Battelle and its logos are registered trademarks of Battelle Memorial Institute. © Battelle Memorial Institute 2014. All Rights Reserved.

Battelle does not engage in research for advertising, sales promotion, or endorsement of our clients’ interests including raising investment capital or recommending investments decisions, or other publicity purposes, or for any use in litigation.

Battelle endeavors at all times to produce work of the highest quality, consistent with our contract commitments. However, because of the research and/or experimental nature of this work the client undertakes the sole responsibility for the consequence of any use or misuse of, or inability to use, any information, apparatus, process or result obtained from Battelle, and Battelle, its employees, officers, or Trustees have no legal liability for the accuracy, adequacy, or efficacy thereof.
Report prepared for the Pharmaceutical Research and Manufacturers of America provided by Battelle Technology Partnership Practice January 2014
CONTENTS:

Executive Summary ............................................................................................................ i

Biopharmaceutical Industry Targets U.S. STEM Education to Fuel Innovation, Maintain Competitiveness ................................................................. 1

U.S. Competitiveness, Global Leadership at Risk Due to STEM Shortfalls ................. 3

Biopharmaceutical Industry, Powered by a Highly Skilled STEM Workforce ............. 11

Biopharmaceutical Companies Nurturing Next Generation of Skilled Workers .......... 14

Conclusion: Arresting STEM Decline to Ensure Tomorrow’s New Medicines, Economic Vitality Requires a Long-Term Commitment .................................................. 33

Appendix ............................................................................................................................. 35
Executive Summary

Continued scientific and technological innovations are critical to fostering sustained economic growth, global competitiveness, and most importantly, helping patients live longer, healthier, and more productive lives. The U.S. innovative biopharmaceutical industry is committed to building on new scientific discoveries and technological advances, relying on a workforce with education and skills in science, technology, engineering, and math (STEM). Around the world, an increasing number of countries have recognized that a robust STEM-skilled workforce is needed to fuel continued economic growth. STEM workers have been shown to be key drivers of innovation and, thus, contribute significantly to economic productivity.

Countries like China and Singapore have developed and implemented strategies specifically aimed at gaining a competitive edge in STEM fields, making major investments in improving the state of STEM education to increase the number of scientists, engineers, and other STEM graduates overall. As a result of their investments, they have the highest rates of science and math literacy among Organization for Economic Cooperation and Development (OECD) countries while the U.S. now ranks among the bottom half. There is increasing concern that the U.S. will lose its competitive edge in STEM talent which will result in a loss of innovative capacity and related economic contributions and eventually lead U.S. businesses to look to other countries for needed STEM talent.

The relative decline in the level of achievement and interest in STEM fields in the U.S. has resulted in an inadequate supply of workers with STEM skills and education, while the demand for STEM talent has continued to increase. To fulfill the nation’s long-term potential for economic growth, it is critical that we advance and improve knowledge in STEM fields and grow the 21st century workforce needed by the increasingly knowledge-based economy. STEM jobs fuel economic growth in many ways including via higher wages and a higher employment multiplier—meaning STEM-based industries generally support a greater number of additional jobs across the economy compared with other industries.

To harness the nation’s great scientific and technological potential, government, commercial, educational, and research organizations need to work together to improve the state of STEM education in the U.S. and to build a robust STEM workforce. America’s innovative biopharmaceutical companies are among those recognizing the need to find new ways to improve the quality of STEM education starting at K-12 and continuing beyond college—they recognize that a STEM workforce is critical in an increasingly competitive global economy. This report catalogues for the first time the many ways in which the nation’s biopharmaceutical companies are partnering with schools, investing in STEM education, and bringing their expertise and resources to bear to improve STEM education in the U.S.
Key findings of the report include:

- Innovative biopharmaceutical companies and their corporate foundations are making significant contributions to U.S. STEM education through a broad range of local, state, and national level programs and initiatives aimed at elementary through post-secondary education. Over the past five years, the 24 PhRMA member companies voluntarily reporting information funded more than 90 individual initiatives focused on students and/or teachers in STEM-related fields, the majority of which have been active within the last year.

- Over the last five years, PhRMA member company STEM programs have impacted over 1.6 million students and 17,500 teachers across the U.S. On a current annual basis, about 500,000 students and 8,000 teachers participate in STEM education programs supported by PhRMA members.

- PhRMA member company programs are impacting students and teachers across the country, through 14 national-level programs that range from funding third-party STEM education initiatives, to supporting scholarships in STEM-related fields, to sponsoring STEM-related competitions to foster interest in STEM careers. Additional STEM activities are being supported in 26 states, Washington D.C., and Puerto Rico, with a larger concentration of activities in states with a deeper industry presence.

- In total, the 24 PhRMA member companies and their foundations responding have invested over $100 million in STEM education related initiatives since 2008, including awarding nearly 600 individual STEM education related grants. In 2012 alone, these PhRMA member companies invested over $10 million in supporting STEM education efforts.

- In addition to financial support, PhRMA member companies are also making significant “in-kind” contributions by leveraging the talents of nearly 4,500 industry employee volunteers, who have collectively volunteered almost 27,000 hours over the past five years. Other in-kind contributions include equipment donations and the use of company laboratory facilities, particularly at the K-12 levels, at a time when public school budgets are shrinking.

- A large majority (85 percent) of industry-supported STEM education programs focus on the K-12 levels and are aimed at improving the preparation of both students and teachers. This suggests that PhRMA member companies are focused on systemic changes in the way STEM education is taught in the U.S. by engaging younger students and early education teachers.

- Over 30 PhRMA member programs are focusing on increasing diversity in STEM fields by providing students of all backgrounds, particularly women and minorities, experience with hands-on, inquiry-based scientific learning opportunities.
The U.S. knowledge economy, which fuels research and development (R&D)-intensive sectors such as the innovative biopharmaceutical industry, is increasingly at risk as the U.S. falls behind other countries in science, technology, engineering, and math (STEM) proficiency leading to current and projected shortages in high-skilled talent.

Developing novel, life-saving therapeutics and diagnostics requires a well-educated, trained, experienced STEM workforce from a range of disciplines. The biopharmaceutical industry draws from a broad range of STEM degree fields that span all levels, from lab technicians to medical scientists and chemists, to mathematicians, statisticians, and industrial engineers.

The STEM talent pool has been critical to the industry’s success, and, by extension, to U.S. global leadership. The U.S. has long been recognized as the global leader in biopharmaceutical R&D, with more than 3,500 drugs and therapeutics in development or under U.S. Food and Drug Administration (FDA) review. In the last ten years, the FDA has approved more than 300 new medicines, including the first medicine to treat the underlying cause of cystic fibrosis, the first vaccine to prevent cervical cancer, and the first therapeutic vaccine to treat prostate cancer.1 The U.S. biopharmaceutical sector supports a total of nearly 3.4 million jobs across the economy, and contributes $789 billion in economic output when direct and indirect effects are considered. These economic impacts are fueled by the R&D enterprise, in which PhRMA member

---

companies alone invested an estimated $48.5 billion in 2012, with most of these investments made in the U.S. This sector serves as “the foundation upon which one of the U.S.’ most dynamic innovation and business ecosystems is built.”2

Given the importance of STEM-skilled workers to driving continued biopharmaceutical innovation and the economic benefits that accompany it, the industry is devoting resources to advancing STEM education in the U.S. As recently stated by Phil Blake, the CEO of Bayer Corporation, “Due to increasing global competition, there is growing demand for a U.S. workforce that is flexible, scientifically literate, and equipped with the critical thinking, problem solving and team working skills fostered by a quality science education. To remain globally competitive, we must commit to improving U.S. STEM education for all students, particularly girls and underrepresented minorities including African-Americans, Hispanics and American Indians. For Bayer, that is the reason we created the Making Science Make Sense program and have been active in efforts to improve STEM over the past 40 years.”

As this report details, an industry-wide effort is underway to address declining trends in STEM education in the U.S. The report examines the growing STEM skills gap in the U.S. economy and the biopharmaceutical sector, discusses the importance of STEM jobs to the ability of the U.S. biopharmaceutical industry to bring new medicines to patients, and documents for the first time in one place information on the broad range of STEM efforts in the U.S. supported by PhRMA member companies and their corporate foundations.

---

The nation’s STEM-related workforce, from scientists and engineers to information technology professionals and mathematicians, drive economic growth in a number of ways and are critical to securing continued growth in an increasingly competitive global economy. Among the positive attributes of a STEM workforce:

- **A rapidly growing source of high-quality, high-wage jobs**: Since 2004, STEM occupations have grown by more than 12 percent while total occupational employment has increased less than two percent. Average wages for STEM fields are almost double overall averages—with the average annual wages for a STEM job at $82,278 versus $45,790 in 2012.3

- **Stable employment with less joblessness**: In 2012, the unemployment rates for key STEM occupations were less than half the national average.4

- **An outsized impact on the rest of the economy**: One STEM job can often support a number of additional jobs through employment multiplier effects. Industries that are STEM-intensive tend to have much higher employment multipliers and thus broader economic impacts.5

### Table 1: U.S. Employment in STEM Occupations, 2012

<table>
<thead>
<tr>
<th>Occupational Groups</th>
<th>2012 Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Occupations</td>
<td>130,287,700</td>
</tr>
<tr>
<td>Computer-related</td>
<td>3,766,240</td>
</tr>
<tr>
<td>Engineers &amp; Engineering Technicians</td>
<td>2,222,850</td>
</tr>
<tr>
<td>Life &amp; Physical Sciences</td>
<td>890,890</td>
</tr>
<tr>
<td>Architects, Drafters, &amp; Surveyors</td>
<td>386,720</td>
</tr>
<tr>
<td>Math-related</td>
<td>121,710</td>
</tr>
<tr>
<td><strong>Total STEM-related Employment</strong></td>
<td><strong>7,388,410</strong></td>
</tr>
</tbody>
</table>


---

3 Battelle analysis of STEM-related occupational employment and wages from the U.S. Bureau of Labor Statistics, Occupational Employment Statistics program. For a detailed definition of STEM-related occupations Battelle is using, see the Appendix.


