

BIOTECHNOLOGY, MEDICAL DEVICES, & PHARMACEUTICAL MANUFACTURING IN CALIFORNIA



2010



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Economic and Workforce Development Program

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Introduction

California's educated workforce, renowned research institutions, and access to venture capital have positioned the state as the nation's leader in biotechnology. According to a national bioscience study released by Battelle Technology Partnership Practice in 2010, California saw more bioscience research and development, initiated more clinical trials, and awarded more bioscience postsecondary degrees than any other state. The study also ranked California first in for highest level of venture capital investments, with 38 percent of the nation's total. ¹

The purpose of this study is to assess and map the workforce and economic trends of the biotechnology sector for the 10 regions in California.² This information will be used by the California Community College's Centers for Applied Competitive Technologies (CACT) to determine how to best serve the industry. The CACTs offer technology education, manufacturing training, and consulting services that contribute to workforce and business development, and technology deployment. More information about the CACTs can be found in Appendix B.

This study provides data comparisons for the following regions:

Region²	Counties
Bay Area	Alameda, Contra Costa, Marin, Napa, San Francisco, Solano, Sonoma
Central Valley	Alpine, Amador, Calaveras, Fresno, Inyo, Kern, Kings, Madera, Mariposa, Merced, Mono, San Joaquin, Stanislaus, Tulare, Tuolumne
Far North	Butte, Colusa, Del Norte, Glenn, Humboldt, Lake, Lassen, Mendocino, Modoc, Plumas, Shasta, Sierra, Siskiyou, Tehama, Trinity
Greater Sacramento	El Dorado, Nevada, Placer, Sacramento, Sutter, Yolo, Yuba
Inland Empire	Inland Empire, Riverside, San Bernardino
Los Angeles	Los Angeles
Orange	Orange
San Diego & Imperial	Imperial, San Diego
Silicon Valley	Monterey, San Benito, San Mateo, Santa Clara, Santa Cruz
South Central	San Luis Obispo, Santa Barbara, Ventura

¹ Battelle/BIO, "State Bioscience Initiatives 2010."

² Regions are defined based on the California Community College Economic and Workforce Development (EWD) delineations.

Industry Overview

This section defines the biotechnology sector, analyzes and maps industry and employment trends, and provides industry projections.

Industry Composition

In its broadest definition, biotechnology is the application of science and technology to living organisms.³ For the purposes of this report, the biotechnology sector is defined as a collection of firms that use cellular and molecular processes to produce value-add products, ranging from pharmaceuticals, medical devices to environmental pesticides.⁴ The three major industry groups of the biotechnology sector include:

- Biotechnology – firms that are engaged in manufacturing ethyl alcohol, cellulosic and noncellulosic organic fibers, soap and other detergents, polish and other sanitation goods, surface active agents, firms that are engaged in research and development, as well as testing and medical laboratories.
- Medical Devices, Equipment and Supplies – firms that are engaged in manufacturing electromedical and electrotherapeutic apparatus, analytical laboratory instrument, irradiation apparatus, laboratory apparatus, surgical and medical instruments, and surgical appliances and supplies.
- Pharmaceuticals and Related Manufacturing – firms that are engaged in medicinal and botanical manufacturing, pharmaceutical preparation manufacturing, in-vitro diagnostic substance, and biological product manufacturing.

Appendix C provides the NAICS codes and industry descriptions for each major industry group in the biotechnology sector. As shown in Table 1, biotechnology is the largest industry group with about 3,400 establishments and 75,500 jobs, followed by medical devices, equipment and supplies with more than 1,240 businesses and about 58,200 jobs.

Table 1: Biotechnology Establishments and Jobs by Major Industry Group in California⁵

Industry Group	2009 Firms	% of Total Firms	2009 Jobs	% of Total Jobs
Biotechnology	3,374	65%	75,492	42%
Medical Devices, Equipment and Supplies	1,241	24%	58,194	33%
Pharmaceuticals and Related Manufacturing	555	11%	44,007	25%
Total	5,170	100%	177,693	100%

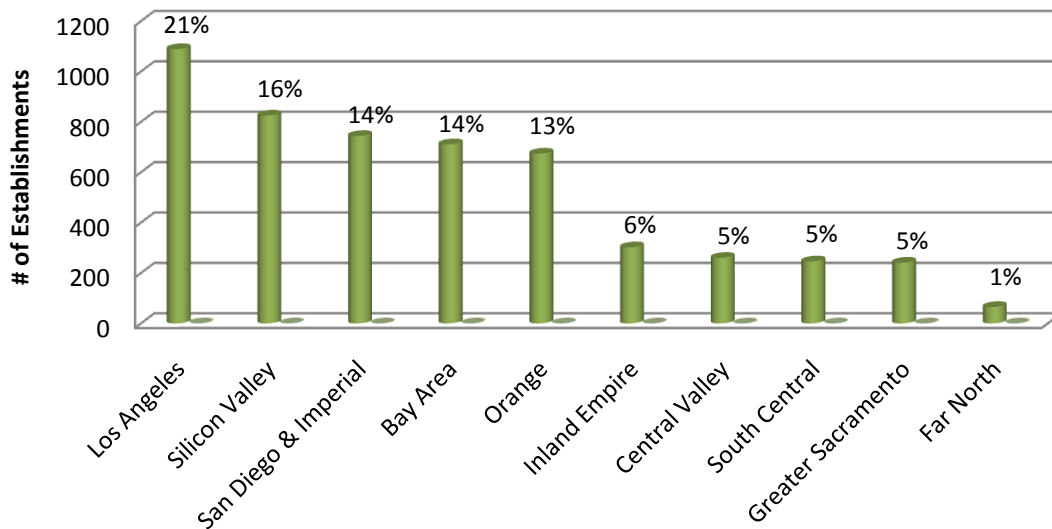
³ Organisation for Economic Co-operation and Development (OECD), www.oecd.org.

⁴ Public Policy Institute of California, "The Dynamics of California's Biotechnology Industry."

⁵ EMSI Complete Employment - 3rd Quarter 2010.

In 2009, there were about 5,170 biotechnology firms located in California, with the most pronounced concentration of firms in the following regions: Los Angeles County (1,085 firms; 21%), Silicon Valley (825; 16%), Bay Area (720 firms; 14%), San Diego & Imperial (720 firms; 14%), and Orange County (670 firms; 13%). More than 75 percent of the firms are located in the Bay/Silicon Valley and Southern California regions.

