

RI-INBRE: A Statewide NIH Program Grant to Improve Institutional Biomedical Research Capacity in Rhode Island

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ABSTRACT

The overarching goal of the Rhode Island-IDEA Network of Biomedical Research Excellence (RI-INBRE) is to improve institutional capacity for biomedical research excellence and expand student experiential training opportunities in the State of Rhode Island. RI-INBRE comprises five major core components: The Administrative Core, the Bioinformatics Core, the Centralized Research Core Facility, the Training Core, and the Developmental Research Project Program Core. Since its inception in 2001, RI-INBRE has made significant investments and marked advancements in the biomedical research infrastructure of Rhode Island. RI-INBRE funding has increased the scale and quality of faculty research and engaged undergraduate students, graduate students, and postdoctoral fellows in structured and mentored research training experiences. Over the last 19 years, RI-INBRE has supported 212 faculty researchers and over 533 projects and has provided research-training opportunities for nearly 2,000 students, resulting in 757 publications. Through its student-training program, RI-INBRE has contributed to regional workforce development by engaging students and encouraging them to pursue careers in biomedical fields. Many of these students have been admitted to graduate or medical schools and obtained biomedical industry jobs following graduation. RI-INBRE has been particularly influential in building the research infrastructure at primarily undergraduate institutions, which have seen significant improvements in research quality and output, student training, and research infrastructure.

KEYWORDS: biomedical research capacity, cancer, neuroscience, environmental health sciences

INTRODUCTION

The Institutional Development Award (IDeA) is a congressionally-mandated program administered by the National Institute of General Medical Sciences (NIGMS) of the National Institutes of Health (NIH). The IDEA Network of Biomedical Research Excellence (INBRE) program is designed to foster the development, coordination, and sharing of research

resources and expertise, and to increase the number of competitive investigators in states where NIH research funding levels have historically been low.¹ While most institutions are eligible to participate in INBRE, an additional emphasis is on institutions such as primarily undergraduate institutions (PUIs) that typically lack the resources and research infrastructure of larger public and private institutions.² The goals of RI-INBRE include 1) financial support of early career scientists to help them achieve sustainable research programs, 2) provide resources to network institutions to increase research infrastructure through facilities upgrades and the hiring of research support staff, 3) to train undergraduate and graduate students and postdoctoral researchers with the goal of encouraging them to apply to graduate or medical school and/or find jobs in the biomedical sector, and 4) to enhance the local state and regional economies by providing a trained workforce in biomedical sciences.

The RI Biomedical Research Infrastructure Network (RI-BRIN) program began in 2001 and was replaced by RI-INBRE in 2004. The network includes the University of Rhode Island (URI), Brown University, associated local hospitals, and the Rhode Island (RI) PUIs: Bryant University, Providence College, Rhode Island College (RIC), Roger Williams University, Salve Regina University, and most recently the Community College of Rhode Island (CCRI). The funds allocated to these institutions support hiring of new biomedical faculty who can devote time to research, which has led to an increase in undergraduate student researchers and research productivity. In 2008 RI-INBRE began the Summer Undergraduate Research Fellowship (SURF) program to fund summer undergraduate research opportunities at the network institutions and local hospitals. This program has grown significantly in the years since and now constitutes an important training component of the RI-INBRE program.

