

MOMENTUM

THE IOWA BIOSCIENCE STRATEGY

Progress Review and 2022 Update



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Prepared By: TEconomy Partners, LLC

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For more information on this report please contact its authors with TEconomy Partners:

Simon Tripp and Jonathan Dworin

1.800.TEC.1296 | info@teconomypartners.com | www.teconomypartners.com

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I. INTRODUCTION

The Power and Promise of Science- and Technology-Driven Economic Development

The global economy, the U.S. economy, and the economies of individual states and regions are constantly experiencing change. Economies are innately dynamic—subject to external and internal forces of change that affect market demand, competition, capital availability, labor supply, operating conditions, the innovation environment, and many other business factors.

Economic development is the discipline that seeks to help economies adapt to and leverage forces of change and to realize their potential in terms of expanding business output, wealth increases, prosperity, and quality job generation. A subset of the discipline is technology-based economic development (TBED), an advanced form of economic development that recognizes the central role played by innovation and the commercialization of technological advancements in modern economic expansion. TBED works to build and sustain a robust and complete innovation-based economic development ecosystem that enables applied R&D discoveries to advance into innovations that form new companies or enhance the operations, products, and services of existing enterprises.

Technology-Based Economic Development (TBED)

Building and maintaining a robust research and development (R&D) and innovation commercialization ecosystem, and the key elements that support it in technology, talent, capital, and modern place-making, are the keys to TBED. Best practices in TBED are grounded in a focus on industry/technology clusters that leverage a combination of significant localized tacit know-how, identified clusters of R&D core competencies, and a line-of-sight to the production of new technologies and services that have significant market potential.

In a complicated, fast-changing, and innovation-driven global economy, those places that cultivate an environment where innovation and entrepreneurship can thrive (leveraging the forces of change to create opportunity) are often among the most competitive. As noted by the U.S. Council on Competitiveness in a recent report:

Technology and innovation—the combination of imagination, insight, ingenuity, invention, and impact in society—are the main drivers of U.S. economic growth and productivity, the main shapers of the future, and principal determinants of economic opportunities and national security for Americans. With such impact for the Nation, U.S. capacity, capability, and performance in leveraging new technology for economic gain and for innovating should be at the top of the economic and national security agenda, and of major concern to U.S. public and private sector leaders.¹

1 The Council on Competitiveness, *Competing in the Next Economy: The New Age of Innovation*, (National Commission on Innovation & Competitiveness Frontiers, 2020.) https://www.compete.org/storage/documents/documents/CoC_Commission_NextEcon_121620_FINAL.pdf

The State of Iowa, through the Iowa Economic Development Authority (IEDA) and its key stakeholders in state and regional economic development, has an established track record in leveraging the transformational power and promise of technological change and innovation. Working with expert TBED consultants at Battelle, TEconomy Partners, and other consultancies and guided by input from state industry and academic leaders, Iowa has been deliberate in forming and executing strategies for core advanced industry clusters in life sciences (industrial, agricultural, and biomedical), advanced manufacturing and manufacturing 4.0, digital and information technologies, educational technologies, and other areas of science- and tech-based opportunity.

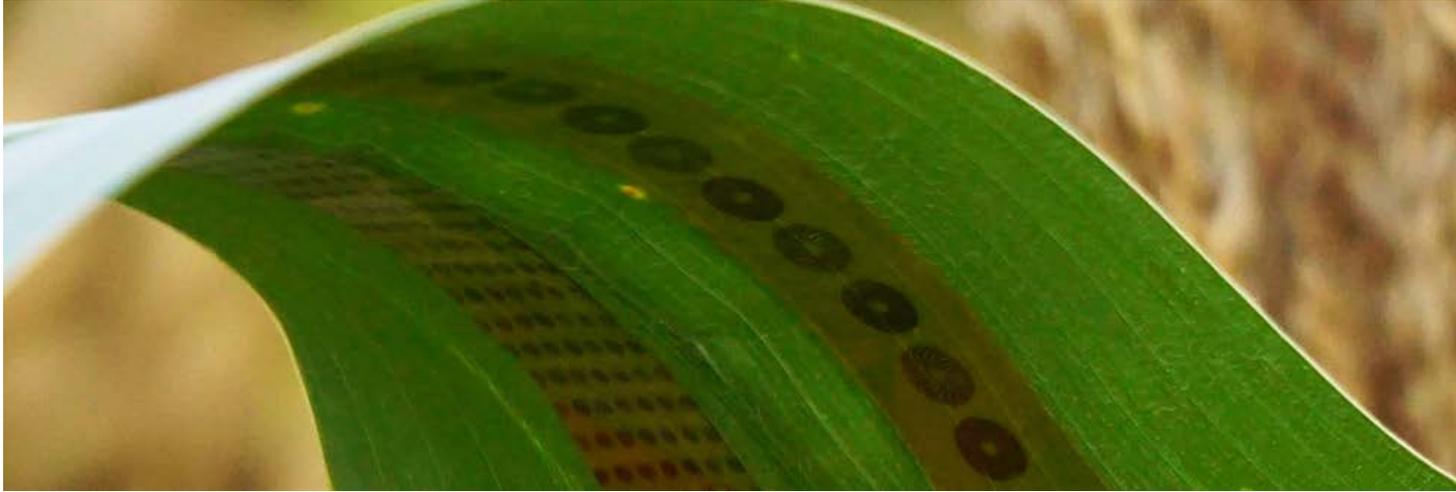
Iowa's History of Supporting Bioscience Cluster Development

Biosciences represent a core focus for Iowa in its economic development based on demonstrable state strengths and assets, together with recognition of the further promise of growth inherent to the sector. Biosciences are particularly attractive as a focus for economic development because:

- They address diverse markets and challenges in human and animal health, food security, industrial bio-based products, and environmental resiliency.
- They are rooted in large-scale R&D and innovation activity that builds upon long-standing national investments in science and technology by the federal government and a powerful base of talent and innovation infrastructure built within U.S. universities, federal labs, and private industry.
- Bioscience innovation commercialization supports the growth of traded industries (see sidebar) that are fundamental to economic growth and wealth generation.
- The biosciences sector supports wages and salaries considerably higher than average private sector pay levels.
- The biosciences sector has demonstrated substantial growth in recent decades and demonstrated resiliency during recessionary economic periods.
- Science and technological advancements are significant in the biosciences, with new platforms of capabilities emerging that promise to continuously push the boundaries of what is possible. Advances in fundamental and applied knowledge have generated profound progress through new and fast-expanding technologies in gene editing, synthetic biology, metabolic engineering, tissue engineering, and many other subdisciplines of bioscience.

Traded Industries

For economic growth to occur, state economic development needs to focus on industry sectors that serve customers and markets beyond the residents and businesses in its state—otherwise known as traded-sector activities. Doing so drives an increase in a state's gross domestic product (GDP), which in turn leads to a higher quality of life for its citizens. By bringing new dollars into the economy, traded-sector firms exhibit a strong multiplier effect. New jobs are created as exporting firms buy from local suppliers and workers buy from local businesses.



- Biosciences are leveraging parallel and complementary advancements in digital technologies, informatics, advanced data analytics, and AI. This convergence of transdisciplinary science and technology holds immense promise for rapidly advancing scientific discovery and innovation.

For the above reasons, Iowa has engaged in the strategic pursuit of biosciences as an advanced industry cluster. The first Iowa bioscience strategy was developed by the Battelle Technology Partnership Practice (TEconomy Partners' forerunner organization) in 2004, and the strategy was evaluated and further refined in 2011. The most recent Iowa bioscience strategy and action plan, developed by TEconomy in two phases in 2017, with the final strategy released in January 2018 entitled *Phase II Report: Strategies and Actions for Iowa's Bioscience Development*, focused on a series of cross-cutting strategies and actions for:

- Organization and connectivity
- Innovation and commercialization acceleration
- Talent development, attraction, and retention
- Enhancement of early-stage capital availability.

Further, the strategy recommended advancing four bioscience platforms in Iowa:

- **Biobased chemicals**
- **Precision and digital agriculture**
- **Vaccines and immunotherapeutics**
- **Medical devices**

These platforms are rooted in identified R&D core competencies, industry assets, and growth opportunities. The Iowa Economic Development Authority (IEDA) immediately went to work implementing key recommended strategies and actions outlined in the report. An early action involved the development of BioConnect Iowa as the non-profit partner of IEDA designated to advance the bioscience development strategy's implementation. Now, five years into the strategy implementation, IEDA is seeking to assess progress made, evaluate the status of each activity, and refine the strategy and action plan as necessary to fine-tune it to present conditions and expand its impacts.

About This Report

TEconomy was retained by IEDA to conduct the evaluation and strategy and actions review outlined herein. The purpose of this 2022 program of work is to:

- Analyze the **current position of Iowa** in the biosciences, as defined by TEconomy/BIO measures. Every two years, TEconomy and the Biotechnology Innovation Organization (BIO) conduct a national and state-by-state review of bioscience development across the United States—and 2022 sees the release of the latest metrics. This allows a detailed overview of recent statistics and trends in Iowa bioscience activity, such as industry and academic research funding, publications, patents, start-ups, employment levels, etc., and for comparisons to be made with other competing states.
- Evaluate how Iowa has implemented the **previous report's strategies** and actions and the effectiveness of actions taken.
- Examine **progress in advancing each of the four platforms** as recommended drivers of bioscience progress and business development for the state.
- Evaluate **emerging opportunity areas associated with the platforms** and observable related bioscience trends, disruptive technologies, and market evolution.
- Refine the **strategies and actions, both platform-specific and crosscutting**, to reflect identified opportunities based on current and future needs.

II. IOWA'S BIOSCIENCE ECONOMY (2018-2021)

The biosciences represent a high-performance component of the U.S. national economy. The data from the new BIO/TEconomy report, *The U.S. Bioscience Economy 2022*, show that the sector across the nation comprises 127,000 business establishments, employing over 2.1 million personnel, and generating \$2.9 trillion in national economic output. Importantly, the biosciences sector serves as a key national engine of rapid economic growth, with the industry demonstrating a gain of 11% in employment since 2018. In contrast, the U.S. economy shed 1.5% of its job base over the same period. The jobs across biosciences also pay significantly above the private sector average, providing family-sustaining wage and benefit levels that averaged \$77,281 per job nationally in 2021.

BIO and TEconomy define the biosciences as comprising five principal sub-sectors (defined by NAICS codes)—1) Agricultural Feedstock & Industrial Biosciences; 2) Pharmaceuticals; 3) Medical Devices & Equipment; 4) Research, Testing, & Medical Laboratories; and 5) Bioscience-related Distribution. These subsector definitions are held constant over time to allow evaluation of changes at a state and national level.

Biosciences in Iowa represent a long-standing strength of the state and continue to experience growth.

For 2021, the BIO/TEconomy report shows Iowa having a specialized location quotient (indicative of a quantitative concentration of bioscience activity above the national normative level) in two of the five bioscience sectors: Agricultural Feedstock & Industrial Biosciences; and Bioscience-related Distribution. In addition, Iowa has recorded growth in the two sectors in which it is not yet specialized: “Pharmaceuticals” and “Research, Testing, and Medical Laboratories.” Four of the five sectors in Iowa experienced employment growth since 2018, with only “Medical Devices & Equipment” seeing an overall employment reduction.

Biosciences are essential to Iowa's economy, but there is substantial competition among other states and international competitors for the high-quality jobs and robust GDP benefits the sector provides. As will be seen in TEconomy's analytics for IEDA, below, although the trajectory of the sector overall for the state is positive, there are some areas of concern – most notably in terms of the growth rate in Iowa lagging behind the national overall bioscience growth rate (indicative of a moderately slipping market share).

Measuring Industry Concentration and State “Specialization”

Employment concentration is a useful metric for gauging the relative importance of an industry in a state economy. Location quotients (LQs) measure the degree of employment concentration within the state relative to the national average. States with an LQ greater than 1.0 are said to have a concentration in a sector. When the LQ is significantly above average, at 1.2 or greater, the state is said to have a “specialization” in the industry.

Industry Performance

As noted above, biosciences overall in Iowa have experienced growth over a sustained period. As illustrated in Figure 1, Iowa's bioscience employment has increased from 24,033 jobs in 2010 to 26,471 in 2021, representing a 10.14% increase (a CAGR of 0.88% for the 11 years). Four out of the five biosciences sectors in Iowa experienced growth across the decade, with only Medical Devices and Equipment recording a decline.

FIGURE 1. GROWTH IN BIOSCIENCE INDUSTRY EMPLOYMENT

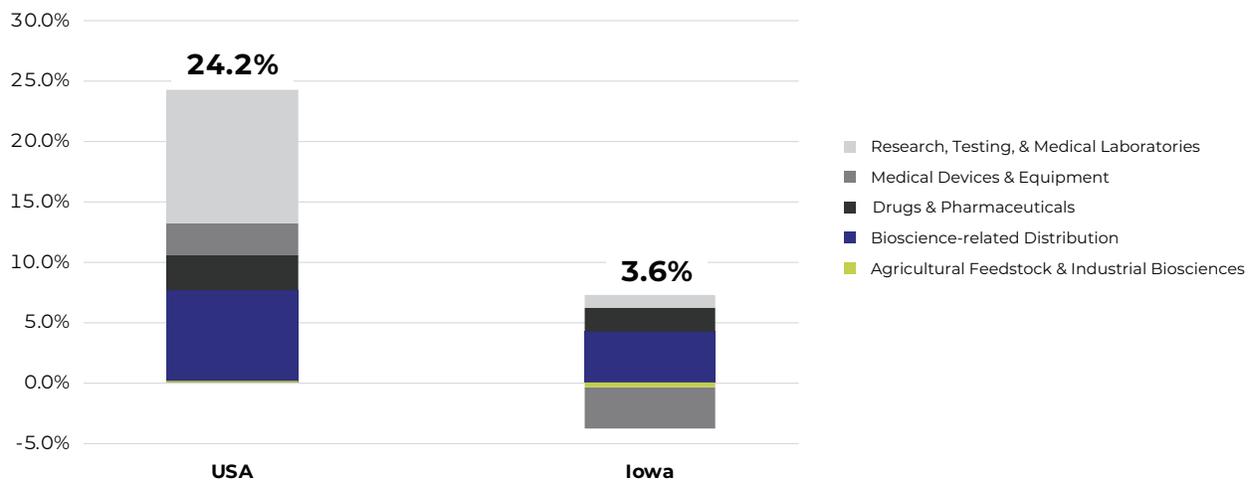


Source: TEconomy Analysis of BLS, QCEW (Lightcast 2022.3)



Looking at the latter half of the decade, Figure 2 shows that, in comparison to the United States, Iowa's slower rate of employment growth in biosciences is leading to a declining share of the pie.

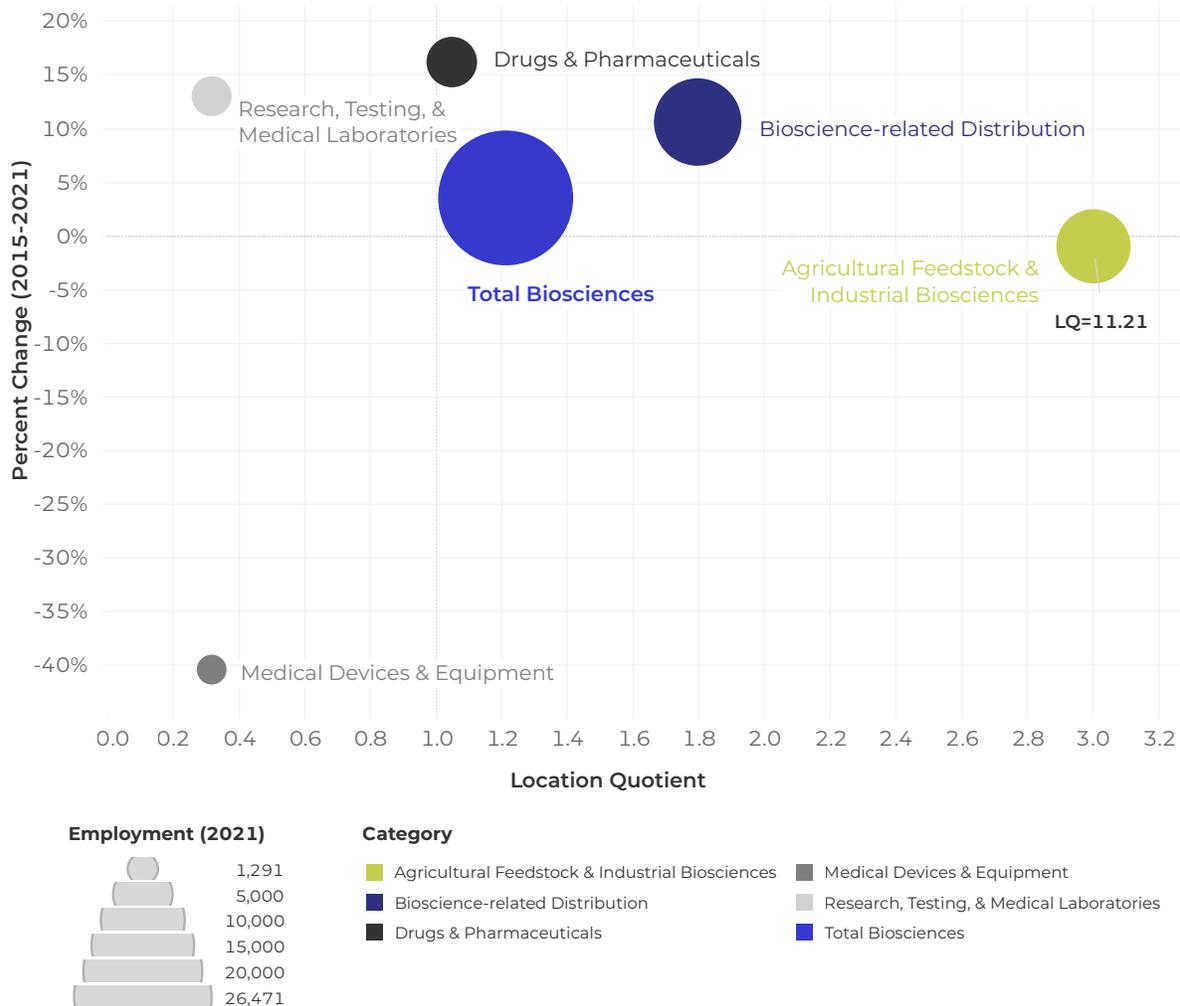
FIGURE 2. CONTRIBUTIONS TO CHANGE IN BIOSCIENCE EMPLOYMENT (2015-2021)



Source: TEconomy Analysis of BLS, QCEW (Lightcast 2022.3)

Figure 3 provides a useful overview of the overall 2015-2021 comparative performance of bioscience and each of the five constituent sectors. The “x” axis shows the location quotient for each sector, while the “y” axis records the percent growth or decline in employment over six years. These data reveal that biosciences overall represent a state-specialized industry for Iowa (having an LQ>1) and a growing industry. The Agricultural Feedstock and Industrial Biosciences sector is a robust contributor in terms of location quotient (with a very high LQ of 11.21), but the sector is not experiencing strong employment growth. A substantial contributor to growth is Drugs and Pharmaceuticals (moving into a concentration), followed by Research, Testing, and Medical Laboratories (not specialized) and Bioscience-related Distribution (a specialized sector for the state). Medical Devices and Equipment is the smallest component of the Iowa biosciences economy and experienced job losses.

FIGURE 3. PERFORMANCE OF IOWA'S BIOSCIENCE INDUSTRY²

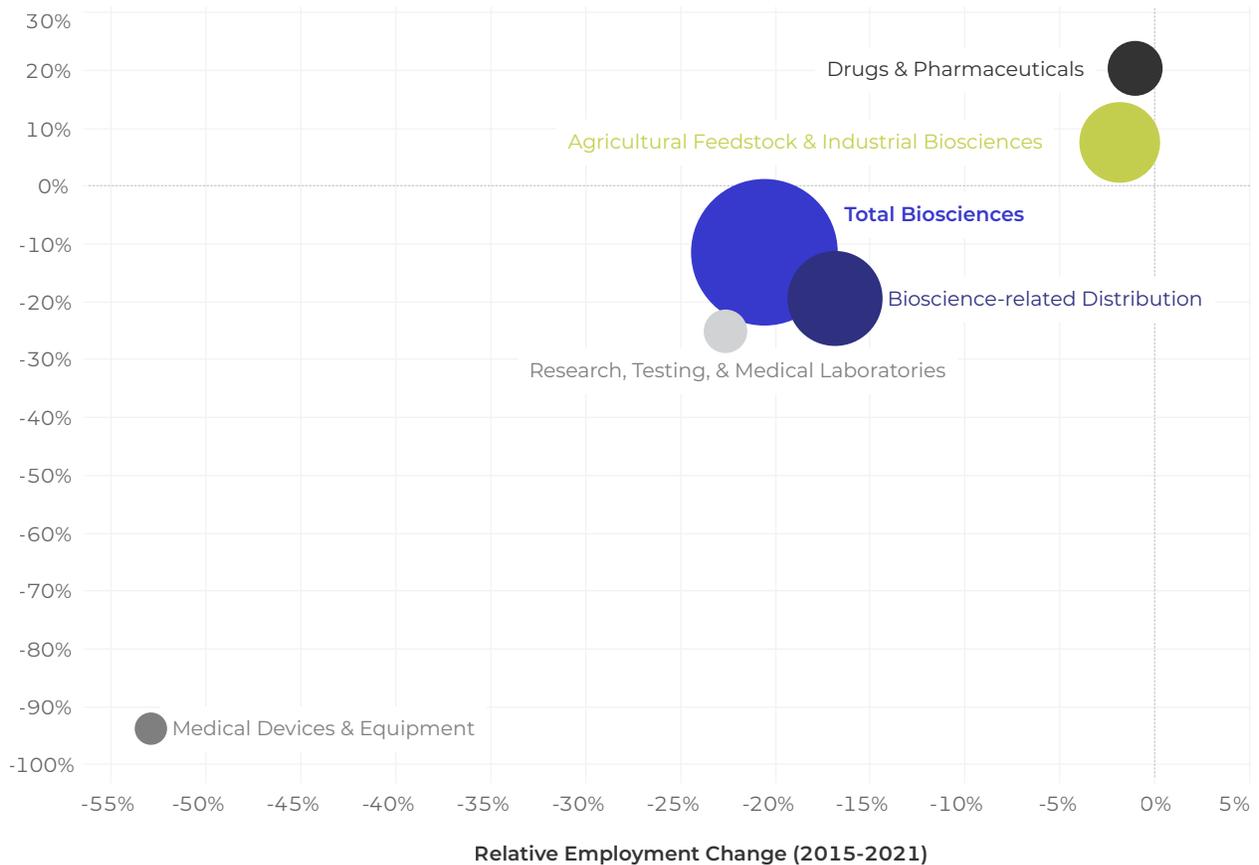


Source: TEconomy Analysis of BLS, QCEW (Lightcast 2022.3)

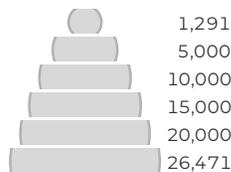
2 This analysis uses the TEconomy/BIO definition of biosciences sectors, using the NAICS codes deployed in the most recent biennial report for BIO titled “The U.S. Bioscience Industry: Fostering Innovation and Driving America’s Economy Forward. 2022.” It should be noted that NAICS codes have limitations in that they are “self-assigned” by each business according to their primary activity. With medical devices, some companies may primarily classify themselves in a general manufacturing NAICS code (such as Plastic Product Manufacturing) and would not be captured under the NAICS used under the TEconomy/BIO definition. As such, it is likely that the Medical Devices & Equipment sector in Iowa is larger than shown on Figure 3.

Figure 4 indicates the relative change in employment for Iowa versus the United States across biosciences overall and for each of the five sectors. The “x” axis shows Iowa’s relative employment change against the United States, and in all sectors this is a negative number—indicating that, while biosciences in Iowa have been growing, they have not been keeping pace with national growth—i.e., Iowa is starting to lose competitive market share.

FIGURE 4. COMPETITIVENESS OF IOWA’S BIOSCIENCE INDUSTRY RELATIVE TO THE U.S. AVERAGE



Employment (2021)



Category

- Agricultural Feedstock & Industrial Biosciences
- Bioscience-related Distribution
- Drugs & Pharmaceuticals
- Medical Devices & Equipment
- Research, Testing, & Medical Laborator
- Total Biosciences

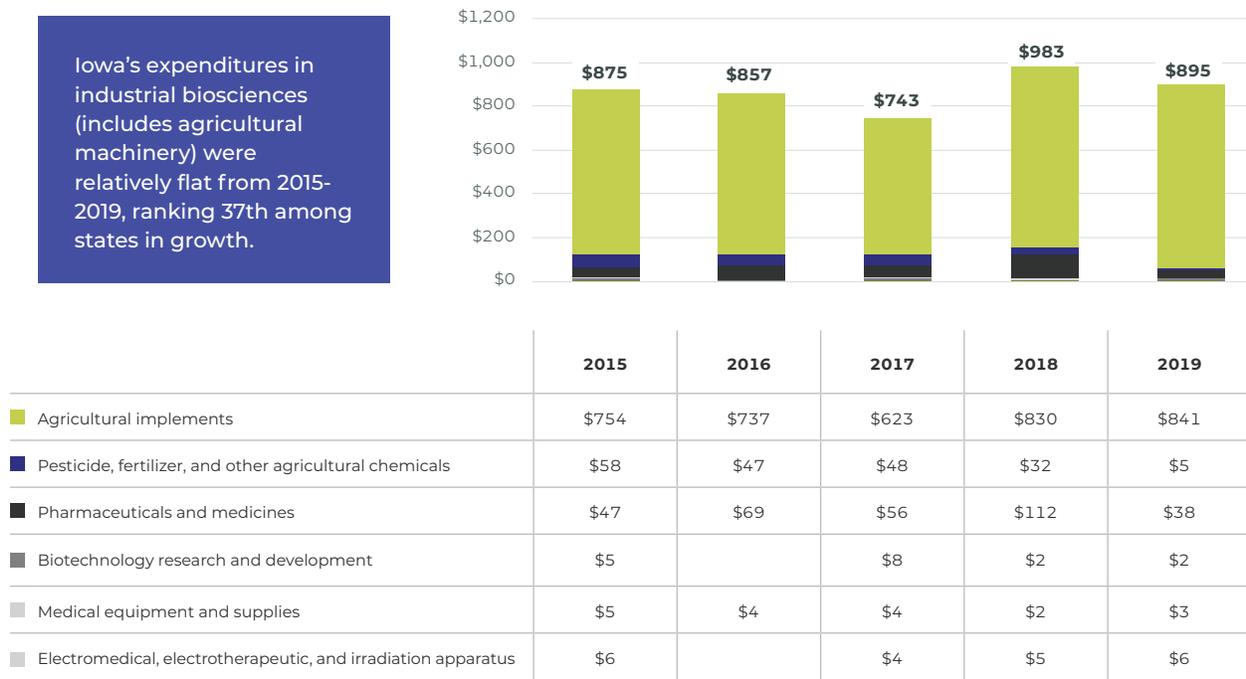
Source: TEconomy Analysis of BLS, QCEW (Lightcast 2022.3)

Research and Development

As a science and technology-driven innovation sector, the performance of bioscience R&D is an important metric to track. R&D within industry, universities, free-standing research institutions, and federal labs provides the bedrock of innovation upon which advanced bioscience industries are built.

