The Changing Landscape of Innovation

Priority Skill Needs of Employers in New Jersey's Life Sciences Industry

A Report of New Jersey's *Ready for the Job* Initiative

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New Jersey's Ready for the Job Initiative: Aligning Workforce Preparation with the Skill Needs of Key Industries

Economic growth in New Jersey requires a highly skilled workforce prepared to meet the evolving demands of the state's global economy. *Ready for the Job* is a key component of Governor Jon S. Corzine's Economic Growth Strategy for New Jersey. The initiative began in 2002 to collect and disseminate information on the workforce challenges and skill needs of the state's key industries and to identify education and training strategies to address these needs. *Ready for the Job* is a partnership among several state agencies and departments led by the State Employment and Training Commission and the New Jersey Department of Labor and Workforce Development.

Five *Ready for the Job* reports, including this document, will be released in 2008, including reports on the life sciences, green jobs in the energy sector, finance, the rise of remote work in New Jersey, and a report on emerging skills that identifies cross-cutting workplace trends and skill needs affecting employers throughout the innovation economy. Including these 5 reports, there have been a total of 17 reports produced for this initiative thus far. Past reports focused on the following industries:

Construction
Emerging Industries
Finance
Health Care
Hospitality and Tourism
Information Technology
Manufacturing
Port Newark/Elizabeth
Public Health/Disaster Management
Retail
Transportation
Utilities/Infrastructure

Information provided in the *Ready for the Job* reports is derived from an Industry Workforce Advisory Council for each industry, interviews with key employers and policymakers, focus groups of educational institutions and other stakeholders, a review of available labor market information, and background research on industry trends. Employer feedback collected in this and other *Ready for the Job* reports will be used to inform efforts to prepare individuals for industry jobs, including workforce development initiatives, K-12 education, higher education, and vocational training programs.

Results and reports from the *Ready for the Job* initiative are distributed through the NJNextStop website (*www.njnextstop.org*). NJNextStop is the State of New Jersey's primary career guidance Internet portal for high school students, counselors, teachers, and parents.

The authors of this report were Maria Heidkamp, Aaron Fichtner, Ph.D., and Jennifer Cleary. Special thanks go to Charyl Staci Yarbrough, Ph.D., for her formatting and work on earlier drafts of this report; Dan Silva for editing and proofreading; and Robb C. Sewell for editing and formatting.

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Executive Summary

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This report highlights the priority workforce skill needs of New Jersey's life sciences industry and presents a statewide action plan to better align education and training with these needs.

New Jersey is a dominant player in the global life sciences industry. The state is home to more pharmaceutical companies than any other state in the nation—or any other country in the world. Fifteen of the nation's 20 largest pharmaceutical companies have operations in New Jersey, many in the central part of the state, and New Jersey receives half of the nation's total R&D investment in new medicines.[1] New Jersey is also home to a growing number of biotechnology companies that perform basic research, as well as a significant number of medical device manufacturers. Overall, the industry employed over 84,500 workers in 2006, or nearly 3% of the state's private-sector workforce. These jobs also pay extremely well, averaging nearly $100,000 per year in 2006.[2]

Despite recent layoffs in some large pharmaceutical companies due to patent expiration cycles, continued globalization of the industry, and other factors, New Jersey is likely to remain a significant center of employment in the life sciences industry. The concentration of new and existing life sciences companies in the state and New Jersey's highly skilled workforce are key strategic advantages for attracting and retaining life sciences employers.

The industry provides a wide array of jobs for workers with varying educational backgrounds. According to a 2006 survey of New Jersey pharmaceutical and medical device companies commissioned by the Healthcare Institute of New Jersey, just over one-fifth of all industry jobs require an advanced degree, while nearly half require just a Bachelor's degree. The remaining jobs require either a high school diploma (25%) or an Associate's degree (4%).[3]

With the headquarter operations of several multinational pharmaceutical firms located in New Jersey, nearly half of the state's life sciences workers are employed in corporate administration, sales, and marketing jobs. One-quarter work in the research and clinical development area, which is focused on basic and clinical research, and the remaining quarter work in technical operations and manufacturing, which handles planning, production, and quality assurance functions.[4]

To remain competitive in today's global, innovation-based economy, life sciences companies in New Jersey—from start-up biotech firms to well-established multinational pharmaceutical companies—need access to a highly skilled and well-trained workforce. As competition, advances in technology, and other factors converge to increase the pace of change in the industry, state agencies and educational institutions must work together to ensure that the education and training systems in the state are responsive to the evolving skill needs of life sciences employers.

This *Ready for the Job* report, a key initiative of Governor Corzine's Economic Growth Strategy for the State of New Jersey, identifies the changing workforce needs of the life sciences industry and presents a statewide plan to address key skill and education gaps. The report is based on feedback from the New Jersey Life Sciences Industry Workforce Advisory Council and interviews with representatives from 10 large industry employers, as well as

discussions with state departments and educational institutions, background research on industry trends, and available labor market information.

The report also draws on a 2006 survey of pharmaceutical companies commissioned by the HealthCare Institute of New Jersey (HINJ) titled, *The Workforce Needs of New Jersey's Pharmaceutical and Medical Technology Industry*. More than two-thirds of HINJ member companies (15 of 22) responded to the survey; these companies represent over 38,000 jobs, or nearly half of all industry jobs in New Jersey.

Priority Workforce Skill Needs of Life Sciences Employers

The skill needs of life sciences industry employers are evolving rapidly in response to several global and industry-specific trends, especially technological and scientific advances. As disciplines such as genetics, bioinformatics, and nanotechnology emerge and advance, workers at life sciences companies must adapt to changes brought about by knowledge and technological breakthroughs.

Other important trends affecting the skill and workforce needs of life sciences employers in New Jersey include increasing global competition and the availability of new forms of communication brought on by advances in information technology, changing cost and payment structures in the industry, changing and increasingly complex regulations, increasing costs associated with drug development, corporate restructuring and mergers, and the increasing importance of risk management strategies. These changes place higher skill and knowledge demands on workers at all levels.

Life sciences employers require continued access to workers who have the education and skills needed to adapt effectively within a rapidly changing, increasingly global, industry. As discussed below, workers must have not only the depth of knowledge traditionally required for jobs in the industry, but an increased breadth of knowledge and skills, as well.