STRUCTURE

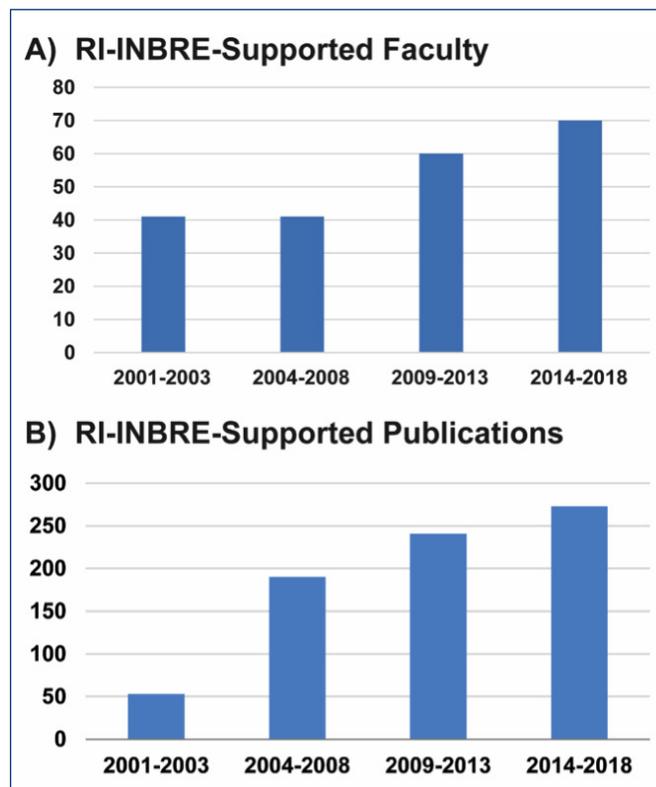
RI-INBRE is organized around several cores. The *Administrative Core* manages the administrative and financial aspects of the grant and is led by Program Director Bongsup Cho and Program Coordinator Niall G. Howlett and supported by Program Assistant Laura Arrighi and Program Business Manager Laura Bellavia. The major goals are to: manage the functions of the External Advisory Committee

(EAC), the Steering Committee (SC), and the Faculty Development Mentoring Committee; create a pipeline of trained individuals for careers in the cancer, neuroscience, and environmental health sciences thematic areas; and implement and oversee comprehensive internal survey and external assessment activities.

The *Developmental Research Project Program* (DRPP or Research Core) led by Program Coordinator Niall G. Howlett develops, solicits, and awards developmental research project funding to investigators at RI-INBRE network institutions (Figure 1A). The current scientific focus areas of RI-INBRE are cancer, neuroscience, and environmental health sciences. Research areas funded under these focus areas are broad and inclusive and include biochemistry and molecular biology, biomedical engineering, toxicology and natural products, psychology, neurodegenerative diseases, and environmental health sciences. A variety of support mechanisms are available to researchers depending on their career stage and specific needs. The primary funding mechanism of the Research Core is the Early Career Development (ECD) award. This is a 2–3-year award designed to support research program development of early career investigators at URI, Brown University, and the RI PUIs. ECD-supported investigators choose an experienced senior investigator to guide them in all aspects of research and professional career development over the course of the funding period. RI-INBRE also promotes innovative collaboration between well-established senior faculty at URI and Brown University and junior faculty at PUIs through the Collaborative Research (CR) award. This is a 2-year award that provides funding to both the junior and senior investigators. By partnering established investigators with junior PUI investigators, we aim to enhance the level of mentorship, thereby facilitating and accelerating research productivity and increasing the level of preparedness of the PUI investigators for submitting competitive independent or collaborative research proposals, e.g. NIH R15 or NSF RUI/ROA applications. The Research Core also supports pilot awards and summer undergraduate research fellowship (SURF) awards to faculty at the PUIs. Recent additions to the Research Core portfolio of funding opportunities include the Enhanced Virtual Education, REsearch, and Training (EVEREST) award to promote novel virtual/remote tools for education, research, and training, and Bioinformatics Pilot Project (BPP) vouchers to fund small-scale next-generation sequencing projects. Together, these mechanisms have supported over 500 faculty projects and led to a significant increase in research productivity as measured by scientific talks, poster presentations and publications (Figure 1B).

