in.
- Martinez-Acosta VG, Favero CB (2018) A Discussion of Diversity and Inclusivity at the Institutional Level: The Need for a Strategic Plan. *J Undergrad Neurosci Educ* 16(3):A252–A260. PMID: 30254540; PMCID: PMC6153014.
- Maton KI, Beason TS, Godsay S, Sto.Domingo MR, Bailey TC, Sun S, Hrabowski III FA (2016) Outcomes and processes in the Meyerhoff scholars program: STEM PhD completion, sense of community, perceived program benefit, science identity, and research self-efficacy. *CBE Life Sciences Education* 15(48):1–11.
- Miller C, Stassun K (2018) A test that fails. *Nature* 510:303–304. doi: 10.1038/nj7504-303a
- Moneta-Koehler L, Brown AM, Petrie KA, Evans BJ, Chalkley R (2017) The Limitations of the GRE in Predicting Success in Biomedical Graduate School. *PLoS ONE* 12:e0166742.
- Museus SD and Liverman D (2010) High-performing institutions and their implications for studying underrepresented minority students in STEM. *New Directions for Institutional Research*, 2010(148):17–27. doi: 10.1002/ir.358
- National Academies of Sciences, Engineering, and Medicine (2019a) The Science of Effective Mentorship in STEM. Washington, DC: The National Academies Press. doi: 10.17226/25568
- National Academies of Sciences, Engineering, and Medicine (2019b) Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce. Washington, DC: The National Academies Press. doi: 10.17226/25257
- National Academies of Sciences, Engineering, and Medicine (2020a) The impacts of racism and bias on black people pursuing careers in science, engineering, and medicine: Proceedings of a workshop. Washington, DC: The National Academies Press. doi: 10.17226/25849
- National Academies of Sciences, Engineering, and Medicine (2020b) Promising practices for addressing the underrepresentation of women in science, engineering, and medicine: Opening doors. Washington, DC: The National Academies Press. doi: 10.17226/25585
- National Center for Science and Engineering Statistics (2021) Doctorate Recipients from U.S. Universities: 2021. NSF 23-300. Alexandria, VA: National Science Foundation. Available at <https://ncses.nsf.gov/pubs/nsf23300>.
- O'Brien LT, Bart, HL, and Garcia DM (2020) Why are there so few ethnic minorities in ecology and evolutionary biology? Challenges to inclusion and the role of sense of belonging. *SocPsychol Educ* 23:449–477. doi: 10.1007/s11218-019-09538-x
- Perna LW (2004) Understanding the decision to enroll in graduate school: Sex and racial/ethnic group differences. *Journal of Higher Education* 75(5):487–527. doi: 10.1353/jhe.2004.0032
- Peters, A. W., Tisdale, V. A., and Swinton, D. J (2019) High-impact educational practices that promote student achievement in STEM. *Broadening Participation in STEM (Diversity in Higher Education)* 22:183–196. doi: 10.1108/S1479-364420190000022008
- Posselt JR (2018) Inside Graduate Admissions: Merit, Diversity, and Faculty Gatekeeping. Cambridge, MA: Harvard University Press.
- Posselt J., Baxter K., and Tang W (2021) Assessing the Landscape for Diversity, Equity, and Inclusion Efforts in U.S. STEM Graduate Education. Los Angeles, CA: University of Southern California, Pullias Center for Higher Education.
- Puritty C, Strickland LR, Alia E, Blonder B, Klein E, Kohl MT, McGee E, Quintana M, Ridley RE, Tellman B, and Gerber L (2017) Without inclusion, diversity initiatives may not be enough. *Science* 357(6356):1101–1102. doi: 10.1126/science.aai9054
- Ramadan B and Ricoy UM (2023) The NEURON Program: Utilizing Low-Cost Neuroscience for Remote Education Outreach. *J Undergrad Neurosci Educ* 21(2):A126–A132. doi: 10.59390/HMMK4371. PMID: 37588648; PMCID: PMC10426826.
- Remich R, Naffziger-Hirsch ME, Gazley JL, McGee R (2016) Scientific Growth and Identity Development during a Postbaccalaureate Program: Results from a Multisite Qualitative Study. *CBE Life Sci Educ* 15(3):ar25. doi: 10.1187/cbe.16-01-0035. PMID: 27496357; PMCID: PMC5008872.
- Sanchez KA, Bevan AJ, Vita AA, Royse EA, Januszkiwicz E, Holt EA (2023) Grit matters to biology doctoral students' perception of barriers to degree completion. *Journal of Biological Education*:1–24.
- Schwartz NB, Risner LE, Domowicz M, Freedman VH (2020) Comparisons and Approaches of PREP Programs at Different Stages of Maturity: Challenges, Best Practices and Benefits. *Ethn Dis* 30(1):55–64. doi: 10.18865/ed.30.1.55. PMID: 31969784; PMCID: PMC6970524.
- Society for Neuroscience (2017) Report for Neuroscience Departments & Programs Survey (Academic Year 2016–2017). Washington, DC: Society for Neuroscience. Available at <https://www.sfn.org/-/media/SfN/Documents/Survey-Reports/NDP-Final-Report.ashx>
- Stanton-Salazar RD (2010) A social capital framework for the study of institutional agents and their role in the empowerment of low-status students and youth. *Youth & Society* 43:1066–1109. doi: 10.17763/haer.67.1.140676g74018u73k
- Stroud D, Tanenbaum C, Roby R, Campbell EPC, Holley-Bockelmann K, Burger A (2022) Fisk-Vanderbilt Master's-to-PhD Bridge Program: A guide to building bridges. Nashville, TN: Fisk-Vanderbilt LSAMP Regional Center of Excellence.
- Supreme Court of the United States (2023) Students for Fair Admissions, Inc. v. President and Fellows of Harvard College,

