

RAIN: A multi-state research alliance to facilitate collaboration, increase student opportunities, and share Core Facility resources

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TRAINING AND MENTORING

RAIN: a multistate research alliance to facilitate collaboration, increase student opportunities, and share core facility resources

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Abstract

Since 2001, the National Institutes of Health (NIH) have funded the Institutional Development Award (IDeA) Network of Biomedical Research Excellence (INBRE) to expand biomedical research capacity among states in which NIH funding was historically low. The Western IDeA Region comprises seven states: Alaska, Hawaii, Idaho, Montana, New Mexico, Nevada, and Wyoming. Beginning in 2017, these states developed an interstate “supernetwork”: the Regional Alliance of INBRE Networks (RAIN). RAIN’s four initiatives are: 1) holding regular INBRE program director/principal investigator (PD/PI) communication and strategy sessions; 2) sharing research Core Facilities and programs; 3) developing interstate undergraduate student research exchanges; and 4) promoting interstate research collaborations. The seven INBRE PD/PIs meet monthly, usually virtually, to share administrative best practices, help each other problem-solve, and support one another’s competitive renewals. Sharing IDeA-built Core Facilities and programs offers unique and/or faster services for researchers, without states needing to duplicate core capabilities. This substantially reduced costs. In 2019, ID-, MT-, and NM-INBREs estimated that sharing their existing Core Facilities and services saved \$27.6 million over the course of one 5-yr funding cycle. Each undergraduate summer research program is open to other RAIN state students, with 29 student participants thus far. Faculty interdisciplinary research is promoted by a Collaboration Studio and special funding. To date, RAIN support has led to 18 scientific presentations, 12 peer-reviewed publications, and generated \$1,400,000 in new NIH grants. RAIN is a model for other programs to share best practices, enhance interdisciplinary collaborations, limit redundant infrastructure, and share research/mentoring expertise.

NEW & NOTEWORTHY The IDeA Network of Biomedical Research Excellence (INBRE) programs in all seven Western region states formed an alliance to compensate for an essentially static National Institutes of Health (NIH) budget but a growing dynamic mission. Biomedical research capacity has grown and our collaboration model benefits grant renewal, access to research Core Facilities, student preparation for the workforce, and faculty interdisciplinary solutions for complex medical problems.

core facility; IDeA Network of Biomedical Research Excellence; INBRE; interstate collaboration; student training

INTRODUCTION

In 1993, the IDeA program (<https://www.nigms.nih.gov/Research/DRCB/IDeA/Pages/default.aspx>; see Table 1 for a list of acronyms and their definitions) was established by the NIH and is currently administered through the National Institute of General Medical Sciences. Its purpose is to expand biomedical research capacity among states in which NIH funding was historically low and thereby address the geographic inequity of NIH funding in the United States. This issue was recently highlighted by a study finding that for fiscal year 2022 the non-IDeA states received 93.6% of the total

NIH funding, whereas IDeA states received only 6.4% (1). There are 23 states and Puerto Rico in four geographic regions eligible for IDeA funding. The Western Region comprises seven states: Alaska, Hawaii, Idaho, Montana, Nevada, New Mexico, and Wyoming (Fig. 1). A funding mechanism initiated in 2001 is the IDeA Network of Biomedical Research Excellence (INBRE) (<https://grants.nih.gov/grants/guide/pa-files/PAR-20-102.html>) program, with one award per state/territory. INBREs are competitive 5-yr awards with a program director/principal investigator (PD/PI). The INBRE PD/PIs are the driving leadership of the program. They have vision and overall responsibility for the design, conduct,



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Submitted 4 November 2024 / Revised 17 January 2025 / Accepted 11 February 2025



Table 1. Acronyms in this manuscript and their definitions

Acronym	Definition
CASI	Center for Advanced Scientific Instrumentation
CC	Community college
DSC	Data Science Core
FIRE	First Research Experience
IDeA	Institutional Development Award
INBRE	IDeA Network of Biomedical Research Excellence
LoI	Letter of intent
NIH	National Institutes of Health
PD/PI	Program director/principal investigator
PEARL	Program Evaluation and Administration of Research Leaders
PUI	Primarily undergraduate institution
RAIN ^a	Regional Alliance of INBRE Networks
RPPR	Research performance progress report
TAG	Technology Access Grant
TC	Tribal college

^aAlso referred to as “the Alliance.”

reporting, and scientific integrity of the program, including compliance with law, regulation, and policy. The PD/PIs are supported by additional members of an administrative core, which may include a Program Coordinator, various Core Directors, and a Program Evaluator. Providing faculty and other researchers with access to Core Facilities, providing research opportunities for undergraduate students, and mentoring and supporting faculty toward research funding independence are among the INBRE programmatic goals.

INBRE programs are tasked to develop a statewide scientific network consisting of the PD/PI's institution, as lead, and additional partner institutions. These include primarily undergraduate institutions (PUIs), tribal colleges (TCs), community colleges (CCs), and research universities/foundations/consortia. Table 2 lists the lead and participating partner institutions in the Western Region INBREs.

In common among the INBRE participants of the Western Region are four interrelated factors that historically have hindered the development of robust and productive research programs. 1) These seven states have small populations spread over large geographic areas. Although the states of the Western Region have almost one-third of the total United States land-mass, only ~3.3% of the United States population lives in these states. For comparison, the total population of Alaska, Hawaii, Idaho, Montana, Nevada, New Mexico, and Wyoming is ~11 million people, which is less than the population of the state of Illinois (<https://www.census.gov/>; December 12, 2023). 2) Mirroring the population distribution in these states, most institutions are relatively isolated and serve underrepresented populations. For example, New Mexico is a majority minority state, and Alaska, New Mexico, and Montana are among the top five states with the highest percentages of American Indian and Alaska Native individuals in the United States, according to the 2020 census (<https://www.census.gov/library/visualizations/interactive/race-and-ethnicity-in-the-united-state-2010-and-2020-census.html>). 3) Four of the seven states (AK, ID, MT, and WY) lack a 4-year medical school. 4) The sparse populations of these states and the long distances between their academic institutions (Fig. 1) led to a third common need, that of sharing limited scientific expertise and infrastructure.

Even in the face of these challenges, the infusion of INBRE funding has had a profound positive effect on increasing

research capacity across the Western Region. In fact, the activity has changed many campus cultures to include biomedical research and student research opportunities where there were none before. To meet an expanding interest, ongoing since 2001, every INBRE has added partner institutions, increased student and faculty participation, and expanded research activities. This has significantly taxed the INBRE budgets, which have remained relatively static.

