

ARTICLE

The Neuroscience Research Opportunities to Increase Diversity Program: Transformative and Successful Research Training Strategies for Undergraduate Students within Hispanic Serving Institutions

Carmen S. Maldonado-Vlaar and José E. García-Ararrás

Biology Department, College of Natural Sciences, University of Puerto Rico- Rio Piedras Campus, San Juan, PR 00931.

<https://doi.org/10.59390/ZGLZ3652>

Over the past 14 years, the Neuroscience Research Opportunities to Increase Diversity (NeuroID) program, funded by the National Institute of Neurological Diseases and Stroke (NINDS), has played a transformative role in training numerous undergraduate Hispanic students within The University of Puerto Rico-Rio Piedras (UPR-RP). This innovative Neuroscience-based research training initiative has successfully guided dozens of Hispanic students toward graduate programs in Neuroscience, significantly contributing to the enhancement of diversity within the academic and scientific fields. The achievements of the NeuroID program can be attributed to three key objectives. Firstly, the establishment of a comprehensive and

innovative program has provided Hispanic undergraduate students with invaluable insights into various facets of a research career in neuroscience. Secondly, the program has fostered a robust mentorship network that supports selected students throughout their journey to become neuroscientists. Thirdly, it has strengthened the neuroscience network in Puerto Rico by bridging the gap between undergraduate teaching universities and research laboratories in top-tier institutions across the mainland United States.

Key words: neuroscience; historically underrepresented; mentoring; research; outreach, resilience, undergraduate

The University of Puerto Rico-Rio Piedras: a top-notch training hub for neuroscience research

The University of Puerto Rico-Rio Piedras Campus (UPR-RP) stands as the premier educational institution in Puerto Rico, boasting prestigious academic rankings as a Research University with High Research Activity (American Council on Education, 2024). As one of the nation's leading Hispanic serving institutions (HSIs), UPR-RP distinguishes itself with its exceptional transdisciplinary research and academic programs. Historically, UPR-RP has been at the forefront of advancing the careers of historically underserved students in Science, Technology, Engineering, and Math (STEM) fields, solidifying its status as a national leader in this endeavor. HSIs like UPR-RP play a pivotal role in fostering Hispanic inclusivity in the United States, particularly within STEM disciplines. In 2010, the U.S. Hispanic population constituted over 14%, a percentage that has since grown to 19% in 2024. The UPR-RP campus is a state-funded, public, co-educational institution and part of the university system of 11 campuses and other specialized research units throughout Puerto Rico. All campuses are accredited by the Middle States Association of Colleges and Universities and University of Puerto Rico is a member of the Hispanic- American Colleges and Universities (HACU). Notably, the UPR-RP has consistently ranked as one of the top 20 doctorate granting HSIs in the nation (National Science Foundation, National Center for Science and Engineering Statistics, Survey of Doctorate Recipients, 2017). In 2024, the UPR system where UPR-PR stands as a flagship campus was ranked #2 overall of the best universities in the Caribbean and one of the top 50

universities in Latin America in student satisfaction, academic achievement, research, and administrative performance (Quacquarelli Symonds (QS) International World university rankings, 2024). It has been documented that UPR-RP generates ~ 70% of the scientific production of Puerto Rico. In this vibrant scientific ecosystem, the field of neuroscience stands as a shining example of UPR-RP's dedication to excellence.

UPR-RP a Champion of Diversity, Equity, Inclusion, and Accessibility (DEIA) in the Biomedical Workforce

UPR-RP offers bachelor's degrees in 74 majors, master's degrees in 46 areas, and PhDs in 14 subjects. The student body at UPR-RP represents over 29% of the system's total. In fall 2022, it had a total enrollment of 12,037 students. Most students are Puerto Rican (82%), 64% are women, and 12.6% have disabilities. (Snyder et al, 2019). In fall 2022, 65% of undergraduates received federal assistance via Pell grants. UPR-RP plays an important role in the education of historically underserved students within the chemical, physical, and biological sciences. The National Science Foundation 2017 Report on "Women, Minorities and Persons with Disabilities in Science and Engineering" states that over a third of Hispanic doctoral recipients earned their bachelor's from a High Hispanic Enrollment institution. In a previous report where the specific origin of the students was reported, UPR-RP was shown to be the top baccalaureate institution of Hispanic science and engineering doctorate recipients (National Science Board, 2008), the top source for Latine who continue to earn PhDs in the sciences and was the top source of Latine PhDs

between 2005 and 2009 (National Academies of Sciences, 2011).

The UPR-RP Strategic Plan- Commitment 2023- states as its main priority, *“the development and advancement of transdisciplinary research combined with the objective to urgently solve problems that critically affect the quality of life of Puerto Rican society and the world”* (UPR-RP-Academic Senate, 2018). This institutional aim is very much present in the UPR-RP College of Natural Sciences (CNS) strategic plan where it prioritizes academic excellence with emphasis on research and impactful collaborations.

In addition, the CNS proposes to integrate the research work into the academic offerings, expand the diversity in the learning experiences and promote interdisciplinary scientific knowledge. In the fall 2022, the CNS enrolled 2,250 full time undergraduate students pursuing degrees in Biology, Chemistry, Computer Science, Environmental Sciences, Interdisciplinary Science, Mathematics, Nutrition, and Physics. In addition, at the graduate level, 286 students are pursuing M.S degrees in Biology, Chemistry, Environmental Sciences, Math, and Physics, and Ph.D. degrees in Biology, Chemical Physics, Computer Science, Chemistry, Environmental Sciences, and Mathematics. In addition, UPR-RP has been recognized by National Institutes of Health (NIH) as one of the most successful United States institutions in the development of historically underserved professionals. One out of every 10 bachelor’s in science recipients of UPR-RP CNS completes a STEM PhD. Moreover, over one third of our undergraduate students are involved in active scientific research projects during their college years. In recent years, virtually all our graduate students found professional positions in industry, academia, or government either in Puerto Rico or the continental United States. Moreover, the CNS has established collaborative relationships with federal and local agencies, nonprofit organizations, and businesses, which facilitate research. In addition, the CNS provides research experience to hundreds of undergraduate students under several impactful and highly competitive NSF and NIH research training grants.