Industry is the largest performer of R&D in the U.S., but within Iowa, industrial R&D expenditures have been relatively flat between 2015 and 2019³. Overall R&D volume has fluctuated year to year, but 2019's \$895 million in Iowa bioscience industry R&D was only up 2.3% across the five years. As the data show, a very high percentage of this R&D is in the "agricultural implements" sector—a more engineering-oriented sector but included in this analysis because of its convergence with the precision and digital agriculture bioscience sector. Looking at the "purer" biosciences sectors shown in Figure 5 (i.e., excluding agricultural implements) shows a decline in all of the subsectors, except for "electromedical, electrotherapeutic, and irradiation apparatus" industrial R&D (which still was only flat).

FIGURE 5. PERFORMANCE OF BROAD AG- AND BIOSCIENCE-RELATED R&D CATEGORIES

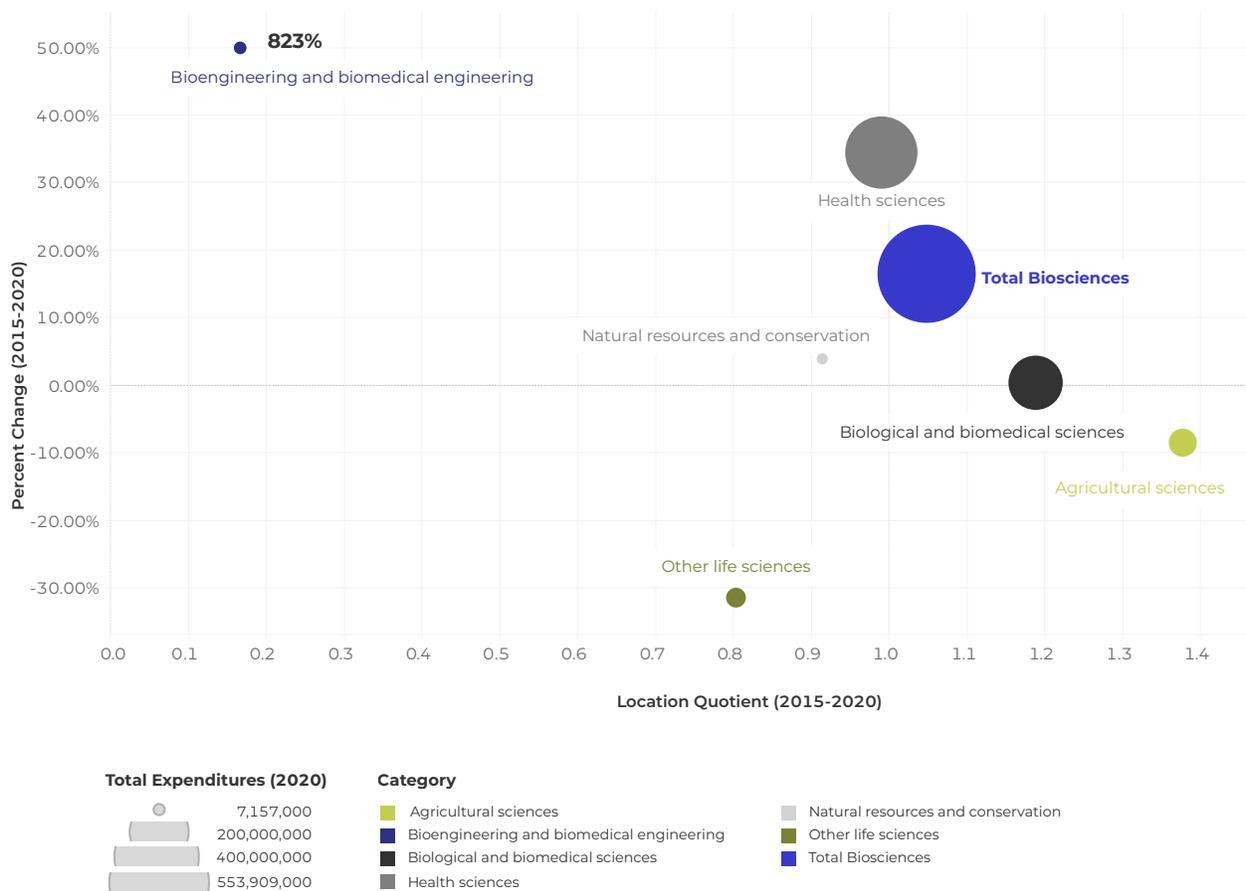


Source: TEconomy analysis of NSF BERD data

³ This report is subject to the limitations of data availability. 2019 is the latest available data in the National Science Foundation's (NSF) Business Enterprise Research and Development Survey (BERD) at the time of this analysis. As such, these data do not account for changes in business conditions occurring during the COVID-19 pandemic.

Figure 6 pivots to show academic biosciences R&D trends for Iowa. R&D categories do not directly match 1:1 to NAICS codes, so these differ from the industrial discussion. The data here are much more positive, showing that academic biosciences R&D experienced strong growth from 2015 through 2020. Specific bioscience fields contributing to growth have been bioengineering and biomedical engineering, health sciences, and natural resources and conservation. Biological and biomedical sciences have seen moderate growth, while agricultural sciences experienced a slight decline.

FIGURE 6. PERFORMANCE OF BROAD BIOSCIENCE ACADEMIC R&D CATEGORIES

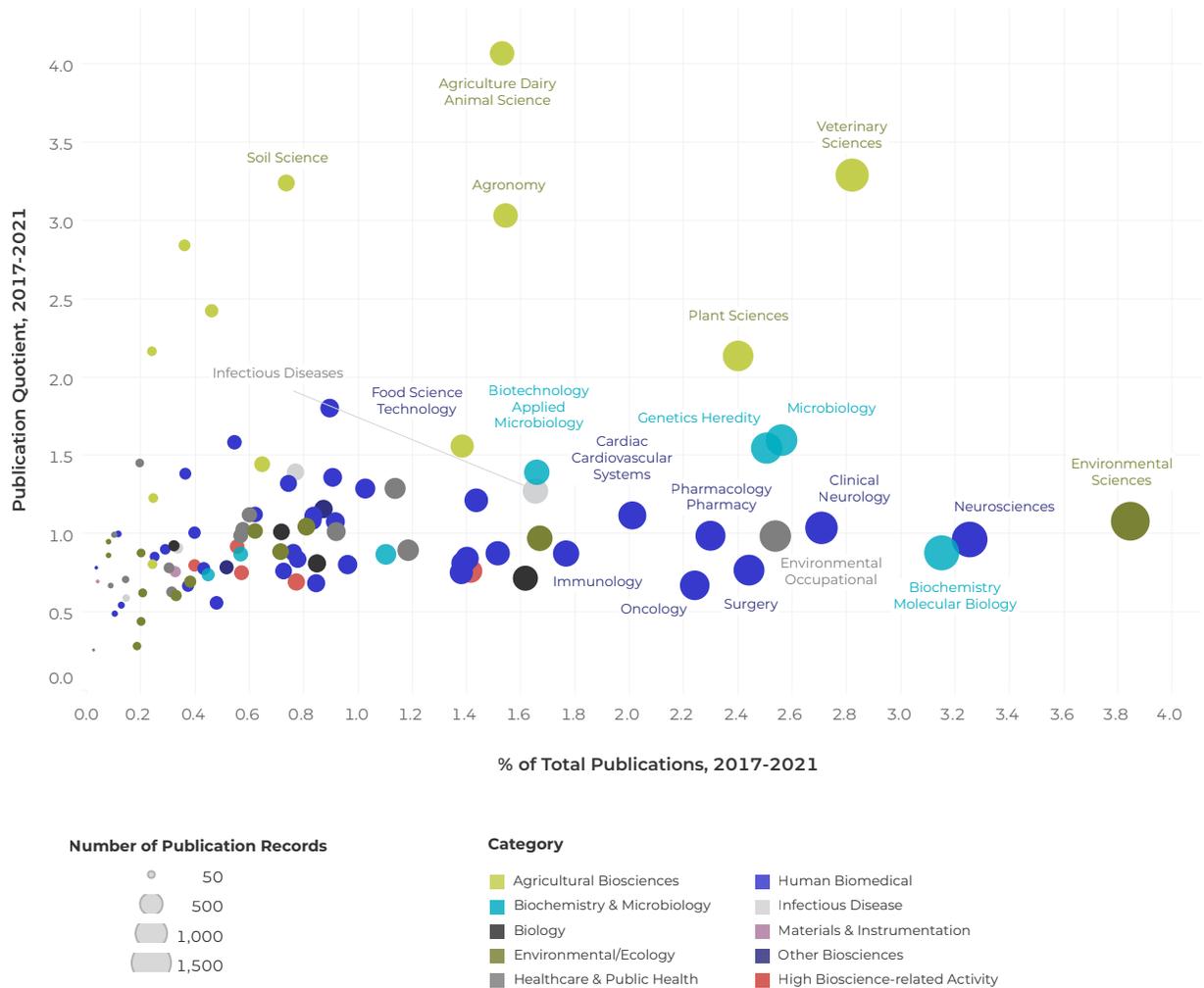


Source: TEconomy analysis of NSF HERD data

Innovation

Academic research and, to a lesser extent, industry research areas of strength can be examined by reference to publications activity. For academic researchers, publishing is the central metric of research output. Figure 7 shows the percentage of Iowa’s overall publications activity comprising each field shown on the “x” axis and the location quotient (comparative specialization versus the nation in each field) on the “y” axis. Evident in these data is a robust level of specialization in Iowa in agricultural-related fields of bioscience inquiry. Also strong are genetics, microbiology, and biotechnology/applied microbiology, which hold relevance to several of the platforms—especially the biobased products platform and the vaccines and immunotherapeutics platform (with this latter also well served by a specialization evident in infectious diseases).

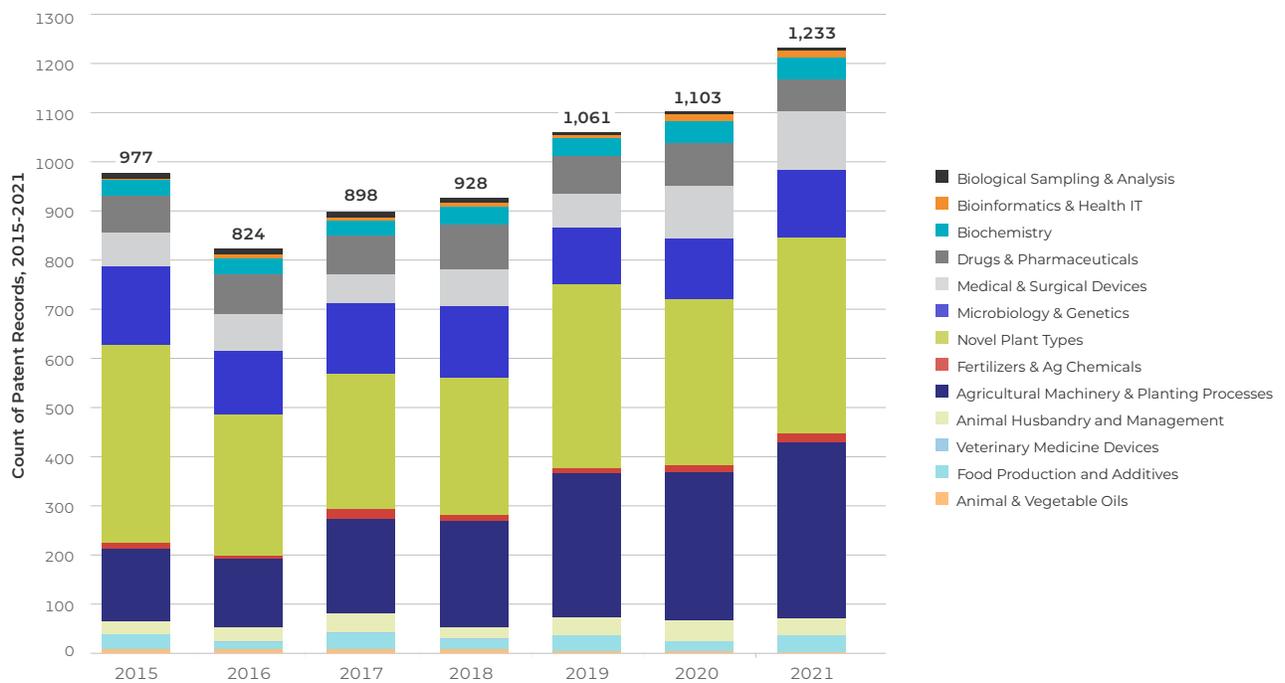
FIGURE 7. KEY AREAS OF PUBLICATION ACTIVITY



Source: TEconomy analysis of Web of Science publications data

Patents are also an important metric to consider when examining innovation activity. In patenting, Iowa biosciences have been experiencing substantial growth. Between 2015 and 2021 overall bioscience-associated patenting in Iowa grew from 977 patents in 2015 to 1,233 in 2021, representing a 26.2% increase overall and a CAGR of 3.38%. Looking across each category of patenting, in Figure 8 it is evident that two agriculture-related sectors comprise the largest volumes (novel plant types and agricultural machinery and planting processes). The largest patent growth is evident in the agricultural machinery and planting processes category and in medical and surgical devices.

FIGURE 8. IOWA-INVENTED BIOSCIENCES PATENTING ACTIVITY (2015-2021)

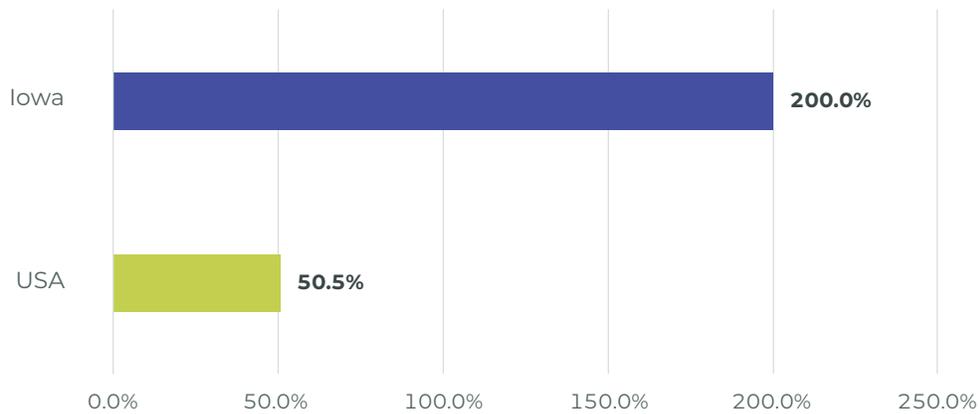


Source: TEconomy analysis of USPTO data from Clarivate Analytics

Growth Capital

One of the weaknesses of Iowa, relevant to the prospects of growing the bioscience economy, was noted in the 2018 biosciences strategy: access to risk capital to fund new and expanding business ventures. Several of the strategic actions recommended in the 2018 report were directed at improving capital access for the sector. A review of VC activity across the 2015-2021 timespan shows that Iowa has achieved a considerable increase in its performance and, as shown in Figure 9, far outpaced the U.S. growth rate in VC deals.

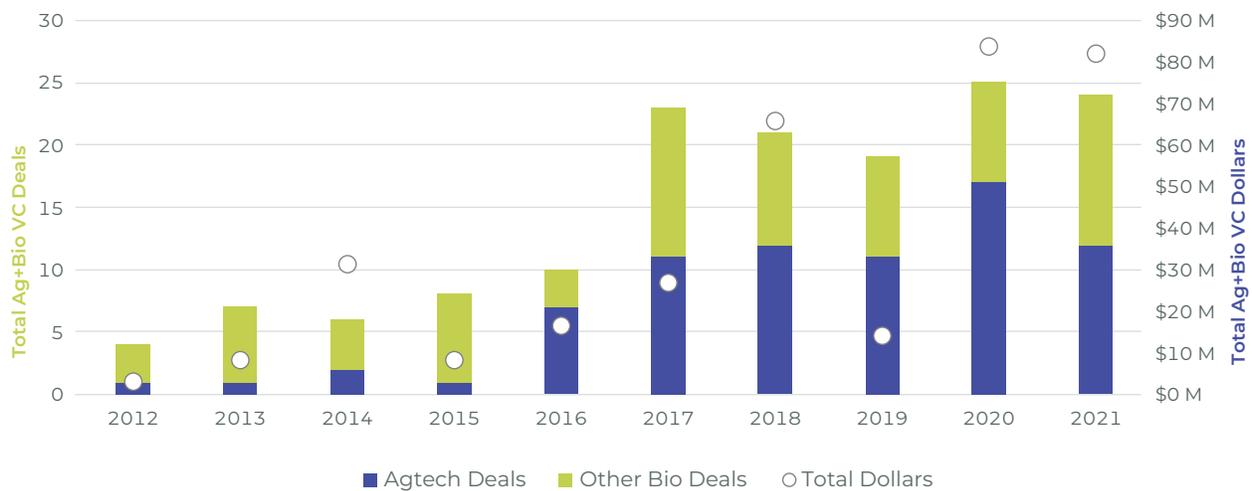
FIGURE 9. PERCENT GROWTH IN AGRICULTURE AND BIOSCIENCE-RELATED VC DEALS (2015-2021)



Source: Pitchbook

Figure 10 provides further insight, recording VC deals and VC dollars flowing to biosciences and associated AgTech deals in the state from 2012 through to the end of 2021. Considerable growth has been achieved in terms of deals and dollars for AgTech and other biosciences VC. This is an exceptionally positive trend for Iowa, reflecting well on parties in the state who are engaged in growing and supporting the biosciences cluster.

FIGURE 10. GROWTH IN IOWA BIOSCIENCE AND AGTECH-RELATED VENTURE CAPITAL (2012-2021)



Source: TEconomy analysis of Pitchbook data

Overall, the quantitative analysis of Iowa’s biosciences sector performance since the release of the 2018 strategy shows a “mixed” performance (see Table 1). On the positive side, overall growth has occurred in employment, R&D activity, publishing and patenting, and VC deals and funding. This must be balanced, however, with the realization that the levels of growth being achieved on many of these measures have been moderately lagging the overall national growth rate. The fact that innovation metrics are trending strongly upward is, however, a very positive sign. Innovation represents the “seed corn” for Iowa, the basis for future growth opportunities and expansion of the sector’s economic performance.

TABLE 1. SUMMARY OF IOWA'S PERFORMANCE ON BIOSCIENCE DEVELOPMENT MEASURES

Eco-system Element	Measure	Recent Volume	Specialized Concentration?	Trendline Since 2015?	Outpacing US?	Summary Performance, Position
Research & Development	Academic Biosciences R&D	\$554M (2020)	Yes	Positive	No	 Mixed: Making gains in select areas but lagging US and losing positioning.
	NIH Funding	\$211M (2021)	No	Positive	No	
	USDA NIFA Funding	\$30M (2021)	Yes	Positive	No	
	Industrial Bioscience R&D	\$895M (2019)	Yes	Positive	No	
Innovation	Biosciences-Related Patents	1,233 (2021)	Yes (specific areas)	Positive	N/A	 Mixed: Growth in patent activity and publications but dominated by relatively small group of companies and institutions.
	Biosciences-Related Publications	4,839 (2021)	Yes (specific areas)	Positive	N/A	
	Lead Sponsor Clinical Trials	1,255 (Active)	N/A	N/A	N/A	
Growth Capital	Venture Capital Funding	\$81.5M (2021)	Yes	Positive	Yes	 Emerging: Growing and outpacing US growth since '15
	NIH and USDA SBIR Funding	\$3.4M (2021)	No	Positive	Yes	
Industry Performance	Biosciences Industry Jobs	26,469 Total Jobs (2021)	Yes	Positive	No	 Mixed: Job growth slower than US in all subsectors since '15, with small set of areas driving state's overall productivity gains
	Biosciences Industry Productivity	\$373,325 GRP/Employee (2021)	Yes	Positive	Yes	

Source: TEconomy analysis of various data sources

III. STRENGTHS, WEAKNESSES, OPPORTUNITIES, AND THREATS ASSESSMENT

Insight from the quantitative analytics was supplemented by in-depth interviews with key stakeholders across the bioscience-development ecosystem in Iowa. The interviews concentrated on providing a current situational assessment for bioscience growth and development in the state, explored the implementation of strategies and actions, and assessed the strengths, weaknesses, opportunities, and threats observable for the development of the sector moving forward. A topline summary of input received is provided below in a strengths, weaknesses, opportunities, and threats (SWOT) format.

Strengths

- Significant progress in bioscience development has been made in Iowa in recent years, and the data shows this: growing across almost all measures and demonstrating a higher concentration than the nation in several industry subsectors. That said, Iowa has been growing slower than the nation across multiple measures, which suggests the state may be at risk of a declining competitive edge.
- Iowa continues to advance as a significant global player in advanced agricultural technologies. Strengths here are multidimensional, drawing from academic and corporate R&D expertise from both agricultural-equipment and plant sciences perspectives.
- Iowa is seeing growth in AgTech entrepreneurship, which is the top sector among bioscience sectors in securing VC funding.
- Chief Technology Officers (CTOs) are viewed by stakeholders as being a very successful addition to the platforms. The CTOs are instrumental in driving innovation commercialization across platforms through their individual commercial experience and because they come with significant relationships and contacts.
- State funds for the bioscience platforms are viewed as highly flexible in their use by universities: able to support seed funds, CTO staffing, and other uses. Because the use of funds has not been overly prescriptive, the universities have been able to direct them to where they feel they will be most effective (which differs by platform).
- The funding provided by the platforms to support researchers has, in turn, been well-leveraged by individual faculty and research teams in securing significant federal grant funding and funds from other external sources (such as industry contracts).
- Platforms have helped organize people around common goals in a way that has resulted in real progress, including moving forward infrastructure projects and pursuing new opportunities:

- **Biobased Chemicals (Products):** Center for Biorenewable Chemicals; pursuit of industry-scale precision fermentation facilities.
 - **Precision and Digital Agriculture:** new \$20M AI initiative that can support platforms in a cross-cutting manner; new John Deere facilities at tech park and strategic R&D partnerships; ARA Rural Wireless Living Lab; BioCentury Research Farm. The Plant Sciences institute at ISU has fostered many of the plant-engineer-data science collaborations that have contributed to advancing the platform, continues to foster new collaborations among these disciplines, and encourages a spirit of entrepreneurship that can contribute to future platform wins.
 - **Pharmaceuticals and immunotherapeutics:** CYVAX; Nanovaccine Institute; strategic partnerships with Merck.
 - **Medical Devices (Technologies):** Iowa's Biocatalysis and Bioprocessing Center and UI pharmaceuticals.
- At Iowa State, entrepreneurship and commercialization work can now factor into faculty promotion and tenure decision-making processes. This is especially important for junior faculty and for attracting faculty interested in highly applied and commercially oriented R&D work.
 - Since 2018 the University of Iowa has built a robust med-tech executive advisory network, with approximately 50 engaged executives and industry experts.
 - Platforms have been able to progress some infrastructure projects. An example of this is CYVAX, a small business incubation, development, and training center established at the ISU Research Park to help advance vaccine-focused companies. Further significant opportunities are being pursued (e.g., a 5000-liter fermentation capacity to help promote scale-up projects for the Biobased Products platform).
 - The State of Iowa has provided \$8.2 million in funding to the University of Iowa to build out new wet-lab space in the College of Pharmacy's buildings to facilitate faculty applied research and commercialization activities and collaborative work with industry.
 - Major corporate investments relevant to the platforms have continued to occur at the ISU Research Park. Examples include investments and expansions by Merck in the vaccines space and John Deere in the precision and digital agriculture field.
 - BioConnect Iowa's new venture fund is an important new development that improves capital access for biosciences commercial ventures.
 - The Rural Vitality Fund manages VC and private equity funds focused on Seed and Series A rounds targeted at the agriculture and AgTech sectors. They have 25 companies in their portfolio.
 - AgStartup Engine, operated by experienced entrepreneurs, has further enhanced the capital access situation for early-stage companies across three of the four Iowa Bioscience platforms.

- Iowa's robust farm economy, with multiple large and sophisticated farms and leading supply-chain companies (such as John Deere, Vermeer, Corteva, etc.) with significant operations in the state, makes for an intrinsically attractive development environment for AgTech.

