

Summary Report

IOWA'S BIOSCIENCE PATHWAY FOR DEVELOPMENT

PREPARED FOR:

The Iowa Department of Economic Development

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July 2004

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Foundations
Government Departments and Programs
Private Businesses
Private Colleges
Regent Institutions
Utility Companies
Venture Capitalists

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Iowa's Bioscience Pathway for Development

Summary and Technical Reports

**Prepared for:
The Iowa Department of Economic Development**

**Prepared by:
Technology Partnership Practice
Battelle**



July 2004

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Acronyms

AUTM	Association of University Technology Managers
BLS	Bureau of Labor Statistics, U.S. Department of Labor
CCUR	Center for Crops Utilization Research
CIAG	Center for Integrated Animal Genomics
CIRAS	Center for Industrial Research and Service
FIRE	Finance, insurance, and real estate
FTE	Full-time employee
GMP	Good Manufacturing Practices
GSP	Gross state product
IBA	Iowa Biotechnology Association
ICIB	Iowa Capital Investment Board
ICIC	Iowa Capital Investment Corporation
IDED	Iowa Department of Economic Development
IDM	Institute for Decision Making
IHCC	Indian Hills Community College
IP	Intellectual Property
IPRT	Institute for Physical Research and Technology
ISI	Institute for Scientific Information
ISU	Iowa State University
LQ	Location quotient
NIH	National Institutes of Health
NSF	National Science Foundation
R&D	Research and development
SBDC	Small business development center
SBIR	Small Business Innovation Research
STTR	Small Business Technology Transfer
SWOT	Strengths, weaknesses, opportunities, and threats
TPP	Battelle Technology Partnership Practice
U of I	University of Iowa
UNI	University of Northern Iowa
USDA	U.S. Department of Agriculture
WARF	Wisconsin Alumni Research Foundation

Summary Report

As the 21st century progresses, the U.S. economy is facing a time of great change that severely impacts the ability of states to maintain their normal economic *modus operandi*. In this nation, where states are free to chart their own courses through the free market economy, the pace of change is likely to produce winners and losers. In winning states, the private sector—with catalytic support from the public sector—is making the proactive decisions and investments that will spur future growth; in other states, they are hampered by a lack of vision and are failing to act at all.

Increasingly, it is technology-based economic development, driven by innovation, talent, and investment capital, that is shaping the future of successful U.S. state economies. An area of science and technology in which rapid advancements are driving development opportunities is that of bioscience. Human, animal, and plant biosciences are driving business opportunities in a broad range of areas such as drugs and pharmaceuticals, research and testing, medical devices, biorenewable chemicals, biomaterials, and biofuels. States, such as Iowa, with core strengths in each of these areas have the opportunity to position themselves to build their bioscience-based economies.

Aware of this potential economic opportunity, the Iowa Department of Economic Development (IDED) retained the services of Battelle's Technology Partnership Practice (TPP) to assess Iowa's core bioscience competencies and to produce a formal strategy and roadmap to drive bioscience growth in the state. The biosciences are complex and diverse; key challenges for any state are to determine which areas of bioscience to pursue and how to allocate resources to accomplish their efficient development. Battelle's analysis provides this guidance.

This strategic roadmap or pathway outlines a comprehensive approach to bioscience-based economic development that requires a long-term commitment from the state, its institutions, and the commercial bioscience sector. Leading technology states have accomplished their growth usually over a decade or more, using a sustained commitment to strategies and actions that build critical mass in research and commercial biosciences—Iowa will need to do no less.

Iowa comes to this path with considerable strengths. It is home to two major bioscience research universities (Iowa State University and the University of Iowa), with supplemental expertise provided by the University of Northern Iowa. In addition to its academic strengths, Iowa is home to a diverse range of bioscience industry, incorporating agbiosciences, traditional biotechnology, pharmaceuticals, medical devices, and various additional sectors. Also, a recent study for BIO, the national biotechnology trade association, compared Iowa's bioscience industry base with the rest of the nation. The report pointed to Iowa's national leadership role in bioenergy, biofuels, and related biomass initiatives. Iowa is one of only six states in the nation that have both a large employment base and a significant specialization in agricultural feedstock and chemicals, which includes organic and agricultural chemicals and agricultural processing and is focused on industrial applications geared toward production agriculture, energy, industrial commodities, and specialty health products.¹

A significant portion of these advances in Iowa's bioscience-based economy can be directly attributed to the initiatives of the state's leaders. In 2001, Governor Vilsack launched a statewide technology cluster

¹ Battelle Technology Partnership Practice and SSTI. *Laboratories of Innovation: State Bioscience Initiatives 2004*, www.bio.org, June 2004.

initiative that identified three areas of focus: biosciences, advanced manufacturing, and information solutions. Furthering this effort, in 2003 the Iowa Legislature approved the Iowa Values Fund, a 7-year, \$503 million state investment in the three cluster areas. The goals of this fund are to help move and grow Iowa's economy, create jobs, and help generate wealth for Iowans. The Iowa Values Fund is composed of four main components:

- Business development and assistance
- University research and development
- Workforce training
- Quality of life.

Iowa also has focused significant programmatic investments to develop tax incentives for research and development, to help universities turn research into business opportunities, and to create venture capital funding to aid business start-ups. For instance, during the 2002 session, Governor Vilsack and the Iowa Legislature enacted an economic stimulus measure designed to encourage private venture capital investment in emerging, expanding, and restructuring business enterprises in communities throughout Iowa. To facilitate the goals set forth in the Act, Governor Vilsack and the Legislature authorized the formation of the Iowa Capital Investment Corporation (ICIC) for the purpose of mobilizing tax credits to incentivize private venture capital investments. ICIC's primary purpose is to organize and manage the Iowa Fund of Funds (Fund of Funds). The Fund of Funds is a private, for-profit limited partnership authorized to make investments in private venture capital funds. To facilitate private investment in the Fund of Funds and minimize the need for public appropriations, the Legislature also authorized the issuance of contingent tax credits to guarantee, at least partially, investments in the Fund of Funds. The Iowa Capital Investment Board (ICIB) oversees the issuance of the tax credits contingent on certain ICIB-developed criteria.