Exhibit 1: Biotechnology in California by Region⁶



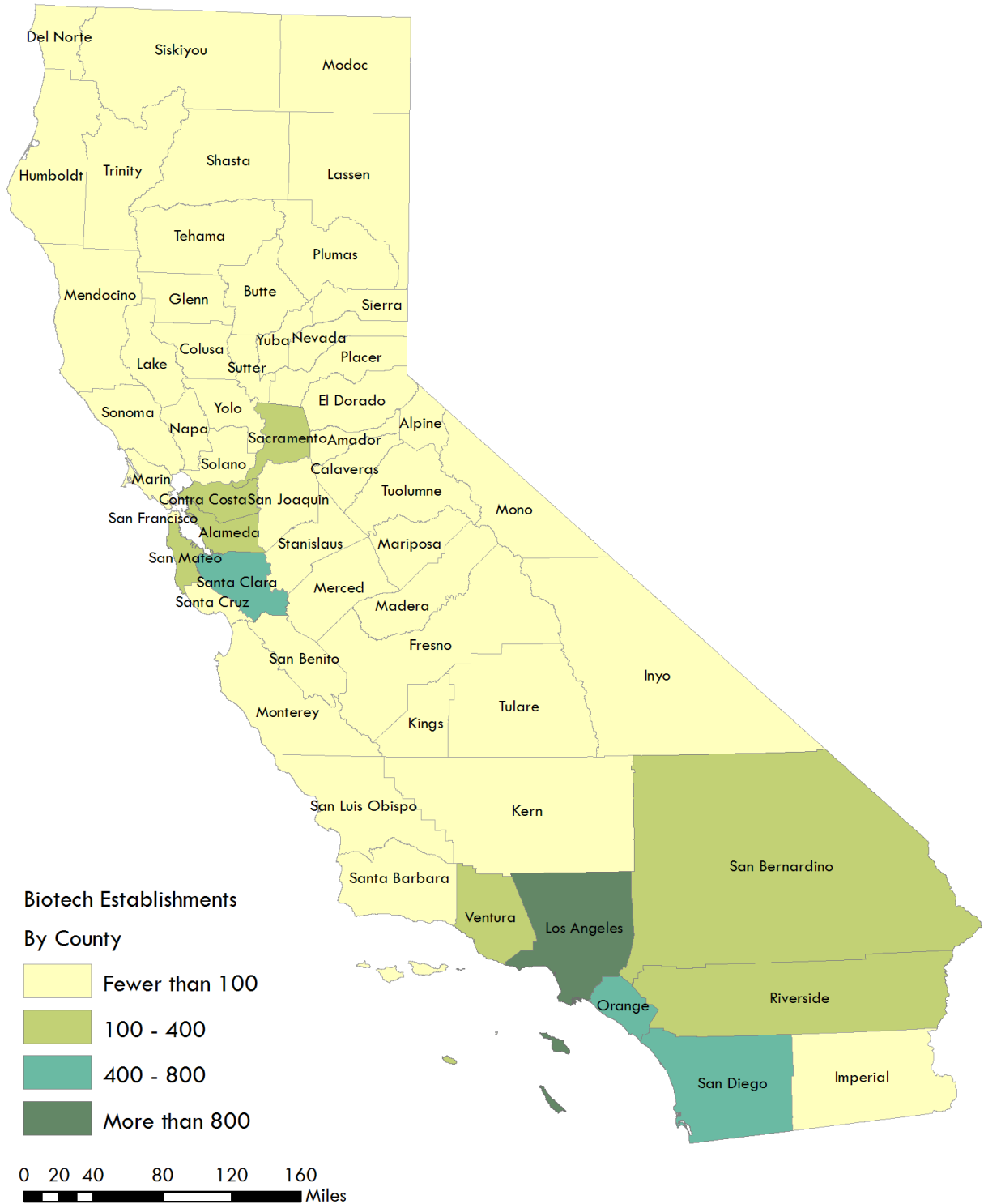
Map 1 displays the locations of biotechnology firms in California by county. As shown, there are 47 counties that have fewer than 100 firms, seven counties that have between 100 and 400 firms, and only four counties with more than 400 firms.

Map 2 displays the density of biotechnology firms in proximity to the CACT locations. As shown, five of the six CACTs are strategically in regions that have a high concentration of biotechnology employment. The Central Valley region has a low concentration of firms located near its CACT, which may make it challenging to serve biotechnology firms in that region.

Appendix D displays biotechnology employment by industry group in California. The majority of the employment in all three industry groups is clustered along the coastline in Southern and Northern California. Yet, there is some variation among counties.

⁶ EMSI Complete Employment - 3rd Quarter 2010.

Map 1: Biotechnology Establishments in California by County



Map 2: Biotechnology Establishments in California by Region



Employment Trends

Between 2004 and 2009, the biotechnology sector added 14,350 jobs statewide. As shown below, the economic recession has only slightly impacted the biotechnology sector as indicated by the small decline in 2009. Despite the economic turbulence, employment in the biotechnology sector has significantly outpaced California's overall economy. California employment grew by three percent during this time period, while the biotechnology sector posted a growth rate of close to nine percent.

As shown in Table 2, employment in the biotechnology sector increased in all regions in California, with the exception of the Far North and South Central regions. The region with the largest employment base, the San Diego & Imperial Region, added the most jobs (6,309) with a 29.6 percent growth rate, followed by Orange County, with 12.7 percent growth or 2,852 jobs.

Exhibit 2: Biotechnology Employment in California, 2004 – 2009⁷

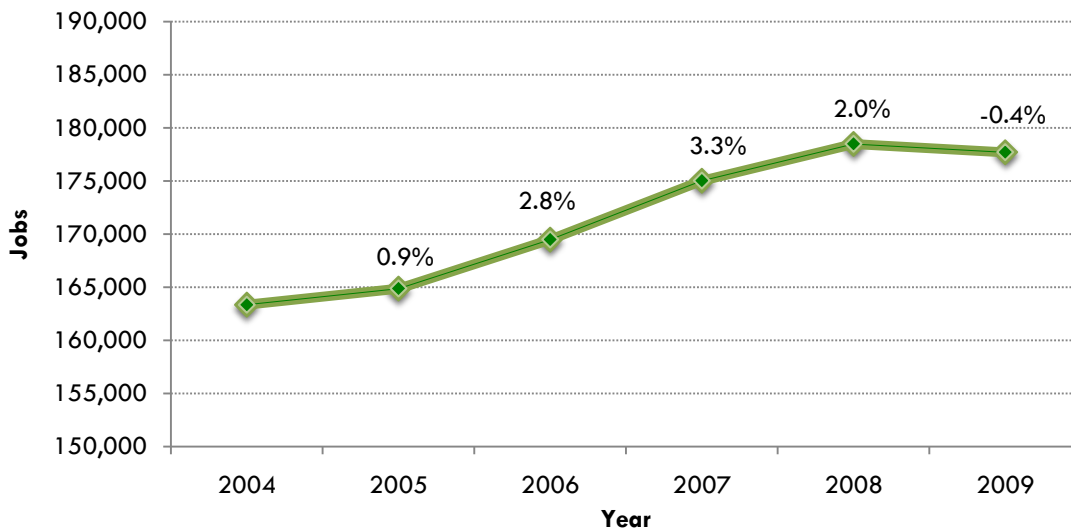


Table 2: Biotechnology Sector Employment by Region, 2004 - 2009⁷

Region	2004 Jobs	2009 Jobs	04-09 Job Change	% Change	2009 Jobs % of Total
San Diego & Imperial	21,303	27,612	6,309	29.6%	15.5%
Orange	22,482	25,334	2,852	12.7%	14.3%
Los Angeles	32,029	34,505	2,476	7.7%	19.4%
Inland Empire	8,254	9,468	1,214	14.7%	5.3%
Silicon Valley	35,608	36,494	886	2.5%	20.5%
Bay Area	22,923	23,614	691	3.0%	13.3%
Central Valley	3,523	4,184	661	18.8%	2.4%
Greater Sacramento	4,172	4,714	542	13.0%	2.7%
Far North	734	570	(164)	-22.3%	0.3%
South Central	12,331	11,213	(1,118)	-9.1%	6.3%
California	163,359	177,708	14,349	8.8%	100.0%

⁷ EMSI Complete Employment - 3rd Quarter 2010.

