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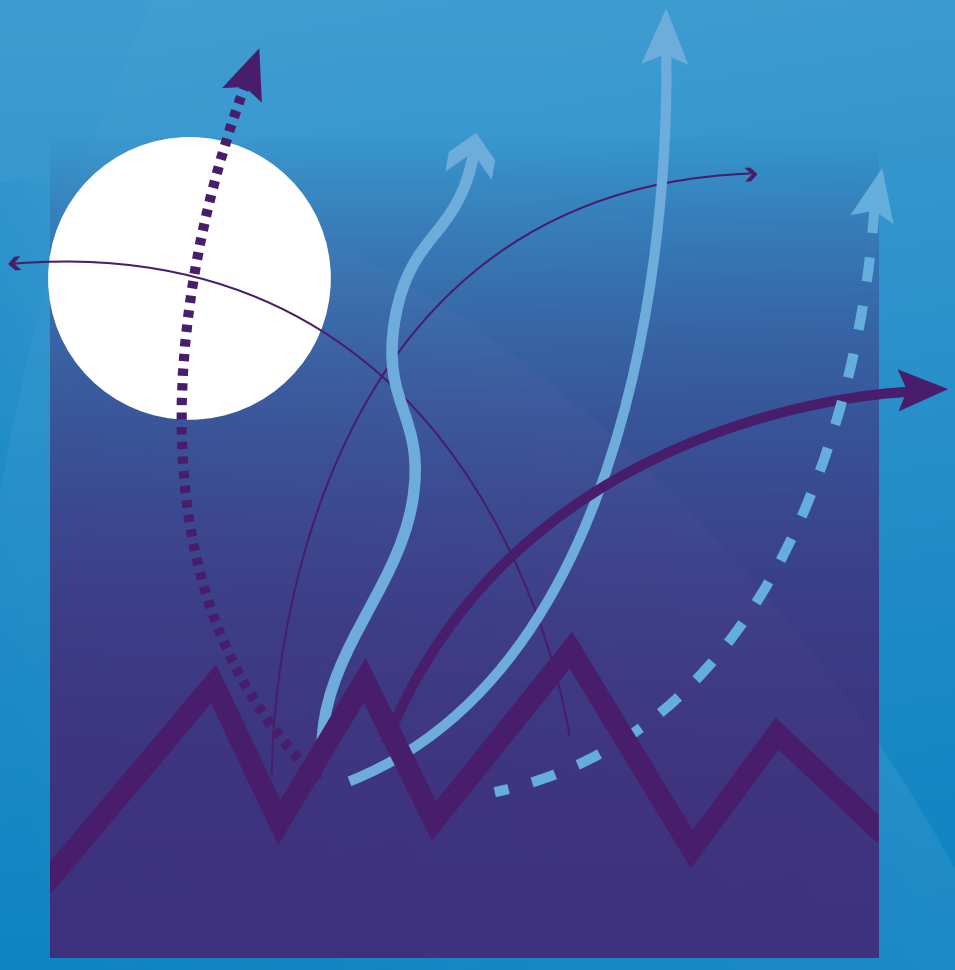
Workforce Shortfalls Cloud the Future for California's Life Sciences Industries

BASIC Study Finds Challenges and Opportunities

BASIC

Bay Area Science and Innovation Consortium



This report is a product of BASIC through a grant from the California Space Authority under the U.S. Department of Labor WIRED initiative.

November 2008

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Bay Area Science and Innovation Consortium

This report was produced through the Bay Area Science and Innovation Consortium (BASIC), an action-oriented collaboration of the region's major research universities, national laboratories, independent research institutions and research-and-development-driven businesses and organizations. BASIC is a program of the Bay Area Council Economic Institute.

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TALENT DRIVING PROSPERITY

Funding for this project was provided by the California Space Authority through the California Labor and Workforce Development Agency, as part of the California Innovation Corridor WIRED (Workforce Innovation in Regional Economic Development) grant from the Employment Training Agency of the U.S. Department of Labor.

CALIFORNIA SPACE AUTHORITY

California Innovation Corridor

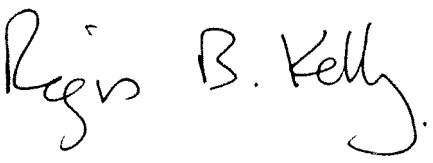
Message from the BASIC Chairman

In early April 2007, BASIC convened a roundtable forum of Bay Area visionaries to discuss the "drivers" of innovation and the exciting potential that could be realized by innovators. They also laid down a challenge: for the region to remain a leader in today's competitive innovative global environment, we must change the way we think; then we must act and work together.