Weaknesses

- Iowa's tight labor markets make it challenging to attract significant inward investment projects. The challenge is exacerbated by U.S. Census Bureau data which project a moderate decline of 2.2% in Iowa's population between 2020 and 2030.⁴
- Talent attraction to Iowa can be somewhat tricky—impacted by a lack of reputation as a tech hub, slowing immigration trends, and perceived quality-of-life issues. Iowa also loses many of its college graduates to out-of-state employment.
- The state's fiscal conservatism can make it challenging to make large co-investments that are often required for securing major federal projects (typically require matching funds).
- For BioConnect Iowa and the platforms, the year-to-year decision-making process for the provision of funds from the state is detrimental to program planning and building momentum.
- The full \$1 million amount for each platform has previously not been forthcoming from the legislature, even though the platforms have demonstrated significant leverage of the funds they have received. However, this has changed with the most recent legislative session.
- BioConnect Iowa has limited staff due to funding constraints, which has restricted its ability to market and build brand awareness both as an organization and across the platforms. It has also limited the organization's ability to work on the complete set of strategies and actions contained in the 2018 report (see next report section for details).
- Platform activities are primarily contained within ISU and UI, and to date, Iowa's smaller public and private colleges and universities have had negligible involvement in the platforms.
- Workforce development has yet to become an explicit focus of the platforms, yet it will be increasingly crucial for scaling and retaining business ventures in platform spaces. A long-term occupational demand and talent supply assessment needs to be performed to ensure biosciences, and other strategic sectors for the state, align their talent demand and supply.
- A lack of C-suite talent, experienced in and capable of scaling startups (e.g., CEO, CFO, Sales, Marketing, etc.), is a challenge across all the platforms.
- There is a limited base of experienced entrepreneurs and associated managerial personnel who can mentor or staff promising start-up ventures.

4 Numeric and percentage change table. <https://www.iowadatacenter.org/browse/projections.html>

- The platforms have a somewhat scattershot approach to securing coordinated industry engagement and input, and none have a formal advisory board. As such, they are primarily internally focused, comprising faculty and staff of the lead universities in terms of their management and planning, and lacking somewhat in external guidance and input.
- Patient VC funding is hard to access in Iowa, and VC is especially limited for non-digital ag ventures.
- There is now a lack of suitable and available lab space for entrepreneurs and scaling startups, a challenge made more pronounced by the lack of space at university research parks.

Opportunities

- Space at university research parks is in heavy demand, and advanced facilities have a waiting list. New space, if developed, is likely to achieve rapid occupancy.
- The current federal administration supports major funding programs and initiatives across several areas relevant to platforms, such as biobased products, biomanufacturing, and other fields.
- There is an opportunity to tell the story of Iowa's bioscience progress more effectively: communicating the value of the four platforms, repositioning certain platforms to improve visibility (e.g., biobased "products," expanding medical devices to embrace a broader set of biomedical innovations such as biopharmaceuticals), and improving connectivity across verticals.
- The new BioConnect VC fund has the potential to fill major capital gaps. Increasing levels of venture financing provides an opportunity to increase the retention of innovative companies founded in Iowa which otherwise may choose to relocate to out-of-state VC funding hubs.
- Multiple competencies align to present a potential opportunity for pursuing tech related to resiliency, carbon neutrality, renewable energy, and sustainability. If there is a line-of-sight to a significant emerging market, this may warrant investigation as a fifth platform.
- There is an improving level of willingness among farmers to test new precision technologies and advanced crop technologies.
- Current platform assets may be significant enough to form the focus of a Cyclotron Road-type program that could attract post-docs and others with promising technologies for further development and piloting. This is the focus of the originally recommended Action 2.1, which has not yet been implemented.
- ISU is starting a Biomedical Engineering program which may complement UI's work in advancing biomedical technologies and enhancing the supply of trained graduates.
- There is ongoing innovation in value-added uses for the key crops grown in Iowa. The Iowa farm economy can benefit significantly from alternative uses for innovated crops that can positively impact market development and prices realized by farmers.

Threats

- The maturity and sophistication of the nearby Minneapolis-St. Paul and Chicago markets affect Iowa's startup stickiness, especially in medical devices and other healthcare technology areas.
- The aging of the workforce in Iowa threatens the ability of legacy industries such as agriculture and manufacturing to meet their personnel needs—especially in skilled occupations.
- The ongoing loss of students to out-of-state employment after graduation hinders strength of talent pipelines.
- The state is experiencing declining medical devices employment, even as the growth rate has accelerated nationwide.
- Concern that some R&D operations have left the state, with data showing significant declines in agricultural chemicals/fertilizer R&D and medical devices.
- There is concern that veterinary medicine companies may be increasingly pivoting to the companion animal space. While this presents opportunities for business development, it does not generate beneficial impacts for Iowa's large animal agriculture sector, which needs solutions to established and emerging livestock diseases.
- Iowa is a leader in renewable energy in terms of liquid fuel production and renewable electricity generation. It should be embracing this leadership. These are powerful assets to build upon in the regenerative and clean tech spaces. Yet, politics in the state and quasi anti-science attitudes in some quarters limit commitment to the opportunity for business leaders around carbon sequestration, alternative fuels, and regenerative agriculture.

The 2018 strategies and actions were designed to address many of the above-cited opportunities and threats. The next section of this report examines progress on these strategies and actions and provides input on additional actions designed to address opportunities and threats facing the Iowa bioscience economy.

IV. STRATEGY AND ACTION IMPLEMENTATION: SITUATIONAL ASSESSMENT AND PROGRESS EVALUATION

Upon receipt of the previously completed bioscience development strategy in 2018, the IEDA moved immediately into strategy implementation. State government and key stakeholder commitment to implementing the strategy has been significant, with annual Iowa legislative appropriations advanced to support crosscutting and platform-specific strategies and actions.

In developing the previous strategies and actions, TEconomy, together with the Iowa Innovation Council, IEDA, and key stakeholders, identified a need to have both cross-cutting strategies and actions (those being elements designed to build and sustain a supportive overall bioscience development ecosystem across the state) and individual platform strategies and actions focused on the specific and specialized needs associated with each of the four platforms.



The 2018 report profiled four key cross-cutting strategies that were recommended by TEconomy for advancing the biosciences economy across Iowa. Specifically, the recommended strategies and associated actions were as follows (Table 2):

TABLE 2. 2018 STRATEGY AND ACTION PLAN RECOMMENDATIONS

Strategy One	Strategy Two	Strategy Three	Strategy Four
Organization and Connectivity	Innovation and Commercialization Acceleration	Talent Development, Attraction, and Retention	Enhance Early-Stage Capital Availability
<i>Iowa must stand up a focused bioscience development organization to coordinate strategy and action implementation and connect it to internal and external stakeholders.</i>	<i>Iowa must increase the flow of R&D-based innovations moving into commercialization.</i>	<i>Iowa must increase the availability and retention of the skilled human capital required for an innovative bioscience economy.</i>	<i>Iowa must increase the availability of early-stage pre-seed and seed capital to increase the number and quality of companies moving to later funding rounds.</i>
Action 1.1: Establish a public/private Iowa Bioscience Development Center (IBDC).	Action 2.1: Develop a funding program to attract innovators with ideas relevant to the IBDC Platforms to come to Iowa to advance their concepts.	Action 3.1: Increase pre-graduation connectivity with targeted platform industries.	Action 4.1: Focus on enhancing early-stage seed capital availability.
Action 1.2: Commit to long-term sustained support for IBDC and associated strategies and actions.	Action 2.2: Increase state support for bioscience focused incubation and acceleration programs at ISU and UI.	Action 3.2: Incentivize development and retention of talent in strategic disciplines relevant to platforms.	Action 4.2: Engage Iowa VC and Angel groups on IBDC board or advisory panel.
Action 1.3: Establish master agreements between IBDC and Regent's universities to facilitate access.	Action 2.3: Facilitate development of open-innovation clusters with large Iowa commercial R&D leaders.	Action 3.3: Significantly increase enrollment in data analytics-related programs.	Action 4.3: Staff position to build and maintain relationships with risk capital firms in and external to Iowa.
Action 1.4: Seek to establish regional networks with adjacent states.			

The IEDA and stakeholders in the sector have been active in advancing strategy implementation. Table 3 illustrates key activities that have occurred since 2018 for each strategy:

A key outcome of the original strategy was also the development of BioConnect Iowa as a dedicated coordinating organization, working to accelerate the growth of Iowa’s bioscience sector. The Iowa Innovation Council (IIC) and the Iowa Economic Development Authority (IEDA) have been highly supportive and engaged in the development of collaborative initiatives and programs focused on advancing the bioscience economy and its constituent platforms in the state.

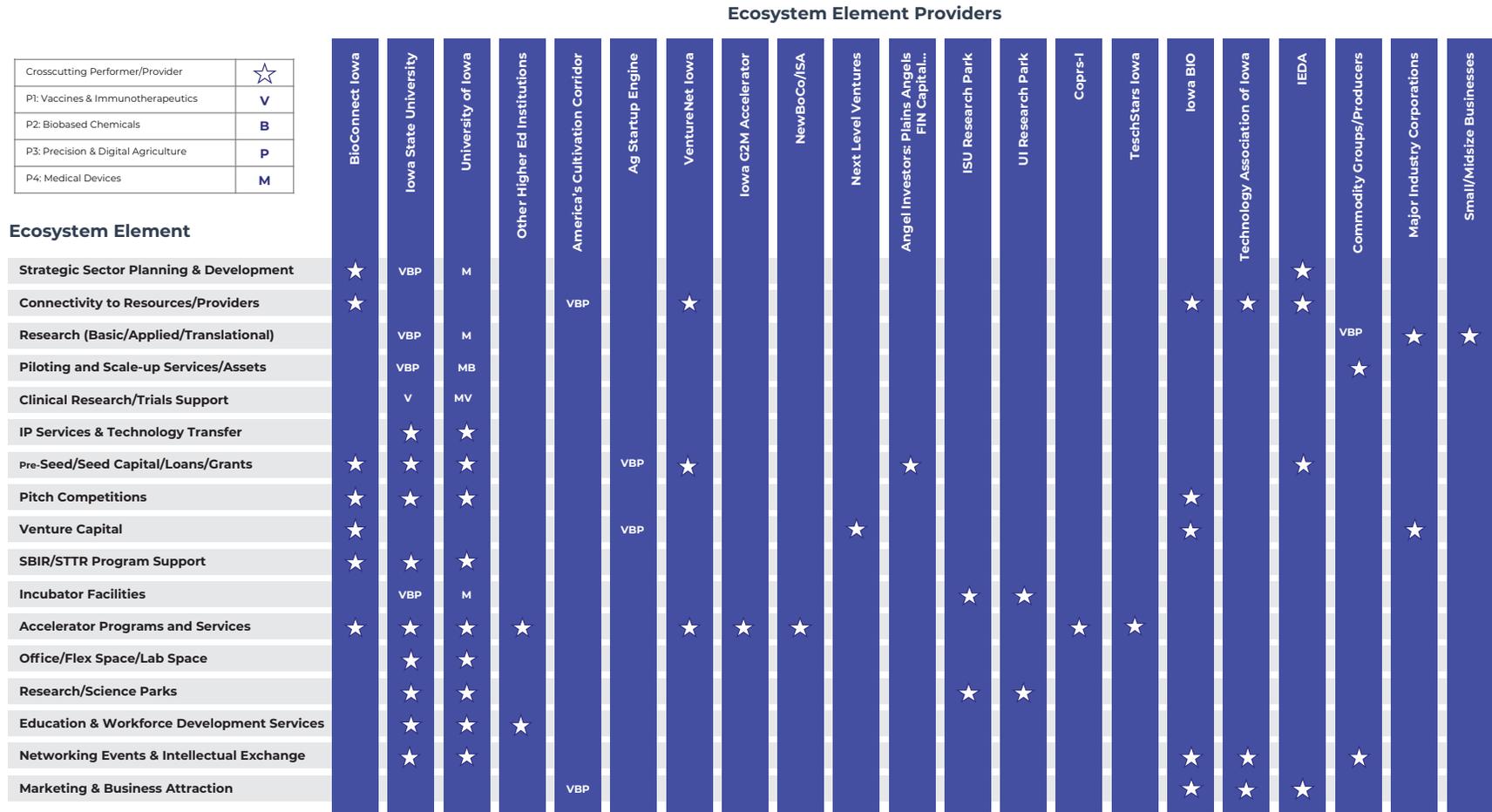
TABLE 3. GENERALIZED STATUS OF STRATEGY IMPLEMENTATION AS OF THIRD QUARTER OF 2022

Organization and Connectivity	Innovation and Commercialization Acceleration	Talent Development, Attraction, and Retention	Enhance Early-Stage Capital Availability
<p>The Iowa Innovation Corp was restructured and refocused to become BioConnect Iowa. BioConnect has been funded and staffed with experienced bioscience professionals but is not yet at the scale envisioned in the original strategy.</p> <p>As noted by BioConnect: <i>The organization’s goal is to accelerate the growth of Iowa’s bioscience sector—doing so by helping move good ideas into successful commercial endeavors. BioConnect provides entrepreneurs with resources, mentorship, and connections to the right people at the right time.</i></p> <p>The CTO positions added to the universities have been important in fostering and building focused university communities and enhancing university/industry connections.</p>	<p>The Iowa ecosystem for supporting innovation and commercialization acceleration has been built out considerably since 2018. Figure 11 provides an overview of the service providers and engaged organizations across the ecosystem.</p> <p>All areas required for a full bioscience-based economic development ecosystem demonstrate organizational coverage, many with more than one key provider organization.</p>	<p>From a platform development standpoint, significant progress has been made in supporting the universities by establishing the CTO positions for each platform.</p> <p>More broadly, in terms of overall workforce development and attraction relative to the platforms, limited work has been performed to assure skilled workforce availability other than the existing higher education activity within universities and the community college system. There is a pending NSF ESPCoR Track-1 proposal, led by ISU, that is focused on biomanufacturing which, if funded, will address workforce development relevant to both the Biobased Products and Vaccines, Diagnostics, and Immunotherapeutics platform.</p>	<p>BioConnect operates Iowa’s SBIR and STTR programs, helping entrepreneurs obtain federal grants and funding matches.</p> <p>Pre-seed capital access has improved for the bioscience platforms through legislative funding awarded to each platform which has flexibility in its use.</p> <p>Agriculture-related ventures have seen improvements in the capital access ecosystem, and AgTech is especially proving successful in attracting major funding.</p> <p>BioConnect is launching a new venture funding program.</p>



As Figure 11 illustrates, Iowa now benefits from having developed a robust and quite complete bioscience and associated technology economic development and innovation ecosystem. Not a single key element of a complete ecosystem is missing in terms of organizations focused on addressing the provision of each element. Indeed, in all cases, more than one organization or program is directed at each element. However, it is important to note that this apparent completeness of the ecosystem does *not* mean that further improvements and enhancements are unnecessary. Key issues remain, but these primarily relate to the *scale* of functions—whereby more resources would be beneficial to meet demand and provide a higher and more effective level of service. In this regard, further resources need to be directed to the development of the following: bioscience-focused business start-up space; entrepreneurial and business development talent development; enhanced access to a supply of skilled technical and business workers; larger available pools of early stage and expansion capital; increased funding to support innovation in each platform, and enhanced funding to increase staffing at BioConnect Iowa.

FIGURE 11. CURRENT STATUS OF THE BIOSCIENCE ECONOMIC DEVELOPMENT ECOSYSTEM IN IOWA



Source: TEconomy Partners via review of organizational websites and interviews with organizational leadership. Additional review by VentureNet Iowa.

Although the bioscience development ecosystem has evolved well in terms of programs and coverage of key ecosystem elements, the full implementation of actions from the 2018 strategy has yet to be achieved. Diving deeper into the status of individual recommended actions, it is evident that progress has been made; however, several of the actions have been only partly addressed and need further attention, and some still need to be advanced. Table 4 shows TEconomy’s subjective scoring of the apparent progress made on each action using the following scale:

- 2 = Achieved as envisioned in original strategy
- 1 = Partially achieved (not to full extent outlined in original strategy)
- 0 = Very limited or no progress

TABLE 4. IMPLEMENTATION STATUS SCORE FOR 2018’S RECOMMENDED ACTIONS AS OF THIRD QUARTER 2022

Strategy One	Strategy Two	Strategy Three	Strategy Four
Organization and Connectivity	Innovation and Commercialization Acceleration	Talent Development, Attraction, and Retention	Enhance Early-Stage Capital Availability
Action 1.1: Establish a public/private Iowa Bioscience Development Center (IBDC).	Action 2.1: Develop a funding program to attract innovators with ideas relevant to the IBDC Platforms to come to Iowa to advance their concepts.	Action 3.1: Increase pre-graduation connectivity with targeted platform industries.	Action 4.1: Focus on enhancing early-stage seed capital availability.
1	0	1	2
Action 1.2: Commit to long-term sustained support for IBDC and associated strategies and actions.	Action 2.2: Increase state support for bioscience focused incubation and acceleration programs at ISU and UI.	Action 3.2: Incentivize development and retention of talent in strategic disciplines relevant to platforms.	Action 4.2: Engage Iowa VC and Angel groups on IBDC board or advisory panel.
1	1	0	0
Action 1.3: Establish master agreements between IBDC and Regent’s universities to facilitate access.	Action 2.3: Facilitate development of open-innovation clusters with large Iowa commercial R&D leaders.	Action 3.3: Significantly increase enrollment in data analytics-related programs.	Action 4.3: Staff position to build and maintain relationships with risk capital firms in and external to Iowa.
1	0	1	2
Action 1.4: Seek to establish regional networks with adjacent states.			
0			

As Table 4 illustrates, progress has undoubtedly been made, but significant further activity is required to fully address the opportunities and recommendations identified in the original strategy. This is covered in the next section.

V. ASSESSING THE ECOSYSTEM: CROSS-CUTTING STRATEGIES AND ACTIONS—PROGRESS AND SUGGESTED CHANGES

The following tables (Tables 5 through 8) provide an overview of the original 2018 strategies and actions, with conclusions regarding each action's status and recommendations for moving forward.

TABLE 5. STRATEGY ONE AND ASSOCIATED RECOMMENDED ACTIONS

Strategy One: Organization and Connectivity
<p>Iowa must stand up a focused bioscience development organization to coordinate strategy and action implementation, connect it to internal and external stakeholders, and advance bioscience platform development.</p>
2018 Action Recommendations
<p>The stakes have been raised in TBED, and less-organized, ad hoc approaches to R&D, innovation, entrepreneurship, skilled talent development, and related factors will likely place a state at a disadvantage. Based on these trends and a review of the current status of technology-based economic development and supporting organizations in Iowa, TEconomy finds that Iowa needs to adopt a more aggressive, formalized approach to organizing for life sciences development. Strategy 1 is rooted in this conclusion.</p> <p>With biosciences representing an existing economic strength for the state, together with presenting broad-ranging opportunities for further technology-based economic development growth, this highly specialized sector now deserves and requires standing-up an organizational structure that will assure strategy and action plan implementation occurs in a centrally organized manner with specific initiatives focused on platform advancement.</p>
Current Status and Recommendations Moving Forward
<p><i>The State of Iowa repurposed the Iowa Innovation Corporation to become BioConnect Iowa. BioConnect, as of mid-year 2022, has a five-person staff and is governed by a seven-member Board of Directors. The Board is supplemented by three ex officio members, representing IEDA, ISU and UI.</i></p>

Action 1.1: Establish a public/private Iowa Bioscience Development Center (IBDC)

NOTE: A different and more effective name was adopted, with the creation of "BioConnect Iowa" (rather than the placeholder "IBDC")

2018 Action Recommendations

Description: Iowa will benefit through establishing an Iowa Bioscience Development Center as a public/private economic development initiative focused on coordinating existing assets and the implementation of the recommended bioscience strategies and actions to advance Iowa bioscience platforms and overall sector growth. It is recommended that this bring together existing assets in the Iowa Innovation Corporation and other related entities, rather than being a separate freestanding operation.

TEconomy recommends that Iowa considers the North Carolina Biotechnology Center, BioSTL Coalition (St. Louis) and BioCrossroads (Central Indiana) organizations as models taking a similarly focused approach to bioscience sector development. This requires organizing a well-staffed and resourced structure able to coordinate, guide, and advance the implementation of focused, long-term strategic actions that assure the bioscience technology-based ecosystem in Iowa is complete and that the most promising sectors, technologies, and new business ventures are provided with optimized conditions in Iowa to advance their growth and success.

The Iowa Innovation Corporation is leading an assessment of the best way to accomplish Action 1.1.

Responsible parties or entities: Iowa Innovation Corporation working in cooperation and consultation with the Iowa Economic Development Authority and the Iowa Innovation Council.

What to do: Form the Iowa Bioscience Development Center (IBDC) as a public/private partnership to coordinate strategy and action implementation to advance bioscience-based economic development in Iowa. IBDC will develop and administer programs including support of:

- R&D and innovation
- New business development and growth
- Workforce development
- Advancing each bioscience platform
- Convener, facilitator, investor, and partner to research community, industry, external investors, and R&D stakeholders
- Connect to existing external resources
- Accountable to a Board
- Advised by advisory boards for each platform
- Marketing to advance the internal and external image of Iowa.

When to do it: First quarter of 2018

Estimation of required resources: Standing-up an organization at 35 percent the scale of the NC Biotech Center (proportionate to the size of Iowa's bioscience economy versus North Carolina's) would result in the following basic figures:

- Staffing – circa 20 personnel
- Total budget (including operations and funds for investment in programs and companies): \$4.76 million.

It should be noted that such a level of resources is already being devoted to activities through IEDA and IIC, and a restructuring of activities (rather than an entirely new appropriation) may accomplish much of what is envisioned.

Current Status and Recommendations Moving Forward

BioConnect Iowa, as established, meets the envisioned organizational structure of being public/private—receiving state funding support and interfacing/partnering with various private sector and nonprofit stakeholders in delivering services to enhance bioscience innovation and associated economic development in Iowa. As recommended, BioConnect was formed through repositioning of the existing Iowa Innovation Corporation.

It was recommended that BioConnect develop and administer programs including support of:

- *R&D and innovation*
- *New business development and growth*
- *Workforce development*
- *Advancing each bioscience platform*
- *Convening, facilitating, investing, and partnering with the research community, industry, external investors, and R&D stakeholders*
- *Connecting to existing external resources*
- *Accountability to a board*
- *Marketing to advance the internal and external image of Iowa.*

As noted further herein, to-date BioConnect has primarily concentrated on:

- *R&D and innovation*
- *New business development and growth*
- *Advancing each bioscience platform*
- *Convening, facilitating, investing, and partnering with the research community, industry, external investors, and R&D stakeholders*
- *Connecting to existing external resources*
- *Accountability to a board.*

Given limited financial resources and staffing levels, TEconomy concludes that BioConnect has directed its resources effectively.

The 2018 strategy projected a “right-sized” budget for the organization to be circa \$4.7 million, supporting a staff of 20. Currently, BioConnect operates under a SOW with IEDA that is \$1 million per year, with funding approval running through FY2024. The approved BioConnect budget for FY2023 is somewhat higher, at \$1.25 million, because a small surplus developed during the COVID shutdown that is now being spent down. Given that BioConnect is operating with a budget considerably smaller than envisioned in the original strategy, it is logical that not all actions recommended in the strategy have been advanced or conducted at the scale originally anticipated. The fact is that BioConnect is accomplishing a great deal with quite limited financial and personnel resources.

To bring BioConnect to the originally envisioned scale of operation, the State of Iowa will need to increase funding levels. Over time it would be appropriate for BioConnect Iowa to also supplement state funding by soliciting funding from major bioscience corporations and philanthropy, in line with the successful funding model used by BioCrossroads in Indiana under the Central Indiana Corporate Partnership (CICP).

Action 1.2: Commit to long-term sustained support for IBDC and associated strategies and actions

2018 Action Recommendations

Description: Success in technology-based economic development (TBED) is a marathon, not a sprint. Successful states and regions in TBED have demonstrated a long-term, sustained commitment to their strategic programs. San Diego CONNECT, for example, has operated for 25 years, the North Carolina Biotechnology Center for 33 years, Pennsylvania's Ben Franklin Technology Partners for 31 years, and the Georgia Research Alliance for 27 years. Locations that have built up successful concentrated clusters of businesses on research parks also have achieved success through a long-term "stick-to-it-ness"—with, for example, Research Triangle Park founded in 1959 and the Stanford Research Park in 1951.

Iowa, in contrast, has not benefited from a focused bioscience economic development organization, and despite having previous strategic planning work performed to grow the sector (by Battelle TPP for example), it has not been organized to sustain a long-term commitment to strategic plan implementation. Rather, Iowa has been characterized by multiple starts, stops, and changes to the Iowa economic development community of organizations. This faltering has negatively impacted the state's ability to pursue a long-term, coordinated strategic approach to platform development.

It is imperative that the formation of the IBDC and the implementation of strategies and actions be accompanied by a long-term commitment from Iowa's legislature and executive branch to support the organization and its work. The organization needs to be protected from short-term unrealistic expectations, variability in political support, and associated funding fluctuations.

Responsible parties or entities: Iowa Economic Development Authority and the Office of the Governor, with support from the Iowa Innovation Council, the board of the Iowa Innovation Corporation and the Iowa Board of Regents.

What to do: Seek to establish legislation providing a dedicated long-term funding stream for support of the IBDC with a commitment to at least a 10-year program of funding support.

When to do it: First quarter of 2018

Estimation of required resources: Resources to secure are covered under Action 1.1. Resources required to implement 1.2 are staff and legal time required to draft supporting legislation (if required) or modify existing legislation.

Current Status and Recommendations Moving Forward

BioConnect has been operating since the initial implementation of the 2018 strategy and, as noted above, is funded through FY2024. The State of Iowa and IEDA have shown sustained financial commitment to supporting BioConnect, although the level of funding has not reached the scale envisioned in the 2018 strategy.

With BioConnect having proven itself as an effective organization (as documented herein), the time is right to approach the Iowa legislature with the originally stated goal of providing a dedicated long-term funding stream for support of BioConnect with a commitment to a 10-year program.

of funding support beyond FY2024. This request also should seek to at least double state support to BioConnect to \$2 million per year, from the current \$1 million. It should be noted that at \$2 million, the organization would be less than half-funded in proportion to competitors such as the NC Biotechnology Center. Iowa's fiscal management has generated a substantial budget surplus for 2022, and the timing may be right to commit some of that surplus to more extensive support of BioConnect and expansion of its programs.

