The postdoc system in the U.S.: How broken is it? And for whom?

Gary McDowell, PhD
Lightoller LLC
info@lightoller.org
July 2025

This paper was commissioned for the “Reimagining STEMM Graduate Education and Postdoctoral Career Development” Summit. Opinions and statements included in the paper are solely those of the individual authors, and are not necessarily adopted, endorsed, or verified as accurate by the Summit planning committee or the National Academies of Sciences, Engineering, and Medicine.

Table of Contents

Disclaimer and Conflicts of Interest

Part of the fascination in studying the postdoc is the complexity of the position. It varies by field, by discipline, by funder, by institution, and even by individual research group/supervisor/mentor in how it operates. Postdocs themselves in the U.S. are an incredibly diverse group, encompassing various nationalities, identities, motivations, incentives, and aspirations. To discuss "postdocs" as one group is already to have missed the mark. So, this paper will by necessity contain limitations and oversimplifications. My own background and expertise is in biomedicine, and so while my aim is to be as encompassing of the nature of the postdoctoral experience, assumptions and generalizations that fall short of the experience of all reading this are likely, for which I apologize and will gladly take feedback on.

A more difficult issue is that there is a serious deficit of data on the postdoc, and the postdoctoral experience. I will argue that this is somewhat by design, either due to a specific desire to avoid evidence of widely-reported issues,[1] or more likely due to a lack of interest in dedicating resources to studying postdocs. I have included, as an Appendix, a recent application to the NSF's National Center for Science and Engineering Statistics, that describes some issues around postdoc data collection, which have also been discussed else (1) where, and has been a topic of debate in national reports for decades. Where possible, I use data to fully justify the claims within this paper; where there are discussions about scenarios where data is scarce,[2] I aim to couch those claims appropriately, and also invite the reader to consider whether it would be possible to provide proof to rebut those claims, and to at least concede the possibility that the problems described can exist. These limitations have long challenged the improvement of the postdoctoral position; and indeed, I myself have moved away from the collection of data to effect change, as it ultimately has little effect on the opinions of those with the power to do so.

Importantly, I am not a postdoc, nor have I recently been a postdoc (especially not since the onset of the COVID-19 pandemic, which has likely marked a historic shift in postdoctoral experiences); I have a business that I use to study how and why people become scientists, and as part of that I have a conflict of interest, in that I receive funds to study aspects of scientific training such as the postdoc. As such my perspective outside the system can be both an asset but also a detriment in preventing me from appreciating nuances of the current system, and the reader should also bear this in mind when reading this paper, particularly in draft format.

Please feel free to send comments and suggestions to info@lightoller.org

[1] This was understood to be the case in discussions that ultimately led to a concerted effort to convince research institutions to release career outcomes data through the *Coalition for Next Generation Life Science*, https://nglscoalition.org/, see Blank et al. (Blank et al., 2017).

[2] Such data may rely on anecdotal reporting in scientific journalism or rely on experiences that are described in a manner that the author concedes are not following the gold standard of methodologies.

Introduction

What is a “postdoc”? Postdoctoral researchers occupy an ill-defined and transient position between completion of a post-graduate diploma (e.g., PhD), and employment in a permanent role. The most generous description of a postdoc position describes a training period to acquire the skills necessary for the individual to succeed in their independent research career: they have learned the skills necessary to do research, while undertaking their graduate studies, but do not have the sufficient skills to carry out and lead independent research, a necessary function of an independent position.[3]

This definition, however, may be an overly-optimistic picture of what the current postdoc position entails.[4] A converse, cynical view of the postdoc would take it as an exploitative position, capitalizing on the hopes, passions, and aspirations of the researcher to provide cheap labor, either in the form of teaching or practical research necessary to support another’s program. Depending on the field of study, this could mean the faculty for whom the postdoc works. It often exists as an extension of the same kind of research activities that they carried out as graduate students. There is little to no opportunity for, nor provision of actual training in, the management, mentorship, and leadership skills required to lead an independent research program. Postdoctoral “training” is not held to the level of accountability of graduate education programs, or equivalent roles like medical residency (see below).

Part of the reason that the “postdoc problem” has been so hard to tackle over the last 50+ years is that for individuals, either of these definitions may be accurate, or they may have an experience anywhere on a spectrum between these extremes.[5] Defining the postdoc is so difficult because of its situational nature. This is a serious problem for a position that is, in so many disciplines, a required default step after graduate school. Some postdocs are in excellent training environments, working with wonderful mentors, who set them up for success. The hands-off, unregulated modality of the postdoc is often credited with this. However, many postdocs are hired in passively or even actively exploitative positions, precisely because of the lack of oversight and scrutiny of postdoc hiring, firing, and everything that comes in between. This has also changed over time, in a way that being in graduate school has not: the outcome of completing a graduate program is a graduate degree. The outcome of a postdoc used to be an essentially guaranteed faculty position, but the default outcome is now work in a non-academic, non-research position.

---

[3] What is meant by “independence” has long been an active discussion, thoroughly debated for the 2018 National Academies “Breaking Through” Report (National Academies of Sciences, Engineering, and Medicine, 2018). For a discussion of thoughts on academic research independence - and graduate student and postdoc perspectives on the matter - please see Singh et al., 2025 (Singh et al., 2025).

[4] Or, indeed, of the nature of graduate education or permanent contract positions currently.

[5] The difficulty in “defining” the postdoc and encompassing these experiences is illustrated by the National Postdoc Association’s “What is a Postdoc?” page. See https://www.nationalpostdoc.org/page/WhatsAPostdoc.

How many postdocs are employed in the U.S. is, to this day, a disputed number; it follows that all other data about the postdoc population is difficult to obtain, and therefore, difficult to interpret. We may state that the system is broken for the majority of postdocs who do not obtain the faculty positions they seek, assuming that most postdocs want to be faculty (and what data exist suggests that they do, see below). But the system does work for those who get faculty positions, for the faculty and universities that employ postdocs, in terms of research output that results in funding awards, and the funding agencies that support postdocs, in being able to demonstrate research outputs to those who provide the funds.

The very success of those who maintain and perpetuate the academic system is a result of their participation within it. To challenge the postdoc position and how it operates necessarily raises implications that those who have succeeded in the current system have not done so by merit, which often generates hostility. Rather, I consider there to be an embarrassment of riches, and there being too many capable researchers for the faculty positions available. This is somewhat different than the assumption that those who obtain faculty positions are the best researchers. While a researcher's body of work is important to securing their role, their network, and the serendipity to work on the research they are working on, when they are working on it, are also factors that are less reflective of merit and more of chance and circumstance. Therefore, these factors ultimately determines who is retained, and who excluded, from the professoriate.

In addition, not only does the system work for a subset of individuals and key partners; the current design has become essential to carry out the labor required to demonstrate productivity to funders, politicians, and society at large. As the postdoc role is essential not only for the production of the professoriate, but also for the production of knowledge, I will invite the reader to consider the question of how broken the postdoc is for knowledge production itself, and the society that benefits from that knowledge.

The postdoc problem has been discussed *ad nauseum* from the early 1960s (2) to the present day (3), with the issues, language**,** and talking points remaining sadly constant as generations of us have passed through committees, summits, and conferences on the manner. While some reforms have been successful, the inability to modify the postdoc over such a long period of time is worth consideration. Various key partners have lacked not the ability, but the will, to implement needed changes to the postdoc system (see (4)).

I wish to raise some overarching themes that, in my experience, are often overlooked during discussions of postdocs: the complexity of the postdoc population, the unique manner in which postdocs are hired, and the tensions implicit in the incentives between how postdocs and faculty carry out research.

The complexity of the postdoc population

Postdocs are part of the academic career trajectory across many fields and disciplines, with complexity arising due to the different cultural approaches of those disciplines to the position

(but, importantly, not all.[6] Much of my discussion will be centered on the biomedical postdoc, as they are the largest population of postdocs, there are more data and information citable about this population, and their structure can often be a default model for how people design postdocs).

The population carrying out postdoctoral research is also arguably the most diverse of all the academic career stages, across a range of demographic factors. For example, ⅔ of the biomedical postdoctoral population are estimated to be foreign-born and are employed on the easiest[7] visas to obtain (J-1 and H-1Bs (unlimited in non-profit settings)). Gender, race, and ethnicity show much more variability than at the faculty level, and these proportions have changed over time (5).

But the reasons for undertaking a postdoc are also varied. Most are undertaking a postdoctoral position for a faculty role, often with a default goal of that position being at a research intensive university. The majority of graduate students and postdocs appear to strive for an academic career (6–8). Recently, U.S.-trained citizen and permanent resident graduate students appear to have exhibited much more discretion about where they undertake graduate study based on subsequent employment opportunities and show increasing skepticism about postdoctoral positions (particularly postdocs described as “White” and “Asian” in NSF’s data collection). Foreign-born researchers can vary between and within national origin on intention to postdoc in order to get a faculty job in the U.S., or to get a faculty job in their own or another country, or indeed to simply follow the easiest route to permanent residency (after marrying a U.S. citizen, depending on which country they come from). The numbers of international postdocs have recently undergone dramatic fluctuations due to the travel restrictions of the COVID-19 pandemic, and to government immigration policies, as illustrated in recent data on postdoctoral populations (9,10).[8]

Not only are the motivations varied; they are mutable. Motivations and intentions can change during the postdoctoral period based on personal and political circumstances; even due to the experience of the postdoc itself.[9] Indeed, this can and has been used to support positive steps

[6] I will mention the perennial example of psychology as a discipline where a postdoc is not deemed essential for a faculty position; likewise how postdocs operate in different disciplines can vary.
[7] The easiest visas to obtain, historically.
[8] A discussion of the caveats and nuances of these data would take up a lot of space; more detail is provided in the references and an informal discussion of 2020 data on postdocs can be found at https://lightoller.org/blog/the-latest-postdoc-census-data-why-the-number-of-us-postdocs-has-decreased-but-also-probably-hasnt.
[9] By way of illustration, I can give my own personal example. I came to postdoc in the U.S. at Harvard Medical School, after completing my PhD at the University of Cambridge in the UK, as a British citizen. Initially, my plan was to follow the well-trodden path of carrying out a postdoc, then returning to the UK, where I would be more competitive for a UK faculty position than if I’d stayed in the UK. However, having met my now-husband, a U.S. citizen undertaking medical training in the U.S., I realized I would need to stay in the U.S., and began to focus on the postdoc as a route to obtaining a Green Card. Subsequent to United States vs Windsor ((2013), found that Section 3 of the Defense of Marriage Act (DOMA), which denied federal recognition of same-sex marriages, was a violation of the Fifth Amendment, essentially opening the door to recognition of same-sex marriages by the federal government), we were able to

in retaining talented researchers: the National Institutes of Health (NIH)'s K12 IRACDA program[10] was a successful intervention to guide postdocs towards teaching-intensive institutions, and has a demonstrated impact on retaining researchers within academia (11). The postdoc position also occurs during a time period of the life of researchers when many are starting and growing families.

Importantly, each of these motivations carries different incentives for what activities are rewarded, ignored, or even punished during the postdoctoral period. What a faculty search committee values for hiring purposes differs from what U.S. Citizenship and Immigration Services (USCIS) values for obtaining a Green Card, which differs again from what employers and clients value from a consultant. What a teaching-intensive institution looks for in a candidate is very different from what a research-intensive institution looks for.

In all, it is important to acknowledge that postdocs are not a homogeneous community acting with the same intentions and motivations, but are conversely incredibly varied in their backgrounds and motivations, thereby affecting their behaviors. While it has been shown that the key factor in people leaving academia is due to their values (12,13), the current modality for postdoctoral training may be seen as rigid and uniform; one avenue for considering change, reform or redesign of the postdoctoral position is to consider allowing a diversity of modalities and forms for postdoctoral training, that would need to be incorporated with, or decoupled from, the needs of faculty and institutions in undertaking labor.

The postdoc is unique in academia in its "hiring and firing"

Depending on the field and discipline, but particularly in STEM fields, U.S. postdoc positions are unique in the academic pathway in being the only point at which a single person is responsible for hiring – and firing – someone from the role. Graduate programs have admissions committees, faculty hiring operates through search committees, and tenure committees decide on tenure, but the postdoc is seen as the unique purview of an individual investigator.

While it should certainly be argued that committees do not represent an entirely fair and equitable way to select and hire candidates, it is important to recognize that the hiring of a postdoc is undertaken by an individual faculty member with no real oversight. This person was likely a postdoc themselves, and it is not standard for postdocs or faculty to have received substantial training about hiring and firing of employees as part of their training. These two points together perhaps highlight a key aspect of who benefits from the postdoc, the importance of networks and network connections in acquiring a postdoc position, and for whom it may be badly designed.

---

marry and obtain my Green Card, at which point my motivation to postdoc shifted to learning more about STEM education itself, and using the time to switch my career goals away from a tenure-track faculty position.

[10] The K-12 Institutional Research and Academic Career Development Awards (IRACDA) of the National Institutes of Health's National Institute of General Medical Sciences provides support for a traditional mentored postdoctoral biomedical and behavioral researcher's experience at an academic institution. See here for a past funding opportunity notice: https://grants.nih.gov/grants/guide/pa-files/PAR-19-366.html.

This individual hiring of postdocs is actually a key factor of why the position is so desirable for academic faculty: for some, the position really did benefit them. Training is at the discretion of individual faculty, therefore some do provide good environments and training, and some postdocs thrive and become faculty. This leads to a survivorship bias effect, where a number of faculty argue that the postdoc is good, because it was specifically good to them, while a majority of postdocs do not have this experience.

Linked to this is the issue of the postdoc's funding source, which leads to field-dependent differences in the postdoctoral experience. Most postdocs in biomedicine, for example, are supported as staff on research project grants, and are not bringing their own support with them. In essence, most postdocs are hired to carry out work on a grant that the faculty member applied for, and was awarded, without the intellectual involvement of the postdoc.