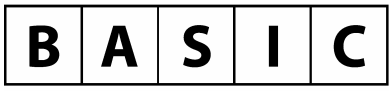
The roundtable forum and resulting initial report helped define innovation. This new report, *Workforce Shortfalls Cloud the Future for California's Life Sciences Industries*, is a first step in responding to one of the challenges laid down at the roundtable—the need to strengthen the Bay Area's highly talented science and technology workforce. This second report highlights the expanded skills required of 21st century science and technology professionals and sets out some of the existing disconnects in industry-university-student linkages. It also recommends four cross-cutting action items to address obstacles and prevent anticipated shortfalls—actions which can be achieved only through a collaborative effort by the public, private and academic sectors.

BASIC is in a unique position to assist in that collaborative approach. Building on the foundation established by the innovation and workforce reports, BASIC could bring together visionary leaders from the research and development industry, research universities and the national laboratories to meet with decision-makers at the state and federal levels. Such meetings would set the stage for developing a unified strategy to implement the critical changes needed to ensure our continued state and national global leadership in science and technology.

BASIC is committed to maintaining the talented science and technology workforce for which this region is noted.



Regis B. Kelly
Chairman, BASIC
Director, QB3



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Workforce Shortfalls Cloud the Future for California's Life Sciences Industries

BASIC Study Finds Challenges and Opportunities

The term "life sciences" was once a synonym for biosciences or biotechnology, but no longer. In recent years, it has been expanded to encompass a broad range of research and development efforts that connect to health, agriculture, energy, the environment and even homeland security. The list of academic disciplines covering life sciences has also broadened to include not only biology, but physics, chemistry and engineering as well. One attribute that all of the industries and research and development efforts under the life sciences umbrella share is that they involve work with living organisms.

Life sciences R&D and industries have become a gold mine for the California economy, generating thousands of jobs and billions of dollars in revenue. The potential is there for them to continue to gild the state's coffers for many years to come, but a huge challenge on the horizon is clouding the future. At a time when dramatic and fast-paced technological changes in the life sciences are demanding increasingly more sophisticated and varied workforce skill sets, there is a rising shortfall in the ability of the state to provide—through education or recruitment—a sufficient number of individuals who possess the necessary skills.

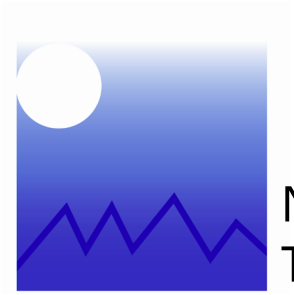
That is the conclusion of an investigative report conducted by the Bay Area Science and Innovation Consortium (BASIC), a regional entity dedicated to advancing the San Francisco Bay Area's leadership in science, technology and innovation in the increasingly competitive national and international R&D environment. If the shortfalls identified in the BASIC report are not addressed, California could see a severe

reduction of its global competitiveness in the life sciences. Furthermore, this state, which enjoys a substantial lead over all others in life sciences R&D and life sciences-generated revenues, might lose its national dominance.

The findings of the BASIC report, which was carried out on behalf of the U.S. Department of Labor's WIRED Initiative (Workforce Innovation in Regional Economic Development), are based on a review of national trends, personal interviews with 17 senior executives and 10 new doctoral graduates in the life sciences, input from stakeholders at national laboratories and research universities, and a BASIC-sponsored roundtable discussion that featured a premier panel of life sciences leaders. This roundtable panel, the culmination of the BASIC investigation, produced recommendations for four cross-cutting action items that could help forestall or prevent the anticipated shortfalls. These action items called upon life sciences stakeholders to:

- acquire a better understanding of pain points;
- address acute areas of need;
- address longer-term areas of need;
- and address fundamental interest in and support for science and science education.

The full report is entitled *21st Century Workforce Preparedness in the Life Sciences: Summary of Findings*, and is available in electronic (PDF) format from the BASIC website (www.bayareabasic.org).



National Trends

The BASIC report's findings on national trends are based on a search of relevant news media coverage, opinion essays, and Congressional testimony published in 2006 and 2007. These findings reveal some disagreement as to the extent and nature of projected shortages in trained scientists. While federal studies contend there is a current shortage of trained scientists and project this shortage to worsen in the future, there are independent studies that show this may not be true across-the-board. These independent studies suggest that there is actually an oversupply of PhDs trying to get into academia, but a shortage of PhD graduates who choose to pursue careers in industry or non-university research. Further contributing to potential workforce shortfalls in the future are an influx of foreign students who may opt to leave the United States after completing their studies and doctoral graduates opting to leave science altogether.

