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Cultivating New Growth: A Profile of Minnesota's Biotechnology Companies

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—Trade &—
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Development

Introduction

Biotechnology is often touted as a promising industry with significant potential for fueling future economic growth. Locally, statewide, and nationally, economic developers are seeking to identify those factors that will facilitate strong growth of the industry in their respective regions. With Minnesota's rich background in medical and agricultural technology and its renowned research institutions, biotechnology may become a significant contributor to the state's future economic growth.

Recently, there has been extensive interest in the local and national media about the state of biotechnology in Minnesota¹. Some articles suggest that Minnesota has fallen behind in the development of a biotechnology industry presence or that Minnesota's biotechnology startup companies' challenges will continue to hinder industry development. However, some reports also stress the state's strengths in complementary areas, such as medical technology; industrial biotechnology innovations and the significance of partnerships among industry, educational/research institutions and government.

To date, there are no existing studies that directly describe the biotechnology industry in Minnesota. The biotechnology industry is not defined by standard statistical sources and as a result, there is no readily available source of data that describes employment, revenues, wages and related variables for the industry. In addition, different organizations use various definitions of the term "biotechnology".

With all these aspects in mind, the Minnesota Department of Trade and Economic Development (DTED) collaborated with MNBIO – Minnesota's leading trade association representing the biotechnology industry – to launch an effort to better understand biotechnology activities occurring in

¹ For example, articles have recently appeared locally on Minnesota Public Radio on June 12, 2002 (interview with Heath Lukatch, a US Bancorp Piper Jaffray venture capitalist specializing in biotechnology) and July 2, 2002 (interview with Bill George, former Medtronic Chief Executive Officer); the *Pioneer Press* on July 7, 2002 ("U Buys into Biotech" by Dave Beal and "The Bright Stuff" by Jim McCartney); and the *Star Tribune* on July 8, 2002 ("Business Forum: Seed Capital – A Famine in the Land" by Harlan Jacobs).

Minnesota. The partnership conducted a survey aimed at identifying the types of biotechnology activities that were occurring in Minnesota, general characteristics of the businesses that perform these activities, and the areas in which these businesses possibly needed external assistance.

Key highlights:

1. Biotech respondents were classified within many standard life-science-related industries, and particularly in R&D and testing-related services. Respondents were also from non-traditional biotech industries such as computer-related services. However, not all respondents in these industries were biotechnology firms. It is also possible that other industries that were not surveyed include some firms that perform biotechnology activities.
2. The firms with biotechnology activities tended to be relatively small, employing fewer than 10 employees and generating less than \$5.0 million in annual biotech-related revenues. The firms were also relatively young, having operated in biotechnology areas for less than 10 years. The biotechnology firms were located throughout Minnesota, though two-thirds were in the Twin Cities, similar to the overall distribution of businesses in the state.
3. More than half (52 percent) were involved with biochemistry and immunochemistry-related technologies, followed by bioprocessing-related technologies (37 percent).
4. Almost half of respondents offered products and services related to human health, while about one-fifth sold products and services in either environmental or agricultural areas. Firms tended to focus their products and services into one, or at most two, areas.
5. Inadequate financing was one of the most common obstacles faced by the respondents, followed by regulatory issues. The respondents felt that Minnesota could support the development of biotechnology by addressing these two areas.

Other Studies

A variety of approaches have been used to quantify the biotechnology industry. Many studies have used statistics on various sets of Standard Industry Classification (SIC) codes or general qualitative industry descriptions.² Because "biotechnology" is not one of the industries defined in the SIC system, using standard statistics to describe the biotechnology industry may not result in a complete picture. Some biotechnology activities are interdisciplinary and therefore cannot be matched with a single SIC code, or a single SIC code may include businesses that are involved with biotechnology and others that are not.

Studies in Canada, France and Australia attempted to address these issues by surveying businesses. The Canadian surveys, which had been administered three times over several years (in contrast to the French and Australian studies), served as a basis for DTED's study. The Canadian studies surveyed companies based on SIC codes in which biotechnology activities would likely occur. Respondents were then asked to indicate their biotechnology activities from a list.

A recent study by Cortwright and Mayer³ examined U.S. metropolitan areas' biotechnology industries and identified a strong research base (higher education or research institutions supporting researchers) and the commercialization of research findings to be most critical to successful biotechnology industries. Minneapolis-St. Paul was not listed among the leading biotechnology centers in the United States. However, this study was limited to medical and pharmaceutical areas of biotechnology.

Another study by Cincinnatus, Inc.⁴ assessed general business conditions for the biomedical and

biotechnology companies in Minnesota but did not directly examine the nature of biotechnology activities in the state.

In a variety of reports, biotechnology businesses identify the following factors as key to their growth and success. Some identify a shortage of investment capital and investors knowledgeable in biotech companies and products. Affordable access to laboratory space, technology and equipment, such as through incubators or leasing arrangements enable startups to survive financially. Qualified and experienced personnel (researchers and managers) are critical to continued research and development operations. The availability of transportation options that provide convenient and quick access to key customers, manufacturing plants and headquarters are also important site location factors.⁵

Methodology

DTED collaborated with MNBIO to develop the list of biotechnology activities used to define the industry, the pool of companies that would receive the survey, and the survey instrument. The aim was to develop a broad definition of biotechnology that encompassed the health and medical; agricultural and food; industrial and environmental manufacturing, and services industries, as well as research areas.

