

Biotechnology in California

Labor Market Information Division

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INTRODUCTION

Biotechnology in California

How would you like to run your car on oil leftover from making french fries? How about discovering new drugs that can combat cancer? What if you could create crops that survive and even thrive with very little water in places where droughts are persistent? You can do all of this and more using biotechnology!

What are biotechnology occupations and why are they vital to California's economy? These are jobs that play a role in the effort to develop and implement innovative technologies that transform California's economic and scientific growth. The broader goal of this changing industry is to apply science and technology to make products, provide services, and improve processes that can enhance human lives and better our world.

Depending on the type of biotechnology product or research conducted, biotechnology workers are found within many industries. These include:

- Pharmaceutical and Medicine Manufacturing
- Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
- Medical Equipment and Supplies Manufacturing
- Professional and Commercial Equipment and Supplies Merchant Wholesalers
- Chemical and Allied Products Merchant Wholesalers' Management
- Scientific and Technical Consulting Services
- Scientific Research and Development Services
- Postsecondary Colleges, Universities, and Schools
- Medical and Diagnostic Laboratories
- Federal, State, and Local Government

What is Biotechnology?

Mention biotechnology and many people think of the latest pharmaceutical drugs being developed to treat illnesses. However, biotechnology encompasses a much wider range of products and processes. From drugs and medical devices to biofuels and agricultural products, biotechnology applies to almost every facet of our daily life. Biotechnology can be defined simply as “the application of science and technology to living organisms.”¹ As a cutting edge field, biotechnology has enabled us to make discoveries toward curing diseases, saving lives, feeding the world, finding alternative energy sources, developing green manufacturing technology, and much more.

¹ “Statistical Definition of Biotechnology,” Organisation for Economic Co-operation and Development (OECD), <<http://www.oecd.org>>, accessed on January 23, 2013.

Bioscience vs. Biotechnology

The terms bioscience and biotechnology are often used synonymously. However, they are actually slightly different concepts. According to the Biotechnology Industry Organization, “the biosciences are a diverse group of industries and activities with a common link—they apply knowledge of the way in which plants, animals and humans function.”² Biotechnology, on the other hand, “is technology based on biology—biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet.”³

A Brief History of Biotechnology

While biotechnology is constantly advancing, it is by no means a new concept. Using or modifying living cells to develop processes and products that improve human life is something that has been done for centuries.⁴ In fact, humans have been applying biotechnology to many aspects of daily living since the beginning of recorded history when they first domesticated crops and livestock and when yeast was used to ferment beer and leaven bread.

Elements of biotechnology have been with us since the beginning of recorded history, here is a look at some of the major milestones in biotechnology⁵:

1865	Gregor Mendel, an Austrian monk, publishes studies showing the inheritance of biological traits in pea plants.
1953	James Watson and Francis Crick discover the double helix structure of DNA.
1978	Human insulin is produced artificially using recombinant DNA.
1986	The first genetically engineered vaccine for humans, the hepatitis B vaccine, is developed. The first biotechnology cancer drug is also produced.
1996	Ian Wilmut and other researchers in Scotland achieve the first cloning of a mammal from an adult cell—a sheep named Dolly, who lived until 2003.

² Biotechnology Industry Organization, “State Bioscience Initiatives 2008: Technology, Talent and Capital,” June, 2008, <http://www3.bio.org/local/battelle2008/State_Bioscience_Initiatives_2008.pdf>, accessed on February 11, 2013.

³ Biotechnology Industry Organization, “What is Biotechnology?” <<http://www.bio.org/articles/what-biotechnology>>, accessed on February 11, 2013.

⁴ Denneal Jamison-McClung, “Teen Biotech Challenge 2013,” <http://teenbiotechchallenge.ucdavis.edu/PDFs/2013/TBC2013_Instructions_v2.pdf>, accessed on January 23, 2013.

⁵ “Milestones in Biotechnology,” *Genetic Engineering and Biotechnology News*, <www.genengnews.com/timeline>, accessed on January 30, 2013.

1998	Human embryonic stem cell lines are isolated by James Thomason, Jeffrey Jones, and their colleagues, who noted that “These cell lines should be useful in human developmental biology, drug discovery, and transplantation medicine.”
2003	The Human Genome Map Project, launched in 1990, is completed.
2008	Researchers at the University of Kentucky publish a study suggesting that some RNAi drugs work by activating the immune system rather than by silencing genes.

