

The **Greater Philadelphia Region Precision Medicine Tech Hub** submits this application for HUB Designation. Focused on “End-to-End” Precision Medicine, our proposal fits squarely within the mission of the EDA Tech HUBs; in fact, its goals can *only* be achieved through this program. Precision Medicine continues its promise to find and deliver new ways to diagnose, prevent and treat disease and has led to an increasing number of evidence-based applications that improve morbidity and mortality, and decrease health disparities<sup>1</sup>. The Greater Philadelphia Region’s (GPR) unique density of assets and committed partners in Precision Medicine makes it the ideal region and distinguishes it from other life-science centers around the country<sup>2-4</sup>. Designation also provides the best opportunity to level up, increase impact, secure *and* mitigate threats to global leadership. Led by Ben Franklin Technology Partners of Southeastern PA (BFTP) and its 50+ inaugural partners (see Letters of Support), this EDA Tech HUB, centered within the Greater Philadelphia MSA, will accelerate the promises of Precision Medicine. The HUB structure is best to build an integrated, inclusive, and iterative approach for technology innovation and deployment, while also building technically competent, community-conscious workforce solutions. This integration of the region’s significant assets leads directly to global competitiveness *of the region* with equitable delivery of these new products, tools and interventions *to the region*, End-to-End Precision Medicine. The HUB’s dynamic solutions can drive and respond across all geographic, population, and economic domains to assure economic stability and resiliency, and solidify global competitiveness leading to increased national security.

The core focus on End-to-End Precision Medicine meets the TRL6+ benchmark. The Key Technology Focus Areas (KTFA) are #7: Biotechnology, medical technology, genomics, and synthetic biology supported by #1: Artificial intelligence, machine learning; #4: Robotics, automation, and advanced manufacturing; and #8: Data storage, data management, and cybersecurity. While this sector is well established, it has significant room for meaningful growth in the ten-year horizon because advancements in technology development far outpace the ability to test and manufacture these technologies, which in turn outpaces the ability to deliver these new interventions. This growing, dense, thriving and expanded view of the precision medicine ecosystem drew swift and clear consensus and the desire to collaborate from our partners.

Our HUB management structure will integrate the unique tri-state regional assets through coordination of seven elements: Technology Development, Specialized Resources, Capital, Policy, Workforce, DEI, and Space. This HUB will, 1) **advance** new technologies as diverse as CRISPR, “just-in-time” vaccines, Cell & Gene Therapy and biopharmaceuticals; 2) **support** these advances utilizing AI, advanced manufacturing, robotics, bioinformatics and IoT along with access to clinical trial networks, diagnostics, and commercialization expertise; 3) **leverage** local federally funded programs from NIH, NSF, DOL, DOC, EDA, and NIST; 4) **create** a partnership between and among businesses, government, institutions, and community to meet stakeholder-defined challenges; 5) **focus** on tangible, equitable, adaptable, and sustainable outcomes; 6) **stimulate** the creation of diverse and diversely-led small companies and catalyze public and private investment, all leading to new firms that are the engines of job creation; 7) **expand** the capacity to house these new companies in new spaces; 8) **build** equity into all elements of the HUB, where members of underserved and underrepresented communities benefit from successful programs that address health equity, workforce and capital access opportunities.

**Technology-based potential of the region for global competitiveness:** The GPR’s potential for global competitiveness in Precision Medicine is built on its significant assets: The GPR MSA has the sixth largest life sciences sector in the US consisting of 15 major medical systems, 5 NCI-designated Cancer Centers, and >\$1B in NIH funding. Regional institutions are participating in more than 1000 clinical trials<sup>5</sup>. More than 50,000 employees<sup>6</sup> work in more than 1000 life science companies ranging from the earliest-stage startup to global pharmaceutical giants. Fifty-nine GPR life science companies have \$94M in active SBIR Phase II

funding<sup>7</sup>. The significant increase in venture funding to emerging life science companies now averages ~\$1B/year<sup>8</sup>. The region's three states (including EPSCoR-designated Delaware) bring extra critical mass. However, the GPR is continuously under-recognized and under-supported despite its life science companies' development of groundbreaking new technologies, from Centocor, the first company to market a monoclonal antibody and diagnostic tests for cancer, to Spark Therapeutics, the first company to market a gene therapy product. While the region is best known for its Cell & Gene therapy (C&GT) assets, other areas under the umbrella of our expanded definition of Precision Medicine are also present—vaccines, biopharma, med devices, and digital health. Platform-based advances using CRISPR and AI (“plug-and-play”) are being applied not just to C&GT<sup>9</sup>, but to vaccine<sup>10</sup> and biopharmaceutical development<sup>11</sup>.

