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COMMENTARY

Highlighting the NIAID Radiation and Nuclear Countermeasures Program's Commitment to Training and Diversifying the Radiation Workforce

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Developing and maintaining a robust and diverse scientific workforce is crucial to advance knowledge, drive innovation, and tackle societal issues that impact the economy and human health. The shortage of trained professionals in radiation and nuclear sciences derives from many factors, such as scarcity of specialized coursework, programming, professional development, and experiential learning at educational institutions, which significantly disrupt the training pipeline. Other challenges include small numbers of faculty and educators with specialized radiation/nuclear expertise that are continually overextended professionally and scientifically, with the burden of training falling on this subset of individuals. Even more alarming is the recent loss of radiobiologists due to increased retirements and deaths, leaving the radiobiology community with a void of mentors and knowledge. Lastly, inconsistency in acquiring stable grant funding to recruit and retain scientists is a major hurdle to training the next generation of radiation and nuclear scientists. Recommendations from the scientific community and the National Academies of Sciences, Engineering, and Medicine describe the need to bolster educational resources and provide more hands-on training experiences. Of equal importance was the suggestion that funding agencies provide more opportunities for training and tracking the radiation workforce. The Radiation and Nuclear Countermeasures Program (RNCP), and the Office of Research Training and Special Programs (ORTSP), both within the National Institute of Allergy and Infectious Diseases (NIAID) are committed to helping to develop and sustain the radiation research workforce. This commentary illustrates the importance of addressing radiation workforce development and outlines steps that the RNCP is taking to help mitigate the issue. In addition, the role for Diversity, Equity, Inclusion, and Accessibility (DEIA) in helping to increase the number of students trained in the radiation sciences is discussed, and the NIH's DEIA priorities and RNCP efforts to improve DEIA in the research community are highlighted. One of the main goals of this commentary is to provide awareness of available educational (i.e., development of a radiation biologist eBook) and funding resources. A summary of available awards targeting early- to mid-stage investigators and diversity candidates is given, and it is hoped that this list, although not exhaustive and not specific for all focus areas in radiation (e.g., cancer research), will encourage more radiation biologists to explore and apply to these under-utilized opportunities.

INTRODUCTION

In the late 1990s, U.S. funding for biomedical radiation research was provided primarily by the National Cancer Institute (NCI), within the National Institutes of Health (NIH), the National Aeronautics and Space Administration, the Department of Energy, and the Department of Defense. These government agencies had clear mandates to fund research to explore mechanisms of radiation injury, identify biomarkers of radiation damage, and develop mitigators to address normal tissue injuries in patients, astronauts, energy workers, and military personnel, respectively. However, through a 2004 congressional mandate, the Radiation and Nuclear Countermeasures Program (RNCP) was established within the National Institute of Allergy and Infectious Diseases (NIAID), NIH, to provide a more focused funding approach to improve human health and develop medical interventions for civilian populations in case of a mass casualty radiological or nuclear

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incident. The core task of the RNCP is to develop and fund a robust radiation research program to accelerate the advancement of approaches in three primary areas: 1. mitigators and therapeutics to minimize radiation-induced tissue damage and improve survival when delivered post-irradiation; 2. methods and devices to assess biological markers of radiation damage for triage and inform patient medical management; and 3. products to remove internalized radionuclides from the body.

This revived area of scientific inquiry, which following the end of the Cold War in 1991 had largely been halted (*1*), was initiated in the years after the attacks on September 11th, 2001, when the U.S. Government acknowledged the need to fund research to develop medical countermeasures (MCMs) for use during a radiological or nuclear public health emergency. When the RNCP made its first research awards in 2005, a bolus of funding (∼$50 million/year) was infused into the field of radiation research, and the RNCP budget has remained relatively stable since that time. Another early need identified by the program was to revive infrastructure and address unmet radiation labor force development needs by providing funding, training, and outreach. Although attempts have been made to encourage investigators to take advantage of available NIAID opportunities, there have been relatively few training grant applications and supplement requests received and funded by the RNCP since 2005 (e.g., F's, T's, K's and diversity supplements).