Within this context, the INBRE programs in Idaho, Montana, and New Mexico initiated the development of a “supernetwork” among their institutions, designated as the Regional Alliance of INBRE Networks (RAIN). The goal was to reduce redundancy and maximize sharing of resources and expertise (Fig. 2). All three RAIN member states were active participants and successfully competed for renewal of their programs, with positive comments from reviewers, especially with respect to the activities of the Alliance. These were in addition to the feedback from faculty and student participants. Core Facilities and technical help were shared, students participated in the research opportunity exchange among states, and faculty developed interdisciplinary research collaborations between states. Driven by this success, RAIN was subsequently expanded to include the four additional INBRE states of the Western Region.

Whereas the individual INBRE programs consist of state-level leadership and the development of state-specific programs, RAIN consists of multilayered connections to address challenges that all seven Western Region INBREs face and to provide resources without disrupting the local approach/mission of each program. The four main initiatives of RAIN were formalized as: 1) frequent and regular INBRE PD/PI communication and strategy sessions; 2) the sharing of access to Core Facilities, including equipment and expertise; 3) the development of interstate undergraduate student research opportunities; and 4) the facilitation of interstate faculty research collaborations.

To monitor the initiatives, metrics were established to evaluate the level of cross-program participation, interaction, and mutual effectiveness. The evolution of this Alliance over the last 6+ years has required further development of methods and tools to assess the ongoing programs and guide their refinement.

Here we describe the four RAIN program areas, present broad findings from our assessment tools, and suggest future approaches to further refine this alliance. This is an innovative approach to enhance regional interdisciplinary collaborations, limit the development of redundant infrastructure, and share research and mentoring expertise. We believe that this Alliance can be a model for other IDeA regions as well as for non-INBRE initiatives that are faced with similar challenges.

MATERIALS AND METHODS

The RAIN Approach

The Alliance was developed in a strategic and thoughtful manner. As the number of participants increased and the needs of the Alliance changed, RAIN has adapted and fine-tuned its programs. We describe below the organizational elements of RAIN as well as the methods associated with the four initiatives.

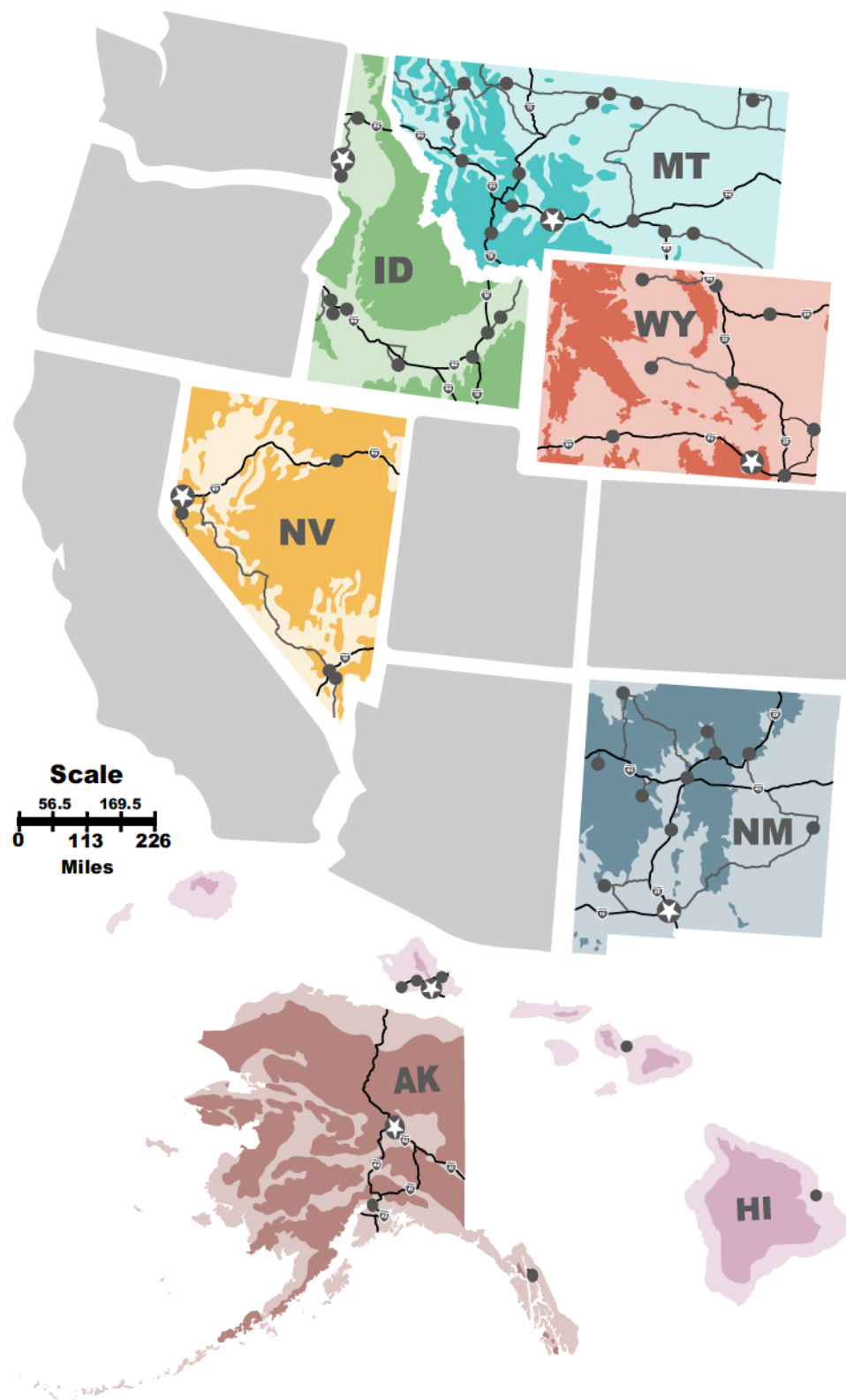


Figure 1. Seven IDEa Network of Biomedical Research Excellence (INBRE) states make up the Western IDEa Region and the Regional Alliance of INBRE Networks (RAIN). The Western INBRE states (not drawn to scale) are shown in color. Star, lead institutions; black circles, partner institutions; lines, major highways.