Please see Appendix I for more detail on Methodology. Appendix II contains the list of industries that was surveyed and Appendix IV contains the list of activities used to define biotechnology in Question 1 of the survey instrument.

Respondents were requested to select their areas of biotechnology activities or to return the blank survey if they did not perform biotechnology activities. There were 349 total respondents for an overall response rate of 26 percent. Of the 349 respondents, there were 65 respondents who performed biotechnology activities (18.6 percent of the respondents) and 284 who did not (81.4 percent of the respondents). The relatively low share of respondents from the initial SIC industry list that were actually engaged in biotechnology activities shows one of the limitations of some studies that

² For example: "The Economic Contributions of the Biotechnology Industry to the U.S. Economy", Ernst & Young Economics Consulting and Quantitative Analysis (May 2000); "State Government Initiatives in Biotechnology 2001", Technology Partnership Practice, Battelle Memorial Institute and State Science and Technology Institute for Biotechnology Industry Organization (BIO) (September 2001).

³ Cortwright, Joseph and Heike Mayer. "Signs of Life: The Growth of Biotechnology Centers in the U.S." The Brookings Institute, June 2002.

⁴ "What It Takes to Thrive: Viewpoints of Biomedical and Biotechnology Companies in Minnesota." Cincinnatus, Inc. Minneapolis, MN. December 2002.

⁵ Presentation by Dennis J. Donovan to "BIO '96 – Unique Aspects of Location Decision-making for the Biotech Industry", June 13, 1996.

characterize biotechnology activities by solely relying on standard SIC-based statistics.

A statistical test (chi-square test) was performed to compare the distribution in the original sample (1,337 businesses) and in the responding sample (349 businesses) by three-digit SIC codes. The difference in the two distributions was not statistically significant at a 95 percent level of confidence, implying that the results can be extended from the responding sample to the surveyed sample and to the population of the selected SIC codes.

About two-thirds of the biotech respondents were classified as research and development, and testing services, followed by 11 percent in surgical and medical instruments industries. Respondents in agricultural-related industries, drugs and pharmaceuticals, and medical and dental labs accounted for the next largest shares.

Survey Results

Biotech respondents were classified across many standard industry codes, and particularly in R&D and testing-related services. However, not all respondents in the selected SIC groups were biotechnology firms. Of the 349 firms that returned surveys, only 65 respondents indicated that they performed at least one of the biotechnology-related technologies listed.

❖ **More than half of respondents (52 percent) were involved with biochemistry and immunochemistry-related technologies. The next largest group of respondents performed bioprocessing-related technologies (37 percent).**

Firms described the different types of technologies they used. More than half of the respondents operated biochemistry and immunochemistry technologies (52 percent). The next most common areas were bioprocessing (37 percent) and DNA-based technologies (25 percent).

Firms tended to specialize by limiting their operations to one or two types of technologies; 38 percent of respondents operated in each one or two types of biotechnology. About 17 percent of respondents indicated biotechnology activities in three or more areas.

Further examining the activities of firms by type or area of biotechnology, firms involved in the general area of biochemistry and immunochemistry and DNA tended to operate two or three different technologies on average. Firms operating in other types of biotechnology were more likely to use one technology.

The most commonly practiced technologies in the biochemistry and immunochemistry area were Microbiology, Virology, and Microbial Ecology (35 percent of those operating biochemistry and immunochemistry technologies), Biomaterials (29 percent), Drug Design and Delivery (26 percent), and Diagnostic Tests/Antibodies (24 percent).

More than half of firms operating in the bioprocessing area performed Fermentation, Bioprocessing, Biotransformation, and Natural Products Chemistry technologies (58 percent) and Extraction, Purification and Separation technologies (54 percent).

Half or more of the firms involved in DNA-based areas used DNA Sequencing, Synthesis and Amplification (56 percent), Gene Probes/DNA Markers (50 percent) and Genetic Engineering and Recombinant DNA (44 percent) technologies.

Appendix III contains the complete frequency distribution of biotechnology activities.

❖ **A slightly larger share of firms provided services than produced goods or conducted research. Almost half of end-products and services were geared toward human health.**

Most of the respondents were services providers (32 percent), followed by manufacturers (29 percent) and researchers (25 percent). Other areas included seed production and organic farms, along with related sales of biotech products.

Firms tended to focus their products and services into one type of market. More than half (55 percent) of respondents sold products and services in one type of market, while 28 percent indicated two areas of products and services. A small share (11 percent) indicated a more diverse offering of products and services that covered three or more areas.

Almost half of respondents (46 percent) offered products and services related to human health, while about one-fifth sold products and services in either environmental or agricultural areas. A large share of respondents (38 percent) offered at least one product or service not related to human health, agriculture, natural resources, the environment, aquaculture, bioinformatics or food processing. Only a few firms specified the nature of these products and services, indicating animal health and dental areas.