Revenue & Wages

As shown below, the biotechnology sectors generated over \$47 billion in sales in 2009. The Bay Area generated 27 percent of the total revenue, followed by Los Angeles and Silicon Valley with 19 and 18 percent respectively. The Silicon Valley region provided the highest earnings per worker (EPW) in 2009, while the Far North region reported the lowest EPW in that year.

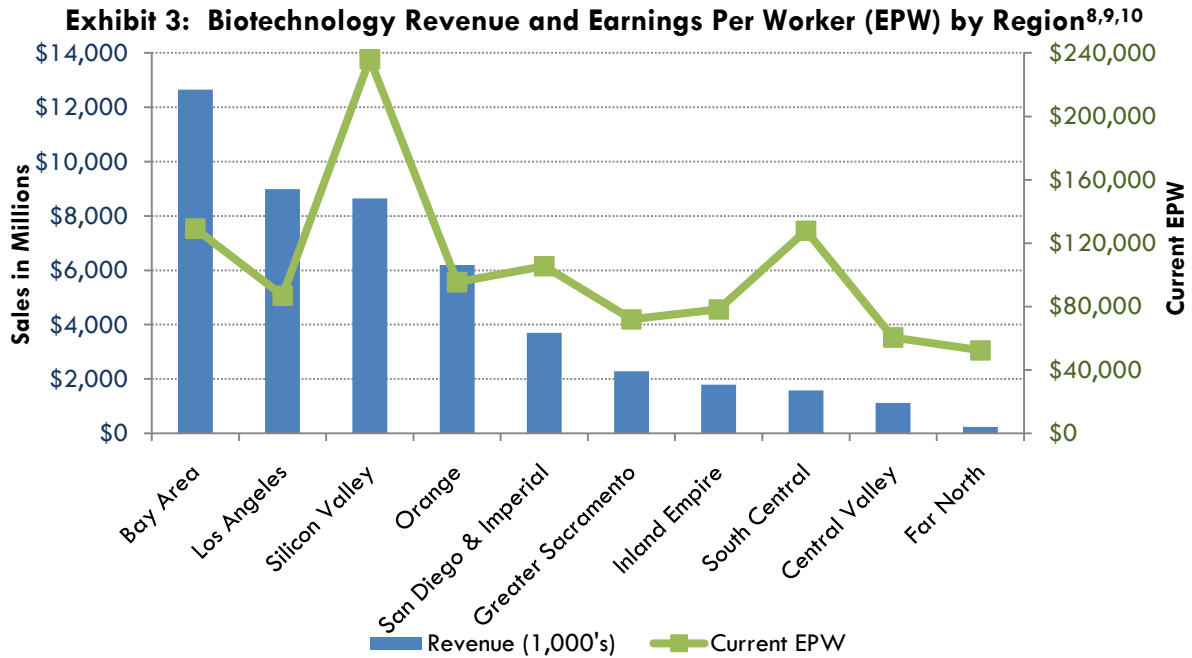


Table 3: Biotechnology Revenue and Earnings Per Worker (EPW) by Region^{9,10}

Region	Revenue (thousands)	Revenue % of Total	Current EPW
Bay Area	\$12,652,804	26.8%	\$129,116
Los Angeles	\$8,989,983	19.0%	\$86,841
Silicon Valley ¹¹	\$8,647,116	18.3%	\$236,073
Orange	\$6,200,719	13.1%	\$95,453
San Diego & Imperial	\$3,704,030	7.8%	\$105,455
Greater Sacramento	\$2,285,730	4.8%	\$71,952
Inland Empire	\$1,794,193	3.8%	\$78,170
South Central	\$1,575,389	3.3%	\$127,845
Central Valley	\$1,122,541	2.4%	\$60,474
Far North	\$235,283	0.5%	\$52,351
Total	\$47,207,788	100.0%	\$127,846

⁸ The earnings per worker includes wages, salaries, profits, bonus, benefits, and all other compensation.

⁹ EMSI Complete Employment - 3rd Quarter 2010.

¹⁰ InfoUSA Data, January 2009.

¹¹ The Earnings Per Worker in Silicon Valley is significantly influenced by the pharmaceutical industry (NAICS 3254115). The EPW for NAICS 3254115 is \$443,000, including all wages, salaries, proprietor earnings and supplements. When NAICS 3254115 is removed from the estimate, the EPW for the Silicon Valley drops from \$236,073 to \$148,358 per worker.

Map 3 displays the biotechnology sectors' revenue by region. This visual representation contrasts the revenue and average earnings among the Southern, Central and Northern California regions. As shown, coastal regions & high population areas generated the highest level of sales in 2009.

Map 3: Biotechnology Revenue in California by Region



Growth Projections

In the next five years, the biotechnology sector is expected to experience positive growth rates, gaining more than 18,500 jobs. As shown in Table 4, all 10 regions are expected to increase employment by 2014. The San Diego & Imperial and Silicon Valley regions are expected to experience the largest gain with the addition of 4,300 and 4,100 jobs respectively. The Far North Region is projected to have the smallest gain with approximately 30 jobs.