Therefore, while Iowa may not yet have reached a critical mass of bioscience activity that places it among the leading states in all areas of the biosciences, as it now has in agricultural feedstock and chemicals, Iowa has the potential to build on its existing assets and increase its economic and research bases in other segments of the biosciences as well. To that end, this roadmap identifies specific strategies and actions that will serve, if acted upon, to help realize a bioscience-driven economy through leveraging existing organizations and programs and developing new initiatives. In other words, this strategy aims to provide guidance for building a strong Iowa economy for the future.

IOWA'S BIOSCIENCE VISION

With strong public and private leadership and long-term commitment on the part of Iowa's research institutions, business community, nonprofit community, and state and local governments, it is reasonable to expect that Iowa can achieve the following vision by 2014:

Iowa is a leading Midwestern state with a comprehensive set of strengths in the plant, animal, and human sciences. Iowa is a leader in the application of biorenewable resources to create value-added products and has become a significant player in the production of advanced food products, drugs, biologics, and related biomedical technologies. The Iowa biosciences are characterized by strong public-private and industry-university relationships, resulting in a strong base of bioscience companies operating in Iowa in the development and production of plant, animal and human bioscience products.

MISSION

To achieve this vision, Iowa must make the following efforts to approach its future in the biosciences:

- **Invest in the further development of key R&D platforms at Iowa's regent universities², including facilities, equipment, scientific resources, and the attraction and retention of Eminent Scholars and their research teams to generate commercializable innovations from these investments.**
- **Put in place incentives, programs, and organizations that will facilitate and encourage the translation of bioscience innovation into products, processes, and other mechanisms of economic value and wealth creation for Iowa.**
- **Secure capital funding sources that will provide the financial resources necessary to move innovative technology from the research bench to commercialization and into full-fledged entrepreneurial businesses growing, expanding, and succeeding from their base in Iowa.**
- **Apply itself to the creation of an educational, economic, and social environment conducive to the creation, attraction, and retention of human talent at all key bioscience business skill levels—from R&D scientists to experienced management and production personnel.**

Iowa has the potential to develop and sustain leadership in key focused bioscience platforms, but realizing that potential will require Iowa to adopt the best practices proven as drivers of technology-based economic development in other states, including

- *Engaged universities taking an active leadership role;*
- *Intensive networking across sectors and with industry;*
- *Available capital covering all stages of the business cycle;*
- *Discretionary federal or other R&D funding support;*
- *Workforce and talent pool on which to build and sustain efforts;*
- *Access to specialized facilities and equipment;*
- *Stable and supportive business, tax, regulatory, and incentive policies; and*
- *Patience and a long-term perspective.*

METHODOLOGY

To facilitate an in-depth understanding of core bioscience opportunities and to develop a strategy for building the Iowa bioscience economy, the IDED engaged TPP to develop a state bioscience strategy and pathway in a two-phase effort:

- **Economic and core competency analyses of the biosciences in Iowa.** This Phase I work was released March 2004 in the report entitled, *The State of Iowa Biosciences Path for Development: Economic and Core Competency Analyses*. In this report, Battelle examined the current quantitative position of Iowa in commercial bioscience sectors and in academic bioscience R&D and produced a formal assessment of core competencies and fundamental strength platforms upon which Iowa's bioscience economy may be built.

² Iowa's regent universities include Iowa State University, The University of Iowa, and the University of Northern Iowa.

- **A strategy and actions roadmap or pathway.** This Phase II report, embodied herein, provides a summary of the Phase I findings and completes the Iowa Bioscience Pathway by providing specific guidance in bioscience-based economic development.

To complete both Phases I and II assignments, Battelle used both quantitative and qualitative techniques, including more than 500 face-to-face interviews with representatives of industry, academe, government, and other stakeholder organizations in Iowa.³ Meeting the key goals for the project required that Battelle

- Conduct an economic analysis of Iowa's existing bioscience industry, identifying trends, current strengths, emerging industries, and emerging clusters within the biosciences;
- Assess Iowa's position in bioscience research and provide a detailed understanding of the bioscience core competencies that form platforms for future bioscience development;
- Identify key barriers and gaps in private and public investments, policies, programs, and activities that negatively impact Iowa's ability to realize its development potential from the biosciences;
- Outline a series of specific strategies and actions designed to fill in the gaps and maximize the economic advantage of Iowa's core bioscience strengths; and
- Provide an implementation plan, showing action priorities, estimated resource requirements, and an organizational structure for moving the roadmap forward.

IOWA'S BIOSCIENCE BASE

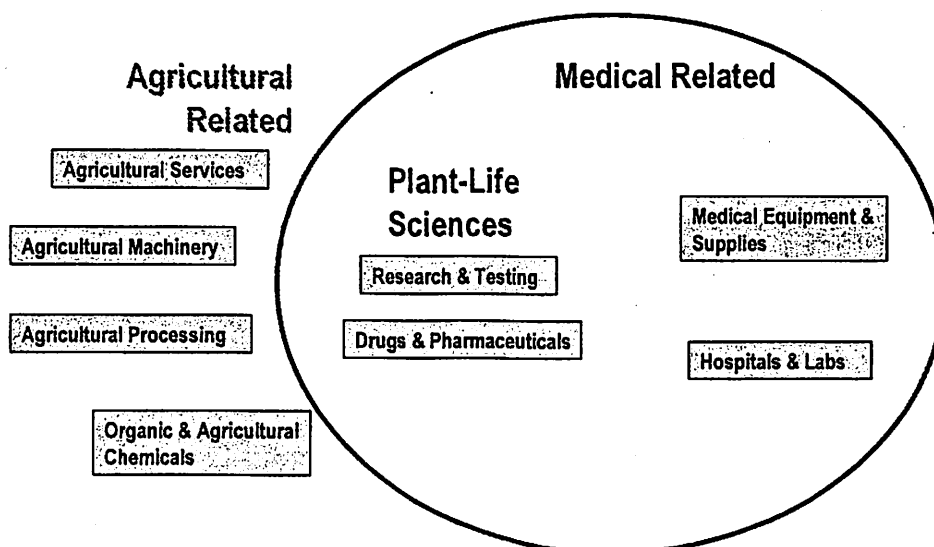
Iowa's Bioscience Industry Sector

This analysis addressed the diversity of the bioscience industry by dividing it into three sectors: agricultural, medical, and plant-life sciences. The agricultural sector consists of those industrial subsectors involved in developing, supporting, and manufacturing new farming and food production technologies for advancing health and nutrition. The medical sector consists of those industrial subsectors involved in manufacturing and developing clinical techniques aimed at and directed toward advancing human health care. The plant-life sciences sector consists of those industrial subsectors involved in research, testing, developing, and manufacturing clinical and agronomic techniques and products for improving the functions of living organisms.

