

What is it?

Biotechnology refers to *the application of scientific advances in the life sciences* to create (1) commercial products and services using living organisms or their parts and (2) products to alter living or non-living materials.

Bioindustry firms (that is, firms in the biotechnology business) can be organized into nine categories based on their end markets:

- therapeutics,
- diagnostics,
- agricultural,
- bioremediation,
- energy,
- materials, including chemicals,
- bioindustry suppliers,
- nanobiotechnology, and
- bioinformatics.

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 not only change biotechnology but also produce a unique materials and productivity advantage for California over the next ten to fifteen years.

Which industries are likely to be affected?

The industries most likely to be affected by future developments in biotechnology are:

- pharmaceuticals,
- medical devices,
- agriculture, including by genetically modified food crops and of plants to produce paramedical, plastics, and energy related products,
- food processing,
- health care, and
- computing and other markets using new nano-biotechnology materials.

In 2005, the global biotechnology marketplace was an estimated \$126.3 billion and is forecast to reach \$226.1 billion by 2010.*

What products are on the market today or are expected to be in the near future?

Increasing costs associated with bringing new products to market can dampen growth. However, there was substantial industry growth in 2006. The success rate of newly developed medications that make it through clinical trials is only one in five. The time between a discovery and market can be as long as eight to ten years, and the process can cost up to \$800 million. However, the pace of patent applications, and approval of California pharmaceuticals and medical devices has increased. At least 643 new drugs are in the pipeline today.

Biotechnology has created more than 200 new therapies and vaccines, including products to treat cancer, diabetes, HIV/AIDS, and autoimmune disorders. Therapies under development include those for: heart disease, stroke, gall bladder disease, osteoarthritis, and sleep apnea. Six new technologies are likely to experience significant change within the next one to three years, resulting in the highest rate of product and market development. The top four are: (1) fermentation, (2) bioprocessing, (3) biotransformation and (4) biomanufacturing. These were followed by (5) energy and environment and (6) personalized medicine. These market-related technologies are expected to experience significant change within the next one to three years.

Six 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, (5) bionanotechnology, and (6) regenerative medicine.

Market change for DNA recombination, DNA sequencing, and DNA amplification technologies may be slower due to their maturity as a technology.

What is California's Competitive Position?

Europe, Canada, Australia, and the U.S. currently dominate biotechnology. While Europe in 2004 had more biotech companies, the U.S. employed nearly three times as many people, with revenues nearly six times that of the rest of the world. Research expenditures are nearly four times greater. The U.S. is the current biotechnology industry leader. California has the highest concentration of biotechnology companies.

According to the Milken Institute, the University of California system was issued 723 U.S. patents from 2000 to 2004, No. 1 among all universities.[†] MIT is the leader on

* Datamonitor as cited in: Texas Biotechnology Industry Report, March 2007 at: www.bidc.state.tx.us/Industry%20Reports/2007TXBioRpt.pdf.

[†] Milken Institute, Mind to Market: A Global Analysis of University Biotechnology Transfer and Commercialization, September 2006.

overall outcome measures. It is first in startups, averaging more than 23 new firms per year. The entire University of California system reported 20 startups.

California universities made up seven of the top global biotech rankings and four of the top ten. UC San Francisco is probably first in patent holdings.

The Milken Institute University Technology Transfer and Commercialization Index shows MIT first in licensing, startups, and related measures. The University of California system ranks second (led by UC San Francisco), with Caltech third, Stanford fourth, and Florida fifth.

Where are Biotechnology related companies located in the Innovation Corridor?

In 2006, California had about 2,700 biotechnology-industry-cluster companies employing 256,600 workers. Total estimated wages were \$18.2 billion.[‡] The following maps are produced by Biofind, www.biofind.com/Directory/Map.aspx. Information on individual companies can be obtained by going to the web site and clicking on a dot.