- ❖ **The typical biotech respondent employed fewer than 10 employees, generated less than \$5.0 million in annual biotech-related revenues, and had ten years or fewer of experience in biotechnology.**

Firms involved in biotechnology tended to be small businesses. The typical responding firm employed fewer than 50 employees. About 58 percent of respondents were very small businesses employing fewer than 10 people, while 25 percent employed between 10 and 50 people.

Because it may take as long as 10 years for a firm to develop and market biotech products, those firms with less than 10 years of experience could be considered relatively young in this industry. About 60 percent of firms were young firms, with ten years or fewer years of experience. These firms were approximately evenly distributed across three years or less of experience, four to six years of experience, or seven to ten years of experience. However, the largest share of firms had been engaged in biotechnology for more than 10 years (28 percent). About 12 percent of respondents did not respond to the question.

With respect to staff resources devoted to biotechnology research, responding firms were generally split between two groups. Forty-three percent of firms devoted less than 10 percent of staff to biotech research while 33 percent of firms had more than 50 percent of staff devoted to biotechnology research.

Firms primarily classified in SIC 873 R&D and Testing Services (comprising 65 percent of biotech respondents) were not necessarily strongly devoted to biotech research. Slightly less than one-third of these biotech firms devoted more than 50 percent of their staff to biotech research while slightly more than

one-third of these biotech firms had less than 10 percent of their staff in biotech research.

The typical annual salary for a biotech researcher was about evenly distributed among the three following salary ranges: less than \$40,000, between \$40,000 and \$65,000, and between \$65,000 and \$90,000. (However, about one-quarter of the firms did not respond to this question.) About 60 percent of the firms (10 firms) that paid salaries of less than \$40,000 per year to a typical researcher devoted less than 10 percent of staff to biotech research. However, there was no apparent general relationship between wages for biotech researchers and the share of staff devoted to biotech research.

- ❖ **Biotech firms were mainly located in the Twin Cities. Those firms located in Greater Minnesota tended to be in southern Minnesota.**

The biotech respondents were located throughout Minnesota, although 71 percent (47 firms) were in the Twin Cities (similar to the overall distribution of businesses in the state). Twenty-two of these firms were located in Hennepin County and 11 of these firms were located in Ramsey County. In Greater Minnesota, there were six located in the Southeast region, and four located in each the Southwest region and in the Northeast region. While these numbers are too small to suggest any pattern of regional industry development in Greater Minnesota, it is interesting to note that 10 of the 19 non-metro responding biotech firms were located in the southern part of the state.

A notable share of biotech firms (15 percent) specialized in biotechnology, with more than half of revenues generated by or staff devoted to biotechnology. Another noteworthy share of biotech firms (20 percent) performed biotechnology activities, among other areas, with less than one-tenth of revenues or staff related to biotechnology.

Firms were largely split between having less than 10 percent and more than 50 percent of revenues being generated by biotechnology activities; these two categories accounted for two-thirds of respondents.

Annual biotech-related revenues were valued at less than \$5.0 million for 75 percent of the respondents, followed by 8 percent of respondents with annual revenues ranging between \$5.1 million and \$20.0

million. No respondents indicated biotech-related revenues between \$20.1 million and \$100.0 million. About 15 percent of respondents did not respond to the question.

- ❖ **Most firms financed biotech activities with retained earnings. Inadequate financing was the most commonly cited obstacle to biotechnology commercialization. Most firms thought that Minnesota could help biotechnology by providing or facilitating more financing resources or incentives.**

Various sources of investment capital were used to finance biotechnology activities. The most common source was retained earnings (48 percent of respondents), followed by private placements or public offerings (25 percent of respondents) and personal funds or credit cards (22 percent of respondents). Government loans and incentives were sources for 11 percent of respondents. About half (54 percent) of respondents used only one source of capital; 19 percent used two sources and 23 percent used three or more sources.

Obtaining adequate financing was the most important obstacle to biotechnology commercialization in Minnesota, as indicated by 43 percent of respondents. Firms felt that Minnesota could best assist biotechnology industry growth in financing-related areas, particularly by increasing the financing resources or incentives available (45 percent of respondents). Some respondents also indicated a need for (unspecified) government incentives.

- ❖ **About half of the respondents experienced revenue growth between 2000 and 2001, although exports were not a source of revenue for the typical firm.**

Growth in biotech-related revenues between 2000 and 2001 was mixed. While 52 percent indicated growth in their biotech-related revenues, about one-quarter of the respondents experienced difficulties between 2000 and 2001 as their biotech-related revenues declined. (About 22 percent of respondents did not answer this question).

International exporting was not a significant activity for most biotechnology respondents; 58 percent reported no such activity while for 17 percent of the respondents, exports accounted for less than 10

percent of biotech-related revenues. However, expanding markets worldwide is important for many growing firms.

