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The Life Sciences Industry in Michigan:

Employment, Economic, and Fiscal Contributions to the State's Economy

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Executive Summary

PURPOSE OF STUDY

The Life Sciences are growing in importance, both to society as a whole and as an economic engine. Not only does the industry bring promise of breakthroughs in health and medicine, but it is increasingly viewed as an integral part of economic development strategies, especially as states look to build a high-skill, high-wage employment base.

There is little question about the importance of the industry's more tangible benefits, such as life-saving cancer treatments, immunizations to protect against deadly disease, and instruments that allow for less intrusive surgical procedures. However, as the economic contributions of the industry are less obvious, members of Michigan's Life Sciences Corridor Core Technology Alliance (CTA) commissioned this report to look more closely at the economic contributions of the Life Sciences industry in Michigan.[1] Specifically, this report:

1. Provides a conservative and reliable definition of the Life Sciences industry;
2. Documents Life Sciences employment and payroll income in Michigan;
3. Discusses the occupations found within the Life Sciences industry;
4. Estimates the economic and fiscal contributions of the industry; and
5. Discusses the characteristics of the industry and the importance of government support for growing the industry.

REVIEW OF FINDINGS

To conduct our assessment of the economic contributions of the Life Sciences industry in Michigan, we had to first define the industry. After a review of past research, an examination of industrial sectors, and a survey of Life Sciences industry stakeholders, we defined the industry as:

> *"businesses whose work helps to improve the quality of human life through the research, development, and application of biological processes, tools, and advanced medical treatments."*

This is a strict definition of the industry, and includes only those sectors directly involved in biological research and development, the production of products required for advanced science and medical procedures, and the practice of advanced medical treatment. See Table 2, "Definition of the Life Sciences Industry," on page 11 for the North American Industry Classification System (NAICS) codes included definition.

1. The Michigan Life Sciences Corridor Core Technology Alliance is a consortium of Michigan State University, Wayne State University and the University of Michigan, and the Van Andel Research Institute.

Adopting such a strict industry definition yields reliable, conservative results, which we present below.

Employment and Earnings in the Life Sciences Industry

- Total employment within Michigan's Life Sciences industry was 31,778 in 2001. This represents 0.8% of total employment in the State and, as a result of higher-wage jobs, 1.15% of total state payroll.
- Employment in Michigan's Life Sciences industry grew more than 12.5% from 1998 - 2001. Total employment in Michigan grew by only 2.3% during the same period.
- We forecast through 2005 and show Life Sciences industry employment in Michigan growing to 41,555. The forecast assumes that factors underlying industry growth, including state support, remain at or above the levels provided during 1998 - 2001. Actual employment growth could be much greater if an existing employer under goes a major expansion, or if a large Life Sciences company shifts more jobs to Michigan. Figure 1 on page 5 provides a graphical display of employment in Michigan's Life Sciences industry.
- Occupations in the Life Sciences industry pay, on average, $15,900 more annually than the U.S. mean annual wage. In fact, all but two of the 22 major occupations pay employees in the Life Sciences more than if they were working in a different industry.
- Further discussion on employment in Michigan's Life Sciences industry can be found starting on page 13.

Economic and Fiscal Contributions of Michigan's Life Sciences Industry

- We estimate the direct and indirect economic contribution of the industry using a much more conservative methodology than is typically found in "economic impact" studies. We include as direct economic contributions only the actual payroll from Life Sciences employers. Indirect contributions include only payroll resulting from purchases made from non-Life Sciences employers for Life Sciences purposes.
- Total direct payroll for the Life Sciences in Michigan was $1.64 billion in 2001, up from $1.35 billion in 1998. This represents the direct economic contribution of the Life Sciences industry.
- Indirect economic contributions from the Life Sciences industry in Michigan amounted to $1.36 billion in 2001. The total direct and indirect economic contribution of the Life Sciences industry in Michigan's economy was just over $3.0 billion in 2001.
- The direct and indirect fiscal contribution of the Life Sciences industry in Michigan consists of the major taxes paid by employers and employees (direct), and

of the indirect economic activities of the industry. We estimate the total fiscal contribution of the Life Sciences industry was just under $659 million in 2001.

- We estimate that Life Sciences employers and their Michigan employees pay $28 million in Single Business Tax, $67 million in Sales and Use Taxes, $158 million in property taxes, and $86 million in income taxes.
- Further discussion on the economic and fiscal contributions of Michigan's Life Sciences industry can be found starting on page 20.

TABLE 1. Summary of Economic and Fiscal Contributions (2001)

	Direct	Indirect	Total
Economic Contribution	$1,640,000,000	$1,360,000,000	$3,000,000,000
Fiscal Contribution	$360,072,777	$298,860,405	$658,933,182

Source: Anderson Economic Group

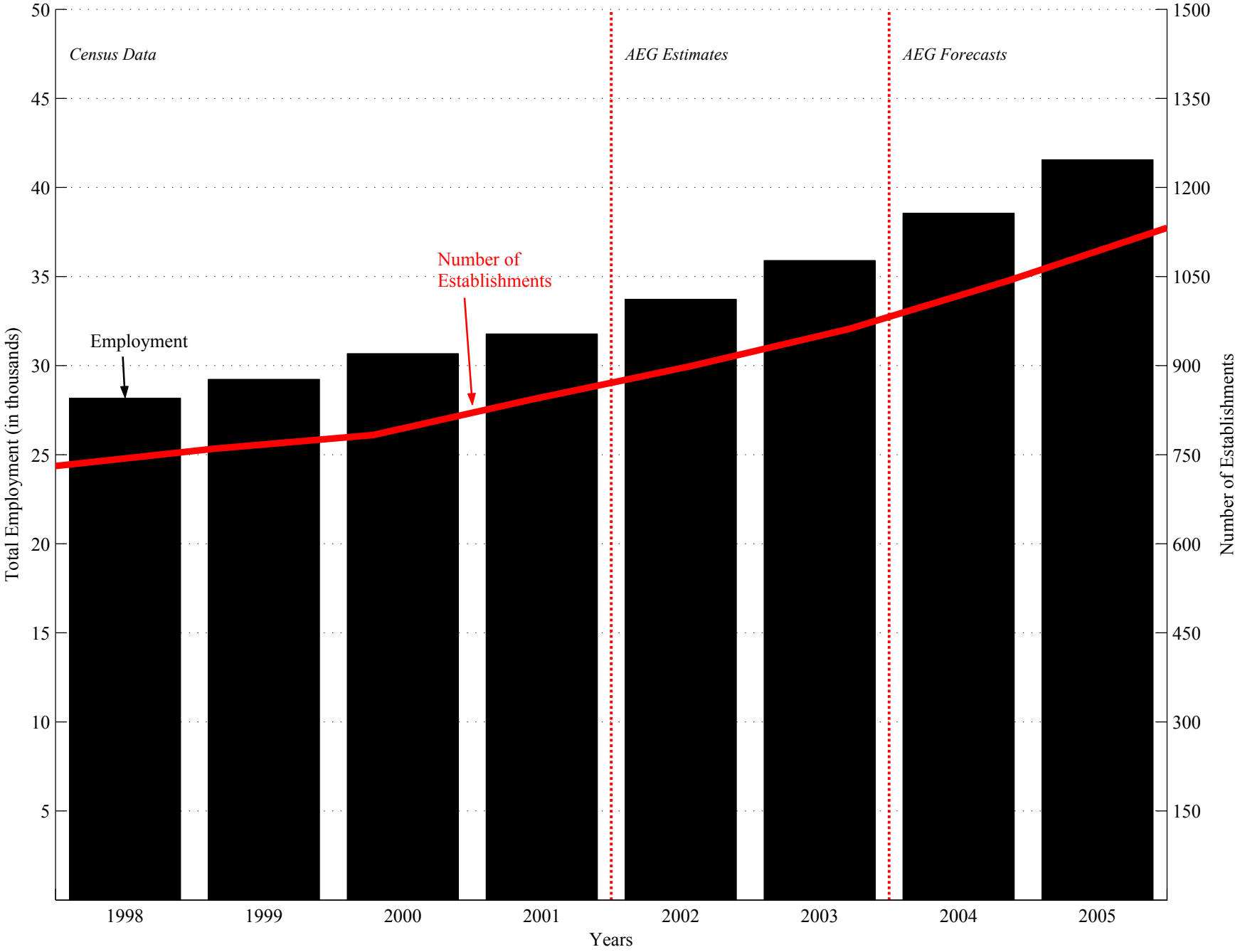
Government Funding of the Life Sciences Industry

- The nature of the Life Sciences industry is such that government support plays a vital role, especially in initial research and development. As a result, Life Sciences employers are apt to locate in states that offer incentives to conduct such research, either through direct funding or through cost reducing measures such as tax breaks.
- Some 40 states have initiatives in place to attract and retain Life Science employers. Such states include Ohio, Illinois, North Carolina, and New York.
- Other factors, such as an educated workforce, well-supported research institutions (including public and private universities), quality of life, and a critical mass of technology, also play a key role in attracting and maintaining Life Sciences employers.
- Further discussion about Government funding in the Life Sciences industry can be found starting on page 24.

Conclusion

- A concentrated and lasting effort to support the Life Sciences is needed to demonstrate Michigan's commitment to the industry. The 1999 launch of the Life Sciences Corridor poised Michigan as a leader in the industry, but a failure to maintain funding for the program has diminished Michigan's position.
- In return for a renewed commitment to the Life Sciences, the State will be positioned for continued strong growth in the industry. The resulting job creation should continue to provide compensation above the national average, creating a large tax base and tax revenues for state and local governments.
- Additionally, as the industry grows, it is likely that additional sources of venture capital and federal funding will come to the State, accelerating the growth of the industry beyond our forecast.
- The risks of not supporting the Life Sciences industry include losing new and current employers to states with more aggressive and committed initiatives, and losing intellectual capital and high-skilled workers, especially as university graduates emigrate to states with more rewarding employment opportunities.