In all UPR-RP colleges, research courses are incorporated in their curriculum. For example, in the Department of Biology at the CNS, the introduction to research undergraduate course in Biology enrolls approximately 500 students from all academic levels (freshman to seniors) per semester and places them in over 150 research labs. Additionally, the CNS, the Deanship of Research, and the Department of Biology support students to attend conferences and report their research results. UPR-RP has a strong reputation for the successful training of historically underserved undergraduate students who are well prepared for, and committed to, continued graduate education after obtaining their baccalaureate degrees. In addition, in a period of 10 years (1999-2018), of the 38 Fulbright Program participants in Puerto Rico, 50% came from UPR-RP. In terms of race and ethnicity, UPR-RP is a very particular institution. It is a HSI where 82% of its undergraduate and 50% of its graduate student body are Latine. At the CNS, the tenured or tenure track faculty

describe themselves as 86% Hispanic or Latine ethnicity, 6% Asian, 6% Non-Hispanic White and 2% Other. Of these, 16% are foreign born, naturalized citizens. The race and ethnicity component of the tenured and tenure-track faculty of the CNS in many ways reflect that of the Puerto Rican population. An example of intersectionality in our institution is the Afro Latino population which has been counted as Latine, eroding their presence in our statistics. As of 2020, it was estimated that 69.5% of our Puerto Rican population was White and almost 20% were Black or African American or of mixed ancestry.

Constructive Efforts to Enhance DEIA Interventions in Neuroscience Research Training

Several studies have shown the impact and relevance that a diverse and inclusive biomedical research workforce has on discovery and innovation across the different realms of human health (Nielsen et al., 2017; Valentine and Collins, 2015, Gibbs et al., 2016). Incorporating the value of inclusion and diversity in recruitment in higher education institutions and private enterprises has been appraised by its leadership as very important to attain programmatic goals and innovation in the workforce. (Bourke and Dillon, 2018). While inclusion can mean different things to different groups, it generally signals that faculty members of all backgrounds feel welcomed and supported on their campuses. For one, inclusive campus climates have positive effects on faculty retention and success, and inclusion efforts play key roles in addressing inequities in higher education (Ullrich et al., 2024; Whittaker et al, 2015).

In addition, demographic diversity helps institutions tap into knowledge and networks specific to a particular demographic group such as historically underserved communities. Finally, studies show that racial diversity stimulates curiosity, and gender balance facilitates conversation turn-taking (Lim et al, 2008). Thus, incorporating diversity and inclusion strategies to achieve an institutional climate based on parity and equity helps create a stronger and broader narrative where everyone within their academic group feels relevant and part of a shared goal. Moreover, embracing diversity in the biomedical sciences will effectively move forward awareness and respect of individuals’ intersectionality and cultural complexities that they bring to the institution.

New developmental and retention activities are needed not only in developing scientific potential but also in creating a more proactive evaluation of the challenges facing our students and faculty within the institutional infrastructure. Thus, addressing intersectionality issues in our student and faculty population also provide UPR-RP with a critical, insightful, and unifying operational framework to empower changes in institutional policy and climate. HSIs are the most important pathway to Latine inclusivity in the US. It is very likely that many more institutions will soon meet the 25 percent Latine enrollment threshold that the US Department of Education has set to designate HSIs. The challenge that HSIs like UPR-RP now face is how to be more effective in achieving equity and excellence for its historically underserved community at all levels of its academic and

research endeavors.

Minority-serving institutions like UPR-RP play a particularly important role in efforts to broaden participation in STEM, by enrolling in high numbers of students and having a thriving faculty from historically underserved backgrounds. At the national level, while historically underserved groups embody approximately 36 percent of the US demographics in 2021, they represent only approximately four percent of the NIH R01 biomedical research grant holders (Taffe and Gilpin, 2021). It is imperative that our scientific community continues to work together in improving access to resources, education and opportunities that intentionally promote diversity, equity, and inclusion initiatives for minoritized individuals in the different fields of the neurosciences.

Before the NeuroID Program: Needs for Change in Neuroscience Training for Hispanic Students

Before the NeuroID program started in 2010, the population of the United States was over 14% Hispanic, a number that was projected to grow in the coming years (it is 19% today). Hispanics involvement in Neuroscience research, however, was highly limited. Our program addressed the need of this population for academic and professional training in neuroscience-related research and developmental activities. Specifically, the NeuroID program is focused on training Hispanic undergraduate students, that at the end the program would pursue a research career in Neuroscience. The core of the program is a comprehensive research experience for undergraduate students based on an established research-with-purpose training philosophy that integrates research and community outreach activities, to enhance empathy, social responsibility, and self-motivation skills. At the end, students have the necessary research, academic and professional skills to succeed in a research career in neuroscience. Participation in a research project is a crucial experience that directs students toward research careers. This is particularly true for Hispanic students who usually enter the University with a partial understanding of scientific careers due to the limited number of role models and/or family pressures that direct them to careers in medicine, dentistry, or medical technicians. The student population at UPR-RP is not exempted from these pressures due to social misconceptions about a scientific career, socioeconomic factors and lack of research experience, among others. The situation at other universities in the San Juan Metropolitan area is exacerbated by the small number of faculty involved in biomedical research and by the lack of research opportunities in behavioral or neuroscience research. Finally, the successful interventions of the NeuroID program have spearheaded other NIH funded training initiatives that have broadened the impact of this program in our undergraduate population beyond the field of Neurosciences.

