PRBio Tech Hub: Designation Narrative

Technology-based potential of the region for global competitiveness

For more than six decades, Puerto Rico has been a global leader in the FDA regulated biotechnology sector establishing PR as a prominent bioscience hub, earning the reputation as the "Medicine Cabinet of the United States". Beginning with the electronics and pharmaceutical industries and then growing into the medical devices, the biosciences industry, reaching 75% of the FDA Class III device manufacturers shares, in 30 medical device facilities, demonstrates PR's leadership in the biosciences. PR is home to 12 of the world's 20 top-grossing pharmaceutical companies, producing top-selling brands such as Humalog, Humira, Eliquis, Opdivo, among others. In 2019, the sector's exports totaled more than $44 billion of which, $30.89B was exported to the US market, significantly more than any US State. The biosciences industry has been the anchor of the PR economy representing 32.2% of its GDP, 33% of all manufacturing jobs, and employing over 83,500 of its total population representing 15.8% of total jobs in PR[1]. With a rich history of highly specialized expertise, state-of-the-art biopharma infrastructure, and a strong regulatory culture, PR's biotechnology and medical device industry offers a solid foundation for innovation and growth. According to the TEConomy/BIO 2022 National Industry Report, PR is the only US jurisdiction specialized in four of the five bioscience subsectors including bioscience-related distribution, pharmaceuticals, medical devices, research, and laboratories[2].

Today, PR meets the highest quality standards, advanced technology, and distributes medicines to more than 120 countries around the world[3]. The ecosystem has shown its ability to survive and transform and PR's universities have been valuable assets in supporting these transformations. In addition to offering science and engineering programs, the University of Puerto Rico at Mayagüez (UPRM) developed the first Industrial Biotechnology program in PR, showing its ability to transform from small molecule tablet-based manufacturing to successfully implementing biologic products in collaboration with Amgen, Abbvie, and Eli Lilly. Today, PR welcomes CytoImmune and OcyonBio to address cell therapy needs. The UPRM Industrial Biotechnology program has opened the door to biotechnology for many talented students and start-ups. UPRM has also offered short-term intensive courses in industrial biotechnology through Amgen BioTalents and BioMinds, resulting in graduates leading top industry positions. The UPR system also established the Molecular Sciences Research Center, a new Ph.D. in Pharmaceutical Sciences at the Medical Sciences Campus and is part of the Engineering Research for Cell Manufacturing Technologies which supports the implementation of continuous manufacturing at Eli Lilly through its research as a member of the NSF Center for Structured Organic Particulate System. The ecosystem further strengthened with a new mission to drive entrepreneurship beginning with the development of companies such as PACIV, which first provided computer validation services and PharmaBioServ, providing services to multiple world-wide location, one example of many within PR. In addition, the ecosystem has developed logistics companies, providing indirect job opportunities, and is adapting to contract manufacturing to focus large pharmaceutical companies in developing new products, while contracting their manufacturing such as with ThermoFisher, Avara, among others.

Additionally, PR's existing assets include, but are not limited to: 1) Expertise in advanced manufacturing and partnerships for drug development in PR's universities and industry, 2) Existing facilities for clinical research, 3) Current academic alliances in pharmaceutical science and engineering to advance pharmaceutical manufacturing, 4) Biopharmaceutical incubators, 5) Existing and developing partnerships with national and local organizations to enhance workforce development, and 6) Existing efforts and implementation of advanced concepts such as Industry

4.0, 5G, and IoT. Furthermore, PR was recently awarded an NSF Engine Development Award 2305699 *Advancing Biopharmaceutical Technologies and Manufacturing Practices PR* managed and operated by the Hub's lead consortium member, PR Science, Technology, and Research Trust (PR Science Trust). In the Fall of 2023, PR Science Trust will also open a 30,000 sq. ft. EDA funded, Forward Center to house incubation and acceleration capabilities for up to 60 technology-driven start-ups and early-stage companies including medical devices. In 2017, the PR Science Trust established a "regional" Technology Transfer Office (TTO) for 17 university campuses, including four US accredited medical schools. The TTO has engaged a total of 179 academic inventors in disclosing new discoveries with a goal for its partner universities to perform at peer standards of US universities by providing best-in-class technology transfer support for PR's scientists and researchers.