California’s Biotechnology Industry

With an educated and highly skilled workforce, a comprehensive higher education system with distinguished research institutions, and access to public and private funding in the form of research grants and venture capital, California has been and continues to be in a unique position to lead the nation in biotechnology.⁶ Here are some key facts:

- California has the largest concentration of biotechnology firms in the United States.⁷
- California’s biomedical industry is the largest segment of California’s biotechnology industry. This subsector includes the core areas of biopharmaceuticals; medical devices; instruments and diagnostics; and research, testing, and medical laboratories.⁸
- Despite the Great Recession over the last five years, California remains the national leader with more than 2,300 biomedical companies and nearly 153,000 workers in 2011.⁹
- There are growing concerns that funding would not be as available due to the economic downturn in recent years, but California still has more than double the number of Massachusetts’ biomedical workers, which ranks second nationally.¹⁰

⁶ Northern California Center of Excellence, “Biotechnology, Medical Devices, & Pharmaceutical Manufacturing in California,” October 2010, <www.coecc.net/documents/biotech_custom_ca_10.pdf>, accessed January 9, 2013, p. 4.

⁷ Gina Frierman-Hunt and Julie Solberg, “Careers in Biotechnology: A Counselor’s Guide to the Best Jobs in the United States, 3rd edition,” August 2008, p. 20.

⁸ “California Biomedical Industry 2013 Report,” <<http://www.californiabiomedreport.com>>, accessed on January 9, 2013.

⁹ Ibid.

¹⁰ Steve Johnson, “California biomedical industry still the biggest, despite tight financing, report says,” *Contra Costa Times*, January 8, 2013, <http://www.contracostatimes.com/breaking-news/ci_22327154/states-biomedical-industry-still-biggest-despite-tight-financing>, accessed on January 9, 2013.

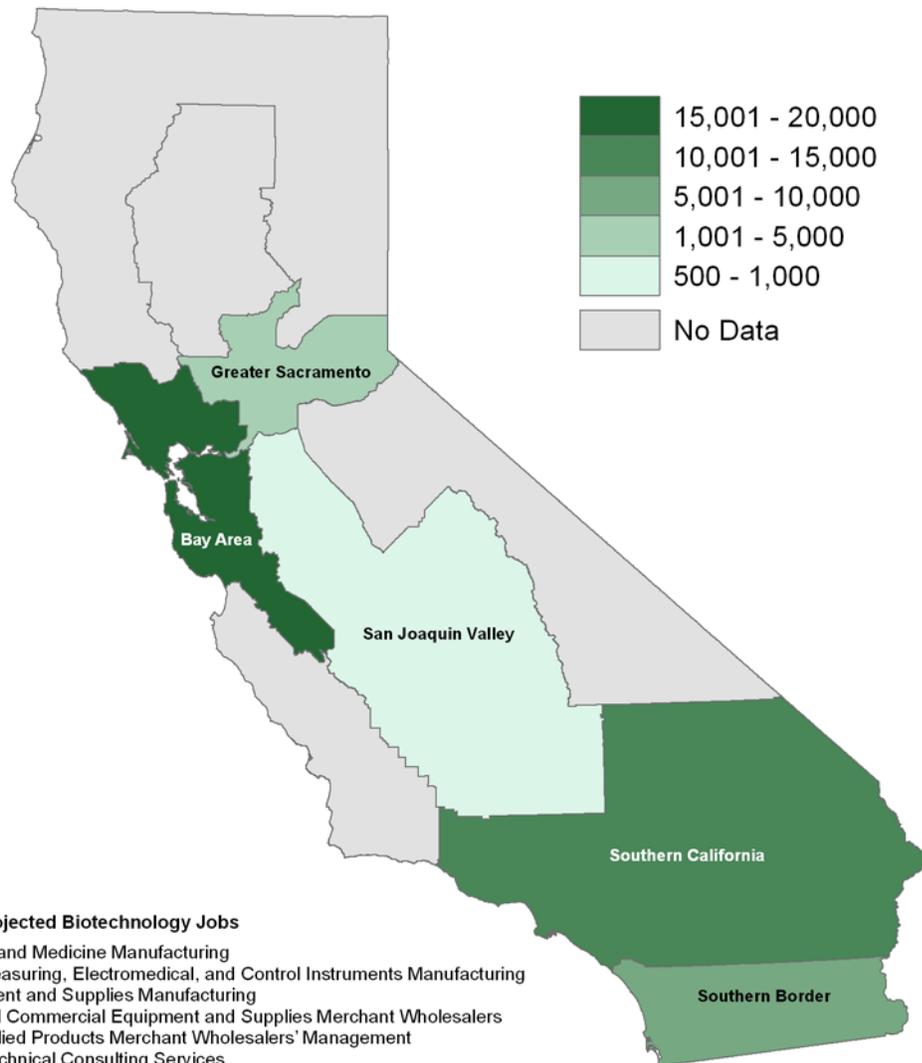
- Regionally, the Bay Area has the largest cluster of biomedical entrepreneurs and employees, with nearly 850 companies and more than 47,000 workers, representing almost one-third of the state’s biomedical jobs.¹¹
- San Diego County has the second largest cluster with nearly 26,000 workers or 17 percent of “core” biomedical jobs. Los Angeles and Orange counties each have about 15 percent of California’s biomedical jobs.¹²