- No. 20-1199 & Students for Fair Admissions, Inc. v. University of North Carolina et al., No. 21-707. Washington, DC: The Supreme Court of the United States. Available at https://www.supremecourt.gov/opinions/22pdf/20-1199_hgdj.pdf.
- Tinto, V (2005) Reflections on retention and persistence: Institutional actions on behalf of student persistence. *Studies in Learning, Evaluation, Innovation and Development* 2(3):89-97. doi: 10.5204/ssj.v8i2.376
- Townsend BK (2008) "Feeling like a freshman again": The transfer student transition. *New Directions for Higher Education* 2008:69-77. doi: 10.1002/he.327
- Weiner OD (2014) How should we be selecting our graduate students? *Mol Biol Cell* 25(4):429-430. doi: 10.1091/mbc.E13-11-0646
- Whittaker JA, Montgomery BL, Martinez-Acosta VG (2015) Retention of Underrepresented Minority Faculty: Strategic Initiatives for Institutional Value Proposition Based on Perspectives from a Range of Academic Institutions. *J Undergrad Neurosci Educ* 13(3):A136-45.
- Zuckerman AL, Lo SM (2021) Transfer student experiences and identity navigation in stem: Overlapping figured worlds of success. *CBE Life Sci Educ* 20:ar48, 1-24. Available at <https://www.lifescied.org/doi/abs/10.1187/cbe.20-06-0121>.
- Zuckerman AL, Juavinett AL, Macagno ER, Bloodgood BL, Gaasterland T, Artis D, Lo SM (2022) A case study of a novel summer bridge program to prepare transfer students for research in biological sciences. *Disciplinary and Interdisciplinary Science Education Research* 4:27.