Exhibit 4: Biotechnology Sector Projected Employment in California, 2009-2014¹²

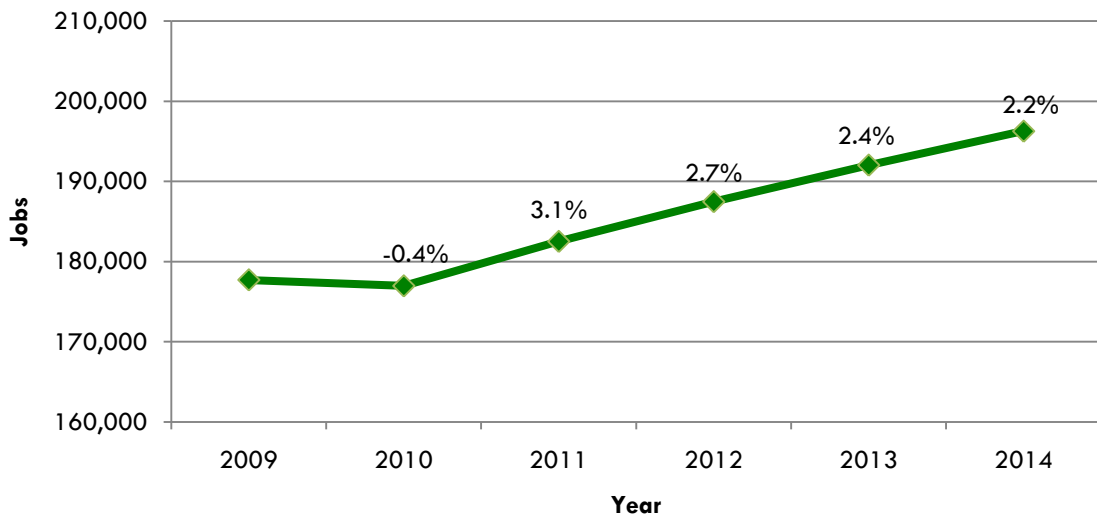


Table 4: Biotechnology Sector Projected Employment by Region, 2009 - 2014¹²

Region	2009 Jobs	2014 Jobs	Change	% Change
San Diego & Imperial	27,612	31,958	4,346	15.70%
Silicon Valley	36,494	40,598	4,104	11.20%
Bay Area	23,614	26,488	2,874	12.20%
Los Angeles	34,505	36,693	2,188	6.30%
Orange	25,334	27,506	2,172	8.60%
Inland Empire	9,468	10,654	1,186	12.50%
Greater Sacramento	4,714	5,394	680	14.40%
South Central	11,213	11,737	524	4.70%
Central Valley	4,184	4,648	464	11.10%
Far North	570	603	33	5.80%
California	177,708	196,279	18,571	10.5%

¹² EMSI Complete Employment - 3rd Quarter 2010.

Occupational Analysis

Table 5 displays the top 10 fastest-growing biotechnology occupations in California.¹³ Medical scientist is expected to have the most job openings in the next five years, followed by medical and clinical laboratory technicians, and biomedical engineers. The education level for five of the 10 occupations is short to long-term on-the-job training, two occupations require a doctoral degree, while another two require a bachelor's degree and one requires an associate degree. Appendix E provides occupational profiles, including tasks and skills requirements.

Table 5: Top 10 Fastest Growing Biotechnology Occupations in California^{14,15}

SOC Code	Description	2009 Jobs	2014 Jobs	Change	% Change	Median Hourly Wage ¹⁶	Education Level
19-1042	Medical scientists, except epidemiologists	6,927	8,445	1,518	22%	\$38.49	Doctoral degree
29-2012	Medical and clinical laboratory technicians	2,489	3,070	581	23%	\$19.29	Associate degree
17-2031	Biomedical engineers	1,379	1,955	576	42%	\$42.55	Bachelor's degree
51-2092	Team assemblers	4,740	5,301	561	12%	\$12.10	Moderate-term on-the-job training
29-2011	Medical and clinical laboratory technologists	2,072	2,575	503	24%	\$35.36	Bachelor's degree
19-1021	Biochemists and biophysicists	2,009	2,469	460	23%	\$39.64	Doctoral degree
31-9099	Healthcare support workers, all other	2,770	3,175	405	15%	\$16.17	Short-term on-the-job training
43-4051	Customer service representatives	2,524	2,879	355	14%	\$16.90	Moderate-term on-the-job training
51-9081	Dental laboratory technicians	2,307	2,644	337	15%	\$18.04	Long-term on-the-job training
51-9023	Mixing and blending machine setters, operators, and tenders	2,304	2,640	336	15%	\$14.87	Moderate-term on-the-job training

¹³ The selection criterion for the fastest growing occupations is based on absolute job growth from 2009 to 2014.

¹⁴ EMSI Complete Employment - 3rd Quarter 2010.

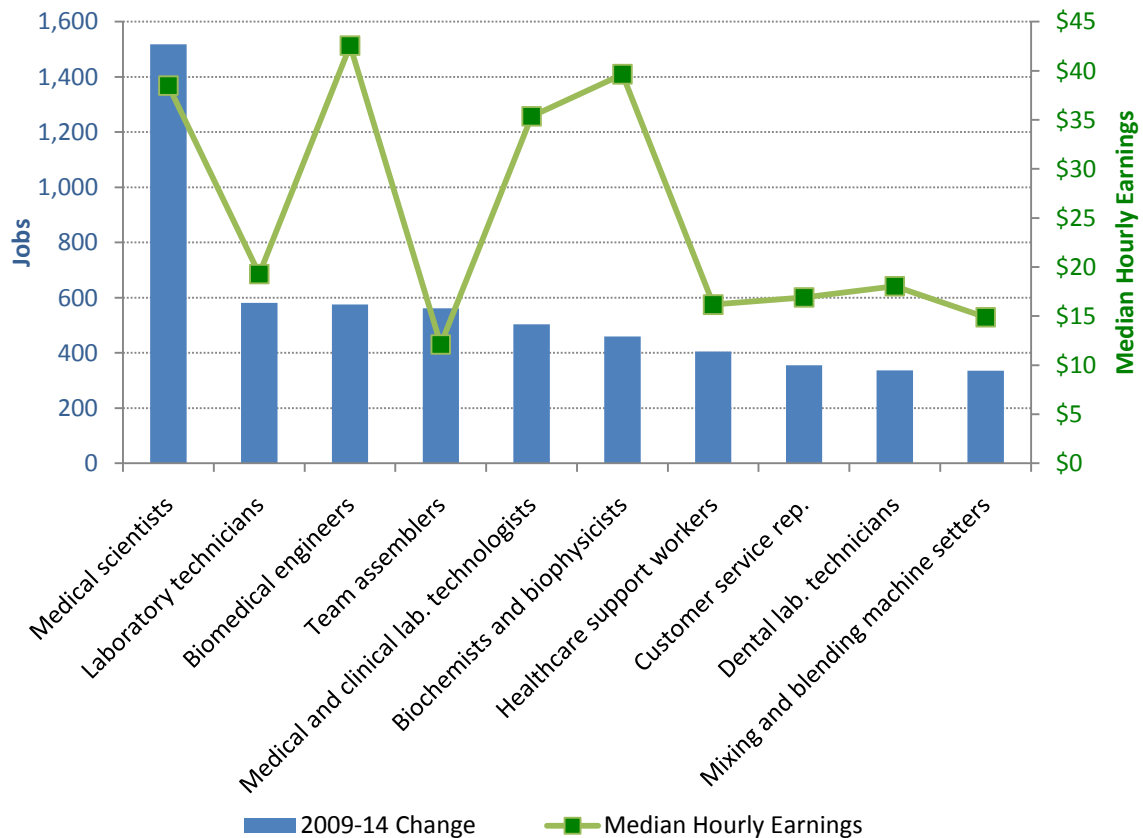
¹⁵ Occupation estimates represent current and projected employment in the biotechnology sector, not current and projected employment across all industries/sectors.

¹⁶ Median wages of a worker exclude benefits.

Exhibit 5 displays the projected job openings over the next five years and current hourly earnings for the top 10 biotechnology occupations in California. This exhibit illustrates the following:

- Medical scientist has the most projected job openings in the next five years and is the third highest paid position with hourly earnings at \$38 per hour or approximately \$79,040 annually.
- Biomedical engineer provides the highest median earnings of \$43 per hour or \$89,440 per year, and also has a high number of projected job openings.
- Medical and clinical laboratory technician has the second highest expected job openings but offers median wages slightly below the statewide average at \$19 per hour (\$39,520 annually).¹⁷

Exhibit 5: Job Openings & Current Hourly Earnings for the Top 10 Fastest Growing Biotechnology Occupations in California¹⁸



¹⁷ Average wages in California across all occupations is \$22.71 per hour.

