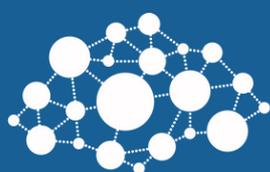


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# Postdoctoral Hiring & Equity Issues in STEM: Employment Trends, Policy, and Research



**IGEN**

Inclusive Graduate Education Network

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## BACKGROUND



Postdoctoral training is integral to individual career trajectories in STEM fields, the development of the STEM labor market, as well as its capacity to advance science and drive innovation (1–5). The National Academy of Sciences, National Academy of Engineering, and Institute of Medicine have described postdoctoral appointments as “a virtual prerequisite” (6) for research careers in industry, government, and the nonprofit sector. In the pipeline for faculty appointments, postdoctoral positions are a critical filter as assistant professors at research-intensive universities are almost universally drawn from postdoctoral scholars trained at prominent research-intensive universities (7, 8).

Because the postdoctoral stage of STEM careers exerts a gatekeeping effect, the practices by which postdocs are hired directly limit the composition of the STEM labor force and the next generation of scientists (7, 9–12).

Inequities in postdoctoral hiring reflect and contribute to inequities in the scientific labor force more broadly. Although their positions are usually temporary, postdoctorates comprise a substantial proportion of the STEM research workforce and conduct a large share of the work generating laboratory productivity (2). These researchers are a highly educated and productive, yet relatively inexpensive, source of labor compared to graduate students and staff scientists (7, 13–15).

**“ THE COMPOSITION OF THE POSTDOC LABOR FORCE – ITS DIVERSITY OR LACK THEREOF – DIRECTLY IMPACTS THE SCIENCE THAT IS CURRENTLY CONDUCTED AND ITS POTENTIAL FOR INNOVATION, AS WELL AS THE MAKEUP OF ITS FUTURE LEADERSHIP. ”**

Moreover, postdoctoral scholars often act as direct supervisors for students in research labs and, compared to faculty, provide more frequent and hands-on support to graduate students, particularly those who are racially/ethnically minoritized (16). Postdocs are also observable role models and more accessible mentors for undergraduate and graduate students, which is “crucial for encouraging and supporting the next generation of STEM professionals” (12). Therefore, the composition of the postdoc labor force – its diversity or lack thereof – directly impacts the science that is currently conducted and its potential for innovation, as well as the makeup of its future leadership.

Despite its potential impact, postdoctoral hiring has not received much attention from either higher education or labor market researchers. There is, however, increasing recognition that systematic data collection and empirical analyses of postdoctoral hiring practices are among the most important data elements needed to understand and address inequities in STEM pathways (12). This brief examines the



state of postdoctoral hiring within U.S. research universities by analyzing the trends in postdoc employment among doctorates from U.S. institutions, reviewing relevant policies and research, and identifying themes from empirical studies. Annotations of selected publications are available at <http://bit.ly/EquityGradEd>

## POSTDOCTORAL EMPLOYMENT TRENDS

Based on data from the Survey of Earned Doctorates (SED), the percent of doctorates who transition to postdoctoral positions increased from 21 to 30% between 1980 and 2009 but steadily declined to 24% in 2014. Since then, about one-quarter of doctorates have entered postdoctoral positions directly after U.S. degree completion. Figure 1 shows trends from 1980 to 2018 in percent of STEM doctorates who enter postdoctoral positions by race/ethnicity,<sup>1</sup> gender,<sup>2</sup> citizenship status,<sup>3</sup> and field. We define STEM as including the fields in all areas of science, technology, engineering, and mathematics listed in Panel 5 of Figure 1.