5 Battelle analysis of IMPLAN Input/Output models.
Current and Projected STEM Shortfall

Evidence of current and projected shortfalls in skilled STEM talent in the U.S. underscores a potential threat to the nation’s economic growth as R&D-intensive industries like the biopharmaceutical sector may be forced to shift R&D investment and manufacturing capabilities to other countries that can fill their STEM skills and education requirements.

Several recent studies highlight the STEM job shortfalls in the U.S. One recent survey of manufacturers reveals that about 600,000 current U.S. manufacturing job openings remain unfilled due to a lack of qualified candidates for technical positions requiring STEM skills. An Information Technology and Innovation Foundation study ranked the United States fourth out of 44 industrialized countries and regions in global innovative-based competitiveness, but second-to-last in progress toward increasing innovation-based competitiveness and capacity, including a strong STEM-based workforce, since 2000. In a survey of Fortune 1000 executives, nearly all (95 percent) are concerned that the U.S. is in danger of losing its global leadership position because of a shortage of STEM talent. According to a recent report by the President’s Council of Advisors on Science and Technology (PCAST), the U.S. will need to produce one million additional STEM graduates over the next decade to maintain its position as the world’s leader in science and technology innovation. Evidence of this growing need for STEM workers can be seen in the rising demand for doctoral degrees in life and physical science occupations, which is expected to increase significantly with PhDs required for nearly one in four scientist jobs by 2018.

Demand for STEM-related talent and skills has grown at a rapid rate in recent years with double-digit job growth through 2012, and forecasts expect this trend to continue. The Bureau of Labor Statistics projects strong growth for STEM occupations to continue relative to all occupations as shown in Figure 1.

---

9 President’s Council of Advisors on Science and Technology, “Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics,” February 2012.
U.S. Trails Other Countries on Key STEM Indicators

The state of STEM education in the U.S. reflects ongoing gaps in achievement, particularly when looking at key STEM indicators such as U.S. student performance on international mathematics and science tests, STEM degrees awarded in U.S. institutions of higher education, and teacher quality in STEM subjects. Further, according to recent budget data, government funding for STEM education has shown a decline over the last few years with federal expenditures for STEM programs down since 2010.

As Table 2 demonstrates, U.S. student performance exhibits a downward trend through the elementary, middle, and high school levels. At the elementary and middle school levels, international assessments find the performance of U.S. fourth and eighth graders ranked 11th and 9th in math, and 7th and 10th in science out of nearly 60 other countries, respectively—lagging behind Russia and much of Asia. Of note, Singapore was ranked number one or two for science and math among fourth and eighth graders. According to the National Assessment of Educational Progress (NAEP), among U.S. 4th graders, only one-third have demonstrated basic proficiency in science and just 39 percent in math. Similarly, by 8th grade, only 31 percent are considered to have basic proficiency or better in science and 34 percent in math. As Table 2 and Figure 2 indicate, while U.S. elementary and middle school students are generally above average across all countries, U.S. high school students score at or below the average for other industrialized countries.

12 NAEP results for 4th and 12th grade students are from 2009, the latest year available; 8th grade results are from 2011.
Table 2: U.S. STEM Education, Student Achievement in an International Context

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4th Grade SCIENCE</td>
<td>4th Grade MATH</td>
</tr>
<tr>
<td>U.S. Ranking</td>
<td>7th</td>
<td>11th</td>
</tr>
<tr>
<td>U.S.</td>
<td>544</td>
<td>541</td>
</tr>
<tr>
<td>Global or OECD Average*</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

**Selected Rankings for Comparison**

<table>
<thead>
<tr>
<th>Country</th>
<th>4th Grade</th>
<th>5th Grade</th>
<th>8th Grade</th>
<th>9th Grade</th>
<th>10th Grade</th>
<th>11th Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>24th</td>
<td>19th</td>
<td>12th</td>
<td>12th</td>
<td>17th</td>
<td>19th</td>
</tr>
<tr>
<td>Canada</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>11th</td>
<td>13th</td>
</tr>
<tr>
<td>Germany</td>
<td>17th</td>
<td>16th</td>
<td>n/a</td>
<td>n/a</td>
<td>12th</td>
<td>16th</td>
</tr>
<tr>
<td>Japan</td>
<td>4th</td>
<td>5th</td>
<td>4th</td>
<td>5th</td>
<td>4th</td>
<td>7th</td>
</tr>
<tr>
<td>South Korea</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>1st</td>
<td>7th</td>
<td>5th</td>
</tr>
<tr>
<td>Shanghai-China</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>1st</td>
<td>1st</td>
</tr>
<tr>
<td>Singapore</td>
<td>2nd</td>
<td>1st</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
<td>2nd</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>15th</td>
<td>9th</td>
<td>9th</td>
<td>10th</td>
<td>21st</td>
<td>26th</td>
</tr>
</tbody>
</table>

Source: National Center for Educational Statistics, Trends in International Math and Science Study (TIMSS); Organization for Economic Cooperation and Development (OECD), Programme for International Student Assessment (PISA).

*For TIMSS figure represents center point among the nearly 60 countries that participated in 2011 (57 countries/education systems for 4th grade; 56 participants for 8th grade). For PISA represents OECD average.

n/a = Did not participate or not reporting results.

At the high school level, U.S. student performance begins to lag well behind most OECD countries. The average scores for U.S. high school students are below the OECD average in math literacy, with U.S. 9th graders ranking 27th out of 34 OECD nations and 36th out of 65 when OECD partner countries and regions are included. In science literacy, the average U.S. score was about average among OECD countries, ranking 20th among the 34 OECD nations and 28th among all 65 countries and regions.

“The domestic and world economies depend more and more on science and engineering. But our primary and secondary schools do not seem able to produce enough students with the interest, motivation, knowledge and skills they will need to compete and prosper in the emerging world.”

– National Research Council

“Rising Above the Gathering Storm”
Figure 2. Shanghai Ranks at the Top in Math and Science Achievement Among 9th Graders while the U.S. Ranks Among the Bottom Half of OECD Countries, 2012

Source: Organization for Economic Cooperation and Development (OECD), Programme for International Student Assessment (PISA).
Note: Data presented for countries with scores at or above the U.S. Examples of some additional countries below the U.S. include Sweden, Israel, Turkey, and Brazil.
Another key concern is the U.S. share of students earning STEM degrees versus other countries. In the U.S., fewer than one-third of bachelor’s degrees earned are in science and engineering fields compared with significantly higher rates in China and Japan (see Figure 3). An analysis of National Center for Educational Statistics data found that 43 percent of the STEM-related doctorate degrees awarded in 2011 were conferred upon nonresident students, most of whom return to their home countries, increasing those countries’ global competitiveness. Additionally, a recent report from the Congressional Research Service expressed concern that the U.S. is falling behind other countries in the production of STEM degrees, which “has been amplified by scale differences between the sizes of the United States’ and Chinese and Indian populations (i.e., about 300 million in the United States compared to about 1.34 billion in China and 1.22 billion in India).”

Figure 3: Share of First University Degrees in Science and Engineering Fields, 2008

![Figure 3: Share of First University Degrees in Science and Engineering Fields, 2008](image)

Source: National Science Board, “Science and Engineering Indicators 2012.” EU represents an average among EU nations published in the study including the United Kingdom, Germany, France, Spain, and Italy.

Many business leaders, including those in the U.S. biopharmaceutical industry, have expressed concern that weaknesses in U.S. STEM skills and talent have and will continue to contribute to national STEM workforce shortages and will ultimately diminish U.S. competitiveness and the U.S. biopharmaceutical industry’s ability to innovate and bring new medicines to patients in need. As noted by Amgen’s CEO Robert Bradway, “I’ve seen the lives of patients transformed as a result of new medicines we’ve discovered, developed and manufactured—and I’ve seen the unrelenting passion of scientists who work on those kinds of therapies. It’s shown me how rewarding it can be to pursue science as a career—and the broad-based benefits that science, technology, engineering, and math (STEM) disciplines can provide. The danger we face today is the possibility that fewer people will enter highly technical fields in the decades ahead, at a time when demand for individuals with these kinds of skills is on the rise.”

---

**Teacher Quality Concerns**

Improvements to K-12 STEM education require attention to both sides of the equation—students and teachers. As noted by the President’s Council of Advisors on Science and Technology, “the most important factor in ensuring excellence is great STEM teachers.”  

This starts with effective teacher training programs, but as a recent report by the National Council on Teacher Quality found, only about 10 percent of the more than 1,200 teacher training programs in the U.S. are “high quality.”

In addition to general teacher training, the most effective STEM teachers have an educational background in the STEM subject they teach, but according to the U.S. Department of Education’s Schools and Staffing Survey, many of the STEM disciplines are assigned teachers that did not major in that field in college, particularly in the physical sciences where fewer than half of teachers have a degree in earth sciences or chemistry, the main subjects they teach. In the U.S., nearly 30 percent of math teachers do not have a math degree and one in four biology teachers do not have a degree in the life sciences.

As noted in a McKinsey & Company study on the importance of teacher selection and training, “The quality of a school system rests on the quality of its teachers...The top-performing school systems have more effective mechanisms for selecting people for teacher training than do the lower-performing systems. They recognize that a bad selection decision can result in up to 40 years of poor teaching.”

The study raises concerns that we are recruiting more teachers from the bottom performers in high school than we should, meaning the prospects for the quality of the education system seem unlikely to improve without a concerted effort to make STEM fields more attractive and improve STEM teacher training.

In contrast, countries with higher performing school systems like those of Singapore and China, place a strong emphasis on recruitment and training for STEM teachers. For example, in Shanghai and throughout China, an emphasis has been placed on improving teacher training and strengthening credentials in recent decades. Rigorous education and testing standards have been put into place to qualify teachers. Beyond these initial credentials, teacher professional development is continuously emphasized and promoted with teachers observing each other’s classes, active mentoring, continual evaluation, regular group discussion based on subject matter to share best practices, and joint lesson planning. In Shanghai, teachers continuously develop their craft and knowledge base by meeting a requirement of 360 hours of professional development every five years of their teaching career.