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APPENDIX A

APPLICATION COUNT	2018	2019	2020	2021	2022	2023
Case Western Neuroscience		405	536	555	696	
Emory BBS Neuroscience	291	367	326	302	313	341
Harvard Program in Neuroscience	402	518	683	655	680	845
Johns Hopkins Neuroscience	398	514	599	522	425	556
MIT Brain & Cognitive Sciences	653	584	556	723	682	800
Northwestern Interdepartmental Neuroscience	280	322	359	319	343	
NYU Neural Science	495	478	445			
Stony Brook University Neuroscience	67	61	54	86	83	95
UCLA Neuroscience	378	444	397	493	468	527
UC San Diego Neuroscience	565	509	560	655	650	
UCSF Neuroscience	403	497	527	491	460	362
University of Chicago Neurobiology	182	184	192	182	159	216
University of Illinois Neuroscience		78	71	82	89	108
University of Pennsylvania Neuroscience				557	566	521
University of Wisconsin Neuroscience	158	197	223	225	177	
AVERAGE	352	378	385	414	393	427
PERCENT ADMITTED	2018	2019	2020	2021	2022	2023
Case Western Neuroscience		19.75	15.86	16.58	14.22	
Emory BBS Neuroscience	13.00	12.00	13.00	16.00	17.89	16.42
Harvard Program in Neuroscience	7.96	5.98	4.25	4.43	4.85	4.14
Johns Hopkins Neuroscience	11.00	10.00	9.00	12.00	10.00	9.89
MIT Brain & Cognitive Sciences	5.70	6.00	5.80	4.00	3.81	3.63
Northwestern Interdepartmental Neuroscience Program	15.00	16.00	14.00	16.00	17.00	
NYU Neural Science	4.00	4.00	4.00			
Stony Brook University	22.39	21.31	38.89	22.09	32.53	25.26
UCLA Neuroscience	10.00	10.00	11.00	8.00	8.00	5.69
UC San Diego	9.03	9.63	9.64	8.70	8.00	
UCSF Neuroscience	9.90	7.80	6.80	7.50	7.80	12.98
University Of Chicago Neurobiology	12.10	10.30	9.40	11.50	14.47	10.19
University Of Illinois		12.82	19.72	32.93	20.22	14.81
University Of Pennsylvania Neuroscience				7.70	9.00	10.20
University Of Wisconsin Neuroscience	15.20	14.70	13.90	16.90	13.56	
AVERAGE	11.27	10.81	12.26	12.90	12.86	11.32

APPENDIX B

Graduate Admissions Resources

- [NIH Diversity & Inclusion Guide](#)
- [CGS Holistic Review in Graduate Admissions Report](#)
- [Equitable Practices for Writing, Reading, and Soliciting Letters of Recommendation](#)
- [Fisk-Vanderbilt Bridge Program toolkit](#) (complete a brief request form on site for download)
- NINDS Workshop Materials: [“Activating a Neural Network: Admissions Strategies to Increase Diverse Trainees”](#)
- [“Inside Graduate Admissions,”](#) Julie R. Posselt
- [“So you want to be a neuroscientist?”](#) Ashley Juavinett
- [Inclusive Graduate Education Network \(IGEN\)](#)
- [Neuroscience PhD Program Fee Waivers](#)
- [NGLS Coalition Data](#)
- [AAAS webinar on SCOTUS ruling](#)
- [“Two Cautions for Educators to Consider in the Aftermath of Affirmative Action Decisions”](#)
- Campaign for College Opportunity [resources](#) & [webinar](#)

Graduate Application Resources

- [Project Short](#) (provides free mentor program to applicants)
- [Científico Latino](#) (Large number of resources related to PhD applications and grad school, including its own free mentorship program for the application process & databases for summer research and post-bac programs)
- [NINDS Building Up The Nerve podcast](#) (many topics, including those relevant to preparing for and succeeding in graduate school)
- Grad school interviews:
 - [How to Ace Your Graduate School Interview: Communicating Your Research Competently and Confidently \(Científico Latino\)](#)
 - [Preparing for Graduate School Interviews](#)
 - [Preparing for Virtual Graduate School Interviews \(NIH OITE, video\)](#)
 - [Tips for Graduate School Interviews \(SfN Neuronline\)](#)
 - [10 Tips for Graduate School Virtual Interviews \(SfN Neuronline\)](#)
 - [Navigating STEM Graduate School Interviews as a Marginalized Trainee \(Robin Aguilar\)](#)
 - [“To ace your Ph.D. program interviews, prepare to answer—and ask—these key questions” \(Science Careers\)](#)
 - [Questions you might want to ask during your PhD interviews](#)