**“ ONE QUARTER OF DOCTORATES HAVE ENTERED POSTDOCTORAL POSITIONS DIRECTLY AFTER U.S. DEGREE COMPLETION. ”**

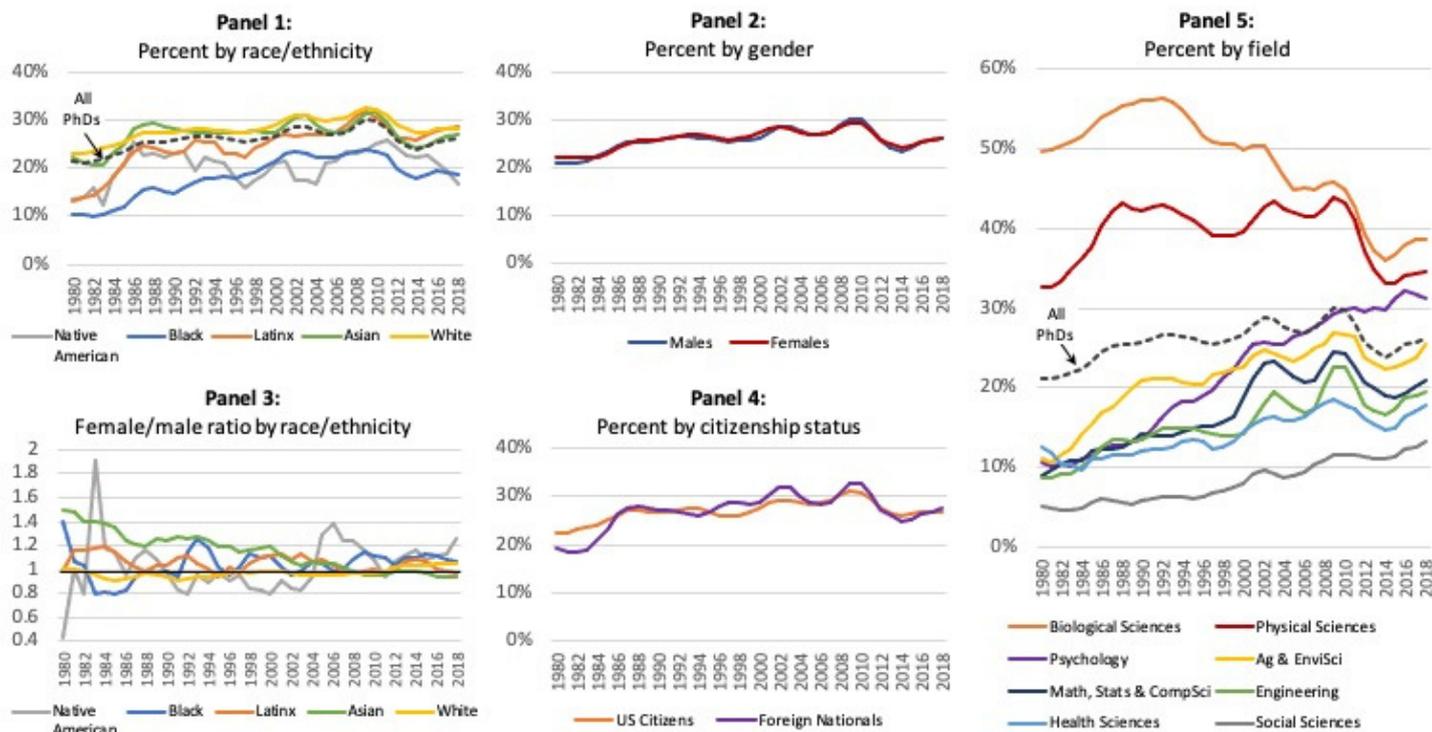
**“ IN 2018, THE PERCENT OF BLACK AND NATIVE AMERICAN DOCTORATES ENTERING POSTDOCTORAL POSITIONS (18.9 AND 16.8%, RESPECTIVELY) WAS 33-41 PERCENT LOWER THAN THE RATE FOR WHITES (28.3%) AND 30-38 PERCENT LOWER THAN THE RATE FOR ASIAN DOCTORATES (27.1%). ”**

Significant racial/ethnic disparities in postdoctoral employment rates have persisted throughout the 38 years included in this analysis (Panel 1). Black and Native American doctorates consistently have lower rates of transition to postdoctoral positions than white and Asian doctorates. The rates for Latinx doctorates were relatively low early in the period but increased to parity with the rates for Asians and whites in the last 12 years. With the exception of this convergence of postdoctoral employment rates for Latinx, white, and Asian doctorates, racial/ethnic gaps have remained significant. In 1980, only 10% of Black doctorates transitioned to postdoctoral positions compared to 13% of Latinx, 14% of Native American doctorates, 23% of white, and 22% of Asian doctorates. In 2018, the percent of Black and Native American doctorates entering postdoctoral positions (18.9 and 16.8%, respectively) was 33-41 percent lower than the rate for whites (28.3%) and 30-38 percent lower than the rate for Asian doctorates (27.1%).