The following map illustrates the regional distribution and concentrations of projected 2010-2020 biotechnology jobs in California. The Bay Area leads the state with more than 15,000 biotechnology jobs. Southern California comes in second with between 10,000 to 15,000 biotechnology jobs, and the Southern Border region follows closely with projections of 5,000 to 10,000 biotechnology jobs. Other growing biotechnology regions include the Greater Sacramento area and the San Joaquin Valley.

¹¹ Ibid.

¹² Ibid.

Projected Biotechnology Jobs by Economic Region, 2010–2020



Industries with Projected Biotechnology Jobs

- Pharmaceutical and Medicine Manufacturing
- Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
- Medical Equipment and Supplies Manufacturing
- Professional and Commercial Equipment and Supplies Merchant Wholesalers
- Chemical and Allied Products Merchant Wholesalers' Management
- Scientific and Technical Consulting Services
- Scientific Research and Development Services
- Postsecondary Colleges, Universities, and Schools
- Medical and Diagnostic Laboratories
- Federal, State, and Local Government

This map will be updated as projections are completed for additional counties.

Greater Sacramento does not include projections for Sutter County or Yuba County.

Bay Area does not include projections for Napa County, Santa Cruz County, or Solano County.

San Joaquin Valley does not include projections for Madera County, Merced County, or Tulare County.

Southern California does not include projections for Ventura County.

Southern Border does not include projections for Imperial County.

Data Source:
Occupational Research Group
Labor Market Information Division
California Employment Development Department.

Cartography by:
Labor Market Information Division
California Employment Development Department
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Areas of Application in Biotechnology

Biotechnology application can be found in many different areas. Although described as a single industry, biotechnology cuts a wide swath across a number of industries – agriculture, pharmaceuticals and medicine, manufacturing, and more. What these industries have in common is that each uses living organisms to produce products and services. What differs is the application of the living organisms and the specific technologies involved.

Agriculture

Advances in biotechnology have had significant impact on the agriculture and food production industries. Biotechnology workers have increased crop yields and plants' resistance to disease, insects, droughts and cold weather; improved the nutritional content, taste, and appearance of food products; and prevented and treated animal diseases. These new technologies have enabled farmers and scientists alike to meet the growing need for food around the world.

Some examples of biotechnology's application in agriculture and food production include:

- Genetically engineered crops that can provide protection from pests.
- Increasing the speed of the fermentation process of soy sauce from a few months to a few days.
- Improving the production process of cheese, cocoa, and tea.¹³

Human Health and Medicine

The application of biotechnology to human diseases has evolved from treating symptoms to addressing the underlying causes. Meanwhile, the established fields of therapeutics and diagnostics continue to be important in improving human health and medicine.

Some examples of biotechnology's application in human health and medicine include:

- Protein therapies for treating heart attacks, strokes, and anemia.
- Antibody therapies that inhibit cancer growth.¹⁴

¹³ Gina Frierman-Hunt and Julie Solberg, "Careers in Biotechnology: A Counselor's Guide to the Best Jobs in the United States, 3rd edition," August 2008, p. 12.

¹⁴ The White House, "The National Bioeconomy Blueprint," April 2012, <http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf>, accessed on November 14, 2012, p. 9.

Energy

Traditional sources of energy are not expected to keep up with growing demand. The development of biofuels has been a promising way to replace fossil fuels, thereby reducing our dependence on imported oil and providing a cleaner source of energy.

Some examples of biotechnology's application in energy generation include:

- Using enzymes and fermentation processes to convert corn syrup into ethanol.
- Repurposing agricultural refuse, such as wood production, garden waste, corn stalks and wheat straws for new uses including feedstock for renewable energy.¹⁵

In addition, new energy applications are emerging as synthetic biology and other genetic-manipulation techniques are used to manufacture new and conventional products.

Environment

Recent biotechnology advances have enabled us to reverse some of the environmental damage caused by industrial and manufacturing processes.

Some examples of biotechnology's application in the environment include:

- Environmental restoration efforts using bacteria and other microorganisms to break down the oil from oil spills, which speeds clean-up efforts.
- New and cleaner manufacturing processes in products such as chemicals, fabric, metals, minerals, and paper.¹⁶

Emerging Technologies in Biotechnology

Several emerging areas in biotechnology are opening up new worlds of scientific discoveries and career opportunities. Let's explore some of these cutting edge areas.