This commentary will discuss RNCP efforts to provide opportunities to train the next generation of radiation biologists. The current state of employment of trained personnel in radiation science will be explored, highlighting RNCP involvement in NIAID and NIH initiatives to expand diversity in the scientific workforce. A list of funding opportunities to advance the careers of radiation biologists is provided as a resource for Principal Investigators (PIs) and early- to mid-stage radiation biologists, with a focus on individuals engaged in the high-dose radiation research that aligns with the mission of the RNCP. Although encompassed in the radiation biology field, cancer-focused radiotherapy applications are not funded through the NIAID program and are normally routed to NCI for consideration. Finally, this commentary will highlight the importance of Diversity, Equity, Inclusion, and Accessibility (DEIA) considerations in seeking project funding, as this could represent a means of increasing the overall number of students in the radiation sciences, while supporting students from under-represented groups. The RNCP has had the most success funding NIH Diversity Supplements to existing grants, as compared to other trainee opportunities, and recognizes the significant contributions scientists from underrepresented backgrounds have already made within the radiobiology community. Although the RNCP believes that addressing DEIA is one of the many solutions that will collectively help to alleviate gaps in radiobiologist development, funding opportunities inclusive of all radiobiologists are acknowledged and promoted, regardless of race, ethnicity, ability, or socioeconomic standing.

Gaps in Radiation Workforce Development

Specific to radiation, many U.S. scientists in the field are retiring, and the number of graduate students enrolling and graduating from educational programs in radiobiology is diminishing (*2*, *3*). Shortages have also been reported for physicians in the medical radiology workforce (*4*), and very few women hold positions of leadership [<10% as faculty (*5*) and department chairs (*6*)]. Recommendations from a 2012 National Academies of Science, Engineering, and Medicine (NASEM) report made recommendations that focused on 1. increasing institutional support; 2. building educational programs with on-the-job-training for knowledge transfer and retention; and 3. establishing programs to collect data to track supply of and demand for nuclear scientists. In 2022, the U.S. Bureau of Labor and Statistics reported a total of 158,291,000 employed persons (16 or older), with a breakdown of the numbers of individuals employed in radiation and nuclear positions. These data included 11,000 (<0.0069%) nuclear engineers; 2,600 (<0.0016%) radiologists; 223,000 (<0.14%) radiologic technologists and technicians; 2,800 (<0.0018%) nuclear medicine technologists/medical dosimetrists; and 1,600 (0.001%) radiation therapists.[3] Of note, a 2022 review also addressed the radiation workforce and highlighted the shrinkage of radiobiologist hires due to a large number of baby boomers retiring (*2*). That report homed in on a systemic failure to replace radiation biology talent (*2*, *7*). In the review, radiation and nuclear jobs were structured into six categories, which included health physics; medical physics; medicine; nuclear engineering; radiation biology; and radiation and nuclear chemistry. The authors utilized data from literature, surveys, membership trends, and other sources. The review states that in 2018, the number of workers in each field were reported as 3,200–7,000 in health physics, 8,000 in medical physics, 37,600 in medicine, 18,000 in nuclear engineering, 500 in radiation biology, and an undetermined number in radiation and nuclear chemistry. Health physics, radiation biology, and nuclear chemistry were the most affected by loss of personnel, potentially due to power plants closures, loss of experts due to retirement, and failure to replace these positions. Shortages in trained nuclear scientists are evidenced by these numbers and are coupled with a high demand for nuclear power and an increased risk of radiological and nuclear threats. The ambiguous categorization of these fields, and an ever-evolving nomenclature for these positions, and the lack of effective tracking mechanisms have made it difficult to monitor these professions accurately.

[3] https://www.bls.gov/cps/cpsaat11.htm.

The Challenge: A Leaky Training Pipeline

Science, technology, engineering, and mathematics (STEM) jobs are among the fastest growing careers in the U.S.,[4] with existing STEM labor shortages predicted to continue to grow. Racial and gender disparities in the technical workforce are also problematic and need to be addressed.[5] A "leaky training pipeline" emphasizes problems in the current educational system. Addressing these issues will hopefully reduce the number of individuals leaving STEM; however, the intent is not to eliminate people from leaving STEM education and careers, but instead to empower people who, when provided the optimum learning environment and resources, will enter and choose not to leave. To address this problem, it is important to understand the basis for workforce attrition, and how loss of certain populations to difficulties in navigating STEM education and careers impacts the overall U.S. STEM workforce. Educational, financial, and training imbalances can lead to a high number of undergraduate students dropping out of college or changing their majors. According to NASEM, although 40% of students enrolling at 2- or 4-year institutions commit to pursue a career in STEM, only a third of students pursue an associate's STEM degree, and only about a half of students that pursue a STEM bachelor's degree actually earn them within four to six years (*8*). Graduate students and postdoctoral researchers embarking on scientific careers may also face other challenges, such as low salaries, increasing child care costs, housing market inaccessibility, rising inflation, workplace inflexibilities, pressure to reach independent research status without support, and toxic work environments (*9*). These hurdles can lead to inequity in the recruitment and retention of these individuals in higher education. Faculty have reported a drop in both the number and quality of graduate school applications (*10*). In addition, many students and postdoctoral researchers are leaving academia, which is affecting research laboratories, especially those of newly established faculty and tenure-track professors.