Eight major bioscience subsectors were included in the economic analysis (Figure SR-1). These subsectors encompass a wide variety of industrial activity upon which Iowa is well situated to further build and strengthen its overall bioscience base.

³ Many individuals were interviewed for both Phase I and Phase II of this analysis.

Figure SR-1: Broadly Defined Iowa "Bioscience" Industry



Iowa's Bioscience Cluster

Recent employment trends since 2000 indicate a bioscience growth rate that is above the national average. In Iowa, the bioscience industry experienced above-average employment growth between 2000 and 2002, growing by 5.3 percent and gaining 4,179 jobs. In 2002, the Iowa bioscience industry employed 82,849 individuals across 1,856 establishments. Even more promising is that this growth rate was above the national average. The bioscience industry across the United States grew at a rate of 3.7 percent between 2000 and 2002.

The bioscience industry also represents a sizable portion of Iowa's economy. Bioscience employment concentrations over the same time period consistently accounted for a larger share of state private-sector employment than at the national level. In 2002, bioscience employment in Iowa accounted for 7.0 percent of total state private-sector employment. Nationally, the bioscience industry accounted for 5.6 percent of total private-sector employment.

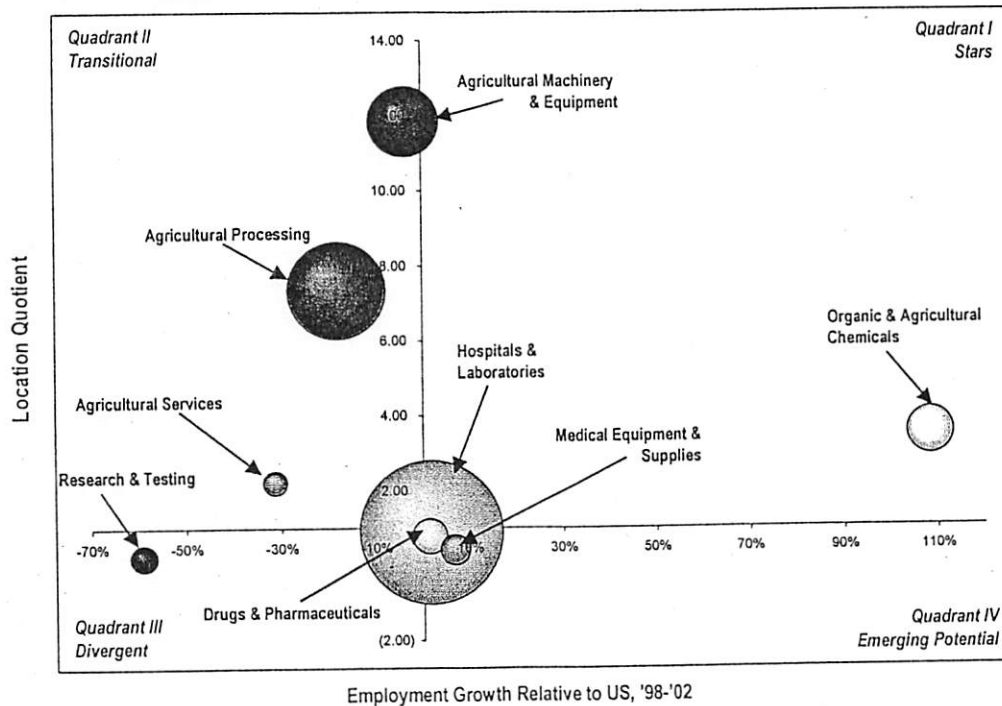
The current level of Iowa's bioscience employment concentration is considered to be regionally specialized. The fact that bioscience employment in Iowa accounts for a larger share of private sector employment than the industry does at the national level results in an above-average location quotient for Iowa. Overall, the state possesses a regional specialization in the bioscience industry that is 24 percent more concentrated than the nation's.

Iowa's Bioscience Cluster Subsectors

Iowa's bioscience subsectors can be categorized into four classes—stars, emerging potential, transitional, and divergent—based upon their growth relative to U.S. growth and their location quotients from 1998 to 2002 (Figure SR-2). Subsectors classified as stars are those that possess significant regional specialization and growth rates exceeding national levels. Emerging potential subsectors are those that are growing more rapidly than the industry at the national level and that present the opportunity to develop a

concentration if rapid growth continues. Subsectors classified as transitional or divergent are not keeping pace with national growth trends. Though the 4-year trend is not irreversible, these subsectors demonstrate current characteristics that may threaten the long-term viability of the industry base in Iowa.

Figure SR-2: Iowa Bioscience Subsector Performance, 1998–2002



Note: Bubble size indicates the subsector employment size.

Source: Battelle calculations based on ES-202 data from the U.S. Department of Labor's Bureau of Labor Statistics and Iowa Workforce Development's Employment Statistics Bureau.

The bioscience industry is a strong driver for the U.S. and Iowa economies, diversifying the economic base; offering good, well-paying jobs; and contributing to overall economic productivity.

Summary and Conclusions

Key conclusions from the economic analysis of Iowa's current economic base include the following:

- The bioscience industry is a significant contributor to the Iowa economy.* In 2002, bioscience employment accounted for 7.0 percent of total employment in Iowa, exceeding the national average of 5.6 percent of total private-sector employment.
- Iowa's bioscience industry is diverse, with subsectors that are growing rapidly.* Iowa has a significant concentration in the organic and agricultural chemicals subsector that is growing rapidly. The drugs and pharmaceuticals and medical equipment and devices subsectors also are growing rapidly. Finally, Iowa has a mature base in the biosciences represented by the number of subsectors in which Iowa is considered to be specialized, including agricultural equipment and machinery, agricultural processing, and agricultural services.