Puerto Rico's pharmaceutical industry is an asset to national security. White House Executive Order 13944 supports the US's need to have a strong Public Health Industrial Base with a resilient domestic supply chain for Essential Medicines, Medical Countermeasures, and Critical Inputs and states that these chains must be capable of meeting national security requirements for responding to threats arising from chemical, biological, radiological, and nuclear (CBRN) threats and public health emergencies. This proposal seeks to further strengthen this important asset for the well-being of all US citizens. As a Designated Hub, PR will continue to concentrate its strengths on the EDA's key technology focus areas (KTFAs) of biotechnology, medical technology, genomics, and synthetic biology. Designation will enable the established ecosystem to also leverage KTFA strengths to enable *in silico*/digital technologies capabilities as artificial intelligence, machine learning, robotics, 3D printing, and advanced 4.0 factory manufacturing to fast-track the discovery, development, manufacturing, and supply of next generation and disruptive products that detect, treat, and cure diseases and ailments.

NSF Engines/Relevant Funding
NSF Engine 2305699 *Advancing Biopharmaceutical Technologies and Manufacturing Practices* $1M, PR Trust
NSF EPSCoR Track I 1849243 *CWAT*, $17.1M, UPRM
Department of Education and Labor Programs
Depart. of Labor *Right to Work (RTW)* (HG-26670-15-60-A-72 H-1B, $7M, PRTEC
DDEC *Short Form Credential Providers & Employers 21st Century Technical & Business Ed Fund*, UPRM
Other Relevant Funding
EDA Disaster Supplement, 017914805, $4.4M, *Forward Center*, PR Science Trust
NIH C06 Biomed Research Facilities, *UPR Center for Incubator & Technology Transfer*, $7.9M, NOA Pending
EDA Investment, *Advancing Science and Technology Research and Entrepreneurship Center,* $9.9M, UPRMSRC
EDA Disaster Recovery, *Smart Hub*, $13M, UPR Ponce

Role of the private sector

The role of the private sector in PR's bioscience industry has been gaining momentum and plays a crucial role in its development. PR currently hosts 12 of the world's top 20 pharmaceutical companies including Amgen, Abbvie, Bristol Myers Squibb, Sartorius, Boston Scientific, among others. According to the Bureau of Labor Statistics, PR led US exports of pharmaceutical and medicine manufacturing in 2020, accounting for 19.3% of total US exports. Therefore, the PR biopharmaceutical, medical device, and supporting technology manufacturing sectors are a cornerstone of the US bioscience industry. Nevertheless, there is significant room for improvement with regards to staying competitive in the global markets and promoting drug development within PR. In the past, the focus has been on the manufacturing sector, focusing on the strengths within establishing drug development in PR fosters continued growth and more resilience to patent life

cycle exposure and technology innovation outside PR. The bioscience industry encompasses a wide range of activities related to biotechnology, pharmaceuticals, medical devices, and other life sciences research and development. Private sectors contribute to PR's bioscience industry in investment and funding, job creation, R&D, manufacturing and export, collaboration with academic institutions, infrastructure development, and economic growth. The bioscience industry's growth, driven by private sector innovation, contributes to economic diversification making PR less reliant on traditional industries and creating a knowledge-based economy.

As a bioscience hub, the private sector, in close cooperation with academic institutions and workforce training facilities, provides a fertile ground for high potentials from local, US, and international business schools forming a nucleus for the transfer of academic research into small innovative businesses. Importantly, it will offer attractive career opportunities; thus, the private sector is essential in PR's designation as a hub as the sector implements sustainable strategies to further develop and increase competitiveness in the global markets and resilience to future challenges.