Postdoctoral researchers and early-stage investigators are burdened by an extremely competitive faculty job market. It has been known for many years that more PhDs are awarded than available faculty slots, and it has become more difficult for PhDs to pursue these positions.[6] It is estimated that fewer than one in six qualified faculty candidates will secure tenure-track professorships at universities, which means that 84% of new PhDs will need to look for other career options.[4] This problem is further exacerbated by a continued decrease in faculty positions. In an evaluation of the U.S. faculty job market through Science Career job boards, a 70% reduction in faculty postings was noted in 2020, as compared to previous years (*11*). Although the number of faculty positions appears to have rebounded somewhat in 2021, due in part to more openings in response to retirees; ineffective mentorship (*12*), and scarcity of funding and resources (*9*) could continue to impact the faculty job market negatively if structural changes needed to meet the demands of academia remain unaddressed.

Another important challenge and main emphasis area of the NIH is to foster diversity in scientific research employment as a strategy to develop the scientific workforce. Inequity of resources (i.e., education, training, finances, household structure, hidden biases, etc.) have historically excluded groups from diverse demographic backgrounds in the biomedical workforce. These inequities can be in anything that individuals utilize to help them advance and achieve a successful outcome (i.e., enroll and graduate from college, obtain their dream job, etc.), for example, study aids or classes to help score well in standardized tests. Another resource example is parents who pay tuition, allowing the student to dedicate all their attention to school, without having to pursue employment to support themselves and their families. In the article by Estrada et al., 2016, the authors provide strong evidence that undergraduates from underrepresented groups often come from low-socioeconomic backgrounds and experience financial strain during college compared to their White/Asian counterparts (*13*). Therefore, the authors postulate that institutions that provide mechanisms for financial support will achieve stronger persistence and higher levels of underrepresented student performance. The National Science Foundation has identified four racial and ethnic groups that are underrepresented in health-related sciences on a national basis, which the NIH has also adopted: 1. Black or African Americans, 2. Hispanic and/or Latino/a/x, 3. American Indian and Alaska Natives, and 4. Native Hawaiians and other Pacific Islanders.[7] In addition, women, individuals with disabilities, and persons from disadvantaged backgrounds also experience challenges that may impede their scientific growth, and funding opportunities are being developed by the NIH to support people from these groups.[8] Studies have shown that underrepresented students choose STEM majors at similar rates as white students, but many individuals from historically marginalized backgrounds switch from STEM to non-STEM tracks and leave college altogether at much higher rates than their white counterparts (*14*). The reasons why this happens are not completely understood; however, it is well established that hidden biases, stereotyping, micro/macro-aggressions, lack of support or inclusion, and/or accessibility can be determinants of success in postsecondary education. Scientists who persist often face additional barriers that can impede their upward mobility,

[4] https://smartasset.com/data-studies/fastest-growing-stem-jobs-in-the-us-2022#:~:text=Of%20the%20total%2074%20jobs,of%20computer%20and% 20mathematical%20occupations.

[5] https://www.uschamberfoundation.org/blog/post/addressing-stem-workforce-shortage.

[6] https://www.nytimes.com/2016/07/14/upshot/so-many-research-scientists-so-few-openings-as-professors.html.

[7] https://www.nsf.gov/statistics/2017/nsf17310/digest/introduction/.