---

15 President’s Council of Advisors on Science and Technology, “Prepare and Inspire: K-12 Education in Science, Technology, Engineering, and Math (STEM) for America’s Future,” Executive Report, September 2010.
19 National Center on Education and the Economy, The Center on International Education Benchmarking; Shanghai-China profile.
To retain global leadership in biopharmaceutical R&D, the U.S. cannot afford to continue to lag behind other countries in building the 21st century STEM workforce needed to fuel the knowledge economy. As noted by The New York Times Editorial Board, “America’s stature as an economic power is being threatened by societies above us and below us on the achievement scale. Wealthy nations with high-performing schools are consolidating advantages and working hard to improve. At the same time, less wealthy countries like Chile, Brazil, Indonesia, and Peru have made what the OECD describes as ‘impressive gains catching up from very low levels of performance.’ In other words, if things remain as they are, countries that lag behind us will one day overtake us.”

The nation’s biopharmaceutical companies, like many other sectors, recognize the need to be a part of the solution and are developing and supporting a range of activities and programs aimed at improving the state of STEM education in the U.S. starting with K-12 and up to and including enhancing teachers’ professional training to foster U.S. ability to compete with other nations.

---

The U.S. biopharmaceutical sector’s ability to develop new medicines is critically tied to its base of high-skilled talent. Its workforce spans a broad spectrum of occupations at the core of U.S. innovation—STEM-related occupations can be found at every stage of the R&D and manufacturing process. Life and physical scientists represent just one of the critical components of the biopharmaceutical workforce, accounting for nearly two out of every three STEM jobs within the biopharmaceutical manufacturing segment alone.

The graphic on the next page illustrates the broad range of STEM jobs involved in researching, developing, and manufacturing new medicines for our most challenging and costly diseases.

STEM-related occupations make up a high share of the biopharmaceutical manufacturing component of the broader industry—nearly 30 percent of industry jobs fall into these primary STEM groups according to available federal data.21 The concentration of these STEM jobs is five times that seen across the entire economy. Nearly two thirds of these individuals are working in biopharmaceutical manufacturing as chemists, medical scientists, biological and chemical technicians, science managers, biochemists, microbiologists, and other highly trained scientific occupations. The higher concentration of STEM occupations in the biopharmaceutical industry speaks to the industry’s vested interest in ensuring the next generation of high-skilled workers.

i. President’s Council of Advisors on Science and Technology, Report to the President on Ensuring American Leadership in Advanced Manufacturing, June ii 11, p. ii, cited in A National Strategic Plan For Advanced Manufacturing, Executive Office of the President, National Science and Technology Council, Feb. 2012.

ii. PhRMA analysis of data from United States International Trade Administration, TradeStats Express: National Export Data.


---


---

ADVANCED MANUFACTURING IN THE BIOPHARMACEUTICAL INDUSTRY

A broad range of STEM expertise is required to support advanced manufacturing performed by the biopharmaceutical industry. The activities “(a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. It involves both new ways to manufacture existing products, and the manufacture of new products emerging from new advanced technologies.”

Advanced manufacturing is an important source of:

- **Exports** – Biopharmaceutical exports have increased more than 300 percent over the fifteen year period between 1998 and 2012.

- **New medical innovations** – More than 300 medicines have been approved in the U.S. over the past decade.

- **Economic sustainability and growth** – According to the National Science Foundation, “The manufacturing sector accounts for about 72 percent of all private-sector R&D spending and employs about 60 percent of U.S. industry’s R&D workforce. As a result, the manufacturing sector develops and produces many of the technologies that advance the competitiveness and growth of the entire economy, including the much larger service sector. Technology-based improvements to productivity made possible by the manufacturing sector consistently generate job growth over time across the economy.”
### Figure 4: STEM-related Jobs Across the Drug Development Process

<table>
<thead>
<tr>
<th>Drug Discovery</th>
<th>Preclinical</th>
<th>Clinical Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Preclinical Chemists</strong>: Study the composition of matter and its properties at preclinical stage, making discoveries, though these can take many years to develop. Typically requires a Bachelor’s or higher in chemistry.</td>
<td><strong>Software Developer</strong>: Creates programs that predicts drug outcomes and software programs to allow clinical trials and their outcomes. Typically in computer science.</td>
<td><strong>Clinical Safety Scientist</strong>: Responsible for testing, ongoing safety evaluation, and regulatory adverse events experienced by patients in a clinical trial. Typically requires a Bachelor’s in sciences, pharmacy, or other health field.</td>
</tr>
<tr>
<td><strong>Research Scientist</strong>: Discover molecules that modulate targets/pathways implicated in disease to serve as starting points for further development towards human investigation. Typically requires a Bachelor’s in science.</td>
<td><strong>Biostatistician</strong>: Involved in developing mathematical models for drug development, such as engaging in the design of clinical trial plans, which requires advanced statistical skills, and using various mathematical models to analyze big data sets. Typically requires a Masters or PhD in statistics or related field.</td>
<td><strong>Programming Manager</strong>: Responsible for the translation of statistical programming activities in clinical trials and submissions to health authorities. Typically requires a Bachelor’s in mathematics or other related field.</td>
</tr>
<tr>
<td><strong>Cell Biology/Immunology Scientist</strong>: Develop, design, and perform studies using cell-based assays for screening, characterization, and mechanism of action studies on drug candidate antibodies in laboratory and human studies. Typically requires a PhD in immunology or related field.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Medicinal Chemist</strong>: Works primarily with biological materials, studying drug candidates with and potential drug interactions. Typically requires a Bachelor’s or higher in chemistry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Biological Technician/Laboratory Aide</strong>: Collect data and samples; maintain lab instruments and equipment; monitor experiment; analyze samples using a variety of high tech equipment. Typically requires an Associate’s degree or higher in a life science field.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHASE III</td>
<td>FDA Review and Approval</td>
<td>Scale-Up to Manufacturing</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------</td>
<td>---------------------------</td>
</tr>
</tbody>
</table>

- **PHASE III**
  - FDA Review and Approval: The collection, processing, and regulatory reporting of potential side effects of receiving medicines.
  - Scale-Up to Manufacturing: The planning and execution of large-scale production.
  - Phase IV/Ongoing Research and Monitoring: Tracking the effectiveness of drugs once they are on the market.

**Jobs Related to Drug Development**

- **Functional Safety Engineer:** Serves as the manufacturing site’s subject matter expert for instrument industry standards and local practices. Typically requires Bachelor’s or higher in engineering.

- **Pharmacovigilance Toxicologist:** Conducts toxicological investigations to support quality assurance in manufacturing. Typically requires a Masters or PhD in medical toxicology.

- **Safety Specialist:** Responsible for coordinating and performing data entry and assessment, coding, and regulatory reporting activities in the clinical and post-approval phases. Typically requires a Bachelor’s in Medical Technology.

- **Production Technician:** Performs daily production activities, including equipment operation and cleaning with strict adherence to all applicable standard operating procedures and Good Manufacturing Practices. Requires high school diploma and relevant work experience.

- **Instrument and Mechanical Technician:** Troubleshoots, maintains, and repairs manufacturing equipment. Typically requires Associate’s degree or high school diploma with relevant work experience.

- **Pharmaceutical Biologics Engineer:** Provides technical support in the clinical manufacturing process by applying fundamental scientific and engineering principles to resolve manufacturing process issues and evaluating process improvements. Typically requires a Bachelor’s or higher in biochemical engineering.

- **Science, Technology, Engineering, Math** (STEM) focus on issues related to drug delivery systems, quality control of pharmaceutical compounds.
Biopharmaceutical Companies Nurturing the Next Generation of Skilled Workers

Companies and entire industries are taking action to improve STEM education in the U.S. against a backdrop of stakeholders advocating for various reforms of the U.S. educational system.

Battelle conducted a survey of PhRMA member biopharmaceutical companies regarding their support for STEM education related programs and initiatives in the U.S. The results indicate that PhRMA members are proactively engaged, not only in creative approaches to improving fundamental science education, but also in reforming the way in which STEM subjects are taught and learned. This is the first time a study has tracked, in detail, the contributions of the innovative biopharmaceutical industry to U.S. STEM education.

Battelle surveyed PhRMA member companies and their foundations in March 2013. Twenty-four PhRMA member companies completed the survey and reported that they or their foundations support at least one STEM-related education program.

In this section of the report we describe:

- Key findings on overall innovative biopharmaceutical industry efforts in support of U.S. STEM education
- Geographic distribution of STEM education activities
- Age groups and educational levels targeted
- Types and examples of STEM activities supported.

WHAT MOTIVATES BIOPHARMACEUTICAL COMPANIES TO SUPPORT STEM EDUCATION INITIATIVES?

“Biogen Idec and the Biogen Idec Foundation are committed to actively supporting and driving educational STEM opportunities and enhancements in an effort to create the next-generation of scientists. Our hope, is to foster a passion and love for science for children—sparking a curiosity and love of problem-solving—while supporting the STEM careers pipeline. As a biotechnology company focused on caring for others, we feel a tremendous responsibility to help close the STEM education achievement gap, embrace diversity and inclusion in STEM careers and support those who are developing or running such programs.”

– Biogen Idec
**Key Findings**
Select findings from companies responding to a survey of their STEM education activities:22

- Annually, innovative biopharmaceutical companies are initiating, supporting, and/or funding STEM education programs with more than 500,000 student participants and nearly 8,000 teachers.
- 14 national-level programs are being supported with additional STEM activities supported in 26 states, D.C., and Puerto Rico.
- 85 percent of STEM-related programs supported by the industry focus on grades K-12, and are aimed at improving preparation and achievement among both students and teachers.

