

# **CALIFORNIA'S BIOTECHNOLOGY WORKFORCE TRAINING NEEDS FOR THE 21<sup>st</sup> CENTURY**

## **Executive Summary**

**Prepared for**

**Applied Biological Technologies Initiative  
Economic and Workforce Development Program  
California Community Colleges**

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# **Biotechnology Workforce Training Needs in the 21<sup>st</sup> Century**

## **Executive Summary**

“The Applied Biological Technologies Initiative specifically serves the workforce needs of the biotechnology and biosciences community in California. The statewide and regional directors of the Applied Biological Technologies Initiative partner with local and regional industry professionals to design skill-based instruction for employers needs; provide employees for both established and start-up bioscience companies, including bioscience company incubators; work with legislative, governmental, and economic development agencies regarding the bioscience workforce; and partner with biotechnology industry organizations on workforce issues.”<sup>i</sup>

As used in this report, Biotechnology refers to the application of scientific advances in the life sciences to create commercial products and services. The biotechnology industry cluster includes all of the support services and manufacturers of various instruments, reagents and other products that support the research, testing, and manufacturing of biotechnology products. Bioindustry firms can be organized into eight categories based on their end markets: therapeutics, diagnostics, agricultural, bioremediation, bioenergy, materials including chemicals, bioindustry suppliers, and bioinformatics. Each sector is defined in the report.

This study forecasts the biotechnology industry’s workforce skills training requirements anticipated over the next five years to ten years. The forecast is based on two studies: first, a literature review of anticipated California and global technological and industry developments and of workforce surveys and of training needs identified in various studies; and second, on a Time Structures survey of future training needs of California biotechnology firms.

### **California Biotechnology Job Growth Means Many Training Opportunities**

Today, US biotechnology firms employ an estimated 146,000 to more than 187,000 workers, depending on the group doing the counting. By 2015, the industry may employ as many as 250,000 or more, particularly if the specialized research identified below increases. The job multiplier is about 1.9 for biotechnology, meaning that almost two additional jobs result from every biotechnology job created. US Dept of Labor projects that between 2002 and 2012, US employment in the Life Sciences will grow by 18 percent. Employment is predicted to grow by 19 percent for biological scientists, 19 percent for biological technicians, and 23 percent for workers in pharmaceutical and medicine manufacturing.

The top five occupations projected to grow in California by the Labor Market Information Division, California Employment Development Department, from 2000-2010 are: Bioinformatics Specialist (99%), Scientific Programmer Analyst (59%), Animal Technician (44%), Microbiologist (41%), and Assay Analyst (35%). A total of

43,600 technicians with at least AA degrees are projected to be needed in 2010, an increase of 17 percent over 2000. An additional 8,100 technician level positions could open up due to separations and internal promotions. These estimates may be conservative given other industry size estimates by independent groups such as the California Health Care Institute, and by Henry Madrid (a data analyst specialist examining trends).

Job opportunities requiring familiarity with biotechnology industry operations and processes will develop as companies expand and as the supplier and specialized service provider networks grow. These developments offer additional training opportunities for occupations like regulatory specialists, Intellectual Property attorneys, and clinical trials experts.

The report lists a large number of biotechnology industry and cluster related careers, including level of preparation required. Industry new hire skill preferences are identified. Examples of needed basic and intermediate occupational skills and of technical, laboratory, production, bioinformatics and other higher levels skills are provided. Suggestions are made for training management to better retrain skilled workers.

### **California Biotechnology Industry Growth and Global Competition**

Like all manufacturing today, biotechnology is global, involving extended research partnerships, specialized supplies chains, and logistics. Many other countries are developing highly competitive niche research or manufacturing capabilities. Countries in Europe (including but not limited to Great Britain, Ireland, Germany, Sweden, Denmark, and France), Japan, China, Russia, Eastern Europe, Cuba, India, Brazil, Malaysia, Thailand, Korea, Singapore, Israel, Bahrain, Dubai, South Africa, Canada, Australia and New Zealand have all established biotechnology clusters. The Asian biotechnology industry is growing rapidly. Global networks will compete with and link these activities to California.

While Biotechnology is growing in the US, it appears to be growing more slowly than in the past. The pharmaceutical portion of the industry may not show a profit until 2010 or 2012. On the other hand, the pace of patent applications and approval of California pharmaceuticals and medical devices has increased. At least 643 new drugs are in the pipeline of pre-clinical and clinical trials. The future issue is how many of the approved drugs will actually be manufactured in California.

Mixed signals on manufacturing were detected in the literature review compared to the industry survey. The California Health Care Institute found that "...in 2003, 66% of the surveyed companies grew their manufacturing capacity in California, while 81% expanded manufacturing outside the borders of the California. Over the next two years, 73% of the surveyed companies expect to grow their manufacturing within the state. However 88% anticipate expanding their manufacturing outside of the state."

## **Biotechnology: Converging Technologies are Creating new Opportunities**

A moment's consideration of the biotechnology definition and sectors provided above shows that a convergence of diverse technologies—life sciences, materials sciences like Nanotechnology/MEMS (micro-electronic mechanical systems), and information technology—is taking place. This convergence will produce a unique materials and productivity advantage<sup>1</sup> for California over the next ten to fifteen year. Biotechnology is one technology of a rapidly emerging *group* of technologies that are bringing together a number of previously separated science and production techniques in the state. From this broader perspective, life-science's biologically based engineering represents a collection of technologies that offer multiple life-sciences applications in essentially—by today's way of thinking—non-biologically based industries. This convergence will cause biotechnology workforce training programs to evolve with them.