- ❖ **Regulations were cited as an area of obstacles to biotechnology commercialization.**

Regulations were a frequently mentioned area that presented obstacles to biotechnology commercialization. More specific "other" obstacles to biotechnology commercialization specified by respondents were: the costs and methods related to testing, the educational focus on biotech, and the quality control of biotechnology products.

Respondents specified the following regulation-type obstacles: the European acceptance of genetically modified organisms (GMOs), the length of time for overlapping government agencies to resolve decisions, and taxation, the absence of rules for indoor air quality⁶ and the insufficient enforcement of environmental laws.

For day-to-day business operations, some respondents needed assistance in labor areas, such as reforming the workers' compensation laws and obtaining truthful information about an employee's status. The availability of workers with experience and education in areas such as cell culture was also impacting businesses. Another issue mentioned was the difficulty in obtaining liability insurance.

- ❖ **However, some firms supported improved environmental regulations or public policy directed to other areas.**

One-third of biotech firms indicated that Minnesota could help industry growth by improving the regulatory environment, such as by enforcing environmental laws. Some firms supported improved environmental regulations to reduce production waste, stricter health-related standards regarding hazardous and sanitary waste disposal, and enforcement of such regulations and standards.

One-third of biotech firms indicated that Minnesota could help industry growth by increasing greater

⁶ The Environmental Health division of the Minnesota Department of Health regulates the quality of indoor air through the Minnesota Clean Indoor Air Act (www.health.state.mn.us/divs/eh/).

industry awareness. Other ideas suggested by respondents to help industry development were creating a biotech-pharmaceutical business park, continued enhancement of collaborative relationships with University research, and learning from biotechnology growth in other countries (such as Ireland).

❖ **Other respondents felt that there were too many regulations and that the government's role in this industry was unclear.**

On the other hand, others suggested that government had a conflict of interest and should not be involved. One-fifth of biotech firms indicated that there were too many or too restrictive regulations. One area cited was eliminating trade barriers to further assist small businesses. Another respondent felt that the lack of vision relating to the biotech industry as a whole, the limited local acceptance of biotech, and the lack of a clear government role were problems.

❖ **Collaborations with trade associations and research organizations were important to many biotech firms.**

Of the 30 respondents who had existing collaborative or cooperative partnerships, most involved a partner in the private sector (18 respondents) or educational or research institutions (15 respondents). Few indicated a partner located in Minnesota. (About one-quarter of respondents did not answer the question and about one-third indicated no partnership agreement currently existed.)

Respondents desired greater access to the University of Minnesota research facilities and increased collaborations between private industry and the University. These aspects were invaluable, according to the respondents. However, a respondent also noted that the University of Minnesota should be more supportive of technologies generated and owned by individuals and private industry.

❖ **Few used government loans and incentives as sources of capital.**

All seven respondents who used government loans and incentives as sources of capital were located in the Twin Cities Metro Area, employed fewer than ten employees, earned less than \$5.0 million per year in biotech sales, had no or few export sales, and were

medical, research and development or testing laboratories. These firms tended to be devoted to biotech activities with more than 50 percent of staff working in biotech research and earned more than 50 percent of revenues from biotechnology activities. The firms showed mixed growth over the past year.

Firms who used government loans and incentives utilized other types of capital to fund biotechnology activities, such as retained earnings (4 firms) and bank loans, family/friends, and private placement/public offering (2 firms each).

These firms tended to work in two different types of biotechnology on average; biochemistry and immunology (six firms) and bioprocessing (five firms) were the most common types. Four firms performed cell/tissues/embryo culture manipulation and three firms performed extraction/purification/separation. A few firms engaged in technologies related to drug design and delivery; biomaterials enzymes; biocatalysts, fermentation, bioprocessing, biotransformation, natural products chemistry; and bioremediation, biofiltration, phytoremediation. The firms each used multiple technologies, with on average three or four technologies per firm.

Similar to the entire pool of respondents, four of the firms indicated a collaboration or partnership with a firm in the private sector and/or with an educational institution. Most also stated that inadequate financing was the most important obstacle to biotechnology commercialization in Minnesota. Many of the seven firms supported more financing or incentives, an improved regulatory environment, more laboratory space and targeted labor force development. Only one of the seven firms desired more tax credits.

❖ **Other**

More than two-thirds of the biotechnology respondents (43) were interested in receiving a copy of the final report and almost 60 percent of the biotechnology respondents (38) desired further contact from DTED about their concerns and issues, which included small business problems, site location in the non-metro area, industry structure and the government's role, indoor air quality and odor control, and genetically-modified organisms.

Final Thoughts

As a first attempt to characterize the biotechnology industry in Minnesota, the survey showed that despite hearing from only 65 biotechnology respondents, the findings were statistically significant. Based on the comprehensive initial list of SIC codes, the findings indicated that 18.6 percent of the firms (or about 250 firms out of the initial 1,337) were likely to be involved in biotechnology activities. This relatively low share of biotech respondents from the SIC list also exhibited a limitation of characterizing biotechnology activities solely by relying on standard SIC-based statistics. For example, of 121 respondents in SIC 873 R&D and Testing Services, only 42 performed biotech-related services. In contrast, there was one respondent involved in biotech activities in a non-traditional biotech industry, computer-related services and software.