The GPR is also home to many supporting companies and organizations essential to commercialization—manufacturing, instrumentation, data management, clinical trial, market research, prototype/fabrication and AI/ML. The importance of such organizations cannot be overstated: the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) for new manufacturing technologies and training programs; the PIER Consortium clinical trial network, and Healthshare Exchange, which gathers and makes electronic patient health information available at the point of care. These collective efforts are bolstered by “breaking set” whereby solutions come from non-life-science sectors: Gore's (Wilmington, DE) innovative vision helped transform its fiber technology to implantables. The regional technologies that meet TRL6+ requirements include: 1) AI, 3D-printed biological substrates and new *in silico* Lab-on-a-Chip technologies to accelerate vaccine or biotherapeutic design; 2) nanotechnology-enabled implantable medical devices; 3) AI tools that drive increases in viability and validity of *in vitro* analysis to predict *in vivo* responses and reduce animal usage; 4) New vaccine platforms that protect against new variants; new adjuvant technologies to increase potency and sustainability; 5) New advances in manufacturing technologies to reduce time and costs; 6) Novel technologies and programs to improve clinical trial development, execution, and management; 7) Facilities that can manufacture small quantities under FDA requirements for early-stage (Phase I/II) clinical trials. Collectively, these advances will improve design, decrease manufacturing processes/time, and increase efficiencies in the supply chain, and deployment.

**Role of the private sector:** Precision Medicine advancements benefit greatly from the region's broad, technology-relevant, and vibrant private sector—the drivers of new technologies, and the employers of the skilled workforce needed to get these products out the door. The region hosts major pharmaceutical, vaccine and biotech companies (J&J, Merck, GSK, Astra Zeneca, Incyte, Spark, Inovio, Sanofi, Century, Carisma, Integral Molecular), supported by instrumentation (ThermoFisher, EMSCO, Agilent, Mobilion), manufacturing (NIIMBL, ChromaTan, Center for Breakthrough Medicines, WuXi Apptec), and data management (AWS, Siemens, SAP, IQVIA). The “AAA” club of companies is supported by non-profit investors such as BFTP, Delaware Innovation, and NJEDA, often in incubators (PA Biotech Center, Pennovation, Science Center, Rowan Tech Park, Delaware Innovation Space, B. Labs). A robust angel and venture community provides funding and support to advance these new technologies to full deployment. These assets become a magnet for attracting interest, companies, and capital from our partner nations.

**Regional coordination & partnerships:** The GPR has made great strides in regional collaboration and cooperation; gaining momentum consistent with the region's improved innovation rankings<sup>12</sup>. HUB Designation is critical to accelerate that growth and assure success. The current 50+ partners have been specifically and purposely engaged based on 1) assets they bring to the HUB, and 2) meaningful, programmatic contribution each will bring to the HUB aligned on measurable and achievable goals. They represent all aspects of the region's innovation ecosystem, from technology generators to the cities/counties and health systems needed to deliver and validate these interventions. Each has signed

Letters of Support/Commitment, demonstrating the consensus of the inaugural partners. This regional coordination strengthens the collective vision of the HUB. Previous regional successes include the groundbreaking Nanotechnology Institute, a nationally recognized university/industry, public/private partnership that brought 13 regional institutions and corporations together under a single MOU to advance the commercialization of the emerging nanotechnology sector<sup>13</sup>. The NIST-funded NIIMBL has more than 100 members, more than 25 within the GPR. Many of these same partners have come together to create proposals for the Amazon HQ2, Build Back Better, Build-to-Scale ARPA-H, BARDA Venture Fund, SBAs SSBCI program and NSF Regional Innovation Engines.