Therefore, in many cases a postdoc is being hired by an individual who will be supervising their work on a project that the faculty-member, not the postdoc, designed. The faculty member has not received training on hiring, management, and mentorship. There is no oversight of the hiring or supervision of the postdoc. In essence, the hiring of postdocs is largely dependent not on what an institution needs, or what the postdoc needs, but what an individual faculty member needs.

1. How did the current postdoctoral system develop in the United States?

What might be called the first institutional postdoctoral research position was set up at Johns Hopkins University in 1876, in the form of Fellowships (16). On the national level, the National Research Fellowship Program was established in 1919 by the National Research Council, funded by the Rockefeller Foundation, and ran for three decades (17). Following the dramatic expansion of the research enterprise during and after World War II, which includes the "Golden Years of NIH Expansion" (18), both the number of postdoctoral researchers, and the expectation that the professoriate would undertake postdoctoral training prior to faculty appointment, increased (Figure 1 and Supplementary Figure 1 in (19)). Mention of postdocs increased from 1944 (20) and in reports from the early 1960s, including a small survey commissioned by the Association of American Universities (AAU) in 1962 (2,21,22). Further detail about the history of postdoctoral reforms can be found in Bankston and McDowell (22).

By 1969, the postdoctoral position had become a sufficient source for concern in academia, and a focus for recommendations, to lead to the first comprehensive national study of the postdoc position by the National Academy of Science, "The Invisible University" (23):

> *"The present report is the result of a concern within the National Research Council and elsewhere about the scope of postdoctoral education in the United States. Although postdoctoral appointees were present on many campuses, their numbers and functions were not known nationally and, in many instances, were not even known to the host*

universities. ***Postdoctoral education, as the title of this report suggests, had grown to institutional status without study or planning.*** *In the absence of information, the costs and benefits of this development to the universities, to the postdoctoral appointees, and to the nation could not be adequately assessed. The financial uncertainties associated with reductions in the federal research budget during the last several years added to the urgency of the need for information.“*

- “*The Invisible University: Postdoctoral Education in the United States*” (23); emphasis added.

As indicated by the text, the origin of the postdoc is somewhat unclear. The tenor of the report suggests that although postdocs have been a feature of individual universities, research institutions, hospitals, and industrial laboratories for some time, there had been a recent national increase in the role across institutions to the extent that scrutiny was warranted. But what was clear from the report was that there had not been a clear strategy for the creation of these roles, nor was there a clear definition, and from this the current confusion surrounding the postdoc had originated.

How the postdoc was utilized in 1969, however, was interesting, and perhaps close to the intent many feel the postdoc should have as a period of exploration in research. Crucially however, one-third of postdocs at the time had already been hired into faculty positions, and were undertaking postdoctoral training in someone else’s lab in a manner similar to a sabbatical, to learn new techniques. This was possible because, at the time, there was not a hypercompetitive environment for acquiring faculty positions, and the postdoc had not yet become a *de facto* requirement in any discipline.

In the early 21st Century, attempts were made to reverse engineer and impose a structure upon the postdoc. The formation of the National Postdoctoral Association (NPA) was created to give voice to the invisible postdoc population, and led to the development of postdoctoral offices, and creation of definitions and guidelines for postdocs that sought to address the problem. But postdoc offices and the NPA did not have the power to shape university policy to provide the necessary structure to the postdoc. Without actual power to impose shape nor structure on postdoctoral positions throughout institutions – and a reticence, indeed reluctance, on the part of federal funders to do so (see below) – the postdoc position has continued to be shaped by the individual circumstances that each postdoc finds themselves in, rather than a structured and scrutinized program such as occurs with undergraduate and graduate education.

The role of federal funders in the current state of the postdoc is important, and it is particularly worth focusing on the NIH, which is the major source for postdoctoral support in the U.S. In the early 1970s, the Nixon administration took exception to the taxpayer footing the bill for the training of science PhDs, and perhaps with some justification: the training of MDs is most comparable to the training of PhDs, but MDs are not paid for with federal funds. Furthermore, in the early 1970s, many PhDs were heading into lucrative roles in the private sector, not remaining in academia, begging the question of why the taxpayer was funding training for this particular group.

Congress disagreed, but did develop concerns that the system was unsustainable. Congress passed the National Research Service Act in 1974, and NIH developed the National Research Service Awards (NRSA) to clearly delineate, they insisted, the “training” workforce in biomedicine (24). However, NIH leadership ensured a workaround, so trainees could still be hired as “staff” on the research awards. Some motivation behind this was practical: the NRSAs were specifically for training U.S. Citizens and Permanent Residents, and there was interest in maintaining access to foreign labor. But it was also philosophical, grounded in a belief that scientists know what science needs better than politicians.

This, in part, has led to the federal definition of postdocs simultaneously as “trainees” and “staff” (U.S. Government: Code of Federal Regulations. Title 2, part 200.400(f)), but often the definition that suits an instance is most usually the one that is to the advantage of the employer or funding agency. For example, “trainee” allows lower wages; “staff” prevents use of student resources. A particularly cruel punishment at some universities would arise for recipients of NRSAs themselves. A postdoc, funded by the taxpayer, through NIH, on a research award funded to the university, and classed as “staff”, may get a NRSA, and while the taxpayer and NIH still fund the postdoc, the salary does not go through the university’s normal salary routes. At this point, the university pronounces the postdoc to no longer be staff. They cut off access to healthcare and benefits, and postdocs have made decisions on whether or not to take the prestigious award based on changing financial circumstances. For example, there are women who have declined the NRSA upon being awarded the fellowship, because they realize that in doing so they will lose access to their childcare.

The staff/trainee duality, and the presence of two types of postdocs on NIH funding, allows the NIH to get away with a curious piece of doublespeak: they fund the majority of the trainees in the world’s largest biomedical enterprise; but they insist they are only responsible for the NRSAs, and their intramural postdocs, and not the other 85% of NIH-funded postdocs. This point was reiterated by former NIH Acting Director Larry Tabak at a meeting of the Advisory Committee of the Director (ACD) in June 2023 (44). The responsibility for those postdocs is laid at the feet of institutions, particularly in discussions about increasing salaries.

We can see therefore that the postdoc position has been shaped to suit the convenience of the individual faculty and institutions that hire them, and there is no coherent strategy nor design to the role of postdoc, and no key partner is held to any accountability nor scrutiny for the role, in comparison to the accreditation and scrutiny applied to undergraduate and graduate education.

2. Is the role of the postdoctoral system dated from a career perspective?

It has become clear that the major career destination of PhDs is not only non-academic, but also non-research roles (e.g., data on the biomedical workforce in the 2018 National Academies Report, “Breaking Through”). The low unemployment rate of PhDs is often cited as an encouraging statistic, but the reason the unemployment rate is so low is not because PhDs are

so employable, but rather the postdoc allows a person to be on the job market for multiple years without losing their source of income, as long as they continue to generate research. A 2% unemployment rate 5 years after the PhD (25) is not meaningful when 80% of biomedical PhDs do a postdoc (7,26) and the average postdoc length is 4.5 to 5 years (26), and suggest an underemployment rate significantly higher than the reported unemployment rate. This is especially when what happens after the postdoc is largely a mystery. Kahn and Ginther demonstrated some time ago that the postdoc is a poor financial investment, with salaries after 15 years not catching up with salaries of peers who have not carried out a postdoc in fields such as industry (26).

Recently, “White” and “Asian” U.S. Citizen PhDs have been increasingly unlikely to continue in postdoctoral research (9), despite the over-representation of these groups in populations such as the professoriate and NIH Principal Investigators (27), indicating a decline in attractiveness for the position, and likely a lack of its utility in the labor market. Greater skepticism has been exhibited by postdocs actively undertaking postdoctoral positions about the role of the position in securing future employment (28).

It might be reasonably expected that training for non-academic roles may be scarce in a traditional academic postdoc, but that the role could still be justified. A longstanding issue with the nature of the postdoctoral position as a training position for faculty roles is that there is a constant struggle to provide access to professional development and training to postdocs who are not on training awards, which is in direct conflict with the role the postdoc actually undertakes, namely carrying out the research they are to undertake.[12] Despite expansion in the training opportunities available at universities, ensuring attendance of postdocs (and graduate students) at programming was hindered by the reluctance of faculty (or a perceived reluctance on the part of the postdocs) to allow their staff to leave the lab in order to attend.

3. What are other postdoctoral systems that offer options for continued training?

Industry

Data on industry postdocs are sparse and anecdotal – private entities guard their data in order to remain competitive – and so much of the data about the experience of the industry postdoc are anecdotal (29). There are some general points about industry postdocs that differentiate them from traditional academic postdocs:

[12] For example, when I was accepted into a teaching fellowship at Harvard College while a postdoc at Harvard Medical School, my PI was required to justify to the NIH why I should be allowed time away from my duties as staff on a research project grant, despite my desire to gain teaching experience as part of my goal of becoming faculty.

- Actual provision of training for postdocs is evident, with programs providing well-defined professional development goals and outcomes (and publicizing them; for example, see the Genentech postdoc program homepage at https://careers.gene.com/us/en/students-postdocs).
- Salaries for industry postdocs are higher than for academic postdocs (29), although it should be borne in mind that the creation of a "training" program in industry could be a means to decrease labor costs, and carry out the same work at less cost to the company, as has been the key advantage to academic laboratories).
- Many industry postdoctoral programs have clear endpoints for the period of training, allowing participants to plan subsequent career steps accordingly. Interestingly, certain programs claim that they will not hire trainees into their own company, but expect them to work elsewhere. While it's certainly possible that companies retain particularly talented postdocs, the expectation that this is not an entry point for employment into the company provides interesting motivations and incentives for the postdoc to consider where to focus their next career steps.

A key misunderstanding for academics is that industry roles do not provide an opportunity to practice science in an "optimal" fashion. Academics will point to a lack of "agency" in what scientists are able to work on as a negative factor; however the lack of agency for postdocs in academia has already been discussed (14), notwithstanding the role that federal funders have in shaping what ideas can – or cannot – be funded. For example, a debate that has raged for decades is the struggle between funding "basic" and "translational" science through the NIH, and the need to justify work in context of a medical problem or issue, even if the link may be somewhat tenuous.

A more concerning point for academics to understand is that the key satisfaction that industry postdocs, as well as academics who have transitioned to industry, have reported anecdotally is the relief in being incentivized to produce work that is reproducible. In academia, one need not demonstrate rigorously that the work in one's publication is actually reproducible; whereas in industry, the key interest is in producing compounds or products that work, and work as often as possible – ideally every time.

National Laboratories

Postdocs at national laboratories[13] are not placed in traditional academic settings, and while research carried out at the laboratories appears to have more similarity with an academic

[13] In the United States, national laboratories generically refer to any government-operated or -sponsored laboratory. These facilities often include "national laboratory" in their name. There are 17 U.S. Department of Energy-affiliated national laboratories (https://www.energy.gov/national-laboratories); the Frederick National Laboratory for Cancer Research, sponsored by the National Cancer Institute; the Galveston National Laboratory, sponsored by the National Institute of Allergy and Infectious Diseases; the International Space Station United States National Laboratory, sponsored by NASA; and the Office of National Laboratories of the Department of Homeland Security Science and Technology Directorate. The Department of Defense operates research and development laboratories that, similar to the national

setting than with industry, it tends to be more focused on specific goals of the funder. Given the greater level of scrutiny, and the fact that postdocs are federal employees, there has historically been greater clarity on career paths and access to training, increased compensation,[14] and greater benefits available compared with postdocs at universities.[15]

4. What are key areas of concern that have been identified with the current postdoctoral system in the United States (e.g., training, exploitation, research inefficiency, perverse incentives)? How do these areas of concern change given the latest changes to federal funding, if at all?

The postdoc "training" fallacy

One argument for postdoctoral positions is that in order to get a faculty position, it is necessary to learn a new technique, or to train in someone else's lab and learn from them. But in 1969, not only was the postdoc not essential for faculty roles; many "postdocs" were actually already tenure-track faculty themselves, on sabbatical to get training (23). This is arguably a more effective way to train faculty, as it trains you for the job you have, not for the job you aspire to, especially when the majority of postdocs will not get a faculty position (30).

But the modern requirement to postdoc before becoming faculty does not reflect a way to address increased training needs, but instead increased competition for faculty positions, which have not grown in number over the last several decades (e.g. for basic science faculty, see "Figures and data" in (31)), while the number of PhDs and postdocs (and, increasingly, "post-postdoc" roles) has risen steadily. Current American scientists have made many brilliant and novel discoveries without postdocs, and there are fields like psychology where there is not an expectation to postdoc. Instead, many disciplines where the postdoc is necessary also happen to be ones that require most intensive labor, particularly in a laboratory setting.

Perhaps a diversion into a postdoc role would make sense on the grounds that individuals may receive training for STEMM occupations; but there is no evidence of such training taking place. It is not even possible to say with certainty how many postdocs there are. Data collection by the

laboratories, also offer postdoctoral positions (https://defenseinnovationmarketplace.dtic.mil/business-opportunities/laboratories/).

[14] See example data in Appendix – Historical Salary Data and Proportion of International Postdocs at NIH (2016 and 2017) (data obtained by Freedom of Information request).

[15] The gap may have closed more recently with greater unionization of postdocs at universities, but unionization at national laboratories has also been taking place.

National Science Foundation – the agency charged with measuring the size and constitution of the scientific workforce in the U.S. – was once so inaccurate, that a 2012 report stated that the number of postdocs could be as much as double the estimate (32), and the situation has not improved sufficiently (1). Analyses over the last decade have shown that the number of postdocs varies wildly by institution year-to-year, making it as much a measure of the ability of the NSF to collect data, and institutions to submit it, than of the number of postdocs laboring at the nation's universities.

Given that we don't have a good handle even on the total number of postdocs funded by the taxpayer, we struggle to learn any subsequent information about them. Basic demographic information eludes us, despite the postdoc-to-faculty transition being the bottleneck to professorial diversity (33). We don't know what country postdocs have ended up in, let alone what career, as a result of U.S. taxpayer investment. Without data about who this population even is, or where they are, it is certainly not possible to claim the taxpayer is getting effective training as a result of their investment.