During the last five years, 24 PhRMA member companies and their foundations have:

- Invested over $100 million in STEM education related initiatives;
- Awarded nearly 600 individual STEM education related grants;
- Leveraged the skills and talents of nearly 4,500 industry employees as volunteers in STEM programs and initiatives;
- Volunteered almost 27,000 hours;
- Supported or served more than 17,500 STEM teachers;
- Impacted more than 1.6 million students in STEM-related education programs sponsored or supported by the industry at all grade and educational levels; and
- Supported or funded more than 90 individual initiatives targeting students and/or teachers at all levels in STEM-related fields, the majority of which have been active within the last year.

Some of the most sizable programs are those that target a national student or teacher population in support of third-party STEM-related initiatives such as Teach for America, or sponsorship for the National Science and Engineering Festival or regional or national science fairs or robotics competitions. Other large programs are statewide efforts to, for example, develop or promote a state science initiative or impact curriculum development.

---

22 Key findings from the survey represent what companies are able to report based on various degrees of tracking participation in and support for STEM education related programs. As many companies do not systematically gather and report this information, these figures likely undercount overall support.
**Geographic Coverage of STEM Activities**

Biopharmaceutical companies are supporting STEM education programs and initiatives that operate coast to coast and vary in their geographic focus from local, regional, and national levels. The industry is supporting programs in 26 states, D.C., and Puerto Rico with larger concentrations in states with a deeper industry presence (see map in Figure 5). Fourteen programs are considered national in scope and potentially impact every state.

**Figure 5: Geographic Coverage of U.S. STEM Education Programs Supported by the Biopharmaceutical Industry**

Biopharmaceutical companies are investing in STEM education within their own communities. Thirty-two programs are supported by companies or their foundations with a primary focus at the local level (city, county, or local region). Nearly all of these are designed to impact STEM students or educators in the local areas and often school districts adjacent to corporate operations.

The multiple geographic levels in which companies and their foundations are supporting STEM-related education programs form an effective, layered approach to improving education by taking on local, state, and national challenges in education.
Financial and In-Kind Support for STEM Education Programs

Support for STEM education is provided in several different ways. While all biopharmaceutical companies do not have corporate foundations, many do and often use the foundation as the umbrella under which they launch initiatives, provide direct funding or in-kind resources, or contribute in other capacities. The survey finds companies generally use a blend of approaches across the programs and initiatives they sponsor. Just over half of companies (55 percent) provide direct support through the company itself, 24 percent support STEM activities through their corporate foundation, and 21 percent use a blended approach.

Biopharmaceutical companies and foundations that are supporting STEM education programs do so in many ways, often through financial donations or grant funding, many times by donating equipment or facilities to use, employees volunteering their time and expertise for service, or other “in-kind” contributions.

Among the 24 companies responding, three-fourths of company-supported STEM initiatives receive financial support which totaled $10.3 million in 2012.23 In the survey, companies providing financial support were asked whether they were the “primary” funder of this program (providing more than 50 percent of all funding) or instead a more general supporter of a broader program effort. Biopharmaceutical companies are primary funders of nearly 30 percent of all STEM education programs receiving any financial support. This share indicates the important and crucial role of these financial contributions in supporting numerous STEM education initiatives and the extent to which biopharmaceutical companies are designing new programs to fully fund or are the primary supporter of existing programs.

During the last five years, among the biopharmaceutical companies surveyed, $100 million has been invested in STEM education programs and initiatives across the U.S. Some of the largest initiatives from a financial funding perspective tend to be multi-state or national in their coverage though they span an array of program designs. These initiatives range from company-initiated and developed national initiatives to impact STEM teaching and learning, to multi-state programs aimed at exposing students and teachers to real-world lab experiences, to strengthening partnerships with third party STEM education initiatives. Support for STEM education programs also involves in-kind contributions—non-financial resources can include employee volunteers, equipment donation or use permission, and allowed use of facilities. In an advanced technology industry such as the biopharmaceutical sector, these resources are extremely valuable as the expertise of scientists and specialized instruments, lab equipment, and facilities are hard to afford or access in most educational settings, particularly in the K-12 levels.

---

23 Numerous companies that report providing financial support for their sponsored program(s) were unable to report an annual figure for calendar year 2012. The 2012 contribution figure, therefore, is likely undercounting overall support.
Companies contribute “in-kind” in multiple ways across individual education programs but the most common, by far, is through employee volunteers. Among the companies and foundations responding to the survey reporting in-kind contributions, they contribute support through:

- Employee volunteers (32 programs; 59 percent of all in-kind activity)
- Donation or allowed use of lab or other equipment (10 programs; 19 percent of all in-kind activity)
- Allowed use or donation of facilities (5 programs; 9 percent of all in-kind activity)
- Support in other capacities, including technical and communications support (7 programs; 13 percent of all in-kind activity)

Many companies were unable to quantify their in-kind support suggesting that these figures may underestimate the full range of support provided. Available data are provided in the figure below.

**Figure 6: In-kind Contributions and Support to U.S. STEM Education Programs**

<table>
<thead>
<tr>
<th>ANNUALLY:</th>
<th>700 employee volunteers</th>
<th>8,648 employee-hours volunteered</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUMULATIVE, last 5 years:</td>
<td>4,463 employee volunteers</td>
<td>26,770 employee-hours volunteered</td>
</tr>
<tr>
<td>OTHER contributions:</td>
<td>Lab equipment</td>
<td>Communications and Public Relations assistance</td>
</tr>
</tbody>
</table>

**Level of Education and Age Groups Supported**

The sector is working to improve and enhance the STEM talent pipeline by targeting all age groups and education levels across more than 90 individual programs or initiatives (see Figure 7). The vast majority (85 percent) of STEM-related programs supported by the industry, however, are targeted at improving STEM education and opportunities among students in grades K-12 with a remarkably even distribution across elementary, middle, and high school grades. Companies are emphasizing the value in supporting STEM-related programs at younger age groups to instill a passion for these fields at an early age, which has been shown to lead to continued academic interest and career pursuits as students age.

**Figure 7: Support for All Levels of the STEM Education Talent Pipeline**

Note: Many programs span multiple grade levels. K-12 detail will not sum to 85% due to some survey responses reporting age groups that span K-12 grade levels, and others that don’t specify which K-12 group. Programs by grade level include both those focused on students as well as teachers.
Types of STEM Activities Supported

Companies are supporting STEM programs designed to improve achievement and outcomes for students as well as for educators. As shown below, 57 percent of industry supported programs are student focused while others target both students and/or teachers. Among the 93 programs or initiatives reported by companies responding to the survey, more than 70 percent were classified into the seven categories shown in the pie chart and are briefly described below.

Figure 8: Focus of Industry-supported STEM Education Programs

<table>
<thead>
<tr>
<th>Focus Type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student focused</td>
<td>57%</td>
</tr>
<tr>
<td>Student &amp; Teacher focused</td>
<td>22%</td>
</tr>
<tr>
<td>Teacher focused</td>
<td>12%</td>
</tr>
<tr>
<td>Other focus</td>
<td>9%</td>
</tr>
</tbody>
</table>

Figure 9: Distribution of STEM-Education Programs Supported

Types of STEM activities supported:

- Third-party related initiatives for students or teachers
- Scholarships for students or teachers
- Science fairs or STEM-related competitions
- Summer research experience or academically-oriented camps for students or teachers
- Teacher workshops or other professional development
- Classroom visits to schools for learning opportunities, career awareness, etc.
- STEM-focused schools
- Other STEM activities

- **Supporting third-party efforts:** The activities most widely supported by the biopharmaceutical companies surveyed are those that sustain an existing third party student or teacher-focused initiative such as Takeda Pharmaceutical Company’s support for science teacher education programs through its grants to the Chicago Museum of Science and Industry’s Center for the Advancement of Science Education. In 2012, Takeda Pharmaceutical Company committed funding to Chicago’s Museum of Science and Industry to support science teacher education programs in Chicagoland’s high-need areas. The Center for the Advancement of Science
Education (CASE) program aims to inspire the next generation of inventors and innovators with programs that empower teachers, engage the community and excite students.

- **Supporting scholarships for students or teachers:** Many companies also provide scholarships for students or teachers to pursue education in a STEM-related field. As just two examples, the Eisai USA Foundation funds $10,000 scholarships to worthy students at the University of the Sciences in Philadelphia and Novo Nordisk supports scholarships for college students who intend to pursue careers in diabetes- or hemophilia-related fields. The Cubist Science Education Leadership Award honors innovative science teachers in middle and high schools throughout New England and partners with the New England Patriots Radio Network to recognize a “Teacher of the Week”. At season’s end, one of these teachers is given an award by Cubist Pharmaceuticals which includes $5,000 for the school’s science department.

- **Sponsoring or hosting science fairs or technology competitions:** Numerous companies are funding state or regional science fairs or robotics competitions such as FIRST Robotics. Celgene Corporation, for example, has been a multi-year sponsor and participant in the annual U.S. Science and Engineering Festival in Washington, DC. The company provides financial support for the event and an exhibit. Sanofi Pasteur supports both the BioGENEius Challenge, a premier national and international competition and recognition for high school students conducting research in biotechnology as well as teams competing in FIRST Robotics.

- **Supporting summer research opportunities or academic summer camps:** Summer research opportunities are also widely supported with one in ten programs providing hands-on, inquiry-based scientific research curriculum at all grade levels (see text box on GlaxoSmithKline’s *Science in the Summer* program on page 24). Novartis provides support to an intensive summer enrichment program for Governors School scholars in New Jersey—high-achieving high school students selected for the program entering their senior year. The scholars live at Drew University during the summer and present their scientific research findings at a conference at the university.