1 The SED category of "Hispanic or Latino" is represented here as "Latinx." Doctorates who identify as multiracial or do not report race or ethnicity are not included in this trend analysis.

2 The SED measures gender identity as a binary construct; a more nuanced operationalization of gender identity is not possible from these data.

3 Permanent residents are included as "U.S. Citizens" in this analysis.

**Figure 1: Percent of doctorates who transition to postdoctoral positions upon U.S. degree completion 1980-2018**

Source: Authors' analysis of Survey of Earned Doctorates (SED) data for the years 1980-2018. Estimates are 3-year moving averages based on respondents who report definite commitments for employment in a postdoctoral position.

Men and women doctorates transitioned to postdoctoral positions in equal proportions throughout the time period (Panel 2), but that aggregate pattern does not hold for all racial/ethnic groups. As shown by the female-to-male ratios presented by race/ethnicity in Panel 3, Asian women were significantly more likely than Asian men to enter postdoctoral positions until the early 2000s when the gap closed and then reversed direction. Since about 2008, Asian male doctorates have transitioned to postdoc employment at slightly higher rates than Asian women. The ratio for whites reflects a slight male advantage in the transition to postdoctoral positions prior to 2000, though that subsequently disappeared and has been replaced with a slight female advantage as of 2012. The female-to-male ratios for Black, Latinx, and Native American postdocs have fluctuated roughly around 1:1

throughout the 38-year period; however, the overall low counts of individuals from these racial/ethnic groups among the annual cohorts of doctoral recipients contributes to the instability of those estimates.

Panel 4 presents rates of transition to postdoctoral employment separately for U.S. citizens and foreign nationals who earned doctorates from U.S. universities. There are small disparities by citizenship status during limited periods; e.g., prior to 1986, foreign nationals were less likely than U.S. citizens to transition to postdoc positions, but that gap reversed direction between 1995 and 2005. Since 2012, U.S. citizens and foreign nationals earning U.S. doctoral degrees have had similar postdoc employment rates.

**“ IN ALL OTHER FIELDS, POSTDOCTORAL POSITIONS GENERALLY BECAME AN INCREASINGLY COMMON CAREER STAGE AMONG NEWLY-MINTED DOCTORATES. ”**



As illustrated in Panel 5, the prevalence of postdoc positions varies significantly across fields and has changed over time. Across the entire 38-year period, the biological and physical sciences were the fields in which doctorates are most likely to enter postdocs, but these also were the only fields to experience sustained declines in postdoc entry rates. Between 1980 and 1993, the rate at which new doctorates in the biological sciences entered postdoctoral positions climbed from 50 to 56%, then it declined to a low of 36% in 2014; this rate rebounded somewhat to 38.6% in 2017. Among physical science doctorates, the percent entering postdoctoral appointments increased from 32 to 43% during the 1980s and remained at 39-43% until 2011 when it steadily declined to rates that were comparable to the early 1980s. In all other fields, postdoctoral positions generally became an increasingly common career stage among newly-minted doctorates. Doctorates in psychology had the most significant and steady increase: In 1980, only 10.6% entered postdoc positions but by 2016 that percentage had risen to 32%.

## POLICY OVERVIEW

Although postdoctoral positions have become an institutionalized stage in the STEM career path and labor force, there is a notable absence of explicit and consistent policy about, guidelines for, and oversight of postdoctoral hiring. Our review of prominent websites, materials, and articles indicates that this characterization applies to federal funding agencies, research universities, and professional associations. As federal funders, the National Institutes of Health (NIH) and National Science Foundation (NSF)

encourage the participation of individuals from underrepresented groups in STEM and have earmarked grants to encourage diversity among postdoctoral scholars (3, 17, 18). While these agencies require mentoring and training plans for postdocs hired using grant funds, neither provides specific guidance for hiring practices or systems of accountability for meeting standards of equity or goals for diversifying the postdoctoral population. The NIH and NSF instead defer to funded researchers and institutions to determine recruitment methods. Hiring guidelines and requirements are lacking even for funds designated to increase diversity, such as the NIH Research Supplements to Promote Diversity in Health-Related Research, which are earmarked to support postdoctoral scholars from underrepresented groups. The supplemental funding is available to Principal Investigators (PIs) post hoc, after the postdoctoral candidate has been identified (18). The problem with this system is that while research-intensive universities are the primary employers of postdoctoral scholars in the U.S., universities typically provide little to any guidance or oversight of postdoctoral hiring. The direct employers are individual researchers who fund the postdoctoral positions from grants obtained externally.