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Cross-Occupational Skill Needs

Employers identified a number of skill-related priorities that cross a variety of occupational boundaries. These priority cross-occupational skill-related needs are:

- **Science Skills and Degrees**

Life sciences employers are concerned about potential shortages of students in the science, technology, engineering, and mathematics (STEM) educational pipeline based on difficulties finding both scientists and other workers who have the science skills and degrees they require. As the demand for scientists and others with strong science and other technical backgrounds

increases, employers believe that fewer students are pursuing a science-based education. Given the number of years it takes to acquire advanced STEM knowledge and/or degrees, employers worry that too few students entering the pipeline now will mean severe shortages of skilled workers in the state and the nation well into the future. It should be noted, however, that while employers are concerned about shortages in the STEM pipeline, based on current hiring difficulties, more research is needed to determine the extent and specific nature of such a shortage.

- **Interdisciplinary Skills and Degrees**

Increasingly, employers in the life sciences seek workers who have developed not only depth of skill in their primary area of work, but also breadth of skill in complementary areas. The most sought-after combinations of skills and credentials are as follows:

- *Science Skills for Business Occupations:* While strong skills and knowledge in relevant science disciplines is of obvious importance in clinical development and other science-based jobs, employers expect nearly everyone in the business, from product marketers to regulatory professionals, to have a strong knowledge base in the life sciences (e.g., biology, chemistry) and related disciplines, such as statistics. For firms to be competitive, workers from various facets of the organization must work closely together on interdisciplinary teams to help move a product from the idea stage to the market. To do this effectively, all members of the team must be able to understand the basic science underlying product development.

- *Business Skills for Science Occupations:* Science-based workers at all levels in life sciences organizations increasingly need strong business knowledge and skills to maximize the marketability of products, as well as to create and sustain new business ventures. As global, knowledge-rich industries, such as life sciences, adopt less hierarchy-driven and more team-driven management approaches, each worker is expected to assume greater responsibility for improving the company's overall business position, including scientists and other science-focused workers, such as medical directors. Project management skills are particularly important for science workers in existing firms, while entrepreneurial skills are needed to start new life sciences businesses.

- *Multiple Technical Disciplines/Degrees:* As technology evolves, once-distinct scientific disciplines are becoming more intertwined. From nanotechnology, which requires knowledge of physics and life sciences disciplines, to the emergence of biostatistics, which requires education in biology and statistics, employers increasingly need workers who have an increased breadth of knowledge across multiple technical disciplines.

- **Communication Skills** (especially presentation skills)

Life sciences workers, from marketing specialists to scientists and analysts, need strong written and verbal communication skills, especially as they relate to delivering presentations. Employers need workers of all types to have the basic design, information technology, and writing skills to develop effective presentations using PowerPoint, Keynote, and other tools. Workers also must have the language and interpersonal skills needed to deliver presentations effectively to co-workers and others who may not share the same level or type of expertise as the presenter.

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- **Teamwork and Leadership Skills** (especially teambuilding and conflict management)

The life sciences sector, perhaps more than many other industries, relies on interdisciplinary, global teams to conduct business. Given the diversity of specialties and cultures represented on these teams, teambuilding and the ability to handle conflict constructively are required competencies not just for leading teams, but for participating on them in any capacity. In addition, workers at all levels of a life sciences organization must be able to communicate effectively with co-workers from other departments within the company in order to accomplish team goals.

- **Applied Skill Sets**

Employers in life sciences place a strong value on applied skills—including laboratory skills for technical occupations, and marketing, sales, and business skills for other types of workers. Given the dynamic, interdisciplinary nature of the industry, students learn valuable competencies by applying the knowledge learned in the classroom in a real-world setting. Increasingly, employers seek workers who have experience, either through previous jobs or through work-based learning associated with academic programs.

Occupational Skill Needs

While employers will continue to need their current and future workers to have high levels of the cross-occupational skills noted above, they also report difficulty finding and retaining workers who have the correct degrees and skill sets for particular job areas. Key jobs employers report having difficulty filling include:

- **Product Management/Marketing**

Key Requirements: Degree requirements range from a B.A./B.S. in a business or related discipline to an M.B.A., plus three to five years of experience in the industry. All workers are expected to have strong science knowledge, teamwork, leadership, and communication skills.

- **Regulatory Affairs**

Key Requirements: B.S. to a Ph.D. in a science discipline and three to seven years of experience, depending on job level. Very strong science knowledge and business skills are required, as well as strong communication and adaptability skills.

- **Basic Research and Clinical Scientist**

Workers who have interdisciplinary degrees in multiple science and/or technical/mathematical disciplines are increasingly in demand but difficult for employers to find.

Key Requirements: Minimum of a B.S. degree. RNs, MDs, and those with a Master's of Science degree or a Pharm.D. are difficult to find. Employers are also interested in finding more workers who have Bachelor's degrees in chemistry, statistics, and other STEM fields. Workers who have interdisciplinary degrees in multiple science and/or technical/mathematical disciplines are also increasingly in demand among employers but difficult for employers to find. Scientists in basic and clinical research also need strong business skills, including project management, as well as strong science and lab work skills.

- **Biostatistician**

Key Requirements: Ph.D. in statistics or biostatistics needed for most jobs, but some companies hire those with a Master's degree and three to five years experience. Employers have difficulty finding workers with experience and sufficient interdisciplinary knowledge of statistics and biology.

Strategies to Address Industry Workforce Skill Needs

Several initiatives are underway in New Jersey to support the development of a qualified workforce for the life sciences, one of the industries targeted in Governor Corzine's Economic Growth Strategy for the State of New Jersey. The largest of these efforts is Bio-1, a multi-year effort to support economic and workforce development in the state's vibrant life sciences corridor in central New Jersey. Funded by a $5 million WIRED (Workforce Innovation in Regional Economic Development) grant from the U.S. Department of Labor, Bio-1 has developed strong ties with industry employers, educational institutions, and state agencies.

Bio-1 is coordinating with the Delaware Valley Innovation Network, another WIRED initiative focused on developing economic and workforce plans to spur growth in the life sciences in portions of southern New Jersey, southeastern Pennsylvania, and Delaware.

State-funded efforts initiated under Governor Corzine's Economic Growth Strategy for the State of New Jersey also address industry skill needs. These include the establishment of the Life Sciences Industry Workforce Advisory Council. This group of senior human resource managers, from some of the

state's key life sciences companies, was instrumental in informing this action plan. The group also provides direct and ongoing feedback to policymakers on industry skill needs and the programs designed to address them.

The Innovation Partnership Institutes is another effort of the Governor's Economic Growth Strategy that seeks to develop curriculum modules in priority skill areas for New Jersey's key industries, including life sciences. The life sciences Innovation Partnership Institute, led by Rutgers, The State University of New Jersey and a consortium of educational institutions, employers, and other stakeholders, has developed curriculum modules that can be used in high schools and colleges around the state to address specific needs of the industry.