The postdoc position avoids accountability for training

Consider medical residency, the medical system's equivalent to the postdoc. Both follow attainment of a doctoral degree, and both experience cultures with unreasonable expectations of work and hours and under-compensation, to meet the labor needs of their employers. But the comparison ends there. The total number of residents, and their length of time in training, is essentially (but not entirely) capped by federal funding. There is no defined cap on the number of postdocs the taxpayer can fund, and no limit on how long taxpayer funding can be used to pay for people employed in "training" positions at universities. Medical residents are virtually guaranteed a well-paying job as an attending-level physician at the end of the training period; whereas we estimate that 80% postdocs do not get faculty positions. There are clear training requirements and outcomes for residency, and a wealth of data on residents. Indeed, for law degrees, medical degrees - even undergraduate degrees - there is a wealth of data on numbers and career outcomes (importantly, these are all degrees where individuals pay tuition to the university, unlike many taxpayer-funded PhD programs).

Until somewhat recently, universities insisted on claiming that they could not gather data about postdocs that they gathered for all their other trainees, despite repeated requests for data, all the while insisting nonetheless that training was taking place. Training outcomes for graduate students and postdocs have been published through the Coalition of Next Generation Life Sciences (34) since work on the Next Generation Researchers Initiative at the National Academies. Looking at these data, one understands why universities have been – and many still are – reluctant to share. Across institutions, a quarter of postdocs are in their positions for less than a year, half of postdocs are in a postdoc for 2 years, and the most common job for a postdoc to move into is another postdoc.

If the point of a postdoc position is to spend substantial time on a project, learning how to become faculty, why do so many PhDs carry out such short postdocs, to then do another postdoc? One reason is the focus on time-to-degree completion rates for graduate programs. U.S. institutions have come under intense scrutiny in recent decades for the length of time it takes students to complete their graduate programs (time-to-degree, or TTD). Because the data don't exist we can’t know how prevalent the phenomenon of graduating a student and having them continue their work afterward to finish up papers was before TTD started to expand or if it was a response to pressure to keep TTD down. Regardless, this practice subverts the purpose of the postdoc and renders the TTD data useless as a metric. We have these universities to thank for collecting and publishing the data on 1-2 year postdocs rather than burying them under some other title. But it works very effectively: because we do not track the movement of individual federally-funded trainees, we cannot differentiate these “postdocs” from someone who has moved into a new role in a new lab at a new institution. It could be argued that it is in the interest of faculty, institutions, and funding agencies that we do not collect good data about postdocs.

5. What are the current expectations of individuals in postdoctoral positions (postdocs) in the U.S. STEMM research ecosystem (including and beyond the life sciences/biomedical fields)?

Postdocs expect to be able to carry out independent research in a supportive mentoring environment that sets them up for success to continue their work in an independent faculty position, all the while receiving compensation, benefits, and professional development commensurate with their experience and expertise.

It is clear that the majority of graduate students and postdocs strive for an academic career (6–8) and while there are data pointing to the low chance of attaining a faculty position, graduate students and postdocs (even, and perhaps especially, those who show an interest in non-academic careers) are continuously encouraged, and made to expect, an academic career will result if they work hard enough.

Efforts to shift compensation have perhaps been most successful in the last decade, with a notable pivot from resistance to raising salaries (22,35,36), to a clear appreciation that appropriate compensation is not only desired, but essential. Unionization efforts amongst postdocs have accelerated in the last ten years (37), bringing attention to not only direct compensation, but benefits such as healthcare and childcare (38).

Overall, the goal of the postdoc is to be able to carry on into an independent, stable position (39). Dependent on field, desire to remain within academia may vary by degree, but still appears

to be the destination desired by the majority. In the current labor market, most postdocs therefore stand to be disappointed and frustrated in these efforts.

6. How would the U.S. STEMM education and research systems need to adapt if the postdoc system was eliminated?

“Elimination” of the postdoc could take many possible forms. One could be a wholesale rejection of the position by the national research enterprise – academia, national laboratories, and industry – and an agreement that the postdoc position itself is no longer fit for purpose. This would represent a cultural shift in the research community itself and would be easier to address as a voluntary choice.

What seems more likely is a piecemeal removal of the postdoc system, that is imposed upon academic key partners, from within or without. For example, universities could decide as a whole not to support the employment of postdoctoral researchers at their institutions, and impose a restriction on faculty at their institutions. Another could be in the form of withdrawal of funding support, to various degrees, for the position, by individual or multiple funders. Another could be a severe shift in market forces, and the decision of graduate students themselves not to undertake postdoctoral positions.

Consider, for example, a system where U.S. federal funding for postdocs is no longer possible. The postdoc could continue to exist, but it would be at the discretion of institutions, and non-federal funders. The postdoc, importantly, in non-U.S. countries would largely remain intact (where federal funding from the U.S. is not also a component of their research enterprises).

In order to be able to afford postdoctoral roles, institutions would have to control access to postdocs, perhaps through the creation of programs and cohorts similar to those for graduate students. It is possible that such a necessity may allow for a rethink entirely of whether postdocs are the best use of institutional resources; discussions on staff scientist positions in recent years have suggested that funding permanent positions as an institutional investment may be a way to ensure research is done, while also supporting institutional research interests, and possibly supporting collaborations by sharing researchers between laboratories or departments (40–42).

There could also be a shift in how federal funding is used to support research, with a focus once again on the original intention of providing a sustainable training pool for the research workforce, and not simply a cheap labor pool. Retention and expansion of actual training mechanisms to support postdoctoral researchers, with a concomitant reduction and eventual elimination of support for postdocs on staff roles (such as research project grants) with the

caveat that ideas for expansion to include international researchers would need to be considered.[16]

This is similar to the current manner in which medical schools and teaching hospitals support "residents." There is a sum of funds provided by the federal government for residency programs, that is the *de facto* limit on the number of medical residents in the U.S. But there is nothing preventing teaching hospitals from hiring more residents and paying their salaries from institutional funds. The simple answer is that most do not and rely on federal funding to limit their own cohort sizes. In the same way, there is no reason that institutions in the U.S. could not fund their own postdocs, and indeed many need to supplement postdoc salaries in order to remain competitive, given that federal funding is no longer sufficient to provide both salary support and support for the materials needed to actually carry out research.

Crucial issues with eliminating postdocs altogether would be:

- Accepting that the postdoc is not an essential step towards becoming faculty for any reason other than due to hyper-competition, and credential inflation, for faculty positions. Faculty search committees could certainly hire faculty straight out of their PhDs: the issue is that this is considered a risk, with less certainty over their potential for continued success, particularly for acquiring funding.
- The need to hire faculty straight out of PhDs, as was more common 50+ years ago, and is practiced currently in various fields and disciplines such as psychology. As there are actually decreasing numbers of tenure-track faculty positions available[17], this means explicitly making clear to graduate students the need to plan for other career directions. This would likely lead to a decrease in graduate school applications – at the moment, the postdoc position acts as a convenient buffer to obfuscate this reality (and is, in part, a strong reason for the academic enterprise to retain the postdoc, and keep academia as an attractive prospect for potential graduate students).

With the hiring of faculty straight from PhDs there would need to be a cultural shift in assumptions about the "readiness" of such individuals. I would invite the reader to consider:

- The current system rewards recency of success, rather than consistency of success. One can have a relatively "unproductive" PhD and seek out a low-risk, high-reward

[16] For the case of the NIH, this would either require a change in the Code of Federal Regulations pertaining to the Department of Health and Human Services, restricting NRSA awards to U.S. Citizens and Permanent Residents (see Appendix), or creation of a new mechanism in the career development awards (K awards) which are at the Director's discretion, and have no such restrictions (see K32 discussion).

[17] In 2023, the American Association of University Professors released a data snapshot highlighting tenure and non-tenure employment patterns among faculty members across the United States from fall 1987 through fall 2021. For more information and additional resources, see https://www.aaup.org/academe/issues/spring-2023/data-snapshot-tenure-and-contingency-us-higher-education.

postdoc position to account for this. Those who demonstrate high productivity in their PhDs may have more to lose by doing a postdoc.

- Concerns will be raised by the lack of training for running a lab that a graduate student may have, but this is a common complaint among current postdocs and faculty, that is more a reflection of the fact that this training does not occur at any point. Currently it is accepted that more experience of research gained through a postdoc position is sufficient to manage and mentor a lab.[18]
- The counter to this, and indeed a trend that was recently occurring,[19] is the "multiple" postdoc problem: that it has become more common to do multiple postdocs, in the hope that one results in becoming competitive.

This is not an exhaustive discussion on the topic; ultimately the elimination of the postdoc presents less of a problem in theoretical terms – graduate education and faculty positions still exist in this scenario – but rather cultural barriers to the perception for the need for training in a dedicated role, and in the short-term, the question of what happens to current postdocs.

7. Where would individuals currently serving as postdocs go for continued training?

The question of what is to happen to current postdocs depends upon the speed and size of a change in the postdoctoral position, as alluded to above.

A question remains as to whether postdocs need further training, as currently imagined. All professions and roles benefit from continuous professional development; whether the postdoc actually adequately prepares postdocs to be faculty, and could not instead be replaced by better support for faculty from institutions, is an important question.

Likewise, whether postdocs in industry could not be replaced with permanent positions that are training-intensive is an open question.

There is also the important question of whether postdocs feel they need further training, or are getting it, versus simply "serving their time" waiting for publications to be ready for their CVs. Evidence for training of postdocs is scarce, and postdocs have long articulated the desire for training, and have articulated frustrations in their ability to acquire training while in a postdoc position.

---

[18] For more information on the responsible conduct of research for those who direct laboratories, centers, departments, or collaborations, see *On Leading a Lab: Strengthening Scientific Leadership in Responsible Research*. Additionally, a National Academies committee will produce a revised, expanded, and online version of *On Being a Scientist: A Guide to the Responsible Conduct of Research*, https://www.nationalacademies.org/our-work/on-being-a-scientist-an-updated-and-online-guide-to-the-responsible-and-ethical-conduct-of-research.

[19] There has been greater attention to postdoc term limits in recent years which may have mitigated this, but may also have pushed more postdocs to be hidden in "post-postdoc" roles that are roughly equivalent.

Where it is agreed that further training is needed, in the short-term that is likely to be abroad, in the academic research enterprises of other countries. The U.S. is fairly unique, in that U.S. researchers are not expected to leave the U.S. at any point in their training (43) (but are expected to move around the country); the academic enterprises of many other countries expect a training period abroad (often in the U.S.) to demonstrate some ability to thrive in different locations.[20]

There has long been a debate about whether to "allow" postdocs to continue to seek training, or whether it does people a disservice to those people, and it is kinder to cut people off from training opportunities after a certain point. It is perhaps better to consider the needs of training, from a broader, societal perspective. What are the best needs for training a scientifically-literate workforce for our society? How can we ensure the success of individuals in a way that also helps to serve and improve our society? There has long been an adage that "more PhDs makes America smarter"; but the simple production of PhDs, without deliberate efforts to support their work and benefit from their expertise, merely serves to benefit those who depend on their direct labor and efforts, and not those outside the academic enterprise. Future considerations of training opportunities, or their necessity, will need to take account of the interests of key partners outside academic institutions.

[20] This is not uniform; some countries also do not look kindly on any time spent abroad. But it is the case that historically relatively few U.S. researchers carry out graduate studies or postdoctoral positions abroad.

Bibliography

1. Pickett C, Bankston A, McDowell GS. The GSS is an unreliable indicator of biological sciences postdoc population trends. *BioRxiv*. 2017 Aug 2.
2. Berelson B. Postdoctoral work in American universities: A recent survey. *Journal of Higher Education*. 1962 Mar;33(3):119.
3. Sabbagh U. The postdoc experience is broken. Funders such as the NIH must help to reimagine it. *Nature*. 2023 Dec;624(7992):475.
4. Bankston A, McDowell GS. Chapter 2 - A Review of Postdoc Reforms in the United States and the Case of the Fair Labor Standards Act Updates of 2016. In: Jaeger A, Dinin AJ, editors. The Postdoc Landscape. *Academic Press*; 2018. p. 15–48.
5. Heggeness ML, Gunsalus KTW, Pacas J, McDowell G. The new face of US science. *Nature*. 2017 Jan 3;541(7635):21–3.
6. Sauermann H, Roach M. Science PhD career preferences: levels, changes, and advisor encouragement. *PLoS ONE*. 2012 May 2;7(5):e36307.
7. Sauermann H, Roach M. Why pursue the postdoc path? *Science*. 2016 May 6;352(6286):663–4.
8. Roach M, Sauermann H. The declining interest in an academic career. *PLoS ONE*. 2017 Sep 18;12(9):e0184130.
9. National Center for Science and Engineering Statistics (NCSES). *Graduate Enrollment and Postdoctoral Appointments in Science, Engineering, and Health Rise, Driven Largely by Increases in the Number of Women and Temporary Visa Holders*. NSF 25-316 [Internet]. National Science Foundation. 2024 [cited 2025 Jul 1]. Available from: https://ncses.nsf.gov/pubs/nsf25316.
10. : Langin K. As professors struggle to recruit postdocs, calls for structural change in academia intensify. *Science*. 2022.
11. Faupel-Badger J, Miklos A. *Outcomes Analysis of the NIGMS Institutional Research and Academic Career Development Awards (IRACDA) Program*. [Internet]. National Institute of General Medical Sciences. 2016 [cited 2025 Jul 9]. Available from: https://loop.nigms.nih.gov/2016/06/outcomes-analysis-of-the-nigms-institutional-research-and-academic-career-development-awards-iracda-program/.
12. Gibbs KD, Griffin KA. What do I want to be with my PhD? The roles of personal values and structural dynamics in shaping the career interests of recent biomedical science PhD graduates. CBELife Sciences Education. 2013;12(4):711–23.
13. Gibbs KD, McGready J, Bennett JC, Griffin K. Biomedical science Ph.D. career interest patterns by race/ethnicity and gender. *PLoS ONE*. 2014 Dec 10;9(12):e114736.
14. Barres BA. Stop blocking postdocs' paths to success. *Nature*. 2017 Aug 30;548(7669):517–9.