¹⁸ EMSI Complete Employment - 3rd Quarter 2010.

Summary

The biotechnology sector is a significant economic driver in California's economy. In the next five years, this sector is expected to add more than 18,500 jobs, a 10.5 percent projected job growth rate. Biotechnology is growing considerably faster than California's overall economy, which is projected to grow by only 6 percent. Much of the biotechnology sector's projected expansion can be attributed to the following key factors.

- Educated and trained workforce. With world-class universities, hospitals, and research institutions, California continues to produce a well trained pool of scientists, doctors, technicians, and researchers whose talents are in demand by biotechnology companies. In fact, California has the highest number of higher education degrees in the biosciences in the nation.¹⁹
- Substantial flow of capital investments and funding. California's biotechnology sector received almost \$23 billion of investments between 2004 to 2009 making it the nation's leading destination for investors in the bioscience industry. In addition, California received the highest funding from the National Institute of Health with over \$3.8 billion in 2009.¹⁹ This extensive access to capital has driven the expansion of the biotechnology industry, which in turn creates demand for biotech workers.
- Pursuit of a healthier and better lifestyle. As the baby boomer generation ages, the demand for products that extend life and foster a healthier lifestyle continue to increase. Further, the search for cures, the development of more productive crops, and the creation of a more sustainable environment are driving biotechnology job growth in California.

¹⁹ Battelle/BIO, "State Bioscience Initiatives 2010."

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Appendix A: About the Centers of Excellence

The Centers of Excellence (COE), in partnership with business and industry, deliver regional workforce research customized for community college and workforce system decision making and resource development. The Northern California COE is one of five regional Centers of Excellence supported by the Chancellor's Office of the California Community Colleges and is tasked with conducting environmental scanning, partnership development and technical assistance activities.

The COE's research team represents expertise in labor market analysis, labor-management partnership projects, project management, and primary research. COE staff are experienced researchers with a focus on research design, partnership development, educational and training program mapping, and identifying skill sets for emerging occupations as well as key skill sets and geospatial analysis.

The COE maintains strategic alliances with research organizations whose relationships and technical expertise enhance COE's research efforts. These alliances enable COE to access information from over 80 public databases using EMSI economic modeling software, GIS technology via the use of a customized geo-mapping software that ties industry codes (NAICS) to a private business database of over 1 million business records. The COE maintains robust partnerships with industry associations that assist in validating research findings, ensuring that the most recent industry and labor market conditions are captured.

COE studies are used to inform policy discussions, industry-wide legislative efforts, and regional workforce development strategies, as well as guide program and resource development efforts by the California Community Colleges. These reports can be accessed at www.coecc.net.

Appendix B: About the Centers for Applied Competitive Technologies

The Centers for Applied Competitive Technologies (CACT) specialize in providing workforce training and technical consultation to help businesses solve operational, personnel, and technical problems in the manufacturing environment. The CACTs offer technology education, manufacturing training, and consulting services that contribute to continuous workforce development, technology deployment and business development. Services include:

- Customized workforce training in areas such as just-in-time production, distribution cycles, and six sigma deployment.
- Consulting services in areas such as organization assessment, quality system audits, process capability, and strategic planning.
- Technical services that provide an unbiased professional evaluation of your advanced technology processes.

The CACTS are funded primarily by the California Community College Economic and Workforce Development Program. These grant funds enable Centers to offer cost-effective workforce training and consultative services for California's advanced technology businesses. The program goal is to provide companies the technical expertise they need to compete successfully in changing markets and the global economy. The CACTs are conveniently located at community colleges across the state. In addition affiliate sites at other colleges are being established. To learn more about these Centers contact one of those listed below or visit www.makingitincalifornia.com.

CACT @ College of the Canyons

26455 Rockwell Canyon Rd.
Santa Clarita, CA 91355
(661) 362-3111

CACT @ De Anza College

Foothill-De Anza Community College District
Professional & Workforce Development
12345 El Monte Road
Los Altos Hills, CA 94022
(650) 949-7795

CACT @ El Camino College

13430 Hawthorne Blvd.
Hawthorne, CA 90250
(310) 973-3170

CACT @ San Diego City College

1414 Park Blvd., Room T-216
San Diego, CA 92101-8747
(619) 388-3730

CACT @ College of the Sequoias

915 S. Mooney Blvd.
Visalia, CA 93277
(559) 737-4838

CACT @ Sierra College

Roseville Gateway Center
5000 Rocklin Rd.
Rocklin, CA 95677
(916) 781-6288

Appendix C: Biotechnology Sector, Major Industry Groups

Biotechnology

325193 Ethyl alcohol manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing nonpotable ethyl alcohol.

325199 All other basic organic chemical manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing basic organic chemical products (except aromatic petrochemicals, industrial gases, synthetic organic dyes and pigments, gum and wood chemicals, cyclic crudes and intermediates, and ethyl alcohol).

325221 Cellulosic organic fiber manufacturing

This U.S. industry comprises establishments primarily engaged in (1) manufacturing cellulosic (i.e., rayon and acetate) fibers and filaments in the form of monofilament, filament yarn, staple, or tow or (2) manufacturing and texturizing cellulosic fibers and filaments.

325222 Noncellulosic organic fiber manufacturing

This U.S. industry consists of establishments primarily engaged in (1) manufacturing noncellulosic (i.e., nylon, polyolefin, and polyester) fibers and filaments in the form of monofilament, filament yarn, staple, or tow, or (2) manufacturing and texturizing noncellulosic fibers and filaments.

325611 Soap and other detergent manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing and packaging soaps and other detergents, such as laundry detergents; dishwashing detergents; toothpaste gels, and tooth powders; and natural glycerin.

325612 Polish and other sanitation good manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing and packaging polishes and specialty cleaning preparations.

325613 Surface active agent manufacturing

This U.S. industry comprises establishments primarily engaged in (1) manufacturing bulk surface active agents for use as wetting agents, emulsifiers, and penetrants, and/or (2) manufacturing textiles and leather finishing agents used to reduce tension or speed the drying process.

541711 Research and Development in Biotechnology

This U.S. industry comprises establishments primarily engaged in conducting biotechnology research and experimental development. Biotechnology research and experimental development involves the study of the use of microorganisms and cellular and biomolecular processes to develop or alter living or non-living materials. This research and development in biotechnology may result in development of new biotechnology processes or in prototypes of new or genetically-altered products that may be reproduced, utilized, or implemented by various industries.

541380 Testing Laboratories

This industry comprises establishments primarily engaged in performing physical, chemical, and other analytical testing services, such as acoustics or vibration testing, assaying, biological testing (except medical and veterinary), calibration testing, electrical and electronic testing, geotechnical testing, mechanical testing, nondestructive testing, or thermal testing. The testing may occur in a laboratory or on-site.