Regional coordination & partnerships

Puerto Rico has committed to transforming the region into a bio manufacturing and product development hub through a cluster where ideas can flourish, and bioscience products can efficiently reach customers. This transformation is strongly supported by initiatives driven by the PR Department of Economic Development and Commerce (DDEC), who in May of 2022 unveiled the strategic framework of sustainable economic development or PR's Comprehensive Economic Development Strategy (CEDS), the *PRoposito*. The strategy is described as an integrated and collaborative project implemented in conjunction with private sector, nonprofits, business associations, and government entities to achieve objectives that transcend administrations to achieve the continuity that is required to reach the common goal: that Puerto Rico becomes the ideal place to visit, live, and do business. In addition, DDEC is tightly aligned with the Hub through various efforts such as an investment in the University of Puerto Rico (UPR) Molecular Sciences Research Center (MSRC), EDA BBB Bioscience R&D sector asset and opportunity mapping, and studies that include Invest Puerto Rico's (IPR) efforts to promote PR as a competitive investment jurisdiction to attract new businesses and capital investments towards a transformational and results-oriented accelerator of economic development. IPR's impact on regional coordination includes assisting new companies moving or establishing their businesses in PR by helping them to navigate incentives, real estate resources, access to a talent-driven workforce, and providing introductions to key stakeholders, sector experts, and industry associations to support new business development. In addition, a coalition of experts collaborates to ensure that the bio cluster has a strategy for long-term success. The following coalition members cross-align with the PRBio Tech Hub Consortium:

- DDEC, Coalition lead focused on economic and workforce development initiatives
- Invest PR, co-leads the formation of a cargo organization and lead marketing messaging
- MSRC, supports early phase pharmaceutical research
- Industry University Research Center (INDUNIV), leads the CEIV certification for air cargo industry compliance for transportation requirements of the pharmaceutical/life sciences industry
- PR Science Trust, leads the EnTRUST Accelerator to move discoveries from lab to market.

Equity & Diversity

The Hub's consortium approach includes enhanced clinical trials, providing drug developers with coordinated access to Hispanic/Latino populations. The distributed manufacturing concept allows for ***diverse*** distribution of jobs, ***equitable*** economic, and ***inclusive*** workforce

development, while raising the existing footprint of the industry in PR. Included Letters of Commitment demonstrate the Hub's commitment to ensuring the representation of underserved communities, businesses, and the PR workforce as they serve the full geographical region of Puerto Rico including underserved, rural, and socioeconomically disadvantaged populations.

Composition and capacity of the regional workforce

Seventy-five percent (75%) of the biotech industry's employees in PR have a college degree; the current industry provides professional development opportunities with leadership and mentoring programs, scholarships, sponsorship of universities and student organizations, internship experiences, summer camps, and others. While PR boasts as the 6th highest availability of scientists and engineers in the world, according to the World Economic Forum's Global Competitiveness Report[4], PR's workforce capacity is also strongly supported by the following:

- Produces 6 of the top 10 biologics in the world[5].
- The highest US concentration of pharmaceutical/medical device manufacturing professionals.
- 50% of university graduates hold STEM degrees, creating over 20.5K STEM graduates annually.
- UPRM is ranked 15th in top chemical engineering schools in the US as well as 11th in granting chemical engineering master's degrees.
- Between 2017 - 2022, PR had a 16.5% job growth with over 1.2M jobs[6].

In addition to PR's extensive list of university assets, there are several applied research centers that provide commercial and academic space to address real world challenges including the MSRC, as well as OcyonBio - a business model for gene and cell therapy startups blending autonomous manufacturing capacity with interconnected infrastructure to support development from pre-clinical to commercial. In 2021, research institutes in PR received a total of $67M in federal funding through NSF and the National Institutes of Health (NIH) combined. While smaller than most US jurisdictions, the funding supported multiple research partnerships and ~111 research projects. With the population of professionals in PR and the years of pharmaceutical manufacturing presence of, not only generics but biologics products, the available talent has the skills required to fuel the Hub. The workforce is also trained in Good Manufacturing Practice as set within the US.