The survey findings showed that Minnesota's biotechnology firms were mainly involved in biochemistry and immunochemistry technologies, followed by bioprocessing technologies. They tended to be located in the Twin Cities, and to a lesser extent, in southern Minnesota. These firms were small, employed fewer than 10 employees, generated less than \$5.0 million in annual biotech revenues, and had operated in biotechnology areas for less than 10 years. The firms generally accessed their retained earnings, followed by private placements and public offerings, to finance biotechnology activities. Inadequate financing was one of the most common obstacles faced by the respondents, followed by regulatory issues. The respondents felt that Minnesota could support the development of biotechnology in the state by addressing these areas.

In addition to the survey results, the following factors have also been identified in various reports as critical to the success and growth of biotechnology.

1. *Start-up and Operational Financing.* Access to investment funds and knowledgeable investors are important challenges. Opportunities for networking among local potential investors and local researchers are critical, such as at the Investor Community Biotech Workshop Series sponsored by the University of Minnesota.
2. *Incubator Space, including Lab Space, Technology and Equipment Leasing.* Expenses relating to equipment and technology purchases may easily overwhelm a start-up or a small firm. Cost-saving and cost-sharing opportunities at incubators are important during a firm's early stages.
3. *Qualified and Experienced Researchers and Managers.* Experienced biotech researchers and skilled managers are critical. A stronger and growing biotechnology community will create jobs that will retain and grow a strong research and managerial base in the Twin Cities.
4. *Technology Commercialization.* Partnerships between industry and higher education institutions serve to share resources including limited financial capital, technical expertise, lab space, advanced technology and equipment, as well as managerial and marketing skills. They also increase networking, advance the progress of research and improve awareness of the industry.

Future research could refine the industry definition and expand to other emerging biotech areas identified by respondents, determine areas of success and where Minnesota has advantages over other regions, and further explore industry driving forces, obstacles to progress and innovative solutions to these obstacles.

Appendix I. Methodology

DTED collaborated with MNBIO to develop the list of biotechnology activities used to define the industry, the pool of companies that would receive the survey, and the survey instrument. The aim was to develop a broad definition of biotechnology that encompassed the health and medical; agricultural and food; industrial and environmental manufacturing, and services industries, as well as research areas.

The first challenge was the development of the critical list of biotechnology activities that would be used as the fundamental definition for the biotechnology industry. Because the Canadian surveys had been administered repeatedly in the mid-to late 1990s, their list of biotechnology activities was used as a starting point and then further refined with assistance from MNBIO. The final list is in Question 1 in the survey instrument (Appendix IV).

The next challenge was to develop the list of SIC codes that was to serve as the basis for the recipients of the survey. First, based on the comprehensive nationwide study by the Battelle Memorial Institute, a general list of biotechnology-related 3- or 4-digit SIC codes that included all subsets of SIC codes used by other states was developed. Second, the list was further refined based on discussions with members of MNBIO. (See Appendix II for the list of SIC codes.)

SIC Code	Industry	Biotech Respondents' Distribution
873	R&D and Testing Services	64.6%
384	Surgical/Medical Instruments	10.8%
287	Agricultural Chemicals	4.6%
072	Crop Services	3.1%
283	Drugs	3.1%
807	Medical/Dental Labs	3.1%
286	Industrial Organic Chemicals	1.5%
382	Lab and Analytical Instruments	1.5%
737	Computer related services	1.5%
289	Misc. Chemicals	0%
355	Special Industrial Machinery	0%
385	Ophthalmic Goods	0%

The generated list of SIC codes was used to query the Business USA CD-ROM 2001 for all companies in Minnesota classified by these primary SIC codes. Combining these results with other businesses identified by the Business Development Liaison at the Patents & Technology Marketing Division at the University of Minnesota, a pool of 1,337 survey recipients was derived. Two mailings of the survey instrument were sent between April and May 2002.

Respondents were requested to indicate their biotechnology areas and to return the blank survey if they did not perform biotechnology activities. There were 349 total respondents for an overall response rate of 26 percent. Of the 349 respondents, there were 65 respondents who performed biotechnology activities (18.6 percent of the respondents) and 284 who did not (81.4 percent of the respondents). The relatively low share of respondents from the initial SIC industry list that were actually engaged in biotechnology activities shows one of the limitations of some studies that characterize biotechnology activities by solely relying on standard SIC statistics.

A statistical test (chi-square test) was performed to compare the distribution in the original sample (1,337 businesses) and in the responding sample (349 businesses) by three-digit SIC codes. The two distributions were not statistically different at a 95 percent level of confidence, implying that the results can be extended from the responding sample to the surveyed sample and to the population of the selected SIC codes.

About two-thirds of the biotech respondents were classified as SIC 873 R&D and Testing Services, followed by 11 percent in SIC 384 Surgical/ Medical Instruments. Respondents in agricultural-related industries (SIC 287 and SIC 072), SIC 283 Drugs, and SIC 807 Medical/Dental Labs accounted for the next largest shares.