- **Within the “other” category:** Several programs are designed for children and/or families to introduce the “hands-on” and fun nature of science. AbbVie (formerly Abbott Laboratories), for example, sponsors a family science program for 3rd and 4th graders with hands-on out of school activities.
**Emphasis on experimental learning.** PhRMA member companies are increasingly emphasizing and encouraging new approaches to science education and company scientists are channeling those experiences that attracted them to science as an exciting education and career path. These new approaches generally emphasize the following key elements:

-Engaging students and teachers in STEM areas and topics through hands-on experimentation focused on real-world inquiry; and
-Using real-world scientific tools, equipment, and curricula to connect with and educate students and teachers in highly relevant lab experiences.

Teachers of 8th grade students taking the NAEP science assessment in 2011 were asked how often their science students did “hands-on” activities or investigations in science. In the 2011 assessment, students of teachers reporting the greatest frequency of hands-on activities and projects—every day or almost every day—scored higher than those students whose teachers report less frequency. Just 16 percent of 8th graders are engaged in daily hands-on learning in science while a majority (56 percent) perform hands-on work once or twice a week.

Amgen, headquartered in Thousand Oaks, California, is a corporate leader in developing and supporting creative STEM education programs through the work of its Foundation. These notable efforts include the Amgen Biotech Experience which began more than 20 years ago and incorporates these hands-on program characteristics with a proven approach to introducing industry-relevant lab experiences to more than 50,000 students and 500 science teachers annually.

Beyond the K-12 level, hands-on experiential program design also remains critical to learning in-demand regulatory science and knowledge. Through its partnership with Rutgers University, Sunovion Pharmaceuticals has developed the Pharmaceutical Industry Fellowship Program which includes a unique 2-year Regulatory Affairs Fellowship. From the program materials:

“Due to the evolving requirements from health authorities, there is an increasing need for trained regulatory professionals to ensure compliance with global regulations and guidance in the development, marketing and manufacture of products. This two-year, post-doctoral fellowship will help to fulfill that need by providing well-structured, specialized, hands-on, in-depth experiences in a corporate environment that will develop the competencies needed to meet the emerging challenges in regulatory affairs.”

---

The Amgen Foundation has supported hands-on educational outreach to middle and high school and college students and teachers for more than 20 years through its pioneering Biotech Experience program. Formerly known as the Amgen-Bruce Wallace Biotechnology Lab Program, this program provides lab and other equipment and curricula assistance to introduce real-world lab experiences in order to advance science literacy and to generate interest in science as an academic and potential career pursuit.

Students and teachers engage in industry-relevant molecular biology curricula, tools, and techniques used in therapeutic discovery including recombinant DNA techniques, the polymerase chain reaction (PCR), and key molecular tracers such as red fluorescent protein. At the same time, students develop science literacy, experience working in a lab setting, and gain valuable insights into potential college and career paths in life science fields. Teachers gain professional development in current, advanced science and a framework and lab equipment for bringing these applications into the classroom. The areas emphasized reflect aspects of the R&D process for which fundamental STEM knowledge and skills are needed.

More than 50,000 students and hundreds of teachers participate annually across five states, Puerto Rico, and the United Kingdom. Since its inception, more than 250,000 students have participated in the Amgen Biotech Experience. Independent evaluators have found significant gains among participating students in all areas relating to science including attitude, interest, confidence, knowledge, and interest in pursuing a career.

The Amgen Foundation has provided more than $3 million in funding for the lab program toward materials and curricula development, supplies, and teacher professional development.

Beyond the Amgen Biotech Experience, the Amgen Foundation is actively supporting a number of substantial regional and national STEM education programs serving both students and teachers.

“We advance STEM education in a number of ways, with the dual goal of inspiring more students to go on to scientific careers and focusing on scientific literacy. There is a dearth of Americans going into scientific fields. We are hoping to get more excited about science.”

— Scott Heimlich, EdD, Senior Program Officer, Amgen Foundation

For more information on the Amgen Biotech Experience (formerly known as the Amgen-Bruce Wallace Lab Program) visit www.amgenbiotechexperience.com.
A Statewide Approach to Reforming K-8 Science Education

Eli Lilly and Company Foundation’s Support for the Indiana Science Initiative

The Lilly Foundation has partnered with BioCrossroads and the Indiana Department of Education to fund and develop a major new initiative in science education under a program developed by I-STEM, the Indiana Science Initiative (ISI). The ISI is designed to implement a set of inquiry-based, hands-on science curriculum in K-8 schools statewide. The Initiative includes professional development for principals and teachers and provides kits tailored to specific grade levels.

Science kits and experiments in the ISI are based around learning modules that in the life sciences range from units on Living Things, Life Cycles, and Plant Growth for grades 1–3 to Ecology, Cell Biology, Bioengineering, and Genetics for upper elementary and middle school students. Additional experiential learning is supported in the earth, space, and physical sciences as well.

The experiential, hands-on nature of the ISI is designed to encourage and foster intellectual curiosity among students in STEM fields. Currently, the Initiative supports and trains 2,000 Indiana teachers and reaches more than 50,000 students annually.

The Lilly Foundation has supported the ISI by donating $1.5 million in seed funding as well as providing extensive strategic direction to develop the Initiative.

“All adults, especially teachers, parents, and mentors must foster excitement in young children about the wonders of science. All kids are naturally curious, and we should encourage them to explore and ask big questions. No one should be excluded. Minorities, girls, kids of all backgrounds, can learn and excel in math and science, and we must identify and eliminate barriers that discourage them from studying these wondrous subjects.”

– John Lechleiter, PhD, CEO, Eli Lilly and Company

For more information on the Indiana Science Initiative visit www.indianascience.org/.
Helping Children “Grow Into Science”
GlaxoSmithKline’s Science in the Summer

In 1986, GlaxoSmithKline developed the Science in the Summer program, which provides free classes and hands-on experiments at local libraries and other community venues to help foster interest in the sciences among elementary school children. The program has served more than 100,000 students in the Greater Philadelphia region. The program has expanded to a number of other communities including those listed below. Each includes its own specialized science sessions based on partnerships in the communities:

- Philadelphia – Genetics (Bucks County); Chemistry (Chester County); Physical Science and Electricity (Delaware County); Simple Machines (Montgomery County); Oceanography (Philadelphia County)
- Pittsburgh – Bioscience (Living things)
- Washington D.C./Baltimore – Chemistry
- North Carolina – Genetics

Examples of topics and curriculum for the specialized sessions include:

- Bioscience – Students will have the opportunity to explore the world of living things by examining plant and animal cells with microscopes, dissecting flowers, and learning about the role bacteria play in nature.
- Physical Science & Electricity – Students will find answers to questions such as: “How do magnets work?” “What is a magnetic field?” and “What makes electricity?”
- Genetics – Students will be introduced to and learn about genes, DNA, basic cell structure, and traits. The students will use activities to identify cell structures, learn where DNA resides in a cell, learn about what genetic traits are and how they are inherited from one’s parents, and explore adaptations that plants and animals have made to help them survive in their given habitats.

An estimated 9,000 students will have gained a better understanding and appreciation of the sciences through this program in 2013.

The program is solely sponsored by GlaxoSmithKline but leverages partnerships with leading regional scientific organizations including Carnegie Mellon in Pittsburgh; The Franklin Institute in Philadelphia; Morehead Planetarium and Science Center in the Research Triangle, NC region; and the American Association for the Advancement of Science in the Washington, DC metro area.

For more information on GlaxoSmithKline’s Science in the Summer program visit http://www.scienceinthesummer.com/.
**Professional Development for Teachers:** Teacher professional development is critical to maintaining and improving teacher quality by ensuring educators stay up to date on the latest advances in science, an ever-changing field, and its applications in technology and R&D-intensive industries where discovery and commercialization meet. Examples include:

- **Bayer Corporation’s Bayer USA Foundation provides an annual grant to the National Science Teachers Association (NSTA) for a Bayer-NSTA Fellows program and to expand the NSTA New Science Teacher Academy.** The NSTA is a membership organization dedicated to promoting excellence and innovation in science teaching and learning. Its 60,000 members include science teachers, administrators, scientists, industry and business representatives, and others committed to science education. The Bayer NSTA Fellows Program supports 10 selected early-career middle and high school science teachers annually with an array of professional development resources and tools over a 3-year period. The NSTA New Science Teacher Academy is a year-long professional development program to help reduce the high-attrition rate among science teachers who are new to the profession.

- **Bristol-Myers Squibb has established three Centers for Science Teaching and Learning, facilities dedicated to teaching and learning by inquiry.** The Centers, located at Rider and Montclair State Universities in New Jersey and at Quinnipiac University in Connecticut, focus on professional development for K-12 science teachers and prospective teachers, among other things. In addition to support for current teaching professionals, the Centers focus on “pre-service” teaching students with courses designed to replicate the inquiry-based approaches they will ultimately be teaching. The Centers are developing a new model for teacher professional development and gauging its efficacy.

- **Biogen Idec has sponsored Teach for America (TFA) STEM teachers in Boston and in Raleigh-Durham.** Teach for America recruits talented teaching professionals who commit to teaching in low-income communities for two years. TFA provides intensive training, support, and career development to the teachers. The partnership, supported by Biogen Idec, aims to help close the achievement gap seen in lower-income communities where Teach for America provides teachers. Biogen Idec is contributing not only through its grant but also by hosting conferences and workshops for teachers at its facilities and offering orientation and training at its community lab.
Recognizing a need for improved K-12 science instruction, Merck established in 1993 the Merck Institute for Science Education (MISE) program to train science teachers and administrators. MISE has evolved from one program 20 years ago into a multi-faceted set of training programs providing education, workshops, support coaches, and family science activity nights for partner school districts in New Jersey and Pennsylvania. These programs are each designed for different audiences and skill levels and include:

- **The Academy for Leadership in Science Instruction (the Academy)** – Launched in 2008, this 3-year professional development initiative for teachers, principals, and district administrators sets out to improve science instruction and deepen their understanding of leadership in a science classroom setting.
- **Peer Teacher Workshops** – These weeklong sessions are designed to help teachers develop their understanding of instructional materials and effectively apply them in a classroom.
- **In-Class Support Coaches** – Provides coaches who offer middle school science teachers assistance in formulating classroom instruction plans, lesson feedback, review of student and assessment data, and in some cases co-teaching on subjects.
- **Family Science Activities** – Science events held at both Merck sites and partner school districts that pair parents and children (grades K-8) to work cooperatively to solve problems and make scientific observations on topics such as physical science, forensics, or astronomy. They also serve as a tool for schools to showcase to parents the way these activities are being presented to students throughout the school district.
- **Merck State Science Day** – A yearly science examination competition taken by New Jersey secondary students—either individually or as a team—competing in the fields of biology, chemistry, physics, and integrated sciences for a chance to become known as a Merck Scholar.