3. The bioscience industry is a tremendous source of well-paying jobs. Compared with other major Iowa industries, the bioscience industry is one of the highest paying in the state. The average wage of a bioscience worker in 2002 exceeded the statewide average annual wage by more than \$12,700 and surpassed wages in such sectors as manufacturing; information; construction; and finance, insurance, and real estate. Because the bioscience industry is diversified, comprises a substantial share of state economic activity, and is a source of high-paying jobs, it is reasonable to support initiatives that focus on it.

IOWA'S BIOSCIENCE R&D BASE

Without a strong bioscience research foundation, it is difficult for any state or region to initiate or sustain major industry development related to the biosciences. Universities are the primary leaders in basic and applied bioscience research. Furthermore, research centers are not only essential to the basic research discoveries that generate product leads for bioscience companies, but also contribute to an environment in which these bioscience companies can flourish. University research centers can be a key asset for the bioscience industry in bridging the gap between basic and applied research.

In identifying core research focus areas in the biosciences, the objective is to identify those fields with a critical mass of ongoing activity and measures of excellence. Core research focus areas are identified using both quantitative and qualitative methods, which for this study included extensive field interviews with more than 360 key administrators, scientists, and researchers across Iowa.

With \$439.8 million in research funds, Iowa ranks 24th in total university R&D funding (according to the National Science Foundation)—notably exceeding its population rank of 30th. Within the academic R&D arena, the state is performing particularly well in the biosciences, with 66 percent of all academic research funds falling under this definition. This level of performance places Iowa 21st in the nation. Also, Iowa ranks better than its population base in the three major macro-categories of bioscience R&D, ranking 19th in medical sciences, 20th in agricultural sciences, and 22nd in biological sciences. However, given Iowa's agricultural base, its ranking in agricultural sciences is a matter of some concern.

OPPORTUNITIES FOR BIOSCIENCE DEVELOPMENT IN IOWA

Core Platforms for Iowa's Bioscience Development

From analysis of peer-reviewed grant activity, publications activity, and interviews with university deans, faculty, and researchers, Battelle has identified six short- or near-term "platforms" that hold potential for the development of the biosciences in Iowa. These include the following:

- **BioEconomy Platform**—Using plant and animal biomass and waste streams to generate chemicals, energy, fuels, and materials for industrial and commercial applications.
- **Integrated Drug Discovery, Development, Piloting, and Production Platform**—Leveraging Iowa's strengths in basic biomedical research, drug development, and Good Manufacturing Practice(s) production into an integrated pipeline of new drugs and therapeutics.
- **Advanced Food and Feed Platform**—Using Iowa's established strengths in plant and animal sciences, production agriculture, food science, nutrition, and processing technology to develop and produce functional foods and nutraceuticals.

- **Integrated Post-Genomic Medicine Platform**—Using Iowa's genomics expertise and specific disease/disorder skills, in conjunction with epidemiologic data and Iowa's stable population, to produce rapid advances in post-genomic medicine and associated discoveries.
- **Animal Systems Platform**—Using Iowa's bioscience and genomics expertise to establish a leadership position in the modeling of animal systems and in the development of technologies and applications for genes, genetic markers, transgenic animals, chimeric animals, and cloning.
- **Integrated Biosecurity Platform**—Deploying the strengths of Iowa's institutions in human, animal, and plant disease prevention, protection, and treatment to establish an integrated approach to securing the environment, food production systems, and human health and safety.

These six areas represent broad platforms upon which a significant R&D base, business base, and bioscience economy may be built in Iowa in the near to short term. They each specifically draw upon Iowa's institutional expertise in multiple fields, because multidisciplinary research increasingly is gaining importance in driving funding, new study areas, technologies, discoveries, and commercializable innovations. In each case, the analysis shows that these platforms match well with large and rapidly growing projected domestic and international markets. In most cases, the markets are characterized in terms of having expanding multibillion-dollar existing and emerging potential.

In addition to the broad technology platforms, biomedical imaging is a niche platform offering an opportunity for development in the near term. Four emerging, longer-term opportunity areas representing potential for additional sector development include

- Host-Parasite Biology and Systems;
- Instrumentation, Devices, and Sensors;
- Formation of a Cardiovascular Research Institute; and
- Formation of a Free Radical Research Institute.

It should be noted that the list of near-term competencies will need to be nurtured and developed over the long term as well. In addition, other cross-cutting, enabling technologies (such as bioinformatics) will affect the potential for these platforms, and investments will need to be considered.

IOWA'S COMPETITIVE POSITION IN THE BIOSCIENCES

Further investigation of Iowa's position in the biosciences and bioscience-based economic development was accomplished through the use of a SWOT (strengths, weaknesses, opportunities, and threats) analysis. This analysis was accomplished through one-on-one interviews, small group discussions, and focus groups involving leaders throughout the state.

STRATEGIES AND ACTIONS

Gap Analysis

Conclusions from the SWOT analysis drove the identification of key issues that need to be addressed for Iowa to achieve its mission and accomplish its bioscience economic development vision. These issues represent gaps in creating an integrated, wealth-generating continuum that begins with R&D and culminates in full-scale and ongoing bioscience business operations. Figure SR-3 summarizes the key gaps that must be addressed to realize Iowa's bioscience development potential.