HUB success requires a carefully structured, efficient, and adaptable leadership and management team including an Oversight Committee (OC), Operating Committee (OpCom) and External Advisory Committees (EAC). This governance structure has a well-documented track record, based on years of experience in developing and managing university/industry, public/private partnerships, advancing structures that worked, and learning from those that did not. The **Oversight Committee** members represent core organizations and bring the full weight of institutional commitment and endorsement to the HUB. The OC works with the OpCom to ensure the fiscal and programmatic responsibilities are maintained and input from partners is incorporated into implementation. At a higher level, the OC also serves as the liaison to other corporate and government offices to procure support for the HUB and its mission. BFTP, as lead institution, will serve as fiscal agent for the program, responsible for assuring segregation of EDA funds, and preparing all agreed-upon reports to EDA. An **Operating Committee**, reporting directly to the OC, will be established to manage the day-to-day operations of the HUB. OpCom members have combined expertise in research, commercialization, business, and workforce development. At its outset, the OpCom will consist of members representing the OC and EACs. The **External Advisory Committees** will ensure the HUB receives strategic direction, advice, and subject-matter expertise that translates intelligence to the scope of its programs. The EACs provide input and direction to advance emerging company technologies, improve and expand opportunities for university/industry partnerships, strengthen regional infrastructures, identify potential funding, and execute and sustain new initiatives. We propose six EACs, with representatives of Technology, Industry, Workforce, Policy and Assessment, Intellectual Property, and Space.

**Equity & diversity:** Addressing DEI is a multi-pronged challenge, priority and opportunity; it must be built into each of the other elements and requires specific yet integrated programs and a long-term vision. Acknowledging the changing landscape to train the next generation of science-innovators and worker training programs reduces the barriers that exacerbate inequalities of race, place, and gender. Current diversity programs in research and to support innovative, entrepreneurial faculty must be met with increased diversity in access to start-up capital and the venture market. Precision medicine interventions must be evaluated through unbiased clinical trials that can assess efficacy among diverse populations. Developing a technically competent workforce while assuring equity in both training and job opportunities includes ensuring means for the equitable distribution of these new interventions, especially in the under-supported inner cities such as Philadelphia, Camden, and Wilmington.

This increase in access can already be seen in programs from the region's cities and counties and medical centers. Examples include the groundbreaking study in which Christiana Care, Drexel and Penn worked together to demonstrate the benefits of treating mild forms of chronic hypertension during pregnancy in a trial including 70% non-white participants<sup>14</sup>. Penn's Healthy Mothers Program addressing critical pregnancy-related conditions, including pre-eclampsia and post-partum hemorrhaging, has developed new sensor technology that alerts patients to seek immediate medical help; it has driven down the maternal morbidity and mortality rate significantly, and is now being deployed by Independence Blue Cross to its members<sup>15</sup>.

**Composition and capacity of the regional workforce:** The HUB's workforce plan will focus on programs for participants to obtain technical skills based on industry standards. Efforts include a combination of exposure and experiential learning with the cumulative effect of enhancing participants' readiness for and transition into more advanced programs and high-demand careers. The need to build and maintain this workforce is acute: Life science companies are desperate to fill positions at all levels, especially in bench-level science, manufacturing/automation, and software. The predictions of automation and AI eliminating many current jobs to be replaced by a different set of jobs<sup>16</sup> requires its own "end-to-end" workforce strategy. Building on the region's over 4000 life science degree recipients each year<sup>1</sup> starts at the middle/high school stage (Coded by Kids, Philadelphia STEM Ecosystem, Zipcode Wilmington, ChristianaCares "CRISPR-in-a-Box", Rowan's STEM Center), continuing with students from the GPR's HBCUs (Cheyney, Lincoln, and Delaware State Universities) and Community Colleges (including Philadelphia, Montgomery, and Camden counties, as well as Delaware Tech). Adults, some without college degrees or in the workforce looking to upskill, are also included, as the HUB partners bring a breadth of programs beyond high school. Current federally and state-funded programs include Philadelphia Works' EDA Good Jobs Challenge Grant, and the Science Center's DOL-supported "First Hand" program offering middle and high school students free, supplemental STEM learning to provide skills-based career exposure. Advanced companies will benefit from programs and services of the NIST/MEP-funded Delaware Valley Industrial Resource Center (DVIRC) and NJMEP. NIST-funded NIIMBL, Wistar's Biotechnology Training program, and Jefferson's Institute for Bioprocessing bring students real-world experience and job opportunities. The West Philly Skills Initiative has a track record of success in connecting workers to hospitals and the life science sector<sup>17</sup>. Other regional programs include AWS cloud training centers, and the GSK-funded STEM Equity Collaborative, to increase the Black and Latino tech population.

**Innovative "lab to market" approaches require innovative Access to Support:** Global competitiveness hinges on gaining early technological footholds; the revolutionary and high impact technologies created at federally funded universities, research institutions, and early-stage startups need a better, more efficient, less costly way to reach beyond TRL6 to the marketplace. The HUB addresses this challenge by eliminating the disconnection between the technology generators (the "push") and the consumers of those technologies (the "pull"), requiring both sides to understand these new technologies' impact on regions, communities, and individuals. Addressing these challenges is integral to the HUB concept and the required support functions to fill that critical gap.