One of the major factors cited for a decline in U.S. doctoral degrees in science compared to other nations is the comparatively greater length of time and cost of university training in this country. Furthermore, there is a dearth of programs between the Bachelor of Science and the PhD, which forces students into either pursuing a PhD in science or leaving the study of science for other pursuits. There have been proposals for the establishment of professional "Masters of Science" degree programs with a broader set of activities, shorter duration of study and opportunities for practical internship experience. The idea is to prepare science-oriented students for careers in R&D industries and government, including entrepreneurship, business, finance and marketing. This proposal has not been universally well-received by research universities because of a cultural and business aversion to professional degrees, the higher status of doctoral programs, and the challenges of making a professional degree responsive and appropriately scoped to meet industry needs.

The BASIC review of national trends uncovered one other factor that is especially relevant to the life sciences: the often very long lab-to-market cycle for life sciences industries can severely impact hiring cycles. Doctoral students need to be more swiftly graduated and placed to reduce the problem of doctoral supply being out of phase with hiring demand. Consideration also needs to be given to the career placement of individuals who are entering the life sciences job market during a hiring downswing.

Senior Executive Perspectives

To get the perspective of senior executives who are responsible for hiring and managing the life sciences workforce, BASIC contracted with the BayBio Institute to conduct personal interviews. Seventeen interviews were completed and a summary of the results was distributed to participants in the BASIC roundtable discussion. Among the key findings was the consensus that the executives see a maturation taking place in the life sciences, similar to what took place in the semiconductor industry of 25–30 years ago. For example, while R&D and business development is likely to remain in California, manufacturing and production will likely move out. Also, while healthcare applications remain the core of the life sciences, there is growing recognition that the top U.S. and global economic concerns can be addressed with life sciences solutions, from dealing with energy (biofuels) and food, to industrial biotech, waste management, water quality, homeland security and even clothing. Although the growth potential in all these areas is strong, tighter profit margins and access to capital are creating significant pressures.

Furthermore, the convergence of life sciences technologies and business trends are shifting workforce needs away from traditional lab skills. For example, manual technical processes in the lab, such as gene sequencing and using pipettes, are increasingly being automated. New diagnostic technologies will require strong technical and computational skills to manage the equipment and the resulting mountains of data. The accumulation of genetic information and a rapidly growing ability to utilize this information will drive an increasing demand for geneticists, medical genetic counselors and genetic laboratories. One executive emphasized the "biology-plus" dynamic in which each subsequent innovation adds a new skill and knowledge set to the required baseline for workers in the life sciences industries.

When asked about specific workforce shortages facing the life sciences in California, the executives described across-the-board shortcomings at a range of levels from technician to professional, and from middle-management to leadership levels of executives. These shortcomings will arise from a lack of solid backgrounds in science, clinical development and business, including business development, finance, regulatory affairs and quality management. More specifically, there are shortages in the next generation of CEOs; doctoral-level scientists and lawyers who possess intellectual property management expertise; and both managerial and technical-level specialists in pre-clinical, clinical and regulatory affairs. The executives also cited niche shortages, such as a lack of qualified chemists.

While the executives agreed that the research universities have done a good job with producing top-level scientists and innovation, they feel that there are problems at the lower academic levels. In addition, they were concerned about an imbalance between advanced degree scientists pursuing academia and industry careers, that affects attrition, turnover and workforce quality. At the same time, workforce turnover and fluctuations in company sizes make in-house training difficult or impossible. The net results for the life sciences industries are high turnover rates, cannibalization into stretch positions, theft of employees between competing companies, and less experienced people assuming senior positions.

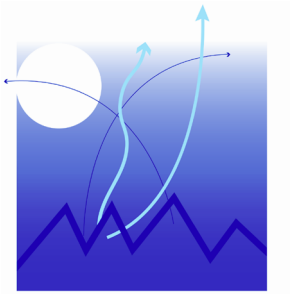
In response, the executives discussed plans by California companies to import talent from outside the state or even outside the U.S. However, searching the world for talent is very expensive for small and mid-sized companies, and some of the interviewed executives noted that it would be easier to retain people from outside the country who have been trained here. However, the cost of living, cultural differences and U.S. green card policies can present stiff barriers to this strategy.

In the worst case scenario, California life sciences companies could hire and expand outside the state and nation through relocation, outsourcing or offshoring. The executives noted that location does matter: there is value in proximity, in the ability for immediate contact and communication, in a stable information technologies (IT) environment, and in the desired ability to tightly control relationships, assets and infrastructure. The executives did underscore that relocation is a

greater concern than outsourcing. Outsourcing can stay local and even offshoring can at least keep core employment here. Relocation is a complete loss to the state. A substantial number of the executives warned that the rest of the nation and the world are trying to take California's place as the leader in the life sciences, and the state needs to take action.