The NeuroID Program: Programmatic Interventions

The NeuroID program is supported since 2010 by the NIH Blueprint for Neuroscience Research and managed by the

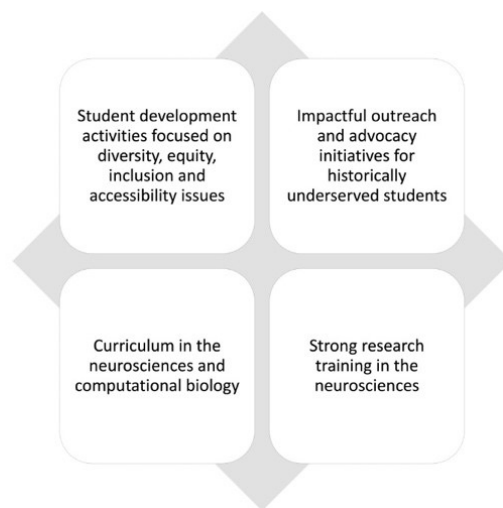


Figure 1. Main objectives for the NeuroID program

National Institute of Neurological Diseases and Stroke (NINDS) through an R25 funding mechanism. Since then, we have led the successful training in Neuroscience for 107 undergraduate Hispanic students. This neuroscience-based research training intervention has enticed and guided Hispanic students toward graduate programs in the neurosciences and achieved the utmost goal of enhancing diversity in academic/scientific fields. The successful accomplishments of the NeuroID program initiatives through the years are guided by three main objectives: first, the establishment of a comprehensive and innovative program that provides historically underserved undergraduate students with the opportunity to assess different aspects of a research career in neuroscience; second, the development of a mentorship network that will support the selected students throughout their training to become neuroscientists; and third, to strengthen the neuroscience network on the island by bringing students from undergraduate teaching universities to research laboratories in the top research institutions, and connecting these laboratories with graduate programs in institutions on mainland USA. These research experiences take place during the semester in one of UPR research laboratories and during the summer in laboratories on the mainland. Parallel to these experiences, students participate in other activities aimed at strengthening their professional development and at also providing a strong understanding of the function and diseases of the nervous system.

Undergraduate research training programs need to include experiences that go beyond bench work and poster presentations to increase the number of students that enter and complete PhD degree programs. The National Research Council and Institute of Medicine of the National Academies identified the lack of underrepresented minority basic and clinical researchers as an important issue that contributes to increasing health disparities (Hahm and Ommaya 2010). In their report, Opportunities to address clinical research workforce diversity needs for 2010, the committee stated that *“those who belong to a group of interest are more likely to have a personal experience that*

will aid in the selection of testable hypotheses and methods appropriate to the population.” The integration of “research with a purpose” philosophy could help undergraduate students to better appreciate a research career in neuroscience.

In summary, the training of undergraduate students needs to integrate an active academic program with the current practices of a research career. Today, scientists face very complex questions and problems that require the integration of different disciplines to gain knowledge and proposed possible solutions. The NeuroID program’s intervention plan includes the integration of biomedical and behavioral research activities to expose students to different aspects of neuroscience research. The undergraduate students are selected from Biology, Chemistry, General Sciences and Psychology, allowing the exchange of and exposure to diverse research topics and interests. In addition, a mentoring program that includes researchers at the UPR and mainland universities serves as a support system not only during the undergraduate training program but also through their graduate studies. The integration of “role-models” at UPR-RP and mainland universities offers a support system to the NeuroID students where they can exchange their experiences and difficulties and find answers to their questions encountered during their training as

researchers. The NeuroID program also incorporates the successful resource local network, CienciaPR (<http://www.cienciapr.org/index.php>), to increase participation and collaboration among Hispanic scientists particularly those in Puerto Rico or of Puerto Rican origin.

First Summer Immersion Program

Students that enter the program are usually at the end of their sophomore year. Students are paired with a local mentor based on their interests. Together with the mentor, the student develops a research plan. The first summer, students are exposed to the Summer Integration to Research Experience initiative which includes several impactful interventions such as: (1) Neuro-classes: students are introduced to basic neuroscience concepts. 2nd year NeuroID students serve as teachers and peer mentors for the incoming trainees. (2) Meeting with the Neuroscientist: each week students can meet one of the NeuroID program’s mentors that will talk about their career path, their research and lead a journal club, (3) Scientific Seminars: Neuroscience and Society-this initiative brings topics where Neuroscience and society intersect. This intervention is available in a webinar format. Topics on Neuroethics, drug addiction, health disparities and other topics have been offered by lead experts in the field. (4) Software Carpentry workshop- students are exposed to an intensive training in Python and R computer languages (5) Professional development interventions: students are exposed to several topics including, how to prepare an Independent development plan (IDP), imposter syndrome, Ethics in research, Implicit bias, Scientific rigor, Lab etiquette, how to prepare an abstract, how to prepare a poster presentation, how to write your personal statement, racism in science. (6) Justice, Equity, Diversity, and Inclusion (JEDI) movie nights: this innovative initiative originated from the need to discuss these important matters regarding DEIA in a safe and structured space among our students and faculty. During the eight-week intensive training, students are also introduced to research by actively participating in their on-site mentor’s laboratory. During the first year in the program, participants take specific courses as part of their credit requirement for graduation from UPR-RP. The courses will provide the foundation toward understanding and increasing the student’s knowledge in neurobiology. Students continue to do research under the on-site mentor supervision during their two years in the program. Under this faculty mentoring, the students learn to explore the scientific literature, develop a research project, technically perform, troubleshoot experiments, and present their research in both oral and written formats. Since students participate in a research project during their first summer and fall semester in the Program, they do have some experimental results by the spring semester of their junior year. Students are also required to take a scientific writing course for one semester.