15. Singh Chawla D. 8% of researchers in Dutch survey have falsified or fabricated data. *Nature*. 2021 Jul 22.

16. Johns Hopkins University. *Graduates and fellows of the Johns Hopkins University, 1876-1913*. Baltimore: Johns Hopkins Press; 1914.

17. National research fellowships in physics and chemistry. Proceedings of the National Academy of Sciences. 1919 Jul 1;5(7):313–5.

18. National Institutes of Health. *NIH Almanac: Chronology of Events* [Internet]. 2016 [cited 2016 May 22]. Available from: http://www.nih.gov/about/almanac/historical/chronology_of_events.htm.

19. Heggeness M, Gunsalus K, Pacas J, McDowell G. *Preparing for the 21st Century Biomedical Research Job Market: Using Census Data to Inform Policy and Career Decision-Making Version 1*. Self-Journals of Science. 2016 Dec 21

20. Israeli N. American Postdoctoral Education. *Journal of Higher Education*. 1944 Nov;15(8):428.

21. Berelson B. *Graduate Education in the United States*. McGraw-Hill Book Company, Incorporated; 1960.

22. Bankston A, McDowell GS. Chapter 2 - A review of postdoc reforms in the united states and the case of the fair labor standards act updates of 2016. *The Postdoc Landscape*. Elsevier; 2018. p. 15–48.

23. National Research Council (NRC). Invisible University: Postdoctoral Education in the United States. Report of a Study Conducted Under the Auspices of the National Research Council. [Richard B. Curtis, Study Director]. Washington, D.C.: National Academies Press; 1969.

24. NRC. Addressing the nation's changing needs for biomedical and behavioral scientists. Washington, D.C.: National Academies Press; 2000.

25. McDowell G. The fool's gold of Ph.D. employment data. *Science*. 2016 Jun 9.

26. Kahn S, Ginther DK. The impact of postdoctoral training on early careers in biomedicine. *Nature Biotechnology*. 2017 Jan 10;35(1):90–4.

27. Ginther DK, Schaffer WT, Schnell J, Masimore B, Liu F, Haak LL, et al. Race, ethnicity, and NIH research awards. *Science*. 2011 Aug 19;333(6045):1015–9.

28. Morin A, Helling BA, Krishnan S, Risner LE, Walker ND, Schwartz NB. Surveying the experience of postdocs in the United States before and during the COVID-19 pandemic. *eLife*. 2022 Jul 26;11.

29. Woolston C. How to find your place in science through an industry postdoc. *Nature*. 2025 Jan;637(8044):241–2.

30. National Academies of Sciences, Engineering, and Medicine. The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through. Beninson L, Daniels R, editors. Washington (DC): National Academies Press (US); 2018.

31. Gibbs KD, Basson J, Xierali IM, Broniatowski DA. Decoupling of the minority PhD talent pool and assistant professor hiring in medical school basic science departments in the US. *eLife*. 2016 Nov 17;5.

32. Biomedical Research Workforce Working Group. Biomedical Research Workforce Working Group Report (Report to the Advisory Committee to the Director). National Institutes of Health. 2012 Jun 14.

33. Meyers LC, Brown AM, Moneta-Koehler L, Chalkley R. Survey of checkpoints along the pathway to diverse biomedical research faculty. *PLoS ONE*. 2018 Jan 16;13(1):e0190606.

34. Blank R, Daniels RJ, Gilliland G, Gutmann A, Hawgood S, Hrabowski FA, et al. A new data effort to inform career choices in biomedicine. *Science*. 2017 Dec 15;358(6369):1388–9.

35. Bankston A, McDowell GS. Monitoring the compliance of the academic enterprise with the Fair Labor Standards Act. [version 2; peer review: 3 approved]. F1000Res. 2016 Nov 17;5:2690.

36. Athanasiadou R, McDowell GS, Bankston A, Carlisle M, Niziolek CA. Assessing the landscape of US postdoctoral salaries. *Studies in Graduate and Postdoctoral Education*. 2018 Nov 12;9(2):213–42.

37. Cain B, Budke JM, Wood KJ, Sweeney NT, Schwessinger B. How postdocs benefit from building a union. *eLife*. 2014 Nov 21;3.

38. Cataldi S. Postdocs Demanding Better—Together. *Issues*. 2025 Jan 1;41(2):75–8.

39. Singh H, Bankston A, McDowell GS. Career transitions: actionable recommendations by graduate students and postdoctoral scholars on achieving research independence in biomedical sciences. *Frontiers in Education*. 2025 Mar 12;10.

40. Kimble J, Bement WM, Chang Q, Cox BL, Drinkwater NR, Gourse RL, et al. Strategies from UW-Madison for rescuing biomedical research in the US. *eLife*. 2015 Jun 30;4:e09305.

41. Powell K. Wanted: staff-scientist positions for postdocs. *Nature*. 2015 Apr 10.

42. Hyman S. Biology needs more staff scientists. *Nature*. 2017 May 16;545(7654):283–4.

43. Polka J. Where Will A Biology PhD Take You? [Internet]. American Society for Cell Biology COMPASS Blog. 2014 [cited 2016 Jul 8]. Available from: http://www.ascb.org/where-will-a-biology-phd-take-you/.

44. National Institutes of Health. Advisory Committee to the Director - June 2023 (Day 2). [Internet]. 2023. Available from: https://videocast.nih.gov/watch=49764.

Appendix - Excerpts from an application for funding to improve postdoc data collection (McDowell & Roca)[21]

[21] This application was created prior to 2025.

NCSES S&T: A Convening of Community Key Partners: Uncovering Diversity Issues in STEM Data About Doctoral Degree Recipients (DDRs)

OVERVIEW: In order to reliably assess the movement of trainees into the STEM workforce, and barriers that they face in doing so, it is necessary to have a thorough understanding of the nuances of collection and utilization of data about this population. The variety of datasets describing U.S. STEM trainee demographics and career outcomes can yield conflicting data for improving STEM training and workforce development. How the data is collected can be highly variable due to issues such as institutional differences in classification of doctoral degree recipients and reporting structures for submitting data to NCSES. This can confound comparison of data about postdoctoral researchers, staff researchers, adjunct and non-tenure track faculty, and various other STEM researchers in temporary training or staffing positions. As this is further complicated by defining who is or is not a postdoc, here we use the term Doctoral Degree Recipients (DDRs) in order to purposefully address data capture about the academic STEM workforce. For these reasons, data about the STEM workforce, such as accuracy of the total number of STEM DDRs in the U.S. is suspect. Therefore, **the study of any *subset* of this population**, such as **DDRs from underrepresented populations**, is problematic. It is therefore important to investigate the parameters defining how data is collected about this population in particular. This project will **convene a charrette** bringing together leaders from institutional data collection efforts to identify inconsistencies in survey and data collection efforts for reporting to NCSES and NSF, and to identify methods for providing training and education resources for working with and submitting these data. As a result, this proposal will generate resources for improved study of the STEM workforce and new knowledge on ways to improve data collection on DDRs, in general, but especially from underrepresented minority (URM) communities.

INTELLECTUAL MERIT: This project will support future studies on, and interventions to support, career transitions of underrepresented scholars in the STEM workforce, with its specific focus on ways to improve and expand the reliability of data collection and its dissemination. This will be achieved through publication of a report centered on the specific issue of improving reliability of data about the national postdoctoral census, especially with respect to URM DDRs. The report will be designed to inform NCSES of the sources and estimates of error and gaps in NCSES DDR data collection, providing a summary of results and specific recommendations impacting reliability of the data, so that NSF can understand and undertake work to correct inconsistencies. The report will also be designed to inform the wider DDR data-entry community (specifically university administrators) of the best practices currently in operation to ensure that data entry is as consistent and efficient as possible; and to highlight the importance of how the data can be used, particularly in relation to issues affecting diversity and retention in the academic community. The report will include analyses of the current state of the data particularly noting the accuracy of current possible analyses, the caveats of and gaps in particular datasets, and trends illustrated in data that can be identified as more reliable and therefore comparable. Dissemination of the report will be designed with the aim of establishing an on-going collaborative network to address these issues in the broader context of diversifying the STEM workforce by a future full grant proposal based on this pilot study.

BROADER IMPACTS: The diversity of the STEM workforce is slowly improving, but this diversity is not spread equally across all disciplines, nor translating into a diversification of certain STEM careers such as the professoriate. The postdoc-to-faculty transition is a key bottleneck in diversifying the professoriate; but, anecdotal attitudes of a lack of diversity in the hiring pool conflict with recent literature on the composition of this pool, particularly in disciplines such as the biological and the physical sciences. Results of this project will allow faculty search committees and institutional training programs to have easy access to datasets with as much accuracy and depth as possible. Moreover, this project will serve URM graduate and postdoctoral scholars with a resource for assessing institutional diversity, equity, and inclusion (DEI) that might reflect an environment more conducive to their career success. This charrette convening will also identify ways of improving data collection and submission efforts at individual institutions, providing education and training materials and disseminating them throughout the wider STEM DEI community.

PROJECT DESCRIPTION

BACKGROUND AND PROJECT RATIONALE

Many organizations, as part of Equal Employment Opportunity and Affirmative Action (EEO/AA) commitments, follow a process whereby employers are required to track demographic information of job applicants and demonstrate that a good-faith effort was made to ensure a diverse applicant pool. Every federal contractor, for example, is required to perform this hiring analysis which would include many faculty hiring committees (reviewed in [Yackee 2020]). In order to monitor this process, standard tables of data about the demographics of the potential hiring population are used. In the case of faculty search committees at research-intensive institutions, it therefore follows that these processes rely on accurate data about postdocs — the actual faculty job candidate pool on the academic career track.

Due to recent efforts to limit the length of the postdoc, and discourage long times in training positions, many applicants may also be employed in staff scientist or other non-faculty researcher positions. We use the term Doctoral Degree Recipients (DDRs) to be inclusive of this broader *post*-doctoral population. The standard source of data about DDRs are the postdoc and non-faculty researcher data recorded in the NCSES Survey of Graduate Students and Postdoctorates in Science and Engineering, also known as the GSS. Specifically, tables describing the demographics of this population (for example, Table 2-2 in the 2019 GSS dataset [NSF 2019]) are used for these processes.

The accuracy of the DDR population numbers and associated demographics affects the targeted outreach efforts used by recruiting institutions. This is especially the case when trying to reach URM job candidates using methods described in affirmative action plans. Also, accurate labor availability pool statistics are critical for determinations of gender and racial discrimination as exemplified in legal discussions (for example [Scott 1978; Chang 1985]). As a specific hypothetical example using data from Table 2-2, a faculty search committee in the biomedical and biological sciences would learn that in a population of the 30,076 postdocs and non-faculty researchers, there are only 307 Black or African-American postdocs, with no race/ethnicity data recorded for non-faculty researchers. Thus, for every 100 job applications, only one candidate might reasonably be expected to be Black (given some simplifying assumptions).

However, these scenarios overlook the fact that an important assumption is being made: that the census of potential applicants is an accurate representation of the DDR population. To put it another way, this is akin to a discussion of the statistical p-values of an experimental result, without taking into account the conditions of collection of the original data and potential caveats of the underlying experiment.

This issue might first be apparent in Table 2-2 itself: demographic information for non-faculty researchers, who comprise a quarter of the potential applicant population, is not captured. But what is perhaps more concerning is when overall data about postdoc populations is investigated more closely. In a previous report, we looked at the yearly changes in the postdoc population [Pickett *et al.* 2017], specifically at the biological sciences postdoc population, in response to a 2016 claim that the biomedical postdoc population had entered a period of decline, fueled primarily by changing career interests in biomedical PhDs [Garrison *et al.* 2016]. A preliminary analysis of the underlying data in the Garrison paper suggested that, in fact, there may have been a bubble of retention of trainees in postdoc positions between 2008 and 2010, immediately after the “Great Recession.” This seemed to play out in anecdotal discussions with those who had been graduate students and postdocs at the time. However, upon looking at the underlying GSS data, we had to abandon drawing any meaningful conclusion from the numbers, because we found that

the institutional variability in reporting biological sciences postdoc populations varied by more than 2-fold over consecutive years at certain institutions, masking larger trends in postdoc population data [Pickett *et al.* 2017]. In response to queries on the matter, universities themselves indicated that the most common causes for the changes were modifications to institutional policies, renaming of departments (which could lead to classification of all students and postdocs in the department as being in different NSF-defined science fields), and variations in effort, often by a specific individual as part of other duties, to track and account for all postdocs throughout the institution.

There are other factors impacting the utility of datasets such as the GSS, as it collects information on DDRs only from Ph.D. granting institutions and omits free-standing research centers and federal institutions that employ DDRs (*e.g.* HHMI's Janelia Campus, the Buck Institute, NIH intramural DDRs, *etc.*). GSS data collection practices can also be fluid. From 2007 to 2010, the GSS altered its methods of postdoc data collection [Einaudi *et al.* 2013]. Also, in 2014, the number of institutions surveyed in the GSS, known as the survey frame, increased so as to include more institutions with postdocs than had been evaluated before [Arbeit *et al.* 2016]. The 2014 dataset also marks the first occasion that non-faculty researchers, an important but overlooked DDR population, began to be counted and reported on explicitly. These improvements in the GSS are welcome and enhance the accuracy of the survey, but they raise an issue of transparency – one needs to know about such improvements when trying to evaluate the size of the DDR population and examine long-term trends. Beyond this, the quality and consistency of the GSS data is dependent on the quality and consistency of DDR information reported by universities. Policy changes at institutions that alter the accounting of DDRs could have significant effects on the reported trends in the DDR population.