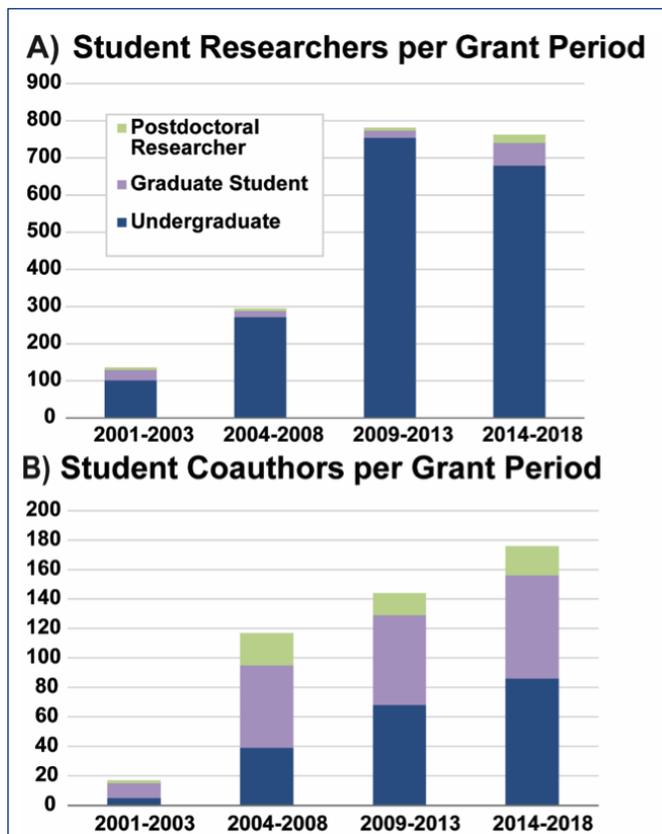
The goal of the *Training Core*, led by Dr. Samantha Meenach, is to establish a robust biomedical workforce pipeline in RI by providing research training opportunities for students, postdoctoral researchers, and occasionally faculty (Figure 2). The SURF program is the major component of this

Figure 1. A) Number of faculty members supported by RI-INBRE per grant period. **B)** Number of publications acknowledging RI-INBRE by grant period.



core and involves pairing undergraduate researchers with faculty mentors at URI, Brown University, and the PUIs to conduct research projects during the summer months. Students undergo training in research standards, lab safety, data handling, and other professional development topics. The program ends with a SURF conference where the students are given the opportunity to present their research to the community in a public poster session. The annual SURF conference is the largest of its kind in the state and draws approximately 400 attendees. Additional programs administered by the Training Core include the Bridges to Graduate School Program, which encourages RI-INBRE undergraduates to attend graduate school in RI, CCRI Summer Research Sabbatical Program, which places CCRI faculty in established labs at URI or Brown, giving them the opportunity to learn new skills to take back to their campus, and Teaching Postdoctoral Fellowships (TPF) Program. The latter is a partnership between RI-INBRE and the PUIs designed to advance the teaching and research mission of the PUIs, and to help train the next generation of teacher-scholars. Nearly 2000 students have been trained in the 19 years of the RI-INBRE program and student research productivity has increased in kind as measured by the growth in the number of student coauthors on manuscripts (Figure 2B).

Figure 2. A) Number and type of students supported by RI-INBRE per grant period. **B)** Number of students co-authors listed on RI-INBRE publications per grant period.



RI-INBRE also funds two core facilities to provide research services and support to the RI-INBRE and the state’s biomedical community. The *Centralized Research Core Facility* (CRCF) based at the URI College of Pharmacy provides a central location for over \$4 million of instrumentation, including microscopes, centrifuges, cell culturing, chromatography, and mass spectrometry. The CRCF is managed by Dr. Al Bach and Kim Andrews and provides training services free to RI-INBRE investigators and at subsidized rates to all other investigators. This facility is the only one of its kind in RI and is often cited by junior faculty as a significant resource in helping them establish and develop their laboratories. The *Bioinformatics Core* led by Dr. Christopher Hemme provides services and training in 1) bioinformatics and data science, 2) molecular modeling and other 3D science visualization tools such as 3D animation and projection, and 3) virtual and augmented reality applications.

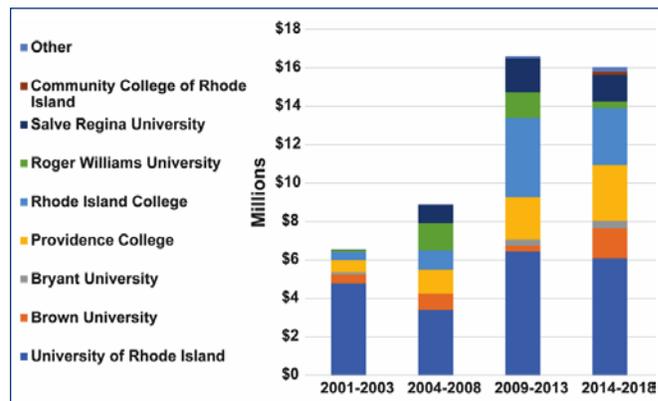
DATA AND IMPACTS

From 2001 to 2024, RI-INBRE will have distributed \$81 million dollars in research and training funding. As of 2020, this has supported 212 faculty researchers over 533 projects