The advancement of new technologies also requires capital-intensive, specialized facilities not readily available or affordable by early-stage technology companies, entrepreneurial faculty, or companies in underrepresented communities. The HUB will move beyond traditional translational research programs with support programs that recognize access to specialized services from prototyping to new manufacturing to market research and commercialization/regulatory strategies. These supports will decrease time and increase efficiency for commercialization and lead to both lower costs and increased access.

The HUB will address those technical and commercial issues by leveraging the region's numerous and location-agnostic programs. Examples include BFTP's EDA-funded FabNet and PRIMA: virtual networks of resources and service providers willing to work with early-stage companies and entrepreneurial faculty to accelerate the commercialization of novel technologies. HUB partners NextFab and Archimedic are examples of the region's premier providers of engineering services and technical facilities including design, prototyping and fabrication, testing, and small-batch manufacturing capabilities in biomedical engineering and digital health. Support for the next generation of entrepreneurs and CEOs comes from Princeton-led

NSF I-Corp, and its partnership with the Science Center’s “Proof Positive” program that fuses startup expertise with the proven lean startup concepts, the many organizational entrepreneur bootcamps and the PACT/Ben Franklin “Mentor Connect” program.

The HUB also supports the other side of commercialization: financing. While the region benefits from early-stage capital organizations such as BFTP and Del Innovation, there is a “missing middle”—the estimated gap of \$7–\$8 billion between supply and demand of capital for small businesses, especially those seeking ≤\$250K to scale<sup>18</sup>. Access to relationships and capital is an ongoing and well-known challenge for under-represented technology entrepreneurs. Early-stage Black and brown-founded businesses “face disproportionate difficulties securing needed capital due to lack of availability of ‘friends and family’ funding within their networks, insufficient credit histories or documentation, and systemic racial biases.”<sup>19</sup> Investors retreat to the networks they know, and away from minorities: Black founders raised just about 0.43% of the nearly \$43 billion deployed in Q3 2022<sup>20</sup>. The HUB will leverage capital programs from Science Center’s Capital Readiness, Rowan’s Startup Opportunity Fund, Plain Sight Capital and UDel’s Summer Fellowship programs to venture organizations such as BFTP, NJ’s Accelerate, and Delaware’s Capital Access programs to the region’s EDA-funded Revolving Loan Funds and DOC’s MBDA programs.

**Impact on economic and national security of the entire United States:** The recent pandemic radically changed the ability of communities to remain economically resilient and stable. Technologies that protect Americans’ health must remain on shore, keeping life saving ideas and products within reach of all American communities. This requires new thinking, programs, and structures focused on quality-of-life issues that impact all stakeholders. This is especially true for underserved communities where disparities in home life, education, health, jobs, opportunities, and community are well documented. Progress, from first concept to final product, requires *innovation in* and *integration of* technology, economic development strategies, policy, entrepreneurship, and workforce development. Investment in innovation—from creation to deployment—can deliver both short-term shots in the arm and longer-term economic security. Equitable job creation and growth from burgeoning breakthroughs and nascent new industries are the “glue” that is vital to power our recovery from the pandemic-led recession and build our future resilience.

The GPR meets this challenge. This regional partnership advances a technology agenda that secures the nation’s health and its corollary, economic vitality and economic resilience. The knowledge gained will lay the foundation for the *next* generation of solutions necessary to address both the current and the inevitable *next* crisis. Investing in that innovation, within our uniquely qualified region and, more broadly, within our country’s borders, will help ensure that the United States remains able to provide for the health needs of its populace, as well as secure from nations that see health supply chains as strategic points of national vulnerability. The GPR is in a unique position to lead the nation and drive multiple benefits for all stakeholders. There has never been a more important time to execute well on these aligned missions in an equitable, place-conscious way.

Innovation does not work in a vacuum. Excellence can only be translated into regional or national benefit when it is surrounded by partners working together to deliver new solutions for stakeholders. The size and complexity of an EDA Tech HUB concept requires the integration of technology generation, capital, corporate engagement, space, workforce, and policy to achieve the goal of strengthening “U.S. economic and national security through place-based investments in regions.” The Greater Philadelphia Region Precision Medicine Tech Hub exceeds all these requirements and deserves Designation status.