New Jersey also provides priority to life sciences employers seeking grants to upgrade the skills of incumbent workers. The Customized Training program, implemented by the New Jersey Department of Labor and Workforce Development, prioritizes key industries, including life sciences, to receive matching grants to train existing workers in new skill sets critical to business competitiveness.

Finally, several colleges, universities, high schools, vocational-technical schools, and workforce investment boards have implemented new or revised curricula that address some of the skill and occupational needs covered in this report. These individual programs are too numerous to describe in detail here.

Priority Action Steps

If New Jersey is to continue to attract and retain quality life sciences jobs, state departments and educational institutions must continue to give employers access to workers with training and education that reflects the changing demands of this global, knowledge-driven industry. The federally funded Bio-1 initiative and the Delaware Valley Innovation Network (DVIN) are well positioned to work in partnership with state officials and other initiatives to implement and coordinate programs across the state to address industry workforce needs statewide. Key action steps to be addressed include:

Step 1: Expand/improve career awareness for students and job seekers

The state should improve the delivery of current career information on the life sciences industry in K-12 schools, colleges, and One-Stop Centers. The life sciences Innovation Partnership Institute and Bio-1 are collaborating with DVIN to develop career awareness content for the industry. This content will include career videos and a map of occupations in the industry. The state should encourage high schools, colleges, and One-Stop Centers to provide that content to students and job seekers.

Step 2: Adjust postsecondary curricula to meet cross-occupational skill needs

Postsecondary educational institutions that prepare individuals for careers in the life sciences should adjust relevant curricula to include needed skills. These include providing students the opportunity to develop their interdisciplinary skills and incorporating additional communication and teamwork, and leadership components to existing curricula.

Step 3: Expand/improve experiential learning opportunities for students

Educational institutions should work closely with life sciences companies and with the industry associations to expand existing co-op and internship programs in the industry. Such programs can give students valuable experience, help ensure that students learn the skills needed for employment, and help companies to identify possible full-time employees. The state should also consider providing technical assistance to colleges and universities to help them establish such programs.

Introduction

- Purpose
- Methods

This report provides a roadmap to understanding and addressing the changing skill needs of employers in New Jersey's innovation-rich life sciences industry.

New Jersey's robust life sciences industry requires ready access to a highly skilled workforce in order to remain competitive in a global economy. New Jersey's state agencies, educational institutions, and other stakeholders must work together to ensure that job seekers and workers have access to the training and education needed to access jobs in the life sciences.

Overview of Report

This report identifies:

- Broad trends affecting workforce skill needs in the life sciences industry,
- Priority skill needs of employers,
- Current state and regional efforts to address critical industry skill needs, and
- Needed action steps that state departments and other stakeholders can take to more fully address these skill needs statewide.

Purpose

This report provides a roadmap to understanding and addressing the evolving skill needs of employers in New Jersey's innovation-rich life sciences industry. The report describes trends affecting workforce skill requirements in the life sciences industry and identifies the priority skill needs of employers, both as they occur across a variety of occupations (cross-occupational skill needs) and as they occur within key occupations for which employers have particular difficulty finding and/or retaining skilled workers (occupational skill needs). Finally, the report identifies current state and regional efforts to address critical industry skill needs in life sciences and outlines the action steps state departments and other stakeholders will take to more fully address these skill needs statewide.

Methods

Several strategies were used to identify the priority skill needs of New Jersey's life sciences industry employers and the solutions required to address them.

Life Sciences Industry Workforce Advisory Council

The Life Sciences Industry Workforce Advisory Council (IWAC) met in spring 2007 to provide input on industry skill needs, as well as guidance on the development of this report. The IWAC consists of senior human resources professionals from major financial corporations, officials from state agencies and educational institutions responsible for industry-related education and training, and other stakeholders. For a full list of the individuals who participated in the IWAC, see the Appendix.

In-Depth Interviews

In-depth interviews were conducted with human resources executives and staffing managers at nine New Jersey life sciences companies, including large, multinational pharmaceutical firms and small biotechnology firms. Interviews were used to understand the skill requirements for key occupations and to better understand the workforce challenges facing various types of life sciences firms in the state.

Discussions with Policymakers and Educators

In fall 2007, higher education institution officials were briefed on employer skill needs in the life sciences industry. The briefing included a roundtable discussion regarding what schools are currently doing to address these needs, as well as a discussion of the gaps in available solutions. Information on industry skill needs was also shared with Workforce Investment Board directors, One-Stop operators, and state officials in winter 2007. Both briefings were used to identify policy solutions to fill gaps in addressing the skill needs of life sciences industry employers.

Background Research and Analysis of Labor Market Data

The most current available labor market information was used to describe key aspects of the life sciences industry and its importance to New Jersey's economy. Industry data were obtained from the U.S. Census Longitudinal Employer-Household Dynamics survey for 2006. Reports and articles describing industry trends and workforce challenges in the life sciences industry were also used to gain a better understanding of the industry and workplace changes that may be affecting employer skill needs. In particular, this report draws on information obtained from a 2006 survey of member companies within the HealthCare Institute of New Jersey, which represents the state's large pharmaceutical companies.

Profile of the Life Sciences Industry in New Jersey

- Corporate Administration, Sales, and Marketing
- Research and Clinical Development
- Technical Operations and Manufacturing

The pharmaceutical, biotechnology, agricultural science, and research and laboratory sectors of the life sciences industry provide over 84,500 high-wage jobs in New Jersey.

New Jersey is known worldwide for being a leader in the life sciences industry. According to the Healthcare Institute of New Jersey (HINJ), it is home to more pharmaceutical companies than any other state in the nation—or any other country in the world. New Jersey is also home to a growing number of biotechnology companies involved in genetics-based research.[5]

Key Facts
Life Sciences Industry
New Jersey

Over 84,500 high-wages jobs in:

- Drugs and Pharmaceuticals
- Medical Devices and Equipment
- Research, Testing, and Medical Laboratories
- Agricultural Feedstock and Chemicals

Source: U.S. Census Local Employment Dynamics, 2006.