and the training of 1975 students. The research funded by the program has resulted in 757 publications with 176 undergraduate co-authors. RI-INBRE funding has been quite impactful in facilitating faculty research. For example, from 2001–2021, RI-INBRE spent 78% of its annual budget to support investigator-initiated research projects (\$54M) (Figure 3). Through 2024, this number is expected to rise to \$63M. RI-INBRE’s impact is most dramatic at PUIs in terms of resources and research culture change. For example, RI-INBRE has provided Rhode Island College with over \$10.0M in grants and equipment support since 2001. In 2001, faculty research and student training were not recognized as a requirement for achieving tenure and promotion at RIC and federal research funding, especially that provided by NIH, was rare. RIC faculty are currently securing ~\$10M per year in external funding. In addition, hundreds of students are now participating in experiential research training during the academic year and summers. RI-INBRE funding has also contributed to facilities and infrastructure upgrades at PUI network institutions. Many of the faculty funded by RI-INBRE have graduated from the program by achieving research independence, often by being awarded NIH R01 and R15 and NSF RUI awards. Given the length of the RI-INBRE program, some former student researchers who are now independent scientists in RI have returned to the program as grant reviewers and research mentors for the next generation of student researchers.

Workforce development is a key goal of the RI-INBRE program. To assess the impact on the state and regional workforce, RI-INBRE staff have attempted to track students for at least five years to assess their career paths, whether they attended graduate or medical school, and whether they remained in the Northeast. Given the length of time the program has run and the large number of students, collecting and processing accurate data is a significant challenge. However, the data collected suggests a strong positive impact of the program on student career developments. Based on the sample of students we were able to track, >70% of

Figure 3. Monetary support of RI-INBRE network institutions by grant period.



undergraduate students who participated in the program are currently employed in the broader biomedical sector in the greater New England area (**Figure 3**). These jobs tend towards the pharmaceutical industry, but include biomedical engineering, chemistry, academic positions, entrepreneurs, and medical jobs (clinicians, nursing, pharmacy, etc.). Upon graduation, most students remained in Massachusetts, Rhode Island, and Connecticut. While most students ended their education with undergraduate (bachelor's or associate) degrees, data suggests ~25% of former RI-INBRE undergraduates went on to earn at least one graduate (masters or PhD) or medical degree. One indication of the improvement of research infrastructure at the PUIs is that many of these students were admitted to prestigious research programs around the country. All indications are that the program has been enormously successful at stimulating student interest in careers in the biomedical sciences and the retention of those students in Rhode Island and the Northeast.

PARTNERSHIPS

Collaboration between IDeA programs and networks is strongly encouraged by the NIH. Five states make up the Northeast IDeA region: Rhode Island, Maine, Vermont, New Hampshire, and Delaware. The Northeast INBRE programs frequently communicate to exchange ideas and determine best practices. Part of this effort includes the Northeast Bioinformatics Collaborative (NEBC), a collaboration between the five Northeast INBRE bioinformatics cores. This collaboration has included such efforts as the Northeast Cyberinfrastructure Consortium to enhance cyberinfrastructure for researchers in the Northeast and coordinated efforts at training through the Maine-New Hampshire Train-the-Trainer workshop, to train students and researchers in bioinformatics and data analysis skills. The NH-INBRE and DE-INBRE programs have been cooperating with RI-INBRE to provide sequencing services for the Bioinformatics Pilot Projects. To complement the mass spectrometry resources provided by RI-INBRE, the CRCF cooperates with the Oklahoma and Arkansas INBRE programs, both of which manage strong proteomics programs. In August 2021, RI-INBRE will host the biennial NorthEast Regional IDeA Conference (NERIC), bringing together all IDeA programs in the Northeast region to present research results, network, and build collaborations. Finally, many of the existing INBRE programs regularly cooperate on this issue of administrative data gathering and management for reporting and metrics tracking. Many of these programs utilize the PieStar software to manage reporting and eventually analysis of legacy data used to judge the effectiveness of the programs.