Appendix II. List of SIC Codes Used to Define the Group of Surveyed Businesses and The Distribution of Respondents and Biotech Respondents

SIC Code	Industry Description	Survey Sample*	All Respondents*	Biotech Respondents*
0273	Animal Aquaculture	1	0	0
0721	Crop Planting, Cultivating and Protecting	56	12	0
0723	Crop Preparation Services	36	15	2
2834	Pharmaceutical Prep.	13	1	0
2835	In Vitro and In Vivo Diagnostic Substances	1	0	0
2836	Biological Products	10	2	2
2869	Misc. Industrial Organic Chemicals	8	2	1
2873	Nitrogenous Fertilizers	23	6	0
2875	Fertilizers, Mixing	69	22	2
2879	Misc. Pesticides, Agricultural Chemicals	4	2	1
2899	Misc. Chemical Preps.	30	7	0
3559	Misc. Special Industry Machinery**	29	7	0
3822	Environmental Controls	30	7	0
3825	Instruments for Electricity	13	3	0
3826	Lab. Analytical Instruments	2	0	0
3827	Optical Instruments, Lenses	4	1	0
3829	Misc. Measuring Devices	30	8	1
3841	Surgical, Medical Instruments	182	38	5
3842	Orthopedic, Prosthetic, Surgical Appliances	40	8	1
3843	Dental Equipment	9	2	1
3845	Electromedical, Electrotherapeutic Apparatus	12	2	0
3851	Ophthalmic Goods	21	9	0
7371	Computer Programming Services***	63	11	0
7372	Pre-packaged Software	30	6	1
8071	Medical Labs	40	3	1
8072	Dental Labs	139	50	1
8731	Commercial Physical/Biological Research	237	69	27
8733	Non-Commercial Research	73	19	6
8734	Testing Laboratories	124	33	9

* A primary SIC code for four firms was not found.

** Only includes: 3559-09 Specialized Industrial machinery NEC; 3559-13 Specialized Industrial machinery, pharmaceutical; 3559-21 Specialized Industrial machinery, chemical; and 3559-33 Specialized Industrial machinery, recycling.

*** Only includes: SIC 7371 Computer Programming Services: 7371-01 Computer services; 7371-02 Computer programming services; and 7371-08 Computer software developers.

Appendix III. Complete Frequency Distribution For Responses To Question 1

Area	Technology Type	Share of Biotech Respondents (65)
Bioprocessing-based	Fermentation, Bioprocessing, Biotransformation, Natural Products Chemistry	22%
Bioprocessing-based	Extraction/Purification/ Separation	20%
Biochemistry, Immunochemistry	Microbiology, Virology, Microbial Ecology	18%
Environment	Bioremediation, Biofiltration, Phytoremediation	17%
Biochemistry, Immunochemistry	Biomaterials	15%
Bioprocessing-based	Cell/Tissues/Embryo Culture Manipulation	15%
Other	Other biotechnology activity. (Respondents specified: air quality testing, dental material, hearing healthcare products, implantable cell biology chambers, process instruments)	15%
Biochemistry, Immunochemistry	Drug Design and Delivery	14%
DNA-based	DNA Sequencing, Synthesis, Amplification	14%
Other	Pharmaceutical research	14%
Biochemistry, Immunochemistry	Diagnostic Tests, Antibodies	12%
DNA-based	Gene Probes/DNA Markers	12%
Biochemistry, Immunochemistry	Molecular Biology Research Tools/Products	11%
DNA-based	Genetic Engineering/Recombinant DNA	11%
DNA-based	Genomics	9%
DNA-based	Proteomics	9%
Other	Specialized biotechnology machinery or equipment	9%
Biochemistry, Immunochemistry	Cell Receptors/Signalling/Pheromones	8%
Biochemistry, Immunochemistry	Enzymes/Biocatalysts	6%
Biochemistry, Immunochemistry	Peptide/Protein Sequencing/Synthesis	5%
Biochemistry, Immunochemistry	Combinatorial Chemistry, 3D Molecular Modeling, Structural Biology	5%
DNA-based	Pharmacogenetics	5%
Biochemistry, Immunochemistry	Vaccines, Immune Stimulants	3%
DNA-based	Bio-informatics	3%
DNA-based	Micro Arrays, Biochips	2%
Environment	Biobleaching, Biopulping, Biodesulphurization	2%
Other	Biotechnology-related software	2%

Appendix IV. Survey Instrument

Instructions

- Please answer all the questions by circling and/or writing in the appropriate answer.
- The number on the survey is for follow-up purposes. Individuals or companies will not be identified in any report.
- Please call Thu-Mai Ho-Kim at (651) 296-8285 with any questions about the survey.
- Please return your completed survey by mail in the enclosed postage-paid self-addressed envelope or send it to:

Analysis and Evaluation Office
Minnesota Department of Trade and Economic Development
121 7th Place East, 500 Metro Square
Saint Paul, MN 55101-2146

1. Indicate the biotechnology activities in which your company or division operates. Circle all that apply.

DNA-based

1. Gene Probes/DNA Markers
2. Bio-informatics
3. Genomics
4. Proteomics
5. Pharmacogenetics
6. Genetic Engineering/Recombinant DNA
7. DNA Sequencing/Synthesis/ Amplification
8. Micro Arrays/Biochips