Merck’s MISE program has served more than 6,000 teachers through nearly 400 Peer Teaching Workshops since 1993. Through the leadership academy, the program has served hundreds of teachers and principals, as well as dozens of school district administrators in the past five years. These teachers and staff then apply these lessons to the more than 89,000 students throughout their school districts. In addition to directly contributing to high-quality science education, MISE is actively engaged in efforts to improve science curriculum, resources, assessments, and related policies. To support these programs Merck has invested several million dollars over the last five years and has leveraged additional grant funding from the National Science Foundation.

*For more information on the Merck Institute for Science Education visit [www.mise.org](http://www.mise.org).*

Note: Student figures are based on the size of the entire school district in the partnership areas (Elizabeth, NJ; Hillside, NJ; Linden, NJ; Newark, NJ; Rahway, NJ; Readington Township, NJ; and North Penn, PA).
Encouraging women and minorities in STEM education. The latest federal data reveal that certain demographic groups are consistently underrepresented in STEM degree programs and jobs, namely women and certain minorities (see text box). This represents both a challenge to encourage these groups to pursue careers in these fields as well as an opportunity to leverage the talents of all of the nations’ “best and brightest.”

PhRMA member companies are engaged in a range of efforts to increase diversity in STEM, particularly with respect to exposing students at young ages to the excitement of hands-on, inquiry-based scientific learning opportunities. The survey finds 18 biopharmaceutical companies and corporate foundations support more than 30 STEM-related education initiatives or programs that primarily target girls or women, minorities, and/or students/teachers in lower income areas.

THE UNDERREPRESENTATION OF WOMEN AND MINORITIES IN SCIENCE AND ENGINEERING

In its 2013 report on the presence of women, minorities, and the disabled in science and engineering, the National Science Foundation (NSF)\(^1\) finds:

- **Relative to their share of the U.S. population, women are less likely than men to:**
  - Pursue a postsecondary degree in math, the physical sciences, computer sciences, and engineering
  - Work as a scientist or engineer relative to their participation in the workforce overall
  - Work full time as a scientist or engineer
  - Work as a full-time, full professor with a science, engineering, and/or health-related doctorate degree (women represent fewer than one in four among these professors)

- **Relative to their share of the U.S. population, “underrepresented minorities” including three racial/ethnic groups—blacks, Hispanics, and American Indians are less likely than their white and Asian counterparts to:**
  - Attend college or to graduate
  - Graduate with a postsecondary science or engineering degree
  - Work as a scientist or engineer relative to their participation in the workforce overall

Women and minorities are gaining ground in certain areas, though evidence from the NSF studied trends indicate progress is modest. Among women, there has been an increase in their share of social science and bioscience related college degrees and they are relatively well-represented in these fields; though their share of degrees in math, physical sciences, engineering, and computer science remain low and show little signs of improvement. Among underrepresented minorities, there have been steady gains in their share of science and engineering degrees over the last two decades with increasing degrees in psychology, social science, and computer science fields.

---

Program examples, which total more than 30, include:

- The Astellas USA Foundation supports Stellar Girls, a program that introduces girls in grades 5 through 8 to current interesting “Big Ideas” in STEM Fields.

- AstraZeneca provides support to TechGYRLS in Delaware. The program encourages middle and high school girls to embrace technology and to consider a career in science, technology, engineering, or math.

- Bayer USA Foundation has long supported Biotech Partners, which is the Bay Area’s only non-profit organization providing a comprehensive, hands-on, bioscience education and job training program for populations underrepresented in the sciences—especially minority students (97 percent), young women (54 percent) and those from low-income households.

- BioMarin Pharmaceutical supports a Summer Algebra Academy targeting high-potential 9th graders from disadvantaged Latino communities.

- Boehringer Ingelheim Cares Foundation has provided financial support to the Boys and Girls Club of Stamford, CT to help fund a science enrichment program, and participation in the Young Scientist Club, an interactive, hands-on science curriculum. The Boys and Girls Club seeks to help narrow the achievement gaps between minority children and their white counterparts as well as low-income children and their more advantaged counterparts.

- Daiichi Sankyo supports Students 2 Science, Inc. (S2S), a non-profit corporation that inspires, motivates and educates middle and high school students to pursue careers in STEM subjects in a lower income school district. S2S operates a 10,000 sq. ft. technology center in East Hanover, New Jersey where students perform hands-on, age-appropriate experiments that emphasize the subjects taught in their science classrooms.

- Johnson & Johnson supports a post-doctoral research program at the University of Michigan for under-represented minority doctoral candidates. The program focuses on research aligned with the immunology therapeutic area’s at Janssen R&D, part of Johnson & Johnson. Each post-doctoral fellow is jointly mentored by a university faculty member and a company scientist, and spend time working at both sites. Research projects are jointly developed to encourage collaboration and alignment of research interests.
Advancing National Science Literacy:
Bayer Corporation’s Making Science Make Sense Program

Bayer Corporation’s award-winning effort to advance science literacy and inspire student interest in science, Making Science Make Sense (MSMS), was initiated more than 40 years ago. The program leverages more than 1,000 employee volunteers and strategic national and local partnerships to fundamentally change the manner in which science is both taught and learned. A new approach to science education is promoted that emphasizes hands-on, inquiry-focused, experiential learning, or in other words, by doing it—a method that has been proven effective at developing science literacy and exciting students about science.

To advance and promote national science literacy, the Bayer Corporation is active on several fronts, including:

- Bayer Facts of Science Education Survey – surveys that reach out to parents, teachers, students, administrators, business executives, and scientists that gauge the state of science education in the U.S. since 1995.
- Bayer Science Literacy Campaign led by Dr. Mae C. Jemison – Dr. Jemison is a physician, scientist, educator, and the nation’s first African-American female astronaut to orbit the Earth, and serves as the lead advocate for Bayer’s science literacy campaign. In her role she accompanies Bayer executives visiting Bayer site communities to emphasize the importance of science literacy and science education reform.
- MSMS Experiment Guide – a free booklet of fun and simple science experiments for parents and children.
- MSMS Audio Series – brief two minute science classes about everyday topics.

Bayer’s MSMS program is working toward systemic science education reform, bringing its emphasis on a shift toward experiential education to seven reform initiatives in local communities including: Pittsburgh, PA; New Haven, CT; Kansas City, MO; Elkhart, IN; New Martinsville, WV; Charleston, SC; and Clayton, NC.

Bayer is leveraging strategic partnerships to affect change across an array of organizations including: American Association for Advancement of Science; National Science Foundation; National Science Resources Center; National Science Teachers Association; and the U.S. Department of Education.

For more information on Bayer Corporation’s Making Science Make Sense Program visit www.BayerUS.com/MSMS.
Lundbeck is partnering with Perspectives/Illinois Institute of Technology Math and Science Academy in Chicago, Illinois, to provide students with access to hands-on experiments in quality laboratories as well as access to Lundbeck employees who volunteer as mentors to the students at the charter school. Through this partnership Lundbeck hopes to inspire students to pursue more education in STEM fields and ultimately enter into a STEM-related career field.

The public-private partnership has two key components: Lundbeck investing in renovations and improvements in the science labs at Perspectives Math and Science Academy. These labs provide students in grades 6 to 12 with the opportunity for hands-on learning and the opportunity to pursue college credit in science through the introduction of an Advanced Placement Chemistry course.

Lundbeck also partners to provide mentoring to charter school students. Lundbeck employees share real-world experiences and insights with students to provide them a window into what a career in STEM entails on a day to day basis. All of the 2,300 students enrolled at Perspectives Math and Science Academy participate in these mentorship programs via in-person classroom discussions and presentations, or through virtual meeting sessions with Lundbeck employees.

“Our commitment to science goes beyond our own labs and into the classroom, where we have an opportunity to inspire the next generation of scientists.”

— Peter Høngaard Andersen, PhD
Head of Global Research, Lundbeck

For more information on Lundbeck’s partnership with Perspectives visit http://www.lundbeck.com/us/our-commitment/community-involvement/stem-education.
Developing the Next Generation of Scientists:
Amgen Scholars

Through the Amgen Foundation’s support of the Amgen Scholars program, undergraduate students are engaged in hands-on university summer research projects at leading U.S. universities. Ten universities in the U.S. and three in Europe host the 8–10 week summer research program designed to engage undergraduates in cutting-edge research spanning a wide range of life science and related disciplines from biochemistry, bioengineering, and biotechnology to neuroscience, toxicology, and molecular genetics. In addition to contributing to university research, students learn through hands-on lab experiences, work alongside faculty mentors, and attend seminars, workshops, networking events, and a mid-summer symposium led by industry and academic scientists. In the U.S., host universities include:

- California Institute of Technology
- Columbia University/Barnard College
- Massachusetts Institute of Technology
- Stanford University
- University of California at Berkeley, Los Angeles, San Diego, and San Francisco
- University of Washington
- Washington University in St. Louis

Amgen Scholars has supported more than 2,400 undergraduates that attend almost 400 different colleges and universities since the program began in the U.S. in 2006 and in Europe in 2008. Eligible students must maintain a high GPA and have an interest in pursuing a PhD or MD and a career in science. The program is successfully reinforcing student interest in pursuing graduate-level science studies and science careers as nearly 90 percent of program alumni that have finished their undergraduate program are now enrolled in advanced degree programs or are working in a scientific field.