Bioinformatics and Computational Biology

- Bioinformatics is "the use of information technology to store, sort, analyze, share, and understand biological data."¹⁷

¹⁵ Gina Frierman-Hunt and Julie Solberg, "Careers in Biotechnology: A Counselor's Guide to the Best Jobs in the United States, 3rd edition," August 2008, p. 13.

¹⁶ Ibid.

¹⁷ Denneal Jamison-McClung, "Teen Biotech Challenge 2013," <http://teenbiotechchallenge.ucdavis.edu/PDFs/2013/TBC2013_Instructions_v2.pdf>, accessed on January 23, 2013.

- Computational biology is “the use of analytical and theoretical methods, mathematical modeling, and simulation techniques to study biological systems.”¹⁸
- Many new research areas now require the analysis of very large and complex datasets, such as those of genome sequences and proteomic cell profiles; therefore, the ability to store, process, analyze, and share very large volumes of data has become essential.
- Using new computer programming languages and data analysis techniques, scientists can create computational models that can predict biological processes and help us understand how biological systems interact.

Nanobiotechnology

- Nanobiotechnology is “the life science-related applications of nanotechnology” where “scientists use nanoscale (10^{-9}) molecular systems to develop medical diagnostic devices, biomaterials, therapeutics, and industrial processes.”¹⁹
- Discoveries in this area are often applicable to various biotechnology fields, such as health care, agriculture, environmental sciences, etc., and therefore become “platform technologies”²⁰ that are useful in many areas.

Personal Genomics and Human Health

- With the advances in both the efficiency and cost-effectiveness of DNA sequencing in recent years, it is now possible for an individual to “understand such things as their individual risk profiles for disease, their physical and biological characteristics, and their personal ancestries.”²¹
- Current applications of this emerging field are somewhat limited and the moral and ethical issues surrounding this area of biotechnology are quite complex.

Proteomics

- Proteomics is “the large-scale study and manipulation of proteins in an organism.”²²
- Proteomics holds the promise of new and exciting discoveries and practical applications in biotechnology. For example, by comparing a healthy lung cell’s

¹⁸ The White House, “The National Bioeconomy Blueprint,” April 2012, <http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf>, accessed on November 14, 2012, p. 16.

¹⁹ Denneal Jamison-McClung, “Teen Biotech Challenge 2013,” <http://teenbiotechchallenge.ucdavis.edu/PDFs/2013/TBC2013_Instructions_v2.pdf >, accessed on January 23, 2013.

²⁰ Ibid.

²¹ Ibid.

²² The White House, “The National Bioeconomy Blueprint,” April 2012, <http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf>, accessed on November 14, 2012, p. 16.

proteome with that of a cancerous lung cell, scientists may be able to “identify a protein, a missing or abnormal molecular decoration of a protein, or unusual combination of proteins that may be promising drug targets.”²³

Regenerative Medicine

- In the field of regenerative medicine, scientists work with stem cells and other advanced biomaterials to find new ways to repair damaged and diseased human tissues and organs.
- New advances now include the use of transplant patients’ own stem cells to overcome the problem of patients’ immune systems rejecting donated organs. These new technologies have enabled transplant patients to have higher quality and longer lives.²⁴

²³ Ibid.

²⁴ Denneal Jamison-McClung, “Teen Biotech Challenge 2013,” <http://teenbiotechchallenge.ucdavis.edu/PDFs/2013/TBC2013_Instructions_v2.pdf >, accessed on January 23, 2013.