[8] https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-031.html.

including racism, discrimination, low socioeconomic status, lack of guidance, cultural disconnect, and undervalued work and pay (*15*, *16*). Recommendations to help remove barriers, allowing students from underrepresented backgrounds to persist in STEM fields, include increased financial support (*13*), mentor networks and training (*17*), and early STEM intervention programs (*18*, *19*). The total number of individuals from historically marginalized communities throughout academia is relatively low. A 2010 survey of higher education reported that although 29.3% of the total U.S. population identify as being from underrepresented backgrounds, only 14.7% percent of bachelor's degrees and 8.3% of doctorates in STEM fields are earned by individuals from underrepresented backgrounds (*13*). Further, the same study found that only 7.3% of STEM doctorates working as full, associate, or assistant professors in 2- and 4-year institutions were from underrepresented backgrounds (*13*). According to the 2022 Labor Force Statistics from the Current Population Survey,[9] conducted by the U.S. Bureau of Labor Statistics, 1.84 million people are employed in life, physical, and social sciences, of a total over 158 million employed individuals. The survey also reported that equal numbers of men and women were employed in life, physical, and social sciences, but ethnic disparities were present (of a total 1,840 total survey respondents, 8.2% were Hispanic or Latino/a/x population, and 6.1% were Black or African American). Women have made much progress, outnumbering men in the overall healthcare profession at 75.7%. Therefore, tapping into historically marginalized communities and motivating individuals to pursue and persist in pursuing STEM careers may be one solution to help build the U.S. scientific workforce. Traditionally, academia has been resilient and largely immune to changes, but recent trends in postdoctoral shortages and market competition are challenges that need to be addressed and overcome to ensure a robust U.S. scientific workforce in the future.

U.S. Efforts to Address the Problem

The Biden Administration signed an Executive Order on Diversity, Equity, Inclusion, and Accessibility (DEIA) in the Federal Workforce in 2021, which established DEIA as priorities for the administration.[10] The NIH also recently released the 2023–2027 NIH Wide Strategic Plan for Diversity, Equity, Inclusion, and Accessibility to strengthen and integrate DEIA across all activities to achieve the agency's mission through research and capacity-building efforts.[11] The plan demonstrates a commitment to integrating the principles of DEIA through research and capacity-building efforts. In addition, in the wake of the 2023 Supreme Court ruling on affirmative action in college admissions, the NIH Office of Extramural Research issued a statement in July 2023, which stated "NIH adheres to federal law and does not make funding decisions based on race. At this time, there are no changes in our policies, processes, or procedures." In alignment with these proposals, the RNCP has joined NIAID and NIH to address systemic challenges that limit upward mobility of individuals or impact policies inside and outside the NIH. It is hoped that encouragement of URG candidates to pursue research in the radiation sciences will help to address the existing deficit. To address DEIA and overall training needs outside of the NIH, an important resource is the NIAID Office of Research Training and Special Programs (ORTSP)[12], which manages research training awards to support the extramural community. Together with the ORTSP, the RNCP endeavors to provide guidance and access to funding opportunities, resources, and training for the radiation research community.

RNCP-Supported Initiatives on Education, Training, and DEIA

Online radiobiology textbook and lectures. One longstanding research initiative that began a year after the establishment of the RNCP is the NIAID-funded Centers for Medical Countermeasures Against Radiation Consortium (CMCRC). The CMCRC program was initially a consortium that included eight cooperative agreement awards (RFA-AI-04-045).[13] This funding mechanism has been recompeted every five years for a total of four cycles from 2005–2025. A stated goal of the CMCRC program is to increase the number of trained radiation biologists, and in the first iteration of the consortium, the RNCP provided dedicated funding for development of training and education cores within each Center. Multi-disciplinary programs were established that provided educational opportunities for technicians, medical and graduate students, postdoctoral fellows, and independent investigators, both within and beyond the CMCRCs. These cores also offered specific training in assays and methodologies, reagents, animal models, and information on regulatory processes to develop new products for radiation indications. Through these cores, NIAID also provided funding to train researchers in radiobiology and epidemiology and to support seminars and scientific meetings. Although no longer a formal part of the Centers, outstanding mentors and researchers within the consortium and throughout the larger RNCP portfolio continue to recruit and train promising students, encouraging them to seek careers in radiation science.

Past and present CMCRC awardees have also provided notable contributions to educational material shared with the radiation community, such as a website hosting

[9] https://www.bls.gov/cps/cpsaat11.htm.

[10] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/06/25/executive-order-on-diversity-equity-inclusion-and-accessibility-in-the-federal-workforce/.

[11] https://www.nih.gov/about-nih/nih-wide-strategic-plan-diversity-equity-inclusion-accessibility-deia.