Table 2. Lead and participating partner institutions for each state INBRE in RAIN

Alaska INBRE (University of Alaska Fairbanks; Brian Barnes, PD/PI) ^a	
Alaska Native Tribal Health Consortium, Anchorage	University of Alaska Anchorage
Ilisaġvik College, Utqiagvik	University of Alaska Southeast Juneau
South Central Foundation, Anchorage	
Hawaii INBRE (University of Hawaii-Manoa; Peter Hoffmann, PD/PI)	
Chaminade University, Honolulu	University of Hawaii, Maui
Hawaii Pacific University, Honolulu	University of Hawaii at Lilo, Hilo
Kapi'olani Community College, Honolulu	University of Hawaii West Oahu, Kapolei
Leeward Community College, Honolulu County (Pearl City)	Windward Community College, Honolulu
Idaho INBRE (University of Idaho, Moscow; Carolyn J. Hovde ^b , PD/PI)	
Boise State University, Boise	Idaho Veterans Research and Education Foundation, Boise
Brigham Young University-Idaho, Rexburg	Lewis-Clark State College, Lewiston
College of Eastern Idaho, Idaho Falls	North Idaho College, Coeur d'Alene
College of Southern Idaho, Twin Falls	Northwest Nazarene University, Nampa
College of Western Idaho, Nampa	The College of Idaho, Caldwell
Idaho State University, Pocatello	
Montana INBRE (Montana State University, Bozeman; Brian Bothner, PD/PI)	
Aaniih Nakoda College, Harlem	Montana State University Northern, Havre
Blackfeet Community College, Browning	Montana Tech of the UM, Butte
Carroll College, Helena	Rocky Mountain College, Billings
Chief Dull Knife College, Lame Deer	Salish Kootenai College, Pablo
Flathead Valley Community College, Kalispell	Stone Child College, Box Elder
Fort Peck Community College, Poplar	University of Montana, Missoula
Little Big Horn College, Crow Agency	University of Montana Western, Dillon
Montana State University, Billings	
Nevada INBRE (University of Nevada, Reno; Josh Baker, PD/PI)	
College of Southern Nevada, Las Vegas	University of Nevada, Las Vegas
Great Basin College, Elko	University of Nevada, Reno
Nevada State University, Henderson	Western Nevada College, Carson City
Truckee Meadows Community College, Reno	
New Mexico INBRE (New Mexico State University, Las Cruces; Shelley Lusetti, PD/PI)	
Acoma, Pueblo Territory	New Mexico Institute of Mining and Technology, Socorro
Burrell College of Osteopathic Medicine, Las Cruces	Northern New Mexico College, Española
Dona Ana Community College, Las Cruces	San Juan College, Farmington
Eastern New Mexico University, Portales	University of New Mexico, Albuquerque
National Center for Genome Resources, Santa Fe	Western New Mexico University, Silver City
New Mexico Highlands University, Las Vegas	Zuni, Pueblo Territory
Wyoming INBRE (University of Wyoming, Laramie; Robert S. Seville, PD/PI)	
Central Wyoming College, Riverton	Northern Wyoming Community College District, Sheridan College
Eastern Wyoming College, Torrington	Northwest College, Powell
Laramie County Community College, Cheyenne	University of Wyoming at Casper and Casper College, Casper
Northern Wyoming Community College District, Gillette College	Western Wyoming Community College, Rock Springs

INBRE, IDeA Network of Biomedical Research Excellence; PD/PI, program director/principal investigator; RAIN, Regional Alliance of INBRE Networks. ^aFor each state INBRE, the lead institution and PD/PI are listed parenthetically. The current AK-INBRE PD/PI is Jason Burkhead. ^baka Carolyn Hovde Bohach.

Growing and reinforcing the Alliance.

RAIN began as a three-state alliance of Idaho, Montana, and New Mexico and was a specific aim in their competitive INBRE renewal applications submitted in 2018. The addition of INBREs from Wyoming followed by Nevada and then Alaska and Hawaii was accomplished as each state submitted its competitive renewal application. Participation was designed to be a long-term and sustainable collaboration. Alliance members created a common written section to be included in everyone's INBRE renewal applications. To participate, each INBRE included an ~\$100,000 line item for RAIN in its annual budget to show commitment and intent to participate.

Developing communication tools to publicize the Alliance.

The creation of a RAIN website (<https://rainresearch.org>) was an early and necessary mechanism for formalizing the Alliance and for publicizing components of its programs. The responsibility for curating the website rotates among the seven INBRE member states, with each state having

editing privileges to facilitate timely updating of materials. The website provides information for RAIN members about Core Facilities, undergraduate summer research programs, and grant opportunities for interstate collaborations, among others. Each state INBRE also maintains a statewide listserv for distribution of information by email, along with a social media presence.

PD/PI in-person meetings and monthly teleconferences.

PD/PI RAIN meetings occur monthly via online video conferences. On those occasions when they can be held in person (e.g., in conjunction with a regional or national IDeA meeting), the in-person meeting takes the place of a virtual meeting. The leadership of these meetings rotates across all seven INBREs, with an INBRE PD/PI serving as chair for 1 year. An agenda for each meeting is developed by the chair with feedback from the other six PD/PIs. Additionally, INBRE administrative support staff meet separately and regularly as the Evaluation Subgroup and the Student Program Subgroup to carry out evolving RAIN directives.

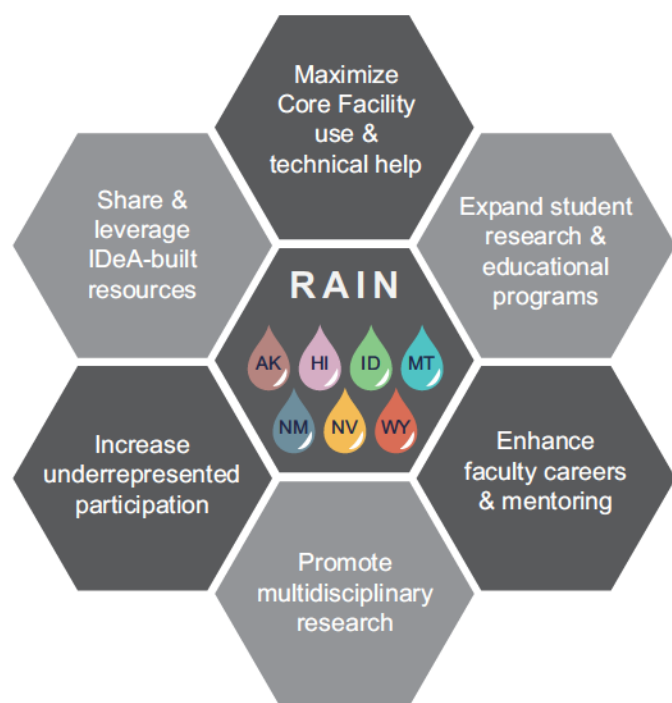


Figure 2. Overview of the Regional Alliance of IDeA Network of Biomedical Research Excellence (INBRE) Networks (RAIN) approach to increase collaborations and reduce redundancies.

Promoting access to core facilities across the Alliance.

Reducing redundancy and maximizing use of Core Facility investments are major benefits of RAIN. Therefore, in addition to the website information, Core Facility Directors are asked to promote their facilities at RAIN-related meetings. The Alliance has developed an open fee structure for all RAIN members such that interstate users pay the same rates as in-network users. Many of the RAIN members have incorporated Technology Access Grants (TAGs) into their INBRE programs. Although these vary in their design, all facilitate the use of out-of-state Core Facilities by researchers from RAIN states. TAGs generally focus on the generation of preliminary data for grant proposals or addressing reviewer comments for submitted manuscripts. Some states allow students and postdoctoral fellows to be the lead on these projects, providing them with valuable experience in writing, submitting, and carrying out a project. Funding for TAGs is included in the RAIN budget set aside by each state. Each Core Facility uses its own system for billing rather than having to add a RAIN-specific billing method.