Biotechnology Occupations at a Glance: Employment Change and Job Openings

Key Occupation	Annual Average Employment		Employment Change		Average Annual Job Openings			Percent of Occupation in designated Biotech Industry [5]
	2010	2020	Numerical [1]	Percent	New Jobs [2]	Replacement Needs [3]	Total Jobs [4]	
Biochemical Engineers [6]	--	--	--	--	--	--	--	--
Biochemists and Biophysicists	6,400	8,800	2,400	37.5	250	140	390	87.5
Biological Technicians	11,400	13,300	1,900	16.7	180	390	570	84.2
Biologists [7]	--	--	--	--	--	--	--	--
Biomedical Engineers	4,000	6,700	2,700	67.5	270	90	360	96.3
Chemical Engineers	1,900	2,200	300	15.8	30	60	90	66.7
Chemical Technicians	6,200	7,100	900	14.5	90	90	180	22.2
Chemists	10,900	12,100	1,200	11.0	120	360	480	41.7
Compliance Officers	25,900	30,000	4,100	15.8	410	310	720	36.6
Electrical Engineers	21,000	23,200	2,200	10.5	230	510	740	13.5
Environmental Scientists and Specialists, Including Health	13,000	16,000	3,000	23.1	290	390	680	80
Epidemiologists [8]	--	--	--	--	--	--	--	--
Management Analysts	82,800	101,400	18,600	22.5	1,870	1,350	3,220	60.2
Market Research Analysts and Marketing Specialists	53,700	78,300	24,600	45.8	2,450	1,430	3,880	30.9
Medical and Clinical Laboratory Technicians	16,900	19,400	2,500	14.8	250	330	580	72
Medical and Clinical Laboratory Technologists	11,800	13,200	1,400	11.9	140	230	370	71.4
Medical Scientists, Except Epidemiologists	27,800	39,300	11,500	41.4	1,150	170	1,320	76.5
Microbiologists	3,600	4,400	800	22.2	80	80	160	75
Natural Sciences Managers	8,800	10,300	1,500	17.0	150	530	680	93.3
Statisticians	3,000	3,600	600	20.0	50	180	230	50
Technical Writers	6,400	7,700	1,300	20.3	120	130	250	38.5

[1] Numerical employment change is the net difference between the base and projected year employment and reflects job growth or decline. The base and projected year employment are independently rounded to 100. Therefore, numerical change may not equal new jobs.

[2] New jobs are only openings due to growth and do not include job declines. If an occupation's employment change is negative, there is no job growth and new jobs are set to zero. New jobs may not equal numerical change.

[3] Replacement needs estimate the number of job openings created when workers retire or permanently leave an occupation and need to be replaced.

[4] Total jobs are the sum of new jobs and replacement needs.

[5] Biotechnology employment is defined as select occupations in the following industries: Pharmaceutical and Medicine Manufacturing; Navigational, Measuring, Electromedical, and Control Instruments Manufacturing; Medical Equipment and Supplies Manufacturing; Professional and Commercial Equipment and Supplies Merchant Wholesalers; Chemical and Allied Products Merchant Wholesalers; Management, Scientific, and Technical Consulting Services; Scientific Research and Development Services; Postsecondary Colleges, Universities, and Schools; Medical and Diagnostic Laboratories; Federal Government; State Government; and Local Government.

[6] Specific data on this subset occupation of the occupational category "Engineers, All Others," is not available.

[7] Biologists represent the broader group which includes Biochemists and Biophysicists; Microbiologists; Zoologists and Wildlife Biologists; and Biological Scientists, All Others. Employment data is not published for this broader group.

[8] Occupations with employment below 1,000 in 2010 are excluded.

Biotechnology Occupations at a Glance: Educational Requirements and Wages

Key Occupation	Education and Training Levels [1]			2012 First Quarter Wages [2]	
	Entry Level Education	Work Experience	On-the-Job Training	Median Hourly	Median Annual
Biochemical Engineers	3	None	None	\$48.52	\$100,936
Biochemists and Biophysicists	1	None	None	\$39.19	\$81,515
Biological Technicians	3	None	None	\$21.45	\$44,607
Biologists [3]	3	None	None	--	--
Biomedical Engineers	3	None	None	\$47.05	\$97,876
Chemical Engineers	3	None	None	\$46.63	\$96,992
Chemical Technicians	4	None	MT OJT	\$21.16	\$44,018
Chemists	3	None	None	\$36.85	\$76,659
Compliance Officers	3	None	MT OJT	\$34.66	\$72,086
Electrical Engineers	3	None	None	\$49.13	\$102,201
Environmental Scientists and Specialists, Including Health	3	None	None	\$36.04	\$74,978
Epidemiologists	2	None	None	\$38.15	\$79,354
Management Analysts	3	1-5 years	None	\$40.60	\$84,448
Market Research Analysts and Marketing Specialists	3	None	None	\$32.74	\$68,104
Medical and Clinical Laboratory Technicians	4	None	None	\$19.61	\$40,799
Medical and Clinical Laboratory Technologists	3	None	None	\$38.97	\$81,068
Medical Scientists, Except Epidemiologists	1	None	None	\$40.12	\$83,430
Microbiologists	3	None	None	\$37.18	\$77,332
Natural Sciences Managers	3	>5 years	None	\$68.79	\$143,098
Statisticians	2	None	None	\$43.13	\$89,712
Technical Writers	3	1-5 years	ST OJT	\$38.99	\$81,101

[1] The Bureau of Labor Statistics develops and assigns education and training categories to each occupation. For more information on these categories, please see http://www.bls.gov/emp/ep_education_training_system.htm

[2] Median hourly and annual wages are the estimated 50th percentile of the distribution of wages; and 50 percent earn wages above the median wage. The wages are from 2012 first quarter and do not include self-employed or unpaid family workers.