Figure 1. Life Sciences in Michigan: Number of Establishment & Employment



Source: US Census Bureau, County Business Patterns; Anderson Economic Group
Analysis & Forecast: Anderson Economic Group

Generated Date: 02/19/2004

APPROACH

The key steps involved in the project included:

1. Reviewing recent reports and other information on the Life Sciences and the Biotechnology industries. A summary of our review is provided in "Appendix A: Summary of Reviewed Sources".
2. Surveying stakeholders in Michigan's Life Sciences industry to gather specific information on what defines the Life Sciences industry; trends in the Life Sciences, including important policies and events; and specific data on Life Sciences employment in their region.
3. Establishing a conservative and reliable definition of the Life Sciences industry comprised of specific sectors, as identified by North American Industry Classification System (NAICS) code. This definition provides an accurate depiction of the sectors directly involved in the Life Sciences and establishes a sound base for conducting economic analyses.
4. Collecting data on employment and establishments in the Life Sciences. Key sources were the U.S. Census Bureau, County Business Patterns, and the Bureau of Labor Statistics.
5. Calculating the economic and fiscal contributions, both direct and indirect, of the Life Sciences industry to Michigan's economy. Calculations were done using payroll data, state tax collection data, and a conservative input-output analysis based on the master tables for the US economy, as published by the U.S. Department of Commerce, Bureau of Economic Analysis.

ABOUT ANDERSON ECONOMIC GROUP

Anderson Economic Group, LLC is a multi-service consulting firm with expertise in economics, public policy, finance, and market research. Our work in these fields is based on our core values of professionalism, integrity, and expertise.

Since our founding in 1996, we have assisted a variety of clients; including private firms, publicly traded companies, state & local governments, and non-profit organizations. Our experience includes assessments of markets throughout the United States, as well as Canada, Mexico, and the Caribbean. More information is available on our web site: http://www.AndersonEconomicGroup.com.

The Life Sciences

BRIEF HISTORY OF THE LIFE SCIENCES

The Life Sciences industry—comprised of businesses whose work helps to improve the quality of human life through the research, development, and application of biological processes, tools, and advanced medical treatments—rapidly evolved in the latter half of the twentieth century. Perhaps the most significant event in the growth of the industry came in 1953, when James Watson and Francis Crick described the double helical structure of DNA. Following the initial research on the DNA structure, Stanley Cohen and Herbert Boyer perfected the techniques for creating recombinant DNA, which provides the foundation for modern medicine development and production.

In recent years, new research and development has led to the commercialization of Life Science products through advances in biologically based technologies, or biotechnology. This trend toward commercialization will, with little doubt, continue to drive growth in the Life Sciences industry well into the 21st century.

BENEFITS FROM THE LIFE SCIENCES

Health Benefits. The implications of an expanding Life Sciences industry are very tangible. For example, more than 325 million people worldwide have been helped by the 155 medicinal drugs and vaccines approved by the U.S. Food and Drug Administration.[1] Medical diagnostic products, such as home pregnancy test kits are possible because of improved biotechnology production, an integral component of the Life Sciences.

Economic Benefits. In addition to health benefits, the Life Sciences industry has grown into an important part of the economy. In this analysis of the Life Sciences, we evaluate the economic and fiscal contributions of existing Life Sciences employers in Michigan. We use the term "contribution" because we are not assuming that these employers are in Michigan aside from any special event, although their presence is certainly encouraged by Michigan's Life Sciences Initiative.

We considered both the *direct* and *indirect* contributions. Direct contributions include only those expenditures that occur directly from employers in the Life Sciences industry. Their purchases from non-Life Sciences employers—even if those purchases are for Life Sciences research—are not included.

The indirect contributions include purchases from other industries. As these purchases occur because of Life Sciences activity, we consider them part of the total contribution of Life Sciences.

1. See Biotechnology Industry Organization's Editors' and Reporters' Guide 2003-2004.

Defining the Life Science Industry

To grasp the economic benefits of an industry, it is necessary to first define the composition of the industry. To do this, we have defined the Life Sciences industry using specific industrial sectors identified by their North American Industry Classification System (NAICS) codes.

The methodology employed to determine an accurate and concise definition of the Life Sciences industry involved:

1. A review of the definitions of the Life Sciences and Biotechnology industries as provided by relevant industry reports, analyses, and other materials.
2. A detailed review of all industries (as classified by NAICS) and a selection of possible sectors to include as part of the Life Sciences industry.[1]
3. A first selection from the NAICS codes (and the corresponding industries) identified in steps one and two, and a determination of industries which would be included, which did not merit consideration, and industries which should be further researched.
4. A survey of key stakeholders in Michigan's Life Sciences industry.
5. A final selection of industry sectors and NAICS codes to include in the definition of the Life Sciences industry, and in some cases, a determination to include only a portion of a sector in the Life Sciences industry.

REVIEW OF EXISTING DEFINITIONS

In our first step we reviewed past reports and other sources involving the Life Sciences to determine if a comprehensive definition of the industry was already available. We found that each document puts forth its own definition. These definitions vary from focusing solely on the Biotechnology sector *(Brookings Institution Report: Signs of Life),* to a definition incorporating biotechnology and diverse medical manufacturing industries *(MEDC Report: Ready for the Next Leap Forward: A competitive assessment and strategic plan to develop Michigan's Life Sciences industry)*. A summary of our review of each source is available in "Appendix A: Summary of Reviewed Sources".

REVIEW OF NAICS INDUSTRY CODES

Our second step was to review the entire list of NAICS industry codes. This was done to ensure that the already completed studies did not exclude any sectors that could be considered a part of the Life Sciences.

Our NAICS review involved first obtaining a complete list of NAICS codes and industry titles at the 6-digit level. We then collected industry code definitions, as

1. Our definitional approach was done at the NAICS 6-digit level, as this is the most detailed level for which U.S. Census data is commonly available. A NAICS code can be between 2 and 6-digits, with each digit providing an additional level of detail. For example, NAICS code 322 represents the paper manufacturing sector, and NAICS code 32223 represents stationery product manufacturing.

well as corresponding SIC code index entries. After carefully reviewing these definitions, as well as discussions with stakeholders in the Life Sciences industry, we identified several NAICS not used in other studies that we felt may be a part of the Life Sciences industry.

SURVEY OF STAKEHOLDERS

Our survey of stakeholders in Michigan's Life Sciences industry was developed to gather specific information about:

1. What defines the Life Sciences industry;
2. Trends in the Life Sciences, including important policies and events; and
3. Specific data on Life Sciences employment.

The surveyed group included executives from corporate firms, scientists from research institutes, state level university research and development officers, and partners of venture capital firms, all of whom are involved in the Life Sciences.

For the purpose of gathering information on the industry definition, question 1, which included 16 sub-questions, asked respondents to indicate the extent of an industry sector's involvement in the Life Sciences. Respondents were asked if specific industry sectors were "largely involved," "somewhat involved," or "not at all involved" in the Life Sciences.[1]

Questions 2 and 3 on the survey were also designed to gather information about the definition of the industry. Question 2 presented four different definitions for the Life Sciences industry and asked respondents to pick the one they felt was most accurate. In question 3, respondents were presented with the option to provide a more accurate definition if they felt the definitions in question 2 were not completely accurate.

The survey's next two questions asked respondents to provide their views on what policies and events may impact, or have impacted, the Life Sciences industry in Michigan, where major Life Sciences employers are located, and how many employees work for each employer. The survey's sixth and final question asked for the respondent's contact information.

1. The 16-sub questions addressed each of the following NAICS: 325188 - Inorganic Chemical Manufacturing; 325199 - Organic Chemical Manufacturing; 334510 - Electromedical & electrotherapeutic apparatus mfg.; 334516 - Analytical laboratory instrument mfg.; 334517 - Irradiation apparatus mfg.; 339112 - Surgical & medical instrument mfg.; 339113 - Surgical appliance & supplies mfg.; 339114 - Dental equipment & supplies mfg.; 339115 - Ophthalmic goods mfg.; 622100 - General Medical and Surgical Hospitals; 622310 - Specialty (except psychiatric & substance abuse) hospitals; 621511 - Medical Laboratories; 621512 - Diagnostic Imaging Centers; 621991 - Blood & organ banks. NAICS 621111 - Offices of Physicians was used in two questions, one to determine if speciality physicians (cardiologists, neurologists) should be considered, and another to consider if general practice physicians should be considered.

SURVEY RESULTS

A total of nine surveys were completed and returned by members of Michigan's Life Sciences industry. A tabulation of the results is provided in "Appendix B: Tabulated Survey Results".

In determining whether or not a NAICS subsector from the survey should be considered a part of the Life Sciences industry, we applied the following criteria:

- The sector was included in the definition if five or more respondents said the subsector was "largely involved," and three or fewer said that it was "not at all involved."
- The sector was included in the definition if four or more respondents said the subsector was "largely involved," and two or fewer said it was "not at all involved."
- If one or none of the respondents indicated that the subsector was "not at all involved" and the rest indicated somewhat of an involvement or a large involvement, then *a portion* (some percentage of total sector employment) of the sector was included in the definition.
- Any subsector that did not meet one of the above criteria was excluded from our definition.

THE LIFE SCIENCES INDUSTRY DEFINED

After the incorporation of the survey results with our review of relevant industry reports, discussions with stakeholders in Michigan's Life Science industry and a detailed assessment of NAICS codes, we were able to make a final determination on the definition of the industry. The NAICS codes that we include are listed in Table 2, "Definition of the Life Sciences Industry," on page 11.

TABLE 2. Definition of the Life Sciences Industry

NAICS Code	NAICS Description
325188	Inorganic Chemical Manufacturing (20% included)
325199	Organic Chemical Manufacturing (80% included)[a]
325411	Medicinal & Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325413	In-vitro Diagnostic Substance Manufacturing
325414	Biological Product(except diagnostic) Manufacturing
334510	Electromedical & Electrotherapeutic Apparatus Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
334517	Irradiation Apparatus Manufacturing
339112	Surgical & Medical Instrument Manufacturing
339113	Surgical Appliance & Supplies Manufacturing
541710	R&D in the Physical, Engineering & Life Sciences
621111	Offices of Physicians (1.5% included)[b]
621511	Medical Laboratories
621512	Diagnostic Imaging Centers
621991	Blood & Organ Banks
622310	Specialty Hospitals

a. To determine the portion of the chemical manufacturing sectors, we provided a detailed list of chemical names that fall under each category to a scientist at Van Andel Institute in Grand Rapids. From this it was estimated that 25 - 33% of the manufacturers of inorganic chemicals were primarily involved in the Life Sciences, and 90 - 95% of organic chemical manufacturers were primarily involved. For the purposes of our study we used a more conservative estimate of 20% and 80% for each respective industry.

b. Because data for the "physician office" subsector is inclusive of both general and speciality physicians, we use 1.5% of total physician office employment. This figure was arrived at by assuming that the ratio of employment in speciality physician offices to total physician office employment is similar to the ratio of employment in speciality hospitals (2,690 in 2001) to total hospital employment (182,782 in 2001).