Overall, the life sciences industry is less affected by broad economic cycles than other industries. While large pharmaceutical companies are affected by cycles of new drug development and patent expirations, biotechnology companies are generally newer, smaller, more flexible organizations that depend on creating new innovations to survive. The industry provided over 84,500 jobs in New Jersey in 2006 or 3% of the state's private-sector workforce. Jobs in New Jersey's life sciences industry pay average wages of nearly $100,000 annually.[6]

New Jersey is unique in the nation because the state has significant employment in all of the following life sciences sub-sectors:

- **Pharmaceutical and Medical Manufacturing.** This category includes the production of commercially available medicinal and diagnostic substances. Firms are generally large and multinational and activities range from business functions, such as sales and marketing, to basic research and clinical drug trials. Pharmaceutical companies make medicine from both plant and chemical compounds. Products include vaccines, oncology and cardiology treatments, tissue and cell culture media, herbal supplements, and diagnostic substances.

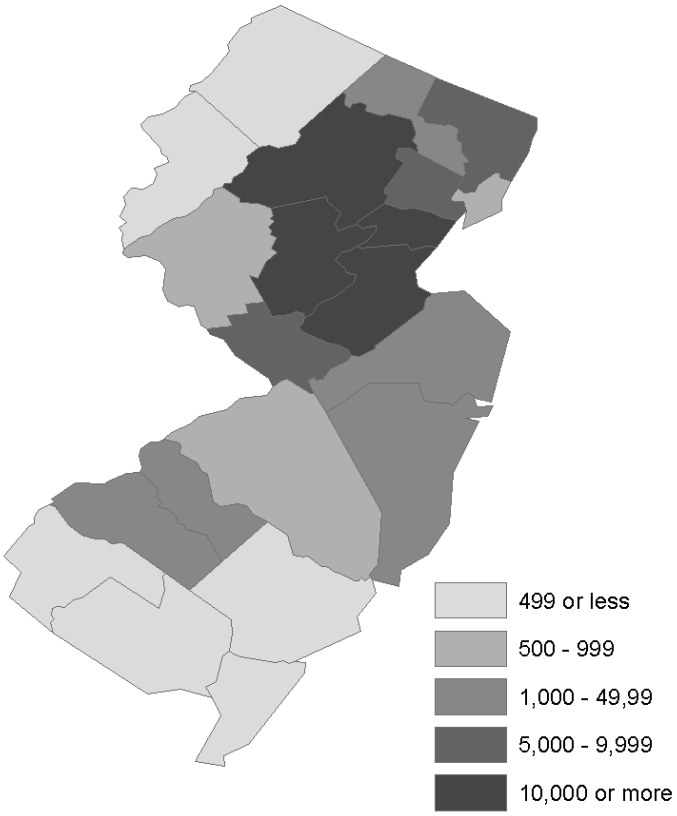
- **Scientific Research and Development Services.** Firms in this sector are research-oriented companies, including biotechnology firms, that develop and commercialize new drugs or other life sciences products. Companies are generally smaller than pharmaceutical firms, and activities in these firms are more focused on basic research. Products include functional genomics and drug discovery techniques, pre-clinical drug therapeutics, and other research and development services.

- **Medical Devices and Equipment.** This sector includes the production of biomedical instruments and health care products and supplies for surgery, patient care, laboratories, and diagnostics. Products include bandages, bioimaging equipment such as MRI machines, orthopedic implants such as knee and hip replacement parts, dental instruments, laser surgery equipment, and implantable devices such as stents and pacemakers.

The main focus of this report is on the human health side of the life sciences industry, especially in the pharmaceutical, medical devices, and laboratories sectors, where many of the state's largest biopharmaceutical employers exist alongside fast-growing biotechnology firms. Agricultural feedstock and chemicals is a relatively small sector in New Jersey.

New Jersey
LIFE SCIENCES INDUSTRY

Total Employment in Life Sciences Industry, by County, 2006



- For every 100 workers in New Jersey, 2 are employed in the life sciences industry.
- Since 2002, the total employment of the life sciences industry has grown by 8.8% as compared to a 2.5% increase in total employment across all industries in New Jersey.
- The life sciences industry represents 4.4% of the total payroll and 1% of new hires in New Jersey.

Jobs (2006)	84,500
Establishments (2005)	1,149
Payroll (2006)	$8,418,566,000
Average Wage (2006)	$99,628
New Hires (2006)	21,312

Sub-Industry Employment

	2002	2006
Pharmacuetical and Medicine Manufacturing	42,220	43,861
Scientific Research and Development Services	24,627	28,838
Medical Equipment and Supplies Manufacturing	12,188	11,801

Sources: U.S. Census, Local Employment Dynamics, New Jersey Department of Labor and Workforce Development

Jobs in the life sciences industry fall into three broad functional areas, which share some common skill sets or educational requirements. Functional areas provide a useful framework for job seekers, educators, and workforce professionals to understand how employment is structured in most life sciences firms.

Corporate Administration, Sales, and Marketing

Three Functional Areas of Life Sciences Industry Employment

Industry jobs fall into three main functional categories:

- Corporate Administration, Sales, and Marketing
- Research and Clinical Development
- Technical Operations and Manufacturing

While most people think of scientists first when thinking about life sciences, many of the jobs in the industry in New Jersey are in corporate administration, sales, and marketing. The survey of pharmaceutical companies conducted by the HealthCare Institute of New Jersey found that fully half of all industry jobs are in corporate administration, sales, and marketing positions.[7]

With so many large pharmaceutical companies headquartered in the state, thousands of workers are needed to handle the business operations in life sciences companies. Companies require workers with varying levels of education to handle human resources, accounting, sales, marketing, and other important business functions. Product management staff comprise the largest job type in the industry in New Jersey. Other common jobs include regulatory affairs staff; corporate management and mid-level managers in departments such as sales, marketing, regulatory affairs, human resources, marketing, facilities, and financial and information technology operations; as well as frontline staff in these departments and clerical and other support staff.

Research and Clinical Development

The research and clinical development function of life sciences companies is focused on the basic research and clinical testing that needs to occur before a drug or medical device can be manufactured and released to the public. After approval from the Food and Drug Administration (FDA) is obtained, clinical developers can begin testing compounds on human subjects. The clinical testing process has several distinct phases, including testing on small groups of relatively healthy people and eventually testing on large groups with varying degrees of disease. During the process, clinical developers test for toxicity, side effects, dosage, compatibility with other drugs, and effectiveness. The entire process from discovery of a compound with promise to FDA approval can take a decade or more.

Jobs in the research and clinical development area account for one-quarter of jobs in the pharmaceutical industry and a greater percentage of jobs in the biotechnology industry.[8] This functional area includes occupations such as basic research scientists, including biologists and chemists, lab technicians, technical writers, clinical researchers and biostatisticians, and medi-

cal experts, such as doctors and nurses. This area also includes the management structure associated with these positions.