Biochemistry, Immunochemistry-based

9. Vaccines/Immune Stimulants
10. Drug Design and Delivery
11. Diagnostic Tests/Antibodies
12. Peptide/Protein Sequencing/Synthesis
13. Cell Receptors/Signalling/Pheromones
14. Combinatorial Chemistry/ 3D Molecular Modeling/ Structural Biology
15. Biomaterials
16. Microbiology/Virology/Microbial Ecology
17. Molecular Biology Research Tools/Products
18. Enzymes/Biocatalysts

Bioprocessing-based

19. Cell/Tissues/Embryo Culture Manipulation
20. Extraction/Purification/ Separation
21. Fermentation/Bioprocessing/
Biotransformation/Natural Products
Chemistry

Environment

22. Biobleaching/Biopulping/
Biodesulphurization
23. Bioremediation/Biofiltration/
Phytoremediation

Other

24. Biotechnology-related software
25. Pharmaceutical research
26. Specialized biotechnology machinery or equipment
27. Other biotechnology activity. Please specify:

*If you currently do not engage in biotechnology activities,
please return the survey in the return prepaid envelope. Thank you!*

2. When did the biotech-related activities of this firm at your location begin? Circle one answer.

1. 1991 or earlier
2. 1992 to 1995
3. 1996 to 1998
4. 1999 or later

3. In which biotechnology areas are your company's current products and services? Circle all that apply.

Human Health

1. Diagnostics
2. Therapeutics
3. Gene Therapy

Agriculture

4. Plant Biotech/Crop improvement
5. Animal Biotech
6. Biofertilizers/Biopesticides
7. Non-Food Agriculture

Natural Resources

8. Microbiologically Enhanced Petroleum/Mineral recovery
9. Industrial Bio-processing
10. Silviculture

Environment

11. Biofiltration
12. Bio- and Phyto-remediation
13. Diagnostics

Aquaculture

14. Fish health
15. Broodstock genetics
16. Bioextraction

Bioinformatics

17. Genomics, Molecular Modeling

Food Processing

18. Bioprocessing
19. Functional Foods and Nutraceuticals

Other

20. Synthesis (chemical or biological)
21. Pharmaceuticals
22. Specialized biotechnology equipment or machinery
23. Biotechnology software
24. Other industrial biotechnology areas
25. Other, please specify:

Please continue to Question 4.

4. What proportion of your location's total revenue arose from biotechnology-related revenues in 2001? Circle one answer.

1. Less than 10 percent
2. Between 10 and 25 percent
3. Between 26 and 50 percent
4. More than 50 percent

5. What were biotech-related revenues at your location in 2001? Circle one answer.

1. Less than \$5.0 million
2. \$5.1 million to \$20.0 million
3. \$20.1 million to \$50.0 million
4. \$50.1 million to \$100.0 million
5. More than \$100.0 million

6. Describe your biotechnology operations' main type of business by revenues. Circle one answer.

1. Manufacturing
2. Services provider
3. Research & development
4. Other: _____

7. What was the growth rate of biotech-related revenues at your location between 2000 and 2001? Circle one answer.

1. Negative (decline)
2. Positive but less than 10 percent
3. Between 10 to 25 percent
4. Between 26 to 50 percent
5. More than 50 percent

8. What percentage of biotech-related revenues came from exports at your location in 2001? Circle one answer.

1. None
2. Less than 10 percent
3. 10 to 25 percent
4. 26 to 50 percent
5. More than 50 percent

9. How many people does your location currently employ? Circle one answer.

1. Less than 10
2. 10 to 50
3. 51 to 100
4. 101 to 250
5. More than 250

10. What percentage of your location's staff works in biotech research? Circle one answer.

1. Less than 10 percent
2. 10 to 25 percent
3. 26 to 50 percent
4. More than 50 percent

11. What is the average salary paid to a biotech researcher at your location? Circle one answer.

1. Less than \$40,000 per year
2. \$40,000 to \$65,000 per year
3. \$65,001 to \$90,000 per year
4. More than \$90,000 per year

12. What sources of capital are used to invest in biotechnology activities? Circle all that apply.

1. Retained Earnings
2. Venture capital funds
3. Bank loans
4. Private placement or public offering
5. Government loans/incentives
6. Personal funds/Credit cards
7. Family/friends
8. Other: _____

13. Which of the following are obstacles to biotechnology commercialization in Minnesota?

Circle all that apply.

1. Inadequate financing
2. Lack/shortage of skilled workers
3. Poor availability of executive/ management skills or resources
4. Too many or restrictive regulations
5. Lack of marketing resources
6. Too restrictive patenting
7. Other: _____

14. If you are involved in collaborative or cooperative partnerships (not including outsourcing/contractual arrangements), describe your partners. Circle all that apply.