Action 1.3: Establish master agreements between IBDC and Regents Universities to facilitate commercial R&D and innovation commercialization programs

2018 Action Recommendations

Description: Iowa's Regent Universities have made considerable strides in developing organizational structures designed to facilitate engagement with industry. ISU, UI and UNI each have staffed positions and dedicated organizational resources to become "business friendly" institutions. Iowa could take industry engagement to a higher-level still, focused on biosciences, by developing master agreements between each university and the IBDC whereby companies being supported by IBDC or participating in it (potentially as member organizations) would have preferred terms on IP ownership and access to university expertise, technical resources, and infrastructure.

When talking to industry, TEconomy finds that the most frequent challenges cited for industry working with universities in the U.S. are: unreasonable levels of university overhead charges; time delays in contracting and a general lack of urgency; problems in reaching agreement on IP valuations, and general challenges in negotiating favorable contracting terms. Universities that are considered "best practice" in working with industry appear to have the following characteristics: good at communication and responsiveness; demonstrate flexibility in contract and IP terms; have a sense of urgency and provide timely performance on projects, and a general sense of professionalism.

One option that might be considered is to have the IBDC hold a pre-negotiated master contract agreement with UI and ISU, designed to provide access to university equipment and expertise at a "speed of industry" pace and on favorable fee and IP terms. Something along the lines of this concept has been developed in the State of California to provide improved industry access to national laboratory resources, and it is recommended that Iowa review the California "CalCharge" model. The CalCharge program at Lawrence Berkeley National Lab is a nonprofit organization, affiliated with the Lab, that facilitates laboratory/industry R&D and technology transfer. CalCharge represents a public-private partnership formed by the California Clean Energy Fund (CalCEF) and Lawrence Berkeley National Lab. The organization's website notes the following:

CalCharge is a battery and electrochemical energy storage consortium comprised of emerging and established companies, research institutions, government programs, and other key stakeholders in the innovation lifecycle. Through CalCharge, members will have access to programs in Technology Assessment and Acceleration, Professional Development, Pre-Commercialization Support, and Ecosystem Facilitation. By being inter-connected through the CalCharge framework and accessing its services, members will be able to accelerate the development, commercialization, and adoption of energy storage technologies for the electric/hybrid vehicle, grid, and consumer electronics markets.

CalCharge notes that its key mission areas are as follows:

- Bring together the innovators, end-users, and other key stakeholders in energy storage technology
- Provide access to the resources and expertise needed to accelerate innovation and market impact for member companies

- Develop programs and services that smooth the “innovation to installation” pathway for emerging energy storage technologies.

CalCharge operates as a member organization, with member companies and organizations able to access Lawrence Berkeley National Lab resources under CalCharge's master CRADA (cooperative research and development agreement). As noted in a recent report, “the scope of the CRADA is broadly defined, encompassing energy storage technologies and, in order for the projects to be covered under the Master Services Agreement, they must stay within that parameter. The critical difference is that Berkeley Lab's CRADA is with CalCharge and not the individual member.”

The key element here would be structuring a pre-negotiated master agreement between the Iowa Bioscience Development Center and the universities that allows consortia (platform) members to readily access university facilities and expertise to advanced related R&D and have favorable terms for access to resulting technologies and innovations.

Responsible parties or entities: Iowa Board of Regents, ISU and UI Research Foundations and offices of their respective VP Research in coordination with the IBDC.

What to do: Examine existing successful models for similar master agreements and develop Iowa versions suited to supporting the work of each platform.

When to do it: Immediately after the IBDC is formed and operational. The Iowa Innovation Corporation could begin a process of reviewing potential models and model agreements in the first quarter of 2018.

Estimation of required resources: Staff time and associated legal services.

Current Status and Recommendations Moving Forward

Although a formal CalCharge-type model as outlined in the 2018 strategy has not been developed, substantial progress has been made in formalizing BioConnect and research university relationships. IEDA is providing financial support to ISU and UI for bioscience platform development at a targeted level of \$1 million per year per platform (as of the most recent legislative session).

It is clear that both ISU and UI have made a concerted effort to enhance their environment for commercial innovation and industry-university research relationships. The funded CTO positions have proven to be very effective in bringing highly experienced talent to the universities to advance the platforms.

The stated 2018 action recommendation of “structuring a pre-negotiated master agreement between the Iowa Bioscience Development Center and the universities that allows consortia (platform) members to readily access university facilities and expertise to advanced related R&D and have favorable terms for access to resulting technologies and innovations” has not been formally put in place. However, the CTOs are an effective single point of contact that can help industry and entrepreneurs access relevant platform resources and expertise.

Action 1.4: Seek to establish regional networks with adjacent states

2018 Action Recommendations

Description: Iowa is a comparatively small state (with a 3.1-million-person population), and it is challenging to have all the resources, infrastructure, and expertise in place to advance complex multidisciplinary advanced technology platforms. Competing with innovation and business development hotspots such as California and Massachusetts is challenging, simply from the perspective of the challenge of scale. An alternative approach to competing would be to collaborate with assets and expertise in adjacent Midwestern states – using consortia approaches to leverage each other's assets. For example:

The Minneapolis/St. Paul region of Minnesota has deep-seated R&D, expertise and specialized resources suited to advancing medical devices. It also has capital access for this industry.

The triangle of Ames, Kansas City, and Lincoln Nebraska contains a high concentration of animal health R&D and industry expertise.

Illinois has extensive clusters of expertise in high performance computing, software engineering, etc.

The region centered on Iowa and including Illinois, Wisconsin, Minnesota, Missouri, Kansas and Nebraska contains the greatest concentration of agricultural science companies in the nation and each will be considering strategic implications of precision and digital ag.

Forming consortia to allow companies to access specialized resources and expertise through a one-stop-shop approach spanning state lines may create an opportunity that is greater than the sum of its individual parts. Perhaps Iowa doesn't have to go it alone to advance its platforms?

Responsible parties or entities: IBDC in collaboration with the IEDA and the Governor's Office (for making high level connections to surrounding states).

What to do: Identify key assets relevant to platforms in adjacent states that will serve to complement and reinforce Iowa's bioscience development platforms. Develop a win-win value proposition for collaborations and preferred access to respective resources suited to platform advancement. Longer-term, build on established networks to promote a Midwest bioscience region, centered on Iowa.

When to do it: After the IBDC is formed and operational. Probably late 2018.

Estimation of required resources: Staff time and associated travel expenses.

Current Status and Recommendations Moving Forward

Forming regional multi-state consortia to advance bioscience development based on shared assets, resources, and interests has not occurred to date (at least not as a formal initiative of BioConnect). An exception is ISU, which is successfully collaborating with major research university peers in neighboring states (e.g., Minnesota and Nebraska) in the pursuit of major federal funding programs in relevant areas. An example of this is the BioMade initiative, led by the University of Minnesota with significant participation by ISU. Current grant submissions are being prepared with neighboring state universities for additional relevant federal funding opportunities. Iowa's success in such initiatives would be enhanced through the state forming a strategic pool of funds that could be drawn upon for state matches (which are often a requirement for a state's institutions to be leaders of major federal initiatives).

Regarding boosting collaborations and leveraging regional assets, BioConnect has been leaning into the strategy:

As part of a new initiative, BioConnect is working with ISU on an NSF grant using an Innovation and Venture Studio Model. This is intended to establish a regional approach between Iowa, Nebraska, Kansas, and Oklahoma. BioConnect notes that "whether we get the grant or not, the work been done as part of developing the grant will continue, especially with Nebraska and Kansas."

As part of a Kauffman Foundation grant, Anne McMahon at BioConnect has been part of an Iowa-Nebraska-Kansas and Missouri SBIR regional information sharing initiative. BioConnect Iowa was part of a Kauffman Heartland Challenge focused on building the community assets to support business owners and founders. The collaborating state teams meet monthly and have done joint programming, including holding a contracting and budget webinar, and are planning an in-person regional event in the spring, 2023.

TABLE 6. STRATEGY TWO AND ASSOCIATED RECOMMENDED ACTIONS

Strategy Two: Innovation and Commercialization Acceleration

Iowa must increase the flow of R&D-based innovations moving into commercialization.

2018 Action Recommendations

Compared to surrounding states, Iowa has significant bioscience strengths. It is among the 8 states in academic bioscience R&D per capita and is 3rd in bioscience patents per capita and has a robust bioscience employment location quotient of 1.36 (ranked 3rd out of 8). It is, however, dead last in terms of advancing bioscience start-up ventures forward into receipt of venture capital investment. In talking to VC firms (see separate TEconomy VC report) the issue is not VC capital availability per se, but rather a lack of early-stage companies receiving seed and angel funding and progressing to the venture capital stages of growth. The issue is one of deal flow – and that starts with assuring a healthy pipeline of early-stage companies are established and nurtured in the state. Strategy Two, therefore, focuses on actions that will increase innovation commercialization in Iowa and the growth of start-up bioscience enterprises.

Current Status and Recommendations Moving Forward

Iowa continues to have strengths to build upon. In comparison to adjacent states (Appendix A) Iowa performs particularly well in terms of bioscience innovations as measured by patents, ranking second behind Minnesota in terms of bioscience patents generated per 100,000 population (for 2018 through 2021). The state, however, slipped to fourth in its ranking of academic biosciences R&D per capita (where Nebraska, Wisconsin, and Missouri are ranked first, second, and third respectively).

Using the TEconomy/BIO definition of life sciences (which omits AgTech deals), Iowa remains stubbornly in last place compared to surrounding states in biosciences venture capital per capita. There is still, evidently, an ongoing challenge in securing a substantial volume of fundable deals and associated VC attraction.

Iowa's bioscience location quotient is fourth among surrounding states (plus Indiana) and, at 1.21, stands at a "state specialization" level as a collective industry.

Action 2.1: Develop a funding program to attract innovators with ideas relevant to the IBDC Platforms to come to Iowa to advance their concepts

2018 Action Recommendations

Description: Iowa does not need to rely solely on existing Iowa academic and commercial R&D programs to produce all bioscience innovations for potential commercialization in the state. Rather, a potential strategy would be to increase the flow of novel ideas and innovations to the Iowa Bioscience Development Platforms through a funding program that would attract entrepreneurial ideas and concepts from outside Iowa to be further gestated and developed within Iowa. Such a program could solicit competitive applications for a two-year, stipend-based, temporary research faculty or post-doc position at ISU or UI for innovators with novel concepts in the Bioscience Platforms that would benefit from Iowa's university infrastructure and multidisciplinary faculty expertise. Effectively operating as a very early-stage accelerator program, the envisioned program would aim to help innovators bridge gaps between their concepts and commercialization.

A model for such a program (which we tentatively term "Iowa Innovates") exists outside of Iowa within the U.S. Department of Energy National Laboratory System with the "Cyclotron Road" program developed at Lawrence Berkeley National Laboratory (LBNL) in California. Cyclotron Road is a novel and innovative program that serves to attract talented inventors (primarily postdocs) to bring their innovative technologies to LBNL to further their development and proof-of-concept testing toward commercialization. The program operates as a competition, with innovators applying to be participants and those winning entry to the program coming to be embedded at LBNL where they are supported in advancing their early-stage commercial concepts (supported via a stipend and health insurance and provided with free access to lab instrumentation and expertise).

A similar program structure could be established in Iowa to leverage existing centers, assets, and clusters of expertise at ISU and UI -- centers such as CBiRC at ISU for advancing biobased chemicals, MERGE at UI for advancing medical devices, etc. It would seek to increase the level of potential commercially viable innovations being incubated within Iowa -- substantially increasing access to novel concepts and innovators directly relevant to the bioscience platforms. Unlike the program at LBNL, which does not have an incubator, both ISU and UI would have the advantage of also having incubator operations that can provide support for new start-up ventures stemming from competition winners, and longer-term the ability for expanding companies to absorb space on the universities' research parks.

Argonne National Laboratory (ANL) has now similarly adopted Cyclotron Road as a model for integration into its efforts to enhance Lab/Industry engagement and commercialization activity. In 2016 ANL founded Chain Reaction Innovations (CRI), a captive venture accelerator explicitly modeled on Cyclotron Road, and like the latter, financed in part through the DOE Lab-Embedded Entrepreneurship Program (LEEP). Like Cyclotron Road, CRI has no dedicated physical incubator facilities. Likewise, it reaches out nationally for entrants to its accelerator, and treats its own scientific staff as resources rather than necessarily as primary candidates for entrepreneurship.

Responsible parties or entities: Coordination, outreach and applications process coordinated by IBDC in collaboration with ISU and UI. Coordination of fellows on-site at each university through the offices of the respective VPs for Research.

What to do: Meet with the current director of the Cyclotron Road program at LBNL to gather further details on the roll-out of their program, preliminary funding levels, successes, and challenges. Build learning from LBNL model into a formal Iowa Innovates fellows program

When to do it: After IBDC is formed. Needs to be timed to begin first admittance of fellows at the start of the academic year at ISU and UI.

Estimation of required resources: This can be fully scalable depending on success. A starting point would be for funding to support three Iowa Innovates fellows for each of the four platforms, for a total of 12. Assuming support of \$40,000 per year in a stipend, plus the cost of providing healthcare insurance and a small amount of office space (say \$10,000 per year), this would require the availability of \$600,000 in annual funding.

Current Status and Recommendations Moving Forward

The recommendation to fund a Cyclotron Road type program has not been implemented. Based on recent discussions, it is evident to TEconomy that there is interest at IEDA, BioConnect, and with other stakeholders in initiating such a program.

This action should be considered a high priority for implementation. A small amount of the state's substantial budget surplus could be used to significant effect to fund the attraction of post-docs and other talented individuals with pre-vetted commercialize innovations to advance.

The original recommendation was for initial funding to support three "Iowa Innovates" fellows for each of the four platforms, for a total of 12. Assuming support of \$40,000 per year in a stipend, plus the cost of providing healthcare insurance and a small amount of office space (say \$10,000 per year), this would require the availability of \$600,000 in annual funding. Allocating \$1 million, accounting for inflation, should be the minimum goal for each platform in 2023. Iowa must increase its volume of fundable deals coming through the pipeline, and this recommended program is a relatively affordable pathway to supplementing domestic Iowa innovation capacity.

Action 2.2: Increase state support for bioscience focused incubation and acceleration programs at ISU and UI

2018 Action Recommendations

Description: Description: The individual platform strategies and actions speak to the thematic specifics of space and resources required to develop and grow innovative Iowa bioscience companies. Shared across all the platforms, however, is a need for business incubator and accelerator space, and associated support services. Currently, both ISU and UI have incubator operations and the State of Iowa should sustain investment into these incubator operations to encourage development of space and services suited to the needs of bioscience platforms companies. The operation of incubators and the support services for entrepreneurial ventures at universities is not a profit-making venture for the universities but plays a critically important role in securing a deal flow of new and growing ventures. State funding support for university incubation operations and associated pilot and support facilities is encouraged.

Responsible parties or entities: Iowa Economic Development Authority

What to do: Recommend \$200,000 in annual incubator financial support be allocated to each platform and directed to the most relevant incubator operations for each.

When to do it: For the start of the new academic year in the Fall of 2018.

Estimation of required resources: \$800,000 annually for support of university incubator and accelerator operations.

Current Status and Recommendations Moving Forward

As Figure 11 illustrates, the availability of accelerator and pre-accelerator programs has expanded significantly since the 2018 strategy. Multiple organizations, together with the research universities, are providing formal accelerator, mentorship, and business incubation programs.

This progress is now being further reinforced through the innovative Iowa G2M accelerator program. Funded through a grant from the U.S. Economic Development Administration's "Build to Scale" program, the Iowa G2M Accelerator was launched in the Fall of 2021 as a partnership between BioConnect Iowa, Iowa State University Startup Factory and VentureNet Iowa. Importantly, the Iowa G2M fills a gap as a "post-accelerator," supporting a rolling cohort for startups through provision of business resources, advanced training, and advising services. BioConnect reports to TEconomy that in the year since its launch nine startups have completed the program. Three additional startups are part of the 4th cohort, which begins in December 2022.⁵

⁵ As reported to TEconomy by BioConnect, the Dean of the ISU Ivy College of Business recently noted that: "Since completing their Iowa G2M program, one startup recently announced they've raised more than \$11 million in Series A funding, another won first place in the investor pitch category with the JPEC (John Pappajohn Entrepreneurial Center) Summer 2022 Accelerator, another won a Small Business Development Center statewide small business award, and three others have received State of Iowa Innovation funding or America's Seed Fund Small Business Innovation Research grants."

Action 2.3: Facilitate development of open-innovation clusters with large Iowa commercial R&D leaders

2018 Action Recommendations

Description: Open innovation is a rising trend for R&D in industry, most notably, but not exclusively, in the biopharmaceutical industry, where the cost of drug discovery and development in combination with the low percentage (circa 2%) of promising drug candidates that make it through trials had led innovative biopharma companies to look for new models of R&D.

Creating environments where industry, academic, and government researchers can come together, and access shared equipment and expertise is an opportunity that could well be a fit for Iowa in some of the bioscience platforms (especially in the vaccines, biobased chemicals and digital agriculture platforms).

An example that may be reviewed as a case study is the Stevenage Bioscience Catalyst (SBC), developed in England 30 miles north of London on the GSK (GlaxoSmithKline) campus. The SBC is a public/private development between GSK; the UK Department for Business, Innovation and Skills; the Wellcome Trust; the East of England Development Agency; and the Technology Strategy Board. GSK provided land, facilities, and investment totaling almost £11 million (\$14.7 million) to help build and launch the campus. GSK notes the following:

Located amid a cluster of academic centres of excellence and other pharma companies, the Stevenage Bioscience Catalyst campus is a major hub for early-stage biotechnology companies. It provides small to medium-sized biotech and life sciences companies and start-ups with access to the expertise, networks and scientific facilities traditionally associated with multinational pharmaceutical companies. A key aim of Stevenage Bioscience Catalyst is to pioneer a culture of open-innovation that will place the UK bioscience sector at the forefront of worldwide biomedical discovery and deliver cutting edge healthcare solutions.

The key is bringing researchers' ideas together with existing industry expertise to accelerate technology evaluation, market analysis, and commercialization. An environment has been created at the SBC such that academic researchers from leading UK universities, including Cambridge, are seeking to relocate to the SBC. Christine Martin, manager, drug discovery, at Cambridge Enterprise, the technology transfer company of the University of Cambridge, explains why some groups at Cambridge want to locate at the open innovation, SBC campus (which is a 30-mile drive from Cambridge University):

*"We help researchers convert their validated targets from aspirational to de-risked, investable assets. Many academics appreciate how challenging the transition from target to drug candidate can be; so what we are doing is identifying those research groups that would benefit from access to drug discovery expertise by collocation with industry at the SBC."*⁶

In the same article, Martino Picardo, the CEO of SBC, notes that:

"Several groups at the University of Cambridge want to be here, as their scientists need access to GSK's drug discovery expertise, as well as that of Scinovo, the organization within GSK that provides consultancy in that area. Our open ecosystem here also provides state-of-the-art facilities and equipment that academics and small companies would not otherwise be able to access."

6 Sue Pearson, Ph.D. "Open Innovation in the Pharma Industry: Is it Being Fully Embraced Yet?" Genetic Engineering and Biotechnology News. December 5, 2012. See <http://www.genengnews.com/gen-exclusives/open-innovation-in-the-pharma-industry/77899732>.

Several aspects of the open innovation model may make it suitable for deployment in Iowa:

- It is likely to be particularly well suited to Iowa platforms where there are well established business leaders present in Iowa:
 - Precision and Digital Agriculture: Deere, Vermeer, DuPont Pioneer, AgLeader, etc.
 - Vaccines and Immunotherapeutics: Boehringer Ingelheim Vetmedica (at ISU Research Park), Merck Animal Health, Zoetis, and Elanco.
 - Biobased Chemicals: existing biofuels companies plus Cargill, GPC, ADM, Bunge, Ag Processing, DuPont Pioneer, Monsanto, Syngenta, etc.
- It would build on existing investment in R&D infrastructure and instrumentation.
- May be attractive to companies both within and external to Iowa.

Responsible parties or entities: IEDA, ISU, UI and the IBDC working in concert with the largest Iowa companies in each of the bioscience development platforms.

What to do: Open discussions with senior research leadership at major Iowa R&D operations of large companies.

When to do it: Upon formation of the IBDC.

Estimation of required resources: Staffing and organizational only.

Current Status and Recommendations Moving Forward

Although a formal CalCharge-type model as outlined in the 2018 strategy has not been developed, substantial progress has been made in formalizing BioConnect and research university relationships. IEDA is providing financial support to ISU and UI for bioscience platform development at a targeted level of \$1 million per year per platform (as of the most recent legislative session).

It is clear that both ISU and UI have made a concerted effort to enhance their environment for commercial innovation and industry-university research relationships. The funded CTO positions have proven to be very effective in bringing highly experienced talent to the universities to advance the platforms.

The stated 2018 action recommendation of “structuring a pre-negotiated master agreement between the Iowa Bioscience Development Center and the universities that allows consortia (platform) members to readily access university facilities and expertise to advanced related R&D and have favorable terms for access to resulting technologies and innovations” has not been formally put in place. However, the CTOs are an effective single point of contact that can help industry and entrepreneurs access relevant platform resources and expertise.

TABLE 7. STRATEGY THREE AND ASSOCIATED RECOMMENDED ACTIONS.

Strategy Three: Talent Development, Attraction and Retention
<p>Iowa must increase the availability and retention of the skilled human capital required for an innovative bioscience economy</p>
<p>2018 Action Recommendations</p>
<p>Innovation and commercialization are inherently driven by human capital, aka “talent.” Iowa’s universities, which have identified core competencies in the platforms, are producing graduate talent with skills directly, or potentially, connected to platform needs and opportunities. The reality is that currently, much of this graduating talent leaves the state to pursue employment opportunities. Programs need to be structured to create early (pre-graduation) attachment of talented students to relevant Iowa employers in the platforms. Internships, sandwich courses, education expense support, job fairs, etc. all present potential paths to retaining talent. Incentives may also be developed (such as loan forgiveness, subsidized education in strategic disciplines, and state tax incentives) to encourage more students to pursue education programs relevant to platforms and to assure they first seek jobs within Iowa. There are also some evident gaps in the volume of graduates available for Iowa employers in key high-demand areas, especially relating to data sciences, computing, and data analytics skills. IBDC will need to work with key stakeholders to develop programs that will enhance the output of Iowa higher education institutions in designated strategic disciplines.</p>
<p>Current Status and Recommendations Moving Forward</p>
<p><i>It is evident that workforce development and talent attraction has not been formally pursued as an element of BioConnect. Certainly, the CTOs at the universities are paying attention to the talent equation, but it is primarily in terms of identifying talent for early-stage venture management and growth positions, rather than a broader approach to workforce development across the respective platform business sectors.</i></p> <p><i>The recent TEconomy/BIO report shows Iowa ranked last among surrounding states in terms of biosciences employment growth in the 2018-2021 timespan, with a growth of just 2.2%. As such, broad development of workforce has perhaps not been a high priority. Into the future, more attention will need to be paid to the workforce skills and availability issue, because if new and existing ventures are to grow in competitive biosciences spaces, they are going to need access to skilled personnel (and with Iowa’s currently low unemployment levels, there is not a deep existing pool of available talent to draw from).</i></p> <p><i>There is a pending NSF EPSCoR Track-1 proposal led by ISU, focused on biomanufacturing (involving Biobased Products and Vaccines and Immunotherapeutics). This proposal, if funded for \$20 million, will bring together higher education institutions, private colleges, community colleges and K-12 in the state to address workforce development related to biomanufacturing.</i></p>

Action 3.1: Increase pre-graduation connectivity with targeted platform industries

2018 Action Recommendations

Description: Retaining skilled Iowa graduates is a more likely prospect if college students engage with companies during their studies and prior to graduation. In Europe, a “sandwich course” model is relatively common in engineering and associated technical and professional disciplines, and consists of a student taking a full or half-year sabbatical from their university courses to work in an industry setting related to their academic field. The term “sandwich” comes from the industry experience being sandwiched between years spent on campus. Similar to internships undertaken in the summer or during the school year, such engagement between companies and students increases the student’s appreciation of and understanding for the relevance of their program of study and serves to create binding connections between sponsoring companies and talented students who may be attracted to become employees after their graduation. In some cases, the connection formed between student and company may be such that a company may choose to sponsor ongoing studies of the student in return for an agreed post-graduation employment term of service at the company.

It should be noted that such sandwich and/or internship opportunities have additional value for low-income students through providing income to support their education. They also serve to build important professional social networks for students within the state, again providing an enhanced likelihood of the student seeking to find employment in Iowa after graduation.

Responsible parties or entities: IBDC should support the universities by having a full-time staff person dedicated to building university-industry relationships.

What to do: Build upon existing programs in industry engagement and internships conducted by the universities and work in consultation with industry to develop enhanced programs, up to and including the development of sandwich courses.

When to do it: Begin process of engaging companies in the design of programs jointly with the universities once the IBDC is formed and a talent manager position filled at the IBDC.

Estimation of required resources: \$50,000 to \$100,000 for talent manager position at IBDC.

Current Status and Recommendations Moving Forward

This action has not been specifically implemented. The original recommended action stands, which is to build upon existing programs in industry engagement and internships conducted by the universities and work in consultation with industry to develop enhanced programs, up to and including the development of sandwich courses. BioConnect should support the universities by receiving state funding to support an additional full-time staff person dedicated to building university-industry talent relationships. Once a talent manager position is filled at BioConnect, the organization should begin the process of engaging companies in the design of programs jointly with the universities.

The universities are active in working to build student-industry connectivity. ISU, for example, has established mentorship programs with two major industry partners for student engagement. There are successful existing internship and co-op experience for engineering students through the engineering career services programs that attracts three to four hundred companies to campus for hiring interns, co-ops and full-time engineers.

Action 3.2: Incentivize development and retention of talent in strategic disciplines relevant to platforms

2018 Action Recommendations

Description: While the pursuit of higher education is important in general and across all disciplines, there are certain disciplines that may be considered to be of special strategic importance to the ongoing development of the Iowa bioscience economy. Skills not only in bioscience disciplines, but in themselves, but also in engineering, computing and data sciences, business management, regulatory affairs, logistics, etc. can be crucial to meeting the recruitment needs of bioscience and related companies in Iowa.