Technical Operations and Manufacturing

The third functional area, which provides one-quarter of all jobs in the pharmaceutical industry in the state, is technical operations and manufacturing. This area handles the planning, production, and quality assurance functions in life sciences. Fifteen percent of workers are employed in technical operations or manufacturing occupations that range from production occupations, to equipment mechanics, to engineers. Another 6% of workers are employed in quality management occupations, such as quality control and validation technicians and managers.[9]

Industry Trends Affecting the Skill Needs of Life Sciences Employers

- Industry Trends and Implications for Workers
- Other Workplace Trends Affecting Skills in the Life Sciences Industry

Competition, globalization, the increasing complexity of information technology, a complex regulatory environment, and other broad economic trends are increasing the level of skills required to do nearly every job in the life sciences industry and contributing to rapid growth among jobs that require the highest levels of skill, knowledge, and education.

This section describes key trends that are affecting the nature of work in the life sciences industry and that are driving key changes in the skill and education requirements for workers across multiple job levels. Some issues vary for small biotech firms and large pharmaceutical companies, but, overall, life sciences companies embody the trends that are consistent with a new economy marked by global markets, rapid change, and a constant search for innovation.

Today, employers report that a clinical research manager in New Jersey may need to coordinate the work of researchers in France, Japan, and Singapore to complete a project.

Industry Trends and Implications for Workers

Trend #1: Rapid technological changes are affecting the life sciences industry and creating demand for new skills.

As an innovation-based industry, companies in the life sciences industry must keep pace with new technological breakthroughs and advances. One significant change has been the shift within the pharmaceutical industry from chemistry-based discoveries to biology-based innovations. As a result of genetics research and the human genome project, companies are now developing bioengineered drugs, also known as "designer" or "custom" drugs (or "pharmacogenomics"). Other advances, such as the use of computer molecular modeling, designing a potential drug molecule through computer modeling instead of through trial and error, are changing the discovery process. Other technological changes mentioned by employers include advances in data management, which have led to new fields such as computational biology or bioinformatics. Companies can now mine databases that are loaded with clinical drug and discovery information to identify new opportunities.

Trend #2: Increasingly global business operations place new demands on workers' communications and business skills.

The advent of global business operations has led to a number of key changes in the industry that affect skill requirements for workers. Workers must lead and/or participate in global teams and project networks, which require workers to use a broader range of communication skills on the job than ever before. Today, employers report that a clinical research manager in New Jersey may need to coordinate the work of researchers in France, Japan, or Singapore to complete a project. These activities require a higher level of cultural awareness, interpersonal, project management, and sometimes language skills, than in the past.

Another impact is that employers are looking for workers who can take a global strategic view of the business. For example, one employer explained that a regulatory affairs manager needs to be able to determine what approaches will result in FDA approval for a certain drug and at what cost, and what approaches, even if more expensive, will result in both FDA and international approvals at the same time.

Trend #3: Cost pressures and intense competition are affecting life sciences industry skill requirements.

As the cost of developing drugs has continued to climb, companies are under increasing pressure to quickly and efficiently make new discoveries and to bring new products to the market. One implication of this trend is that companies have to make the "go/no-go" decisions about new products earlier in the process than in the past. Researchers are required to understand the total drug development process and the costs involved.

As one researcher explained, "They must understand what to ask, what to look for, how to do a risk/benefit analysis, how to have a multidisciplinary perspective."[10]

Trend #4: Mergers and acquisitions often lead to rapid changes in work requirements.

Mergers and acquisitions are especially common in the life sciences industry as companies compete in an increasingly global and deregulated marketplace. These company takeovers can lead to rapid shifts in corporate culture and work processes. Workers need communication, problem-solving, lifelong learning, career management, and critical thinking skills to adapt quickly to new rules, the prospect of layoffs, as well as to what is often a higher set of expectations for performance from new managers.

Other Workplace Trends Affecting Skills in the Life Sciences Industry

Several general workplace trends are contributing to rising skill requirements for jobs in nearly all industries in today's economy. In 2007, the State Employment and Training Commission released a report that identified six broad workplace trends affecting the skill needs of employers in nearly all industries and across many occupational levels. These trends are:

- The increasing competitive advantage of firms that successfully harness knowledge and innovation;
- The decentralization of business operations and management around the globe;
- Expanded reliance on technology in the workplace to improve the quality and efficiency of work processes and to train workers;
- Increasing diversity in the workplace;
- Increasing employer concern over security, privacy, and ethics issues; and
- Business processes changing in response to shifts in regulatory environments, new patterns of regulation, and mergers and acquisitions.

These workplace trends are likely to have ongoing effects on the skill needs of employers in the life sciences industry, as well. For more information on these trends and the ways that they affect employers' skill needs across a variety of industries, see the report *The Emerging Skill Needs of a Rapidly Changing, Innovation-Driven Economy*, available at *www.heldrich.rutgers.edu*.

Priority *Cross-Occupational* Skill Needs of Life Sciences Employers in New Jersey

- Key Skill-Related Workforce Challenges Employers Face
- Priority Skill Needs

The life sciences sector produces innovation-oriented jobs that require workers to adapt to the complexities of a highly technical and global industry.

Many people assume that the majority of life sciences jobs are for scientists alone when, in fact, they are largely devoted to business functions. The industry is also commonly misperceived to have few job opportunities for people without advanced professional degrees. According to the 2006 HINJ survey, job seekers with a Bachelor's degree may qualify for almost half of all jobs in the pharmaceutical and medical technology industry (46%). Over one-quarter of jobs (27%) require no more than a high school diploma, while 4% require an Associate's degree. By contrast, less than one-quarter of life sciences jobs require a Master's degree or higher.[11]

As workplaces in the life sciences industry evolve rapidly in response to a technologically rich, global economy, job seekers and workers must acquire not only degrees, but key skills and hands-on experience to succeed. Beyond basic academic skills and job- or degree-specific knowledge, life sciences employers agree on a set of core skills and competencies that nearly all industry workers need. Employers also share similar workforce challenges and concerns about the preparation of the future workforce for the life sciences industry.