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- 4 Hired postdocs referred to as "employee-postdocs," "postdoctoral researchers," or "postdoctoral associates," are typically funded by research grants, institutional funds, or other financial backing obtained and controlled by labs, research institutes, or individual faculty or researchers. The postdoc hiring market accounts for the vast majority of postdoctoral positions and funding, and its processes are distinct from the processes of open application, competitive review, and selection used to award "independent postdocs" (19). Independently-funded postdocs, who are sometimes referred to as "postdoctoral fellows" or "scholar trainees" (2, 20, 21), control their funding and scholarly activities, in contrast to postdoctoral researchers whose research activities are paid from and directed by a principal investigator's grant.

To compose a current snapshot of university policy on postdoctoral hiring, we investigated the policies at the University of California and the University of Michigan. These research-intensive public universities together employ thousands of postdoctoral scholars each year.<sup>5</sup>

At the **University of California (UC)**, both the system-wide policies and the postdoctoral labor union defer oversight of employment policies to individual campuses and researchers (5, 19).<sup>6</sup> Although all campuses are “encouraged to post postdoctoral positions<sup>7</sup> in order to promote equal opportunity for all candidates,” (5) UC campuses may exempt postdoctoral hires from requirements of public advertisement, formal application, and systematic applicant review (20, 21) that routinely apply to all other academic and non-academic positions. These exemptions, which institutions justify by citing the temporary nature and decentralized funding of postdoctoral positions, exempt campuses from providing support or oversight by granting significant autonomy in the hiring process to the individual faculty and researchers who fund postdoctoral positions.

The **University of Michigan** policies specify requirements aimed at ensuring a standard set of resources are allocated to each postdoctoral position (e.g., salary, fringe benefits, physical space, mentoring, and conflict resolution support) prior to its receiving approval for hiring. Yet requirements for the hiring process are minimal. Rather, the policies cite “the variety of existing post-doctoral programs” as justification for minimal oversight and freedom from institutionally uniform search or selection procedures (22).

Professional associations provide the infrastructure for both the formal advertisement and informal networking that drives postdoctoral hiring conduits, though they may not be engaged in efforts to systematize the postdoc labor market or formalize hiring policies or practices. A search of empirical literature identified only the Association of Postdoctoral Programs in Clinical Neuropsychology (APPCN) as offering an association-sponsored postdoctoral hiring system.<sup>8</sup> Clinical neuropsychology board certification requires completion of a postdoctoral fellowship, and APPCN's centralized match system is intended to facilitate and systematize access to fellowships fulfilling that requirement.



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- 5 As recognized leaders in the advancement of systemic efforts to increase equity and diversity among faculty, the University of California and the University of Michigan are instrumental choices and may not represent the “average” research university's approach to hiring.
  - 6 Both the University of California and the University of Michigan have active President's Postdoctoral Fellowship Programs (PPFP). Because PPFP is a highly competitive and prestigious program that funds a limited number of fellows each year and differs significantly from the majority of postdoctoral positions, we exclude PPFP from our policy review.
  - 7 The channels through which Principal Investigators advertise postdoctoral positions vary greatly and may include the UC system used to manage academic hiring, independent platforms for postdoc recruitment, professional association websites and listservs, as well as personal networks.
  - 8 While APPCN's match system was the only one identified in a search of peer-reviewed studies, a myriad of STEM professional associations exist and may also facilitate postdoctoral recruitments.



A review of postdoctoral recruitment in neuropsychology, however, showed that about one-third of available fellowship programs did not participate in the centralized system, prompting calls for the postdoctoral match system to be reorganized (23).

Federal funding agencies, research universities, and professional associations alike currently lack explicit and consistent policy around postdoctoral hiring. While these organizations each have a stake in the development of STEM researchers, there exists a missed opportunity in identifying promising practices for the recruitment of postdocs.

## EMERGING THEMES ABOUT EQUITY FROM STUDIES OF POSTDOCTORAL HIRING

Given the influence postdoctoral training has on both individual careers and the conduct of science, ensuring equal and inclusive access to, experience during, and placement after postdoctoral positions is key to achieving equity, diversity, and innovation in STEM. Yet the processes that affect access to and participation in postdoctoral training have received limited attention from researchers. The informality and idiosyncratic nature of postdoctoral hiring limits the opportunities to observe and systematically analyze, while the lack of oversight simultaneously makes disparities more likely.