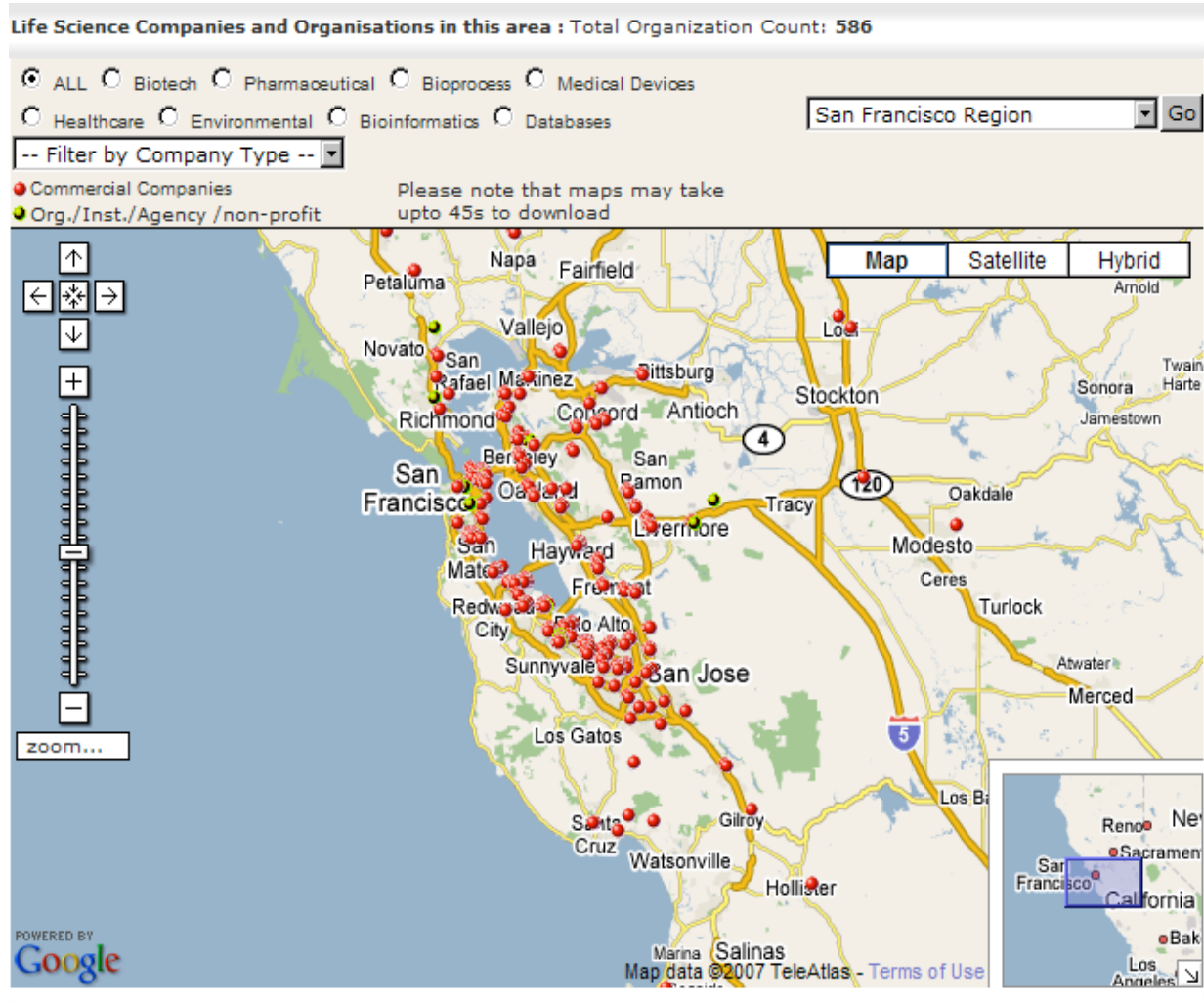
Where Companies and Jobs Are In The Innovation Corridor

Concentration of Biotechnology Companies and Jobs by California Region (2003)			
Region	Employment	Companies	Research Institutions
Bay Area	85,600	699	31
Sacramento	5,000	98	2
Ventura/Santa Barbara	12,000	131	
Los Angeles	47,500	322	22
Orange County	31,300	317	1
Inland Empire	7,300	82	1
San Diego	27,800	502	18