621511 Medical Laboratories

This U.S. industry comprises establishments known as medical laboratories primarily engaged in providing analytic or diagnostic services, including body fluid analysis, generally to the medical profession or to the patient on referral from a health practitioner.

Medical Devices, Equipment and Supplies

334510 Electromedical and Electrotherapeutic Apparatus Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing electromedical and electrotherapeutic apparatus, such as magnetic resonance imaging equipment, medical ultrasound equipment, pacemakers, hearing aids, electrocardiographs, and electromedical endoscopic equipment.

334516 Analytical Laboratory Instrument Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing instruments and instrumentation systems for laboratory analysis of the chemical or physical composition or concentration of samples of solid, fluid, gaseous, or composite material.

334517 Irradiation Apparatus Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing irradiation apparatus and tubes for applications, such as medical diagnostic, medical therapeutic, industrial, research and scientific evaluation. Irradiation can take the form of beta-rays, gamma-rays, X-rays, or other ionizing radiation.

339111 Laboratory Apparatus and Furniture Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing laboratory apparatus and laboratory and hospital furniture (except dental). Examples of products made by these establishments are hospital beds, operating room tables, laboratory balances and scales, furnaces, ovens, centrifuges, cabinets, cases, benches, tables, and stools.

339112 Surgical and Medical Instrument Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing medical, surgical, ophthalmic, and veterinary instruments and apparatus (except electrotherapeutic, electromedical and irradiation apparatus). Examples of products made by these establishments are syringes, hypodermic needles, anesthesia apparatus, blood transfusion equipment, catheters, surgical clamps, and medical thermometers.

339113 Surgical Appliance and Supplies Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing surgical appliances and supplies. Examples of products made by these establishments are orthopedic devices, prosthetic appliances, surgical dressings, crutches, surgical sutures, personal industrial safety devices (except protective eyewear), hospital beds, and operating room tables.

Pharmaceuticals and Related Manufacturing

325411 Medicinal and Botanical Manufacturing

This U.S. industry comprises establishments primarily engaged in (1) manufacturing uncompounded medicinal chemicals and their derivatives (i.e., generally for use by pharmaceutical preparation manufacturers) and/or (2) grading, grinding, and milling uncompounded botanicals.

325412 Pharmaceutical Preparation Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing in-vivo diagnostic substances and pharmaceutical preparations (except biological) intended for internal and external consumption in dose forms, such as ampoules, tablets, capsules, vials, ointments, powders, solutions, and suspensions.

325413 In-Vitro Diagnostic Substance Manufacturing

This U.S. industry comprises establishments primarily engaged in manufacturing in-vitro (i.e., not taken internally) diagnostic substances, such as chemical, biological, or radioactive substances. The substances are used for diagnostic tests that are performed in test tubes, petri dishes, machines, and other diagnostic test-type devices.

325414 Biological Product (except Diagnostic) Manufacturing

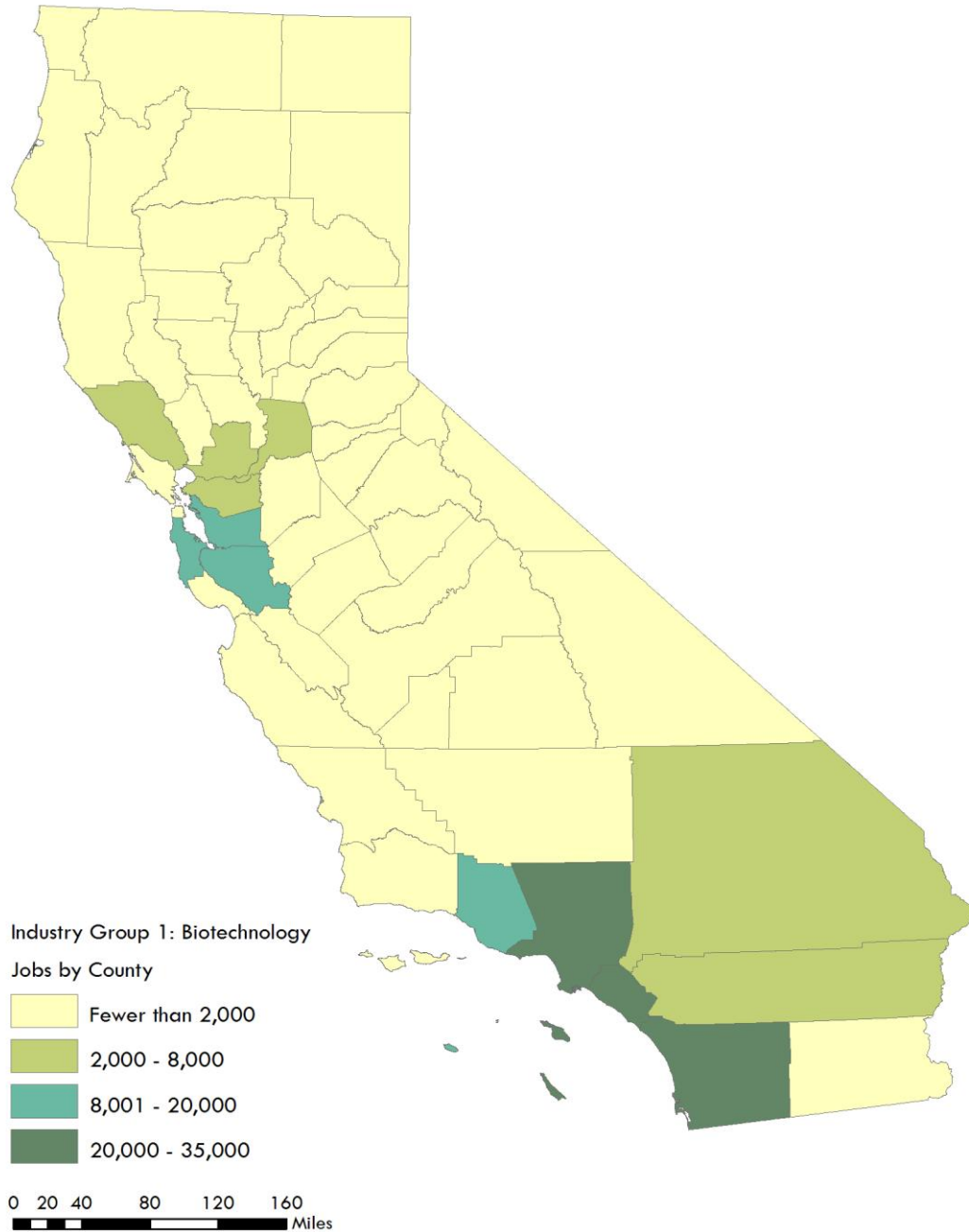
This U.S. industry comprises establishments primarily engaged in manufacturing vaccines, toxoids, blood fractions, and culture media of plant or animal origin (except diagnostic).

Source: U.S. Census Bureau, North American Industry Classification System (NAICS), <http://www.census.gov/eos/www/naics/index.html>.