Existing studies have capitalized on available data for a small number of fields within STEM. These studies have been primarily qualitative and have relied on data drawn from documents and websites (10, 13, 14, 23–25) or interviews (7, 10, 13, 14), although a few quantitative studies have analyzed survey data (9, 11, 23, 24, 26), letters of recommendation (25), or fellowship reviewer scores (27). The following themes emerge from the literature and indicate fruitful directions for this developing area of research.

“ **GIVEN THE INFLUENCE POSTDOCTORAL TRAINING HAS ON BOTH INDIVIDUAL CAREERS AND THE CONDUCT OF SCIENCE, ENSURING EQUAL AND INCLUSIVE ACCESS TO, EXPERIENCE DURING, AND PLACEMENT AFTER POSTDOCTORAL POSITIONS IS KEY TO ACHIEVING EQUITY, DIVERSITY, AND INNOVATION IN STEM.** ”





## DISPARITIES EXIST BY GENDER, RACE/ETHNICITY, AND INTERNATIONAL STATUS

Published studies document disparities in postdoc hiring by gender (7, 8, 26), race/ethnicity (28), and international status (11, 13, 14). The available data, however, are insufficient to identify the causal mechanisms, the steps in the hiring process where inequities are most likely, or whether the disparities vary by field. Some scholars attribute the gaps to “persistent gender stereotypes in the construction of the ideal academic” that work against the full participation and consideration of women in STEM (29). This explanation is supported by experimental studies and those using observational data that reveal biases in the evaluation of women and members of underrepresented racial/ethnic groups (25, 27, 28). Historically, women have been more likely than men to enter postdoctoral positions (26) but less likely to attain the most prestigious postdocs (8). International status influences access to informal postdoctoral job search networks, job match quality or ‘fit,’ satisfaction, productivity, and turnover (11), and increases the risk of exploitative employment arrangements (13).<sup>9</sup>

## INTERSECTIONAL INQUIRIES ARE CRITICAL YET RARE

A lens of intersectionality that incorporates cultural and historical contexts, domains and systems of institutional power, and scholars’ multiple social identities is essential for broadening participation in STEM (30). Most studies of postdoctoral hiring, however, lack an intersectional analytic framework despite growing recognition that social categories “simultaneously affect the perceptions, experiences, and opportunities of everyone living in a society stratified along those dimensions” (31). Neglecting intersectionality prevents an accurate and nuanced understanding of social processes, experiences, and outcomes. Studies of postdoctoral hiring generally lack sufficient sample sizes to examine the combined effects of race/ethnicity, gender, and other relevant characteristics, such as citizenship status, academic field, and institutional prestige, which leaves substantial gaps in the postdoctoral hiring literature. Research on disparities in academic (32) and nonacademic STEM employment (33) shows that Black, Latinx, and Asian women experience the combined effects of racial and gender biases in multiple ways that directly impact their careers (28), their disciplines, and the overall STEM enterprise. Further investigations replicating and contextualizing those findings, and addressing intersectionality are needed (34–36).

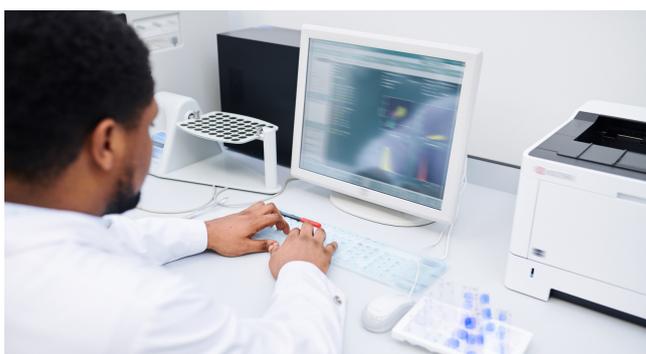
**“RESEARCH SHOWS THAT BLACK, LATINX, AND ASIAN WOMEN EXPERIENCE THE COMBINED EFFECTS OF RACIAL AND GENDER BIASES IN MULTIPLE WAYS THAT DIRECTLY IMPACT THEIR CAREERS, THEIR DISCIPLINES, AND THE OVERALL STEM ENTERPRISE.”**

<sup>9</sup> In order to be competitive within the U.S. academic system, international scholars may be expected to have additional postdoctoral training relative to domestic doctorates. That is, postdoctoral experience may serve as a more critical filter for the labor market prospects of international scientists and engineers and perhaps especially so in a tenure-track faculty search.