Key Skill-Related Workforce Challenges Employers Face

Employers in the life sciences industry face key workforce challenges around developing, hiring, and retaining skilled workers. These challenges affect a wide array of occupations in the industry. Key challenges include:

- **Employers face the most difficulty finding and keeping skilled workers for the jobs that require advanced degrees.**

Jobs that require a Master's degree or better account for less than one-quarter of all jobs in the pharmaceutical industry.[12] It is among these jobs, however, that employers report the most difficulty finding workers with the right degrees, experience, and skills. In the case of science-based jobs, employers have difficulty finding workers who have science-based Master's, Ph.D., and M.D. degrees, especially in areas such as chemistry and biochemistry. With regard to non-science advanced degree holders, including MBAs, employers report difficulties not in finding workers who have the requisite degrees, but in finding degree holders who have enough science and technical knowledge to work effectively in the organization.

- **Life sciences employers in New Jersey are concerned that not enough students are entering and succeeding within the education pipeline in science, technology, engineering, and mathematics fields.**

Due to the difficulties they face finding workers with advanced science degrees, life sciences employers are concerned about potential shortages of students in the science, technology, engineering, and mathematics (STEM) educational pipeline. As the industry, especially biotechnology compa-

nies, grows, demand for scientists and others with strong science and other technical backgrounds will increase. In addition, persons with advanced STEM degrees are in demand across growing numbers of industries, and in a growing number of locations around the world.

Given the number of years it takes to acquire an advanced STEM degree, employers worry that too few students entering the pipeline now will mean severe shortages of skilled workers in the state and the nation well into the future. It should be noted, however, that while employers are concerned about shortages in the STEM pipeline based on current hiring difficulties, more research is needed to determine the extent that such a shortage exists in New Jersey or elsewhere.

- **Life sciences employers have difficulty finding workers who have a strong background in science, as well as scientists who have a strong background in business.**

Employers are generally satisfied with the level and quality of science knowledge that science-based workers in the industry have. Similarly, workers who are employed in non-science-based jobs often bring solid business or other core skills to their jobs. Life sciences employers operating in an increasingly competitive and technologically advanced marketplace, however, need science workers with strong business skills as well as business specialists with a strong background in science.

- **Employers are concerned about the ability of incumbent workers to keep pace with changes in the industry.**

With business needs and technology advancing rapidly on a global scale, life sciences employers are seeing some signs that current workers are having difficulty adapting to the pace of these changes. Increasingly, workers need more interdisciplinary skills to understand and adapt to evolving new technologies, such as nanotechnology and biostatistics. While employers have difficulty finding job seekers who have interdisciplinary degrees, they face added challenges with regard to broadening the interdisciplinary skills and knowledge among incumbent employees who were educated in more "pure" science or business-related disciplines.

- **The life sciences industry requires more workers who have hands-on experience in the industry.**

From scientists and lab workers who need hands-on experience working in a lab environment, to business specialists who need a better understanding of how to apply business principles in the highly technical, science-based environment in life sciences, industry employers need more workers who have had some exposure to the industry before applying for a job. Most jobs in the industry, including those that require advanced degrees as well as those that require little formal education, expect workers to have relevant experience as a prerequisite for hire. Some workers are able to gain experience in a hospital or other similar setting, or by getting in the door at

a small life sciences company that imposes fewer requirements. Other job applicants get their experience through work-based learning in educational settings ranging from high school to graduate school. Employers report, however, that they face increasing difficulties finding workers with applied knowledge of work in the industry.

Priority Skill Needs

These skill priorities represent skill areas that employers report are both increasingly important in the workplace and increasingly difficult to find among both job applicants and current workers.

New Jersey's life sciences industry employers increasingly demand the following key skills of their workers at nearly all levels of employment. These skill priorities represent skill areas that employers report are both increasingly important in the workplace and increasingly difficult to find among both job applicants and current workers. Key cross-occupational skill priorities include:

Strong Science Background

In an age where all workers in life sciences organizations need to form an efficient product-focused chain, workers at all levels and in nearly all departments are expected to have a strong background in science. Workers from multiple departments—from regulatory affairs, to marketing, to research—need to function on interdisciplinary teams to ensure the market success for new products. To do this effectively, all members of the team must be able to understand the basic science underlying product development. Even business workers need knowledge, and sometimes degrees, in the scientific, math, and other technical disciplines most relevant to their operations.

Specific science knowledge and skills that many non-science workers may need include:

Biology, Chemistry, and Biochemistry: Biology and chemistry form the scientific foundation for the life sciences. Workers in science-based jobs are generally required to have a degree that covers knowledge in one or more of these areas. Workers who have developed specialized knowledge in particular areas of these life sciences, such as genomics, are also needed for many research positions. Business professionals in the industry—from CEOs, to product marketing and sales staff, to regulatory affairs workers—also need advanced knowledge of the life sciences, if not a degree, to be able to do their jobs effectively. Finally, workers in technical operations and manufacturing also need strong knowledge of the life sciences, with greater knowledge expected in high-level positions.

The Role of Basic Research and Clinical Trials in the Life Sciences: Workers at all levels of a life sciences organization need to understand the life cycle of drug and medical device development. Workers need to understand how basic research contributes to product development, as well as how the clinical trial process blends with regulations and determines the marketability of products.

Physics: The advent of nanotechnology, in particular, has made physics knowledge, especially when blended with a knowledge of the life sciences, a desirable knowledge set for workers ranging from scientists to product sales and marketing staff.

Statistics and Computer Science: Similarly, the emergence of fields such as biostatistics and bioinformatics has made workers who have degrees and specialized knowledge in statistics and computer science more valuable in the life sciences industry.

Interdisciplinary Skills (especially interdisciplinary science and technical skills, and degrees that combine business and science)

Increasingly, scientists and researchers are fusing their skills in distinct scientific disciplines to create new technologies and products that draw on knowledge from more than one technical area. For example, nanotechnology requires knowledge of physics, engineering, and life sciences disciplines, biostatisticians need skills in biology and statistics, and bioinformatics specialists need blended knowledge of biology and computer science. Workers still need to acquire sufficient depth of skill in their primary discipline, but employers are increasingly on the lookout for workers who have skills, knowledge, and degrees in complementary technical disciplines.

While demand for interdisciplinary skills is strongest for clinical scientists and biostatisticians, employers increasingly seek interdisciplinary degrees and skills across a wide range of occupations, including many business-related jobs, such as marketing managers and regulatory affairs personnel. Employers are increasingly demanding dual advanced degrees that blend science and business knowledge, such as those who possess an M.D. or Ph.D. in a science discipline, as well as an MBA.

Business Skills

Employers agree that workers at all levels are expected to have a basic understanding of business operations to maximize the marketability of products, as well as to create and sustain new business ventures. This is especially true for jobs that require a college degree or above, which comprises a large portion of industry jobs. Specific business skills that employers increasingly look for in their workers include:

Project Management Skills: Product managers make up the largest job category in the industry. These workers need project management skills to follow through effectively on large, often global projects. Employers now increasingly prefer that job seekers and current workers in jobs ranging from product managers, to information technology workers, to scientists, to managers and human resources staff, have strong project management skills.