The collection of data about DDRs may have caveats as a result of evolving survey parameters, but a clearly major source of error is the variable administration responsibilities (and effort devoted to this work) within and across institutions. As part of the preliminary work on the GSS data, we called for the adoption by institutions for a unified definition of "postdoc" and for the consolidation of postdoc titles, or at the very least inclusion of each institutions classification of what constitutes a postdoc [Pickett *et al.* 2017]. Simultaneously, we worked on ways of overcoming these internal institutional barriers using specific examples from Boston University and the Biological Sciences Division of the University of Chicago ([Schaller *et al.* 2017], with support from our advisory board members Dr. Sarah Hokanson and Dr. Nancy Schwartz, respectively).

With respect to the important mission of diversifying the STEM workforce, there is a clear need to ensure that there is reliable data on URM DDRs, so that these data can be used to ensure the diversification of the professoriate and the broader STEM workforce. This is especially important for ethnic/racial information concerning the "post-postdoc" community which is currently not reported, yet a potentially important pool for faculty hires. Monitoring data about the URM DDR population is important for crafting and evaluating policies that affect this critical population. These issues become all the more acute in the context of the COVID-19 pandemic and the rapid changes affecting different demographics of DDRs, such as how the NSF has already described for temporary visa holders in the 2020 GSS dataset [Arbeit 2022].

PROJECT GOALS and OBJECTIVES

Problems exist for data collection for all surveys. We propose that there is an opportunity to use our specific expertise in this arena, combined with our ability to convene and collaborate with many key partners collecting and using data about DDRs, to provide critical insight and guidance to the data collection, entry, and usage communities. While ***instructional webinars are offered for conducting NCSES data entry***, there are ***no checks and balances on the accuracy and***

reliability of data submitted. The proposed work below builds upon past efforts recommending improvements to federal doctoral surveys [Milam 1998].

OBJECTIVE 1: We will engage a broad representation of contributors to, and users of, NCSES DDR data resources via surveys, structured workshops and a virtual charette for the long-term goal of improving STEM workforce diversity.

OBJECTIVE 2: Information gathered at each point of this project will be used to revise and adapt future steps, to hone in on data-driven recommendations and actions.

Outcomes: This work will take up STEM workforce data-focused recommendations issued by the National Academies of Sciences, Engineering and Medicine 2018 report "The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through" [NASEM 2018] by supplementing its findings, and putting recommendations relevant to the work of NCSES into action, particularly through the inclusion of two of its co-authors in this project.

PROJECT ACTIVITIES AND METHODOLOGY

OBJECTIVE 1. We will engage a broad representation of contributors to, and users of, NCSES DDR data resources via surveys, structured workshops, and a virtual charette for the long-term goal of improving STEM workforce diversity. Expected Outcome: Our project's participants will be engaged to identify ways to address sources of error, which will then be reported out to meet the project goals described above.

Variations in DDR classification, gaps in NCSES DDR data collection and reporting, and other sources of error will be discussed in order to develop recommendations to multiple key partners to improve the accuracy of data on all DDRs, with an emphasis on URM DDRs. Central to this process will be an approach whereby information gathered at each point of the process will be used to revise and to adapt future steps, to focus on data-driven recommendations and actions.

This convening will be used to identify gaps in survey and data collection efforts to report back to NCSES and NSF, and to identify methods for providing training and education resources for working with and submitting this data. As a result, this proposal will generate resources for improved study of the STEM workforce and new knowledge on ways to improve data collection on underrepresented DDRs.

Activity 1. Identifying, Surveying, and Inviting Charette Participants:

There are approximately 320 academic institutions who currently submit data about DDRs to NCSES surveys such as the GSS, with up to 400 having submitted data from 2016 onwards. For this activity, we will conduct a broad survey (**Activity 1.1**) of many contributing institutions regarding current policies and procedures for collecting and submitting GSS data on DDRs that will also be used ultimately for the dissemination of the project's outcomes.

The people at institutions who carry out the data entry within postdoctoral offices and institutional administration will be contacted using currently available networks and organizational consortia such as the American Association of Medical Colleges GREAT group, making use of our team's contacts. Data-entry representatives for institutions will be invited to fill out a survey asking questions about experiences in completing data entry for the GSS. This survey will identify issues with data entry and gaps that institutional representatives may have identified, as well as allowing a simple way to provide summary institutional data or links to policies that explain, *e.g.*, how their institution defines a postdoc, whether data collection is centralized or through multiple (*e.g.*,

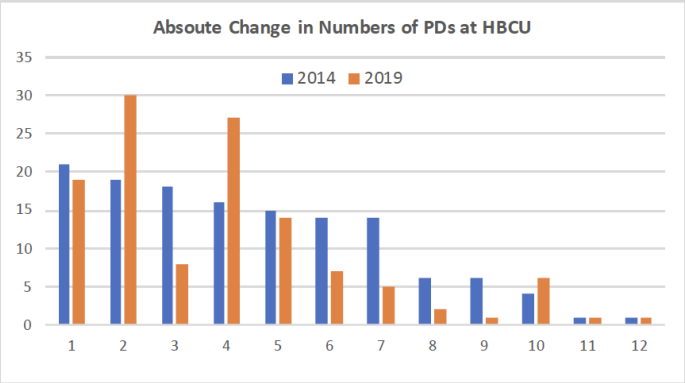
departmental) contributors, *etc*. ***The results from this survey will be used to inform the specific topics for the structured workshops described below***. Questions will focus both on the process and clarity of entering data, for work to provide feedback to NSF and RTI international; and also on the internal institutional processes of data collection and aggregation about DDRs in preparation for entering data. This survey will be advertised widely to the communities of administrators who have postdocs in their portfolio, and will aim to cooperate with NCSES and RTI international in contacting persons identified with data entry at institutions. This survey will aim to receive as many responses covering GSS-reporting institutions as possible, with the target of the minimal dataset being 60 responses, from which to select willing participants for the virtual charrette. The convening will be advertised to these potential participants and their participation will be requested, highlighting the specific aim of supporting their needs to improve the efficiency of their data entry work.

For the purposes of the virtual charrette (**Activity 1.2**) we will aim to *invite* specific representatives from 10% of all GSS-reporting institutions (around 30), focusing on attracting participants from a diverse range of institutional types and sizes, and considering institutions without dedicated postdoctoral offices and institutions whose data varies substantially from year to year. This will be undertaken to avoid replication of efforts by existing consortia, which may be organized according to institutional type or activity, and instead attempt to gather as much data as possible (*i.e.* maximizing collection of data on examples of existing barriers and best practices to overcome them). This effort will naturally inform the effort on how to prioritize targeting individual institutions for the survey described above.

Users of postdoc data:
We will also recruit those who use data for processes such as EEO/AA analysis from institutions, using both institutional contacts and consortia such as the American Association for Access, Equity and Diversity. Survey questions will ask about their use of data, and to present hypothetical scenarios that may have been informed by actual experiences, in order to inform charrette discussions. The meeting will also engage users of the GSS data from federal and private funding agencies, including NSF; institutional Equal Opportunity offices; think tank and non-profit representatives, such as the early career researcher advocacy group Future of Research. Finally, we will be particularly reaching out to institutional postdoctoral associations, as well as countrywide key partners such as the National Postdoctoral Association.

Explicit representation of HBCU and HSI institutions:
Of institutions represented in the GSS survey, we estimate that only about 0.5% of postdocs are at HBCUs/HSIs (Historically Black Colleges and Universities/Hispanic Serving Institutions, according to the Department of Education's definitions [de Brey *et al.* 2020]) Carnegie Classification "R2" institutions [Indiana n.d.]. However, we consider it particularly important that institutions specifically serving URM DDRs be over-represented and supported in this project in order to reflect their possible over-representation in support of the minority postdoc population. Many HBCUs and HSIs have seen changes in their reported postdoctoral populations from 2014-2019 (see examples in Figure 2) and ensuring that these institutions are supported in the resolution of any data collection or usage issues is of particular importance to our project.

	HBCU	2014	2019
1	Florida A&M U.	21	19
2	Hampton U.	19	30
3	Howard U.	18	8
4	Jackson State U.	16	27
5	Meharry Medical C.	15	14
6	Morehouse School of Medicine	14	7
7	Morgan State U.	14	5
8	Norfolk State U.	6	2
9	North Carolina A&T State U.	6	1
10	Savannah State U.	4	6
11	Texas Southern U.	1	1
12	Tuskegee U.	1	1



	HIS	2014	2019
1	San Diego State U.	32	23
2	Northern Arizona U.	29	35
3	Texas State U.	22	17
4	San Francisco State U.	13	7
5	Florida Atlantic U.	11	41
6	Florida Institute of Technology	9	3
7	Charles R. Drew U. of Medicine and Science	3	3
8	New Mexico Institute of Mining and	1	2

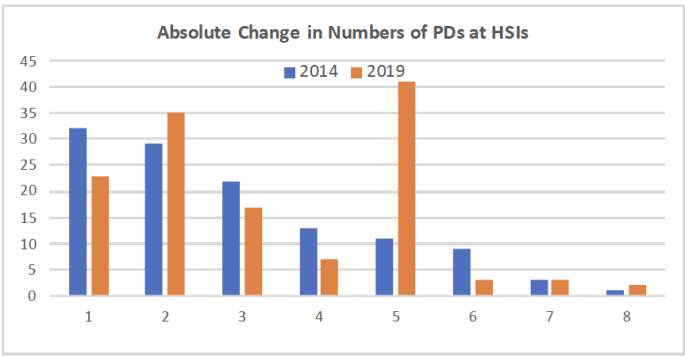


Figure 2: HBCU and HSI postdoc populations for 2015 and 2019, with relative change in postdoc populations for this 5-year time period.

Existing members of the project and advisory board will be able to provide representation for a number of institutions, with specific institutions, and possible examples to be contacted, listed below in Table 1.

Outcomes:
The data gathered in this preparatory phase will be used to structure the discussions at the event itself, determining subject matter for further work, as described below.

*Table 1: Example institutions for invitation. *Institutions with high year-to-year data variation*

Institution type	Examples of institutions to invite
R1 (Private)	Stanford University, Boston Univ, Univ of Chicago, Yale Univ
R1 (Public)	University of Wisconsin-Madison, Michigan State University, University of California Santa Cruz*, Univ of Maryland-Baltimore*
R1 (Medical)	Albert Einstein Coll of Medicine, Univ of Pennsylvania Schl of Medicine
R1 HSI	Univ of Arizona, Univ of California (UC) Irvine, UC Santa Barbara, UC Riverside, Texas Tech, Univ of Illinois - Chicago

R2 HBCU/HSI	Howard U, North Carolina A&T State U, Jackson State U, Meharry Medical Coll., Morehouse Sch. of Med., Florida Atlantic, Texas State U, Northern Arizona U, Univ of Puerto Rico, San Diego State Univ
Other R2 (Private)	Illinois Institute of Technology*, Loyola University Chicago
Other R2 (Public)	University of Arkansas at Little Rock
D/PU	University of South Carolina

Activity 1.2. – Convene a Virtual Charrette Designed to Uncover and Address Diversity Issues in NCSES Data

The virtual charrette will take place in conjunction with the 2023 DiverseScholar virtual conference held in the Fall. This event is specifically designed to enhance the professional development of postdocs especially for faculty careers [Rodriguez & Roca 2017]. *Colocalizing the charrette with this meeting brings the people whose careers are touched by federal initiatives to diversify the workforce based on NCSES data, i.e. postdocs, into the discussion and will provide focus and clarity to the mission of the charrette.* As a professional development and recruiting event, the DiverseScholar conference also engages STEM workforce diversity key partners. Such attendees are also users of NCSES postdoc data to inform decisions about applicant pool availability with the ultimate goal of diversifying the professoriate.

Number of Participants:

The charrette will aim to include approximately 30 institutional representatives, as described above, plus 10 individuals representing institutional diversity office representatives, postdoctoral association representatives, and representatives from RTI and NCSES. This group of up to 40 participants will be manageable for activities below, particularly with the team of 8 supporting this proposal who can facilitate breakout rooms of up to 5 participants that can be adapted to institutional type, size, and overall subject matter based on the results of the pre-event survey.

Focused presentations:

The virtual charette will include complementary sessions with the objective of providing background on issues related to diversifying the workforce, data gathering, identifying issues and defining potential solutions. Time spent on unidirectional sessions (*e.g.* talks and lectures) will be kept to an absolute minimum to ensure that time spent in structured, interactive workshops is maximized. Currently we propose at least the following sessions:

- A plenary presentation which will highlight why we are undertaking this work, with a speaker such as Dr. Richard Baker (President of the American Association for Access, Equity and Diversity – a professional society for EEO/AA administrators) discussing how data are used. DiverseScholar board member Dr. Sibby Anderson-Thompkins (and currently an academic Chief Diversity Officer) would be the discussant.
- The plenary will be followed by a presentation by an expert in postdoc data efforts such as labor economist and advisory board member, Dr. Paula Stephan, in conversation with co-P.I. Dr. McDowell. Both co-authored recommendations on postdoc data collection for the National Academies of Sciences, Engineering and Medicine 2018 report “The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through” [NASEM 2018].
- A panel session would specifically focus on minority postdocs who have previously participated in the DiverseScholar conference to discuss their experiences relating to how these issues have been important to their career path, such as their use of NCSES data to evaluate the diversity climate of a potential employer.

- We will also seek to include a speaker from RTI International to provide an overview of the survey and how they interact with contributors when support questions arise.

Structured Workshops:
One session will summarize the information gathered from the pre-survey, which will have been used to design the structured breakout sessions and assignment of participants to specific rooms. Breakout rooms will be designed that focus on identified problems and the contributing factors to that problem, towards designing proposed solutions to address these specific factors. This method has been employed by Dr. McDowell at a number of workshops and conferences to gather large amounts of specific data on a wide variety of topics [McDowell *et al.* 2014; Bankston *et al.* 2019; Ruiz *et al.* 2019]. Proposed topics currently include: barriers to data collection at institutional vs NCSES levels; data needs of Equal Employment Opportunity (EEO) officers, and how they are currently met; data needed to address studies on retention within the academy; *etc*. Dr. McDowell will also draw on other work bringing key partners from different disciplines together [Tennial *et al.* 2019; Campbell-Montalvo *et al.* 2020] to foster an inclusive environment that maximizes the focus on identifying and discussing problems with a collective vision towards improved data collection efficiency and data usability for all key partners.