Developing interstate undergraduate research opportunities.

Summer undergraduate interstate student exchange programs allow undergraduates to gain research experience at institutions outside their own college or university, sometimes in research areas not available in their home state. At an organizational level, this program involves advertising and outreach to engage prospective undergraduate researchers, application review, facilitation of travel and housing arrangements, and connecting students with a research group. Students apply directly to the hosting state's student program(s). After a student is accepted, the home state's INBRE program works with the host state to arrange for

travel and housing. RAIN students are paid a competitive salary by the hosting state's INBRE program. The goal is to integrate students into a rich environment of student researchers from different states and to expose them to new professional development activities. RAIN students join the in-state students in a full-time 8- to 10-wk program for an intensive mentored research experience guided by accomplished research faculty. In addition to research, the students participate in career workshops, networking activities, poster sessions, and attend scientific seminars. Other RAIN student opportunities include placement at a regional National Laboratory and research boot camps.

Promoting interstate collaborations among RAIN researchers.

One of the most innovative activities for INBRE researchers is the annual RAIN Collaboration Studio. The studio focuses on early-stage investigators and facilitates faculty interactions to promote interstate research. The intimate 2-day meeting is hosted on a rotating basis by each RAIN state and consists of 50–70 participants. Each state INBRE is limited to no more than five faculty attendees and determines how to allocate their slots. Often the PD/PIs use these meetings to introduce new researchers to INBRE opportunities. Partner institution INBRE campus leaders can suggest individuals, with the goal of inviting faculty who would benefit from finding a collaboration or who would be good collaborators for other researchers.

The meeting format begins with a keynote presentation about how to develop successful collaborations to benefit a research program. This is followed by 3-min “flash” research talks by every faculty attendee as an introduction. The Core Facilities and expertise of each RAIN state are showcased. A “mix-master” coordinates an interactive session during which faculty rotate through groups to discuss potential collaborative ideas (somewhat like speed dating). At the end of the session, self-initiated pairs/groups of investigators from different states develop on the spot a hypothetical collaborative project based on their complementary expertise. On the second day of the meeting, each pair/group presents its collaborative research concept. The top idea, as judged by the PD/PIs, wins a prize of \$2,000/researcher to be used to further develop the potential collaboration with experiments and/or travel.

All participants are encouraged to apply for a RAIN Collaboration Grant, a competitive funding process that supports interstate projects. First, there is a letter of intent (LoI) containing an abstract of the proposed project. The LoIs are pre-screened by each participating state, ranked, and selected for mutual approval. Full applications are invited, using the NIH R21 format, and reviewed based on NIH criteria. Meritorious proposals are funded at \$20,000/investigator for 1 year. Each state funds only their own applicant in the project pair/group. Awardees are expected to include students on their projects and to have milestone productivity expectations that include coauthored publications and an NIH grant application to further the collaborative project.

Data Collection and Program Assessments

For each of the four RAIN initiatives described above, the dates and number of participants are recorded for related meetings and events. The number of users for Core Facilities and the number of applications and awards associated with

requests for proposals are all recorded, as is information about presentations, external funding, and publications. These data are entered across multiple tabs of an *Airtable* (<https://www.airtable.com/>) database, which allows cross-referencing with other data sources, double-checking within *Airtable*, and the ability to quickly gather summary statistics for the programs. Data entry is the responsibility of a single designated individual from each state. Data are reported for an annual reporting period that runs from September through August of each year, so that data are completed for use in each individual INBRE's mandatory NIH research performance progress reports (RPPRs). The use of a single reporting period per year reduces the complexity of coordinating the RAIN *Airtable* data with the variation in NIH funding cycles among the seven states. Subsets of administrators from the seven INBREs meet as needed (typically virtually) as the Evaluation Subgroup to further coordinate data collection efforts and efficiency.

Surveys are a major source of RAIN-related data and assessment. These include activity- and event-related surveys that have asked the same questions year upon year to allow longitudinal comparisons. The Student Program Subgroup has also developed a survey for participants in the undergraduate Student Exchange research programs. All surveys were approved by the institutional review board or committee of each relevant INBRE lead institution and were carried out with appropriate compliance.

The data collected by RAIN record the collaborative activity of the Western IDeA INBREs and are in addition to the standard NIH RPPR metrics of each individual program. Both sets of data play an important role, as they allow cross-checking between *Airtable* and RPPRs, for example. Although the survey data are more extensive than those required for RPPRs, by their nature surveys collect data only from individuals who respond, whereas RPPRs will have all-inclusive information. We also emphasize that the RAIN data measure only interstate interactions, which occur in addition to the many programs supported by the individual INBREs across their home-state institutions.

Data Used to Generate Figures

Data used to generate Fig. 3, Fig. 4, and Table 4 were downloaded from *Airtable* and are provided in full in Supplemental Tables S1–S3 (all Supplemental Material is available at <https://dx.doi.org/10.6084/m9.figshare.28319480>).

RESULTS AND DISCUSSION

Inception and Growth of RAIN

Formal discussions among the Idaho, Montana, and New Mexico PD/Pis began in 2016 at the National IDeA Symposium of Biomedical Research Excellence meeting in Washington, DC. Three administrative planning meetings followed, to identify how the INBREs in these three states could limit redundancies (2), take full advantage of the IDeA-built infrastructure that had been developed at their institutions, and help one another advance their common goals to build biomedical research and education capacity.

The first RAIN Biomedical Research Conference took place in June 2017, in Big Sky, MT. This meeting brought together

INBRE-supported faculty investigators from Idaho, Montana, and New Mexico to share their research findings, identify creative collaborations, and communicate with each other about their experiences. It was attended by ~50 individuals who included 30 researchers, Core Facility staff, and INBRE administrators. The participants from the three founding RAIN states helped lay the groundwork for continued collaboration. The format of this meeting, which included opportunities to generate interstate collaborations and share information about Core Facilities, contributed to the structure of future Collaboration Studios (see below).

The competitive renewal applications for the founding RAIN states (ID, MT, and NM) scored well, and reviewers especially praised the RAIN innovation (a specific shared aim in each application). This spurred invitations to each Western Region state as their competitive INBRE renewals came due or were being prepared. WY-INBRE joined RAIN in 2019; NV-INBRE joined in 2020; and AK-INBRE and HI-INBRE joined in 2022. As the organization grew, its structure adapted accordingly. For example, in late 2020, a working group of representatives from the five members of RAIN at that time proposed the development of a central clearinghouse for RAIN-related data. The process for the development of the proposal and the goals for the database were clearly documented. A key challenge has been the need to balance cohesion and consistency with flexibility, growth, and programmatic course correction. In addition to the documentation within the database itself, detailed instructions for reporting have been developed and are updated annually. This has facilitated communication about the process across the seven INBREs.