Financial Management Skills: Especially important for entrepreneurial scientists and others that plan to begin a start-up company, workers of all types need at least a basic understanding of finance and profitability structures in the industry and how best to contribute to the company's bottom line.

Regulation Interpretation Skills: Workers need to not only be familiar with the "letter of the law" with regard to understanding key regulations, they also need a working knowledge of how to apply these regulations effectively in dynamic situations. While not all workers need to be as familiar with these regulations as others, employers expect most workers to have a general understanding of regulations governing their line of work.

Communication Skills (especially presentation skills)

Life sciences workers, from marketing specialists to scientists and analysts, need strong written and verbal communication skills, especially as they relate to delivering presentations. Particular skills that employers have difficulty finding among job applicants and incumbent workers include:

Presentation Skills: Employers expect an increasing number of workers to have the ability to create visual, electronic presentations using programs such as PowerPoint and Keynote, as well as to have the communication skills to deliver presentations effectively to a variety of audiences. For example, information technology staff are expected to give clear, succinct presentations to management on complex projects.

Business Writing: Life sciences employers need a variety of workers to have strong business writing skills to ensure accurate and concise communications on key topics. Workers must also be efficient and appropriate when responding to email, especially given the cultural sensitivities in communicating with colleagues from around the world through global teams.

Teamwork and Leadership Skills (especially teambuilding and conflict management)

The life sciences sector, perhaps more than many other industries, relies on interdisciplinary, global teams to conduct business. Life sciences workers are often asked to participate in and lead teams of all types in order to conduct complex projects. In addition, employers prefer that even entry-level workers have the basic leadership and team-building skills needed to move into higher positions of authority. Specific types of teamwork and leadership skills needed include:

Global Teamwork Skills: As the life sciences industry becomes increasingly global, workers are expected to interact with team members in other countries, as well as those in the next cubicle. Workers need cultural knowledge, and very strong written and verbal communication and negotiation skills, to work effectively on a global team.

Conflict Management Skills: Global teams that blend people of various educational backgrounds, levels of technical and business knowledge, ages, and cultures require all team members, and especially team leaders, to have strong conflict management skills. Misunderstandings can arise easily, especially when face-to-face interaction is limited and team membership is diverse. Workers need to have the emotional intelligence and interpersonal ability to encourage productive dialogue among team members and to avoid creating or worsening existing group or individual conflicts.

Leadership Skills: In order for diverse teams to be effective, whether they involve colleagues from down the hall or across the globe, workers who lead teams need to have the leadership skills to manage them effectively. In today's life sciences workplace, one need not necessarily be in a supervisory position to be placed in a team leadership role to conduct a project or manage a phase of product development. These workers need to be able to establish project goals, inspire members to work together efficiently and effectively, and keep everyone informed and motivated throughout the project. Scientists and other technical workers not accustomed to working in groups are especially in need of developing strong leadership skills.

Applied Skill Sets

Employers in life sciences place a strong value on applied skills—including laboratory skills for technical occupations, and marketing, sales, and business skills—within a life sciences environment for other types of workers. Given the dynamic, interdisciplinary nature of the industry, students learn valuable competencies by applying the knowledge learned in the classroom in a real-world setting. Increasingly, employers seek workers who have experience, either through previous jobs or through work-based learning associated with academic programs.

Employers indicated that students who lack exposure to industry during their education face difficulty adapting to the complex work environment in the life sciences industry. Employers expressed a preference for new hires with some experience learning how to apply skills effectively in the fast-paced, global work environment. Some employers preferred to hire students from colleges, many of which were outside New Jersey, that offer simulated work environments in the classroom, well-structured externship and internship or co-operative education programs, and other effective methods.

Priority *Occupational* Skill Needs of Life Sciences Employers in New Jersey

- Corporate Management, Sales, and Marketing
- Research and Clinical Development

Life sciences employers in New Jersey need access to skilled workers for many types of jobs, but key jobs in business and scientific research functions are the most difficult to fill, according to employers.

This section provides insight into which types of jobs are most difficult for life sciences employers to fill, as well as the key skills and educational credentials now required among workers and job applicants for these positions. Beyond the degree requirements associated with particular jobs, the skills that employers demand within particular occupational areas mirror those identified in the previous section of this report, although the emphasis on particular priority skills within occupations may vary.

Employers identified three groups of occupations across two functional areas of the industry that are difficult to fill. These jobs include product managers/marketing managers and regulatory affairs managers in the corporate administration, sales, and marketing area, as well as clinical scientists (including clinical research coordinators), medical doctors, and biostatisticians. The following provides an in-depth description of the particular skill gaps associated with each occupation or group of occupations.

Corporate Administration, Sales, and Marketing

Occupations New Jersey's Life Sciences Employers Report Difficulty Finding and Retaining Skilled Workers

Corporate Administration, Sales, and Marketing
- Product Marketing Professionals
- Regulatory Affairs Personnel*

Research and Clinical Development
- Basic Research and Clinical Scientists (including Clinical Research Coordinators*)

* These jobs have been identified by the U.S. Department of Labor's O*Net Occupational Database as "new and emerging occupations."

New Jersey is home to the world or North American headquarters of some of the world's largest life sciences companies, including Johnson & Johnson, Sanofi-Aventis, and many others. These corporate offices and satellite locations provide a wide array of jobs that handle the business aspects of the industry—from corporate management teams and support staff, to product management staff and regulatory specialists, to accounting and human resources, to advertising, market research, and sales professionals. Most positions in the corporate administration area require at least a Bachelor's degree in a business or science-related field at the entry level. Nearly all workers in this area need both a strong science background and solid business skills relevant to their job area.

As life sciences businesses compete in an increasingly complex marketplace marked by mergers and acquisitions and complicated regulations, they must invest significant resources in their business functions. Companies now market their products directly to consumers, sell their products on a global scale, and must deal with a constantly shifting regulatory marketplace. Drug patent expiration cycles have also forced many large pharmaceutical companies, whose profits depend on a handful of popular medicines, to invest more time and energy in planning new routes of business success.