The resulting definition presents both a conservative and reliable overview of the Life Sciences industry, including firms from the manufacturing, service, and research sectors. This definition captures not only the biotechnology sector, but also those sectors working to apply biotech research through advanced medical care, as well as the industries that develop products used in biological research and advanced medical care.

SECTORS EXCLUDED FROM OUR DEFINITION

Our definition remains conservative as we exclude some sectors that were previously included in other reports as part of the Life Sciences. Such sectors include:

- Other Industrial Machinery Manufacturing (NAICS 333298), which was included as part of the Life Sciences in the 2003 MEDC report "Ready for the Next Leap Forward: A competitive assessment and strategic plan to develop Michigan's Life Sciences industry." This sector employed 4,251 people in 2001.
- Also included in the 2003 MEDC report, but excluded here, is Dental Equipment and Supplies Manufacturing (NAICS 339114), which employed some 437 people in 2001.

We exclude these sectors, along with the others listed in Table 3 on page 12, because their primary products or services—despite playing an important role in health and medicine—are general in nature, and less impacted by new biological discoveries than are the industries included in our definition.

TABLE 3. Sectors Considered, but not included, in Life Sciences Definition

NAICS Code	NAICS Description
333298	Other Industrial Machinery Manufacturing
333314	Optical Instrument and Lens Manufacturing
339111	Laboratory Apparatus and Furniture Manufacturing
339114	Dental Equipment and Supplies Manufacturing
339115	Ophthalmic Goods Manufacturing
339116	Dental Laboratories
622110	General Medical and Surgical Hospitals
621111	Offices of Physicians (98.5% excluded)

Life Sciences Employment in Michigan

Employment in Michigan's Life Sciences industry, as defined in the previous section, includes the employees of select manufacturing, research, and service businesses. To determine just how many people these businesses employ in Michigan we rely on data from the United States Census Bureau County Business Patterns, which provide an accurate source of state level employment data for each NAICS industry sector. We also draw on data from the United States Bureau of Labor and Statistics (BLS) to assess to occupations held by employees of the Life Sciences industry.

EMPLOYMENT AND ESTABLISHMENT DATA: 1998 - 2001

Anderson Economic Group's analysis of U.S. Census County Business Patterns data indicates that total Life Sciences industry employment in Michigan for 2001 was 31,778. These jobs were provided by 843 establishments, and represent a 0.79% share of total Michigan employment.

Life Sciences employment by more than 12.5% in Michigan between 1998 and 2001. This is exceptionally strong growth compared to total Michigan employment growth of 2.3% during the same period. Note also that the Life Sciences share of total employment increased each year during 1998 - 2001. This can be attributed as much to growth in the Life Sciences industry as to the stagnant total employment growth.

For more detail, see Table 4, "Life Sciences Industry Employment in Michigan, 1998-2001," on page 13. See also "Appendix C: Michigan Life Sciences Industry Employment: 1998 - 2001" and "Life Sciences in Michigan: No. of Establishments and Employment" on page 5

TABLE 4. Life Sciences Industry Employment in Michigan, 1998-2001

	1998	1999	2000	2001
Total Employment in Life Sciences, Michigan	28,164	29,227	30,671	31,778
Number of Establishments in Life Sciences, Michigan	731	760	783	843
Average Employment per Establishment	39	39	39	38
Total Michigan Employment	3,919,567	3,996,300	4,072,786	4,008,572
Life Sciences Share of Total Michigan Employment	0.72%	0.73%	0.76%	0.79%

Data Source: US Census Bureau, County Business Patterns; Anderson Economic Group
Analysis: Anderson Economic Group

EMPLOYMENT AND ESTABLISHMENT DATA: 2002 - 2005 FORECAST

TABLE 5. Life Sciences Industry Employment Projections in Michigan, 2002-05

	2002 Estimate	2003 Estimate	2004 Forecast	2005 Forecast
Total Employment in Life Sciences, Michigan	33,720	35,900	38,549	41,555
Number of Establishments in Life Sciences, Michigan	899	962	1043	1132
Average Employment per Establishment	38	37	37	37

Source: Anderson Economic Group

With 2001 being the last year for which US Census County Business Pattern data was available, we projected 2002-2005 employment for each subsector based on the Census data from 1998 to 2001.[1] We estimate total employment in Michigan's Life Sciences industry to be 35,900 in 2003. Our forecast shows that the industry employment would increase to 44,555 in 2005. Actual employment growth could be much greater if an existing employer under goes a major expansion, or if a large Life Sciences company shifts more jobs to Michigan. However, if support for the industry is reduced, it is *not* likely that job growth would occur at the projected rates.

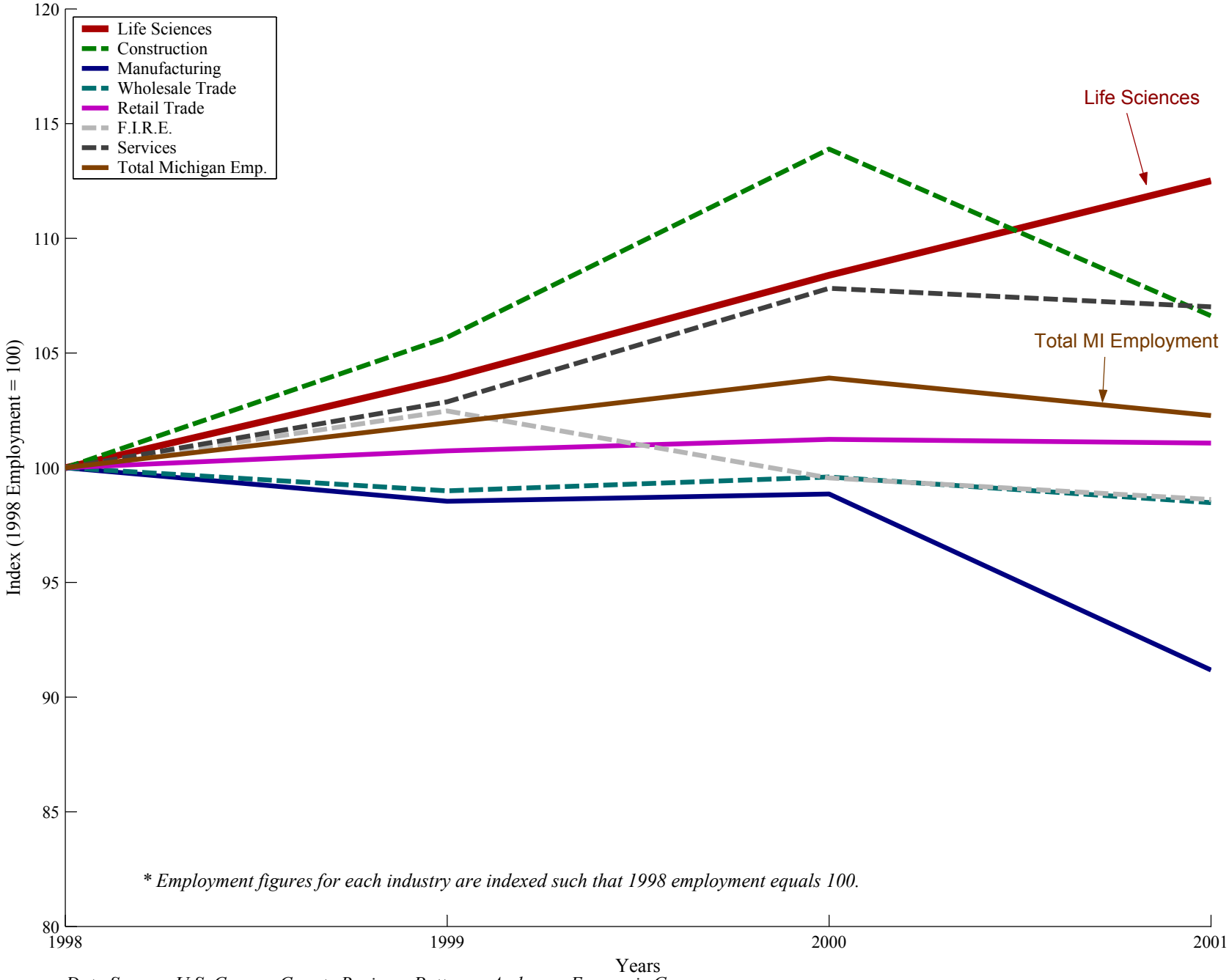
See Table 5, "Life Sciences Industry Employment Projections in Michigan, 2002-05," on page 14, as well as "Appendix D: Michigan Life Sciences Industry Employment: 2002 - 2005 Forecast" on page 1.

Employment Patterns by Industry

We compared growth in Life Sciences employment with that in other industry sectors, as well as to total employment growth for Michigan during 1998 - 2001. Table 2, "Michigan Employment Index," on page 15 reveals that the Life Sciences was the only industry of those listed to demonstrate a steady positive growth in employment over the four year span. Wholesale and Retail trade remained steady across the board, while F.I.R.E. and Services experienced fluctuations until both plateaued in 2000. The Construction industry began in 1998 with positive growth while Manufacturing stayed below average, yet both industries experienced a sharp plunge in the employment index in 2000, and were continuing to decline going into 2001.

1. For estimation and forecasting, we used trend analysis and a simple linear regression model, and assume that the factors affecting growth in the Life Sciences industry, including government support, will hold steady. An adjustment to 2003 employment figures was made to account for the affect of Pfizer's layoffs in Kalamazoo County.