[3] Biologists represent the broader group which includes Biochemists and Biophysicists; Microbiologists; Zoologists and Wildlife Biologists; and Biological Scientists, All Others. Wage data is not published for this broader group.

Entry Level Education
1- Doctoral or professional degree
2- Master's degree
3- Bachelor's degree
4- Associate's degree

Work Experience in a Related Occupation	
>5 years	More than 5 years experience in a related occupation or field is common.
1-5 years	Between 1 and 5 years experience in a related occupation or field is common.
<1 year	Less than 1 year experience in a related occupation or field is common.
None	No work experience is typically required.

On-the-Job Training	
MT OJT	Moderate-term on-the-job training
ST OJT	Short-term on-the-job training

Top 10 Skills of 21 Key Biotechnology Occupations

	Biochemical Engineers	Biochemists and Biophysicists	Biological Technicians	Biologists	Biomedical Engineers	Chemical Engineers	Chemical Technicians	Chemists	Compliance Officers	Electrical Engineers	Environmental Scientists and Specialists, Including Health	Epidemiologists	Management Analysts	Market Research Analysis and Marketing Specialists	Medical and Clinical laboratory Technicians	Medical and Clinical laboratory Technologists	Medical Scientists, Except Epidemiologists	Microbiologist	Natural Sciences Managers	Statisticians	Technical Writers	
Reading Comprehension	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Critical Thinking	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Speaking	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Active Listening	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Writing	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Active Learning	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Science	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Judgment and Decision Making	●		●	●	●	●			●		●	●	●	●			●	●			●	
Monitoring		●	●			●	●			●		●		●	●	●		●				●
Mathematics		●	●	●	●	●	●	●		●	●									●		
Complex Problem Solving	●			●	●	●		●		●	●	●					●				●	●
Coordination							●		●	●					●				●			●
Instructing		●						●									●			●		
Systems Analysis						●			●				●	●								
Systems Evaluation						●			●				●	●								
Operations Analysis	●				●								●						●			
Time Management										●									●			
Quality Control Analysis							●									●						
Operation Monitoring															●	●						
Learning Strategies																		●				
Management of Personnel Resources																			●			
Persuasion									●													

Source: U.S. Department of Labor Occupational Information Network (O*NET) at online.onetcenter.org

Top 10 Work Activities of 21 Key Biotechnology Occupations

	Biochemical Engineers	Biochemists and Biophysicists	Biological Technicians	Biologists	Biomedical Engineers	Chemical Engineers	Chemical Technicians	Chemists	Compliance Officers	Electrical Engineers	Environmental Scientists and Specialists, Including Health	Epidemiologists	Management Analysts	Market Research Analysts and Marketing Specialists	Medical and Clinical Laboratory Technicians	Medical and Clinical Laboratory Technologists	Medical Scientists, Except Epidemiologists	Microbiologists	Natural Sciences Managers	Statisticians	Technical Writers	
Processing Information	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Updating and Using Relevant Knowledge	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Organizing, Planning, and Prioritizing Work	●		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●
Communicating with Supervisors, Peers, or Subordinates			●	●		●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●
Analyzing Data or Information	●	●	●	●	●	●		●		●		●	●	●			●	●	●	●	●	●
Getting Information	●	●	●	●	●	●			●	●	●	●	●	●			●	●	●	●	●	
Making Decisions and Solving Problems	●	●	●		●	●		●		●	●	●	●	●	●	●		●	●	●	●	
Identifying Objects, Actions, and Events	●	●	●	●	●		●		●			●		●	●	●	●	●	●			●
Monitor Processes, Materials, or Surroundings	●		●	●	●	●	●	●			●		●		●	●	●					
Thinking Creatively	●	●		●	●	●		●		●							●	●	●	●		
Establishing and Maintaining Interpersonal Relationships							●	●	●		●		●	●			●		●			●
Evaluating Information to Determine Compliance with Standards							●	●	●	●	●				●	●						
Interpreting the Meaning of Information for Others		●			●				●			●						●		●	●	
Documenting/Recording Information			●				●								●	●						●
Communicating with Persons Outside Organization				●					●		●	●		●								
Inspecting Equipment, Structures, or Material							●								●	●						
Interacting With Computers										●												●
Provide Consultation and Advice to Others						●															●	
Estimating the Quantifiable Characteristics of Products, Events, or Information	●	●																				
Controlling Machines and Processes															●							
Scheduling Work and Activities													●									
Training and Teaching Others		●																				
Drafting, Laying Out, and Specifying Technical Devices, Parts, and Equipment										●												