An example of a state-level program designed to accomplish enhanced post-graduation student retention is the Rhode Island Commerce Corporation's Wavemaker Fellowship. The Wavemaker program is intended to attract and retain STEM and design workers by defraying the cost of student loan payments for graduates who have incurred student loan debt while completing an associate, bachelor's, or master's degree. Fellows are selected through a competitive, merit-based application process and receive an annual tax credit that may be awarded for up to four years. In addition to a financial benefit, the initiative includes an engagement element that is designed to add a "stickiness" factor intended to deepen the fellows' connection and investment in the state. Although still in its early stages, the program has already heard from participants and their employers that the Fellowship award was part of their decision to turn down a job out of state and instead pursue a career in Rhode Island. In its inaugural year, Fellows represented 110 companies in the targeted advanced industries across Rhode Island.

Responsible parties or entities: IBDC, IEDA, Board of Regents, and the Regents Universities in consultation with platform industry advisory groups.

What to do: IBDC and university representatives should work with an advisory board comprising Iowa bioscience industry human resource professionals to develop profiles of current and future workforce education/skill requirement and projections of relevant output of graduates. For those graduate categories projected to be in high demand, and of strategic importance to bioscience platform growth and advancement, incentive programs should be developed to help encourage the retention of students in Iowa. Loan forgiveness, subsidized education support, and other incentives only for degrees designated as "bioscience strategic" may be pursued to encourage more students to pursue education programs relevant to platforms and to assure they first seek jobs within Iowa.

When to do it: Creating talent pipelines takes time, because they need to be organized prior to students achieving their higher education, or at least mid-way through it. As such, this action should be a high priority for the IBDC once the organization is formed.

Estimation of required resources: Staff resource of \$50,000 to \$100,000 for talent manager position at IBDC. Plus, administrative support for arranging meetings of advisory boards, etc. Actions 3.1 and 3.2 combined likely require a budget of circa \$200,000 annually to operate, not including the cost of financial incentives developed to encourage student participation and retention. The latter should be developed using a combination of state funding and industry and philanthropic support.

Current Status and Recommendations Moving Forward

This action has not been implemented. The original recommended action is still relevant and should be pursued. Namely that:

BioConnect and university representatives should work with an advisory board comprising Iowa bioscience industry human resource professionals to develop profiles of current and future workforce education/skill requirement and projections of relevant output of graduates. For those graduate categories projected to be in high demand, and of strategic importance to bioscience platform growth and advancement, incentive programs should be developed to help encourage the retention of students in Iowa. Loan forgiveness, subsidized education support, and other incentives only for degrees designated as “bioscience strategic” may be pursued to encourage more students to pursue education programs relevant to platforms and to assure they first seek jobs within Iowa.

Action 3.3: Significantly increase enrollment in data analytics-related programs

2018 Action Recommendations

Description: Technology sectors, including those in biosciences, are increasingly driven by the intersection between physical and biological science and data analytics. The future for platforms such as “precision and digital agriculture,” “vaccines and immunotherapeutics,” “medical devices,” and “biobased chemicals” will be increasingly driven by the intersection between biology, engineering, computer science and associated modeling, simulation, and data analytics (informatics). Companies interviewed during the TEconomy Phase I and II work have expressed particular concern regarding the availability of talent in the data analytics space, especially in terms of the ability to attract and retain talent in IT, software engineering, programming, and data analytics. Increasing enrollment of qualified students in relevant IT/data analytics disciplines is of significant strategic importance to Iowa in general and specifically across its bioscience platforms.

Responsible parties or entities: Board of Regents and the individual Iowa research universities.

What to do: The individual universities know best what will be required to increase enrollments, not least of which will be a need to increase the numbers of faculty to support increased enrollment.

An interesting model to look to in terms of attracting high quality students to computer sciences and associated disciplines is the Jeffrey S. Raikes School of Computer Science and Management (Raikes School) located at the University of Nebraska–Lincoln. Supported in part by the philanthropic gift of Jeffrey Raikes (past CEO of the Bill and Melinda Gates Foundation and President of the Microsoft Business Division). Students accepted into the Raikes School typically receive a scholarship that covers meals and housing in the Kauffman Residential Center at UNL (which houses the School and its classes) and students are also part of the University Honors Program. Because of its unique program characteristics and its financial support, Raikes is able to select students from the nation's top high school graduates. The average ACT score for a student at the Raikes School is 33.5 (SAT a 1480 for combined two tests of Critical Reading and Math).

When to do it: Creating talent pipelines takes time, because they need to be organized prior to students achieving their higher education, or at least mid-way through it. The Board of Regents should be looking into options to increase strategic graduate output in data analytics as soon as possible.

Estimation of required resources: Initial state investment may be required to help universities defray the cost of new faculty start-up packages, salaries and fringe as the universities seek to scale up their education programs in strategic data analytics disciplines. Duplicating something successful along the lines of the Raikes School would require securing a major philanthropic gift.

Current Status and Recommendations Moving Forward

The prediction that life sciences and data sciences were on a significant convergence path has proven to be true since the 2018 report was published. Students with data science/analytcs skills are in extremely high demand by employers across most commercial sectors in the United States, including in biosciences. Advanced analytics, up to and including AI, are proving to be a powerful tool to advance scientific discovery and commercial insights and are leading to significant opportunities to advance relevant innovations in Iowa's biosciences platforms—in digital agriculture, in biopharmaceuticals development, in computational chemistry, intelligent medical devices, and digital supply chain development across sectors.

States that struggle to meet demand for advanced analytics occupations will see their growth curtailed. Unfortunately, TEconomy analysis shows that degrees awarded in data science and related fields have decreased in Iowa by 7% since 2015, whereas the nation overall saw significant 18% growth over the same period. A gap is evident in Iowa's bachelor's and higher degree growth versus the nation's in key disciplines including business and financial analytics (Iowa -30.7% vs. U.S. +5.4%), computer and information sciences (Iowa +43.7% vs. U.S. +61.4%), engineering with a data science focus (Iowa +7.7% vs. U.S. +13.3%), and mathematics and statistics (Iowa +7.4% vs. U.S. +23%).

The challenge is likely to be broadly felt for Iowa, and certainly not limited to just the biosciences sector. As such, TEconomy recommends that IEDA and Iowa Workforce Development collaborate to develop a strategic plan for enhancing the data analytics workforce for the state through degree expansions, higher retention of degree graduates, retraining/upskilling programs, and assistance for employers in attracting key personnel from out-of-state. It will also be important to ensure that Iowa does not have impediments in its tax or other regulatory framework that may impede access to remote workers (who may serve to fill some of the void).

Helping the situation is the fact that ISU has new data science related programs that have come online in the past three years, as well I as a new NSF-NRT graduate training program in dependable data-drive discovery.

TABLE 8. STRATEGY FOUR AND ASSOCIATED RECOMMENDED ACTIONS

Strategy Four: Enhance Early-Stage Capital Availability

Iowa must increase the availability of early-stage pre-seed and seed capital to increase the number and quality of companies moving to later funding rounds

2018 Action Recommendations

Iowa is quite competitive in terms of the performance of academic bioscience R&D and in terms of innovation (as measured using patents as proxies). Where it is far less than competitive is in venture capital to finance the growth of companies based on Iowa innovations. Increasing Iowa's bioscience employment, especially in high-paying technology ventures, is hampered by a comparative lack of risk capital investment—particularly investment required to scale an enterprise post proof-of-concept. Iowa's performance in attracting venture capital places it at the bottom of performance among surrounding Midwestern states, and in the fourth quintile overall among all U.S. states (see separate VC Status Report by TEconomy for IEDA and IIC).

Solving the VC access challenge for Iowa is no easy task. The state's prior experience with an unsuccessful Fund of Funds program (which closed under threat of default in 2012) justifiably makes the administration and legislature gun-shy about revisiting such an approach. Yet, fund-of-funds models are working in other states.

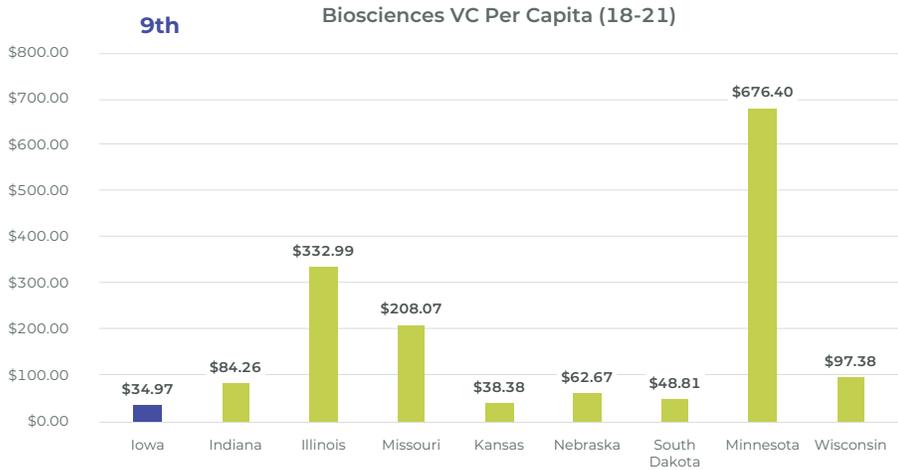
It should be noted that in performing the VC Status Report (see separate document) TEconomy interviewed multiple VC firms investing in, or familiar with, Iowa ventures. The overall conclusion reached was that Iowa is not lacking in available "A Round" capital for promising qualified ventures; rather, the issue is with earlier-stage seed funding supporting a steady flow of high-quality new ventures that can later scale to seek venture capital. Evidently, there is an expanding base of VC firms willing and able to focus on Midwest business ventures, including in biosciences. The gap is in pre-seed and seed capital required to accelerate the formation and growth of entrepreneurial technology companies in the early stages of their life cycle—prior to them achieving revenue. This is not a challenge unique to Iowa, but the fact that Iowa ranks last among its adjacent states in VC funding suggests that there is a definite problem in Iowa in getting companies to scale to the VC application stage.

Current Status and Recommendations Moving Forward

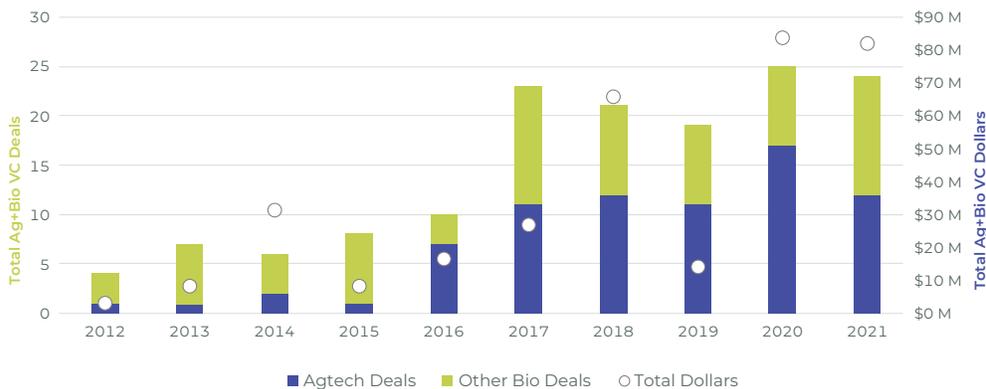
Key stakeholders in the innovation ecosystem in Iowa have clearly been working to improve the early-stage and VC capital access issues for bioscience companies (and technology companies) across the state.

A key new program is the InnoVenture Iowa fund—a \$30 million co-investment fund targeting early-stage companies that have a term sheet from a lead VC investor. Providing between \$250,000 and \$2 million per investment, the fund seeks to represent up to 25% of a funding round. Bioscience companies are a specific target of the fund (together with companies in advanced manufacturing and IT).

The InnoVenture Iowa fund is too new to have been a factor in Iowa's VC performance since 2018. It is an important fund, given that Iowa's overall bioscience VC performance has been very much constrained, as evidenced in the 2022 TEconomy/BIO report which shows Iowa ranked last among its neighboring states in bioscience VC funding per capita. As the figure below shows, Iowa's performance is strongly eclipsed by the funding raised in Minnesota, Illinois, and Missouri.



The TEconomy/BIO study does not include the AgTech sector, and the situational assessment for VC in Iowa improves somewhat when AgTech deals are included. The figure below shows that AgTech has been responsible for approximately half, or more, of the bioscience-related VC capital deals in the state consistently since emerging strongly in 2016. Also evident on the figure is that the total dollar volume of VC funding raised has been generally trending upwards, except for the significant dip in 2019. Analysis also shows that the growth in Iowa VC funding deals now exceeds the national VC deal growth rate. Between 2015 and 2021, Iowa saw its VC deals increase by 200%, versus the national growth rate of 50.5%.



Action 4.1: Focus on enhancing early-stage seed capital availability

2018 Action Recommendations

Description: After interviewing venture capital and early-stage capital firms in Iowa and outside the State, the general diagnosis is that the comparatively poor performance of Iowa in securing venture capital investments stems from a lack of deal flow; that is, viable companies moving through seed stages of funding to a point of successful business development that appeals to venture capital. It seems that a lack of adequate seed capital is preventing the maturation of a cadre of fast-growing technology companies (and it is a special challenge for bioscience business start-ups that need “patient” seed capital given the comparatively long-timeline from conceptualization to market).

The State of Iowa does operate several seed funding programs with management provided by VentureNet and the Iowa Innovation Corporation. The key programs are:

- Proof of Commercial Relevance (POCR) program which provides low interest loans of up to \$25,000 (requiring a 1:2 private:public match.)
- Demonstration Fund which provides up to \$100,000 primarily via loans or royalty arrangements with a 1:2 private:public match.
- The Iowa Innovation Acceleration Fund, comprising the PROPEL program offering up to \$300,000 in funding with a 1:1 match, and the Innovation Expansion program, providing up to \$500,000.

Although it is positive that Iowa has the above State programs, some aspects of them create challenges for a bioscience-based commercialization model. The larger funds, for example, under the Iowa Innovation Acceleration Fund, require companies to have significant customer revenue, and in the case of the Innovation Expansion program, to be profitable. These requirements tend to exclude life sciences companies that typically need this level of funding at a developmental stage prior to releasing commercial products.

Capital experts interviewed pointed out a need for a significant State fund able to make seed investments in the \$250,000 to \$1 million range in companies that may well be pre-revenue. This level of investment is likely to be required before companies emanating from the bioscience platforms reach a level of commercial development where they can successfully pitch for A Round venture capital. It was noted that there are already sufficient VC funds formed in Iowa (together with funds external to Iowa that are investing across the Midwest) to carry forward a good flow of projects, but this capital needs to be presented with a robust quality deal flow coming out of a well-funded seed stage of business development.

There are some additional small seed funds and Angel funds operating in Iowa. For example, the Ag Startup Engine is a \$1.5 million fund that invests in \$40,000 tranches. The issue is that these funds are typically relatively small and unable to bridge the bioscience need for significant seed round investment prior to venture capital attraction.

Responsible parties or entities: IEDA in collaboration with the Iowa Innovation Corporation and VentureNet for developing parameters and structures of a new seed fund. State of Iowa for investment in a new seed fund.

What to do: Iowa has invested in funding programs already. Similar processes to those used successfully before to secure legislative support should be pursued. The created fund must be required to invest in Iowa enterprises.

When to do it: Discussions pertaining to forming a large seed fund should begin immediately (1st quarter of 2018).

Estimation of required resources: To be optimally effective, a fund of \$25 million should be sought. This level of capitalization would not need to occur immediately, since it will take time to build up a qualified flow of seed round bioscience deals.

Current Status and Recommendations Moving Forward

The 2018 strategy's conclusion still holds true that the "comparatively poor performance of Iowa in securing venture capital investments stems from a lack of deal flow—that is, viable companies moving through seed stages of funding to a point of successful business development that appeals to venture capital."

For the most part, the important seed funding programs supported by the State of Iowa are still in place and available to qualifying new ventures. These funds continue to be managed through VentureNet and include:

- *Proof of Commercial Relevance (POCR) program which provides low interest loans of up to \$50,000 requiring a 1:2 private:public match. This represents a 2x increase in maximum loan size over previous funding levels.*
- *Demonstration Fund which now provides up to \$175,000 primarily via loans or royalty arrangements with a 1:1 private:public match.*
- *The Iowa Innovation Acceleration Fund, comprising:*
- *"LAUNCH awards up to \$250,000 to help revenue generating companies overcome the principal challenges of scaling and move from a commercially viable product to an established customer base.*
- *PROPEL awards up to \$500,000 to accelerate market development for companies that have critical management in place, have a validated business model and an established customer base that's generating substantive revenue.*
- *INNOVATION EXPANSION awards up to \$1,000,000 to encourage expansion of product lines in companies that have a complete management infrastructure, a demonstrated historical profitability and an established customer base; funding provides assistance for product refinement and market expansion activities for unique, innovative and competitive products.⁷"*
- *SBIR/STTR matching program that can provide up to \$50,000 in matching funds on Phase I awards.*

Other sources of early-stage funding are available through additional ecosystem providers, including ISU and UI, AgStartUp Engine, VentureNet Iowa, and angel investors. In addition, several pitch competitions are operated in Iowa and open to bioscience ventures. In talking with companies and risk-capital providers, the concern now is less about capital availability and more about a limited flow of quality business concepts seeking capital. There is a need to encourage more entrepreneurship among those engaged in Iowa R&D and innovation, and to help interested parties (who will often have limited to no experience in building and operating a start-up business) successfully navigate the complex process of developing a successful venture.

Boosting Deal Flow: *Iowa needs to bring forward a more significant deal flow in terms of innovative new ideas moving from a concept into formation of a company advancing a new product or service. Data herein show that Iowa performs comparatively well in terms of bioscience R&D per capita and in bioscience intellectual property generation (as measured by patents), yet the volume of fundable deals flowing out of this R&D and innovation enterprise is apparently constrained. This is an issue that has*

7 <https://www.iowaeda.com/innovate/innovation-acceleration-fund/>

been recognized by BioConnect, universities, and other key stakeholders in the bioscience ecosystem, and it is clear that significant steps are being taken to improve the situation, and new initiatives are being considered. Among these is the new Venture Studio concept proposed by BioConnect and InnoVenture. The proposed program is intended to fill a need for a hands-on support program that will shepherd innovations from their first evaluation for commercial potential onwards through the process of early-stage company formation, capitalization, technical and managerial team building, business development, and growth. Ventures going through a venture studio model have access to skilled venture managers, professional advisors, and business building resources throughout their journey from ideation to fully operational business. Looking to learn from existing models, such as BIOSTL's Biogenerator and Indiana's High Alpha Innovation, and the Minneapolis Great North Venture Studio, the BioConnect concept for a Venture Studio is detailed further in a series of slides provided in Appendix C.

Another important development is the administration and delivery of the SBIR/STTR (America's Seed Fund) Outreach Program by BioConnect Iowa on behalf of the IEDA. This is an effective program working to help companies apply for America's Seed Fund grants, which represent an important early source of non-dilutive funds. The program is proactive in providing professional assistance to companies applying to the federal program and administering the state matching funds for awarded companies. Each year America's Seed Fund awards over \$200 million in funding across 400+ ventures. Working to maximize Iowa's potential success in winning these awards is important, and BioConnect's work in this regard is a shrewd investment. IEDA provides important support for SBIR/STTR funding through matching awards of \$25,000 for Phase I award and \$25,000 for submission of Phase II proposal. Iowa has demonstrated a robust upward trend in success rate of applications, total number of awards, and total dollars awarded (Appendix B). From FY2015 through FY2022, 98 SBIR/STTR awards were made totaling \$41 million.

Action 4.2: Engage Iowa VC and Angel groups on IBDC board or advisory panel

2018 Action Recommendations

Description: Capital is so crucial to bioscience ventures that expertise of angel and venture capital executives should be sought for participation on the IBDC board. This may be taken further to establish a specific capital advisory panel that can serve IBDC in assuring Iowa has appropriate availability of capital across the investment timing spectrum and structured in a manner suited to the long-term development horizon of bioscience companies.

There is also a need for the IBDC to have access to experts able to provide due diligence assistance to angel investors.

Responsible parties or entities: IBDC with IIC and VentureNet, in collaboration with regional VC and seed round investors.

What to do: Initially form an advisory board with 8-10 members with an initial task of defining recommended parameters for a significant seed fund to fill the observed gap in major seed funding availability for bioscience firms.

When to do it: First quarter of 2018.

Estimation of required resources: Administrative support and meeting space provided through IBDC when formed, and via IEDA in the interim.

Current Status and Recommendations Moving Forward

This recommended action was attempted by BioConnect, who approached VC's active in Iowa with the concept. BioConnect reports that there was evident resistance from the VC community to provide direct advisory services on a board, with the individual funds preferring to sustain independence and concentrate on their individual investing portfolios.

*The development of the InnoVenture Iowa fund as a substantial \$30 million fund able to make significant investments as a co-investor alongside an external lead funder, has, however, helped to bring BioConnect "inside" the VC community, with an effective seat at the table and membership in the Iowa Venture Capital Association (IVCA) effective in 2022. **As a significant co-investor and member of the IVCA, BioConnect will be more readily able to draw upon the expertise maintained within the VC community.***

Action 4.3: Staff a position to build and maintain relationships with risk capital firms in and external to Iowa

2018 Action Recommendations

Description: A recommendation from the Iowa Innovation Council bioscience advisory committee is for the IBDC to staff a full-time position dedicated to building and maintaining relationships with major risk capital funders providing seed and venture funding. TEconomy's Iowa venture capital status report has examined both the Thompson and Pitchbook datasets to identify companies that are sources of such capital that:

- Have already invested in Iowa-based ventures.
- Invested in surrounding states in companies operating in sectors in, or directly related to, the four Iowa bioscience platforms.

These risk capital providers should form the initial targets for IBDC building robust relationships with companies favorably disposed to review Iowa bioscience deal flow.

Responsible parties or entities: IBDC.

What to do: Establish initial contact and build relationships with leadership in relevant risk capital companies.

When to do it: Upon formation of IBDC.

Estimation of required resources: Staff resource of \$50,000 to \$100,000 for capital access manager position at IBDC. Plus, administrative support for arranging meetings of capital advisory boards and other related tasks.

Current Status and Recommendations Moving Forward

This action is being fulfilled by the InnoVenture Iowa Fund Investment Director, Kaylee Williams. Part of Ms. Williams's remit is to specifically build and maintain relationships with VC and other risk capital firms, both within and external to Iowa.

In Summary

The formation of BioConnect Iowa, in combination with state support for progressing the four bioscience platforms, has advanced implementation activity across the strategies and specific actions laid out in the 2018 strategic plan. Two of the four strategies have advanced considerably, with Strategy Four (Enhance Early-Stage Capital Availability) and Strategy One (Organization and Connectivity) seeing progress on most of the recommended actions. That said, two strategies have received only moderate implementation activity: Strategy Two, which comprised three recommended actions to enhance innovation and commercialization, has not advanced as recommended; however, the recommended actions are still relevant and could be addressed moving forward. Similarly, Strategy Three (Talent Development, Attraction, and Retention) has not been a significant focus of attention.

The only partial implementation of the 2018 strategy is understandable, considering two principal factors:

- The level of funding recommended for BioConnect Iowa, as the principal entity tasked with coordinating strategy implementation, at circa \$1 million a year, has only been circa 20% of the level of funding originally recommended as rightsized to Iowa's needs. Given the constraints of its funding, BioConnect and engaged stakeholders across the ecosystem have done an admirable job—but there is no escaping the fact that Iowa's bioscience sector has not grown at the rate of surrounding states, and TEconomy's diagnosis is that this is, in part, associated with strategic efforts being comparatively underfunded.
- The COVID-19 pandemic obviously impacted the biosciences development ecosystem, and constrained activities for a significant period of time.

It should be noted that the total commitment of state dollars to strategy implementation also includes significant investment in each platform provided directly to the universities, which for 2022 totaled approximately \$3.7 million. As such, total state funding in support of the strategy approached \$5 million for 2022. The main issue is that BioConnect needs a higher level of funding to further scale its initiatives and more fully implement the 2018 strategies and actions that remain relevant to advancing the state's bioscience economy.

REVIEW OF PLATFORMS FOR ADVANCING IOWA’S BIOSCIENCE INNOVATION ECONOMY

The overall assessment of TEconomy, and the ecosystem stakeholders interviewed across the project, is that the four platforms accurately capture the four main core-competency-based opportunities for the state in and related to bioscience. That said, learning has occurred that leads to a recommendation for moderate platform adjustments (Table 9).

TABLE 9. IOWA BIOSCIENCE PLATFORMS—SUGGESTED MODIFICATIONS.

Original Platform	Recommended Modification	Justification
Precision and Digital Agriculture	No changes needed	This platform is seeing rapid advancement on multiple fronts and is broad enough to embrace the full scope of competencies and opportunities presented.
Vaccines and Immunotherapeutics	Addition of diagnostics as a component of the platform	The vaccines core competency continues to advance innovation-based opportunities for Iowa, but effective approaches to combatting infectious diseases in both animals and humans also require diagnostics. The competencies at ISU, and within Iowa industry in the space, extend into diagnostics, and this market space is projected to see considerable growth.
Biobased Chemicals	Renaming to be “Biobased Products” as a more inclusive terminology for the full scope of opportunities	Iowa’s deep strengths in biomass processing technologies, combined with chemistry/biochemistry, materials science, and other associated disciplines, means that the term “chemicals” is too restrictive in terms of the full scope of biobased materials, functional biobased compounds, and other products that may be derived from biologically sourced materials and the use of plants as molecular manufacturing systems.
Medical Devices	Expanding and renaming to be “Medical Innovations”	The University of Iowa, where this platform is centered, is advancing a broad pipeline of biomedical technologies, particularly those involving drugs and biologics. The new Pharmacy Building and associated developments have expanded the capacity of the University to build on core competencies in multiple research and clinical specializations, and UI Pharmaceuticals continues to be a unique asset. IEDA has already provided leeway and flexibility for IU to direct platform funding to presenting opportunities, but a formal acknowledgement of a broadening of the platform will be helpful.