Building a network requires establishing connections and then working to strengthen those connections through shared experience and mutual benefit. For the Alliance members, these initial connections were strengthened by the strategic development of four initiatives—consistent and formalized interactions among the INBRE PD/Pis, interstate access to research Core Facilities, opportunities for undergraduate students, and the development of interstate collaborations—some of which existed in a more loosely designated form before RAIN. The formalization of the Alliance allowed the amplification of the impacts of INBRE funding and has contributed to a critical mass of infrastructure and researchers across these seven states.

Interactions among INBRE PD/Pis

The seven INBRE PD/Pis (Table 2) meet monthly, usually virtually, as well as twice yearly in person. From our standpoint as PD/Pis, this element of RAIN has had a significant positive impact on our overall performance and productivity. Through these monthly interactions, we are sharing administrative best practices and helping each other with problem-solving. We also provide support for one another's renewals and share expertise on grant writing. The group consensus is that we are better at our jobs because of these interactions. These meetings also encapsulate a key aspect of RAIN: each state's INBRE sees the strength in having every other state be successful. This focus on collaboration is a theme that repeats throughout the organizational structure of RAIN.

Since the first PD/PI Planning Meeting that was attended by all seven INBRE PD/Pis in December 2021, there have been subsequent meetings in 23 of the 24 months from January

2021 to December 2023. For those 23 meetings, all seven PD/PIs attended each meeting, with the exception of four meetings from which a single RAIN PD/PI was missing. The consistency with which these meetings are scheduled and attended is an indicator of the importance placed on these events. The familiarity established among programs has improved efficiency. For example, the NIH Western Regional IDEa meetings, which occur every 2 years, are more productive because the PD/PIs arrive with a shared knowledge of each state's programs, faculty, and students. This facilitates making connections, resource sharing, and problem-solving. A good example is the RAIN network of funded successful faculty who can serve as reviewers and mentors to others across the region. This automatically expands the pool of experts that can mentor our developing faculty by evaluating preproposals before their formal submission to funding agencies. These experts are unique compared with the national pool because they are like-minded, are similarly positioned, and understand the challenges of doing competitive biomedical research in the Western Region.

Meetings among other administrators across the Alliance, such as the Evaluation Subgroup and the Student Program Subgroup (see METHODS), reinforce this network, providing additional connections across the Alliance. An inherent strength of INBRE is local (i.e., state level) leadership and program design; RAIN has provided a mechanism for interstate collaboration and shared expertise at the administrative level, increasing the effectiveness of individual INBREs while developing a culture of collaboration and networking at other levels of the Alliance.

Interstate Access to IDEa-Built Core Facilities

A key benefit of INBRE funding across the Western Region states has been the ability to develop research infrastructure

to serve researchers at isolated and, in most cases, underfunded institutions (3, 4). Core Facilities are especially relevant to early-stage investigators, a priority group for INBRE, because they can use such facilities to effectively augment both the size of their research groups and their output (5). One of the founding principles of RAIN was to avoid unnecessary duplication of Core Facility resources. The Alliance formalized this approach to build capacity at their respective Core Facilities, with planned redundancy only in highly needed areas (Table 3). There was also some precedent for such resource sharing on a smaller scale among Western Region IDEa states that predated the formal membership of individual states in RAIN (6) and underscored the need for this access across state boundaries.

Sharing IDEa-built Core Facilities and programs can substantially reduce costs. In 2019, the three founding INBREs (ID, MT, NM) calculated that sharing their existing facilities and services, rather than duplicating resources in each state, would save, by a conservative estimate, a combined \$27.6 million over the course of one 5-yr funding cycle. (This dollar amount was the summation of: 1) ~\$5 million in administrative staff and faculty for the Idaho bioinformatics B.S., M.S., and Ph.D. degree programs; 2) ~\$8 million in equipment and technical staff for the Montana Bioinformatics and Biostatistics Core; 3) ~\$12.6 million for instrumentation, extensive hands-on training, advanced data analysis, and guidance for the New Mexico Sequencing and Bioinformatics Core; and 4) ~\$2 million for staff, research navigators, community consultants, and a mobile laboratory for the Montana Community Engagement Core.) As an added benefit, this arrangement offers unique services that researchers are able to access without their state needing to duplicate the capability. Montana's IDEa Community Engagement Core to improve community health through engagement, dialogue, and collective problem-solving

Table 3. Core Facility resources shared with RAIN partners by state

Alaska	Hawaii	Idaho	Montana
Training: Biomedical and Behavioral Research Course Community-Based Participatory Research Core Facilities: Analytical Chemistry Genomics Stable Isotopes	Training: Cancer Research Training Core Facilities: Analytical Chemistry Genomics Monoclonal Antibodies Natural Product Library Surface Plasmon Resonance	Training: Bioinformatics Degree Programs ^a Core Facilities: Analytical Chemistry Bioprinting and Tissue Lab Computational Biology Flow Cytometry Genomics/Imaging, Histology Proteomics	Training: Community Engagement Metabolomics Core Facilities: Community Engagement Genomics Human Ecology Learning and Problem Solving Metabolomics ^b Proteomics
Nevada	New Mexico	Wyoming	
Training: Undergraduate Summer Bootcamp in Microbiome Research Core Facilities: Genomics Proteomics	Training: Undergraduate Summer Bootcamp in Microbiology Virtual Bioinformatics Core Facilities: Analytical Chemistry Genomics Imaging Lipidomics	Training: Train the Trainer (Data Science) ^c Core Facilities: Analytical Chemistry Genomics Imaging ^d	

^aTraining is offered for BA/BS-, MS-, and PhD-level degrees; out-of-state tuition waivers are available for Regional Alliance of INBRE Networks (RAIN) members. ^bThis Core Facility includes instrumentation for analytical chemistry. ^cThis is one of a series of workshops presented by WY-INBRE that focus on data science and are open to RAIN members. ^dThis University of Wyoming facility, formally known as the Center for Advanced Scientific Instrumentation (CASI), has received extensive financial support from WY-INBRE and is included under the RAIN agreement.

was one example of this benefit. Because this unique Core Facility was well developed in Montana and was made accessible through RAIN, there was no need for a similar Core Facility to be developed in Idaho and New Mexico. Likewise, this benefit was extended to other states as they joined RAIN.