Figure 2. Michigan Employment Index*



Data Source: U.S. Census, County Business Patterns; Anderson Economic Group

Analysis: Anderson Economic Group

Generated Date: 01/20/2004

OCCUPATIONS IN THE LIFE SCIENCES INDUSTRY

Despite the "white-coat" scientist view of the Life Sciences, the industry actually employs workers in a broad range of occupations. These occupations are listed in Table 6, "Occupations in the Life Sciences Industry," on page 16. Only 12.7% of those employed in the industry have occupations rooted in math or science.[1] Many others working in the Life Sciences have occupations as Healthcare Practitioners (25% of the industry); Office and Administrative Support (26%); and Production (11%).

TABLE 6. Occupations in the Life Sciences Industry

Occupation	Job Types	Portion of Total Industry Employment[a]
Architecture and Engineering	Architects; Aerospace Engineers; Agricultural Engineers; Biomedical Engineers; Chemical Engineers; Computer Engineers; Electrical Engineers; Environmental Engineers; Industrial Engineers; Materials Engineers; Mechanical Engineers; Nuclear Engineers.	5%
Arts, Design, and Media	Commercial and Industrial Designers; Graphic Designers; Public Relations Specialists; Editors; Technical Writers.	< 0.5%
Building and Grounds Maint.	Janitors and Cleaners; Landscaping and Groundskeeping Workers.	1%
Business and Financial	Buyers; Employment, Recruitment, and Placement Specialists; Compensation, Benefits, and Job Analysis Specialists; Training Specialists; Management Analysts; Accountants and Auditors; Financial Analysts.	3%
Community and Social Services	Rehabilitation Counselors; Medical and Public Health Social Workers; Health Educators.	1%
Computer and Mathematical Science	Computer and Information Scientists; Computer Programmers; Software Engineers; Systems Analysts; Database Administrators; Network Administrators; Mathematicians; Statisticians.	3%
Construction and Extraction	Construction Laborers; Operating Engineers and Other Construction Equipment Operators; Reinforcing Iron and Rebar Workers; Roofers; Hazardous Materials Removal Workers; Mining.	< 0.5%
Education and Training	Librarians; Audio-Visual Collections Specialists; Instructional Coordinators.	< 0.5%
Farming, Fishing, and Forestry	Agricultural Inspectors; Breeders; Graders and Sorters, Agricultural Products; Farmworkers and Laborers, Crop, Nursery, and Greenhouse.	< 0.5%
Food Preparations and Serving	Cooks, Institution and Cafeteria; Combined Food Preparation and Serving Workers, Including Cafeteria.	< 0.5%
Healthcare Practitioners and Technical	Pharmacists; Surgeons; Physician Assistants; Podiatrists; Nurses; Occupational Therapists; Radiation Therapists; Medical and Clinical Laboratory Technologists and Technicians; Cardiovascular Technologists and Technicians; Diagnostic Sonographers; Nuclear Medicine Technologists; Radiologic Technologists; Surgical Technologists.	25%
Healthcare Support	Physical Therapist Assistants; Medical Assistants; Medical Equipment Preparers.	9%

1. This includes those working as "Life, Physical, and Social Scientists;" "Engineers and Architects;" and "Computer and Mathematical Scientists."

TABLE 6. Occupations in the Life Sciences Industry

Occupation	Job Types	Portion of Total Industry Employment[a]
Installation, Maintenance, and Repair	Mechanics, Installers, and Repairers; Office Machine Repairers; Electrical and Electronics Repairers; Industrial Machinery Mechanics; Maintenance and Repair Workers; Medical Equipment Repairers.	2%
Legal	Lawyers; Paralegals and Legal Assistants; Law Clerks; Title Examiners, Abstractors, and Searchers.	< 0.5%
Life, Physical, and Social Scientist	Agricultural and Food Scientists; Biochemists and Biophysicists; Microbiologists; Zoologists and Wildlife Biologists; Conservation Scientists; Epidemiologists; Medical Scientists; Physicists; Chemists; Materials Scientists; Environmental Scientists and Specialists, Including Health; Geoscientists; Biological Technicians; Chemical Technicians; Geological and Petroleum Technicians; Nuclear Technicians; Environmental Science and Protection Technicians, Including Health.	4%
Management	Chief Executives; General and Operations Managers; Marketing Managers; Sales Managers; Public Relations Managers; Information Systems Managers; Financial Managers; Human Resources Managers; Purchasing Managers; Engineering Managers; Food Service Managers; Medical and Health Services Managers; Natural Sciences Managers.	6%
Office and Administrative Support	Bill and Account Collectors; Payroll and Timekeeping Clerks; Customer Service Representatives; Human Resources Assistants; Executive Secretaries; Legal Secretaries; Medical Secretaries; Office Clerks; Proofreaders and Copy Markers; Statistical Assistants.	26%
Personal Care and Service	Personal Service Workers; Tour Guides and Escorts; Child Care Workers; Personal and Home Care Aides.	< 0.5%
Production Occupations	Electromechanical Equipment Assemblers; Chemical Plant and System Operators; Chemical Equipment Operators and Tenders; Medical Appliance Technicians; Semiconductor Processors.	11%
Protective Service	Fire Fighting and Prevention Workers; Security Guards.	< 0.5%
Sales and Related	Advertising Sales Agents; Sales Representatives, Technical and Scientific Products; Product Promoters; Sales Engineers.	1%
Transportation	Truck Drivers; Conveyor Operators; Crane and Tower Operators; Freight, Stock, and Material Movers; Machine Feeders and Offbearers; Packagers.	1%

Data Source: United States Bureau of Labor Statistics
Analysis: Anderson Economic Group

a. Figures are rounded; may not sum to 100%.

EARNINGS

The Bureau of Labor Statistics (BLS) also provides occupational wage data, which is presented in Table 7, "Annual Wage by Occupation: Life Sciences v. National Average (2001)," on page 18.

Occupations in the Life Sciences industry pay, on average, $15,913 more annually than the U.S. mean annual wage. In fact, all but two of the 22 major occupations pay employees in the Life Sciences more than if they were working in a different industry. This disparity ranges from $932 more each year for transportation workers, to $28,778 more per year for legal workers and $25,913 more per year for healthcare practitioners and technical personnel.

TABLE 7. Annual Wage by Occupation: Life Sciences v. National Average (2001)

Occupation	Mean Annual Wage: Life Sciences Industry	Mean Annual Wage: U.S. Industry Average	Difference
Architecture and Engineering	$65,168.41	$58,020.00	$7,148.41
Arts, Design, and Media	$51,522.76	$41,660.00	$9,862.76
Building and Grounds Maintenance	$22,136.92	$20,850.00	$1,286.92
Business and Financial	$56,743.23	$53,350.00	$3,393.23
Community and Social Services	$35,809.88	$34,630.00	$1,179.88
Computer and Mathematical Science	$68,702.21	$61,630.00	$7,072.21
Construction and Extraction	$43,381.42	$36,340.00	$7,041.42
Education and Training	$39,501.58	$40,160.00	($658.42)
Farming, Fishing, and Forestry	$22,366.00	$20,220.00	$2,146.00
Food Preparations and Serving	$21,083.32	$17,180.00	$3,903.32
Healthcare Practitioners and Technical	$79,902.56	$53,990.00	$25,912.56
Healthcare Support	$25,311.62	$22,410.00	$2,901.62
Installation, Maintenance, and Repair	$41,865.84	$35,780.00	$6,085.84
Legal	$106,107.89	$77,330.00	$28,777.89
Life, Physical, and Social Scientist	$57,529.39	$52,380.00	$5,149.39
Management	$93,597.24	$78,870.00	$14,727.24
Office and Administrative Support	$27,666.54	$27,910.00	($243.46)
Personal Care and Service	$22,928.95	$21,370.00	$1,558.95
Production Occupations	$31,727.78	$28,190.00	$3,537.78
Protective Service	$34,575.01	$33,330.00	$1,245.01
Sales and Related	$57,348.85	$30,610.00	$26,738.85
Transportation	$28,152.27	$27,220.00	$932.27
Industry Total	$51,473.48	$35,560.00	$15,913.48

Data Source: Bureau of Labor Statistics
Analysis: Anderson Economic Group

Limitations of the Occupation Data

Occupation by industry data is available from the Bureau of Labor Statistics at the national level. Therefore, our analysis misses specific distribution variances within Michigan's Life Sciences industry.

Additionally, this data is only provided at the 4, and sometimes 5-digit, NAICS code level. To collect this data, as well as the corresponding wage data, we selected the parent NAICS code for each of the 6-digit codes included as part of the Life Sciences industry (as defined in Table 2 on page 11). For example, occupation and wage data are not provided for inorganic chemical manufacturers (NAICS 325188), so we used the data for the parent sector, which is basic chemical manufacturing (NAICS code 325100).

The Economic & Fiscal Contributions of Life Sciences in Michigan

DEFINITIONS

Anderson Economic Group has rigorously completed, and critiqued, numerous economic and fiscal impact analyses. We depart from many other practitioners by insisting on a specific, conservative, and realistic definition of "economic impact."

We define an economic impact as *bona fide,* economic activity directly or indirectly caused by the subject. In calculating the effects, we take into account both costs and benefits. In particular, we subtract from the total net benefit figure any reductions in economic activity due to displacement or substitution effects. The resulting findings are much more conservative, and realistic, than many reported analyses that fail to subtract costs, ignore substitution effects, or exaggerate benefits.

We define "fiscal impact" similarly, by including only *bona fide* new tax revenue or reduced government expenditures. To arrive at our total net fiscal impact figure, we subtract out any lost tax revenue or increased expenditures.

For this analysis of the Life Sciences, we evaluate the economic and fiscal contributions of the existing Life Sciences employers. We use the term "contribution" because we are not assuming that these employers are in Michigan aside from any special event, although their presence is certainly encouraged by the Life Sciences Initiative.

ECONOMIC CONTRIBUTION

We estimate the economic contribution of the Life Sciences industry in Michigan using a rigorous, conservative methodology. In particular, we strictly include the economic contributions of only those companies whose primary role is in the Life Sciences. For "Life Sciences," we use the definition provided in Table 2, "Definition of the Life Sciences Industry," on page 11.

We consider the *direct* and *indirect* contributions. Direct contributions include only those expenditures that occur directly from Life Sciences employers. Their purchases from non-Life Sciences employers—even if those purchases are for Life Sciences research—are not included.