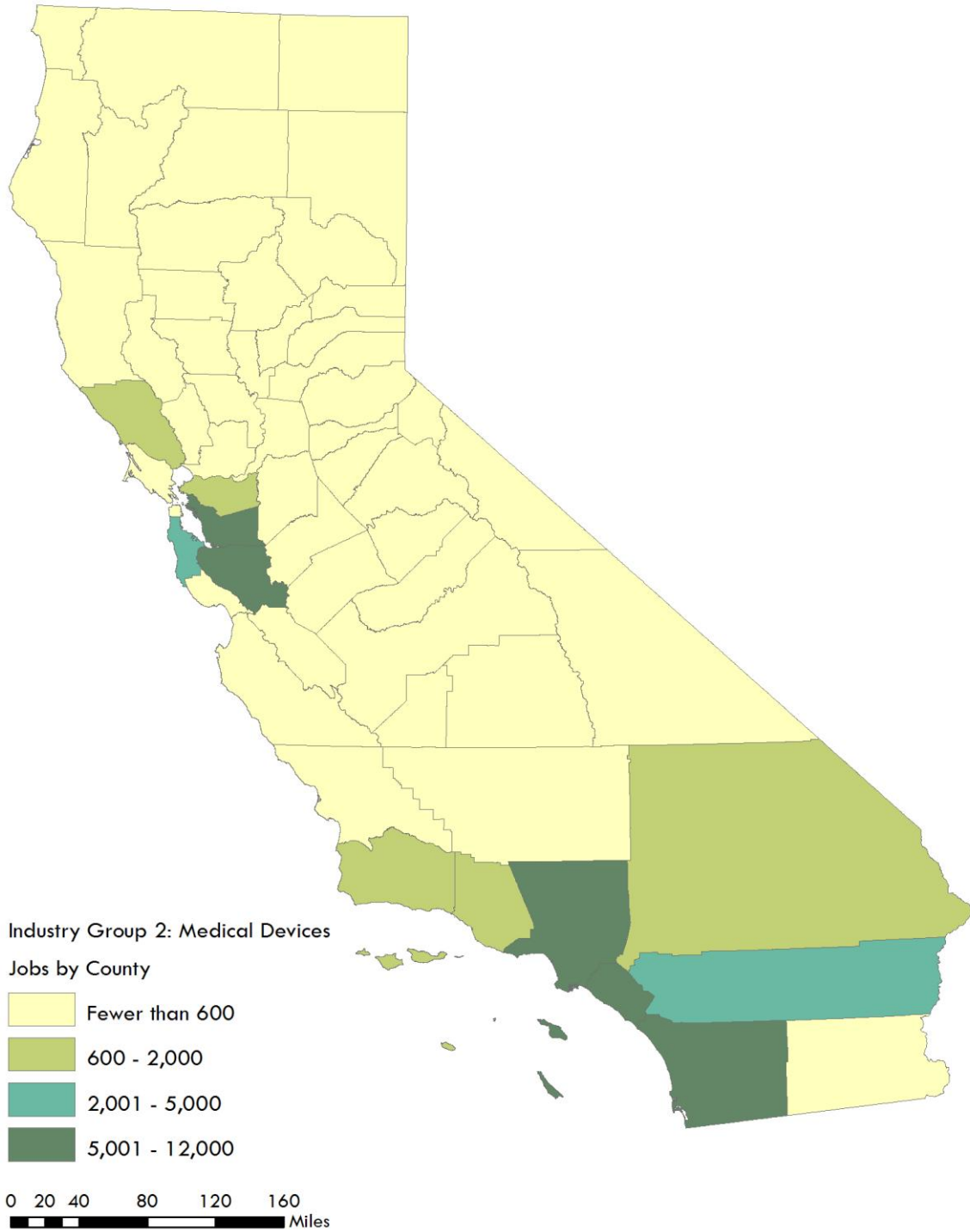
Appendix D: Biotechnology Jobs by Industry Group in California

The following three maps display the biotechnology employment by industry group in California. As shown, there is some variation among counties. For example, there is a higher clustering of pharmaceutical employment in the northern counties compared to medical device manufacturing in the same region.

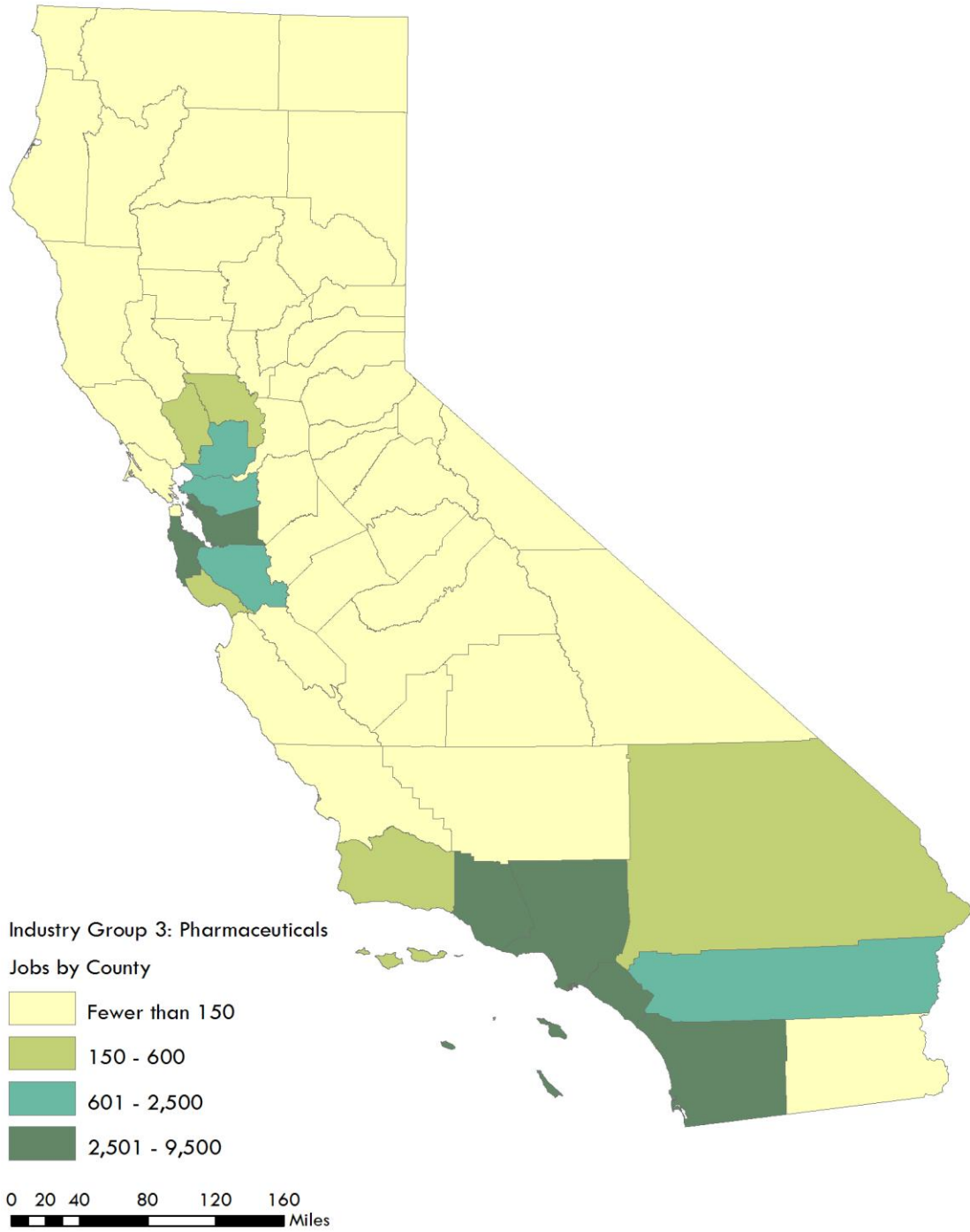
Map D1: Biotechnology Employment



Map D2: Medical Devices, Equipment and Supplies Employment



Map D3: Pharmaceuticals and Related Manufacturing Employment



Appendix E: Occupation Profiles

The following nine occupations are projected to increase employment by 2014. Each occupation profile includes a description of the main tasks performed and top skills.