The resulting interstate access to Core Facilities and other resources has provided RAIN researchers with extra capacity in key areas. Each INBRE program has a Data Science Core (DSC), and most of these DSCs have some overlapping capabilities/services in genomics, imaging, biostatistics, and experimental design assistance. Before RAIN, when a Core Facility at a given institution exceeded its capacity, investigators at that institution needed to wait for service. Now, opening interstate access has addressed this capacity need by distributing resources and maximizing every Core Facility's use (Fig. 3). This illustrates how RAIN Core Facility access has increased the efficiency of researchers. For example, researchers in Idaho and Nevada have sent larger sequencing projects to the NM-DSC, which has the capacity to handle projects that could overwhelm their home-state DSCs. Shared resources also include access to experts who work in the Core Facilities. Knowledge and training are provided to faculty and students through one-on-one sessions as well as through formalized in-person or virtual trainings.

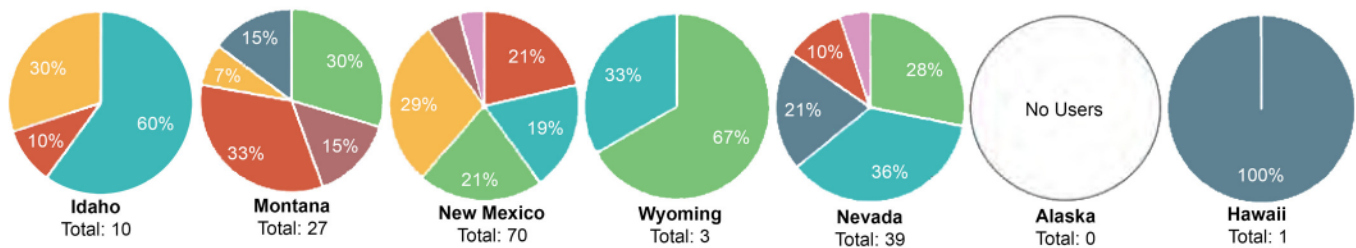
Three main mechanisms facilitate interstate access to Core Facility resources: 1) promotion/advertising; 2) a consistent

fee structure across the Alliance; and 3) TAGs. An effective element for promoting broad access to resources across the Alliance has been publicizing Core Facility availability, especially to junior faculty and to each state as it joined the Alliance. This has been accomplished through presentations by Core Facility Directors at Collaboration Studio meetings (see below), the RAIN website (which links back to each INBRE's website), and distribution lists managed by each state INBRE program.

The second mechanism, the INBRE fee for service in each Core Facility, is honored for all RAIN members (relative to out-of-state or nonacademic rates, for example). This popular arrangement has been in place since the inception of RAIN (in 2017) and accounts for most interstate Core Facility use (Fig. 3).

The third and newest mechanism, the TAG, varies across the INBRE programs, another example of the flexibility and local control that is built into the structure of RAIN. For example, ID-, NV-, and NM-INBRE TAGs are competitive small grants that were initially providing access to Core Facilities only in their own state. Now, their TAGs include access to Core Facilities in the other RAIN states. MT-INBRE, in contrast, has set up their competitive TAGs to fund researchers from RAIN states outside of Montana who are interested in using MT-INBRE Core Facilities. Since the start of this program in 2021 through the last complete reporting year (i.e.,

Core Service



Core Users

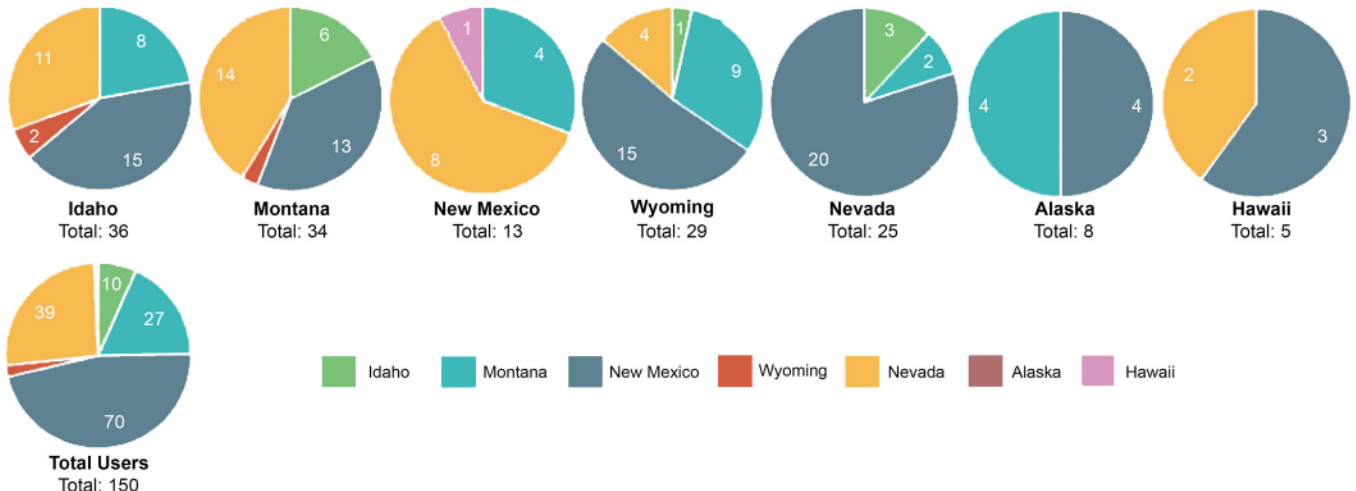


Figure 3. Use of Core Facilities among Regional Alliance of IDEa Network of Biomedical Research Excellence (INBRE) Networks (RAIN) member states. *Top:* the percentage of users that made use of each state's Core Facilities. These data include usage by INBRE states as they were ramping on toward RAIN membership. *Middle:* which Core Facilities were used by researchers from each state. Note that the number of users does not represent the number of unique users. *Bottom:* the total number of users that used each Core Facility (HI, 1 user; WY, 3 users). Throughout the figure, only data for out-of-state users are shown. Data are from the inception of RAIN through the last complete reporting year (i.e., September 2022–August 2023).

September 2022–August 2023), the Alliance has funded 11 TAGs for a total of ~\$13,500. The number of TAG recipients, however, makes up a minority of out-of-state RAIN users who access these Core Facilities (Fig. 3). For example, WY-INBRE does not have a TAG program and relies solely on the fee-for-service process to access all RAIN Core Facilities.

The usage statistics for these resources show that although RAIN provided access to unique resources (e.g., the HI-INBRE Natural Product Library, the MT-INBRE Community Engagement Core), it was the availability of in-demand resources that, although present in a user's home state, was most often accessed. For example, every Core Facility that was available in New Mexico before the current funding cycle was also present among the Core Facilities of the other RAIN states, but as the cumulative usage shows (Fig. 3), those facilities in New Mexico were frequently used by out-of-state RAIN researchers. Thus, RAIN allowed researchers access to the tools they needed to move their studies forward while ensuring maximal usage of Core Facilities across the Western Region.