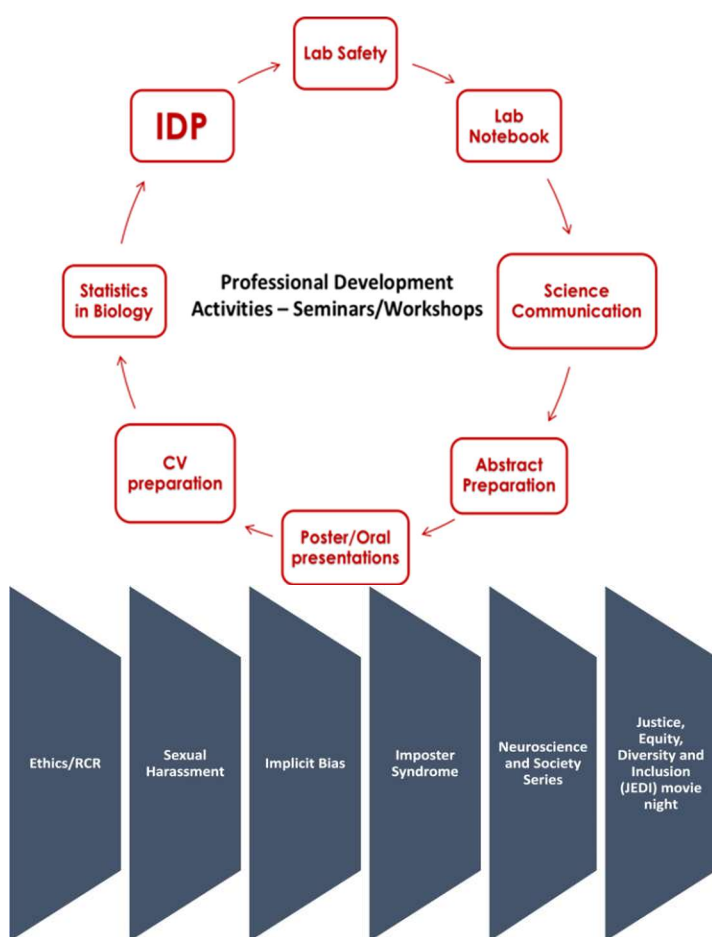


Figure 2. Training activities within the NeuroID 1st year summer immersion program

Structured Activities during the Academic Years

In spring of their junior year, the students make their first presentation at a scientific meeting. This is usually within the PRISM/Jr. Tech meeting, the largest meeting in Puerto

Rico, where undergraduates present their work in a 15-minute oral presentation format. It is our experience that presentation of their results helps the student organize their ideas, improve their understanding of the research activities, and increase the student commitment and enthusiasm in their research field. During the summer following their junior year, students participate in an intensive research experience at one of the collaborating institutions in the mainland. During their stay at this institution, students meet with graduate students and faculty in the graduate program committee (as well as with the P.I. of the T32 program in those institutions with this type of program) to explore his/her possible application to the graduate program. During the fall semester of their senior year, students have the choice to take several courses in the neurosciences such as the Neurobiology course, Psychopharmacology course or the Biopsychology course. These are advanced courses for undergraduates. During the first semester, students are expected to present a poster at the Society for Neurosciences meeting and/or at the Puerto Rico Neuroscience Conference. Toward the end of the semester students meet to discuss their plans for graduate school and begin applications to graduate programs.

During their two-year tenure in the program, students meet once a month. These meetings, named Neuro-Pizza nights are used to discuss, in an informal setting, experiences surrounding a research career (local and invited neuroscientists), discussion on neuroethics topics and presentation on advanced technical approaches in neuroscience. Students are informed of all Neuroscience related seminars offered in the San Juan Metro area. Some of these seminars (at least 4/year) are organized by our program. The students attend at least 10 seminars/ year.

Impactful Outreach and Advocacy Initiatives

The program also exposes the trainees to extracurricular activities that range from career development activities to community outreach. Altogether, the students are exposed to a comprehensive program based on two specific teaching philosophies: “research-with-purpose” and “student-citizen.” NeuroID students are required to organize and be involved in community outreach activities. The community outreach requirement can be fulfilled serving as volunteers of a nonprofit organization such as the Puerto Rico Alzheimer, or any other organization related to a neurological or neurodevelopmental disease. Alternatively, the students organized activities for “Brain awareness week” at the CNS in the UPR-RP, other university campuses or at schools. The students visit elementary, middle, and high schools with activities to illustrate the structure of the brain and its function. Most of these activities are done in collaboration with the National Neuroscience Student Association (NNSA). This is a student organization that was established several years ago by the NeuroID student cohorts. The aims of the NNSA are like those of NeuroID – to provide the necessary tools and opportunities to historically underserved students interested in personal, academic, and professional development, with an emphasis in neuroscience research. The NNSA gives students the