Source: U.S. Department of Labor Occupational Information Network (O*NET) at online.onetcenter.org

The Importance of Being Well-Rounded in Biotechnology

The biotechnology industry is a dynamic and evolving field; therefore, employers are looking for well-rounded individuals who can offer more than traditional technical research skills. To be competitive, job seekers must have strong verbal and written communication, advanced analytical, problem solving, and organizational skills as well as a strong foundation in the sciences.²⁵ Particularly important is the ability to communicate with colleagues and others who may not have the same educational background, to report data and scientific information to audiences across disciplines, and to understand business, finance, and marketing aspects of the biotechnology economy.²⁶

According to Dr. Judith Kjelstrom and Dr. Denneal Jamison-McClung of the UC Davis Biotechnology Program, those who are interested in a biotechnology career should have characteristics that will make them successful within the biotech business and research culture. The students in the Designated Emphasis in Biotechnology program need academic expertise as well as “social awareness” and entrepreneurship. Deep, narrow expertise, gained through research, must be balanced with broad, global perspectives to be an effective leader in the 21st century. To create effective cross-disciplinary teams, students must value the so-called “soft skills” of business.²⁷

“Biomedical research workforce development requires new approaches because of today’s increasingly complex scientific and technically sophisticated knowledge base, which includes the fields of bioinformatics, statistics, genomics, nanotechnology and regenerative biology. The biomedical research workforce must evolve with our rapidly changing scientific development,” said Pomeroy. “Biomedical science trainees require a new set of core knowledge competencies in addition to the traditional scientific disciplines so that they can optimize their potential to make important and relevant discoveries.”²⁸

Students pursuing careers in biotechnology or biomedical fields should develop basic technical skills such as maintenance of laboratory records or notebook; developing SOPs (standard operating procedures) and GLP (good laboratory procedures); aseptic (sterile) technique; computer science, molecular and cellular biology and biochemistry; and proper use and troubleshooting of analytic equipment. They should also develop personal characteristics, which include effective communication, compassion, adaptability to change, a spirit of creativity and innovation, self-motivation, a strong aptitude for teamwork and leadership, collaboration amongst other disciplines, and the ability to multi-task and work in fast-paced and dynamic environments. Attention to

²⁵ Educating Biotechnicians for Future Industry Needs, <<http://www.bio-link.org/home/sites/files/BiotechReportFinal.pdf>>, accessed on January 29, 2013.

²⁶ Paul Smaglik, “Getting better at Biotech,” <<http://www.nature.com/naturejobs/science/articles/10.1038/nj7293-1394a>>, accessed on February 22, 2013.

²⁷ Judith A. Kjelstrom, Karen McDonald, Andrew Hargadon, Wilton Agatstein, and Meg Arnold, “The University of California, Davis, collaborative model for biotechnology education and training,” *Journal of Commercial Biotechnology*, Vol. 18, No. 4, October 2012, p. 87–97.

²⁸ Ibid.

detail, common sense and a strong understanding of the product development process, and scientific enterprise are also important in biotechnology.²⁹ As Dr. Kjelstrom explains to students, “Your technical skills will get you the interview, but your social skills will land you the job.”³⁰ Ultimately, employers are looking for candidates who are balanced individuals with a diverse set of skills.

Biotech candidates can develop their soft skills in several ways. One way is to join university- and association-sponsored biotechnology clubs for opportunities to interact with industry professionals, network for internships and job placements, and work with other students to enhance their soft skills.³¹ Another avenue is through courses offered by biotechnology organizations. A third option is through university extension classes which allows biotech working professionals the opportunity to enrich their skills and credentials at night, on weekends, or online, without interruptions to their work schedules. Some professionals may even pursue graduate degrees in business and management. All of these enrichment options allow biotech workers to grow along their career paths.³²

Profiles of Key Biotechnology Occupations

The following section contains profiles of 21 key biotechnology occupations in California. Some of these occupations are new or emerging, while others are traditional, yet require specialized skills or knowledge to perform the necessary tasks. Each profile highlights the most essential occupational information by providing a concise general job description, several examples of tasks specific to the biotechnology field, job outlook and wage data, and typical qualification requirements.

²⁹ Judith Kjelstrom and Denneal Jamison-McClung. Interview. January 16, 2013.

³⁰ “Career Snapshots” in Nature Reviews. Vol 7. March, 2008.

³¹ Nicole G. Gravagna, “Creating Alternatives in Science.” Journal of Commercial Biotechnology. Vol 15, 2, 161-170

³² Paul Smaglik. “Getting better at Biotech” retrieved 2/22/2013 from www.nature.com/naturejobs/science/articles/10.1038/nj7293-1394a

Biochemical Engineers in California

Common Biotechnology Occupational Titles: Biochemical Process Engineers, Development Engineers, and Process Engineers.