RAIN has allowed the expertise associated with Core Facilities and other state-based resources to be disseminated more broadly through virtual and in-person workshops and training developed by the individual Core Facilities. For example, WY-INBRE's Summer of Code in 2021 capitalized on COVID-19-related travel restrictions with a virtual program that had 120 attendees from across the RAIN states. Although this program was an outlier with respect to the number of recipients, the numerous other Core Facility-related workshops have consistently shown that 95% of attendees consider them to be effective, on the basis of post-workshop surveys.

Student Opportunities

Research experience has a powerful and positive impact on undergraduate students (7–9). Enhancing opportunities for undergraduates to carry out leading-edge research is a major component of INBRE. The need for expanding access to such research experiences was recognized before the inception of RAIN through the Western IDeA Student Exchange. As RAIN developed, this student exchange program was refined and formally expanded to all Western Region IDeA states. This did not require the creation of any new programs; rather, it capitalized on expanded access to previously developed programs. Each RAIN state's established summer research program was opened to out-of-state undergraduates. Summer exchange students work full time in a research laboratory at a host institution for 8–10 wk. At the end of their research experience, students present their results at a research symposium, celebration, poster session, or similar event (10). Although the size of the applicant pool has varied from year to year, there has generally been substantial interest in these exchange programs, as demonstrated by the number of applicants (Table 4). In all cases, the number of awards is constrained because of the expense. For example, HI-INBRE currently limits their RAIN awards to two exchange students per year.

The student exchange programs require close coordination between the host and home INBRE programs. Each student receives a package that includes a salary and sometimes housing that is paid for by the host

Table 4. Participation in the RAIN Student Exchange from 2019 through 2023

RAIN Student Exchange 2019–2023										
Student Home State	Applicants ^a	Awardees ^b	Host State ^c							
			ID	MT	NM	WY	NV	AK	HI	
ID	20	9	— ^d	5	1	1	1	0	1	
MT	6	2	1	—	0	0	1	0	0	
NM	11	2	0	0	—	0	0	0	2	
WY	9	7	1	2	3	—	1	0	0	
NV	30	11	7	0	4	0	—	0	0	
AK	1	0	0	0	0	0	0	—	0	
HI	1	1	0	0	0	0	1	0	—	
Totals	78	32	9	7	8	1	4	0	3	

^aApplicants, no. of students applying for competitive out-of-state Regional Alliance of INBRE Networks (RAIN) research opportunities. ^bAwardees, no. of students winning an out-of-state mentored summer research position. ^cHost state, student awardees traveled to this state to participate in its INBRE program summer mentored research. ^d—, not applicable.

INBRE. The home-state INBRE usually covers travel costs for the student. The exchange students broadened not only their research experiences but also their life experiences. Expanded opportunities came in the form of specific programs. For example, students interested in cancer research have had access to the HI-INBRE, the only RAIN member that offers an NIH Cancer Center-focused summer research experience. In terms of life experiences, the RAIN student exchange was the first out-of-state travel and living experience for several students. For some, travel to their host institution was their first time on an airplane.

To ensure that the exchange process runs smoothly for all students, INBRE administrative representatives developed a Student Program Subgroup in September of 2021. The subgroup provides a support system for the student and alerts both the host and home state to any concerns. The Subgroup meets virtually and routinely to monitor the program. To improve their process, the Student Program Subgroup instituted a survey that was given for the first time to the 2023 RAIN Student Exchange cohort. The >25 questions ask about the participants' satisfaction with every step of the exchange process, including how their first day went at their host institution, ease of transportation in the host community, and the quality of their mentoring and research experiences. Several questions also ask about advice for future students in the program.

With full participation among the seven RAIN states beginning in 2022 and with the COVID-19-related interruptions affecting earlier RAIN student cohorts, it is too early to assess outcomes of these research exchanges on the 29 undergraduates who have participated through 2023. RAIN will continue to collect data on student participants for at least 5 years as a long-term follow-up (11).

Additional opportunities for undergraduate students (and in some cases graduate students) include access to online and in-person courses across the Alliance, such as NM-INBRE's Undergraduate Summer Bootcamp in Microbiology and ID-INBRE's degree programs in bioinformatics. These offerings will change as needed programs are introduced and less successful programs are modified or terminated.

For example, a 4-year program to place undergraduates from RAIN members into summer internship positions at the National Laboratories in Montana, Idaho, and New Mexico was revamped. Despite high levels of interest on the part of the students, this program was hampered by participation limitations during COVID and the competitive pool of nationwide applicants from which the National Laboratories fill internship positions. RAIN pivoted to now facilitating student awareness of existing internship programs at National Laboratories while no longer participating in placement efforts. In contrast is the addition of AK-INBRE's new First Research Experience (FiRE) program for undergraduates without previous research experience. This is a 1-wk classroom introduction to research methods and expectations followed by a 9-wk research project. This program takes advantage of Alaska's unique resources by providing opportunities for research through the Alaska Native Tribal Health Consortium or Iñisagvik College in Utqiagvik, AK. In addition, the University of Alaska campuses will be available to host RAIN undergraduates starting in 2025.

Promote Interstate Collaborations among RAIN Researchers

The isolated nature of many of the research institutions across the Western Region (Fig. 1) and the relatively small number of researchers at these institutions can be impediments to building collaborative research projects at these universities and colleges. The PD/PIs recognize that successful biomedical research is frequently built on multidisciplinary efforts. Thus, from the first RAIN meeting in 2017, there has been a deliberate effort to promote interstate collaboration among RAIN researchers and to develop the collaborative skills of these scientists. In addition, these collaborations often use the RAIN Core Facilities.

These activities became formalized and were renamed as the Collaboration Studio (see METHODS). The first of this rebranded event took place in Boise, ID in 2021. At the meeting there were 46 early-stage investigators and administrators from the four RAIN member states and from NV-INBRE (who would officially join the Alliance the following year).

The keynote speaker at the meeting was Dr. Jeffery B. Arterburn from New Mexico State University, whose NIH-funded career has been recognized for its successful collaborations. His research program has generated scientific manuscripts with >3,000 citations. There have been two subsequent

Collaboration Studios in Reno, NV and Honolulu, HI, which had 59 and 44 participants, respectively.

Each Collaboration Studio is followed by a competitive RAIN research funding announcement for interstate collaboration, open to all RAIN researchers (see METHODS). Thus, these grants provide relevant grant writing experience with a collaborator while supporting interstate projects. The number of proposals funded by individual INBREs depends on available funds.

Beginning with the earliest version of a collaboration-promoting meeting in 2017, which was a component of the inaugural RAIN Biomedical Research Conference in Montana, through the Collaboration Studio in the summer of 2023, RAIN has awarded \$26,000 in Collaboration Studio winner awards (\$2,000/faculty). Illustrating their growth and popularity, during the recent Nevada (2022) and Hawaii (2023) Collaboration Studios three awards were made to 10 researchers (\$20,000 out of the \$26,000 total). These awards provide multidisciplinary faculty with the means to explore potential interstate collaborations.