resources necessary to become competitive candidates for graduate school. The NNSA will collaborate in activities such as neuroscience outreach, volunteer work and workshops, so that student members can gain experiences beyond the classroom that teach them skills they otherwise have no access to. These skills focus on science communications and peer-to-peer mentoring with the ultimate goal of inspiring students to become mentors early in their careers. Following these grassroots efforts and ‘do it yourself’ spirit, what sets NNSA apart from other neuroscience outreach associations is that NNSA provides undergraduate students a platform to develop their own ideas. In this way, the NNSA works both as a student organization that provides practical services to members, but also as a creative incubator in favor of project building. Recognizing a need in Puerto Rico for multidisciplinary and high-impact projects that stimulate intellectual conversation and foster a collaborative community of philanthropy, the NNSA allows students to become project advocates and lead their own proposed projects. A series of extracurricular activities to better prepare them for a research career in neuroscience are developed through the NNSA. These training activities provide the necessary proficiency to successfully apply to a graduate program, understand the requirements to pursue a biomedical and clinical research career and, importantly, relate a research career to community service. Although these activities are aimed at the 16 NeuroID scholars in our two cohorts, many of them are available to other students. Finally, the intersection between scientific endeavors and outreach activities developed by the NeuroID students offer a strong contribution to the NeuroID program in enhancing new knowledge of the neurosciences for local and national Hispanic communities. These efforts are evident in the two current student-based neuroscience organizations like the NNSA and more recently the NeuroBoricuas that the Society for Neuroscience recognized with the Science Educator Award.

Pivoting Near-Peer Mentorship and Training

Another innovative initiative recently established within the NeuroID Program is the “NeuroID Peers”. This intervention has impacted a total of 46 students in the last three years. Students interested in Neurosciences are invited to participate in certain NeuroID activities, such as seminars, professional workshops and other activities that can help the students expand their understanding of neurosciences and improve their personal and academic development. Those students that would like to begin training in a research laboratory will be guided toward a laboratory in their field of research interest and where a good mentor-mentee relationship can be established. This group of students also works as a pipeline for the NeuroID program since first- and second-year students are candidates as they advance in their coursework. Similarly, some pre-med students eventually re-direct their career goals to MD/PhD or PhD as they advance in their studies and encounter research experiences. The main purpose of this group, however, is to expand the impact of our Program (and thus of NIH) by

having a larger number of students benefit from our program's activities. This initiative enhances the impact of near-peer strategies by exposing students to Neuroscience activities that might be important or pivotal in their future careers, whether medical research training or other health-related professions.

Strong and Successful Institutional Partnerships with Local Universities and Research 1 Institutions in the US

An intricate part of the successes that the NeuroID program has achieved come from productive and strong partnerships with universities from local and national levels. At the local level, the NeuroID Program has recruited students from six institutions in the San Juan metropolitan area. UPR-RP is the main site of the NeuroID program and from where most of the students have been recruited (~70%). Together, these local metro area institutions provide a very large pool of students that are served with the opportunity to advance their training to enter competitive doctoral neuroscience programs in the mainland. Through the years, the NeuroID program has coordinated synergistic events with many institutions where researchers from several prestigious universities visit our campus and meet with our students. Partnerships with several higher education research institutions have developed strong collaborative ties with the NeuroID program. For example, one institutional partner in the US has provided our students access to an in-person, one-week Quantitative Biology Workshop. The NeuroID students evaluated this experience as an excellent opportunity for learning about computational biology and enhancing their networking and communication skills. Successful outcomes of these partnerships resulted in many universities actively recruiting our NeuroID students because of their outstanding academic performance and rigorous neuroscience training. Finally, an example of a strong local partnership that the NeuroID program has developed through its funding cycles is the Puerto Rico Neuroscience Annual Conference (PRNeuro). The PRNeuro takes place the first weekend of December. The objective of this meeting is to promote networking and collaboration among neuroscientists in Puerto Rico. For the last 30 years, this has been the most important annual event of Neuroscience in Puerto Rico. An event that supports the Neuroscience research and training in Puerto Rico and beyond. In 2021, UPR-RP hosted the event in partnership with five local partners. This annual conference includes a very scientific driven agenda with usually four plenary talks by leading neuroscience researchers from around the world. In the past the event hosted a Women in Neuroscience panel with three promising Puerto Rican neuroscientists. Also, the event includes poster/oral presentations from undergraduate, graduate students, post-doctorals, and faculty interested in a broad spectrum of topics within the neurosciences. Annually, the PRNeuro event is an excellent way for students and faculty to interact, learn and discover the outstanding neuroscience research conducted in Puerto Rico and in the mainland. For the last 30 years, this event has impacted thousands of historically underserved students across the island. An average of 300

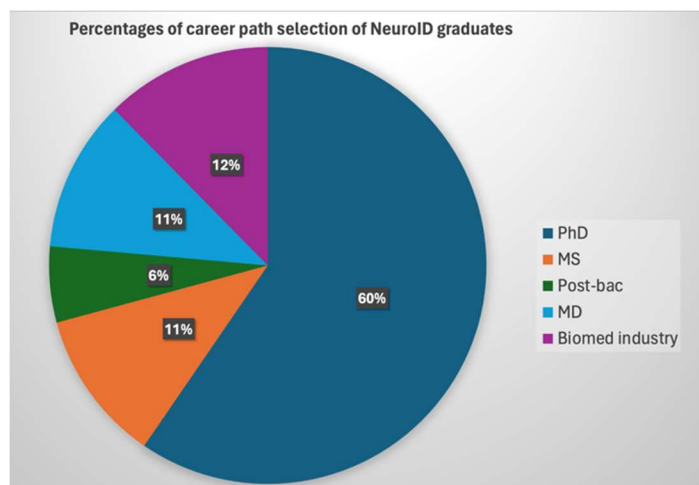


Figure 3. Academic and training paths continued by NeuroID alumni over the years.

participants attend the yearly event. The invited speakers meet with the students to talk about their academic careers, usually providing guidance or suggestions on the many ways that different investigators have reached their positions.