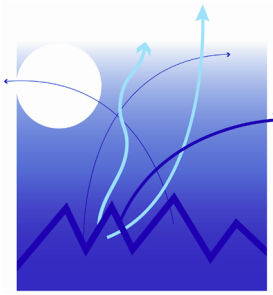
One of the major recommendations by the executives was a call for more excellent, committed and motivated math and science teachers, and a complete overhaul of the K–12 public education system, which many feel has already reached a crisis stage. There are far too many drop-outs due to popular ignorance of the importance and excitement of science, technology, engineering and math. The executives also called on universities to adapt more rapidly to changing workforce needs, to provide more information technology and computational training, and to accelerate advanced scientific and business training. Education in the life sciences needs to inform and be informed by macro trends in the life sciences industries.

Recent PhD Perspectives



For a better understanding of potential issues in supply and attrition among doctoral level scientists, BASIC commissioned interviews of ten recent PhDs. The results were consistent with the national trend data and with the perspectives of the senior executives. All of the new PhDs said that the strongest factor influencing their choice of a career in life sciences was a good experience in high school or undergraduate study. Although all were reasonably satisfied with their academic experience, they expressed great frustration with the average of eight years that was required to complete their respective doctoral programs. Only half of them felt that their educational training gave them the best chance to meet their immediate goals, and most complained that university career guidance was weak. Almost all of those interviewed articulated a desire to abandon the life sciences field, and nearly a third said they have already made specific plans to do so. This negativity appears to stem from what is seen as a lack of opportunity in academia. However, nine out of these ten new doctoral scientists lacked any clear career plan.

The new scientists did offer suggestions to improve the quality of the university experience with regard to preparation for a career in the life sciences. These suggestions included that universities streamline their doctoral programs in science to reduce the amount of time needed for completion; consider implementing a two-tier PhD system for people heading to industry versus academia and/or a "Masters of Science" type program; provide a broader range of career knowledge earlier on, and arrange more involvement of industry and provision of information about careers in industry; limit the number of people in life sciences programs to reduce competition for jobs; provide more rotation projects or internships; improve the system for addressing grievances caused by advisor-student power imbalances; and offer incentives rather than penalties for students doing industry internships.



View from National Laboratories and Universities

Because the national laboratories are the keystone of federally funded basic scientific research as well as employers in the life sciences, BASIC invited the four national laboratories in Northern California to provide input for this report. The response came primarily from the Lawrence Livermore National Laboratory (LLNL) whose involvement in the life sciences stems from its programs in bio-security and bio-defense. Again the response was consistent with those from other input sources, but LLNL's multidisciplinary activities afforded the ability to compare and contrast the life sciences with other fields. LLNL's comments suggested that researchers in the life sciences seem less able to cut across disciplines into chemistry and computational science than scientists from other disciplines. The feeling was that this limitation might be the result of pressures that are unique to the life sciences, such as the types of projects that life scientists work on and the narrow focus of PhD funding for the life sciences. In the life sciences, team skills also appear to be a secondary priority because of the traditional culture in which biologists, particularly at the PhD level, work in small teams, rather than the large teams often found in the physical sciences. There is a strong need in the life sciences, according to LLNL, for a greater emphasis on interdisciplinary skills.

California's research universities, as the primary suppliers of the state's life sciences workforce, hold a critical perspective on the future of that workforce. BASIC therefore sought the input of representatives from four University of California campuses—Berkeley, Davis, San Francisco and Santa Cruz—and one major private university—Stanford. This input had the dual purpose of clarifying current academic programs and practices for supplying talent in the life sciences and responding to the various criticisms voiced by the executives, doctoral students and respondents from the national laboratories.

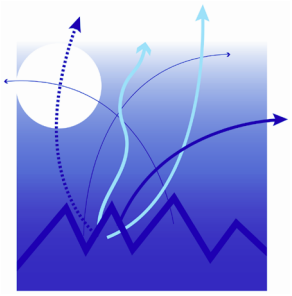
The university input underscored that there has been a great deal of attention to developing curricula and supporting programs to expand California's talent base in the life sciences. For example, three of the UC campuses—San Francisco, Berkeley and Santa Cruz—have collaborated with representatives from private industry to form the California Institute for Quantitative Biosciences (also known as QB3, a moniker derived from the venture's original name: the Center for Quantitative Biology, Biochemistry and Bioengineering). This effort intends to harness the quantitative sciences—math, physics, chemistry and engineering—to integrate the understanding of biological systems at all levels of complexity for the benefit of human health. In addition to the creation of fundamental new knowledge and potent new technologies, a major goal of QB3 is to train a new generation of students able to fully integrate the quantitative sciences with biomedical research. Stanford and UC Davis have intensive life sciences programs of their own, as do the individual member institutes of QB3.