In addition to RI-INBRE, Rhode Island currently has 12 COBRE programs and an Advance-CTR program. Regular communication is maintained to identify synergistic activities between programs. The multiple core facilities

periodically gather to discuss cooperative opportunities and needs of the RI IDeA programs. The Bioinformatics Core has individually cooperated with the Advance-CTR Brown Center for Biomedical Informatics (BCBI) and the COBRE Brown Center for Computational Biology of Human Disease (CBHD) on a variety of efforts. These efforts have included inviting speakers to URI from the BCBI, a metagenomics workshop with the CBHD, and the Rhode Island Microbiome Symposium 2020 with CBHD.³ The symposium was an effort to bring together both environmental and clinical microbiome researchers from around RI and New England to discuss microbiome-related research. Over 100 researchers attended the conference and a follow-up conference will be organized once the COVID-19 pandemic has passed. This past summer, RI-INBRE organized a weekly virtual seminar series that involved the 12 IDeA program directors in RI. The series highlighted the state's capacity building and training programs and recognized the directors' valuable contributions in improving RI's biomedical research capacity. This virtual event was the first of its kind in RI and provided the state's biomedical community with great networking opportunities.

RI-INBRE has also established cooperative efforts with non-IDeA programs. Traditionally, the RI-INBRE SURF program collaborates with the NSF EPSCoR C-AIM to hold a single SURF conference at the end of each summer where all SURF participants are given the opportunity to present their research to the community. This year the RI-INBRE SURF program welcomed Maximizing Access to Research Careers (MARC) Undergraduate Student Training in Academic Research (U-STAR) program trainees to participate in professional development and research training activities and to present their data at the annual SURF symposium. The MARC U-STAR program is a research and professional development program supported by NIGMS for undergraduate students from underrepresented backgrounds.⁴

To promote entrepreneurship and intellectual property development by RI-INBRE researchers, RI-INBRE collaborates with the NIH-funded Northeast DRIVEN Acceleration Hub and RI Bio life sciences industry group to share best practices and provide workshops, webinars, forums, and resources to the RI's innovative and entrepreneurial community.

FUTURE EFFORTS

The RI-INBRE program has undergone significant changes since its inception 20 years ago and has had a truly transformative effect on RI's biomedical research community. The program has inspired a culture change among researchers, especially at the PUIs, launching and supporting the independent careers of multiple faculty and promoting new collaborations across all the RI colleges and universities. The two goals of student training and junior scientist support will

remain priorities in the future. We will continue to adapt and innovate moving forward. The RI-INBRE program is also committed to promoting a diverse, equitable, and inclusive biomedical research culture across the state of Rhode Island. The program actively supports and promotes the hiring of both faculty and postdoctoral research fellows from diverse/unrepresented backgrounds at the RI PUIs and will continue to support and lead statewide efforts to diversify the biomedical and scientific workforce. A centralized data reporting and tracking system will simplify annual reporting and metrics tracking and will provide an accurate assessment of trends within the RI-INBRE program and between INBRE and other IDeA programs. New initiatives such as the EVEREST and BPP funding mechanisms will expand the scope of existing research funding mechanisms allowing the maximum number of faculty to participate and stimulating new ways to train the next generation of biomedical researchers. The program will continue to recruit quality students and engage them in research activities while encouraging them to pursue biomedical careers following graduation. Ultimately, these activities will continue to greatly enhance the biomedical infrastructure of Rhode Island, meeting the primary goal of the IDeA INBRE mechanism.

References

1. <https://www.nigms.nih.gov/capacity-building/division-for-research-capacity-building/institutional-development-award-idea>
2. <https://web.uri.edu/riinbre/>
3. <https://web.uri.edu/riinbre/microbiome-symposium-2020/>
4. <https://diversity.nih.gov/about-us/population-underrepresented>

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