[12] https://www.niaid.nih.gov/about/research-training-special-programs.

[13] https://grants.nih.gov/grants/guide/rfa-files/rfa-ai-04-045.html.

publications by CMCRC investigators,[14] online radiobiology lectures,[15] and a unique, web-based radiobiology textbook.[16] The latter two initiatives were developed to provide resources for training in radiobiology by experts in the field. The lecture series is a compilation of videos and resources that are routinely updated to cover topics such as radiotherapy, radiation targets, molecular signaling, dosimetry, and radiation physics. The CMCRC web-based radiobiology textbook, curated in 2015–2020 under the supervision of the University of Pittsburgh, is a comprehensive teaching tool that can be accessed for free.[14] The textbook is a static resource that consists of 32 chapters, including applications of radiation science, radiation physics, acute and late radiation effects, animal models, radiation-specific cellular response mechanisms, and many other radiobiology emphasis areas.

Community outreach. The NIAID RNCP encourages education and training through its continued participation in the Annual Meetings of the Radiation Research Society (RRS). Since 2006, the RNCP has supported mentoring-focused, Scholars-in-Training sessions that precede the meeting, providing travel support, serving as panelists, imparting NIH and career guidance, and giving presentations on aspects of the NIH and available funding for students, postdoctoral fellows, and early-stage investigators.

Funding Gaps for Trainees in the RNCP Portfolio

Using NIH database resources, a limited grants portfolio assessment was done by the authors to explore applicant use of the NIH diversity supplement mechanism (Research Supplements to Promote Diversity in Health-Related Research)[17]. This search found that 3,038 diversity supplements were awarded across all the NIH institutes and centers for award years 2021–2023 in response to PA-21-071. Of those 3,038 supplements made to parent grants, $\sim$1% (42 awards) were provided by NIAID, which has an overall budget of \$6.6 billion. Within the NCI, which has a budget of \$7.3 billion, 374 supplements were awarded during the same time period, representing 12% of all the NIH diversity supplement awards. When the search of the 3,038 supplement awards was refined to include radiation studies only (using a search term that specified "radiation" in the title, abstract, or specific aims), only 69 (2% of all NIH diversity supplements) were awarded to support radiation research (including, e.g., ultraviolet), with 44 of them awarded to NCI PIs, and 1 to NIAID grantees. These findings indicate that NIAID is not awarding enough radiation-focused diversity supplements at this time, despite past successes in this part of the portfolio. This outcome also suggests that either poor quality applications are being submitted, or more likely, that NIAID PIs within the RNCP portfolio are not aware of these opportunities or are not applying for them. In past years, the NIAID has supported six trainees through this supplement mechanism, and these resources have made a difference for these students from diverse backgrounds, providing excellent mentoring and allowing several of them to establish careers in radiation science and medicine. While admirable, the fact that so few individuals were aware of this additional funding and did not seek the opportunity to have NIAID support for training of students in their laboratories is troubling, and it is one of the reasons that this commentary was drafted. Sharing of information on available NIH opportunities for training and education with an emphasis in DEIA areas has been offered informally to awardees in RNCP-supported research consortia, through presentations on research funding, and subsequent one-on-one support. The RNCP remains committed to increasing the number of funding opportunities to support the next generation of radiobiologists, and some of these are detailed in this commentary. As more is learned about the shortcomings in available training and education, the RNCP will pivot to help close these gaps by providing guidance and awareness of these initiatives and perhaps future funding opportunities allowing for devoted training and education elements.

NIH Research Training Opportunities in Radiation Research

Continued and stable funding opportunities to support outreach efforts, to introduce more individuals to the field and assist in developing their careers, has been recommended (*2*, *3*). In this section, the objective is to highlight several existing mechanisms of support, with the goal of educating the radiation community about under-utilized research funding opportunities in radiation biology. There are many mechanisms used by the NIH to provide extramural training and education funding. Figure 1 provides a list of these awards, with timelines highlighting when they are available throughout the course of an individual's career, for either the PhD or health professionals track. Many of these offerings are available to applicants from all backgrounds; however, key opportunities that address advancement of diverse candidates are specifically highlighted below.

Individual awards. Generally, these opportunities are available for PhD trainees and healthcare professionals, with different tracks depending on specialty area and educational stage. Available mechanisms include R, F, T, K, and DP awards, with overlap between programs for individuals pursuing health professional degrees or PhDs.