The indirect contributions include those purchases from other industries. As these purchases occur because of Life Sciences activity, we consider them part of the total contribution of Life Sciences. We use the master input-output tables for the US Economy to determine the ratio between indirect and direct activity.[1]

This is a conservative methodology, and results in a much smaller estimated economic impact than most of the naive, and often exaggerated, "multiplier" analyses. We do not include any "induced" economic activity, although new Life Sciences investments clearly do induce other investment.

The direct economic contribution are estimated using data on payroll and employment in specific Life Sciences industries in Michigan. These sums are compared with overall payroll and employment in the state, to arrive at the base fraction of economic activity in the state that consists of Life Sciences. See Table 8 on page 21.

TABLE 8. Life Sciences Industry Payroll in Michigan, 1998-2001

	1998	1999	2000	2001
Direct Payroll in Life Sciences, Michigan (in billions)	$1.35	$1.44	$1.54	$1.64
Total Michigan Payroll (in billions)	$128.6	$138.3	$145.5	$142.9
Life Sciences Share of Total Michigan Payroll	*1.05%*	*1.04%*	*1.06%*	*1.15%*
Input-Output Ratio	0.83	0.83	0.83	0.83
Indirect Payroll from Life Sciences Industry Life Sciences (in billions)	$1.12	$1.20	$1.28	$1.36
Total Direct and Indirect Payroll (in billions)	*$2.47*	*$2.64*	*$2.82*	*$3.00*

Data Source: US Census Bureau, County Business Patterns; Anderson Economic Group
Analysis: Anderson Economic Group

The table shows that about 1.15% of all payroll in the State is paid directly by Life Sciences employers. We consider this share-of-state-payroll ratio to be a reliable indicator of the overall direct economic contribution to the state, because it captures the most fundamental contribution: wage and salary earnings to workers.[1] Thus, using this ratio as a basis, we estimate approximately $1.6 billion in direct payroll from Life Sciences employers in 2001, up from $1.35 billion in 1998.

Incorporating indirect effects, using the conservative ratio of indirect to direct economic activity, results in a total payroll of $3.0 billion. Note that this is a conservative measure, as it excludes many employers who are partially involved in Life Sciences.

1. These are published by the US Department of Commerce, Bureau of Economic Analysis, in *Benchmark Input-Output Accounts of the United States, 1992.*
1. There are other factors that may be missed by this measure, such as business income and transfer payments. However, there is likely to be a higher amount of business income in this sector than in the average sector, and therefore the exclusion of this amount makes the analysis more conservative.

FISCAL IMPACT

An industry of this size generates sizable tax revenue. We estimate these taxes by using the payroll ratio, and further estimate by adjusting this fraction for the incidence of individual taxes.

For example, Life Sciences employers have a large amount of personal property (such as machines, computers, and other equipment), and therefore we estimate that they pay a proportionately higher property tax burden than all employers as a group. On the other hand, we estimate they pay a somewhat lower sales tax burden, as some of their output would be considered sales tax exempt. There are scant data available on this topic, so the judgement of AEG economists is the source of these adjustments.

Table 9, "State and Local Tax Payments, Michigan Life Sciences Employers and Employees," on page 23, summarizes these calculations. We estimate that Life Sciences employers, and their employees, pay $360 million in state and local taxes annually, including SBT, Sales, Property, Individual Income, and Transportation taxes. Adding the indirect activity—again using the quite conservative ratio derived above—results in a total tax collection from the industry's people and businesses of $658 million.

Of course, the employers and the employees of this industry, like those in every other industry, also receive government services. We do not attempt to estimate a "net" fiscal benefit to the state. However, it seems highly likely that the fiscal contributions far outweigh the direct fiscal costs.

CONCLUSIONS

The Life Sciences industry accounts for slightly less than 0.8% of all employment in Michigan, and about 1.1% of all direct payroll. For 2001, this calculates to a direct economic contribution of over $1.6 billion. When a conservative input-output ratio is applied, and indirect contributions are added, it is estimated that more than $3.0 billion in total Michigan payroll is attributable to the Life Sciences industry. This accounts for about 2% of payroll income in the State.

Because Life Sciences employers typically pay higher wages, and purchase and use more equipment, we estimate they pay somewhat higher overall state and local taxes than average employers in other industries. By major tax, we estimate that Life Science employers and their Michigan employees pay $28 million in SBT, $67 million in Sales and Use Taxes, $158 million in property taxes, and $86 million in income taxes.

Table 9. State and Local Tax Payments, Michigan Life Sciences Employers and Employees

Taxes	Life Sciences Payroll Share of Total Michigan Payroll (2001)	Adjustment	Michigan 2002 Collections	Life Sciences Direct Payments	Life Sciences Indirect Payments	Life Sciences Total Payments
SBT - Net	1.15%	1.2	$ 2,052,239,000	$ 28,271,644	$ 23,465,465	$ 51,737,109
Sales	1.15%	0.9	$ 6,492,547,000	$ 67,080,996	$ 55,677,226	$ 122,758,222
Property						
- Utility			$ 140,841,000			
- Estate			$ 141,475,000			
- State Real Estate Transfers			$ 254,237,000			
- State Education			$ 1,578,743,000			
- General Property			$ 9,385,393,828			
Property Total	1.15%	1.2	$ 11,500,689,828	$ 158,433,503	$ 131,499,808	$ 289,933,311
Individual Income - Net	1.15%	1.2	$ 6,260,348,000	$ 86,242,554	$ 71,581,320	$ 157,823,874
Transportation Taxes	1.15%	0.9	$ 1,940,000,000	$ 20,044,080	$ 16,636,586	$ 36,680,666
Total Major Tax Payments to Michigan State and Local Governments				**$ 360,072,777**	**$ 298,860,405**	**$ 658,933,182**

Sources: Citizen's Research Council of Michigan; Anderson Economic Group; U.S. Department of Labor, BLS

memo:	
Life Sciences Payroll Ratio	*0.01148*
Indirect/Direct Ratio	*0.83*

Government Support of the Life Sciences Industry

As traditional manufacturing jobs have declined as a share of overall employment, many states have turned to economic development strategies that aim to build a more high-tech employment base. As a result, competition to attract and retain jobs in industries such as the Life Sciences is fierce.[1] This competition has unveiled itself in the form of aggressive tax subsidies, site selection enhancements for technology companies, grants, and other sources of government funding.

IMPORTANCE OF GOVERNMENT FUNDING FOR THE LIFE SCIENCES

Government funding is particularly important in the Life Sciences industry as it funds advanced research and development that would otherwise not be conducted. This is largely attributable to the fact that much of the research supported by government funding culminates in discoveries that can be classified as "public goods."

Public goods are those whose consumption is nonrival and nonexcludable. For example, once findings of a research project are published, one persons use of the findings (consumption) does not negatively impact another persons ability also use the findings (nonrival). Additionally, once the research is published it is possible for anyone to obtain the results (nonexcludable).

Non-excludability gives rise to the free-rider problem, whereby firms knowing that they can get the goods (research) at no cost are left with no incentive to conduct the research on their own. In addition, if the research has positive spillover effects, whereby benefits accrue to people other than those paying for the research, there is marginal or no incentive to conduct the initial research. As a result, research and development in the sciences, national defense, and other such areas are often publicly funded.

Venture capitalists cannot be expected to provide funding for an industry such as the Life Sciences until there is a likelihood of profits being earned. Therefore, Life Science firms must rely on government funding (or large private donations) for nearly all of their initial research and development. It is not until this research and development is complete, and the results show an opportunity for commercial applications, that venture capital and other such sources of funds will become available.

Given the importance of government funding in the Life Sciences industry, it is not surprising that state-sponsored programs supporting the industry are a major

1. An article in the January 2004 edition of "Site Selection Magazine" notes that 40 states offer incentives for biotech firms.

site selection consideration for Life Science employers and entrepreneurs. Not only do such programs provide funding for important research, but they also open the door to other sources of funding by adding legitimacy to a research initiative, and by giving researchers a more detailed understanding of the topic, allowing them to better solicit funds for continued and expanded research.[1]

STATE INITIATIVES IN THE LIFE SCIENCES

Many states throughout the country are working to attract Life Science employers. Despite budget shortfalls, these states have increased their efforts to build the Life Sciences industry, hoping to secure a source of high-wage employment for years to come. Below we describe the efforts under way in several such states.

California. Governor Gray Davis initiated the use of $100 million in state funding for the institute for Bioengineering, Biotechnology, and Quantitative Biomedical Research. The State's goal is collaboration with state universities and industries to develop jointly funded research programs. California offers 15% (in-house) and 24% (outsourced) research and development tax credits, 100% net operating loss carry forward, a 7% job-creation tax credit, and 6% manufacturing credit.

In 2000, CalPERS, the California Public Employees' Retirement System, established the California Biotechnology Program. CalPERS is the nation's largest state pension fund with assets of $170 billion, $500 million of which is dedicated to investing in biotechnology through the local venture capital community.

Florida. In October 2003, Florida lawmakers approved a $510 million incentive package independently brokered by Governor Jeb Bush to lure the Scripps Research Institute to Palm Beach, Florida. The Governor promised $310 million in state incentives while Palm Beach County offered up to $200 million more, using a bond issue to help pay for the land and facility for Scripps. Bush emphasized these state incentives were part of 2003's $948 million federal stimulus package for Florida and that the Scripps' funding is one-time seed money.

Georgia. In 2000, Governor Roy Barnes called for the establishment of the Georgia Cancer Coalition (GCC) which is a statewide network of people and institutions focusing on cancer research. The State pledged between $300-400 million over the next 5-7 years to the GCC, with funding to be leveraged threefold, creating an overall $1 billion initiative.

The Georgia Research Alliance (GRA), created in 1990, is a partnership between the state legislature, Georgia research universities and state businesses.

1. Two of the largest sources of funding for research in the Life Sciences industry are the National Institute of Health (NIH), and the National Science Foundation (NSF).

It has helped the State capitalize on the biosciences industry with the help of over $375 million in funds from the Georgia Legislature.

Illinois. In 2000, Governor George Ryan developed the VentureTECH initiative, a 5-year, $1.9 billion technology investment program. This was a strategy for investing state resources in education and advanced research and development, health sciences and biotechnology and advanced information technology programs.