The NeuroID Program: Successful Training Outcomes

A total of 89 students have participated in the program, all Hispanics. Of the students that were admitted to the program, 85% completed the program requirements, more than 90% attended summer research opportunity programs in prestigious R1 institutions. The remaining 15% were students that dropped from the program, usually in their second year because of their decision to continue toward a medical career. It is important to highlight that 76% of the students completing the NeuroID program continued into graduate or post-bachelor programs and 100% are in the biomedical workforce. Our strong research training effort resulted in 94% of NeuroID students presenting their research work in several scientific meetings. A total of 152 poster presentations and 32 oral presentations were made by the NeuroID students during this 2015-2020 period.

Insightful External Evaluation Data of Our Programmatic Performance

It is important to highlight that the NeuroID program is evaluated annually by an external reviewer as well by an external advisory committee. Data from our programmatic outcomes have been analyzed throughout the past 14 years. Using a mixed method of quantitative and qualitative assessment protocols, the external evaluators have reported important data that drive the program's evidence-based approach. For example, evaluation data from both the 1st Summer Integration to Research Experience and the Offsite Summer Research Experience revealed that 87% of the students indicated they were very satisfied and satisfied with the experience. The highest gain was observed in the students' understanding of how scientists work on real problems. With regards to academic performance, 98.3% of the students passed the required courses within the

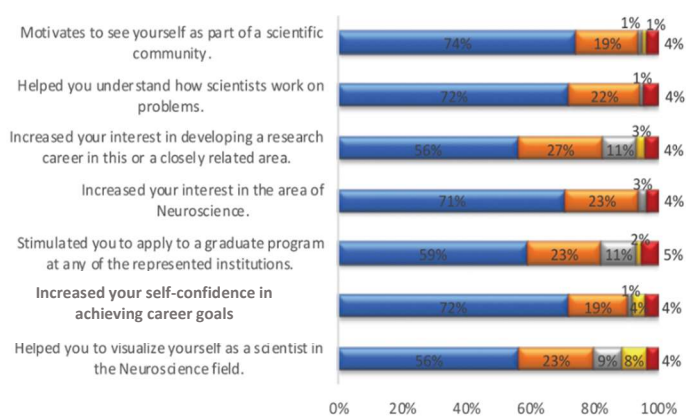


Figure 4. Spring seminars promoted motivation and scientific identity among the participants. Responses indicated that 94% of the students felt that the seminars helped them understand how scientists work on the problem and motivate them to see themselves as part of a scientific community.

neuroscience and computational biology curriculum with a grade of B or higher. In addition, because of the activities offered to foster student's development, an average of 81% of the students showed a very high to high gain in the knowledge needed for applying to a Neuroscience Graduate Program.

Through the years, the NeuroID program has actively adapted to the evaluation outcomes and improved its strategies in several of its initiatives. Moreover, the NeuroID program has integrated effective strategies to create a sense of group identity and teamwork among the students. Teamwork is very important in retention due to the peer-mentoring that naturally develops. For example, qualitative analysis of focus group interventions showed that students highlighted that the research experiences in teamwork settings had motivated them to continue a research career and better understand the importance of research and contribution to society. Also, during the focus group, participants indicated that they had gained literature review skills due to their research work. Students' comments supported that their oral and presentation skills have improved due to their participation in NeuroID because they could present at scientific meetings and laboratory meetings. Because the program is structured to create a strong sense of belonging and community among the two cohorts, this gives the opportunity for the students to exchange personal statements and reports to provide feedback to each other. They also take courses together so that they can study as a group (collaborative learning). Another important contribution to develop affective variables like scientific identity, motivation, and retention in research has been the seminar series coordinated by the program. As students' responses showed, the Fall and Spring Seminar Series increased participant interest in Neuroscience (95% Fall and 94% Spring strongly agree and agree). Students' testimonials about the seminar series express: *"It was a great seminar that provided me with more information about the different topics that can be explored in the field of neuroscience,"* *"I really loved the presentation and would*

love to further do the experimentation myself," and *"This seminar has exceeded my expectations."* The program's evaluators also assessed mentor mentee relationships among our student and faculty. Currently, the program has 15 neuroscience affiliated faculty with extensive and successful experience in mentoring undergraduate and graduate students in their laboratories. During the annual evaluation, students were asked the following questions: *How was the relationship between you and your mentor? Is he/she available to respond to your questions and provide prompt guidance?* In general, students affirmed that they had a good relationship with their mentor. They also described their mentors as attentive, approachable, available, and excellent mentors. Moreover, participants acknowledged that their mentors provided good guidance when needed. Overall, the students gave no negative comments about the relationship with their mentors. With regards to the laboratory dynamics, the evaluation data revealed that 91% of the students engage in journal club activities, followed by 82% who indicate using this time to present their research results. Likewise, 73% of the students indicated that they discuss research literature and review and discuss new research ideas and techniques during their laboratory meetings. This evidence supports the program's strategies to continue an impactful neuroscience training approach. The evaluation data from the past 14 years of several transformative interventions yields evidence of a robust training program with 95% served as an opportunity to advance their knowledge gain.

Neuroid Program and its Institutional Impact

In addition to the significant impact the NeuroID program has on the career development of our students in their pursuit to achieve an academic/research position within the biomedical workforce, the program has also provided a strong platform for other two successful NIH training initiatives that focus on biomedical research: the NeuroGRAD and the IDGeNe programs. The Neuroscience Graduate, Resilience, Affirmation and Diversity Program at the University of Puerto Rico (NeuroGRAD@UPR) has the mission to successfully impact, educate, train, and develop a new cadre of promising historically underserved neuroscience graduate scholars within the UPR-RP in collaboration with prestigious neuroscience research programs across the US. One of the programmatic goals of the NeuroGRAD program is to build strong synergistic collaborations and mentoring teams between a diverse group of Neuroscience research mentors from UPR and our R1 partnering institutions. These mentoring teams successfully support and provide helpful guidance throughout the career path of each student. The proposed NeuroGRAD mentoring network is custom-made for each student based on his/her research interests. To accomplish an effective mentoring network, the selected R1 researcher is an external member of the thesis committee of the student. In addition, the students will have yearly visits to the external mentor's laboratory to strengthen networking and research activities. NeuroGRAD students are also able to participate in research seminars and training activities