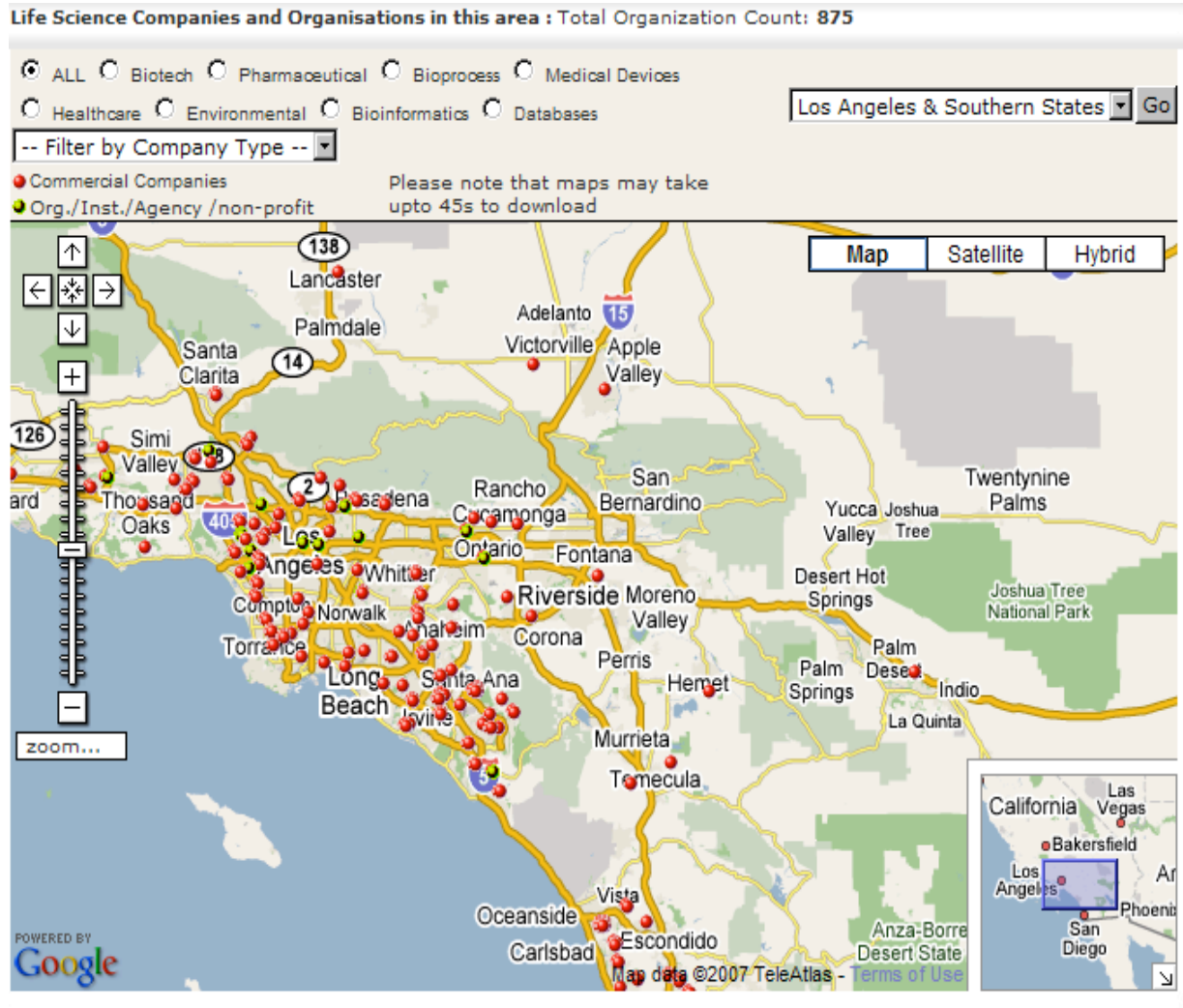
Source: California Trade and Commerce Agency, 2002.

[‡] California Health Care Institute (2006). California's Biomedical Industry 2006 Report.