To date the Amgen Foundation has committed $34 million over eight years to support thousands of students globally in its initiative to inspire and prepare the next generation of scientists.

For more information on the Amgen Scholars program visit http://www.amgenscholars.com/.

“I’ve learned more about how to conduct scientific research and about myself on a personal level in the two-and-a-half months I was in New York than I have in my entire college career.”
– Amgen 2007 Scholar Karen Levy, University of Nevada, Biology, Biochemistry

Photos courtesy of Amgen
THE ROLE OF PUBLIC-PRIVATE PARTNERSHIPS IN ADVANCING AND IMPROVING U.S. STEM EDUCATION

Biopharmaceutical companies are leveraging strategic partnerships to ensure their initiatives are effective and their goals are reinforced by a complementary organization with like-minded goals and approaches. Much of the partnering efforts align public and private entities in strategic partnerships, which, if coordinated effectively, can bring together the best of both sectors. For instance, a biopharmaceutical company can lend professional industry expertise and resources in designing a STEM education program and tap into an existing public network or entity such as a university or public school system. Today, companies and their foundations are partnering with more than 60 individual organizations spanning government and the private sector and widespread geography. Examples include:

- National Science Teachers Association
- National Governors Association
- American Chemical Society
- Teach For America’s STEM Initiative
- 100Kin10
- The American Association for the Advancement of Science
- National Board for Professional Teaching Standards
- United Negro College Fund
- Boys and Girls Club
- The Franklin Institute (PA)
- Delaware Biotech Institute (DE)
- Chicago Public Schools (IL)
- Newark Public Schools (NJ)
- North Carolina New Schools Project (NC)
- North Penn School District (PA)
- Wake and Durham Public School Systems (NC)
- Carnegie Mellon (PA)
- Duke University (NC)
- Drew University (NJ)
- Northampton Community College (PA)
- Independent College Fund of New Jersey (NJ)
Conclusion: Arresting STEM Decline to Ensure Tomorrow’s New Medicines, Economic Vitality Requires Long-Term Commitment

The U.S. is facing major challenges in ensuring a robust supply of STEM workers to meet the increasing needs of the nation’s knowledge economy. At issue is an increasing STEM skills gap in the U.S., a concern for R&D-intensive industries such as the innovative biopharmaceutical industry, which require a broad range of STEM skills, training, and education at all degree levels.

The potential implications are significant for the U.S. economy—and patients—if the country is unable to grow the next generation of workers equipped with the STEM skills needed to maintain the U.S. position as a world leader in biopharmaceutical R&D. A shortage of skilled workers could undermine the ability to develop tomorrow’s new treatments here in the U.S. for our most challenging and costly diseases.

As evidenced by this report, biopharmaceutical companies and their corporate foundations are lending their resources and leveraging key partnerships to make substantial contributions nationally, in programs specific to more than half of all U.S. states, and at the local level, particularly in those communities in which they reside. Just as they vary in their geographic reach and scale, so too do these initiatives target the varied layers of the U.S. education system—across all levels from K-12 through postsecondary, and spanning both students and educators. Significant resources are being leveraged with over $100 million in financial support to STEM education programs over five years and nearly 4,500 skilled employee volunteers contributing almost 27,000 hours to STEM education efforts. These efforts have had a major impact by reaching 1.6 million students and 17,500 teachers with innovative approaches to learning, teaching, and exciting students about STEM careers.

As outlined in this report, employment in STEM-related jobs has grown rapidly and is projected to continue to grow at a faster pace than overall employment. Federal occupational forecasts expect the net job growth to continue with overall STEM jobs expected to increase by 17 percent from 2010 through 2020 versus 14 percent for all occupations.

While the demand for STEM talent has increased, U.S. rankings in key global STEM indicators have declined and other countries continue to increase their STEM investments and strengthen their
STEM educational pipelines. Globally, countries are seeking to establish a competitive advantage and have developed and launched initiatives focused on improving STEM education in their nation as part of their broader strategies to attract and grow R&D-intensive sectors such as the innovative biopharmaceutical industry. These industries are particularly attractive due to the high wages, stability, and steady contributions to local and national economies.

This report highlights the innovative biopharmaceutical industry’s long-term commitment to help fill the STEM education gap by strengthening our STEM pipeline and improving teacher quality through a range of programs and activities. As the report illustrates, all stakeholders, including industries that rely on these highly-skilled employees to innovate, have a role to play in improving the nation’s standing as a global leader in innovation.

The nation’s economic sustainability and growth is based on the competitive advantage of a steady supply of highly-skilled STEM workers. In the face of increasing competition in STEM education and workers from countries like China and Japan, to remain the world’s engine of discovery and innovation, we cannot continue to lag behind other countries in the quality and quantity of our STEM talent. It is a national imperative if the U.S. is to continue to retain high-R&D industries, like the U.S. innovative biopharmaceutical industry, and the high-wage, high-value jobs they bring.
Appendix

Survey Methodology
Battelle surveyed PhRMA member companies and their foundations in March 2013 regarding the programs and initiatives they support relating to STEM education. Twenty-four of 48 PhRMA member companies and research associates (or their respective corporate foundations) completed the survey and reported at least one program supported\(^{25}\) (50 percent); the responses represent 77 percent of the 30 full member companies.

The survey sought to identify any and all education-related initiatives, programs, or other efforts that each organization has participated in, funded, or otherwise contributed to in the U.S. during the last five years that specifically were targeted to advance STEM related education fields (Science, Technology, Engineering, and/or Mathematics). Companies and foundations were asked to provide information in an inclusive manner including programs or initiatives at all education and geographic levels and those that target any education-related constituents including students, teachers, and/or administrators.

The survey was designed to collect detailed information on each education initiative or program supported to gather information on key program characteristics including:

- Type of program
- Focus of program (student, teacher, student and teacher, administrator, or other focus)
- Education level
- Scale of program (number of participants)
- Program focus with respect to specific population groups (e.g., women or girls, minorities, schools, students, or teachers in lower income areas)
- Geographic scope of program (local, state, or national)
- Type of support provided (financial and/or in-kind)
- Description of program
- Partner(s) or collaborators.

Survey information was supplemented with publicly available information from corporate and/or foundation websites in some cases to develop a more complete programmatic profile.

For more information visit: www.phrma.org/innovation/STEM.

\(^{25}\) This does not double count in the case where a company and its foundation both responded.
Additional Supporting Data

Companies and Foundations Responding to the Survey

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Foundation Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>AbbVie (formerly Abbott Laboratories)</td>
<td>Eisai USA Foundation</td>
</tr>
<tr>
<td>Amgen Foundation</td>
<td>Eli Lilly and Company</td>
</tr>
<tr>
<td>Astellas USA Foundation</td>
<td>Endo Pharmaceuticals</td>
</tr>
<tr>
<td>AstraZeneca</td>
<td>GlaxoSmithKline (GSK)</td>
</tr>
<tr>
<td>Bayer USA Foundation</td>
<td>Johnson &amp; Johnson</td>
</tr>
<tr>
<td>Biogen Idec Foundation</td>
<td>Lundbeck</td>
</tr>
<tr>
<td>BioMarin Pharmaceutical</td>
<td>Merck &amp; Co.</td>
</tr>
<tr>
<td>Boehringer Ingelheim Pharmaceuticals</td>
<td>Novartis</td>
</tr>
<tr>
<td>Bristol-Myers Squibb</td>
<td>Novo Nordisk</td>
</tr>
<tr>
<td>Celgene Corporation</td>
<td>Sanofi</td>
</tr>
<tr>
<td>Cubist Pharmaceuticals</td>
<td>Sunovion Pharmaceuticals</td>
</tr>
<tr>
<td>Daiichi Sankyo</td>
<td>Takeda Pharmaceutical Company</td>
</tr>
</tbody>
</table>

Defining STEM Occupations

In consideration of what can or should be considered a “STEM” related job, Battelle examined several recent studies that have developed different approaches though each is generally similar in the broad occupational categories included. Generally included as STEM occupations are math and computer science jobs; architecture and engineering occupations; and life and physical sciences. Occupations within these broad categories are likely to require postsecondary education and/or related experience in STEM fields applied frequently on the job. Building from this research and applying its own experience in workforce studies across the country, Battelle has developed a similar blended definition of the primary STEM workforce shown in detail in Table A-1 (see page 38). Some examples of key scientist jobs in the biopharmaceutical industry are profiled here.

16% of Scientist Jobs in Biopharmaceuticals:

Medical Scientists

What they do: Medical scientists conduct biomedical research in a variety of capacities and are often physicians, dentists, pharmacologists, or other health practitioners that primarily conduct research about understanding disease or improving human health. They must understand all aspects of disease from symptoms to causes to treatments.

In academia, medical scientists typically teach and publish research findings in medical journals, while those working in a clinical setting will conduct clinical trials and biomedical experiments and publish those findings. Most medical scientists will specialize in fields that could range from oncology, neurology, or pediatrics, to pharmaceutical, biomedical engineering, or psychiatry. Biopharmaceutical companies typically hire medical scientists to design, advance, or improve upon a new drug.

Most medical research positions require extensive education including a PhD in a life science field or a medical degree, or sometimes both. These jobs usually require years of experience and specialized training.
28% of Scientist Jobs in Biopharmaceuticals: Chemists

What they do: Chemists study the composition of matter and its properties though what this entails can vary substantially on the area in which they specialize or the industry or sector in which they work. Outside of academia and government labs, the chemicals industry and more specifically biopharmaceutical manufacturing is the top employer of chemists. Chemists typically enjoy exploring the unknown and making discoveries, though these can often take years to develop.

Medicinal chemistry and biochemistry are especially important to the biopharmaceutical industry in designing and developing new therapeutics and understanding the reactions that occur in living organisms. Researchers working as medicinal chemists work on the cutting edge of drug development working toward new compounds that can ultimately save lives.