thorough virtual platforms from the partnering institutions. Being mentored by a variety of peers can mitigate isolation that is endemic for many STEM women and historically underserved groups and may assist them in developing productive work relationships. Moreover, finding mentors, including peers, who have had similar gendered experiences is likely to be important to ensuring historically underserved groups and women's success in STEM disciplines (Etzkowitz et al. 2001). Relationship building activities between the NeuroGRAD students, and their mentors establishes a sustainable and strong mentoring network thus charting pathways to successful PhD completion and career advancement. The Increasing Diversity in Genomics for the Next Generation (IDGeNe) Program is another training initiative with a similar format to the NeuroID program. IDGeNe is part of an NIH program whose long-term goal is to increase the diversity of the Genomic field workforce by establishing a cohort of interested students that will receive academic and professional training in genomic-related research. Students undergo an 8–10-week summer research experience at several R1 institutions in the US. Upon completion of the program, students are well prepared to continue their education in MS or PhD programs, enter fields of interest, such as Genomic Medicine or Public Health or integrate directly into the Genomics workforce. The program takes advantage of the strong expertise in genomics and genomic-related fields among UPR faculty. Twenty-two UPR faculty whose research involves genomics/bioinformatics participate as mentors in the Program. Collectively these faculty members have mentored hundreds of undergraduate students in their labs and have vast experience to implement and carry forward a highly successful research and mentoring program.

The NeuroID program: Innovative Approaches During the COVID-19 Pandemic

There were several innovative approaches that the NeuroID program designed during the coronavirus pandemic that significantly impacted our students. For example, to maintain our active scientific interactions with faculty in our partnering institutions, the NeuroID Program created and hosted the first Blueprint Initiative-Enhancing Neuroscience Diversity through Undergraduate Research Education Experiences-BP-ENDURE virtual seminar series. The NeuroID program is part of the BP-ENDURE initiative which aims to raise interest and opportunities in neuroscience research for individuals who are typically underrepresented in the field. The transformative seminar series was opened to all BP ENDURE community in a virtual setting. During the Fall semester, the seminar series entitled 'Innovative neuroscience and impactful networking' was launched. This virtual series was coordinated with faculty of several partner institutions in the US and was offered weekly. Importantly, the seminar series included a science talk and a chance to meet excellent neuroscientists. It also allowed the opportunity to receive guidance and important information about graduate programs from recruitment officers at each visiting institution. A total of 15 talks were offered. In the

following Spring semester, we launched another BP ENDURE virtual seminar series entitled "Champions of Diversity in Neuroscience". In this initiative, a total of nine research talks from amazing neuroscientists from historically underserved backgrounds from across the US participated. All seminars from both series were recorded and are available for viewing in the NeuroID program webpage and YouTube channel. The NeuroID Program continued its training efforts by also developing a multidimensional and virtual summer research training program to continue the summer integration plan using virtual tools available at the time. This innovative and successful intervention included the following initiatives, all online: (a) peer-led basic neuroscience lectures, (b) BP-ENDURE Summer virtual seminars, (c) Neuroscience and society seminar series, (d) workshop on software carpentry, (e) discussion forum on issues of racism, discrimination and inequity in the sciences that resulted in an e-letter publication in *Science* (Maldonado-Vlaar, 2020). This innovative intervention and its evaluation data was presented as a virtual poster in the Society for Neuroscience Annual meeting (Maldonado-Vlaar et al., 2021).

In conclusion, the NeuroID program approach and outcomes are exemplary of a comprehensive research experience based on an established research-with-purpose training philosophy that integrates research and community outreach activities to enhance empathy, social responsibility, and self-motivation skills in Hispanic students.

REFERENCES

- American Council on Education (2024) Carnegie Classification of Institutions of Higher Education. Washington, DC: American Council on Education. Available at: <https://carnegieclassifications.acenet.edu/carnegie-classification/classification-methodology/basic-classification/>.
- Bourke J (2018) The diversity and inclusion revolution: Eight powerful truths. *Deloitte Review* 22. Available at: <https://www2.deloitte.com/us/en/insights/deloitte-review/issue-22/diversity-and-inclusion-at-work-eight-powerful-truths.html>.
- CienciaPR (2024) Ciencia Puerto Rico. Puerto Rico: CienciaPR. Available at: <http://www.cienciapr.org/index.php>.
- Etzkowitz, H, (2001) The second academic revolution and the rise of entrepreneurial science. *IEEE Technology and Society Magazine* 20(2):18-29. doi: 10.1109/44.948843.
- Gibbs KD, Basson J, Xierali IM, Broniatowski DA (2016) Decoupling of the minority PhD talent pool and assistant professor hiring in medical school basic science departments in the US. *eLife* 5: e21393. doi: 10.7554/eLife.21393
- Hahm JO, Ommaya A, eds (2006) National Research Council (US) and Institute of Medicine (US) Committee on Opportunities to Address Clinical Research Workforce Diversity Needs for 2010. *Opportunities to Address Clinical Research Workforce Diversity Needs for 2010*. Washington (DC): National Academies Press (US). PMID: 20669446.
- Lim RF, Luo JS, Suo S, Hales RE (2008) Diversity initiatives in academic psychiatry: applying cultural competences. *Acad Psychiatry* 32:283-290. doi.org/10.1176/appi.ap.32.4.283
- Maldonado-Vlaar, CS (2020). *eLetter* sent as a commentary to the article Thorp, H. Holden. "Time to look in the mirror." *Science* 368.6496:1161. Available at: <https://science.sciencemag.org/content/368/6496/1161>.
- Maldonado-Vlaar, CS, García-Arrarás JE, Calderón-Cruz E,