Biochemists and Biophysicists – SOC 19-1021

Biochemists and biophysicists study the chemical composition and physical principles of living cells and organisms, their electrical and mechanical energy, and related phenomena. They may conduct research to further understanding of the complex chemical combinations and reactions involved in metabolism, reproduction, growth, and heredity. Moreover, they may determine the effects of foods, drugs, serums, hormones, and other substances on tissues and vital processes of living organisms. The top skills of biochemists and biophysicists include:

- Ability to use logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Ability to enter, transcribe, record, store, or maintain information in written or electronic/magnetic form.
- Ability to identify the underlying principles, reasons, or facts of information by breaking down information or data into separate parts.
- Ability to compile, code, categorize, calculate, tabulate, audit, or verify information or data.

Biomedical Engineers – SOC 17-2031

Biomedical engineers apply knowledge of engineering, biology, and biomechanical principles to the design, development, and evaluation of biological and health systems and products, such as artificial organs, prostheses, instrumentation, medical information systems, and health management and care delivery systems. Their top skills include:

- Ability to use logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Ability to choose the right mathematical methods or formulas to solve a problem.
- Ability to identify the underlying principles, reasons, or facts of information by breaking down information or data into separate parts.
- Ability to use computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.

Customer Service Representatives – SOC 43-4051

Customer service representatives interact with customers to provide information in response to inquiries about products and services and to handle and resolve complaints. Their top skills include:

- Ability to use computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.
- Ability to listen to and understand information and ideas presented through spoken words and sentences.
- Ability to observe, receive, and otherwise obtain information from all relevant sources.
- Ability to compile, code, categorize, calculate, tabulate, audit, or verify information or data.

Dental Laboratory Technicians – SOC 51-9081

Dental laboratory technicians construct and repair full or partial dentures or dental appliances. Their top skills include:

- Ability to conduct tests and inspections of products, services, or processes to evaluate quality or performance.
- Ability to watch gauges, dials, or other indicators to make sure a machine is working properly.
- Ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
- Ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions.

Medical and Clinical Laboratory Technicians – SOC 29-2012

Medical and clinical laboratory technicians perform routine medical laboratory tests for the diagnosis, treatment, and prevention of disease. Their top skills include:

- Ability to watch gauges, dials, or other indicators to make sure a machine is working properly.
- Ability to monitor and assess performance of yourself, other individuals, or organizations to make improvements or take corrective action.
- Ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
- Ability to ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position.

Medical and Clinical Laboratory Technologists – SOC 29-2011

Medical and clinical laboratory technologists Perform complex medical laboratory tests for diagnosis, treatment, and prevention of disease. May train or supervise staff. Their top skills include:

- Ability to monitor and assess performance of yourself, other individuals, or organizations to make improvements or take corrective action.
- Ability to conduct tests and inspections of products, services, or processes to evaluate quality or performance.
- Ability to use computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.
- Ability to enter, transcribe, record, store, or maintain information in written or electronic/magnetic form.

Medical Scientists – SOC 19-1042

Medical scientists conduct research dealing with the understanding of human diseases and the improvement of human health. They also engage in clinical investigation or other research, production, technical writing, or related activities. Their top skills include:

- Ability to identify complex problems and reviewing related information to develop and evaluate options and implement solutions.
- Ability to Ability to compile, code, categorize, calculate, tabulate, audit, or verify information or data.

- Ability to use computers and computer systems (including hardware and software) to program, write software, set up functions, enter data, or process information.
- Ability to enter, transcribe, record, store, or maintain information in written or electronic/magnetic form.

Mixing and Blending Machine Setters, Operators, and Tenders – SOC 51-9023

Mixing and blending machine setters, operators, and tenders set up, operate, or tend machines to mix or blend materials, such as chemicals, tobacco, liquids, color pigments, or explosive ingredients. Their top skills include:

- Ability to watch gauges, dials, or other indicators to make sure a machine is working properly.
- Ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.
- Ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
- Ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position.

Team Assemblers – SOC 51-2092

Team members work as part of a team having responsibility for assembling an entire product or component of a product. Team assemblers can perform all tasks conducted by the team in the assembly process and rotate through all or most of them rather than being assigned to a specific task on a permanent basis. Their top skills include:

- Ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position.
- Ability to quickly move your hand, your hand together with your arm, or your two hands to grasp, manipulate, or assemble objects.
- Ability to make precisely coordinated movements of the fingers of one or both hands to grasp, manipulate, or assemble very small objects.
- Ability to keep your hand and arm steady while moving your arm or while holding your arm and hand in one position.

Source: O*Net; U.S. Bureau of Labor Statistics

Note: Profile for Healthcare Support Workers, all other – SOC 31-9099 was not included because it represent a group of more specific occupations, rather than a single occupation.

Appendix F: Locating Biotechnology Related Degree & Certificate Programs

The California Community Colleges offer a range of instructional programs that support the biotechnology sector. To locate the programs use the Taxonomy of Programs (TOP) list below with the searchable data base found on the California Community College Chancellor's Office website. The URL is: https://misweb.cccco.edu/webproginv/prod/topodelist_n.cfm. Using these codes you can find which colleges have programs. For example if one puts in TOP code 0430.00 (Biotechnology and Biomedical Technology), eighteen colleges offering related programs will be identified.

While not every program found will be oriented to biotechnology manufacturing, the following TOP codes are those most closely associated with it:

- 0101.00 Agriculture Technology and Sciences, General
- 0401.00 Biology, General
- 0403.00 Microbiology
- 0430.00 Biotechnology and Biomedical Technology
- 0934.60 Biomedical Instrumentation
- 0934.70 Electron Microscopy
- 0943.00 Instrumentation Technology
- 0945.00 Industrial Systems Technology and Maintenance
- 0956.00 Manufacturing and Industrial Technology
- 0956.80 Industrial Quality Control
- 1212.00 Electro-Neurodiagnostic Technology
- 1905.00 Chemistry, General
- 4902.00 Biological and Physical Sciences (and Mathematics)

Source: California Community Colleges Chancellor's Office, Inventory of Approved Programs, October 2010