Figure SR-3: Iowa's Key Gaps Along the Biosciences Development Continuum

	Research	Technology Development	Bioscience Firm Formation	Firm Attraction & Expansion
Key Gaps	<ul style="list-style-type: none"> • Need to strengthen certain research areas with additional faculty and research personnel • Need to reinforce platforms with additional equipment and resources • Need to encourage and reward faculty and staff R&D leading to translational discoveries • Need to encourage and reward faculty and staff work in commercialization and collaborative programs with targeted bioscience industry • Need to incentivize the creation of key collaborative consortia to accelerate platform progress 	<ul style="list-style-type: none"> • Need discretionary funds to facilitate de-risking and prototyping activities with promising university technologies • Need to enhance staffing and resources for university technology transfer and entrepreneurship • Need to provide funding to facilitate and leverage industry-to-academe relationships • Need to enhance industry access to faculty, equipment, and resources • Need a senior bioscience advocate or office within state government 	<ul style="list-style-type: none"> • Need to increase mentoring, support and assistance for entrepreneurs • Need to increase availability of skilled managerial staff for start-up enterprises • Need to provide access to seed funding and early stage angel/venture financing rounds • Need to increase incubator and accelerator space proximate to main university campuses • Need to increase networking and advocacy capacity of bioscience support associations 	<ul style="list-style-type: none"> • Need to increase the visibility and voice of the sector in Iowa • Need to anchor growing bioscience businesses in Iowa with access to expansion capital and targeted incentives and favorable policies • Need to build critical mass of companies in core platform-based sectors • Need to enhance the connectivity of post-secondary education and workforce development providers to bioscience industry • Need to facilitate key supply-chain linkages and development of support sectors

Strategies and Actions

For biosciences to realize their potential as a major economic engine for Iowa, the state must simultaneously address both the strengthening of research drivers and the efficient development of commercial enterprise from research innovations. Four strategies and 20 associated actions have been identified to further develop Iowa's bioscience research base and build a critical mass of bioscience companies.

- **Strategy One:** Build Iowa's bioscience research capacity around selected technology platforms focusing on investments in talent, facilities, and equipment.
- **Strategy Two:** Encourage and facilitate the commercialization of bioscience R&D to enhance opportunities for start-up, emerging, and existing Iowa firms.
- **Strategy Three:** Foster a business environment that supports, sustains, and encourages the growth and sustainability of bioscience firms in Iowa.
- **Strategy Four:** Invest in and develop Iowa's bioscience talent pool.

These strategies and associated actions are summarized in Table SR-1. Implementation of these strategies and actions is anticipated as a 5-year period. *Immediate* priorities should be undertaken in the next year to 18 months, *short-term* priorities should be undertaken in 18 months to 3 years, and *mid-term* priorities in 3 to 5 years.

Table SR-1: Iowa Bioscience Pathway Strategies and Actions

Strategy	Actions	Priority
Strategy One: Build Iowa's bioscience research capacity around selected technology platforms focusing on investments in talent, facilities and equipment.	<ul style="list-style-type: none"> Undertake key recruitment, capacity building, and required investments to ensure rapid scientific progress in the core bioscience platforms. 	Short-term
	<ul style="list-style-type: none"> Create an Endowed Chairs Program to attract world-class, entrepreneurial talent in the core bioscience platforms. 	Short-term
	<ul style="list-style-type: none"> Form a Strategic Technology Platform Infrastructure Fund to strengthen and accelerate the scientific and commercialization work of the core bioscience platforms. 	Short-term
	<ul style="list-style-type: none"> Engage Iowa's Congressional Delegation in discussions pertaining to federal funding and specific project support. 	Immediate
	<ul style="list-style-type: none"> Institute an industry-university matching grant program dedicated to the identified bioscience technology platforms to encourage relationships between academic researchers and industry. 	Immediate
Strategy Two: Encourage and facilitate the commercialization of bioscience R&D to enhance opportunities for start-up, emerging, and existing Iowa firms.	<ul style="list-style-type: none"> Create and Fund an Economic Development Director position at the Iowa Board of Regents to provide catalytic support for regent university economic development initiatives. 	Immediate
	<ul style="list-style-type: none"> Develop and implement policies and procedures that actively encourage faculty entrepreneurship and commercialization activities at the regent universities. 	Immediate
	<ul style="list-style-type: none"> Increase funding to the regent universities to allow for sufficient staffing and resources for commercialization activities. 	Immediate
	<ul style="list-style-type: none"> Establish and fund a University Entrepreneurs Center at each university. 	Short-term
	<ul style="list-style-type: none"> Form a statewide commercialization intermediary for supporting, building, and sustaining development of new bioscience business enterprises in Iowa. 	Immediate

Table SR-1: Iowa Bioscience Pathway Strategies and Actions (continued)

Strategy	Actions	Priority
Strategy Three: <i>Foster a business environment that supports, sustains, and encourages the growth and sustainability of bioscience firms in Iowa.</i>	<ul style="list-style-type: none"> Form the Iowa Bioscience Alliance to facilitate communications, foster joint approaches to issues, and develop a critical mass of support to stimulate actions required to realize Iowa's bioscience vision. 	Short-term
	<ul style="list-style-type: none"> Establish a State Bioscience Advocate position, reporting to the Director of IDED, to drive the implementation of this strategy. 	Short-term
	<ul style="list-style-type: none"> Implement Iowa's bioscience image and brand through aggressive marketing, public relations, and signature events. 	Immediate
	<ul style="list-style-type: none"> Review and make necessary changes to state incentives (including the Iowa Values Fund), tax policies, and legal code to be responsive to the needs of growing bioscience firms. 	Short-term
	<ul style="list-style-type: none"> Conduct an economic impact study to measure the projected returns to the state and its regions that are estimated to result from proposed bioscience investments. The study should pay special attention to geographic equity and the diffusion of innovation benefits throughout the state. 	Short-term
	<ul style="list-style-type: none"> Develop a training program for state and local economic development professionals that would include information on university bioscience technology platforms and technical capabilities, the specialized needs of bioscience companies, and programs and incentives that can be used to assist new bioscience ventures and expanding and/or relocating firms. 	Mid-term
Strategy Four: <i>Invest in and develop Iowa's bioscience talent pool.</i>	<ul style="list-style-type: none"> Improve K-12 scientific education by focusing on stimulating interest among Iowa's children in science, thereby preparing them for careers in Iowa's growing bioscience sectors. 	Mid-term
	<ul style="list-style-type: none"> Develop a bioscience vocational career education program and ensure seamless delivery between secondary and community college programs that serve Iowa's growing concentration of bioscience employers. 	Mid-term
	<ul style="list-style-type: none"> Streamline bioscience articulation agreements within and between community colleges and Iowa's regent universities to allow students to transfer credits between academic institutions. 	Short-term
	<ul style="list-style-type: none"> Leverage alumni associations and the state's Human Resources Recruitment Consortium to attract to Iowa bioscience professionals, including experienced bioscience managers. 	Immediate

IMPLEMENTATION PLAN

Obviously, the biosciences already are an important part of the Iowa economy and show great potential for expanding their positive economic impacts for the state. However, if Iowa is to achieve its vision for the biosciences, it must aggressively implement the strategies and actions outlined in this report. Because the state does not have unlimited resources, it is, of course, important to set priorities. The following section summarizes the critical actions that must be taken to develop Iowa's bioscience sector.