These scientists work in a laboratory setting and must work through numerous issues with respect to drug delivery, quality control, and understanding potentially harmful interactions when administered in humans. They work with specialized computer software that helps them identify the molecular structure of the compounds they are working with. In addition to software, chemists use an array of high-tech tools and equipment including centrifuges, lasers, vacuum pumps, and spectrometers.

Chemists typically have a master’s degree though need at least a bachelor’s degree, and many have a doctoral or professional degree in chemistry. Professional experience is often critical.

13% of Scientist Jobs in Biopharmaceuticals: Biological Technicians

What they do: Biological technicians are laboratory aides that help biological and medical scientists conduct research. These technicians typically collect data and samples in a variety of lab settings from academic or government to industry. They maintain lab instruments and equipment, monitor experiments, and calculate and record outcomes and results. Technicians, therefore, are consistently using and mastering a variety of high-tech equipment as well as computers and electronic measuring devices. For a biological technician, the samples analyzed may often include blood, viruses, bacteria, food, or drugs.

In an industry setting, many biological technicians will work on translating scientific experiments and findings into commercial products.

Examples of what a biological technician might be working on could include:
- Administering and testing a new drug that suppresses tumors to mice in a pharmaceutical research study.
- Testing water or soil samples for contamination.
- Run samples of genetically modified foods to test how changes affect proteins.
- Performing genetics research by sequencing DNA samples.

In addition to an associate’s or bachelor’s degree in a life science field, a biological technician often needs a strong background in chemistry and math.
### Table A-1. STEM Occupations (Based on 2010 Standard Occupational Classification Structure)

<table>
<thead>
<tr>
<th>SOC Code</th>
<th>OCCUPATIONAL TITLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-1011</td>
<td>Architects, Except Landscape and Naval</td>
</tr>
<tr>
<td>17-1012</td>
<td>Landscape Architects</td>
</tr>
<tr>
<td>17-1021</td>
<td>Cartographers and Photogrammetrists</td>
</tr>
<tr>
<td>17-1022</td>
<td>Surveyors</td>
</tr>
<tr>
<td>17-3011</td>
<td>Architectural and Civil Drafters</td>
</tr>
<tr>
<td>17-3012</td>
<td>Electrical and Electronics Drafters</td>
</tr>
<tr>
<td>17-3013</td>
<td>Mechanical Drafters</td>
</tr>
<tr>
<td>17-3019</td>
<td>Drafters, All Other</td>
</tr>
<tr>
<td>17-3031</td>
<td>Surveying and Mapping Technicians</td>
</tr>
<tr>
<td>11-3021</td>
<td>Computer and Information Systems Managers</td>
</tr>
<tr>
<td>15-1111</td>
<td>Computer and Information Research Scientists</td>
</tr>
<tr>
<td>15-1121</td>
<td>Computer Systems Analysts</td>
</tr>
<tr>
<td>15-1131</td>
<td>Computer Programmers</td>
</tr>
<tr>
<td>15-1132</td>
<td>Software Developers, Applications</td>
</tr>
<tr>
<td>15-1133</td>
<td>Software Developers, Systems Software</td>
</tr>
<tr>
<td>15-1141</td>
<td>Database Administrators</td>
</tr>
<tr>
<td>15-1142</td>
<td>Network and Computer Systems Administrators</td>
</tr>
<tr>
<td>15-1150</td>
<td>Computer Support Specialists</td>
</tr>
<tr>
<td>15-1179</td>
<td>Information Security Analysts, Web Developers, and Computer Network Architects</td>
</tr>
<tr>
<td>15-1799</td>
<td>Computer Occupations, All Other</td>
</tr>
<tr>
<td>11-9041</td>
<td>Architectural and Engineering Managers</td>
</tr>
<tr>
<td>17-2011</td>
<td>Aerospace Engineers</td>
</tr>
<tr>
<td>17-2021</td>
<td>Agricultural Engineers</td>
</tr>
<tr>
<td>17-2031</td>
<td>Biomedical Engineers</td>
</tr>
<tr>
<td>17-2041</td>
<td>Chemical Engineers</td>
</tr>
<tr>
<td>17-2051</td>
<td>Civil Engineers</td>
</tr>
<tr>
<td>17-2061</td>
<td>Computer Hardware Engineers</td>
</tr>
<tr>
<td>17-2071</td>
<td>Electrical Engineers</td>
</tr>
<tr>
<td>17-2072</td>
<td>Electronics Engineers, Except Computer</td>
</tr>
<tr>
<td>17-2081</td>
<td>Environmental Engineers</td>
</tr>
<tr>
<td>17-2111</td>
<td>Health and Safety Engineers, Except Mining Safety Engineers and Inspectors</td>
</tr>
<tr>
<td>17-2112</td>
<td>Industrial Engineers</td>
</tr>
<tr>
<td>17-2121</td>
<td>Marine Engineers and Naval Architects</td>
</tr>
<tr>
<td>17-2131</td>
<td>Materials Engineers</td>
</tr>
<tr>
<td>17-2141</td>
<td>Mechanical Engineers</td>
</tr>
<tr>
<td>17-2151</td>
<td>Mining and Geological Engineers, Including Mining Safety Engineers</td>
</tr>
<tr>
<td>17-2161</td>
<td>Nuclear Engineers</td>
</tr>
<tr>
<td>17-2171</td>
<td>Petroleum Engineers</td>
</tr>
<tr>
<td>17-2199</td>
<td>Engineers, All Other</td>
</tr>
<tr>
<td>17-3021</td>
<td>Aerospace Engineering and Operations Technicians</td>
</tr>
<tr>
<td>17-3022</td>
<td>Civil Engineering Technicians</td>
</tr>
<tr>
<td>17-3023</td>
<td>Electrical and Electronics Engineering Technicians</td>
</tr>
<tr>
<td>17-3024</td>
<td>Electro-Mechanical Technicians</td>
</tr>
<tr>
<td>17-3025</td>
<td>Environmental Engineering Technicians</td>
</tr>
<tr>
<td>SOC Code</td>
<td>OCCUPATIONAL TITLE</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>17-3026</td>
<td>Industrial Engineering Technicians</td>
</tr>
<tr>
<td>17-3027</td>
<td>Mechanical Engineering Technicians</td>
</tr>
<tr>
<td>17-3029</td>
<td>Engineering Technicians, Except Drafters, All Other</td>
</tr>
<tr>
<td>41-9031</td>
<td>Sales Engineers</td>
</tr>
<tr>
<td></td>
<td><strong>Life &amp; Physical Sciences</strong></td>
</tr>
<tr>
<td>11-9121</td>
<td>Natural Sciences Managers</td>
</tr>
<tr>
<td>19-1011</td>
<td>Animal Scientists</td>
</tr>
<tr>
<td>19-1012</td>
<td>Food Scientists and Technologists</td>
</tr>
<tr>
<td>19-1013</td>
<td>Soil and Plant Scientists</td>
</tr>
<tr>
<td>19-1021</td>
<td>Biochemists and Biophysicists</td>
</tr>
<tr>
<td>19-1022</td>
<td>Microbiologists</td>
</tr>
<tr>
<td>19-1023</td>
<td>Zoologists and Wildlife Biologists</td>
</tr>
<tr>
<td>19-1029</td>
<td>Biological Scientists, All Other</td>
</tr>
<tr>
<td>19-1031</td>
<td>Conservation Scientists</td>
</tr>
<tr>
<td>19-1032</td>
<td>Foresters</td>
</tr>
<tr>
<td>19-1041</td>
<td>Epidemiologists</td>
</tr>
<tr>
<td>19-1042</td>
<td>Medical Scientists, Except Epidemiologists</td>
</tr>
<tr>
<td>19-1099</td>
<td>Life Scientists, All Other</td>
</tr>
<tr>
<td>19-2011</td>
<td>Astronomers</td>
</tr>
<tr>
<td>19-2012</td>
<td>Physicists</td>
</tr>
<tr>
<td>19-2021</td>
<td>Atmospheric and Space Scientists</td>
</tr>
<tr>
<td>19-2031</td>
<td>Chemists</td>
</tr>
<tr>
<td>19-2032</td>
<td>Materials Scientists</td>
</tr>
<tr>
<td>19-2041</td>
<td>Environmental Scientists and Specialists, Including Health</td>
</tr>
<tr>
<td>19-2042</td>
<td>Geoscientists, Except Hydrologists and Geographers</td>
</tr>
<tr>
<td>19-2043</td>
<td>Hydrologists</td>
</tr>
<tr>
<td>19-2099</td>
<td>Physical Scientists, All Other</td>
</tr>
<tr>
<td>19-4011</td>
<td>Agricultural and Food Science Technicians</td>
</tr>
<tr>
<td>19-4021</td>
<td>Biological Technicians</td>
</tr>
<tr>
<td>19-4031</td>
<td>Chemical Technicians</td>
</tr>
<tr>
<td>19-4041</td>
<td>Geological and Petroleum Technicians</td>
</tr>
<tr>
<td>19-4051</td>
<td>Nuclear Technicians</td>
</tr>
<tr>
<td>19-4091</td>
<td>Environmental Science and Protection Technicians, Including Health</td>
</tr>
<tr>
<td>19-4092</td>
<td>Forensic Science Technicians</td>
</tr>
<tr>
<td>19-4093</td>
<td>Forest and Conservation Technicians</td>
</tr>
<tr>
<td>19-4099</td>
<td>Life, Physical, and Social Science Technicians, All Other</td>
</tr>
<tr>
<td></td>
<td><strong>Math-related</strong></td>
</tr>
<tr>
<td>15-2011</td>
<td>Actuaries</td>
</tr>
<tr>
<td>15-2021</td>
<td>Mathematicians</td>
</tr>
<tr>
<td>15-2031</td>
<td>Operations Research Analysts</td>
</tr>
<tr>
<td>15-2041</td>
<td>Statisticians</td>
</tr>
<tr>
<td>15-2091</td>
<td>Mathematical Technicians</td>
</tr>
<tr>
<td>15-2099</td>
<td>Mathematical Science Occupations, All Other</td>
</tr>
</tbody>
</table>