- Kirschstein National Research Service Awards fellowships (F)[18] are intended to ensure a diverse pool of highly trained scientists in appropriate scientific disciplines. These awards can support dual degree trainees such as

[14] https://cmcrcniaid.org/content/publications.
[15] https://cmcrcniaid.org/content/radiobiologylectures.
[16] https://cmcrcniaid.org/content/cmcrcradiobiologybook.
[17] 2024 open announcement can be found at https://grants.nih.gov/grants/guide/pa-files/PA-23-189.html.
[18] https://www.niaid.nih.gov/grants-contracts/fellowship-grants.

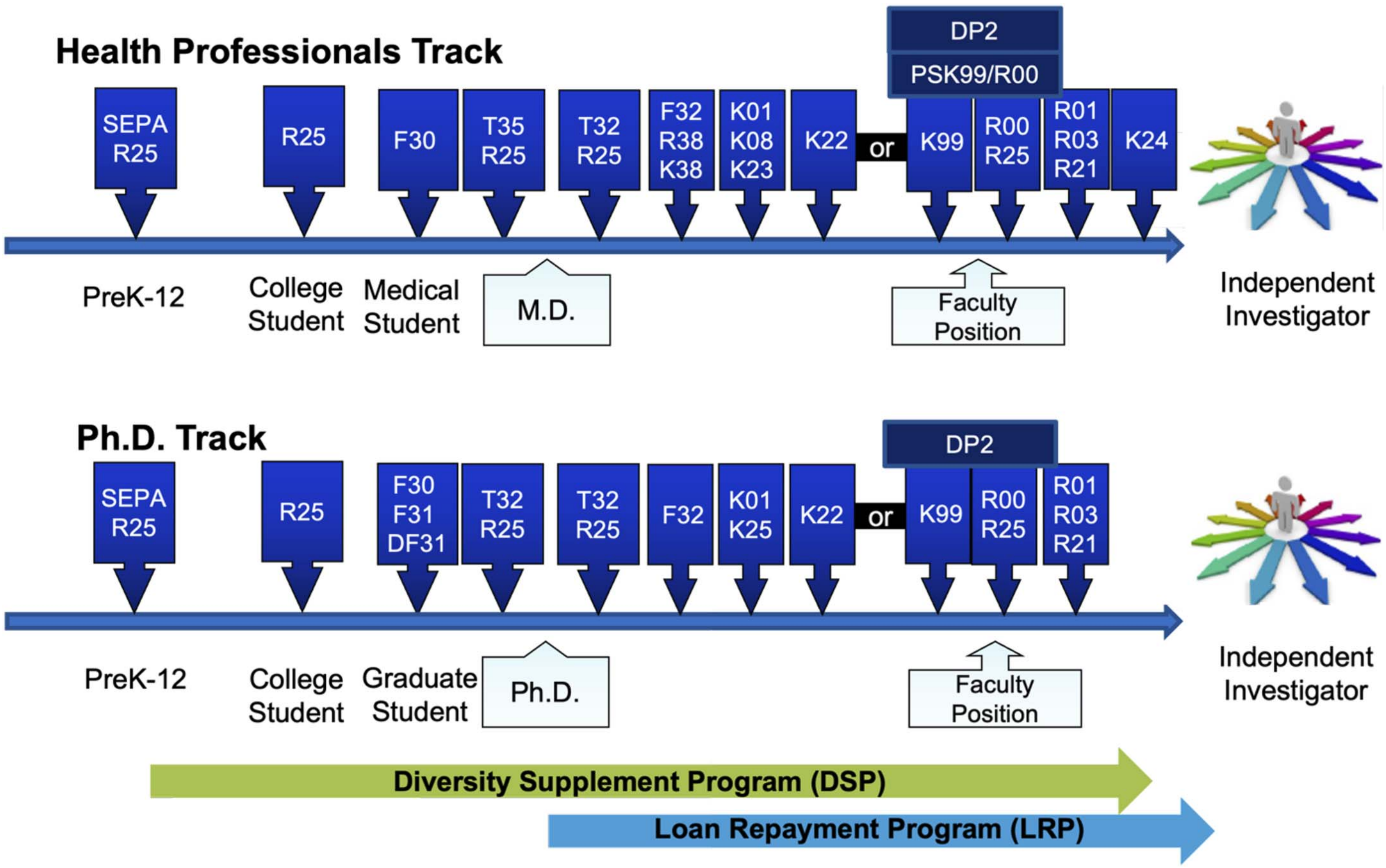

FIG. 1. Available programs for PhD candidates or health professionals seeking funding to continue their scientific careers (image courtesy of ORTSP, NIAID).