Critical Actions

To realize the full bioscience economic potential that this roadmap lays out, Iowa must successfully implement certain critical actions. Specifically, the ultimate success of the strategy hinges on the forward movement of six activities, in essence Iowa's bioscience critical path. In other words, it is these six critical actions that are most significant to, and the underlying foundation for, the eventual success of this strategy. Therefore, when initial resource allocations are being determined, efforts must be made to ensure that the following critical actions receive funding priority:

- **Form a Strategic Technology Platform Infrastructure Fund to reinforce the core bioscience platforms** by supporting faculty recruitment, entrepreneurial endowed chairs, and other key actions. The fund will be directed through academic consortia set up to develop the six bioscience platforms. Financed perhaps by bonds or other sources, the fund also would provide infrastructure and equipment funding to reinforce the platforms.
- **Develop and implement policies and procedures at the regent universities** to ensure the highest level of encouragement and support for private-sector partnering, commercialization, and entrepreneurship.
- **Form a statewide commercialization intermediary for supporting, building, and sustaining development of new bioscience business enterprises in Iowa.** This organization will proactively assist Iowa's bioscience entrepreneurs, and provide business development services to companies formed from university-based technology transfer and commercialization efforts and from other sources of intellectual capital.
- **Form the Iowa Bioscience Alliance** to serve as a guiding force in engaging industry in the strategy implementation and stewardship. Connect the Alliance to the proposed academic consortia to be formed around the bioscience platforms to ensure industry-university collaboration of platform R&D and commercialization of innovations.
- **Institute an industry-university matching grant program** dedicated to the identified bioscience technology platforms to boost bioscience R&D collaborations between academia and industry in Iowa.
- **Increase funding to the regent universities to allow for sufficient staffing and resources for commercialization activities.**

The above actions will ensure the following: that the strengths of the current core bioscience platforms are leveraged and further built; that industry and academe work together on joint R&D initiatives to develop commercial innovations from each platform; that funding and support are available to develop bioscience entrepreneurs and their business ventures; and that the regent universities are optimally leveraged for the bioscience-based economic development of the state.

Immediate Priorities

Immediate work plan priorities are those steps that should be undertaken in the first 12 months of strategy implementation, regardless of how critical they are to the overall strategy. Several immediate priorities can be implemented right away, while others will need to be planned and allocated funds before they can become fully operational. The following actions should be undertaken in the first year:

- Create and fund an Economic Development Director position on the Iowa Board of Regents to provide catalytic support for regent university economic development initiatives.
- Develop and implement policies and procedures that actively encourage faculty entrepreneurship and commercialization activities at the regent universities.
- Engage Iowa's Congressional Delegation in discussions pertaining to federal funding and specific project support.
- Institute an industry-university matching grant program dedicated to the identified bioscience technology platforms to encourage relationships between academic researchers and industry.
- Increase funding to the regent universities to allow for sufficient staffing and resources for commercialization activities.
- Form a statewide commercialization intermediary for supporting, building, and sustaining development of new bioscience business enterprises in Iowa. The commercialization organization will work to address technology, capital, and talent issues.
- Implement Iowa's bioscience image and brand through aggressive marketing, public relations, and signature events.
- Leverage alumni associations and the state's Human Resources Recruitment Consortium to attract to Iowa bioscience professionals. An initial emphasis should be placed on attracting individuals with experience in bioscience management.

Resource Requirements

For each action, Table SR-2 indicates the priority of the action, breaks down state funding needs into two 5-year phases, and indicates the anticipated external leverage. In addition to the Iowa Bioscience Pathway financial plan detailed in Table SR-2, the proposed revenue sources to be allocated from the state for this financial plan are broken down in Table SR-3. Overall, total costs to the state government in two 5-year phases are \$301.6 million, of which \$169.8 million is bond financed and \$131.8 million is financed through general fund appropriations. State general fund and bond financing investments over a 10-year period are estimated to generate external leverage of more than \$1.5 billion, or \$5 of outside funds for every \$1 invested by the state. Bond financing support is focused on further building Iowa's strengths in its technology platforms and the associated investments found in several actions primarily under Strategy One. Phase I totals \$144.2 million, including bond financing of \$96.8 million for capacity building of infrastructure, recruitment, and matching support; and \$47.4 million in general fund appropriations. In Phase II (years 6 to 10), state funds of \$157.3 million would be required, including \$73 million in bond financing for further capacity building and \$84.3 million in general fund appropriations.

Table SR-2: Iowa Bioscience Pathway Financial Plan

Action	Priority	Annual State Funding by Year: Years 1-5	Annual State Funding by Year: Years 6-10	Estimated One- Time Costs	Leverage Ratio of Private and Federal Funds
Capacity building in the key platform areas	Short-term	Consortia: \$1.2 M increasing to \$2.0 M by year 5 Matching grants: \$1.7 M increasing to \$3.8 M—this item covered under Infrastructure Fund	Consortia: \$2 M per year rising to \$5 M by year 10 Matching grants: \$3.8 M staying constant years 6-10	\$10.188 M annually for first 5 years for platform investments, or \$50.94 M from the bond-financed Strategic Investment Fund (see below)	9:1 federal funding leverage based on other state performance
Entrepreneurial Endowed Chairs program	Short-term	\$2 M per year for 3 years and \$1M in year 4	Second round of additional chairs: \$3 M for 3 years and \$1.5 M in year 4		2:1 (match to state funds)
Strategic Technology Platform Infrastructure Fund	Short-term	This Fund supports above actions in capacity building of platforms and endowed chairs as well as matching grants item below and one-time costs of these and prototype fund		\$169.44 M capitalization via bonds with \$96.76 M in Phase I 5-year period and \$73 M in Phase II 5-year period	
Engage Iowa's Congressional Delegation for federal funding	Immediate	Existing resources			
Industry-university matching grant program	Immediate	Initial year funding at \$1.5 M rising to \$3.0 M by year 5	Years 6 through 10 rise from \$3.0 M to \$5.0 M		3:1 (match to state funds)
Economic Development Director position on the Iowa Board of Regents	Immediate	\$150,000 per year	\$175,000 per year		