Data Analysis:
Using a modified Delphi method employed in other work [McDowell *et al.* 2021], Dr. McDowell will seek to maximize input from participants, facilitating their effort to generate recommendations and written best practices that are of maximal use to a wide variety of key partners. Our project's final report will publish recommendations for NCSES and to institutional representatives and other key partners providing recommendations and guidance on data collection and data usage. In brief, the process makes use of an iterative approach whereby data are analyzed and recommendations crafted, that are then sent out to participants to review and provide commentary that is shared within the community anonymously, in order to facilitate honest conversations about what each key partner needs.

OBJECTIVE 2: Information gathered at each point of this project will be used to revise and adapt future steps, to hone in on data-driven recommendations and actions.

Activity 2.1. Post-charette survey:
Participants will complete an exit survey at the end of the charrette to capture any immediate reflections, outgoing thoughts, and aspirations for the outcomes of the work. Charrette participants will then be contacted 2-weeks post-charrette by Dr. McDowell to discuss the potential impact of the charrette on policies and procedures at their institution, and to clarify future expectations and goals for data entry, to then be articulated in the final report. Following up from this, Dr. McDowell will then use the modified Delphi process (modified because participants are not completely anonymous to each other, but will provide feedback to Dr. McDowell that will be de-identified and shared among key partners anonymously as part of the process) to generate draft recommendations and proposals for participants to critique.

Activity 2.2. Summary of results and final report preparation:
The data and insights gained from the virtual charrette and post-event Delphi process will be synthesized into summary results and specific recommendations geared to a number of key partners. The report will, at minimum, be distributed to all attendees of the charrette, to all contacted as part of the pre-survey work, to partner networks likely to be of interest, and posted to the DiverseScholar website. Opportunities to publish a commentary essay in a journal and discuss the work at conferences will be explored as part of the work, and participants will be

encouraged to engage in the dissemination of the work, for example by hosting project team members for talks or discussions at their institutions.

The report will be designed to inform NCSES of the sources and estimates of error and gaps in NCSES postdoc data collection, providing a summary of results and specific recommendations impacting reliability of the data, so that NSF can understand and undertake work to correct inconsistencies. The report will also be designed to inform the wider postdoc data-entry community (specifically administrators at universities) of the best practices currently in operation to ensure data entry is as consistent and efficient as possible; and to highlight the importance of how the data can be used, particularly in relation to issues affecting diversity and retention in the academic community. The report will include analyses of the current state of the data; particularly noting the accuracy of current possible analyses, and the caveats of and gaps in particular datasets. Such knowledge gaps could include, for example, demographic data about DDRs that are currently not collected such as ethnic/racial categories that are more granular than current federal definitions. Dissemination of the report will be designed with the aim of establishing an on-going collaborative network to address these issues in the broader context of diversifying the STEM workforce by a future grant proposal based on this pilot study.

The charrette itself will be novel in its approach to connecting disparate groups to solve a collective issue including NCSES and survey designers; institutional representatives responsible for data entry; institutional representatives for diversity processes; and URM postdocs themselves. The meeting will also explicitly seek to be different than other meeting events which provide recommendations, in that it will actively seek to generate actionable items and usable processes with clear steps for action to be taken by a group of key partners. The project will also seek to identify those wishing to undertake future work in this direction. The meeting will therefore be able to take recommendations issued by organizations such as NASEM, and fulfill NASEM's aspirations that recommendations are acted upon by subsequent efforts.

BROADER IMPACTS

The diversity of the STEM workforce is slowly improving, but this diversity is not spread equally across all disciplines, nor translating into a diversification of certain STEM professions, such as the professoriate. The postdoc-to-faculty transition is a key bottleneck in diversifying the professoriate [Meyers *et al.* 2018], but anecdotal attitudes of a lack of diversity in the hiring pool conflict with recent literature on the composition of this pool, particularly in disciplines such as the biological and the physical sciences.

The results of this project will allow faculty search committees and institutional training programs to have access to datasets with as much accuracy and depth as possible. We explicitly seek to uncover the hidden deficiencies in the recruiting process that can only be addressed by connecting the key partners together, to share the issues faced by each group and work towards a common goal of improving URM postdoc data collection. This will therefore lead to data that is more useful for a number of processes and policies affecting URM postdocs, while also making the caveats and limitations of the data clearer so that policies are also not created under false assumptions about what the data can and cannot show.

Moreover, this project will provide URM graduate and postdoc scholars with a resource for assessing institutional diversity that might reflect an environment more conducive to their career success thereby potentially broadening the participation of those successfully achieving faculty careers. This proposal aims to support NSF in the goal of making NCSES data as accessible and useful as possible to those wishing to effect change in this arena. This project will also identify ways of improving data collection and submission efforts at individual institutions, providing

education and training materials and disseminating them throughout the wider STEM DEI community. The results should also prove useful for funding agencies to assess the need for new initiatives toward serving this community of scholars that are drastically underrepresented in STEM academia.

BIBLIOGRAPHY

Arbeit CA, Einaudi P, Green P, Kang KH (2016) Assessing the Impact of Frame Changes on Trend Data from the Survey of Graduate Students and Postdoctorates in Science and Engineering. *Special Report NSF 16-314*, National Center for Science and Engineering Statistics, National Science Foundation, Arlington, VA

Arbeit CA, Yamaner MI (2022) Universities Report Growth in U.S. Citizen and Permanent Resident Enrollment along with Declines in Enrollment of Temporary Visa Holders at Master's and Doctoral Levels Due to the COVID-19 Pandemic, *InfoBrief NSF 22-313*, National Center for Science and Engineering Statistics, National Science Foundation, Alexandria, VA

Bankston A, Fagen AP, McDowell GS, Gunsalus K, Hall S (2019) Enhancing the connections between institutions and organizations to advance postdoctoral training. *PeerJ Preprints* 7:e27568v1

Campbell-Montalvo RA, Caporale N, McDowell GS, Idlebird C, Wiens KM, Jackson KM, Marcette JD, Moore ME (2020) Insights from the Inclusive Environments and Metrics in Biology Education and Research Network: Our Experience Organizing Inclusive Biology Education Research Events. *Journal of Microbiology & Biology Education* 21(1): 2083

Chang v. University of Rhode Island (1985) 606 F. Supp. 1161 - Dist. Court, D. Rhode Island

de Brey C, Zhang A, Duffy S (2020) *Digest of Education Statistics*, National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC

Einaudi P, Heuer R, Green P (2013) Counts of Postdoctoral Appointees in Science, Engineering, and Health Rise with Reporting Improvements. *InfoBrief NSF 13-334*, National Science Foundation, Alexandria, VA

Garrison HH, Justement LB, Gerbi SA (2016) Biomedical science postdocs: an end to the era of expansion. *The FASEB Journal* 30(1):41-44

Indiana University Center for Postsecondary Research (n.d.) The Carnegie Classification of Institutions of Higher Education, 2021 edition, Bloomington, IN

McDowell GS, Gunsalus KTW, MacKellar DC, Mazzilli SA, Pai VP, Goodwin PR, Walsh EM, Robinson-Mosher A, Bowman TA, Kraemer J, Erb ML, Schoenfeld E, Shokri L, Jackson JD, Islam A, Mattozzi MD, Krukenberg KA, Polka JK (2014) Shaping the Future of Research: a perspective from junior scientists. *F1000Research* 3: 291

McDowell GS, Polka JK, Ross-Hellauer T, Stein G (2021) The DocMaps Framework for representing assertions on research products in an extensible, machine-readable, and discoverable format. *bioRxiv* 2021.07.13.452204

Meyers LC, Brown AM, Moneta-Koehler L, Chalkley R (2018) Survey of checkpoints along the pathway to diverse biomedical research faculty. *PLoS One* 13(1): e0190606

Milam J (1998) The Glut of Ph.D.s: Complex Models for the Faculty Workforce. Conference paper for the Association for Institutional Research (Minneapolis, MN)

Moore ME, Vega DM, Wiens KM, Caporale N (2020) Connecting Theory to Practice: Using Self-Determination Theory To Better Understand Inclusion in STEM. *Journal of Microbiology & Biology Education* 21(1): 1955

National Academies of Sciences, Engineering, and Medicine (2018) The Next Generation of Biomedical and Behavioral Sciences Researchers: Breaking Through. The National Academies Press, Washington, DC

National Science Foundation (2019) Survey of Graduate Students and Postdoctorates in Science and Engineering (GSS). National Science Foundation, Alexandria, VA

Pickett C, Bankston A, McDowell GS (2017) The GSS is an unreliable indicator of biological sciences postdoc population trends. *bioRxiv* 171314

Rodriguez BA and Roca AI (2017) DiverseScholar Conference Preps Underrepresented Postdocs for Faculty Jobs. *DiverseScholar* 8:2

Ruiz JP, Gurel P, Olds WH, Bankston A, McDowell GS (2019) Inspiring and ethical mentorship in STEM: A meeting highlighting need for engagement, incentives, and accountability. *PeerJ Preprints* 7: e27474v1

Scott v. University of Delaware (1978) 455 F. Supp. 1102 - Dist. Court, D. Delaware

Schaller MD, McDowell G, Porter A, Shippen D, Friedman KL, Gentry MS, Serio TR, Sundquist WI (2017) What's in a name? *eLife* 6: e32437

Tennial RE, Solomon ED, Hammonds-Odie L, McDowell GS, Moore M, Roca AI, Marcette J (2019) Formation of the inclusive environments and metrics in biology education and research (iEMBER) network: building a culture of diversity, equity, and inclusion. *CBE Life Sciences Education* 18(1): mr1

Yackee J (2021) Targets of Opportunity? The History, Law, and Practice of Affirmative Action in University Faculty Hiring. *Wisconsin Law Review* 2020(6): 1199

Appendix - Draft Recommendations from Future of Research (Gary McDowell and Jessica Polka) during Next Generation Researchers Initiative

The pathways from postdoctoral fellowships to independent research careers both within and outside of academia need to be more robust and responsive.

- NIH should increase the number of NRSA Individual Postdoctoral Fellowship Awards and Career Development Awards to support one-third of the postdoctoral population. In order to accommodate international postdocs, the NIH should create a new fellowship mechanism for which they are eligible (see K32 rationale below). The awards should provide benefits to postdoctoral researchers that are appropriate to their level of experience and commensurate with benefits given to equivalent full-time employees at their host institution.
- NIH should phase in a 3-year cap on salary support for postdoctoral researchers on research grants. This cap should not apply to any time spent on fellowships or career development awards, which may occur after, before, or in between periods of support on grants awarded to any principal investigator. Congress should require NIH to report within 12 months of implementation of the 3-year cap on how it believes senior domestic and foreign postdocs should be supported once their 3-year cap expires.

Rationale
The postdoctoral experience should be a period of a mentored transition to independence, providing 1) increasing intellectual control of scientific direction and 2) professional development in skills necessary to lead a research project.

Today, however, the majority of postdocs are supported on funding mechanisms that do not adequately promote this transition. Research project grants and other funding awarded to and controlled solely by the PI enable the use of postdocs as technicians who are expected to execute predefined aims. Under these conditions, many postdocs face barriers to cultivating independence. The number of available fellowships is much smaller than the number of postdocs, and it has declined in real terms over time despite the fact that previous reports have recommended its increase (as summarized in (Pickett et al. 2015)).

We advocate for a dramatic increase in the proportion of postdocs supported by F and K mechanisms and the introduction of a K fellowship mechanism to accommodate foreign postdocs (see “K32” section below), who constitute the majority of the workforce and are highly productive (Stephan and Levin 2001). Postdocs supported by these mechanisms can pursue research of their own design, and the portability of these fellowships can ensure a suitable mentoring experience by tying the postdoc to a project rather than particular PI. Furthermore, fellowships permit the direct evaluation of scientists with the potential to make great

contributions to science; currently, with most postdocs on research project grants, PIs can be incentivized to select productive subordinates rather than independent thinkers.

We specifically recommend increases in independent fellowships rather than training grants. Postdocs on fellowships performed better on all outcomes measured compared with postdocs on project grants and training grants (Biomedical Research Workforce Working Group 2012). Indeed, it has been identified as potentially disadvantageous for underrepresented populations to be on research grants rather than training or fellowship mechanisms (Working Group on Diversity in the Biomedical Research Workforce 2012). Because PIs spend a large percentage of their time crafting applications for funding, grantsmanship is a key skill for researchers aiming to attain independence in academia. Applying for an individual fellowship should therefore become a standard part of the postdoctoral training experience.

Shifting all postdocs to fellowships would pose challenges, such as requiring students to apply before reaching their postdoc lab, removing a buffer for those who do not succeed on their first application, and potentially reducing flexibility in timing subsequent career moves.

Instead, we recommend capping the cumulative duration of any postdoc's salary support on any grants awarded to any faculty member. For example, a postdoc could be supported for three years on their PI's grant before transitioning to a fellowship or career development award. If the postdoc's fellowship or career development award is funded after only one year on their PI's grant, that postdoc can return to being funded on grants for two years after the completion of their fellowship or career development award. This arrangement creates the expectation of increased independence during the postdoctoral period, while providing a buffer to account for gaps in funding **before, after, or between fellowships.** In extenuating circumstances, this limit could be extended to 3.5 years with proper justification.