Finally, the Hub consortium includes the PR TechnoEconomic Corridor (PRTEC), a recognized industry leader in work readiness and industry needs for underemployed, unemployed, and incumbent workers and employers in PR for over 20 years. PRTEC brings together necessary resources to comprehensively assist both the business community and those seeking employment within the local workforce. PRTEC has developed an ecosystem over the past two decades including the management of VITEC, the first high tech business incubator in PR supporting over 60 local technology startups and the medical device cluster, providing training certification courses in technology, entrepreneurship, and other necessary skill sets. Through the Department of Labor's Ready to Work funding, PRTEC developed a training program including more than 30 employers from information technology, aerospace, and medical devices industries with training providers with an inventory of over 40 courses/certifications. Work readiness and job training courses will continue within the PRTEC partnership to foster a growing workforce for PR.

Innovative "lab to market" Approaches

Puerto Rico continues to expand and scale-up its lab-to-market approaches to bring its biosciences products to market for global competitiveness. Innovated approaches include PR's role as a global air transshipment manufacturing hub for a range of pharmaceutical and medical goods, and as a critical component of the global drug supply chain. According to the US Census Bureau's Foreign Trade Statistics, PR is the US's top pharma exporting region with Puerto Rican-produced pharmaceuticals accounting for 22% of total US pharma exports in 2018. Furthermore, 12 of the

top 20 global pharmaceutical companies manufacture in PR, and 19 of the top 30 pharma, biotech, and medical device companies have operations in PR[7]. One example of PR's industry approach to lab to market is the recent development of D-square, a business model focused on the development of drugs and medical devices for partners and start-up companies. Dsquare offers solutions for innovative, young biotechs and entrepreneurs to build their companies as coaches, raise funding, and perform development and commercialization. Dsquare is a partner of Galephar Pharmaceuticals (among others), a local pharmaceutical manufacturer focused on the development of proprietary innovative drug formulations of the synthesis, production, or manufacturing of drugs for clients. Dsquare has established a local biopharma in PR with an established research laboratory within the MSRC with an innovative product from bench stage to currently, a clinical Phase II. The partnership between Dsquare and Galephar is a prototypic example of how the private sector, through smart networking and leverage of complementing skills, can not only contribute to the local realization of innovative product ideas, but also to the training and growth of a high-end workforce in the biotech sector.

In addition, PR Science Trust's regional Technology Transfer Office (TTO) manages a portfolio of 96 technologies from its partner universities. Diversity in inventorship is exceptional, as 42% of the TTO's inventors (76 of 179 total) are female compared to the US average of 13% female inventor-patentees. In 2021, the TTO implemented a lab-to-market accelerator program, EnTRUST to assist in building the pipeline. EnTRUST is a bootcamp offered in conjunction with Columbia University's Irving Institute for Clinical and Translational Research that offers a 12-week course exposing academic researchers to key aspects of drug development, design, and commercialization. In cooperation with the Trust's Grant Program, research teams compete for pilot funding awards to de-risk their technologies. In 2023, EnTRUST supported seven research teams, consisting of 12 researchers, from four universities receiving a total of $375K in funding.

In 2018, the Southeast XLerator Network was established with a $3.5M grant from NIH MIGMS to a regional consortium with the PR Science Trust as the PR State Lead. The Network consists of over 25 universities across the Southeast IDeA region. Annually, the Network offers resources to biomedical researchers interested in bringing promising technologies from the lab to market including SBIR readiness, proof-of-concept funding, subject matter experts, and Executives-On-Roster®. In 2023, the NIH provided an additional $3.25M for IDeA Regional Entrepreneurship Development to offer a suite of experience-based entrepreneurship educational products and tools to build university-based biomedical researchers' and students' entrepreneurial skills needed to translate scientific discoveries and innovative technologies into commercial products and shorten the time it takes to get these technologies from bench to market.

Impact on economic and national security of the US

The Hub will follow the standards of the PR Science Trust's NSF Engine award to ensure an immediate measurable impact on the economy (with a contribution to GDP expected in five years) and increase the number of jobs and workforce training strategies to propel PR to one of the largest biosciences hubs in the US. The PRBio Tech Hub will follow the Natural Ecosystem Natural EcoSystem™ concept shown in the figure developed as part of the Peace Engineering ecosystem at the University of New Mexico[8]. The concept depicts the interactivity of all the parts of an ecosystem, contained in the PR Tech Hub consortium, to obtain sustained economic growth.