Table SR-2: Iowa Bioscience Pathway Financial Plan (continued)

Action	Priority	Annual State Funding by Year: Years 1-5	Annual State Funding by Year: Years 6-10	Estimated One-Time Costs	Leverage Ratio of Private and Federal Funds
Policies and procedures that actively encourage faculty entrepreneurship and commercialization	Immediate	\$200,000 per year	\$240,000 per year		
Funding to the regent universities for commercialization activities/tech transfer	Immediate	<p>\$2.9 M in year 1 increasing to \$9.55 M in year 5</p> <p>Mining: start at \$300,000 and increase to \$600,000 by year 5</p> <p>TT: start at \$1.5 M and increase to \$5.8 M by year 5</p> <p>Business development: start at \$300,000 and increase to \$750,000 by year 5</p> <p>Industry liaison: start at \$300,000 and increase to \$1.2 M by year 5</p> <p>Marketing and communications: start at \$500,000 and increase to \$1.2 M by year 5</p>	<p>Increase by 10% per year or:</p> <p>Year 6: \$10.5 M</p> <p>Year 7: \$11.55 M</p> <p>Year 8: \$12.71 M</p> <p>Year 9: \$13.98 M</p> <p>Year 10: \$15.38 M</p>	\$1 M to be covered as infrastructure funds from Strategic Infrastructure Fund	6:1 leveraged return in increased sponsored research, licensing revenue, and equity in start-ups
Establish a University Entrepreneurs Center	Short-term	\$450,000 per year	Years 6 and beyond increase to \$600,000 per year		

Table SR-2: Iowa Bioscience Pathway Financial Plan (continued)

Action	Priority	Annual State Funding by Year: Years 1-5	Annual State Funding by Year: Years 6-10	Estimated One-Time Costs	Leverage Ratio of Private and Federal Funds
Form a statewide commercialization intermediary	Immediate	\$1 M year 1 \$1.5 M year 2 \$2 M years 3, 4, and 5	Years 6 and beyond increase to \$2.2 M per year	\$3 M to \$5 M Prototype Development Fund over first 5 years and similar amount for years 6-10 financed by Infrastructure Fund \$25 M to \$50 M initial capitalization for BioSeed Fund as part of Fund of Funds (nondirect state) and privately financed thereafter	Leveraged 6:1 return in private funds, sales, and other income
Form the Iowa Bioscience Alliance	Short-term	\$400,000 in year 1 decreasing in year 5 to \$100,000	Ongoing support in years 6 and beyond of \$100,000 per year		Leverage 3:1 private, university, and other funds
Establish a State Bioscience Advocate position	Short-term	\$125,000 in year 1 increasing to \$175,000 in year 5	\$200,000 in year 6 increasing to \$300,000 in year 10		
Implement Iowa's bioscience image and brand through aggressive marketing	Immediate	As currently budgeted IDED			
Review and make necessary changes to state incentives, tax policies, and legal code	Short-term			\$100,000 for study and review in year 2	
Conduct an economic impact study for bioscience strategy	Short-term			\$100,000 for study and review in year 1	

Table SR-2: Iowa Bioscience Pathway Financial Plan (continued)

Action	Priority	Annual State Funding by Year: Years 1-5	Annual State Funding by Year: Years 6-10	Estimated One-Time Costs	Leverage Ratio of Private and Federal Funds
Develop a biosciences-development training program for state and local economic development professionals	Mid-term	\$470,000 for UNI's IDM operations funded (currently they are at \$280,000) beginning in years 2 through 5	Maintain funding at \$470,000 per year in years 6 through 10		
Improve K-12 scientific education	Mid-term	To be determined			
Provide articulation agreements between K-12 and community colleges in bioscience education	Mid-term			\$500,000 in year 3	
Streamline bioscience articulation agreements within and between community colleges and universities	Short-term	Existing resources			
Leverage alumni associations and the state's Human Resources Recruitment Consortium	Immediate	Existing resources			

Table SR-3: Financial Plan by Year and Proposed Sources of Revenue
(state funds only—dollars in millions)

Year	Total State Investments	Bond Financed	General Fund Support
1	21.913	16.588	5.325
2	30.193	22.633	7.530
3	29.878	19.738	10.140
4	30.158	18.813	11.345
5	32.083	18.988	13.095
Subtotal Year 1-5	\$144.225	\$96.76	\$47.435
6	26.685	12.200	14.485
7	33.930	18.350	15.580
8	31.265	14.500	16.765
9	32.195	14.150	18.045
10	33.265	13.800	19.465
Subtotal Year 6-10	\$157.340	\$73.000	\$84.340
Grand Total	\$301.565	\$169.76	\$131.775

Organization and Structure

State science and technology initiatives are most effective when they are executed on a bipartisan basis, with strong executive and legislative branch support, involvement, and cooperation. States such as Pennsylvania, New York, Maine, Maryland, and North Carolina have been successful with their science and technology investments because their efforts have been broad based, they have mobilized private sector champions behind them, and their initiatives have become institutionalized into both economic development and higher education at state and regional levels.