The concept of capping postdoctoral time is not new, although most current implementations are insensitive to the type of funding support. These caps are motivated by the fact that a large number of postdocs are undertaking multiple postdoc positions and staying in postdoctoral research for a long period of time (Biomedical Research Workforce Working Group 2012). For example, the National Postdoc Survey demonstrated that in 2016, one-third of surveyed postdocs reported being in their second (or multiple) postdoc experience, and just under one half of 2005 PhD recipients undertook postdoctoral training beyond 5 years (National Academies of Sciences, Engineering, and Medicine 2018). This phenomenon is a symptom of hypercompetition driven by the need to amass an impressive CV in order to be considered for faculty jobs. To address this symptom, a number of institutions have a nominal cap on the length of time one can carry out postdoctoral research, but it is not possible to know whether these caps are effective due to the use of multiple postdoc titles and the haphazard state of administration of postdocs (Schaller et al. 2017). These limits simply result in a change in title after 5 years to what is nominally the same position, obfuscating the length of the postdoc and masking the severity of the problem.

Because institutional caps can be circumvented, we argue that NIH should track all PhD-level researchers supported by grants to PIs. This would close the loophole presently allowing researchers to essentially continue their postdoc appointments under a nominally different title. Specifically, this should include guidelines for salary and benefits offered to staff scientists, which should be higher than those offered to postdocs. A universally-implemented tracking system will not solve the underlying problem of hypercompetition, but it will improve upon the current situation by limiting the time that postdocs can spend in a holding tank and drive career decisions and planning because a defined timescale exists.

Mentoring plans should be carefully scrutinized to ensure that the PI has enough time to devote to each fellow in their lab. Fellowships currently tend to go to larger labs and well-funded institutions; a percentage commitment by a PI to each fellowship could limit the number per lab, and we recommend that the award of these fellowships is made with attention to diversity in geographic location and underrepresented status. In addition, postdocs mentored by ESIs may be disadvantaged in applying for fellowships due to a lack of their PI's track record. Alternative evaluation mechanisms should be considered to remove this bias.

Any change to the proportion of postdocs on research grants would need to accommodate foreign talent and balance it with opportunities for underrepresented populations in the US. We propose consideration of a new Career Development Award, the "K32", specifically for foreign postdocs, and provide the rationale below.

Proposal for a "K32" Career Development Award for international postdoctoral researchers

Premise

NIH should consider the creation of a new K award mechanism specifically for recruiting and retaining the best international scientific talent to maintain the United State's global leadership in biomedical research.

The United States has long been the global leader in biomedical research, and the resources and intellectual freedom that are hallmarks of this system attract the most talented scientists from across the globe. Approximately ⅔ of current biomedical postdocs in the United States are foreign, and 52% of the PhD-holding U.S. biomedical workforce is composed of foreign-born workers (Heggeness et al. 2016; Heggeness et al. 2017). Foreign-born researchers are highly productive and increase the scientific output of the U.S. (Stephan and Levin 2001). However, as other countries increase their investments in their own biomedical research infrastructure and talent, many of these foreign-born, U.S.-trained scientists are returning to their home countries to conduct their research.

The only NIH mechanism for funding postdoctoral talent from abroad is the K99/R00 award, in which foreign postdocs compete with U.S. citizens and permanent residents. This mechanism facilitates the transition to independence later in the postdoctoral experience, but there are no options for independent support in the early postdoctoral phase. As a result, many currently come on foreign fellowships, which may include requirements to return to the awarding country after training, or are funded from research project grants, which can offer few opportunities for

intellectual independence (see above) and no assessment of training and evaluation of postdocs. It is therefore difficult to identify talented, foreign-born investigators who could contribute to the breadth of science funded by NIH and target them specifically for retention. By placing foreign postdocs at a disadvantage relative to their domestic counterparts, the U.S., which currently leads in training the world's scientists, may face more fierce competition in coming years for the world's best talent.

Proposal

NIH should seek to attract, identify and retain the best researchers from around the world through the creation of a dedicated career development award, the K32 Career Development Award. This award could combine appropriate components of the F32 National Research Service Award, the K01 Mentored Research Scientist Development Award, and the NCI Predoctoral to Postdoctoral Fellow Transition F99/K00 award, but is necessarily different in the following ways:

- National Research Service Awards under Federal law cannot be made to non-citizen/resident applicants, and the F99/K00 and K01 are not open to non-citizens/residents;
- The K01 citizenship requirement could be adjusted by NIH, but it would still need extensive repurposing and is not currently used across all institutes;
- The evaluation and implementation of a K32 mechanism could address differences in PhD training across the world, including shorter PhD lengths (for example, in Europe) leading to the need for extra mentoring for independence in a U.S. context;
- A specific mechanism for international researchers also allows for more opportunities to modulate the population, which can be adjusted in order to be a competitive award to attract talented researchers to the U.S.
- The K32 program should ideally be similar in size to the F32 program.

Design

Foreign researchers coming to the U.S. to postdoc require advance preparation to acquire the proper visa documentation, and are therefore well-positioned to apply for a fellowship during this already protracted planning process. Encouraging those looking to come to the U.S. to apply for this award in advance as part of that process would allow the award to be targeted to those who have just begun their postdoctoral training. Key to the award is the identification of those with the *potential* to thrive in the U.S. biomedical enterprise, but with *gaps in training* compared to U.S.-trained peers. A 3-year award could involve the following components:

- A mentoring team that consists of not only the Principal Investigator with whom they propose to undertake their research, but also other faculty, perhaps of similar regional origin, to identify gaps in training that may exist, and staff from the research institution with expertise in cultural differences to identify barriers they may face or strengths these researchers may bring. This could fit as a component of the larger diversity plan for the institution, most particularly around the subject of creating inclusive environments.
- Specific training in aspects such as grantsmanship and scientific writing (requirements for papers on graduation from foreign PhDs are variable); leadership and management;

development and encouragement of independent thought; and other factors that have been identified that may limit their potential.

- The award should be limited to applicants with less than one year of postdoctoral research experience. The ideal mechanism would enable activation of the award immediately upon beginning their postdoctoral research, but funding the candidate for up to one year on a research project grant should be allowable to accommodate circumstances such as timing of visas and movement requirements. The application process should begin as a natural fit with the identification of the mentor and project, and not once the candidate has arrived in the U.S.
- The award is mentored but independent and thus needs to include research costs for the postdoc only. The funds should be portable, so that if the awardee gets a faculty job, they can take it with them, though this is not the goal. This differentiates from K22 and K99/R00 awards which are dependent on such a move for release of the full funds.

Further Considerations

There are two foreign postdoctoral populations that should be taken under consideration: foreign nationals with U.S.-based PhD training and those with foreign PhDs. It should be considered whether to open up the K01 to non-citizens/residents who have had PhD training in the U.S. and extend its use across institutions, and use the K32 only to attract those with foreign PhDs who are ineligible for other fellowship mechanisms. In this way appropriate mechanisms could exist for both U.S.-trained and foreign-trained PhDs that could be used as controlled experiments to evaluate how NIH balances attracting foreign talent with ensuring it is also training citizens. This would also prevent one group from being unfairly disadvantaged compared to the other in the process of recruiting the best talent.

Concluding Thoughts

These ideas are radical, but we hope that in proposing them the logic of supporting postdocs on funding mechanisms that facilitate professional development and intellectual independence, rather than the use of postdocs as cheaper staff scientists on research project grants, is clear. These approaches would also allow better counting of the number of postdocs in the US, which is currently unknown after 50 years of discussion on the topic. This should be a source of embarrassment given the essentiality of the postdoc road to the professoriate. Institutions are variable in their ability to count and administer their postdocs effectively; some have solved this relatively trivial problem, but the community is still waiting on others (Schaller et al. 2017). Such institutions are likely wasting both their and the nation's money with their inability to count and administer their own postdocs effectively. This hinders the federally-funded NSF effort to count them (Pickett et al. 2017); it causes more work for administrators and delays benefits to affected employees in complying with federal regulations (Bankston and McDowell 2016), and also leads to highly variable reports of metrics as simple as salaries (Athanasiadou et al. 2017).

Much as careful tracking of physician scientists has highlighted the urgent need to find ways to retain them, actually counting postdocs will likely highlight that there are far too many postdocs for positions that require them. This is a conclusion already borne out by current labor market data suggesting the existence of a large labor market gap in biomedicine due to the postdoc

surplus (Mason et al. 2016), and that the jobs for the next generation of researchers lie not in biomedical fields but in computational ones (Fayer et al. 2017). 80% of U.S. biomedical PhDs go on to postdoctoral positions (National Academies of Sciences, Engineering, and Medicine 2018). The status of the postdoc as a default extension of the PhD raises serious questions about the necessity of this path for PhDs, particularly as these positions are largely funded by the U.S. taxpayer. Careful tracking of postdocs and supporting a greater population on fellowship mechanisms could provide a way to gradually reduce their number. Transitions out of training for the next generation of researchers should increasingly be made out of graduate school, and should not involve postdoctoral research unless such an experience truly provides value to the scientist, their potential employers, and the nation.

Appendix - Freedom of Information Request from NIH regarding exclusion of international researchers from NRSA mechanisms

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

National Institutes of Health
Freedom of Information Office
Building 31, Room 5B-35
31 Center Drive, MSC 2107
Bethesda, Maryland 20892-2107
phone: (301) 496-5633
fax: (301) 402-4541

Email: info@lightoller.org

April 5, 2021

Dr. Gary Steven McDowell
Consultant
Lightoller LLC

22

Re: FOI Case Nos. 55524 and 55525

Dear Dr. McDowell:

This is the final response to your December 8, 2020, Freedom of Information Act (FOIA) requests addressed to the NIH FOIA Office and the Office of Extramural Research (OER) at the National Institutes of Health (NIH) and received in this office on December 9, 2020.

In both requests, you requested the legal text which prevents the National Institutes of Health from awarding National Research Service Awards (e.g. T32, F32) to applicants who are neither U.S. citizens nor U.S. Permanent Residents.

Please be advised that your requests are not proper FOIA requests, but in good faith the NIH is providing the following information:

> The regulations for the National Institutes of Health (NIH) Ruth L. Kirschstein National Research Service Awards (NRSA) are at 42 Code of Federal Regulations (CFR) Part 66. The NRSA program provides fellowship awards to individuals for training to undertake biomedical and behavioral research; and grants to institutions to enable those institutions to make awards to individuals for training in biomedical and behavioral research. The following regulatory provisions address citizenship requirements under the NRSA program for both fellowship awards and institutional grants:
>
> Fellowship awards to individuals
>
> 42 CFR § 66.103:
> To be eligible for a National Research Service Award an individual must:
>
> (a) Be a citizen, noncitizen national of the United States, or lawfully admitted to the United States for permanent residence at the time of the award.

[22] Image edited to remove mailing address.

42 CFR § 66.102(f): Noncitizen national of the United States means a person who, though not a citizen of the United States, owes permanent allegiance to the United States [8 U.S.C. 1101(a) (22)].

Institutional grants

42 CFR § 66.205:

(a) No Award shall be made to an individual from a grant under this subpart unless:

(2) The individual is a citizen or noncitizen national of the United States or has been lawfully admitted to the United States for permanent residence at the time of the award

42 CFR § 66.202: The definitions in § 66.102 of subpart A of this part apply to this subpart.

If you are not satisfied with the processing and handling of this requests, you may contact the NIH FOIA Public Liaison and/or the Office of Government Information Services (OGIS):

NIH FOIA Public Liaison
Public Affairs Specialist
NIH FOIA Office
Building 31 Room 5B35
31 Center Drive
Bethesda, MD 20892
301-496-5633 (phone)
nihfoia@od.nih.gov (email)

OGIS
National Archives and Records Admin.
8601 Adelphi Rd – OGIS
College Park, MD 20740-6001
202-741-5770 (phone)
1-877-684-6448 (toll-free)
202-741-5769 (fax)
ogis@nara.gov (email)

In certain circumstances provisions of the FOIA and HHS FOIA Regulations allow us to recover part of the cost of responding to your requests. Because no unusual circumstances apply to the processing of your requests, there is no charge associated with our response.

If you have any questions about this response please call me at 301-496-5633.

Sincerely,

Gorka Garcia-malene -S

Digitally signed by Gorka Garcia-malene -S
Date: 2021.04.05 15:50:56 -04'00'

Gorka Garcia-Malene
Freedom of Information Officer, NIH

Appendix - Historical Salary Data and Proportion of International Postdocs at NIH (2016 and 2017)

Number of Postdocs at NIH, by Institute:

Institute	# Postdocs 2016	# Postdocs 2017
	All Institutes: 2149	**All Institutes: 2119**
NIE	59	56
NIAAA	39	33
NIAID	253	242
NIDA	69	65
NIA	116	114
NIAMS	31	43
NIBIB	19	22
NICHD	191	188
NINDS	114	96
NLM	0	0
NIMHD	3	0
NHGRI	47	53
NIGMS	23	22
NINR	5	6
NHLBI	122	97
NIMH	61	67
NIDDK	189	188
NIDCD	23	18
NIDCR	31	6
NCI	649	687
NIEHS	105	116