## INTERNATIONALIZATION OF THE POSTDOC MARKET IS RELATIVELY UNDERSTUDIED

Research is needed into the potentially racialized causes of foreign doctorates' rising representation among postdoctoral positions. Some speculate that the scarcity of longer-term academic prospects (i.e., tenure-track faculty appointments) and the draw of lucrative employment in industry are linked to declining interest in postdoctoral positions among domestic doctorates (9, 37). However, the increasing representation of international scholars in the U.S. is also attributed to the "large global supply of well-trained scientific labour" and racialized perception of these postdocs, particularly from Asian countries, as "quiet" and "extremely hard working" (14). Meaningful examination of this issue will require the development of data sources that recognize the full extent of the international flow of STEM talent. Although over 100 countries are represented in one study (11) and others include regionally-specific international samples (7), the global expansion of the postdoc market, its implications for individual scholars, and the causes for shifting representation patterns in the U.S. are all understudied.

**“ PERHAPS DUE TO THE PRECARIETY AND LOW PAY FOR POSTDOCTORAL LABOR, THE MARKET RELIANCE ON INFORMAL NETWORKS AND PROCESSES MAKE DISPARITIES BOTH MORE LIKELY AND MORE DIFFICULT TO MEASURE AND ADDRESS. ”**



## INFORMAL POSTDOCTORAL HIRING GENERATES INEQUITIES

A final theme in existing studies -- one with clear implications for equity in the postdoctoral system -- concerns the informality of the postdoc labor market. A consequence of this informality is the undue influence of informal networks which generate inequities in access to postdoctoral positions. The majority of the postdoc market lacks centralized systems or oversight for advertising available positions, collecting application materials, facilitating the review of applicants, and tracking who is hired. Perhaps due to the precarity and low pay<sup>10</sup> for postdoctoral labor (7, 14), the market reliance on informal networks and processes make disparities both more likely and more difficult to measure and address (38). Postdoctoral scholars are generally hired through personal connections and direct contact with potential advisors (6, 10). Given demographic imbalances in STEM and the influence of homophily (39–41), male, white, and domestic graduate students are more likely than females, scholars from underrepresented groups, and international candidates to benefit from networks in postdoctoral hiring (11, 29).

The themes we have identified in extant research suggest multiple lines of inquiry and action will be needed to address equity issues in postdoctoral hiring. As leads for the IGEN Research Hub's scholarship in this area, we invite you to connect with us about relevant efforts in which you are engaged. For additional information about on-going IGEN Research Hub activities in this area please see <http://bit.ly/EquityGradEd>.

<sup>10</sup> The median expected salary in 2018 for science and engineering postdoctorates was \$48,435 (40).

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## WHO WE ARE

The vision of the Inclusive Graduate Education Network (IGEN) is to advance equity for underrepresented groups in doctoral degree attainment in the physical sciences. We are proud to be supported by NSF as one of the inaugural INCLUDES Alliances. Within IGEN, the Research Hub gathers scholars from diverse personal, disciplinary, and methodological perspectives with three objectives:

- Advance knowledge through carefully designed research studies. Our current studies span entry into graduate education through the transition to postdoctoral positions, and are generally aimed at one of two goals:
  - Understanding or documenting structural barriers to equitable outcomes
  - Developing and evaluating promising practices for improving outcomes.
- Inform disciplinary societies, universities, and others about effective practices and change strategies they can promote.
- Collaborate with the Inclusive Practices Hub to develop evidence-based professional development materials for faculty and other leaders.

The members of the Research Hub conduct a combination of basic/theoretical and translational research, and are committed to putting to work our findings in the world by collaborating with stakeholders in disciplinary societies, universities, and other scientific and educational institutions. We take an institutional perspective, and are committed to advancing solutions that change the system – not students. We are part of an effort to move beyond pipeline thinking toward a reimagining of the architecture and designs by which we select and serve graduate students. This leads us to attend to structures, cultures, systems and how they might be reconfigured to close disparities and empower racially minoritized and other historically marginalized groups.

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