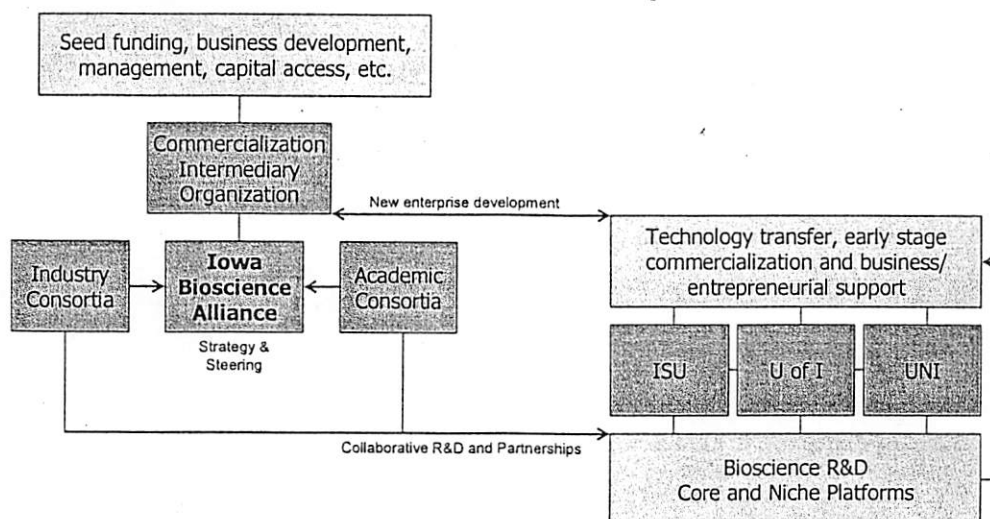
The following deficiencies indicate that Iowa is less than optimally organized to develop its bioscience-based economy:

- No Science and Technology Office, Science and Technology Advisor, or Bioscience Advocate at the state government level. As a result, policies are more likely to be enacted in an *ad hoc* fashion, rather than following a formal strategic plan and pathway.
- No economic development function coordinated at the level of the Iowa Board of Regents. Thus, the individual universities hold sole responsibility for setting strategy and actions.
- Declining funds to support regent university economic development, technology transfer, and commercialization activities. With budget cuts of more than 60 percent in the past 3 years, the regent universities have seen their organizational capacity in these key functions drastically reduced.
- Small and comparatively under-resourced bioscience-related industry organizations (such as the Iowa Biotechnology Association and BIOWA). Therefore, the services and bioscience development initiatives they can undertake are limited.
- No clear organizational and assistance structures for would-be bioscience entrepreneurs to follow in terms of accessing business development assistance, prototype development and pre-seed/seed funding, management talent, expansion capital, etc.

To help solve these organizational deficiencies, the Iowa Bioscience Pathway proposes a set of strategies and actions that involve multiple public and private organizations and entities. These strategies and actions have been designed to build on the base of organizational capabilities that currently exist in Iowa and to provide resources and actions that create a structure for filling critical gaps.

Directing and administering the implementation of the Iowa Bioscience Pathway are critically important functions. Given the important role that industry, academe, and government each must play, it is imperative that an organization be structured that will engage each of these groups in the process. The logical convening entity would be the Iowa Bioscience Alliance (as shown in Figure SR-4). The Alliance, staffed and financially supported by the Iowa Department of Economic Development, would be a formal collaboration between industry and academe. Industry and academic consortia, established for each bioscience platform, would be the core constituent components of the Iowa Bioscience Alliance, working to advance applied bioscience R&D in the state. In addition, it is proposed that the commercialization intermediary organization directly report to the Alliance.

Figure SR-4: Basic Organizing Structure of Iowa Bioscience Development



Measures of Success and Accountability

The following measures and performance goals, to be monitored on an ongoing basis by the Iowa Bioscience Alliance, should be used to determine the successful accomplishment of performance objectives:

- There will be more than 130 new bioscience business start-ups in Iowa by 2014.
- Iowa's location quotient in all the biosciences will exceed 1.4 to 1.5 by 2008, compared with 1.24 in 2002.
- Iowa will increase its university R&D funding (primarily from federal sources) for bioscience-related research from \$291 million in 2001 to \$700 million by 2010 and more than \$900 million by 2014.
- The state will leverage at least \$5 in federal and other dollars for every \$1 of state support.
- There will be substantial implementation progress on the actions outlined in this pathway – at least 70 percent will have substantial action after 3 years and 90 percent within 5 years.

10-Year Economic Impact

The state's proposed investment of \$302 million in bond financing and general fund support over the next 10 years will leverage an estimated \$1.5 billion in federal, industry, and other funds. This level of investment is projected to translate into more than 5,100 private sector jobs through new and relocated firms, as well as an additional 10,950 private sector jobs from an indirect multiplier impact on other industries and businesses, for a total projected impact of 16,050 jobs by the year 2014. These numbers likely will increase substantially in a 15- to 20-year period as the exponential impact multiplies again and again. Total sales in year 10 are projected at nearly \$1.4 billion.

Although it takes considerable time for state and private investments to have measurable impacts on a state economy, it is important to note that the overall economic impacts surely will include some that cannot be projected such as additional increases in direct university employment and retained private sector jobs with higher skills and better pay.

CONCLUSION

Iowa has the opportunity to build its economy through the application of advanced biosciences. Indeed, given the state's agricultural-bioscience expertise, its leading-edge work in biorenewables, and its distinct strengths in various areas of human and animal medicine, the biosciences represent the most logical path to a high-productivity, high-wage, 21st century economy. Iowa already is beginning to see distinct progress around advanced areas of bioscience; but, a definite opportunity exists to accelerate the process and optimize the growth of the sector in the state.

This pathway for development lays out a detailed approach to accomplishing bioscience-based economic development in Iowa. The strategy puts forward a bioscience agenda that effectively integrates the private, public, and academic sectors in Iowa into a unified driving force for development centered on Iowa's bioscience platform strengths. In addition, the pathway seeks to leverage the significant momentum that already has been built through the state's investments in programs such as the Iowa Values Fund.

However, for Iowa to succeed in achieving its bioscience vision, the state must take a comprehensive approach that addresses each of the key recommendations in this strategy. Strengthening Iowa's bioscience research infrastructure will result in jobs and income for the citizens of Iowa only if research findings are commercialized and new companies created based on technological innovation. Similarly, for commercialization to be successful, there must be a steady pipeline of discoveries. To retain and grow bioscience firms, firms must feel that Iowa supports them in its policies and regulations. And lastly, if Iowa's economy is to benefit from innovation in the biosciences, the state must have a talent pool ready to fill the new jobs created in bioscience companies. A comprehensive and integrated approach is needed for Iowa to become a significant player in the biosciences.