- Ramirez-Leiton J (2021) A multidimensional and virtual summer research training program in the Neurosciences for undergraduate students from underrepresented backgrounds at a Hispanic Serving Institution. In: SFN Global connectome, January 11-13. Washington, DC: Society for Neuroscience.
- National Academy of Sciences (US), National Academy of Engineering (US), and Institute of Medicine (US) Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline. (2011) Expanding Underrepresented Minority Participation. Washington, DC: National Academies Press. Available at https://efaidnbmnnnibpcajpcglclefindmkaj/https://www.ncbi.nlm.nih.gov/books/NBK83377/pdf/Bookshelf_NBK83377.pdf.
- National Science Board (2008) National Science Foundation Report of Science and Engineering Indicators 2008, Volume 1, pp 1-67. Arlington, VA: National Science Foundation. Available at: <https://files.eric.ed.gov/fulltext/ED499643.pdf>.
- National Science Foundation, National Center for Science and Engineering Statistics (2017) Women, Minorities, and Persons with Disabilities in Science and Engineering. Arlington, VA: National Science Foundation. Available at: <https://www.nsf.gov/statistics/2017/nsf17310/digest/enrollment/hhes.cfm>.
- National Science Foundation, National Center for Science and Engineering Statistics (2017) Survey of Doctorate Recipients. Arlington, VA: National Science Foundation. Available at https://ncsesdata.nsf.gov/doctoratework/2017/html/sdr2017_dst_09.html.
- National Academies of Sciences, Engineering, and Medicine (2018) The Impacts of Racism and Bias on Black People Pursuing Careers in Science, Engineering, and Medicine: Proceedings of a Workshop. Washington, DC: The National Academies Press. doi: 10.17226/25849.AAMC.
- NeuroID (2024) Neuroscience Research Opportunities to Increase Diversity (NeuroID) Program. San Juan, Puerto Rico: University of Puerto Rico. Available at: <https://neuroid.uprrp.edu/>.
- National Neuroscience Student Association (nd) National Neuroscience Student Association Facebook Page. Available at: <https://www.facebook.com/NNSAcircuit/>.
- Nielsen, MW, Alegria S, Börjeson L, Etzkowitz H, Falk-Krzesinski HJ, Joshi A, Leahey E, Smith-Doerr L, Woolley AW, Schiebinger L (2017) Opinion: Gender diversity leads to better science. Proceedings of the National Academy of Sciences of the United States of America, 114(8):1740–1742. doi: 10.1073/pnas.1700616114
- Quacquarelli Symonds (2024) International World University Rankings Portfolio. Available at <https://www.qs.com/rankings-performance/>.
- Snyder TD, Brey CB, Dillow SA (2019) Digest of Educational Statistics 2017 (NCES 2018-070). 53rd edition. Washington, DC: US Department of Education, National Center for Education Statistics. Available at: <https://nces.ed.gov/pubs2018/2018070.pdf>.
- Taffe MA, Gilpin NW. (2021) Racial inequity in grant funding from the US National Institutes of Health eLife 10:e65697. doi: <https://doi.org/10.7554/eLife.65697>
- Ullrich LE, Ogawa JO, Jones-London ME (2024) A Retrospective Analysis of Career Outcomes in Neuroscience eNeuro 9. doi: 10.1523/ENEURO.0054-24.
- University of Puerto Rico-Rio Piedras Campus (2018) Plan estratégico 2018-2023, Academic Senate Publication No. 79. 2018. San Juan, Puerto Rico: University of Puerto Rico-Rio Piedras Campus. Available at <https://senado.uprrp.edu/wp-content/uploads/2018/11/CSA-79-2017-2018.pdf>.
- Valantine HA, Collins FS (2015) National Institutes of Health addresses the science of diversity. Proc Natl Acad Sci U S A. 112(40):12240-2. doi: 10.1073/pnas.1515612112
- Valantine HA, Lund PK, Gammie AE (2016) From the NIH: A Systems Approach to Increasing the Diversity of the Biomedical Research Workforce. CBE Life Sci Educ. 15(3):fe4. doi: 10.1187/cbe.16-03-0138.
- Whittaker JA, Montgomery BL, Martinez Acosta VG (2015) Retention of Underrepresented Minority Faculty: Strategic Initiatives for Institutional Value Proposition Based on Perspectives from a Range of Academic Institutions. J Undergrad Neurosci Educ 13(3):A136–A145. PMID: 26240521; PMCID: PMC4521729.

Received February 23, 2024; revised May 27, 2024; accepted May 31, 2024.

This work was supported by the NIH Blueprint for Neuroscience Research and managed by the National Institute of Neurological Diseases and Stroke (NINDS). The authors thank Ms. Marimar Velazquez and Natalia Figueroa for their excellent clerical support, Edjean Calderon and John Ramirez our external evaluators (CooPSEI) and all our NeuroID Fellows and mentors. In 2024, the UPR-RP received the NIH Institutional Excellence in Diversity, Equity, Inclusion, and Accessibility (DEIA) in Biomedical and Behavioral Research Prize (<https://www.nihdeiaprize.org/results>) for implementing the NeuroID Program (<https://neuroid.uprrp.edu>)

Address correspondence to: Dr. Carmen S. Maldonado-Vlaar, Biology Department, University of Puerto Rico-Rio Piedras, PO BOX 23360, San Juan Puerto Rico. Email: carmen.maldonado7@upr.edu

Copyright © 2024 Faculty for Undergraduate Neuroscience

www.funjournal.org