The combination of platform scientific directors plus CTOs in the platforms has created hubs of coordinated activity at the universities that are highly conducive to further platform advancement. Overarching support provided by BioConnect Iowa and other key stakeholders in bioscience-based economic development in the state, supported by IEDA, is generating connective tissue across the platforms and biosciences development in general. Below, an overarching summary is provided for each of the four platforms.

Platform Situational Assessment: Precision and Digital Agriculture

With half or more of the “bioscience” related venture capital investment deals in Iowa over the past five years in this platform, precision and digital agriculture has developed significant momentum in the state. The platform leverages multiple Iowa assets (a powerhouse agricultural sector, major industry presence in terms of inputs and agricultural equipment corporations, and multi-faceted academic R&D core competencies). It is also successfully spurring the development of highly innovative new business ventures with substantial commercial potential. This platform is a prime example of tech-based economic development at its best: leveraging academic and industry R&D core competencies, addressing products and services that can enhance a major Iowa sector’s economic performance (production agriculture), providing a pathway to improving the products and introducing new products for existing Iowa manufacturers, and providing a ready launch ramp for new, fast-growing entrepreneurial ventures. The presence of software and associated hardware systems in the platform also appeals to a broad venture capital sector that has long invested in IT and to the entrepreneurs and innovators from the IT sector.

TABLE 10. OVERVIEW OF QUANTITATIVE FINDINGS

Ecosystem Element	Status from Quantitative Review
Research & Development	High concentration of research in ag-related research funding, reflecting strong aligned research activity
Innovation	Highly specialized ag applications in academic research, major presence of anchoring industry innovation
Growth Capital	Major increase in deal flow in ag tech-related funding
Industry Performance	Highly specialized industry base

OPPORTUNITIES AND NEEDS

- Several competing locations in the United States and internationally are developing or planning “farms of the future” or modifying existing agricultural experiment stations at the signature land-grant universities (LGUs), which specifically target R&D, piloting, and demonstration of digital agriculture solutions. Purdue University, the University of Minnesota, Texas A&M, and UC Davis are examples of major LGUs engaged in this research. Conflicting input was provided over the course of the project regarding whether this is needed at ISU. Several university and external stakeholders considered developing a “farm of the future” to be important, especially if it could be adjacent to the ISU Research Park and also integrate with the assets of the existing BioCentury Research Farm. There is concern that not having such a designated site might place ISU at a competitive market disadvantage. An alternative view is that a single site is not required and that current assets, combined with collaborations with production agriculture sites, can fulfill foreseeable needs. TEConomy recommends that a feasibility study be conducted for a major Farm of the Future project at ISU that can be used for multiple purposes:
 - Serve as a key R&D, piloting, and demonstration site for the University, existing companies, and new business ventures.
 - Serve as an education site for undergraduate and graduate students, and for continuing outreach and producer education provided by ISU Extension.
 - Integrate with a potential fifth platform, as a site also working on Sustainable and Resilient Agriculture (Regenerative Tech).
 - Form the center of a hub-and-spoke model, integrating smart agriculture development at ISU Experiment Stations and participating private-sector production agriculture sites and industry test locations.
- The University of Nebraska has long operated its Tractor Test Lab, which provides important testing and validation services for power and propulsion systems in major agricultural equipment. There is an opportunity to develop something similar at ISU focused on testing and validating precision and digital agriculture technologies and systems. Producers are facing a very real challenge in terms of cutting through the noise of constant product and service launches to determine which technologies and solutions may positively impact their bottom line and provide a robust return on investment. ISU could operate such an initiative and would likely receive the support of major commodity groups both in and out of state in developing this as a service sphere.
- Small and midsize companies and innovators seeking to test and validate their in-development products cannot easily access field trials. Although these smaller companies need to obtain independent test results from an LGU, there is a distinct shortage of university faculty able to participate in leading this type of research. Iowa may benefit, not only in terms of its own innovations but also in attracting innovators to collaborate from outside of the state, if the state were to fund some dedicated PhD-level scientist positions at ISU to provide this service.

- Precision and digital agriculture technological and data processing advancements are paving the way for longer-term development and adoption of autonomous robotic agriculture solutions. Given the large-scale labor shortage and wage cost inflation experienced in agriculture (and agricultural processing), robotics is a technology with a particular appeal. Rapid advancements in AI systems, machine vision systems, integrated sensor technology, and high-resolution guidance systems are converging to enable advancement in the sector. Interviews at ISU noted “robotics and autonomy” as areas that are not current strengths for the institution, and there is a need to build capabilities in this space. A potential alternative is to forge a partnership with a robotics and autonomy leader, like Carnegie Mellon University⁸, which is in an urban setting (Pittsburgh, PA) and lacks ready access to agricultural expertise and testing facilities. ISU would bring the agricultural know-how and knowledge regarding industry needs where robotics may have a robust ROI justification, and a partnering robotics-focused institution would bring domain expertise.
- The Cultivo Academy, operated by America’s Cultivation Corridor, is a novel and innovative program working to bring externally derived ideas and opportunities in agricultural-associated ventures to Iowa for further development. The program started in 2021, and to date 13 entrepreneurs have participated.

GLOBAL MARKET

Advancing precision and digital agriculture as a core R&D competency in Iowa and a platform for advanced industry development will provide the state with a position in a fast moving, high growth global growth marketspace. As Table 11 illustrates, the precision agriculture sector is still in its early stages and is characterized by rapid growth projections in the near term. BCC Research places the sector’s projected growth globally at a CAGR of 12.6% for 2019-2024.

TABLE 11. PRECISION AGRICULTURE GLOBAL MARKET PROJECTIONS⁹

2019 Market Size	2024 Projected Market Size	CAGR 2019-2024
\$5.2 billion	\$9.4 billion	12.6%

8 Carnegie Mellon is one of seven universities engaged in an NSF and USDA-NIFA funded major initiative that is led by ISU, the AI Institute for Regenerative Agriculture. AIIRA operates with a vision to “transform agriculture by creating a new AI-driven framework for modeling plants at various agronomically relevant scales...by introducing AI-driven digital twins that fuse diverse data with siloed domain knowledge.” <https://aiira.iastate.edu/research/vision/>

9 Source: BCC Research. Global Markets for Precision Farming. Report Number FOD087A. December 2019.

Platform Situational Assessment: Biobased Products (Previously “Biobased Chemicals”)

Renewed national attention to the critical importance of alternative energy and materials sources (versus fossil-fuel-derived resources), sustainable and carbon-neutral economic development, and to the strategic advantages of domestic resource utilization contribute to the momentum for further biobased platform growth. It is a space that Iowa already excels in via its robust biorefinery base and key university R&D assets and expertise. It is also vital to Iowa economically because, as noted by commodity groups, it is highly influential to farming economics—providing a means to find and innovate new value-added uses for major crops (rather than just focusing on yield increases which may have relatively nominal returns given supply/demand price relationships). With Iowa not being a significant producer of fossil-based resources and fuels, a focus on building the bioeconomy does not generate negative externalities in terms of impacts on existing industries; instead, this sector builds on Iowa’s powerhouse leadership position in the production of renewable energy (in terms of both wind-generated electricity and ethanol liquid fuels).

TABLE 12. OVERVIEW OF QUANTITATIVE FINDINGS

Ecosystem Element	Status from Quantitative Review
Research & Development	High concentration of research in ag-related research funding, and well-aligned industry base and research activity.
Innovation	High volumes of biochemistry-related research, and evidence of multidisciplinary applications in industry innovation.
Growth Capital	Relatively low VC activity in key verticals.
Industry Performance	Highly specialized industry base as measured by location quotient.

OPPORTUNITIES AND NEEDS

- This is an essential sector for Iowa, addressing large-scale and expanding global markets (see below) and providing the additional benefit of leveraging in-state agricultural production to generate value-added products.
- The global community has achieved consensus on the imperative to find sustainable solutions to energy and materials production, and consumer demands for accountability are driving corporate actions to achieve sustainability goals. On the national stage, the current federal administration has committed considerable resources to pursue sustainable development goals from both policy and government funding perspectives.

- Iowa's high-productivity cropland is particularly well-suited to efficient production of leading row crops that feed into industrial-scale refinery operations.
- ISU's competencies in bioprocessing and biorefining, in combination with world-class capabilities in plant transformation and the engineering of plants as "factories" for specific chemical compounds, place the state at the nexus of scientific advancement in the space. Supported by investments such as the BioCentury Research Farm and the Plant Sciences Institute, ISU has built capabilities that span the continuum from fundamental basic science inquiries to highly applied piloting, scale-up, and demonstration work. Additional asset enhancement, such as expanding fermentation to a 5,000-liter scale, will help to further cement ISU's academic leadership position (assuming the University receives support from the state, private industry, and federal sources to help realize its ambitions).
- Innovative companies, such as Power Pollen and Pivot Bio, together with existing companies such as Kemin, are finding Iowa conducive to their R&D and innovation activities focused on transforming plant production to express valuable chemicals and finding alternative biotech-based pathways to stimulate crop growth. Whether converting existing commodity crops or developing modified and novel crops, Iowa is on the leading edge of bioeconomy development.

Iowa State University Platform Advancement Through Commercial Relationships

ISU's leadership in advancing commercialization and joint R&D with industry is evident across multiple significant developments:

- ADM and ISU are collaborating to develop polymers and specialty chemical products, such as adhesives, using corn feedstocks
- Siegwirk's R&D center collaboration with ISU to create UV-blocking coatings
- Kent Corporation-ISU collaboration on production of value-added microbial antifreeze proteins from a low-value corn wet milling co-product
- Cargill, Kemin, and Puretein Agri are collaborating with ISU on microbial technology for high-value fermentation products such as nutraceuticals
- SoyLei Technologies, LLC, was founded in 2020 to help commercialize soybean-based asphalt modifier technology developed at ISU
- Sumatra Biorenewables, LLC was formed to commercialize novel nylon polymers derived from cornstarch.

Source: Iowa State University. 2020 Bioscience-based Initiatives Progress Report

In terms of disruptive technology, Iowa needs to pay attention to the potential impact of the electrification of transportation as a competitor to liquid fuels (ethanol). Iowa is well-positioned to be a supplier of renewable electricity via wind power to support electric vehicle charging¹⁰, but the ongoing

¹⁰ Iowa may have an additional significant opportunity for economic development in hydrogen production. Hydrogen holds promise as a key component of a future sustainable energy system. Iowa's robust position in electricity from renewable wind resources may position the state to potentially produce hydrogen from water via electrolysis (a process that is much more environmentally friendly than the current steam-reforming process using natural gas feedstocks). In an electrolysis process, hydrogen is produced using an electric current to split water into hydrogen and oxygen. If the process electricity is produced by renewable sources, such as solar or wind, the resulting hydrogen will be considered renewable as well, and has numerous emissions benefits. Affordable hydrogen would see significant market opportunities because it has multiple characteristics in its favor as a renewable fuel. It may be used directly as a fuel for use in appropriately designed internal combustion engines or may be used in fuel cells to generate electricity; hydrogen has the advantage of not generating direct combustion-related particulates in an internal combustion engine nor releasing greenhouse gases; and, hydrogen can be deployed for refueling as a high-pressure gas using infrastructure similar to that currently deployed at petroleum/diesel gas stations, allowing rapid refueling using familiar, widely distributed outlets with moderate infrastructural changes.

growth of electric passenger and fleet vehicles will cut into demand for liquid fuels (including ethanol). A technological opportunity to pivot to ethanol's use as a fuel for use in modified diesel engines (a technology being advanced by Clear Flame Engine Technologies) holds promise for sustaining and expanding the use of ethanol because diesel combustion engines are better suited (versus electric power) to the high-load propulsion characteristics of over-the-road trucks, construction vehicles, marine engines, and other mobile systems. Chevron's \$3.15 billion acquisition of Renewable Energy Group in Ames further anchors Iowa's position in sustainable biodiesel. Given the integrated nature of crop production and ethanol refining as an Iowa industry, finding new and expanding uses of ethanol and co-products of its production, as well as new ways to produce sustainable diesel, is of high economic importance to the state.

GLOBAL MARKET

The global market for biobased products is very large at \$624.7 billion in 2022 and projected to grow at a healthy pace with a CAGR of 8% for 2022 through 2027 (Table 13). The market for biobased renewable energy products represents about one-third the market size in 2022, whereas non-energetic biobased products (e.g., coatings, polymers, composites, ingredients for health products, etc.) is two-thirds of the market (and projected to grow the fastest with a projected CAGR of 9.5% from 2022-2027). This reflects the more mature nature of current-generation biofuels and supports the concept of expanding the biobased chemicals platform to broadly encompass biobased products holistically.

TABLE 13. BIOBASED PRODUCTS GLOBAL MARKET PROJECTIONS¹¹

	2022 Market Size	2027 Projected Market Size	CAGR 2022-2027
Total	\$624.7 billion	\$920 billion	8%
Bioenergetic products	\$213.9 billion	\$272.3 billion	4.9%
Non-bioenergetic Products	\$410.7 billion	\$647.6 billion	9.5%

¹¹ Source: BCC Research. Biorefinery Products: Global Markets. Report Number EGY117D. November 2022.

Platform Situational Assessment: Vaccines, Diagnostics, and Immunotherapeutics (Previously “Vaccines and Immunotherapeutics”)

The 2018 Strategy, through the designation of the platform, helped to coalesce interested parties around collaborations to advance vaccines and commercial R&D relationships. For ISU, the platform with its CTO has become a central resource for internal and external stakeholders to align interests and capabilities.

Iowa continues to be an important hub for animal vaccines, with operations of large industry players and an expanding base of new emerging ventures. Ames, anchored by the ISU Research Park, the Nanovaccine Institute, and the federal National Animal Disease Center, together with major global company operations and activity in new venture commercialization (including the new ISU CYVAX facility), has increased its profile and awareness on a national and international stage.

TABLE 14. OVERVIEW OF QUANTITATIVE FINDINGS

Ecosystem Element	Status from Quantitative Review
Research & Development	A diverse environment with presence of industry, federal government, and major research university R&D activity. Impact of COVID and various livestock diseases, driving attention and financing to the sector.
Innovation	Multiple areas of expertise, especially in vaccines for major economic species relevant to Iowa farm economy (especially swine). Niche areas of advanced science and technology in areas such as nanovaccines, polymers and sensors, agents for emerging animal diseases are evident.
Growth Capital	Sporadic activity, but no evidence of major shift in funding flows supporting the platform since 2016.
Industry Performance	Specialized and growing pharmaceuticals/vaccines industry supporting further commercialization

Iowa State University is the leader on the platform, and has been developing success across four pillars of activity:

- Providing seed grants to advanced early-stage innovations with perceived commercial potential.
- Developing meaningful and strategic engagements between stakeholders in the platform at ISU and the commercial vaccine industry. The platform director notes that they have relationships with 66 companies, a multi-year strategic funding commitment from Merck, and other master agreements in discussion.

- Development of on-campus/ISU Research Park space and infrastructure focused on facilitating start-up company development. The CYVAX wet-lab facility at the Research Park provides a multi-tenant space designed to help companies in development and training and provide access to specialized resources and expertise needed by early-stage ventures.
- Assembly of a team of mentors, industry executives, regulators, and other experienced leaders able to support the platform by advising faculty innovators and early-stage ventures.

OPPORTUNITIES AND NEEDS

- Nano vaccines represent a clear core competency. Helped by the validation of mRNA vaccines working against COVID-19, nano vaccines are increasingly seeing advancement as platforms also for livestock and companion animal health applications. In addition to the ISU Nanovaccine Institute, Ames is also home to Merck's core site for this technology.
- Both Merck and Boehringer Ingelheim are applying a nanovaccine approach to vaccines for economically harmful swine diseases—something of considerable importance to Iowa's large scale animal agriculture operations.
- Companies are now able to leverage ISU labs (such as the metabolomics lab) and their technical expertise and equipment, helping to avoid companies diluting their capital through investments in duplicative equipment and personnel.
- An identified challenge continues to be the need to access CEOs for start-up ventures who have some experience in the space. Generally, faculty working in the vaccines space at ISU are not expressing interest in taking on a role for which they do not have experience. It was noted that this is more of a challenge than capital for this platform.
- It was noted that BioConnect Iowa's support in SBIR applications has generated a good success rate for applications from the platform.
- The federal cluster, with the National Animal Disease Center, is getting more engaged, and some personnel have participated in training at the CYVAX Center.
- As the vaccines, diagnostic, and immunotherapeutics commercial sector in Ames (and more broadly across the state) continues to grow, it will be important to pay attention to workforce training needs within the industry. It can be difficult to train workers in specialized aseptic and regulated production environments, and the model of the BTEC (Biotechnology Training and Education Center) in North Carolina should be examined as a potential model for state engagement in advancing specialized bioscience workforce development. Locating such a center at ISU would help not only in workforce development for industry but can also be applied in the hands-on training of students at certificate, undergraduate, and graduate levels. This could build upon what is already being done on a small scale through the CYVAX Center.



GLOBAL MARKET

Vaccines and diagnostics for livestock and companion animal health applications represent a fast-expanding market, projected to grow at a CAGR of 6.8% between 2019-2024 (Table 15). TEconomy views these market projections as conservative, especially considering the significant attention being paid to diagnostics and vaccines in light of the COVID-19 pandemic and ongoing challenges presented by emerging livestock and poultry diseases.

TABLE 15. ANIMAL VACCINES AND DIAGNOSTICS GLOBAL MARKET PROJECTIONS¹²

	2019 Market Size	2024 Projected Market Size	CAGR 2019-2024
Total	\$11.27 billion	\$15.67 billion	6.8%
Animal Vaccines	\$7.8 billion	\$10.5 billion	6.1%
Diagnostics ¹³	\$3.47 billion	\$5.17 billion	8.3%

In addition, a potentially relevant market is “medicinal additives to feed,” which in 2019 represented an estimated \$3.52 billion in global market size, projected to grow to \$4.17 billion in 2024 (for a 2019-2024 CAGR of 3.5%).

¹² Source: BCC Research. Global Markets for Animal Therapeutics and Diagnostics. Report Number HLC034F. March 2020.

¹³ Includes rapid test kits plus diagnostic analyzers and consumables.

Platform Situational Assessment: Medical Innovations (Previously “Medical Devices”)

The medical devices sector declined in terms of employment in Iowa since 2018, but, from a broader perspective, biomedical sciences continue to show considerable promise as a basis for economic development in Iowa. Focused on the world-class academic health center complex at the University of Iowa, there is evident activity not only in device commercialization opportunities, but also in diagnostics, biopharmaceuticals, and health tech. The broad scope of biomedical innovation being generated suggests a potential to pivot the platform to encompass the advancement, growth, and attraction of biomedical and health products more generally (rather than just devices).

TABLE 16. OVERVIEW OF QUANTITATIVE FINDINGS

Ecosystem Element	Status from Quantitative Review
Research & Development	Health sciences drives overall bioscience academic research dollar volume and growth in state, but spending has a much broader focus than the platform.
Innovation	Significant presence in academic research, with evident recent increase in surgical and diagnostic device activity.
Growth Capital	Some activity, but no evidence of major shift in funding flows supporting the platforms since 2016.
Industry Performance	Small subsector, with declining Iowa employment, suggests innovation is not yet translating into significant business growth.

OPPORTUNITIES AND NEEDS

- The opening of the new University of Iowa Pharmacy Building has not only created state-of-the-art space for pharmaceutical sciences education and research, but also has freed-up significant space in the partially vacated original pharmaceutical sciences building for potential company development labs and associated support space. This provides a signature opportunity to expand business incubation in the heart of the UI biomedical research complex.
- Developing more space to accommodate new ventures is important at UI, as the BioVentures Center has seen significant success and is effectively full. Commercial wet-lab space is in short supply in the Iowa City region.

- University of Iowa representatives noted that the state funding for the platform has been very helpful and has been well-leveraged, resulting in an uptick in advancement of medical device and associated biomedical technology innovations going forward.
- The primary need is to broaden the platform beyond just medical devices, to enable investment in a wider range of biomedical and healthcare technologies ranging from human therapeutics to health-tech innovations. The ecosystem supports and programs developed by UI are well-suited to this broadening of applications and already are working to advance health technology, biopharmaceuticals, and other products and services in addition to devices.

The University of Iowa has made a significant commitment to building a holistic ecosystem of support to encourage innovation, commercialization, and entrepreneurial activity across the campus community. Life sciences, especially biomedical and health sciences, are at the core of this activity at UI. Biomedical ventures are well-recognized as being particularly challenging to advance given the usual clinical focus of products and services and the long runway required to move from proof of concept through prototyping and various stages of clinical trials on the way to regulatory approval. The complexity of the company development process in biomedical innovations demands that attention be paid to setting up a well-structured series of custom support mechanisms and programs to help innovators and entrepreneurs navigate the process. UI has been deliberate in forming these supports, operating a system that includes:

- An incubator program, with the BioVentures Center (BVC) and Translational Research Incubator (TRI), together with newly funded wet-lab space being developed at the College of Pharmacy.
- A university SBIR/STTR support program
- UI Accelerate Program, supporting five companies annually
- Funding support through the College of Medicine Gap Fund (supporting up to \$60,000 in prototype development funding), an Engineering Innovation Fund supporting medical technology investments (up to \$50,000), the College of Dentistry Innovation Fund (\$50,000), College of Pharmacy Innovation Fund (\$50,000), and a Nursing Jumpstart Fund (\$5,000-\$10,000 awards).
- The MADE program, an innovative program designed to help prototype and facilitate web-based sales of novel Class 1 biomedical devices and health tech. The program allows students to get hands-on experience in venture development and business operations.
- Operation of Protostudios which provides rapid prototyping, industrial engineering, machining and 3D printing services, and design services, for Iowa entrepreneurs.
- A fellowship program initiated for residents, fellows, and post-docs supporting activities to advance innovations, with 12 participants engaged so far. The Innovation Fellows program has gained significant traction.

- The CTO/CIO at UI has assembled a substantial advisory team of 45 medical technology experts, focusing on people with expertise in starting and scaling biomedical business ventures. He has also created connections with 30 venture firms willing to review Iowa opportunities.
- Access to a network of medical professionals, entrepreneurs in residence, and other engaged professionals able to support UI entrepreneurial and commercial-research partnerships.

Spearheaded by UI Ventures, faculty, researcher, and student entrepreneurs and innovators are assisted by programs that help analyze the commercialization and market potential of discoveries, assess venture funding opportunities, assist in company formation and management team building, and support the development of business plans.

Churn as a Sign of Ecosystem Health

It should be noted that a healthy start-up and entrepreneurial ecosystem will see turnover in its portfolio of companies. Multiple new companies will start, and many will fail. Those that are successful may grow locally, benefiting from relationships and tacit assets in the ecosystem that birthed them. Others will be acquired or move to national or international locations favorable to their operations. Such wins, draws, and losses are to be expected, and benefits actually accrue from each event. The hard-earned experiences of personnel engaged in new enterprise development, including those that ultimately fail, will often be leveraged for multiple follow-on new ventures. Companies acquired and ultimately relocated outside of a state typically result in a significant injection of wealth back to founders, workers granted equity, and early-stage investors that may remain in-state. The churn of new ideas, ventures, skilled personnel, and capital is a characteristic of tech-based economic development. They are a feature, not a bug.

UI has experienced biomedical business venture events across this full spectrum. The acquisition of Farapulse by Boston Scientific was a \$295 million buyout. The company moved but considerable wealth was generated within Iowa. Others are scaling within the Iowa City region (e.g., Integrated DNA Technologies and Digital Diagnostics), and the pool of individuals who have gained considerable experience in the emerging biomedical business development ecosystem in the region is expanding.

GLOBAL MARKET

Individually and combined, the medical devices and biopharmaceuticals global markets are extremely large and projected to continue to grow at a rapid pace. Medical devices are projected to grow at a CAGR for 2021-2027 of 7.1% to reach almost \$1 trillion dollars in sales by 2027 (Table 17). Pharmaceuticals are projected to grow at a similar pace (CAGR of 6.7%) through 2027, to reach over \$1.7 trillion in global sales (Table 18).

TABLE 17. MEDICAL DEVICES GLOBAL MARKET ESTIMATES¹⁴

	2021 Market Size	2027 Projected Market Size	CAGR 2021-2027
Medical Devices ¹⁵	\$639.1 billion	\$953.4 billion	7.1%

TABLE 18. PHARMACEUTICALS (DRUGS AND BIOLOGICS) GLOBAL MARKET ESTIMATES¹⁶

	2020 Market Size	2025 Projected Market Size	CAGR 2020-2025
Pharmaceuticals ¹⁷	\$1,228.4 billion	\$1,701 billion	6.73%

¹⁴ Source: BCC Research. Medical Devices: Technologies and Global Markets. Report Number HLC170E. September 2022.

¹⁵ Includes drug delivery devices, in vitro diagnostics, imaging devices, cardiovascular devices, orthopedics and spine devices, urology and renal devices, and endoscopy.

¹⁶ Source: The Business Research Company. *Pharmaceuticals Global Market Competitive Briefing*. December 2021.

¹⁷ Projected to be 79.3% pharmaceuticals and 20.6% biologics.

Additional Recommendations for Enhancing Iowa Bioscience Development

The evaluation of quantitative and qualitative, interview-based information collected over the course of the project, together with specific input provided by ecosystem stakeholders, leads to a series of additional cross-cutting recommendations.

RECOMMENDATION 1: EVALUATE AN ADDITIONAL PLATFORM OPPORTUNITY

Although TEconomy is somewhat reluctant to recommend the development of a fifth life science platform and wary of diluting efforts, it is evident that Iowa is likely well-positioned to advance an additional opportunity space. Multiple parties raised the core competencies and assets that the state has to advance a position in sustainable and regenerative agriculture and associated “regenerative tech.”

Defining Regenerative Agriculture. This emerging field adopts a systems approach to developing farming practices and technologies that work to regenerate topsoil, enhance natural ecosystem services, promote bio-sequestration of carbon, improve farm energy efficiency, and reduce negative externalities (such as greenhouse gas emissions and excess nutrient flows).