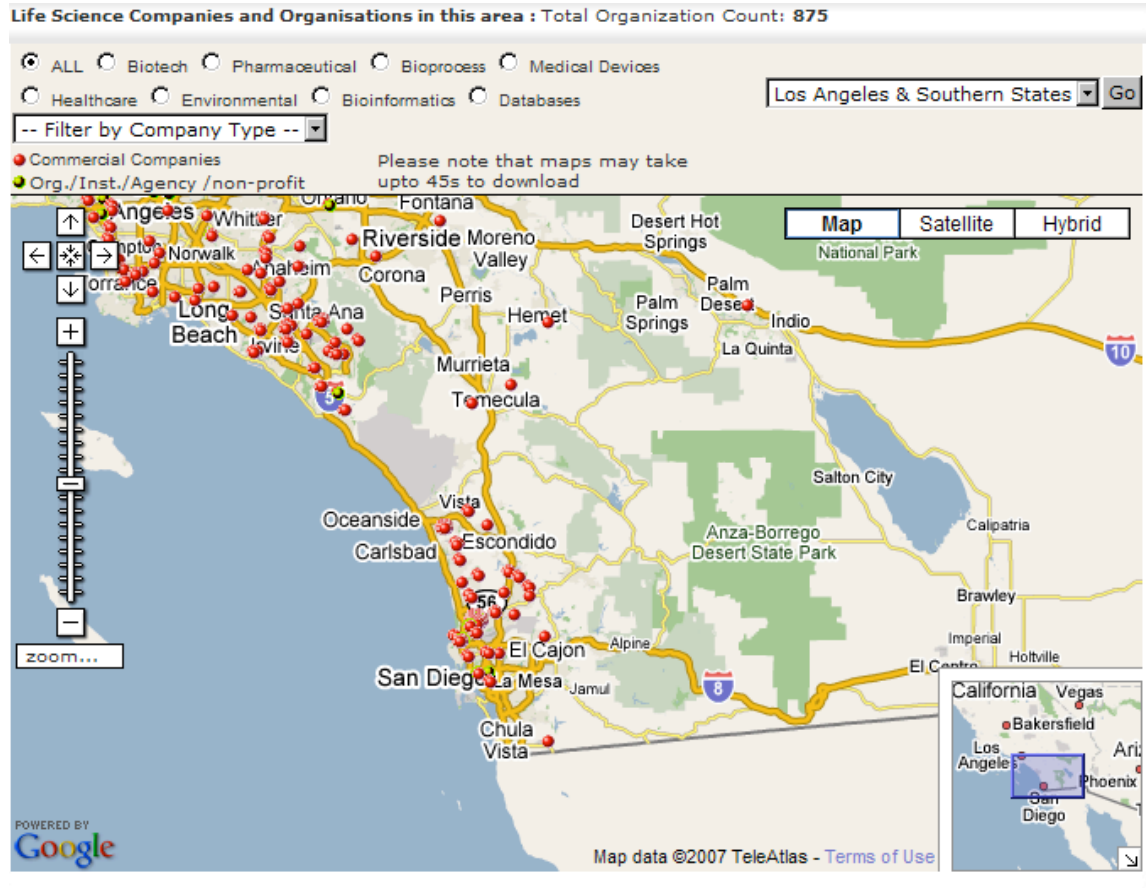
San Francisco and Santa Cruz Area



Los Angeles, San Bernardino, Riverside, and Santa Barbara Areas

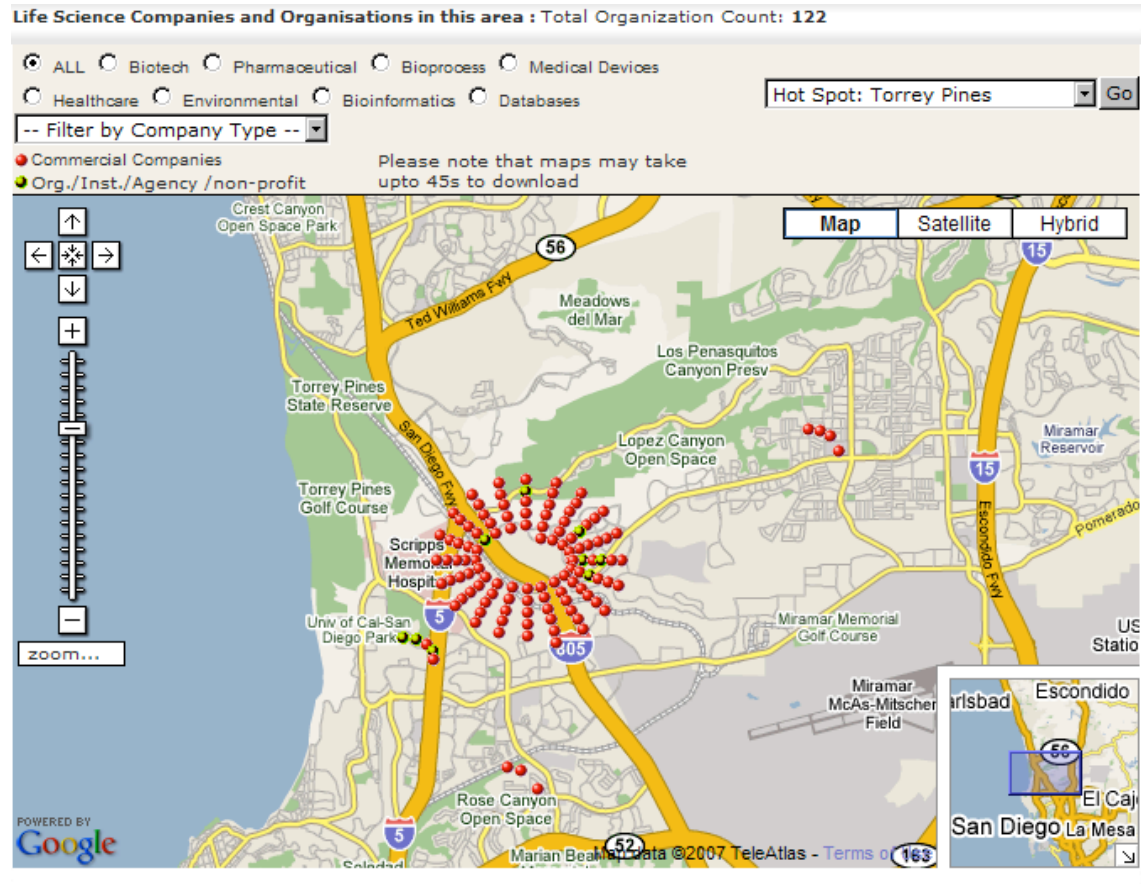


San Diego Area



LabhooMaps provide a 'real-time' representation of the Life Science sector.
Copyright Scanraid Ltd. 2007 - optimized for FireFox browser

San Diego Area (2)



LabhooMaps provide a 'real-time' representation of the Life Science sector.
 Copyright Scanraid Ltd. 2007 - optimized for FireFox browser

How many new jobs will be created or affected by the new technology?

Today, U.S. biotechnology firms employ between an estimated 146,000 to more than 187,000 workers. By 2015, the industry may employ as many as 250,000 or more, particularly if the specialized research identified below takes off. The job multiplier is about 1.9 for biotechnology, meaning that almost two additional jobs result from every biotechnology job created. The U.S. Department of Labor projects that between 2002 and 2012, U.S. 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 percent), Scientific Programmer Analyst (59 percent), Animal Technician (44 percent), Microbiologist (41 percent), and Assay Analyst (35 percent). 43,600 technicians with 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.

Our brief review of industry development suggests that new products will be coming on the market soon. The issue is, where will they be manufactured? If they are manufactured in California, this will create a need for technicians and others trained to manage production operations. Globalization, including research and production networks, continues. Agricultural biotechnology appears to be growing in some parts of the world that have less regulation compared to the U.S. or Europe. Generally, it appears that there will be steady growth, which will create additional research and manufacturing openings.

What skills will the new workforce require?

Time Structures surveyed biotechnology companies in 2006 to get their opinion on which technologies were likely to develop in the near future. These are identified in “Biotechnologies to Train to.” Most of these have projected market growth ranges of 1-5 years, with three technologies having a projected growth over ten years. Additional survey results are available from the EWDP program, California Community Colleges.