### **California Biotechnology Company's Assessment of Future Technologies and Perceptions of Workforce Training Needs**

Time Structures interviewed sixteen biotech business executives and seven spokespersons from universities and industry associations. They were interviewed by telephone during Autumn 2005, to obtain their perspectives on biotech trends and training needs for the 21st century.

#### Fastest Moving Technologies

When asked to evaluate the rate of market development for 19 biotechnologies, the four following areas ranked as evolving the fastest: 1) fermentation, 2) bioprocessing, 3) biotransformation and 4) biomanufacturing. These market-related technologies are expected to experience significant change within the next one to three years.

Five other market related technologies are expected to undergo similar but slower spurts of growth: 1) advanced drug delivery systems, 2) drug design, 3) culture and manipulation of cells, stem cells, tissues and embryos, 4) diagnostic tests, and 5) nanotechnology.

One area – protein extraction, purification and separation technologies – was the most popular with business respondents. Significant market change – perhaps based on new product development – is expected within the next 1 to 5 years. Markets for the three areas of cell receptors, cell signaling and signaling pheromone technologies are expected to experience the same rate of growth.

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<sup>1</sup> The productivity of Advanced Manufacturing is examined in: Time Structures (2005). *Advanced Manufacturing Workforce Training for the 21<sup>st</sup> Century*. Applied Competitive Technologies, Economic and Workforce Development Program, Chancellors Office, California Community Colleges.

Market change for the three technologies for DNA (deoxyribonucleic acid) of DNA recombination, DNA sequencing and DNA amplification technologies may be slower due to their maturity as a technology.

Three other technologies were given mixed reviews on their ability to influence market change, partly because of maturity assessments and partly because of ambiguity about whether the question referred to research or application: peptide and protein sequencing and synthesis; microbiology, virology and microbial ecology; and combinatorial chemistry, 3D molecular modeling, and structural biology all may experience significant long-term change within one to ten years.

While the market may be hot for some of these technologies, public policy issues are viewed as obstructions because of regulatory issues and problems with coordinating different levels of government.

#### Technical Workforce Skill Needs

Because the industry is rapidly changing in technology and applications, training in the basics is a continuing need. The most requested "skills" are knowledge of biochemistry, molecular biology, cloning and cell culture. The second most requested skill has to do with the ability to perform basic research. Lab protocols and techniques are needed (such as aseptic techniques), and knowledge of instrumentation and data analysis. Most employers provide in-house training on procedures specific to their activities, but a foundation in practical laboratory procedures is necessary. More detail on skill occupational projections, skills, and business training needs are developed from other surveys and materials and are provided in the report.

#### **Continuing Global Biotechnology Specialization and Diversity will Challenge the Biotechnology Initiative to be Flexible and Agile**

Time Structures' survey identified the need to strengthen existing skills consistent with basic research and manufacturing requirements. Businesses have also identified significant new and evolving technologies that will affect market position. The broader look at industry provided by the literature review indicates that a number of new enabling technologies are on the horizon and are expected to grow in influence. These converging technologies—nanotechnology, information technology, MEMS, and advanced engineering/manufacturing technologies—will revolutionize existing industries and produce new sectors and jobs in the next five to fifteen years.

The difficulty is that it is unclear how well California is actually positioned to take advantage of these developments even though many of these technologies are already highly developed in the state. "First move advantage" could be achieved by other developed nations in Europe or East Asia. "Niche" competition from smaller nations could winnow away individual sectors. This suggests a strong need for the Applied Biological Technologies Initiative to monitor promising convergent technology sectors and to firmly reach out to emerging industry sectors.

## **Biotechnology Workforce Training Opportunities for California's Community Colleges**

California biotechnology businesses and association expressed a desire in the Time Structures survey to have the community colleges communicate and collaborate with them, to keep up with current trends through market and trend research, and to continuously update core programs. Many used the survey opportunity to give accolades to the community colleges, saying that the colleges should keep doing what they are already doing because it is being done well and meeting industry needs. Industry also is willing to serve as a resource for training both students and teachers by providing facilities. Many talked about developing internships. They expressed an interest in having trained students introduced to them. Some spoke to the issue of improving the community colleges' course content by strengthening practical lab experience. Interviewees also expressed interest in improving their business' customer service.

Time Structures research for the Biotechnology and other Economic and Workforce Development Programs indicates that it is important to resolve various Community College and system wide policy issues that limit Biotechnology's and other initiative's ability to hire instructors, to fund successful centers, and to disburse and/or integrate key programs amongst campuses. Specific options that could improve the Economic and Workforce Development Program's operations include the following suggestions: 1) complete the removal of the statutory sunset clause from the California Community College's Economic and Workforce Development Program's enabling legislation; 2) that the Economic and Workforce Development Program create or facilitate a strategy that will satisfy the Community College system, making possible the rapid hiring of qualified part-time and full-time instructors for the Centers by examining limitations imposed by the "25%/75%" rule on program growth; and 3) that the Economic and Workforce Development Program investigate a strategy and develop options for a plan to facilitate movement of mature programs onto campus throughout the system without losing their essential capacity to generate new curricula in response to changing industry and workforce needs.

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<sup>1</sup> [http://www.ccewd.net/services\\_detail.cfm?l=6](http://www.ccewd.net/services_detail.cfm?l=6)