Summary NIH Postdoc Salary Data, by Year and Institute

Institute	Year	Title	Average	Median	Min	Max	% Inter-national
NEI	2016	POST DOCTORAL VISITING FELLOW	$54,101	$53,480	$49,200	$65,450	
NEI	2016	POST DOCTORAL-IRTA	$54,789	$53,600	$49,400	$69,250	
NEI	**2016**	**ALL**	**$54,318**	**$53,540**	**$49,200**	**$69,250**	**71%**
NEI	2017	POST DOCTORAL VISITING FELLOW	$54,189	$53,040	$48,450	$65,450	
NEI	2017	POST DOCTORAL-IRTA	$56,744	$55,600	$50,350	$69,250	
NEI	**2017**	**ALL**	**$54,782**	**$54,000**	**$48,450**	**$69,250**	**77%**
NIAAA	2016	POST DOCTORAL VISITING FELLOW	$55,715	$55,500	$49,500	$63,900	
NIAAA	2016	POST DOCTORAL-IRTA	$57,539	$56,000	$53,450	$65,800	
NIAAA	**2016**	**ALL**	**$56,340**	**$56,000**	**$49,500**	**$65,800**	**66%**
NIAAA	2017	POST DOCTORAL VISITING FELLOW	$54,657	$53,525	$49,400	$63,900	
NIAAA	2017	POST DOCTORAL-IRTA	$56,988	$56,000	$48,450	$65,800	
NIAAA	**2017**	**ALL**	**$55,434**	**$54,000**	**$48,450**	**$65,800**	**67%**
NIAID	2016	POSTDOCTORAL VISITING FELLOW	$51,401	$51,500	$47,000	$63,000	
NIAID	2016	POSTDOCTORAL IRTA	$51,415	$51,500	$47,000	$58,500	
NIAID	**2016**	**ALL**	**$51,406**	**$51,500**	**$47,000**	**$63,000**	**64%**
NIAID	2017	POSTDOCTORAL VISITING FELLOW	$52,364	$52,000	$48,450	$63,200	
NIAID	2017	POSTDOCTORAL IRTA	$53,212	$52,550	$48,450	$68,350	
NIAID	**2017**	**ALL**	**$52,675**	**$52,550**	**$48,450**	**$68,350**	**64%**
NIDA	2016	POSTDOCTORAL VISITING FELLOW	$50,770	$51,375	$18,375	$63,300	
NIDA	2016	POST-DOC PAN AM VIS	$52,550	$52,550	$52,550	$52,550	
NIDA	2016	POSTDOCTORAL IRTA	$54,881	$54,550	$47,500	$65,800	
NIDA	**2016**	**ALL**	**$52,821**	**$53,000**	**$18,375**	**$65,800**	**51%**
NIDA	2017	POSTDOCTORAL VISITING FELLOW	$52,786	$53,000	$19,425	$62,000	
NIDA	2017	POST-DOC PAN AM VIS	$54,500	$54,500	$54,500	$54,500	
NIDA	2017	POSTDOCTORAL IRTA	$55,910	$54,500	$49,450	$71,300	
NIDA	**2017**	**ALL**	**$54,446**	**$54,050**	**$19,425**	**$71,300**	**48%**

Institute	Year	Title	Average	Median	Min	Max	% Inter-national
NIA	2016	VISITING FELLOW	$52,404	$51,850	$33,800	$68,150	
NIA	2016	POST-DOC IRTA	$52,205	$51,975	$47,750	$57,200	
NIA	**2016**	**ALL**	**$52,352**	**$51,950**	**$33,800**	**$68,150**	**74%**
NIA	2017	VISITING FELLOW	$52,131	$51,000	$36,150	$68,150	
NIA	2017	POST-DOC IRTA	$52,813	$51,800	$48,450	$67,750	
NIA	**2017**	**ALL**	**$52,320**	**$51,425**	**$36,150**	**$68,150**	**73%**
NIAMS	2016	POSTDOCTORAL FELLOW (VP)	$52,803	$52,525	$36,150	$60,050	
NIAMS	2016	POSTDOCTORAL FELLOW	$51,700	$52,975	$38,850	$59,700	
NIAMS	**2016**	**ALL**	**$52,488**	**$52,525**	**$36,150**	**$60,050**	**74%**
NIAMS	2017	POSTDOCTORAL FELLOW (VP)	$55,003	$54,050	$49,450	$66,600	
NIAMS	2017	POSTDOCTORAL FELLOW	$54,452	$52,250	$50,024	$60,500	
NIAMS	**2017**	**ALL**	**$54,869**	**$54,000**	**$50,024**	**$66,600**	**77%**
NIBIB	2016	VISITING FELLOW	$54,156	$48,250	$45,500	$105,267	
NIBIB	2016	POST-DOC IRTA	$54,457	$55,600	$50,633	$58,000	
NIBIB	**2016**	**ALL**	**$54,250**	**$50,092**	**$45,500**	**$105,267**	**74%**
NIBIB	2017	VISITING FELLOW	$52,067	$50,450	$49,000	$66,000	
NIBIB	2017	POST-DOC IRTA	$56,455	$57,100	$46,450	$65,050	
NIBIB	**2017**	**ALL**	**$53,602**	**$51,475**	**$46,450**	**$66,000**	**68%**
NICHD	2016	POST DOCTORAL-IRTA	$54,817	$54,050	$27,025	$71,350	
NICHD	2016	POST DOCTORAL-VF	$53,617	$52,550	$47,300	$71,300	
NICHD	**2016**	**ALL**	**$54,021**	**$53,025**	**$27,025**	**$71,350**	**68%**
NICHD	2017	POST DOCTORAL-IRTA	$54,040	$53,000	$27,025	$71,350	
NICHD	2017	POST DOCTORAL-VF	$53,188	$52,550	$47,500	$75,050	
NICHD	**2017**	**ALL**	**$53,453**	**$52,550**	**$27,025**	**$75,050**	**70%**
NINDS	2016	CLINICAL FELLOW	$72,422	$72,422	$72,422	$72,422	
NINDS	2016	CONTRACTOR - OTHER	$55,794	$55,794	$34,000	$77,587	
NINDS	2016	IRTA (POSTDOC)	$52,379	$53,550	$14,135	$65,750	
NINDS	2016	POST-DOC PAN AM VIS	$59,200	$59,200	$59,200	$59,200	
NINDS	2016	VISITING FELLOW (POSTDOC)	$53,183	$52,950	$47,000	$63,750	
NINDS	**2016**	**ALL**	**$53,189**	**$53,225**	**$14,135**	**$77,587**	**65%**
NINDS	2017	CONTRACTOR - OTHER	$77,587	$77,587	$77,587	$77,587	
NINDS	2017	IRTA (POSTDOC)	$52,649	$52,775	$27,540	$65,750	
NINDS	2017	POST-DOC PAN AM VIS	$59,200	$59,200	$59,200	$59,200	
NINDS	2017	VISITING FELLOW (POSTDOC)	$53,250	$51,800	$16,274	$15,616	
NINDS	**2017**	**ALL**	**$53,396**	**$52,525**	**$16,274**	**$77,587**	**70%**
NIMHD	2016	POSTDOCTORAL IRTA	$51,375	$51,375	$48,100	$54,650	

Institute	Year	Title	Average	Median	Min	Max	% Inter-national
NIMHD	2016	POST-DOC PAN AM VIS	$52,950	$52,950	$52,950	$52,950	
NIMHD	**2016**	**ALL**	**$51,900**	**$52,950**	**$48,100**	**$54,650**	**33%**
NIMHD	**2017**	**ALL**	**-**	**-**	**-**	**-**	**-**
NLM	**2016**	**ALL**	**-**	**-**	**-**	**-**	**-**
NLM	**2017**	**ALL**	**-**	**-**	**-**	**-**	**-**
NHGRI	2016	POSTDOCTORAL IRTA	$51,236	$51,450	$47,000	$58,100	
NHGRI	2016	VISITING FELLOW (POSTDOC)	$51,579	$51,500	$47,400	$60,000	
NHGRI	**2016**	**ALL**	**$51,419**	**$51,500**	**$47,000**	**$60,000**	**53%**
NHGRI	2017	POSTDOCTORAL IRTA	$53,029	$52,950	$48,450	$59,250	
NHGRI	2017	VISITING FELLOW (POSTDOC)	$53,034	$52,550	$33,150	$63,250	
NHGRI	**2017**	**ALL**	**$53,032**	**$52,550**	**$33,150**	**$63,250**	**64%**
NIGMS	2016	POSTDOCTORAL IRTA	$61,074	$62,400	$14,820	$76,800	
NIGMS	2016	VISITING FELLOW (POSTDOC)	$46,400	$46,400	$46,400	$46,400	
NIGMS	**2016**	**ALL**	**$60,436**	**$62,400**	**$14,820**	**$76,800**	**4%**
NIGMS	2017	POSTDOCTORAL IRTA	$58,882	$61,150	$14,568	$65,100	
NIGMS	2017	VISITING FELLOW (POSTDOC)	$52,550	$52,550	$52,550	$52,550	
NIGMS	**2017**	**ALL**	**$58,594**	**$61,150**	**$14,568**	**$65,100**	**5%**
NINR	2016	POSTDOCTORAL IRTA	$52,383	$52,062	$44,256	$61,152	
NINR	2016	VISITING FELLOW (POSTDOC)	$30,960	$30,960	$30,960	$30,960	
NINR	**2016**	**ALL**	**$48,098**	**$45,000**	**$30,960**	**$61,152**	**20%**
NINR	2017	POSTDOCTORAL IRTA	$40,585	$46,452	$2,016	$65,052	
NINR	2017	VISITING FELLOW (POSTDOC)	$7,908	$7,908	$7,908	$7,908	
NINR	**2017**	**ALL**	**$35,138**	**$43,200**	**$2,016**	**$65,052**	**17%**
NHLBI	2016	POSTDOCTORAL IRTA	$55,233	$54,050	$47,500	$64,800	
NHLBI	2016	POST-DOC PAN AM VIS	$56,563	$56,275	$51,500	$62,200	
NHLBI	2016	VISITING FELLOW (POSTDOC)	$54,671	$53,600	$48,400	$67,500	
NHLBI	**2016**	**ALL**	**$54,986**	**$53,950**	**$47,500**	**$64,800**	**55%**
NHLBI	2017	POSTDOCTORAL IRTA	$56,855	$55,750	$48,500	$75,650	
NHLBI	2017	POST-DOC PAN AM VIS	$55,272	$53,500	$49,400	$62,200	
NHLBI	2017	VISITING FELLOW (POSTDOC)	$54,738	$54,000	$48,450	$67,050	
NHLBI	**2017**	**ALL**	**$55,617**	**$54,550**	**$48,450**	**$75,650**	**60%**
NIMH	2016	POSTDOCTORAL IRTA	$56,313	$55,550	$51,400	$66,650	
NIMH	2016	VISITING FELLOW (POSTDOC)	$57,959	$55,899	$51,400	$68,094	
NIMH	**2016**	**ALL**	**$57,149**	**$55,550**	**$51,400**	**$68,094**	**51%**
NIMH	2017	POSTDOCTORAL IRTA	$57,937	$56,550	$54,000	$68,150	
NIMH	2017	VISITING FELLOW (POSTDOC)	$58,185	$56,100	$50,950	$67,900	
NIMH	**2017**	**ALL**	**$58,059**	**$56,100**	**$50,950**	**$68,150**	**49%**

Institute	Year	Title	Average	Median	Min	Max	% Inter-national
NIDDK	2016	POSTDOCTORAL IRTA	$53,287	$52,550	$42,400	$61,950	
NIDDK	2016	VISITING FELLOW (POSTDOC)	$53,997	$53,000	$35,450	$89,650	
NIDDK	**2016**	**ALL**	**$53,821**	**$53,000**	**$35,450**	**$89,650**	**76%**
NIDDK	2017	POSTDOCTORAL IRTA	$52,021	$52,550	$48,450	$57,500	
NIDDK	2017	VISITING FELLOW (POSTDOC)	$52,958	$52,550	$48,450	$64,750	
NIDDK	**2017**	**ALL**	**$52,740**	**$52,550**	**$48,450**	**$64,750**	**77%**
NIDCD	2016	POSTDOCTORAL IRTA	$56,029	$56,050	$48,900	$66,700	
NIDCD	2016	VISITING FELLOW (POSTDOC)	$52,198	$50,374	$47,500	$67,500	
NIDCD	**2016**	**ALL**	**$54,196**	**$53,500**	**$47,500**	**$67,500**	**48%**
NIDCD	2017	POSTDOCTORAL IRTA	$58,444	$58,875	$48,450	$70,050	
NIDCD	2017	VISITING FELLOW (POSTDOC)	$53,453	$52,674	$51,000	$56,000	
NIDCD	**2017**	**ALL**	$56,606	$56,000	$48,450	$70,050	**37%**
NIDCR	2016	POSTDOCTORAL IRTA	$50,319	$50,500	$44,450	$53,950	
NIDCR	2016	VISITING FELLOW (POSTDOC)	$47,517	$47,500	$36,100	$62,700	
NIDCR	**2016**	**ALL**	**$48,379**	**$50,000**	**$36,100**	**$62,700**	**74%**
NIDCR	2017	POSTDOCTORAL IRTA	$50,625	$50,625	$48,450	$52,800	
NIDCR	2017	VISITING FELLOW (POSTDOC)	$51,450	$51,400	$48,450	$54,550	
NIDCR	**2017**	**ALL**	**$51,175**	**$51,400**	**$48,450**	**$52,800**	**71%**
NCI	2016	POSTDOCTORAL CRTA	$61,761	$61,900	$51,040	$81,600	
NCI	2016	POST-DOC PAN AM VIS	$57,333	$56,400	$56,300	$59,300	
NCI	2016	VISITING FELLOW (POSTDOC)	$60,738	$59,300	$50,400	$81,600	
NCI	**2016**	**ALL**	**$61,129**	**$59,300**	**$50,400**	**$81,600**	**60%**
NCI	2017	POSTDOCTORAL CRTA	$63,566	$64,000	$50,800	$83,200	
NCI	2017	POST-DOC PAN AM VIS	$60,280	$60,500	$57,400	$65,100	
NCI	2017	VISITING FELLOW (POSTDOC)	$62,761	$60,500	$51,900	$83,200	
NCI	**2017**	**ALL**	**$63,076**	**$62,900**	**$50,800**	**$83,200**	**60%**
NIEHS	2016	POSTDOCTORAL IRTA	$57,080	$55,100	$51,200	$77,000	
NIEHS	2016	VISITING FELLOW (POSTDOC)	$55,905	$55,100	$51,200	$66,700	
NIEHS	**2016**	**ALL**	**$56,543**	**$55,100**	**$51,200**	**$77,000**	**46%**
NIEHS	2017	POSTDOCTORAL IRTA	$56,417	$54,425	$51,200	$67,850	
NIEHS	2017	VISITING FELLOW (POSTDOC)	$55,983	$56,050	$51,200	$66,050	
NIEHS	**2017**	**ALL**	**$56,237**	**$56,000**	**$51,200**	**$67,850**	**41%**