Despite the academic and research richness available to drive innovation and competitiveness in the California life sciences workforce, the university respondents stressed the essential need for California and the rest of the nation to get organized and better compete with models in other countries. The German model for technology education, career placement and commercialization was specifically mentioned. There were also criticisms about the life sciences lacking the systematic planning that exists in other domains. A major challenge will be defining the workforce problem and need so as to develop a master plan and model to update academic programs and systematically link them to industry needs.

With regard to specialized applied training, there were arguments made that universities should be able to train excellent, well-rounded talent in fundamentals, and that such training should be able to meet employer needs without training for very specific, narrowly defined jobs. There was also concern about the challenge of meeting smaller company needs for specifically trained people. Part of these concerns evolved from the intellectual argument in favor of broader education, and part from industry's acknowledged uncertainty and short timeframes with regard to projecting hiring needs.

In commenting on the importance of undergraduate talent for meeting industry needs, university respondents spoke of a need for more dual-degree programs to enable a Bachelor of Science graduate to get a relevant job immediately out of a four-year program and subsequently consider postgraduate study after gaining work experience. The comparison was made with the financial industry in which students move immediately into a job upon graduation. On this basis, the job potential for an academic program could be a key criterion regarding its design.

BASIC Roundtable Forum



On May 15, 2008, BASIC held an executive roundtable discussion at the QB3 facility at UCSF Mission Bay. The roundtable participants included representatives from industry (most of whom had also been interviewed prior to the roundtable), universities, a national laboratory, a workforce development consultant, observers from the California Space Authority WIRED project and other WIRED partners. While the recommendations for four broad cross-cutting action items that emerged from the roundtable discussion are aimed specifically at California, they are also expected to be applicable to any state or geographic region seeking workforce improvements in the life sciences.

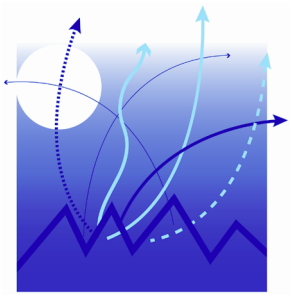
Under the recommendation to acquire a better understanding of pain points, the roundtable group called for a focused investigation to determine whether California has a fundamental worker supply problem (i.e., a lack of people entering relevant courses of study) or a capacity issue (i.e., an inability to graduate enough people with the right skills).

Under the recommendation to address acute areas of need, the group called for a number of actions including the development of an ongoing, institutionalized process amongst life sciences employers and educational institutions to specifically define just what are the areas of acute need. The group also called for the establishment of specialized technical training academies to supplement university and community college resources. Such academies would provide focused, rapidly developed and flexible coursework in very specific areas that address the needs of industry, and provide re-training for displaced workers. These academies would also arrange life sciences industry internships to address identified needs, and leverage trainers and employers to speak at universities or serve as adjunct lecturers. In addition, the group called for: a review of the existing Trade Adjustment Assistance and Department of Labor funding for possible financial support; the production of a Web-based information resource for life

sciences students, counselors, teachers and professors; and a coordinated effort with local policy organizations to lobby for a green card fast track program in the life sciences.

Under actions to address longer-term needs, the roundtable called for a gathering of the complete set of educational institutions—including representatives from secondary schools, technical training institutions, community colleges, undergraduate institutions, postgraduate universities and research institutions—to become involved in addressing industry-education-government coordination. There should also be an ongoing analysis of government spending, macro trends and other indicators to assess medium-term needs and develop a strategic plan to meet industry workforce and other needs.

Finally, under actions to increase interest in and support for science and science teaching, the roundtable group called for a coordinated public relations campaign—a collaborative effort by all sectors concerned about our nation's science future. This concept is exemplified by the Coalition on the Public Understanding of Science (COPUS), a grassroots national network of public and private organizations committed to increasing public understanding and appreciation of the critical contribution science makes to the world's quality of life. COPUS has declared 2009 as the Year of Science. It was the roundtable group's consensus that if the objectives of COPUS and similar science educational organizations were supported by all sectors, 2009 could signal the start of a new era for science in this country. BASIC is in a unique position to convene meetings of visionaries from the Bay Area's R&D industry, research universities and national laboratories with decision-makers at state and federal levels to develop a unified strategy for responding to the critical changes that are needed to ensure the future of the state and the nation's leadership in science and technology.



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