In many respects, such a platform would have a strong intersection with the Precision and Digital Agriculture platform (leveraging sensor, IoT, and information systems and the improved efficiency of precision ag equipment) and the Biobased Products platform (leveraging biotechnology and plant transformation techniques to produce biological pest controls, new approaches to plant nutrition, and more energy and resource efficient crops, for example). The platform also would be able to integrate Iowa’s highly developed renewable energy assets as a component of the regenerative agriculture opportunity.

Noted earlier in this report was the potential to develop a farm of the future project at ISU to further advance innovation in Precision and Digital Agriculture and the testing and validation of technologies and solutions. Such a project could be designed to also leverage sensor systems, IoT technologies, advanced analytics, and other tools to further R&D in regenerative agriculture.

The space is inherently multi-disciplinary, requiring the engagement of environmental and ecological sciences, atmospheric sciences, biochemistry, soil science, entomology, plant sciences, various engineering disciplines, and computational and data sciences. TEconomy recommends that the Office of the Vice President for Research at ISU assemble and lead an exploratory committee tasked with developing a white paper outlining the opportunity space, key university assets, potential pathways to commercial product and service development, and recommendations for whether a platform should be advanced. Several companies in Iowa (such as Benson Hill) also are working on closed-loop systems in agriculture and resource use; these companies should be integrated into the evaluation process. From an economic development standpoint, IEDA should only consider this as a potential fifth platform if it can be demonstrated that there is an identifiable pathway for work in regenerative agriculture leading to the development of novel commercialized innovations, technologies, and services.

RECOMMENDATION 2: ENHANCE COMMUNICATIONS

Iowa has a story to tell, both in terms of its overall strength in biosciences (as evidenced in the quantitative data herein) and the focused assets and expertise within the bioscience platforms. There is also an important story to convey in terms of the holistic ecosystem that has been constructed to support R&D and the growth and development of commercial bioscience businesses and business operations. Because BioConnect Iowa is the organizational coordinator of strategy implementation and supports the individual platforms, it is time for BioConnect to become more sophisticated in its communications. Compared to competing state organizations promoting bioscience-based economic development, BioConnect's website is sparsely populated with information.

BioCrossroads in Indiana and the NC Biotechnology Center's websites are information-rich and convey the impression that much is going on across the sector in their respective states.

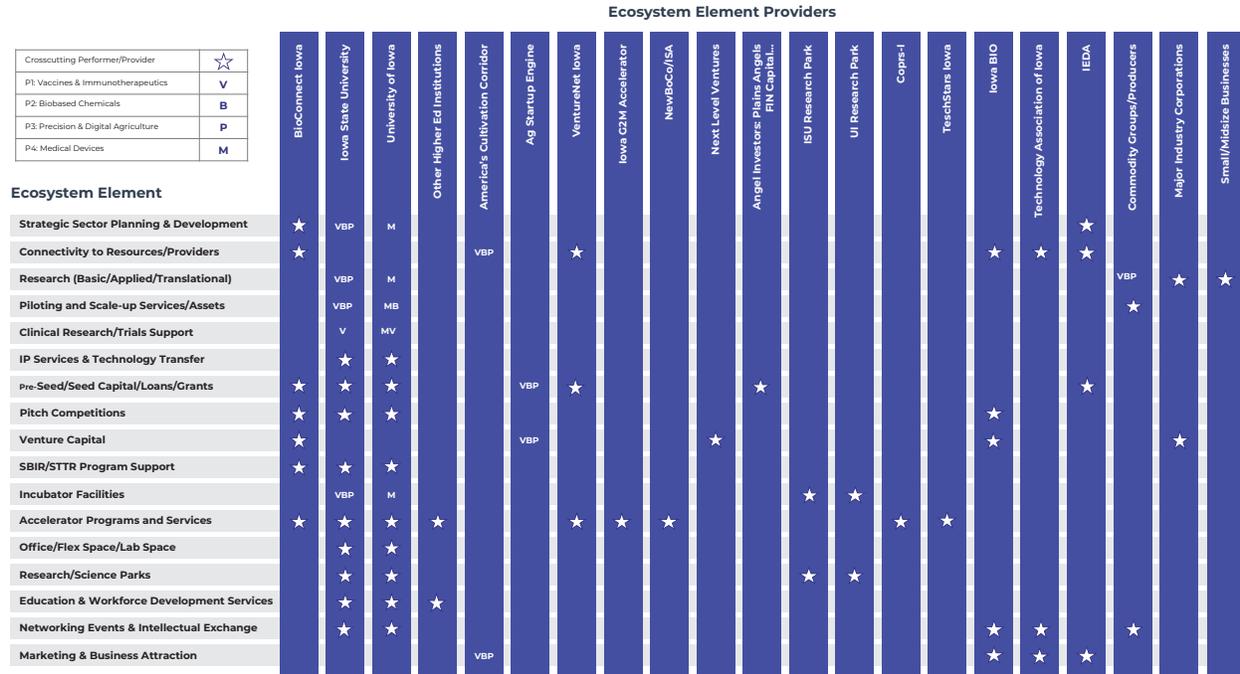
The information on each platform on the BioConnect website is particularly thin, and it is imperative that each platform has richly populated, informational web pages that provide compelling information. These pages need to convey the focus of the platforms, "why Iowa"—clearly conveying assets, expertise, corporate presence, etc.—and information on how to connect with and participate in the platform.¹⁸ The CTOs and participants in the platforms at the universities need to be proactive in supporting the website's development, frequently updating accomplishments, research advancements, new venture developments, IP available, meetings and events.

In terms of providing an overview of the holistic ecosystem for bioscience development and providing connectivity to key resources, TEconomy recommends using the matrix in Figure 12 as an organizational principle for part of the website, providing a means to connect to key assets and providers across each key ecosystem element:

The CTO position, in combination with the scientific platform directors, has provided a very effective mechanism for assuring both R&D and business development/commercialization objectives are equally factored into the bioscience development equation. The dedicated CTO position provides a mechanism for building relationships and teams around identified opportunities (identified both inside the universities and external to them). The commercial experience, industry connections, and gravitas of the CTO's adds a dimension to the evolution of the platforms that was missing. It also puts boots on the ground inside the universities who are thinking about platform based economic development every day.

¹⁸ America's Cultivation Corridor has a more informative web presence, but it is only relevant to three out of the four platforms and does not specifically address these.

FIGURE 12. CURRENT STATUS OF THE BIOSCIENCE ECONOMIC DEVELOPMENT ECOSYSTEM IN IOWA



Source: TEconomy Partners via review of organizational websites and interviews with organizational leadership. Additional review by VentureNet Iowa.

RECOMMENDATION 3: CONCENTRATE ON INCREASING DEAL FLOW TO LEVERAGE THE BUILT ECOSYSTEM

As Figure 12 illustrates, Iowa now benefits from a well-structured suite of organizations and services that support biosciences along a continuum from R&D through successful business development and expansion. Building more supporting organizations or programs is now less important than **increasing the flow of deals moving through the ecosystem that can leverage the assets and services already in place.**

Both ISU and UI are working to advance increased levels of faculty and student entrepreneurship (with ISU even revising tenure processes to encourage this further), but both institutions note that invention disclosures have not been trending as positively as they would like. Without a more consistent flow of innovations progressing into commercialization, the relationships that have been built with venture capital providers and other stakeholders are at risk of diminishing through a lack of momentum.

The state funds provided to each platform are an important source of very early-stage pre-seed funding, able to be deployed in a flexible fashion by the platforms to support the advancement of early innovations and assess commercial potential. Increasing the level of state funding for this purpose is likely to be a particularly cost effective approach to increasing innovation throughput and is likely to be highly positive in terms of bringing in further funding from federal and other sources (given the evident track record of leverage achieved on the funding to-date). In addition, it is highly recommended that IEDA and BioConnect work to implement the original Action 2.1—to develop a funding program to attract innovators with ideas relevant to the Platforms to come to Iowa to advance their concepts. Based on the model of Cyclotron Road from Lawrence Berkeley National Laboratory, this represents a proven approach to boosting the flow of innovations into an ecosystem designed to provide support. On an international stage, Cultivation Corridor has been advancing a similar concept through its “Cultivo Virtual Academy,” which provides global scaleup companies preparing to enter the U.S. ag, food, or bioscience market with a virtual program that covers introductions to “U.S. finance, regulatory, legal and market systems and makes valuable connections to Iowa leaders, researchers and farmers.” Cultivo is showing that innovators can be attracted to connect to Iowa’s asset and resource base to advance their concepts.

Advancing entrepreneurial business development is especially important for states like Iowa that are constrained in terms of population growth and workforce availability. Major, large-scale inward investment projects can be hard to accommodate in this labor climate where companies must compete for labor with existing Iowa companies; therefore, a key mission for IEDA needs to be less about large-scale employment growth and more about wealth generation and per capita GDP increases. Now is the time to invest in building new companies in advanced industries that generate significant capital and high-wage jobs. These are also the types of ventures that have the potential to produce substantial wealth-generating capital exits, able to prime the pump with further funds and expertise to spark subsequent rounds of entrepreneurial business development.

RECOMMENDATION 4: INCREASE FUNDING

Iowa is presently in an enviable position, able to strategically invest into cost-effective and well-leveraged economic development initiatives that will position the state for growth in GDP per capita, build a position in new and expanding advanced industries, and create what the Brookings Institution calls “good quality” jobs.

Opportunities exist to fund three categories of investments:

1. **Operational Investments**—Increasing funding to BioConnect to further scale the organization and its programs and to each of the four platforms. Based on input from key stakeholders, both BioConnect and the four platforms can readily absorb at least twice the level of their annual funding. Indeed, funding at an even higher level could be deployed effectively without experiencing diminishing returns on the capital. To help BioConnect build long-term sustainability via diversifying its funding sources, it is recommended that additional state funding (above the level currently committed) be provided with a requirement for a dollar-for-dollar match from the private sector, philanthropy, or other funding sources (such as federal grants).
2. **Asset Investments**—Several concepts and potential capital investments are referenced in this report. For example:
 - Increasing fermentation capacity for the Biobased Products platform.
 - Investing in cGMP facilities for biomanufacturing of next generation vaccines.
 - Developing additional business incubation and wet lab space for start-up ventures and industry-university development projects. Noted locations include conversion of space in the old pharmaceutical sciences building at UI, and new space at the ISU Research Park.
 - Potentially developing an integrated “farm of the future” to support R&D, product testing, scale-up, and validation of solutions in precision and digital agriculture, biobased products, and a potential new platform in regenerative agriculture and associated tech.
3. **Matching Strategic Investment Funding**—Recent major federally funded initiatives in science and technology development fields that are relevant to the Iowa bioscience development platforms have been advancing. Such federal initiative investments are competitive, and winning the funds is often contingent on the provision of matching funds by the home state and engaged institutions and stakeholders. Building a \$5-10 million strategic investment fund to support platform-relevant federal funding awards would represent a sound use of state resources.

It should also be noted that long-term funding needs to be committed to build the biosciences economy and sustain momentum in the growth of programs and initiatives. The State of Iowa has appropriated funds to the platforms on an annual basis, a process that makes planning, initiative building, and the hiring of personnel more difficult. It would be better if the funds could be committed in 3-to-5-year funding periods to better facilitate stable operations. Now that the platforms have

demonstrated progress and achieved significant financial leverage of state funds to secure federal and other external funds, there is a strong rationale to provide a longer-term commitment.

The present process of the Iowa Board of Regents seeking funding support from the legislature that then gets allocated to the universities may not be an optimal system. Full levels of requested funding have not occurred each year, and the importance of the platforms may not be fully realized in the current process. TEconomy recommends that an alternative approach be considered whereby the funding is allocated by the legislature to the IEDA, and then IEDA provides the funding to the universities and BioConnect Iowa to implement platform actions. Given that the biosciences strategy is a focused economic development initiative, there is a strong rationale for IEDA to be in control of the overall funding flows and monitor their progress against strategic goals.

An additional financial commitment by the state was suggested by those engaged in raising capital for early-stage ventures. It was noted that angel tax credits are oversubscribed, and a larger allocation of tax credits to the program would be beneficial.

Additional Input

TEconomy notes that the new InnoVenture Fund is an important addition to the capital pool available to entrepreneurial bioscience ventures in the state. It is notable, however, that the fund will not be a lead investor and requires applicant companies to already be in possession of a term sheet from a lead investor. This is a relatively cautious approach but understandable given Iowa's previous challenges with a state fund-of-funds. TEconomy hopes that the InnoVenture Fund will be able to evolve to take a higher risk leadership position in investments over time as experience builds and the state becomes more comfortable in being a risk capital investor.

CONCLUSION

Biosciences in Iowa represent a long-standing strength for the state and continue to demonstrate growth. The recently released 2022 BIO/TEconomy report shows Iowa having a specialized location quotient (indicative of a quantitative concentration of bioscience activity above the national normative level) in two out of five bioscience sectors: Agricultural Feedstock & Industrial Biosciences, and Bioscience-related Distribution. In addition, Iowa has recorded growth in two sectors in which it is not yet specialized, “Pharmaceuticals” and “Research, Testing, and Medical Laboratories.” Four of the five sectors in Iowa experienced employment growth since 2018, with only “Medical Devices & Equipment” seeing an overall employment reduction.

Clearly, biosciences are important to Iowa’s economy, but there exists substantial competition among U.S. states and international competitors for the high-quality jobs and robust GDP-expanding benefits provided by the sector. TEconomy’s analysis for IEDA finds that while the trajectory of the sector overall for the state is positive, there are some emerging issues. Overall, the quantitative analysis of Iowa’s biosciences sector since the release of the 2018 Iowa Bioscience Development Strategy shows a mixed performance. On the positive side, overall growth has occurred in employment, in R&D activity, in publishing and patenting, and in VC deals and funding. This must be balanced, however, with the realization that the levels of growth being achieved on some of these measures have been moderately lagging the overall national growth rate. The fact that innovation metrics are trending strongly upwards is, however, a very positive sign and the basis for forthcoming growth opportunities and expanding economic performance from the sector.

Iowa’s positioning for bioscience growth has certainly been advanced by implementing the 2018 Iowa Biosciences Development Strategy, and a well-populated economic development ecosystem has formed to support bioscience advancement. The formation of BioConnect Iowa, in combination with state support for progressing the four bioscience platforms, has advanced implementation activity across many of the strategies and specific actions recommended in 2018. Two of the four strategies have advanced considerably, with Strategy Four (Enhance Early-Stage Capital Availability) and Strategy One (Organization and Connectivity) seeing progress on most of the recommended actions. However, two strategies have received only moderate implementation activity—Strategy Two, which comprised three recommended actions to enhance innovation and commercialization, has not advanced as recommended, but the recommended actions are still relevant and should be addressed moving forward. Similarly, Strategy Three (Talent Development, Attraction and Retention) has not been a significant focus of attention.

The overall assessment of TEconomy, and the ecosystem stakeholders interviewed across the project, is that the four Iowa Bioscience Platforms capture and encompass the main core-competency-based opportunities for the state in and related to bioscience. That said, learning has occurred that leads to a recommendation for moderate platform adjustments:

- Adding “Diagnostics” to the Vaccines and Immunotherapeutics platform.
- Changing “Biobased Chemicals” to “Biobased Products” as a more inclusive term, encompassing opportunities across diverse products and technologies.
- Changing “Medical Devices” to “Medical Innovations” considering the expanding activities at UI and within the state in biopharmaceuticals and other medical technology innovations.

The combination of accomplished platform scientific directors plus the recruitment of highly experienced and well-connected CTOs for each platform has created notable hubs of coordinated activity at the universities that are developing momentum that is highly conducive to further platform advancement.

With momentum building but growth performance still mixed, it is important for Iowa to more fully implement the full set of strategies and actions that were outlined in 2018. The strategies and actions were designed to work in concert to produce desired economic stimulus, and thus their full implementation is desirable. In addition, four primary recommendations have been identified through the 2022 review that should be considered by IEDA and key stakeholders:

1. Evaluate an emerging opportunity to advance an additional platform in “Regenerative Agriculture and Regenerative Technologies.”
2. Significantly improve communication of Iowa’s well-rounded bioscience assets and programs, with a primary emphasis on making the BioConnect website a highly information-rich and constantly updated hub for intelligence on Iowa biosciences and each of the platforms.
3. Place an emphasis on increasing deal flow which can leverage the robust ecosystem that has now been built to support bioscience development. This includes implementing actions outlined in the strategy that are designed to both support internal activities and attract external innovators to Iowa.
4. Significantly increase State funding support in three areas:
 - a. Increase funding support of BioConnect Iowa and each platform by a factor of 2x, with a requirement that additional funds provided to BioConnect carry a requirement for a match from the private sector or other sources.
 - b. Strategic infrastructure investments requested by the platforms.
 - c. Development of a strategic matching state investment fund for major federal opportunities related to the platforms.

The State should strategically invest in boosting funding to BioConnect and the platforms. This will enable the full set of recommended strategies and actions to realize opportunities to grow the Iowa bioscience economy. Iowa has established a strong position to build upon in an advanced industry that generates high-wage jobs and produces significant wealth and GDP expansion. Notably, the bioscience platforms are also supportive of large sectors that underpin much of the Iowa economy in terms of agriculture, healthcare, and manufacturing—a position that should make bioscience development and platform advancement an especially high economic priority for the State.

APPENDICES

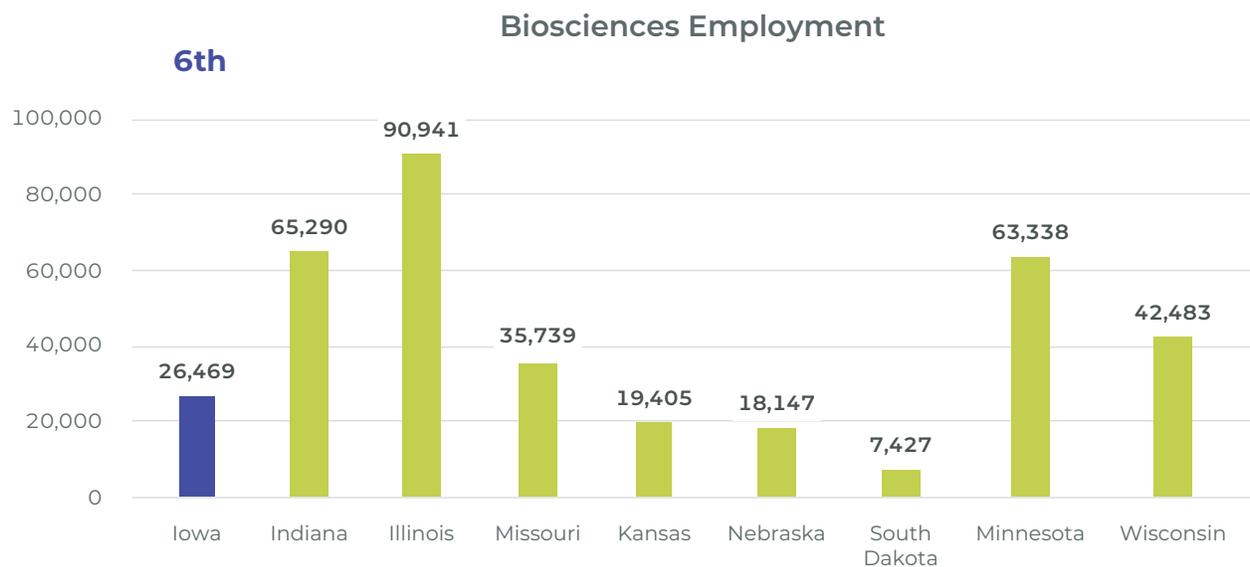
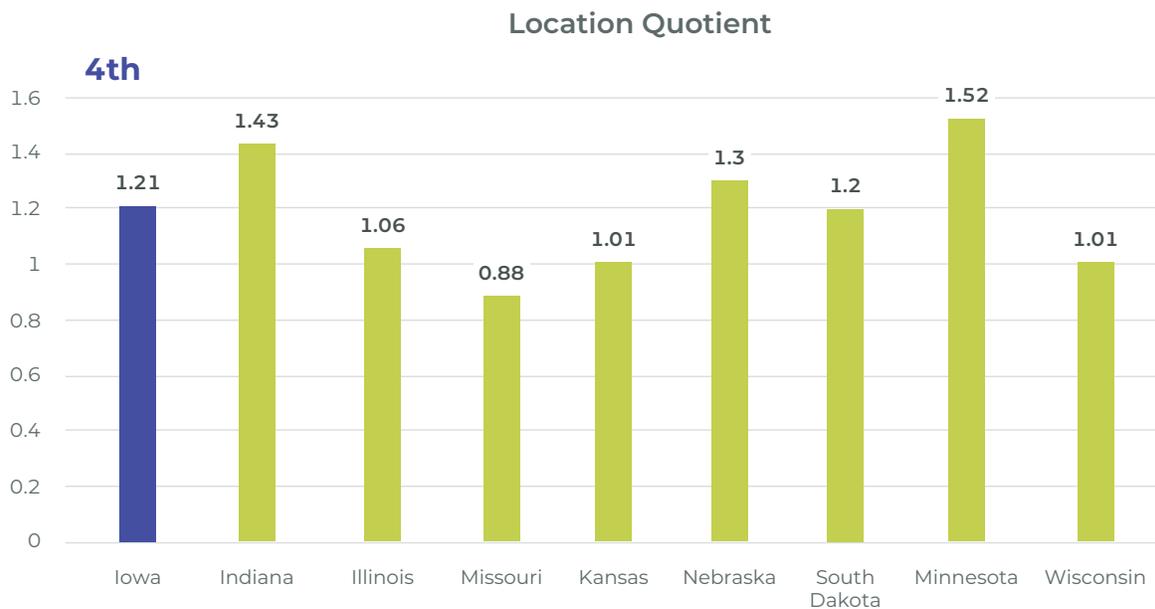
Appendix A: TEconomy/BIO 2022 Bioscience Report. Iowa Biosciences Compared to Neighboring States.

Appendix B: America's Seed Fund (SBIR/STTR) Funding—Iowa.

Appendix C: Preliminary Outline of Venture Studio Concept for Iowa Biosciences.

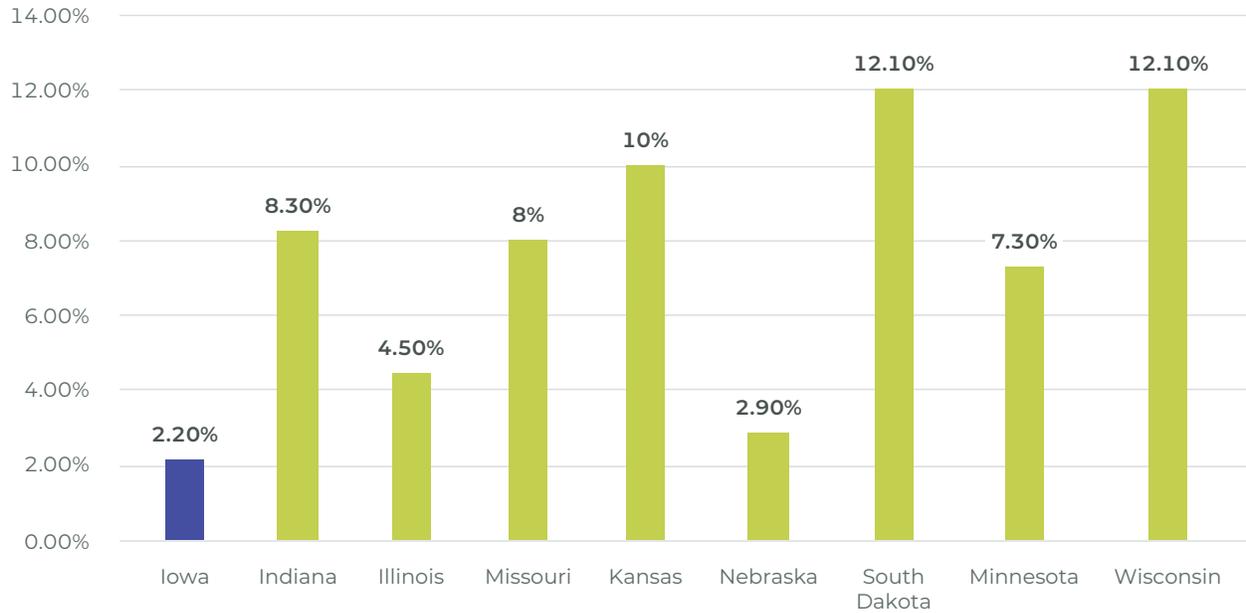
APPENDIX A: TECONOMY/BIO 2022 BIOSCIENCE REPORT. IOWA BIOSCIENCES COMPARED TO NEIGHBORING STATES.

Source: TEconomy/BIO. The U.S. Bioscience Industry: Fostering Innovation and Driving America's Economy Forward: 2022.