Chicago, Illinois is home to one of the nation's largest biotech incubators and is a center for the Life Sciences. To invest in its biotech future, the city of Chicago and the State of Illinois offer the following incentives: low interest business loans and industrial revenue bonds, tax increment finance funds, property tax reductions, Illinois EDGE and Enterprise Zone tax credits, large business development program incentives, Illinois investment technology capital, and industrial training and grant programs.

Massachusetts. In 1985, the state created the Massachusetts Biomedical Initiatives with $8 million in cumulative state investment. Massachusetts offers a 10% research and development tax credit and a 3% credit on depreciable assets. The State also offers tax credits against excise tax for leased personal property, a tax credit for a corporation renting or leasing tangible property, and credit against corporate excise tax. The Massachusetts Biotechnology Council teamed with the Boston Consulting Group to create MassBiotech 2010: Achieving Global Leadership in the Life-Sciences Economy as an initiative to further the strength of the Life Sciences industry.

Missouri. In December 2003, Governor Bob Holden announced “Jobs Now,” a comprehensive plan to accelerate the progress of the state's economy. This includes creating the Life Sciences Research District Program, which allows for the use of incremental state and local tax revenues from designated Life Sciences research programs at universities. It would also include efforts to strengthen collaboration between business and research institutions to ensure products and jobs stay in the state of Missouri. “Jobs Now” also allows for the expansion of job training opportunities by increasing the debt ceiling allowance for community colleges; authorizing pooled bonding for higher education institutions; and prioritizing job training grants to focus on Life Sciences jobs and companies with matching funds.

New York. In 1999 the state enacted “Jobs 2000”, which created the New York State Office of Science, Technology, and Academic Research with a $500 million state funded investment. The State also established the New York Venture Capital Investment Program, a $250 million investment fund capitalized by the New York State Retirement System. For the 2002-2003 budget, New York included a new initiative called Gen*NY*sis, Generating Employment by New York Science, which would provide funding of $225 million over three years.

New York also offers research and development tax exemption, sales tax exemption for production, research and development, and the Qualified Emerging Technology Company employment credit and capital tax credit.

North Carolina. In 1981, the state funded the North Carolina Biotechnology Center (NCBC) making North Carolina a forerunner in life science initiatives. In the 2001-2002 fiscal year, the budget for the NCBC was $8.7 million, $4.5 million of that coming from the General Assembly. The state also offers a 5% research and development tax credit and a 7% tax credit for machine and equipment leases.

In 1997, North Carolina began a $40 million investment to create the North Carolina Bioscience Investment Fund, which provides working capital to biotechnology and bioscience companies and plans to designate $42 - $150 million in tobacco settlement money for biomanufacturing.

Ohio. In 2002, Governor Taft announced "Third Frontier", a project to invest $1.6 billion of state funds in biotech and high-tech research over the next decade. The money comes in part from Ohio's share of the tobacco settlement and the rest from capital and general revenue funds.

Pennsylvania. In 2002, Governor Mark Schweiker pledged $2 billion dollars in tobacco settlement funds to stimulate the life sciences industry. This strategy includes $1.6 billion in funding for the state's research universities and institutions, the establishment of a Life Sciences Venture Fund, and the creation of regional Life Science Greenhouses. Three Greenhouses have been established across the state and the Governor hopes these programs will leverage over $150 million more in private capital over the next 5 years.

CONCLUSION

As Michigan positions its economy for a prosperous 21st century, it should continue to focus on attracting high-skill, high-wage jobs in industries such as the Life Sciences. To do this requires a concentrated and lasting effort that will demonstrate Michigan's committment to the industry. Such an effort was launched in 1999 when the 20 year, $50 million per year Life Sciences Corridor was formed. However, funding for the program has not been maintained, and as a result, Michigan's position as a leader in state support for the Life Sciences has diminished.[1]

In return for a successful commitment to the Life Sciences, the State can expect to see strong growth in the industry, such as that occurring between 1998 and

1. The May 2002 issue of *Site Selection* magazine featured a cover story on Pfizer's expansion in Ann Arbor, in which much was said about Michigan's Life Sciences Corridor. Only two years later, and after state support for the LSC was greatly reduced, a January 2004 *Site Selection* article devoted entirely to state programs aimed at the Life Sciences does not make a single mention of Michigan.

2001 (See Table 4 on page 13). The jobs that are created in the industry should continue to provide compensation above the national average, creating a large tax base and tax revenues for state and local governments. Additionally, as the industry grows, it is likely that additional sources of venture capital and federal funding will come to the State, accelerating the growth of the industry beyond our forecasts.

The risks of not supporting the Life Sciences industry are real. Michigan will continue to lose ground as a leader in the Life Science as employers are attracted to states with more attractive — and just as importantly, stable — sources of funding. As a result, growth in the industry could, over time, fall below the rates projected in Table 5 on page 14. The State would also likely experience a decline in the experience and knowledge of its workforce, especially as university graduates emigrate to states with more rewarding employment opportunities.

Appendices Begin on Next:

Appendix A: Summary of Reviewed Sources

- "Signs of life: The growth of Biotechnology Centers in the U.S.," as completed in 2002 by The Brookings Institution, defines the biotechnology industry as involving the application of biological knowledge and techniques pertaining to molecular, cellular, and genetic processes to develop products and services. The report states that biotechnology is predominantly used in applied health and medical sciences, treating, diagnosing and preventing diseases. This definition explicitly excludes manufacturers of diagnostic equipment, medical devices, and software firms involved in programming technologies to maintain medical records or for other related purposes. The definition includes only firms involved in the R&D of the physical, engineering and Life Sciences, as well as pharmaceutical and medicine manufacturing firms.

- "Ready for the Next Leap Forward: A competitive assessment and strategic plan to develop Michigan's Life Sciences industry," a report issued in 2003 by the Michigan Economic Development Corporation, segments the Life Sciences industry to include pharmaceutical, medical devices, instrumentation, diagnostics and biotechnology based research and ancillary service firms.

- "An Analysis of Virginia's Biotechnology Industry," released in 1999 by the Center for Public Policy at the Virginia Commonwealth University, defines biotechnology as the "use of cellular and biomolecular processes to solve problems or make products." This definition is adopted from the Biotechnology Industry Association, a national organization providing business information, advocacy and services about the Biotechnology Industry in the United States.

- "The economic contributions of the biotechnology industry in the U.S. economy", a 2000 report from Ernst & Young, defines the biotechnology industry utilizing the Biotechnology Industry Association's definition. Biotechnology is defined as "the use of cellular and molecular processes to solve problems or make products." This definition includes companies that use cells and biological molecules for applications in medicine, agriculture and environmental management.

- The Michigan Economic Development Corporation released a report titled "The Battelle Report" - A Strategy Study, completed to help assess and strategize Michigan to be a competitor state in the global Life Science industry. The report outlines that the Life Sciences includes pharmaceuticals, medical diagnostics, medical equipment and supply companies, as well as firms involved in biotechnology and information based companies providing biologically based technology services such as bioinformatics.

- The Michigan Technology Tri-Corridor (MTTC) fund, which provides funding on a competitive basis, defines the Life Sciences, for the purposes of the 2004 MTTC competition, as including "Pharmaceuticals, Medical Devices, Instrumentation, Diagnostics, and Biotechnology Research and Ancillary Services. Life Sciences will not include projects that address healthcare delivery, public health, epidemiology, natural resources management, agriculture, or ecology."

- The "Editors' and Reporters' Guide 2003-2004," released by the Biotechnology Industry Organization (BIO) notes that biotechnology, in the traditional sense, is the use of biological processes to solve problems and make useful products. They then note that a more accurate and current definition of biotechnology would be "the use of cellular and biomolecular processes to solve problems or make products."
- MICHBIO, the leading association of Life Sciences companies in Michigan, notes on its web site (http://www.michbio.org) that they serve "a diverse membership, including new and established Life Sciences companies, academic and research institutions, as well as service providers and related organizations throughout the state." Their "Michigan Life Sciences Directory" includes the following membership categories: Agriculture, Bio defense, Bioinformatics, Biopharmaceutical, Biosurgery, Business Development/Planning Consultants, Cancer Research, Chemical/biochemical, Clinical Focus, Contract Research, Core Technology, Dental Devices/Tools, Dermatology, Diagnostics, Drug Delivery, Drug Developmental, Education, Environmental, Genetic testing, Genomics, Health Care, Health Info Services, Lab Equipment Providers, Medical Imaging, Medical devices, Microchip Technology, Microfluidics, Nanoengineering, Nutrition, Pharmaceutical, Prosthetics/Orthotics, Proteomics, Prototyping/Testing Services, Research Institute, Sensors, Supplier, Technology Transfer, Therapeutics, Tissue engineering, Toxicology, University, Venture Capital, and Veterinary Sciences.

Appendix B: Survey Responses by Key Stakeholders in MI Life Sciences Economy

1) To what extent are the following businesses involved in the Life Science industry?	**Response Option**	**Response Tally**
a) A manufacturer of inorganic chemicals that are used in biological research and medical treatment Such inorganic chemicals include ammonium hydroxide, copper sulfate, potassium bromide, and thiocyanate.	Largely Somewhat Not at all	2 5 1
b) A manufacturer of organic chemicals that are used in biological research and medical treatment. Such organic chemicals include acetaldehyde, carbon tetrachloride, oxalates, and propylene glycol.	Largely Somewhat Not at all	3 4 1
c) A manufacturer of ophthalmic goods, such as eyeglass frames, lens coatings, and contact lenses.	Largely Somewhat Not at all	2 5 2
d) A manufacturer of irradiation apparatus', such as beta-ray irradiation equipment, CT/CAT scanners, fluoroscopes, x-ray equipment, and radium equipment.	Largely Somewhat Not at all	6 0 3
e) A manufacturer of medical and surgical supplies, such as adhesive tape, clean room suits, orthopedic devices, surgical sutures, and wheelchairs.	Largely Somewhat Not at all	6 2 1
f) A manufacturer of surgical and medical instruments, including blood transfusion equipment, catheters, gastroscopes, skin gafting equipment, surgical knives, and tonometers.	Largely Somewhat Not at all	6 2 1
g) A manufacturer of laboratory instruments, including amino acid analyzers, electron microscopes, osmometers, and spectrographs.	Largely Somewhat Not at all	6 3 0
h) A manufacturer of electromedical and electrotherapeutic apparatus', including cardiographs, dialysis equipment, pacemakers, and ultrasonic scanning devices.	Largely Somewhat Not at all	6 2 1
i) A manufacturer of dental equipment and supplies, including amalgams, dental wax, and orthodontic appliances.	Largely Somewhat Not at all	3 4 2
j) Physicians in a general practice, including pediatricians and family doctors.	Largely Somewhat Not at all	3 3 3
k) Physicians providing specialty care and treatments, such as cardiologists, neurologists, oncologists, proctologists, and urologists.	Largely Somewhat Not at all	4 3 2
l) A medical laboratory, such as a toxicology lab, DNA testing lab, or a bacteriological lab.	Largely Somewhat Not at all	6 3 0
m) A diagnostic imaging center, such as a radiology lab, MRI centers, or CT-SCAN centers.	Largely Somewhat Not at all	6 2 1
n) A blood or organ bank.	Largely Somewhat Not at all	5 3 1
o) A general medical or surgical hospital providing routine treatment and emergency care to a local population.	Largely Somewhat Not at all	4 2 3
p) A specialty hospital providing advance care that a general hospital can not provide. This would include a children's hospital, chronic disease hospitals, and cancer hospitals.	Largely Somewhat Not at all	5 2 1

2) In your opinion, which of the following most accurately defines the Life Sciences Industry?