Open to all RAIN members whether they have attended a Collaboration Studio or not, the Faculty Research Collaboration opportunity has generated 69 LoIs, 29 invited applications, and 18 funded projects (Fig. 4A). The LoIs serve as a prescreening mechanism (see METHODS) that is necessary because of funding limitations and save unnecessary labor on the part of researchers whose full proposal is unlikely to be funded. They are an indication of the amount of interest in these collaborations among RAIN researchers. For example, the 26 LoIs submitted in 2021 indicate that at least 52 researchers were interested in developing collaborative interstate research projects. The interstate distribution of awards is shown in Fig. 4B. The founding three states (ID, MT, and NM) account for ~60% of these awards, with the incoming states increasing their participation as time in the program increases. Alaska has not yet funded a project. The total investment in this RAIN program since 2019 has been >\$1,063,000. Every award includes at least one student in each state, so dozens of students have participated and benefited from seeing their mentor collaborate with researchers from other states. It is still early to assess the full impact of this program.

Assessing the results of these collaboration-promoting programs has been a multipronged effort and will continue to evolve. The Collaboration Survey, an annual survey of all

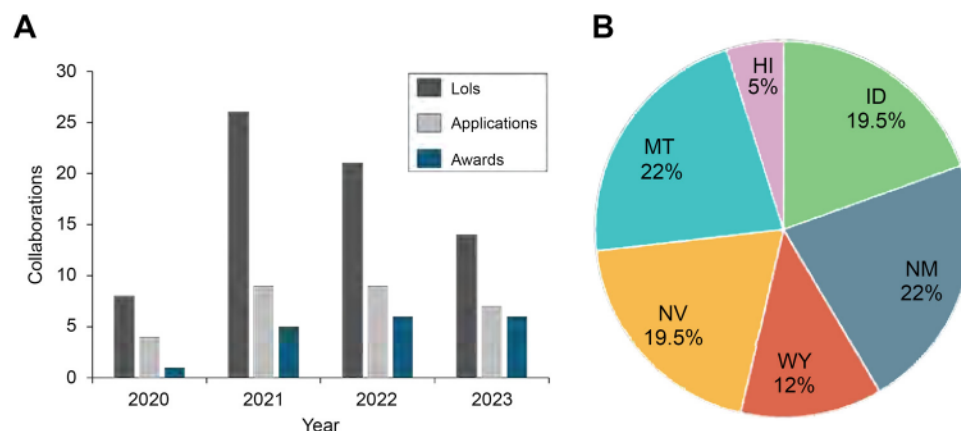


Figure 4. Regional Alliance of IDEa Network of Biomedical Research Excellence (INBRE) Networks (RAIN) support for interstate faculty research collaborations. **A:** no. of letters of intent (LoIs), completed full applications, and Faculty Research Collaboration awards. **B:** distribution of the 18 Faculty Research Collaboration awards by recipient's home state.

RAIN-supported collaborators conducted by NM-INBRE, is important for quantifying the outcomes of these programs as perceived by the researchers themselves. The outcomes reported by researchers with respect to external funding applications and publications also provide a means of cross-checking data in the RAIN Airtable. The surveys in 2022 and 2023 each had a response rate of >70%. As data accumulate, we will have the ability to carry out social network analyses (e.g., Refs. 12, 13) and other effects analyses (e.g., Refs. 14, 15). Because most collaborations are still in their infancy, there are few outcomes to report with respect to publications and external funding that have resulted specifically from these interstate projects. (See below for data about the aggregate effects of RAIN.)

CONCLUSIONS

There has been a tradition among the IDeA states of building networks that support their mission. This is apparent in the collaborative assessment of summer undergraduate research programs across 11 INBRE states (16), as well as in PEARL (Program Evaluation and Administration of Research Leaders), a collaborative network of IDeA administrators from across the country that grew out of an initial network developed by individuals in Alaska, Idaho, Nevada, and New Mexico. RAIN has continued in this tradition by adding to and amplifying networks across the IDeA Western Region as its membership has grown and its programs have continued to evolve.

Given the short period of time that many of these programs (and the full RAIN cohort) have been in existence, it is easiest to view the outcomes from RAIN in the aggregate. Since 2017, RAIN funding has contributed to 18 scientific presentations and 12 peer-reviewed publications and has generated \$1,400,000 in new NIH grants.

There are, of course, additional challenges inherent to a multistate, multi-institutional program: administrative differences, political climate (and its effect on institutional resources), and the sometimes disparate needs of the participant institutions. Despite the shared obstacles that our seven states have with respect to developing successful research programs, we also have differences that our individual state INBREs must focus on addressing. Certainly, the monthly PD/PI meetings have forged relationships among us and have helped us to work together on the basis of our commonalities while respecting those differences and our need to prioritize our state INBRE programming in certain instances. The nature of the INBRE program, including its federal funding and the flexibility of the PD/PIs in conjunction with the NIH program officer in designing individual state initiatives, helps us to overcome some of these challenges.

We believe our experiences from this relatively young Alliance, as well as the organizational infrastructure that we are developing, may be of interest to other IDeA research programs across the country that face similar resource challenges. Our approach also may be applicable to research groups or like organizations that want to reduce redundancy, share resources, and promote collaboration.

DATA AVAILABILITY

Data are provided as Supplemental Material.

SUPPLEMENTAL MATERIAL

Supplemental Tables S1–S3: <https://doi.org/10.6084/m9.figshare.28319480>.

ACKNOWLEDGMENTS

The authors thank Ashley Bogar (University of Idaho) and Chantel Ibarra (New Mexico State University) for data collection, analyses, and creating the final figures and tables and thank members of the RAIN INBRE program staff for data collection, curation, and helpful discussions during preparation of this manuscript. They also acknowledge and thank Scott A. Minnich (University of Idaho) for discussions and review, William Stadwiser (Montana State University) for Airtable support, and Amy Fluet for assistance in manuscript drafting and editing.

GRANTS

Research reported in this publication was supported by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under award number P20GM103474 (to B. Bothner), P20GM103451 (to S.L.L.), P20GM103432 (to R.S.S.), P20GM103440 (to J.E.B.), P20GM103395 (to B. Barnes), P20GM103466 (to P.R.H.), and P20GM103408 (to C.J.H.).

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

B. Bothner, S.L.L., and C.J.H. conceived and designed research; B. Bothner, S.L.L., and C.J.H. analyzed data; B. Bothner, S.L.L., and C.J.H. interpreted results of experiments; B. Bothner, S.L.L., and C.J.H. prepared figures; B. Bothner, S.L.L., and C.J.H. drafted manuscript; B. Bothner, S.L.L., R.S.S., J.E.B., B. Barnes, P.R.H., and C.J.H. edited and revised manuscript; B. Bothner, S.L.L., R.S.S., J.E.B., B. Barnes, P.R.H., and C.J.H. approved final version of manuscript.

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