Priority Corporate Administration, Sales, and Marketing Occupational Skill Needs

While skilled workers are needed for a range of business-related jobs—jobs in corporate administration, sales, and marketing comprise half of all

industry jobs statewide—employers have particular difficulty finding skilled workers in two key areas:

Priority Occupational Area #1: Product Management

Product management personnel are responsible for planning and managing the life cycle of new drugs or other life sciences products. These individuals work with scientists, corporate strategists, regulatory professionals, and others to identify the marketability of new product ideas, and to ensure that the research, development, testing, manufacturing, marketing, and sales functions of the organization are aligned with company goals.

Key Educational and Skill Priorities

At the entry level, product management personnel are expected to have a Bachelor's degree in a business or science-related discipline. The requirement for managers is generally an MBA. Industry experience is a key requirement for most positions given the wide breadth of knowledge these workers need to do their jobs well. Since they are responsible for managing the marketability of products throughout the products' life cycles, they need to be familiar with virtually all aspects of the life sciences business. Product management staff need an equally strong mix of business skills and science knowledge, as well as a strong understanding of the regulatory environment governing their company's product lines.

Priority Occupational Area #2: Regulatory Affairs

Regulatory affairs managers are involved throughout the development process, acting as a link between the company and agencies such as the FDA. These employees need to understand both the basic chemistry of drug behavior as well as regulatory requirements to ensure a company is in compliance with all regulations.

Key Educational and Skill Priorities

These positions generally require a Bachelor's of Science in biology, chemistry, or a related field plus two to four years of experience to perform entry-level duties such as documentation. At more advanced levels, which involve product labeling, managing the submission of regulatory documents, and interaction with government regulatory officials, among other duties, workers need at least a Master's of Science degree in a related discipline, plus two to eight years of experience, depending on the position. Regulatory affairs directors must have at least a Master's degree, with a Ph.D. preferred, and upwards of 10 years of experience in the field.

Basic Research and Clinical Development

Home to nearly one-quarter of industry jobs in New Jersey, workers in this functional area of the life sciences perform the research and development needed to create new products and move them through the FDA testing process. Basic research—also sometimes called "discovery research"—is needed to find new drug compounds or to develop new medical technologies. Jobs in discovery research often involve the identification and/or creation of biologically active molecules and compounds that have therapeutic value. Employees in these jobs conduct extensive testing on the potential compounds to determine how they act and whether they are are safe for human testing. This early-stage research is the primary domain of many biotechnology firms and other small life sciences research companies. Large pharmaceutical companies also invest a portion of their business to the basic research needed to discover new potential product ideas in their drug specialty areas.

Clinical development involves the experimental testing research that is needed to ensure that a product is helpful—and not harmful—to potential human patients. The FDA has established an extensive, multi-year phased clinical testing process that life sciences companies must follow before a drug can be marketed to the American public. This process, which involves testing the product on animals and then humans, allows companies to document the benefits and potential side effects of their products before they are released widely. This clinical development process can take up to a decade or more to complete in the United States.

At the entry level, workers need a high school diploma or an Associate's degree with one to two years of lab experience to qualify as a laboratory assistant. To advance, workers need at least a Bachelor's of Science in a related discipline, plus two to eight years of experience depending on the position. Advanced positions in basic research and clinical development, which include senior medical experts and research directors, require a Ph.D. or an M.D. and up to 10 years of experience. Most science-based workers who hold advanced degrees work in this area of a life sciences firm.

Priority Research and Clinical Development Occupational Skill Needs

Employers identified one priority occupation for which they are having increasing difficulty finding and/or retaining skilled workers:

Priority Occupational Area: Basic Research and Clinical Scientist (including clinical research coordinator)

Employers are having difficulty finding scientists—from research associates to advanced-degreed researchers—to perform basic research and clinical trial work at life sciences companies. In addition, employers also need

more research associates and clinical research coordinators to fill important research positions.

Key Educational and Skill Priorities

Entry-level scientist positions in life sciences generally require at least a Bachelor's of Science and between 2 to 10 years of experience, depending upon the position. Employers especially need more workers who have advanced degrees in chemistry, biochemistry, and other relevant disciplines. Workers who have dual degrees in multiple science-related disciplines are also highly sought after by employers and reportedly difficult to find.

Endnotes

1 BioNJ website, accessed on May 1, 2008 at *http://www.biotechnj.org/njinfo_00.shtml*.

2 U.S. Census Bureau, *Longitudinal Employer-Household Dynamics* (Washington, D.C., 2007).

3 John. J. Heldrich Center for Workforce Development, Rutgers University, *The Workforce Needs of New Jersey's Pharmaceutical and Medical Technology Industries* (New Brunswick, NJ, 2007).

4 Ibid.

5 HealthCare Institute of New Jersey website, accessed on May 1, 2008 at *http://www.hinj.org*.

6 U.S. Census Bureau, *Longitudinal Employer-Household Dynamics*.

7 John. J. Heldrich Center for Workforce Development, Rutgers University, *The Workforce Needs of New Jersey's Pharmaceutical and Medical Technology Industries*.

8 Ibid.

9 Ibid.

10 Employer interview, Fall 2007.

11 John. J. Heldrich Center for Workforce Development, Rutgers University, *The Workforce Needs of New Jersey's Pharmaceutical and Medical Technology Industries*.

Appendix: Employers and Individuals Consulted for this Study

Several large and small life sciences industry employers and government officials contributed to this report through interviews and participation in New Jersey's Life Sciences Industry Workforce Advisory Council, which met in spring 2007 to discuss the priority skill needs of industry employers and the steps required to address these needs. Convened by the New Jersey Department of Labor and Workforce Development as part of Governor Corzine's Economic Growth Strategy for New Jersey, the Council consists of senior-level human resources managers from the state's leading life sciences industry employers and officials from state agencies responsible for education and training. The following employers participated in the Council and provided input and guidance on the development of this report and action plan.

Employers

Becton Dickinson
Karen Steinberg

Biotechnology Council of New Jersey, Inc.
Ron Halperin

Chromocell
Christian Kopfli

Elusys Therapeutics, Inc.
Elizabeth Posillico, Ph.D.

HealthCare Institute of New Jersey
William Healey

Hoffmann-La Roche
Brad Smith

Johnson & Johnson
Roy Chen

Novartis
Donald Davidson

Organon Inc.
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Stryker Orthopedic
Randy Reardon

Wyeth Pharmaceuticals
Deborah Helmer

Government Partners

Governor's Office of Economic Growth
Gary Rose, Chief

New Jersey Commission on Higher Education
Jane Oates, Commissioner

New Jersey Department of Labor and Workforce Development
David Socolow, Commissioner

New Jersey State Employment and Training Commission
Henry Plotkin, Ph.D., Executive Director (represented by David Novak, Policy Analyst)