Response Option	Number of Responses
The Life Sciences include organizations that conduct research, development, and patient care to advance knowledge, create innovative technologies, develop products, or improve the quality and length of life for humans, animals, or plants.	3
The Life Sciences industry is primarily concentrated in the field of biotechnology, defined by companies using advanced biological techniques to improve human and animal health, agricultural productivity, food processing, renewable resources and environmental affairs.	4
The Life Sciences industry is primarily focused in the field of medicine and biotechnologies, organized around pharmaceutical, medical equipment and supply, medical diagnostics companies, medical research institutions, and health care providers.	1
The Life Sciences industry involves biotechnology research and development laboratories, pharmaceutical and medicine manufacturing, medical research institutions, and specialty hospitals.	1

3) Is the definition you chose in question two an accurate definition of the Life Sciences? If not, how do you define the Life Sciences Industry?

Yes: 6 No: 3

Responses to "How do you define the Life Sciences"

Inclusion of care givers while a vital part of the Life Science industry, is not a good reflection of much other than population. A vital Life Science industry requires the involvement of local care givers, be they community hospitals, physicians etc. however, for the purposes of economic reporting, it is not a reflection so much of anything other than population
The Life Science industry is the study of living things. The life science industry is composed of those people and entities who do research and product or service development to promote this study, or to utilize its outcomes
The Life Sciences industry includes Biotechnology & Pharmaceuticals, health care services, medical devices, and diagnostics. The Life Sciences does not include health care professionals like doctors and dentists amongst others.

4) What recent or upcoming events do you feel will impact the Life Sciences industry, both Statewide and within your part of the State?

Response Option

New innovations, aging population, antibiotic resistance, insurance costs, decrease in the insurance coverage, structure and decision process of tri-technology corridor funding will all impact the Life Sciences.

State budget deficit and further cuts, Pfizer's purchase of Pharmacia, Relative dearth of venture capital funding in Michigan, and the National Institutes of Health roadmap - federal funding in Life Sciences, will impact the industry.

State support will erode with the budget crisis and Private companies will look to other states without the State level funding support. The current fiscal crisis and lack of long term vision in State Life Sciences will detract away from private enterprise and Venture Capital funding in the State.

State funding being redirected from the Life Sciences to other sectors will have negative a impact. In addition, the Pfizer/Pharmacia merger may have a negative impact (in terms of job losses and transfer of research projects to Pfizer locations outside of Michigan). Focused private investment is needed to jump start the industry, and without this industry may have to rely on public funds. Many states are looking at the Life Science sector as their largest economic stimulus opportunity. Multiple states, private investors have committed to this growth sector, but without investment dollars flowing into a region, the Life Science industry will not be sustained.

The Life sciences corridor, if it is funded appropriately and not diluted in its efforts by the addition of the task to serve other industry sectors may benefit the Life Sciences. The State's efforts to promote venture capital is still pending, and the importance of the University of Michigan's Life sciences Institute is critical to the success of Life Sciences in Michigan.

Changing the "tri-corridor" back to the Life sciences. The 15 million into the tri-corridor for the Life sciences is a wasted and diluted effort. As the other efforts of homeland security and automotive technology do not fit in well, and will not benefit from a mere 15 million each.

Sustained Government funding, both at State and Federal level is required if the Life Sciences is deemed to grow as a sector in Michigan's economy.

Enhanced funding for Research Budgets of the major universities and research institutes. Success of University of Michigan's Life Sciences Institute. Success of the Michigan Life Sciences Corridor effort and continual funding from the State. Michigan should continually fund economic development programs in the Life Sciences (even through different administrations), while staying abreast of competitor states in the region. Increase skill labor pool of Michigan in Life Sciences will have an impact. Need for more risk, venture capital into Michigan may have a positive impact towards the Life Sciences.

5) Please list the Life Science Employer's in your region, including name of employers, number of employees, and company location(s)?

responses:

West Michigan Employers	Location	Number of Employees
Van Andel Research Institute	Grand Rapids	190
Spectrum Health	Grand Rapids	N/A
Mary Free Bed	Grand Rapids	N/A
St. Mary's Hospital	Grand Rapids	N/A
Mercy Health Partners	Muskegon	N/A
Stryker Corp.	Kalamazoo	5000
Hackley Hospital	Grand Rapids	N/A
North Ottawa Hospital	Grand Haven	N/A
Grand Valley State University	Allendale	N/A
Gerber Foods	Fremont	N/A
Kellog's	Grand Rapids	N/A
A-Tech Manufacturing	Grand Rapids	100
Inrad	Grand Rapids	30
Hart Manufacturing	Sparta	100
Skytron	Grand Rapids	200
Rose Medical	Grand Rapids	15
Pfizer	Kalamazoo	3000
Ideasphere	Grand Rapids	50
Tech Group	Grand Rapids	150
Oliver	Grand Rapids	100
Western Michigan University	N/A	N/A
Aspen Surgical	N/A	N/A
Corium	N/A	N/A

Southeast Michigan Employers	Location	Number of Employees
Pfizer	Ann Arbor	N/A
University of Michigan	Ann Arbor	N/A
University of Michigan Medical School	Ann Arbor	N/A
Rubicon Genomics	Ann Arbor	N/A
Aastrom Biosciences	Ann Arbor	N/A
GeneCodes	Ann Arbor	N/A
Handylab, Inc.	Ann Arbor	N/A
Nanobio	Ann Arbor	N/A
Henry Ford Hospital	N/A	N/A
Karmanos	N/A	N/A
Wayne State University Medical	N/A	N/A
Detroit Medical Center	N/A	N/A

Note: The above are the responses to the survey, not a complete list of life sciences employers, or an accurate count of jobs. N/A indicates the respondent did not provide the information.

Appendix C: Michigan Life Science Industry Employment: 1998 - 2001

NAICS sector	*NAICS Description*	% of Jobs in Life Sciences	Employment 1998: MI	Num. of Establish. 1998:MI	Employment 1999: MI	Num. of Establish. 1999:MI	Employment 2000: MI	Num. of Establish. 2000:MI	Employment 2001: MI	Num. of Establish. 2001:MI
325188	Manufacturing: All Other Basic Inorganic Chemical Manufacturing	*20.0%*	574	13	650	15	750	17	890	20
325199	Manufacturing: All Other Basic Organic Chemical Manufacturing	*80.0%*	3,500	18	3,347	16	3,556	17	2,997	19
621111	Health Care and Social Assistance: Offices of Physicians (except mental health)	*1.5%*	53,690	6,153	56,125	6,078	59,527	6,115	60,211	6,173
621511	Health Care and Social Assistance: Medical Laboratories	*100.0%*	2,636	108	2,750	121	2,653	121	3,185	151
621512	Health Care and Social Assistance: Diagnostic Imaging Centers	*100.0%*	1,852	134	1,873	135	1,731	141	2,218	155
621991	Blood & organ banks	*100.0%*	1,529	34	1,131	29	1,186	29	1,145	25
622310	Specialty (except psychiatric & substance abuse) hospitals	*100.0%*	2,035	12	2,169	17	2,317	17	2,690	25
325411	Medicinal & botanical mfg	*100.0%*	490	6	600	6	725	6	499	6
325412	Pharmaceutical preparation mfg	*100.0%*	6,486	18	7,231	18	7,234	21	7,336	21
325413	In-vitro diagnostic substance mfg	*100.0%*	315	9	320	9	355	10	550	10
325414	Biological product (except diagnostic) mfg	*100.0%*	375	10	436	10	553	10	500	9
541710	Research & development in the physical, engineering, life sciences	*100.0%*	3,496 43	174	3,590	195	4,216	206	4,261	222
334510	Electromedical & electrotherapeutic apparatus mfg	*100.0%*	433	10	350	9	453	9	275	6
334516	Analytical laboratory instrument mfg	*100.0%*	939	13	933	13	919	12	890	11
334517	Irradiation apparatus mfg	*100.0%*	40	2	60	3	80	4	32	1
339112	Surgical & medical instrument mfg	*100.0%*	1,588	33	1,397	31	1,600	34	2,240	37
339113	Surgical appliance & supplies mfg	*100.0%*	2,230	59	2,738	57	2,761	54	2,478	52
	Total Life Sciences Industry Employment		**28,164**	**731**	**29,227**	**760**	**30,671**	**783**	**31,778**	**843**
	Total Michigan Employment		3,919,567	235,403	3,996,300	236,456	4,072,786	236,912	4,008,572	236,711
	Percentage of Life Sciences Employment in Michigan		**0.72%**		**0.73%**		**0.75%**		**0.79%**	

Shaded: Exact census data is not available. AEG estimates based on census provided ranges.