MD/PhDs (F30)[19,20], graduate students (F31)[21], graduate students from diverse backgrounds (F31-diversity)[22] and postdoctoral researchers (F32)[23].

- Research Career Development Awards (K) support postdoctoral or early career researchers to help them obtain independent research careers, with more than a dozen different programs. There are many awards that can supplement support to scientists and physician-scientists, but in this section, we have elaborated on awards that are most relevant to our community.
  - The K99/R00 mechanisms fund scientists in mentored research programs in two phases, supporting postdoctoral (K99) or faculty (R00) research work for up to five years. This award is one of the few opportunities that is open to non-U.S. citizens and supports postdoctoral scientists[24] or postdoctoral physician-scientists, with[25] and without a clinical trial requirement[26].
  - To specifically support biomedical faculty from underrepresented backgrounds, the Maximizing Opportunities for Scientific and Academic Independent Careers (MOSAIC) Postdoctoral Career Transition Award to Promote Diversity[27,28,29] was initiated by NIGMS, with other participating NIH institutions including NIAID.
- Awards that focus on early-stage, diverse or at-risk faculty include the NIAID New Innovator Award (DP2)[30] for high-risk, novel and innovative research, and the Katz Early-Stage Investigator Award[31] to support a shift in research direction. An R01 research opportunity for new and at-risk investigators was also released in 2023, with participation from NIAID and the National Institute of Diabetes and Digestive and Kidney Diseases[32], with the goal of improving scientist diversity.[33]

Institutional awards. Opportunities for new training initiatives and educational programs could be revamped through access to institutional funds. The loss of specialized programs

[19] https://grants.nih.gov/grants/guide/pa-files/PA-21-049.html.
[20] https://grants.nih.gov/grants/guide/pa-files/PA-21-050.html.
[21] https://grants.nih.gov/grants/guide/pa-files/PA-21-051.html.
[22] https://grants.nih.gov/grants/guide/pa-files/PA-21-052.html.
[23] https://grants.nih.gov/grants/guide/pa-files/PA-21-048.html.
[24] https://grants.nih.gov/grants/guide/pa-files/PA-20-188.html.
[25] https://grants.nih.gov/grants/guide/pa-files/PAR-23-071.html.
[26] https://grants.nih.gov/grants/guide/pa-files/PAR-23-070.html.
[27] https://grants.nih.gov/grants/guide/pa-files/PAR-21-271.html.
[28] https://grants.nih.gov/grants/guide/pa-files/PAR-21-272.html.
[29] https://grants.nih.gov/grants/guide/pa-files/PAR-21-273.html.
[30] https://grants.nih.gov/grants/guide/pa-files/PAR-23-198.html.
[31] https://grants.nih.gov/grants/guide/pa-files/PAR-21-038.html.
[32] https://grants.nih.gov/grants/guide/pa-files/par-23-275.html.
[33] https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-031.html.

to train radiation biologists at all levels (undergraduate, masters, doctoral, and postdoctoral) will continue to lead to loss of innovation and limit progress in areas of research and application that heavily rely on biological productivity. Institutions that need financial assistance to strengthen their research capital are eligible to receive several awards:

- R15 awards (the Academic Research Enhancement Award for Undergraduate-Focused Institutions (AREA)[34], or the Research Enhancement Award Program (REAP) for Health Professional Schools and Graduate School Programs[35]) are intended to strengthen and support research at institutions that have not been major recipients of NIH support.
- Support for Research Excellence (SuRE) Research Awards (R16)[36] provide grant support for faculty investigators from eligible institutions who have prior experience in leading externally-funded, independent research but are not currently funded by any NIH Research Project Grants.
- Support for Research Excellence First Independent Research (SuRE-First) Awards (R16)[37] provide grant support for faculty investigators from eligible institutions who have not had prior independent external research grants.
- MOSAIC Institutionally-Focused Research Education Award to Promote Diversity (UE5)[38] is designed to support educational activities that encourage individuals from diverse backgrounds to pursue careers as independent investigators at research-intensive academic institutions. It is different from the previously discussed individual MOSAIC award, in that it is focused on courses for skills development and mentoring activities at an institutional level.
- National Research Service Award Training Grants (T32)[39], Medical Scientist Training Program (T32)[40], and Short-Term Institutional Research Training Grants (T35)[41] are utilized to train groups of research scientists.
- R25 awards promote research experiences, mentored activities, and professional development. Included among these mechanisms is the NIAID Research Education Program Advancing the Careers of a Diverse Research Workforce[42], which supports educational activities that encourage individuals from diverse backgrounds.