Biotechnologies to Train To		
Significant Technologies to Respondents Business (Time Structures Survey, 2006)		
Technology	Times Selected	Market Growth
1. Protein Extraction, Purification, and Separation	81%	1-5 yrs.
2. Fermentation, Bioprocessing, Biotransformation, and Biomanufacturing	75%	1-3 yrs.
3. DNA Recombination, DNA Sequencing, and DNA Amplification	69%	5-10 yrs.
4. Advanced Drug Delivery Systems	63%	1-3 yrs.
5. Peptide and Protein Sequencing and Synthesis	56%	1-10 yrs.
6. Drug Design	56%	1-3 yrs.
7. Culture and Manipulation of Cells, Stem Cells, Tissues and Embryos	56%	1-3 yrs.
8. Microbiology, Virology, and Microbial Ecology	50%	1-10 yrs.
9. Diagnostic Tests	50%	1-3 yrs.
10. Cell Receptors, Cell Signaling, Signaling Pheromones	44%	1-5 yrs.
11. Combinatorial Chemistry, 3D Molecular Modeling, and Structural Biology	44%	1-10 yrs.
12. Nanotechnology	44%	1-3 yrs.

Biotechnology Job Projections

Exhibit 5: Biotechnology Careers at a Glance

Occupation Clusters	Education	Growth 2000–2010 ¹	75th Percentile Hourly Wage ²
Research and Development Occupations			
Greenhouse Assistants*	High School	23%	\$16.95 to \$22.56
Laboratory Support Workers*	High School	-2%	\$8.43 to \$16.48
Laboratory Assistants*	Certification or Associate	28%	\$21.96 to \$22.56
Plant Breeders*	Bachelor's	22%	\$16.95 to \$34.49
Research Associates (R&D)*	Bachelor's	34%	\$28.28 to \$42.59
Research Scientists*	Doctorate	34%	\$28.28 to \$42.59
Clinical Research Occupations			
Animal Handlers	High School	34%	\$11.97
Animal Technicians	Certification or Associate	44%	\$11.94
Biostatisticians	Master's	13%	\$42.48
Bioinformatics Specialists*	Master's	99%	\$42.28 to \$50.04
Clinical Research Associates*	Bachelor's	28%	\$35.92 to \$39.24
Medical (Technical) Writers	Bachelor's	30%	\$38.03
Manufacturing Occupations			
Assay Analysts*	Certification or Associate	35%	\$21.96 to \$22.37
Biochemical Development Engineers	Bachelor's	21%	\$49.96
Instrumentation/Calibration Technicians*	Certification or Associate	3%	\$18.06 to \$29.44
Manufacturing Engineers	Bachelor's	6%	\$43.18
Manufacturing Research Associates*	Bachelor's	21%	\$33.91 to \$43.18
Manufacturing Technicians*	Certification or Associate	9%	\$11.02 to \$18.66
Process Development Associates*	Bachelor's	15%	\$34.20 to \$43.18
Process Development Engineers*	Bachelor's	8%	\$43.18 to \$49.96
Production Planner Schedulers*	Bachelor's	14%	\$22.74 to \$43.18
Regulatory Affairs Occupations			
Documentation Coordinators	High School	19%	\$15.52
Documentation Specialists	Bachelor's	34%	\$47.73
Quality Systems Occupations			
Microbiologist	Bachelor's	41%	\$33.91
Quality Assurance Auditors	Bachelor's	12%	\$29.96
Quality Control Analysts	Bachelor's	12%	\$29.96
Quality Control Engineers	Bachelor's	6%	\$43.18
Quality Control Inspectors	High School	-1%	\$18.06
Safety Specialists	Bachelor's	24%	\$33.16
Validation Technicians	Certification or Associate	-1%	\$18.06
Information Systems Occupations			
Library Assistants	High School	27%	\$16.18
Scientific Programmer Analysts	Bachelor's	59%	\$41.18
Marketing and Sales			
Customer Service Representatives	Bachelor's	34%	\$18.44
Graphic Designers	Bachelor's	29%	\$27.70
Sales Representatives	Bachelor's	14%	\$45.67
Technical Services Representatives	Bachelor's	23%	\$22.56

*Wages and employment reported for these occupations represent a sum of two or more Standard Occupational Classification (SOC) categories that together more fully describe the job within the biotechnology industry.

¹See individual occupation descriptions for details about estimated number of job opportunities.

²The 75th percentile wage means that 75 percent of workers earn less than the 75th percentile wage and 25 percent of workers earn more. A range of wages in the 75th percentile wage column represents the spread among all the SOC categories that represent the biotechnology occupation.

Source: EDD/LMD's *Employment Projections by Occupation 2000–2010* and *Occupational Employment Statistics Survey, 2004*.