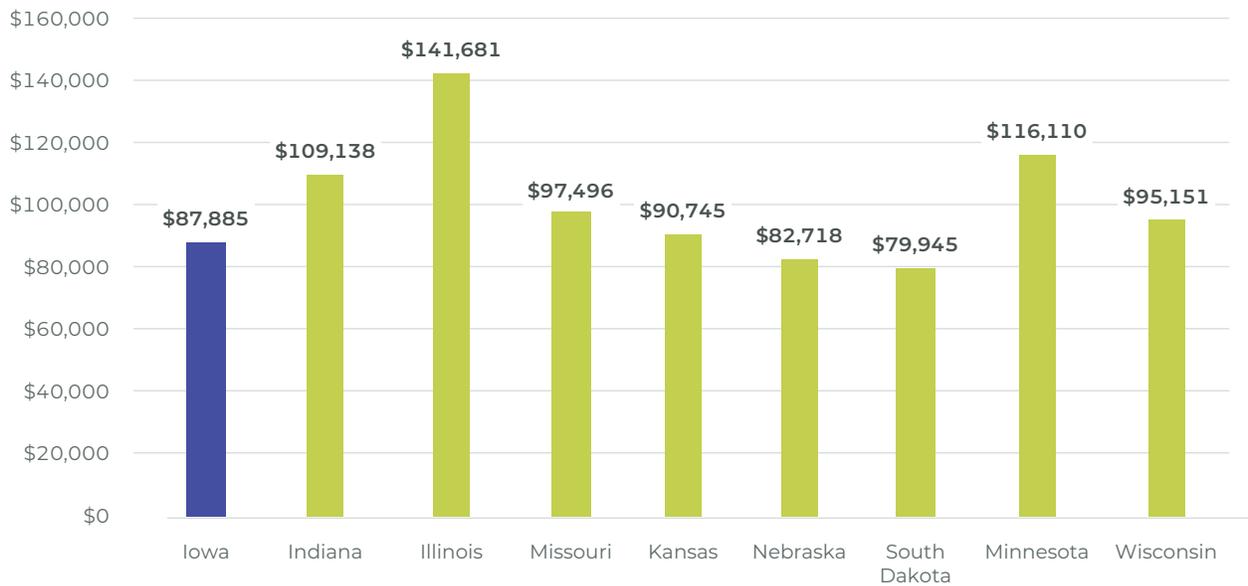
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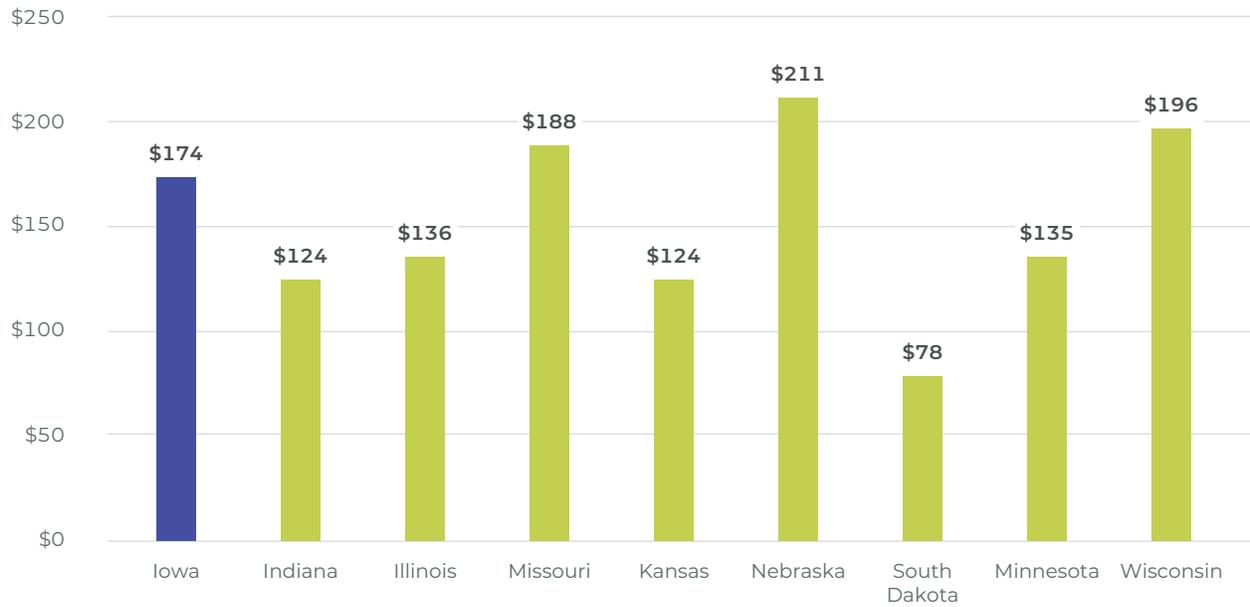
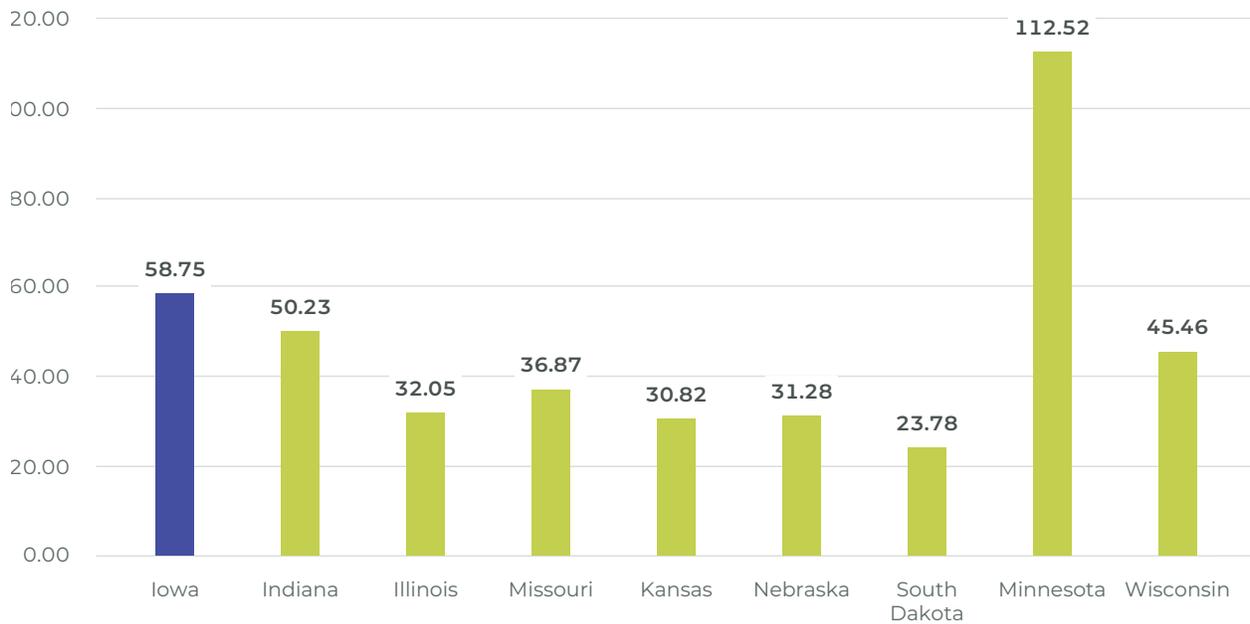
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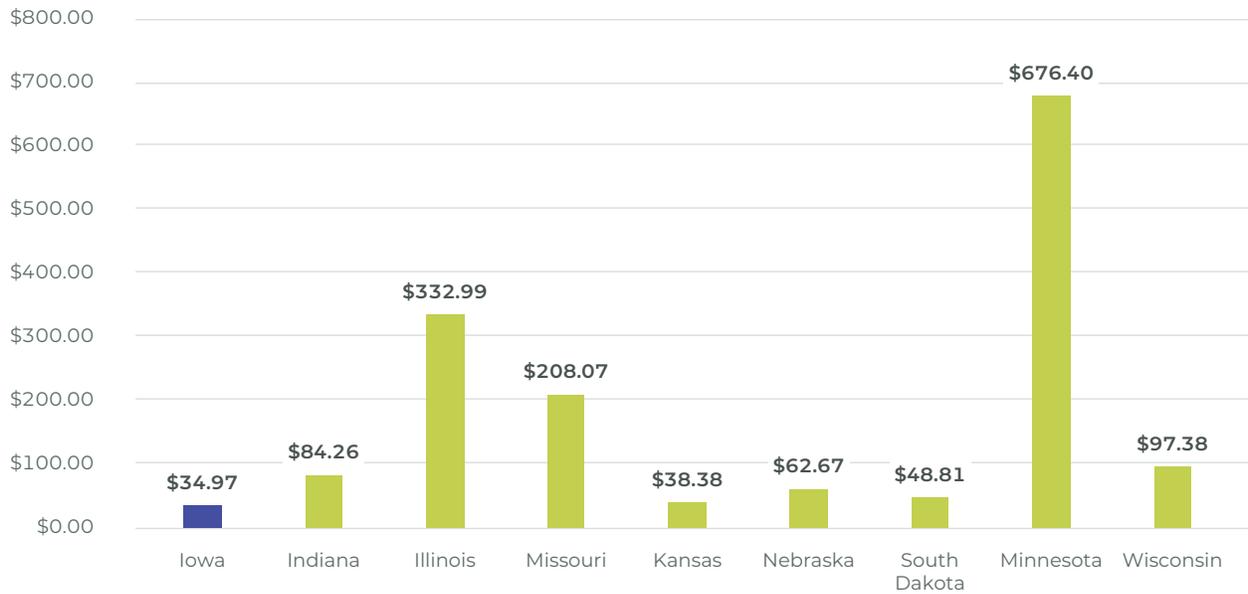
Avg Bioscience Wage



4th**Academic Biosciences R&D Per Capita****2nd****Biosciences Patents Per 100,000 pop'n (18-21)**

9th

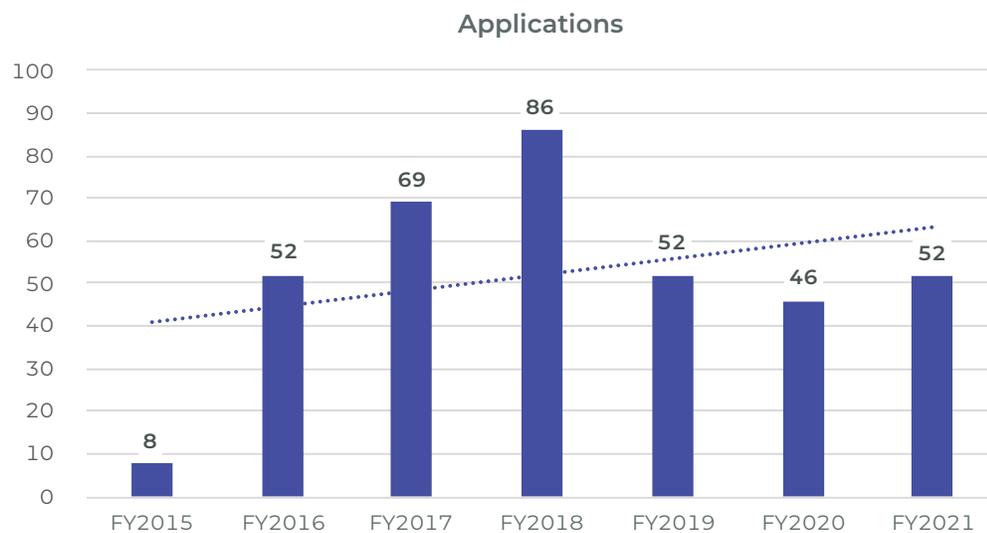
Biosciences VC Per Capita (18-21)



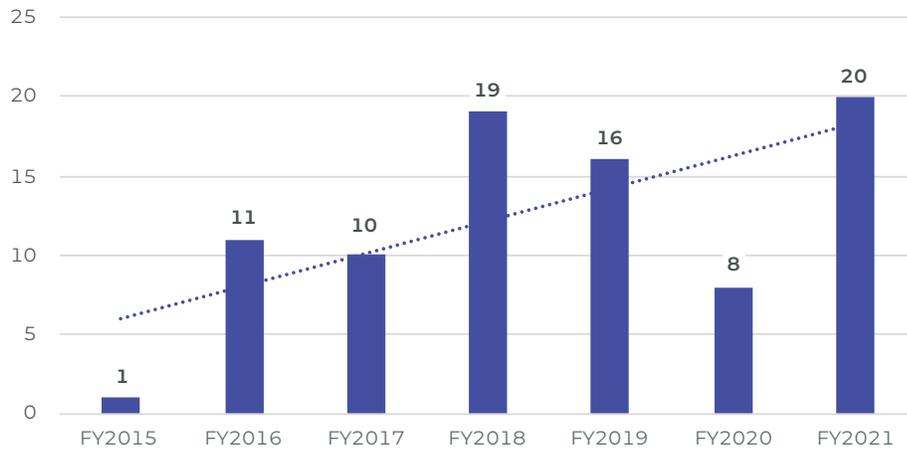
APPENDIX B: AMERICA'S SEED FUND (SBIR/STTR) FUNDING—IOWA

Source: BioConnect Iowa

Year	Applications	Awards	\$ Total	Success Rate
FY2015	8	1	\$150,000	13%
FY2016	52	11	\$2,750,000	21%
FY2017	69	10	\$5,800,000	14%
FY2018	86	19	\$7,000,000	22%
FY2019	52	16	\$4,000,000	30%
FY2020	46	8	\$6,300,000	17%
FY2021	52	20	\$11,000,000	38%
FY2022	38	13	\$4,000,000	34%
Total	403	98	\$41,000,000	Avg = 24%



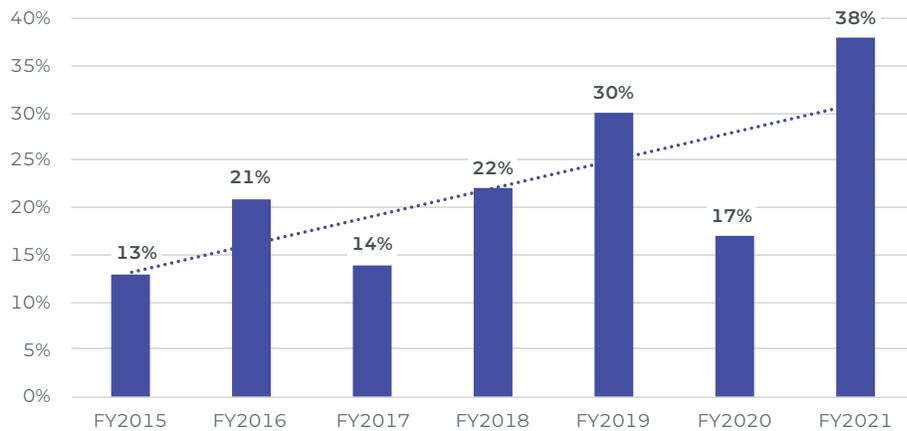
Awards



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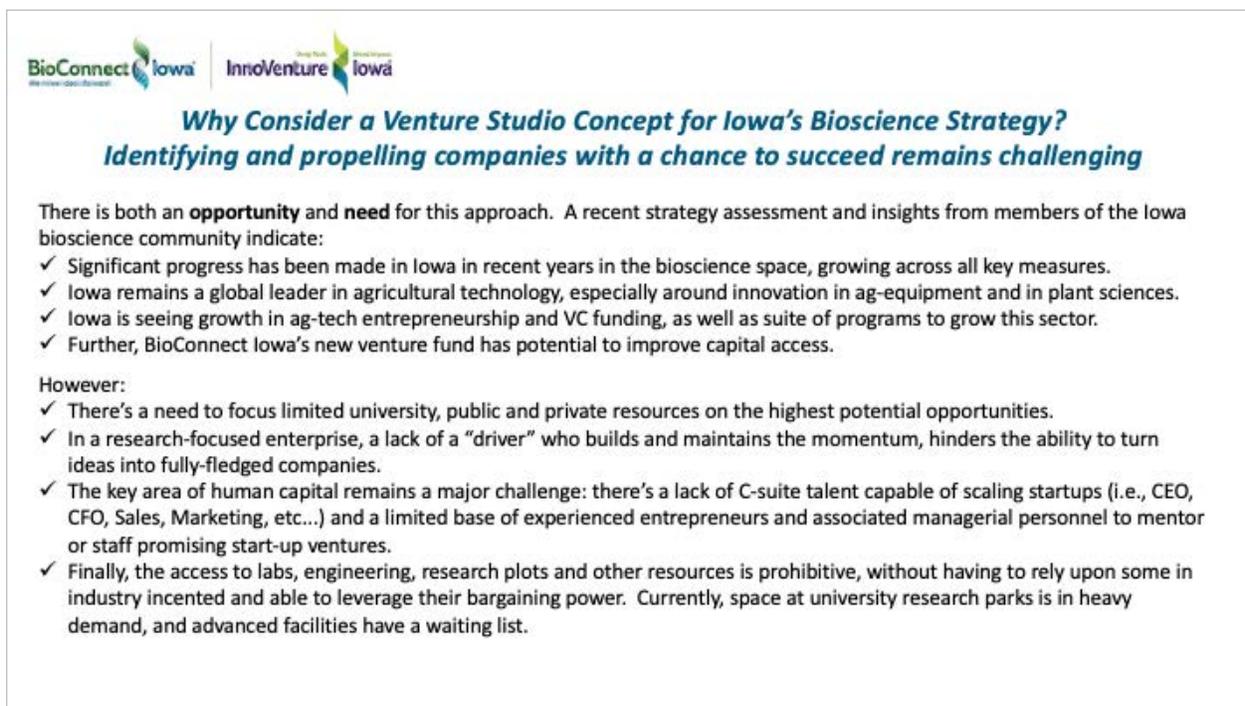
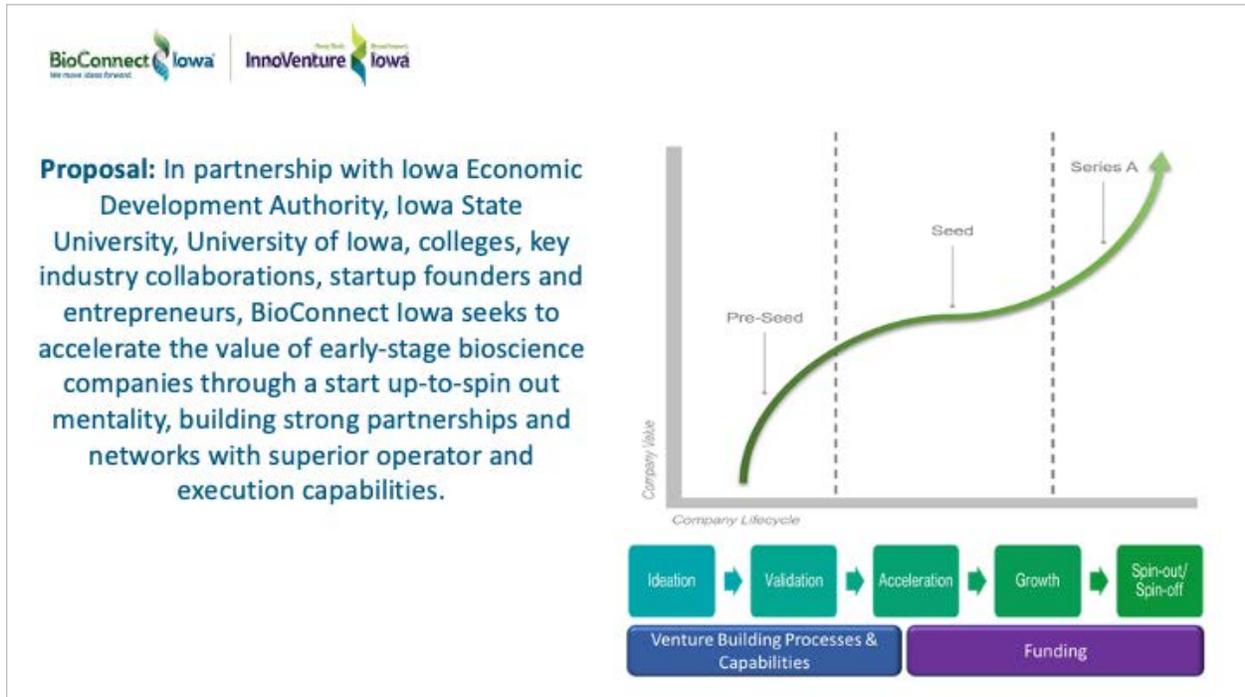


Success Rate



APPENDIX C: PRELIMINARY OUTLINE OF VENTURE STUDIO CONCEPT FOR IOWA BIOSCIENCES

Source: BioConnect Iowa





Innovation Venture studios take the raw materials of ventures - a market trend, a new technology or an entrepreneurial team – and turn them into fully-fledged companies



Goal: accelerate development and de-risk business ideas at each stage



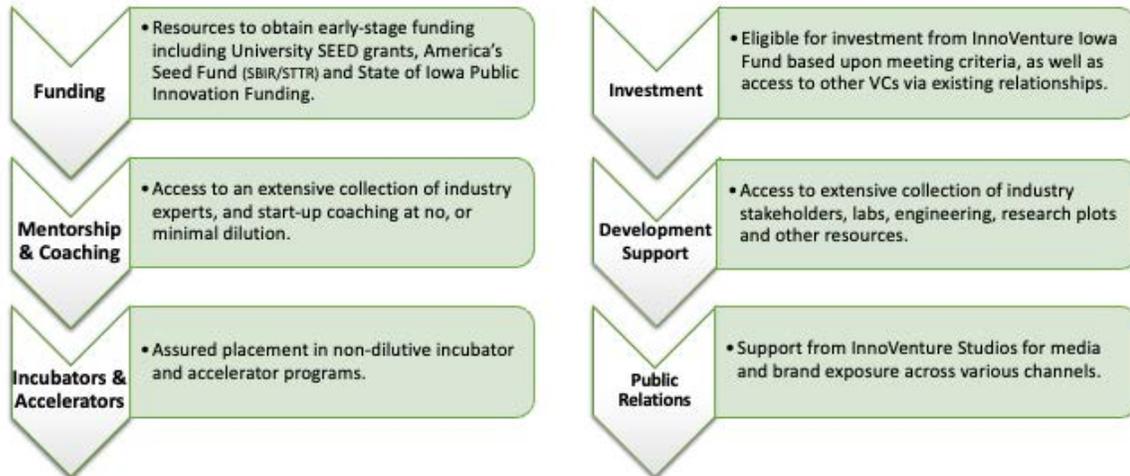
The Core Building Blocks for a Robust Studio Approach to Drive Iowa's Bioscience Strategy Already Exists



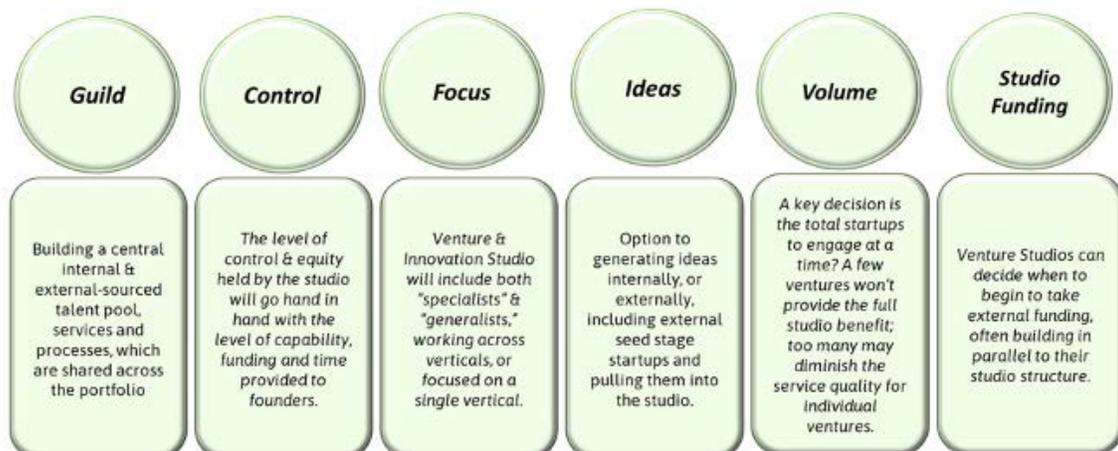
 IOWA STATE UNIVERSITY Office of Innovation Commercialization	 IOWA STATE UNIVERSITY Office of Innovation Commercialization	 IowaG2M Accelerator	 BioConnect Iowa We move ideas forward.	 BioConnect Iowa We move ideas forward.
 IOWA Innovation Programs - Proof of Commercial Relevance - Research Activities Tax Credit	 IOWA Innovation Programs - Demonstration Fund - Angel Investor Tax Credit	 IOWA Innovation Programs - Innovation Acceleration Fund	 IOWA Innovation Programs - Innovation Proposal Fund - Innovation Expansion Fund - Renewable Chemical Production Tax Credit	 IOWA Innovation Programs - Innovation Fund Tax Credit
 BioConnect Iowa We move ideas forward. High Tech Connect Iowa Professional Consulting	 BioConnect Iowa We move ideas forward. High Tech Connect Iowa Professional Consulting	 BioConnect Iowa We move ideas forward. High Tech Connect Iowa Professional Consulting	 BioConnect Iowa We move ideas forward.	 InnoVenture Iowa We move ideas forward.
 AMERICA'S SEED FUND	 AMERICA'S SEED FUND	 InnoVenture Iowa We move ideas forward.		



Core Components of the Studio



Studio Design Factors to Consider



BioConnect Iowa | InnoVenture Iowa

Other Midwest Venture Studios

Nebraska

Supporting technology leaders in our states largest industry

NEBRASKA INVEST NEBRASKA

Minneapolis

WE KNOW GOOD EXECUTION, GROWTH, AND TEAM-BUILDING

Madison

What is Varsity Venture Studio?
Varsity Venture Studio is a collaboration between the University of Wisconsin-Madison, Wisconsin Alumni Research Foundation (WARF) and High Alpha Innovation and the first university venture studio of its kind. Varsity primarily focus on InsureTech, AgTech, Healthcare, and Supply Chain.

St. Louis

BIOSTL

CREATING, GROWING AND INVESTING IN PROMISING STARTUPS AND ENTREPRENEURS

Indianapolis

VENTURE FUND | VENTURE STUDIO

INDICATOR | ACCELERATOR

Strategic Expertise & Focus

Structures & Incentives

Refined Systems & Processes

BioConnect Iowa | InnoVenture Iowa

Venture Studio Gaps & Questions to Address

Support

Human Capital

Markets

Culture

Policy

Finance

- Building the culture for and understanding the interest of researchers and Founders for this level of engagement, including dilution.
- Based on the level of services, funding and time provided to founders, determining the right balance between the involvement, control and equity between founders and the Studio
- Building the Studio talent pool, services and processes.
- Building a strong external talent pool to support Studio partnerships: CEO, CFO, Sales, Marketing, Operations, Engineering, etc.
- Strengthening the pool of experienced entrepreneurs and industry mentors to partner with the Studio.
- Strengthen engagement with Iowa's bioscience industry, VCs and customers to foster innovation, identify and validate market opportunities, and serve as resources for startup efforts.
- Providing suitable lab-space and facilities to scale-up start-ups.
- Building Iowa's entrepreneurial culture by communicating the value of Iowa's bioscience efforts and approach and telling the success stories and opportunities in Iowa .
- Funding & support from core partners (IEDA, ISU, Ulowa, industry partners, etc...)



TECONOMY
PARTNERS LLC