1. Not involved in collaborative or cooperative partnerships
2. Firm in the private sector
3. A government department or agency
4. Related industry or trade association
5. Educational or research institutions
6. Partner is located in Minnesota
7. Other: _____

15. How can Minnesota help biotechnology? Circle all that apply.

1. More financing resources or incentives
2. More tax credits
3. Improved regulatory environment
4. Targeted university research funding
5. Targeted labor force development
6. More laboratory space
7. Increased awareness of industry
8. Other: _____

16. Would you like to receive a copy of the final report? Circle one answer.

1. Yes
2. No

17. May we contact you about your issues or concerns?

1. Yes.

Name: _____

Phone: _____

Areas: _____

2. No.

Please feel free to call Gene Goddard, DTED's biotechnology industry representative at (651) 296-7102 or contact him via e-mail at Gene.Goddard@state.mn.us.

18. In what other ways can Minnesota improve the environment for biotechnology? Please elaborate on your answer(s) to Question 15 or suggest additional areas for improvement or support.

Appendix IV. Resources and Contacts for Biotechnology Businesses

1. **Minnesota Department of Trade & Economic Development**
Gene Goddard, Ag/Biotech Industry Specialist
Phone: 651-296-7102
E-mail: gene.goddard@state.mn.us
Internet: www.dted.state.mn.us

2. **MNBIO**
Ray Frost, Executive Director
Phone: 651-290-6296
E-mail: rayf@ewald.com
Internet: www.minnesotabiotech.com

3. **Minnesota Technology**
Laurie Hennen
Phone : 612-373-2960
E-mail : lhennen@mntech.org
Internet:
www.minnesotatechnology.org

4. **Medical Alley**
Liz Rammer, Vice President
Phone: 952-542-3077
E-mail: lrammer@medicalalley.org
Internet: www.medicalalley.org

5. **Minnesota Project Innovation, Inc.**
Pat Dillon, SBIR Program Director
Phone: (612) 338-3280
E-mail: pdillon@mpi.org
Internet: www.mpi.org

6. **University of Minnesota**
a. **Biodale**
Marc von Keitz, Ph.D.
Phone: 612-624-6758
E-mail: vonkeitz@cbs.umn.edu
Internet:
www.cbs.umn.edu/biodale

b. **Biotechnology Institute**
Kenneth J. Valentas, Ph.D.
Phone: 612-625-4250
E-mail: valentas@cbs.umn.edu
Internet: www.cbs.umn.edu/bti

c. **Business & Technology Commercialization**
Dick Sommerstad
Phone: 612-625-8352
E-mail: somme024@umn.edu
Internet: www.rtportal.umn.edu

d. **College of Agriculture**
Charles C. Muscoplat, Ph.D.,
Dean
Phone: 612-624-3009
E-mail: cmuscop@umn.edu
Internet: www.coafes.umn.edu

e. **College of Biological Sciences**
Robert Elde, Ph.D., Dean
Phone: 612-624-2244
E-mail: elde@umn.edu
Internet: www.cbs.umn.edu

f. **College of Veterinary Medicine**
Jeffrey Klausner, DVM, MS,
Dean
Phone: 612-625-3793
E-mail: klaus001@umn.edu
Internet: www.cvm.umn.edu

g. **Institute of Technology**
H. Ted Davis, Ph.D., Dean
Phone: (612) 624-2006
E-mail: davis@itdean.umn.edu
Internet: www.it.umn.edu

The Minnesota Department of Trade and Economic Development is the state's principal economic development agency. The mission of the department is to employ all available state government resources to facilitate an economic environment that produces net new job growth in excess of the national average and to increase non-resident and resident tourism revenues.

The department includes:

Minnesota Trade Office

The Minnesota Trade Office is the export and foreign investment development division for the state. It provides information, education, counseling and financial services to Minnesota businesses. Its principal goal is to promote, facilitate and deliver international business export assistance and services to Minnesota businesses.

Business and Community Development Division

The Business and Community Development Division provides a variety of financial and technical services to businesses, communities and economic development professionals. This division administers programs which provide business financing, technical assistance, location assistance, capacity building and infrastructure financing.

Minnesota Office of Tourism

The Minnesota Office of Tourism promotes the state's tourism industry to increase non-resident and resident tourism revenues. It markets Minnesota's products and services related to travel, conducts organizational partnerships, and provides information to travelers. The office generates travel to and tourism within the state and supports the state's communities and tourism industry.

Workforce Development Division

The Workforce Development Division provides training and support services to unemployed and dislocated workers; financial assistance for businesses seeking to upgrade worker skills; grants to help ease a shortage of workers in the health and human services industry; and short-term, no interest loans to businesses for training new or existing employees.

Communications and Analysis Division

The Communications and Analysis Division supports department activities through centralized communications, marketing, research, analysis and program evaluation services. Recent publications include *Compare Minnesota*, *Positively Minnesota*, *2001 Progress Report* and *Minnesota: World Competitor*. Recently-completed research covers a wide range of topics including the effects of mergers and acquisitions on the state's economy, the biotech industry, business start-ups, business subsidies, exporter needs, travel and tourism trends, and dislocated workers-turned entrepreneurs. The division also maintains the department's web site.