Research supplements to NIH grants. There are several NIH research supplements provided to existing awardees which, promote trainee growth in different scenarios[43]. Those opportunities with a primary focus on applicants from underrepresented backgrounds are highlighted.

- Research Supplement to Promote Diversity in Health-Related Research Careers[44] provides salary, supplies, publications, and travel of underrepresented scientists at all stages. Underrepresented scientists may fall into four distinct categories to qualify, 1) individuals from ethnic/racial groups underrepresented in health-related sciences; 2) individuals with disabilities; 3) individuals from disadvantaged backgrounds; and 4) women from the above categories.
- Primary Caregiver Technical Assistance Supplement[45] supports postdoctoral researchers who need to be away from the laboratory to care for a child or sick family member. This award would provide funds to enable a postdoctoral fellow to hire a technician for a up to two years to allow for work to progress while the postdoctoral researcher is away from the bench.
- Research Supplement to Promote Reentry and Reintegration into Health-Related Research Careers[46] supports scientists who have left the bench for at least 6 months of interruption in their research careers or have been adversely affected by toxicity in the lab environment. Interruptions due to family responsibilities, or other qualifying circumstances are considered. To provide relief for predoctoral and postdoctoral researchers who qualify, supplemental re-integration awards aim to transition these scientists into safer laboratory environments. These supplements provide for a minimum of one year of funding in a mentored research experience.
- Administrative Supplement to Promote Diversity in Research and Development in Small Business[47] is open to small businesses (<500 employees) or academic laboratories partnering with a business to support diverse scientists from all levels (undergraduate through early faculty). Researchers need to fall into one of the four diversity categories described above to qualify.

CONCLUSION

This commentary details the NIH, NIAID, and more specifically, RNCP commitment to education, training, and DEIA throughout the funded research portfolio. Although there remains a "leaky" radiation employment pipeline, the RNCP has taken steps to help address the problem by offering targeted training on the many NIH funding sources available to enhance workforce diversity, in the hopes that encouraging more radiation-centered PIs, trainees and under-represented individuals to pursue careers in radiation research will help to address acknowledged personnel shortages. Lastly, the authors have focused on providing

[34] https://grants.nih.gov/grants/guide/pa-files/PAR-21-155.html.
[35] https://grants.nih.gov/grants/guide/pa-files/PAR-22-060.html.
[36] https://grants.nih.gov/grants/guide/pa-files/par-21-169.html.
[37] https://grants.nih.gov/grants/guide/pa-files/par-21-173.html.
[38] https://grants.nih.gov/grants/guide/pa-files/par-21-277.html.
[39] https://grants.nih.gov/grants/guide/pa-files/PA-23-048.html.
[40] https://grants.nih.gov/grants/guide/pa-files/PAR-21-189.html.
[41] https://grants.nih.gov/grants/guide/pa-files/PA-23-080.html.
[42] https://grants.nih.gov/grants/guide/pa-files/par-21-258.html.
[43] https://www.niaid.nih.gov/grants-contracts/research-supplements.
[44] https://grants.nih.gov/grants/guide/pa-files/PA-23-189.html.
[45] https://grants.nih.gov/grants/guide/notice-files/NOT-AI-21-074.html.
[46] https://grants.nih.gov/grants/guide/notice-files/NOT-OD-21-134.html.
[47] https://grants.nih.gov/grants/guide/pa-files/PA-21-345.html.

information on important RNCP-initiated educational material and a list of different NIH funding opportunities for pre-doctoral, postdoctoral, and early-career investigators. The RNCP will continue to identify and promote trainee professional development and endeavor to find innovative ways to support students and scientists at all career levels in the radiation sciences, while also encouraging entry and funding of diversity candidates throughout the radiation research community.

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