Source: US Census Bureau, County Business Patterns; Anderson Economic Group

Analysis: Anderson Economic Group

Appendix D: Michigan Life Science Industry Employment: 2002 - 2005 Estimates and Forecast

NAICS sector	*NAICS Description*	*% of Jobs in Life Sciences*	Employment 2002: MI	Num. of Establish. 2002:MI	Employment 2003: MI	Num. of Establish. 2003:MI	Employment 2004: MI	Num. of Establish. 2004:MI	Employment 2005: MI	Num. of Establish. 2005:MI
325188	Manufacturing: All Other Basic Inorganic Chemical Manufacturing	*20.0%*	1,022	23	1,187	26	1,382	31	1,602	35
325199	Manufacturing: All Other Basic Organic Chemical Manufacturing	*80.0%*	2,957	19	2,846	21	2,675	22	2,563	23
621111	Health Care and Social Assistance: Offices of Physicians (except mental health)	*1.5%*	62,300	6,192	64,431	6,227	66,279	6,264	68,389	6,296
621511	Health Care and Social Assistance: Medical Laboratories	*100.0%*	3,473	172	3,793	196	4,243	229	4,683	264
621512	Health Care and Social Assistance: Diagnostic Imaging Centers	*100.0%*	2,455	164	2,733	175	3,152	188	3,561	201
621991	Blood & organ banks	*100.0%*	1,066	23	1,035	21	991	19	946	17
622310	Specialty (except psychiatric & substance abuse) hospitals	*100.0%*	2,984	33	3,326	42	3,741	57	4,181	75
325411	Medicinal & botanical mfg	*100.0%*	579	6	597	6	588	6	613	6
325412	Pharmaceutical preparation mfg	*100.0%*	7,594	22	7,747	23	7,927	24	8,127	26
325413	In-vitro diagnostic substance mfg	*100.0%*	619	11	798	11	1,059	12	1,303	12
325414	Biological product (except diagnostic) mfg	*100.0%*	539	9	579	8	597	8	631	7
541710	Research & development in the physical, engineering, life sciences	*100.0%*	4,533	240	4,875	258	5,147	278	5,475	300
334510	Electromedical & electrotherapeutic apparatus mfg	*100.0%*	278	5	267	5	237	4	223	3
334516	Analytical laboratory instrument mfg	*100.0%*	872	10	852	10	832	9	813	8
334517	Irradiation apparatus mfg	*100.0%*	38	1	38	1	34	1	35	1
339112	Surgical & medical instrument mfg	*100.0%*	2,673	39	3,324	42	4,214	45	5,233	48
339113	Surgical appliance & supplies mfg	*100.0%*	2,511	50	2,454	48	2,376	46	2,334	44
	Total Life Sciences Industry Employment		**33,720**	**899**	**35,900**	**962**	**38,549**	**1,043**	**41,555**	**1,132**

Source: US Census Bureau, County Business Patterns; Anderson Economic Group
Analysis: Anderson Economic Group

Note: Forecast assumes conditions affecting Michigan's life sciences industry in 2002 - 2005 remain similar to those present in 1998 - 2001.

Appendix E: Michigan Life Science Industry Payroll: 1998 - 2001

NAICS sector	*NAICS Description*	% of Jobs in Life Sciences	Payroll 1998: (000)	Payroll 1999: (000)	Payroll 2000: (000)	Payroll 2001: (000)
325188	Manufacturing: All Other Basic Inorganic Chemical Manufacturing	*20.0%*	$ 235,586	$ 233,485	$ 231,402	$ 229,338
325199	Manufacturing: All Other Basic Organic Chemical Manufacturing	*80.0%*	$ 235,586	$ 233,485	$ 231,402	$ 229,338
621111	Health Care and Social Assistance: Offices of Physicians (except mental health)	*1.5%*	$ 2,996,234	$ 3,099,948	$ 3,433,119	$ 3,648,675
621511	Health Care and Social Assistance: Medical Laboratories	*100.0%*	$ 90,714	$ 99,472	$ 106,931	$ 128,668
621512	Health Care and Social Assistance: Diagnostic Imaging Centers	*100.0%*	$ 88,488	$ 93,263	$ 103,591	$ 122,037
621991	Blood & organ banks	*100.0%*	$ 47,227	$ 38,663	$ 40,407	$ 41,243
622310	Specialty (except psychiatric & substance abuse) hospitals	*100.0%*	$ 62,492	$ 71,573	$ 74,126	$ 87,094
325411	Medicinal & botanical mfg	*100.0%*	$ 36,829	$ 36,444	$ 38,313	$ 40,643
325412	Pharmaceutical preparation mfg	*100.0%*	$ 319,676	$ 316,341	$ 332,560	$ 352,783
325413	In-vitro diagnostic substance mfg	*100.0%*	$ 14,879	$ 14,875	$ 15,768	$ 16,716
325414	Biological product (except diagnostic) mfg	*100.0%*	$ 17,755	$ 21,383	$ 25,753	$ 27,045
541710	Research & development in the physical, engineering, life sciences	*100.0%*	$ 182,488	$ 212,941	$ 243,570	$ 276,679
334510	Electromedical & electrotherapeutic apparatus mfg	*100.0%*	$ 19,353	$ 20,195	$ 20,120	$ 18,732
334516	Analytical laboratory instrument mfg	*100.0%*	$ 33,480	$ 34,937	$ 37,847	$ 35,236
334517	Irradiation apparatus mfg	*100.0%*	$ 17,611	$ 18,377	$ 19,322	$ 17,989
339112	Surgical & medical instrument mfg	*100.0%*	$ 61,751	$ 55,481	$ 60,792	$ 88,135
339113	Surgical appliance & supplies mfg	*100.0%*	$ 82,958	$ 126,177	$ 138,256	$ 103,689
	Total Life Sciences Industry Payroll		**1,356,229**	**1,440,107**	**1,540,255**	**1,640,757**
	Total Michigan Payroll		128,649,484	138,301,024	145,482,490	142,938,848
	Percentage of Life Sciences Employment in Michigan		**1.05%**	**1.04%**	**1.06%**	**1.15%**

Shaded: Census data is not available. AEG estimates.

Source: US Census Bureau, County Business Patterns; Anderson Economic Group
Analysis: Anderson Economic Group

Appendix F: Project Team

This project was conducted under the direction of Patrick L. Anderson, Principal with Anderson Economic Group. The project was managed by Scott D. Watkins, AEG's Director of Marketing and Administration.

Also contributing to the research, analysis, and writing of this report were Ilhan K. Geckil, Vladimir Hlasny, Megan Boone, and Karan Singh.

PATRICK L. ANDERSON

Mr. Anderson founded the consulting firm of Anderson Economic Group in 1996, and serves as a Principal in the company. In this role he has successfully directed projects for state governments, cities, counties, nonprofit organizations, and corporations in over half of the United States.

Prior to founding Anderson Economic Group, Mr. Anderson served as the chief of staff of the Michigan Department of State, where he supervised over 182 offices, 2,100 employees and annual tax collections of over $1.4 billion. He also served as a deputy director of the Michigan Department of Management and Budget, where he was involved in the largest state privatization project in U.S. history and the landmark 1994 school finance reform constitutional amendment.

Prior to his involvement in State Government, Mr. Anderson was an assistant vice president of Alexander Hamilton Life Insurance, where he shared responsibility for $5 billion in invested assets, an economist for Manufacturers National Bank of Detroit, and a graduate fellow with the Central Intelligence Agency in Washington DC.

Mr. Anderson has written over eighty-five articles published in periodicals such as *The Wall Street Journal, The Detroit News, The Detroit Free Press, American Outlook, Crain's Detroit Business*; and monographs published by the Mackinac Center for Public Policy, The Economic Enterprise Foundation of Detroit, the Ethan Allen Institute in Vermont, and the Heartland Institute of Chicago. His book *Business Economics and Finance* will be published by CRC Press in April 2004.

Mr. Anderson is a graduate of the University of Michigan, where he earned a Masters degree in Public Policy and a Bachelors degree in Political Science. He has been a member of the National Association for Business Economics since 1983.

SCOTT D. WATKINS

Mr. Watkins is the Director of Marketing and Administration at Anderson Economic Group. In this role he oversees the firm's administrative staff and procedures and implements marketing strategies.

Mr. Watkins also works as a Consultant on projects involving policy analyses and market assessments. Among the clients for whom he has worked are General Motors Corporation, the State of Wisconsin, SBC Ameritech, Michigan Chamber of Commerce, Michigan Retailers Association, and the City of Detroit. He has extensive background in market research, development strategies, and analyzing legislation and market data.

Prior to joining Anderson Economic Group, Mr. Watkins was an Analyst in the automotive market and planning group at J.D. Power and Associates, where he performed qualitative and quantitative research and analysis. Mr. Watkins also held a marketing assistantship with Foster, Swift, Collins, and Smith P.C.

Mr. Watkins is a graduate of Michigan State University with a B.A. in Marketing from Eli Broad College of Business and a B.A. in International Relations from the James Madison College.

CONTRIBUTORS

Ilhan K. Geckil—Mr. Geckil is a Consultant with Anderson Economic Group with backgrounds in applied economics, industrial organization, statistics, and public finance. Mr. Geckil's work includes economic and financial modeling, game-theoretical modeling and analysis, strategy development, and advanced statistical & econometric analysis. He holds a Masters degree in Economics from the Eli Broad Graduate School of Management at Michigan State University, and Bachelor degrees in Economics and International Relations from KOC University in Istanbul, Turkey.

Vladimir Hlasny—Mr. Hlasny is an Analyst at Anderson Economic Group, with experience in conducting regression analysis, market research and spatial economic analysis using GIS. He holds an M.A. in Economics from Michigan State University. He is currently pursuing a Ph.D. in Economics at MSU. His specialization is in Microeconomics and Econometrics, with an emphasis on market structure, regulation of public utilities, and firm performance.

Karan Singh—Mr. Singh is an Analyst at Anderson Economic Group, with experience in geographical and spatial analysis utilizing geographic information systems (GIS). In addition, Mr. Singh has experience in conducting economic, demographic, and community development assessments using applied statistical and economic procedures. He is pursuing a joint Master’s Degree at Michigan State University in Urban & Regional Planning and Urban Studies.

Megan Boone—Ms. Boone is an Executive Administrative Assistant at Anderson Economic Group and is involved in the internal operations of the firm as well as current client projects. She has performed data research on a number of topics, including the automotive industry, economic development, and public policy. She is a graduate of the James Madison College at Michigan State University with a dual degree in International Relations and Social Relations.