What Would I Do?

Using their knowledge of cell and molecular biology, chemistry, and engineering, Biochemical Engineers develop products such as food, medicine, or vaccines. They also design or improve environmental processes such as water purification or convert biomass to fuel. They prepare and conduct experiments and analyze the results using strict methodologies. Biochemical Engineers consult and collaborate with biologists, chemists, environmental consultants, manufacturing personnel, and others as they design and evaluate products or processes. They also develop procedures to shift product development from the laboratory to large-scale manufacturing.

In the biotechnology field, Biochemical Engineers may run experiments involving proteins, antibodies, and other macromolecules. Some Biochemical Engineers conduct statistical analysis of data generated from clinical experiments while others may work in purification or downstream development, designing processes to purify proteins produced in synthesis reactions for use in clinical studies.

Job Outlook and Wages

Most job openings will be created by the need to replace Biochemical Engineers who retire or leave the field for other reasons.

A formal salary survey for Biochemical Engineers is not available; however, their earnings are typically comparable to the broader group of Engineers, All Other. According to the Occupational Employment Statistics Survey, wages in 2012 for Engineers, All Other in California range from \$78,423 to \$123,868 annually or \$37.70 to \$59.56 hourly. The median wage is \$100,936 annually or \$48.52 hourly. The median is the point at which half of the workers earn more and half earn less.

How Do I Qualify?

- A bachelor's degree in biochemical or chemical engineering, or a related field is generally the minimum educational level required by employers.
- Biochemical and chemical engineering programs involve extensive coursework in biology, chemistry, mathematics, and physics, as well as hands-on laboratory classes.
- Advanced computer skills are also vital.

For more information about this occupation, view the [California Occupational Guide](#) (coming soon).

Biochemists and Biophysicists in California

Common Biotechnology Occupational Titles: Clinical Laboratory Scientists, Clinical Researchers, Research Chemists, Research Scientists, and Scientists.

What Would I Do?

Biochemists and Biophysicists are scientists who seek to understand the chemical composition and physical principles of living cells and organisms, their electrical and mechanical energy, and how they relate to the environment. In biotechnology firms, these scientists apply their research to discover, manufacture, or improve upon products which include tumor-inhibiting medicines, chemical applications, genetic testing kits, medical instruments, and acne creams.

Biochemists' and Biophysicists' research may result in new applications that enhance medical outcomes, crop yields, and environmental remediation capabilities. For example, Biochemists and Biophysicists may use bacteria and other microorganisms to break down oil from oil spills which speeds up clean-up efforts.

Job Outlook and Wages

With increased focus on biotechnology research and development in areas such as genetics, agriculture, and pharmaceuticals, demand for Biochemists and Biophysicists is expected to grow.

The median wage in 2012 for Biochemists and Biophysicists in California was \$81,515 annually or \$39.19 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A Ph.D. is usually necessary for independent and industrial research and development, as well as for advancement to administrative or teaching positions.
- Employers often require two to five years of laboratory and research experience from their candidates, usually in the form of postdoctoral positions.
- A master's degree with extensive laboratory research experience may be enough to meet some employers' requirements.

For more information about this occupation, view the [California Occupational Guide](#).

Biological Technicians in California

Common Biotechnology Occupational Titles: Biological Science Laboratory Technicians, Bioprocess Technicians, Laboratory Technicians, Research and Development Assistants, and Sample Handling Technicians.

What Would I Do?

Biological Technicians work with biologists studying living organisms. They set up, operate, and maintain laboratory instruments; monitor experiments; make observations; calculate and record results; and develop conclusions. Those who work for pharmaceutical companies help develop and manufacture medicines, while those working in the field of microbiology generally work as laboratory assistants, studying living organisms and infectious agents.

Biological Technicians, in the biotechnology industry, apply knowledge and techniques gained from basic research, including gene splicing and recombinant DNA, to product development. Some Biological Technicians may also aid in the production of biofuels. For example, Biological Technicians may work with modified seed stocks to produce plants that can be used as biofuels.

Job Outlook and Wages

Most job openings will be created by the need to replace Biological Technicians who retire, transfer to supervisory positions, or leave the field for other reasons.

The median wage in 2012 for Biological Technicians in California was \$44,607 annually or \$21.45 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A high school diploma and five years of biotechnology experience or an associate degree and two years of biotechnology experience is the minimum educational requirement.
- Some employers prefer applicants with a bachelor's degree with a science focus.
- Technicians are not required to hold licenses or certifications, but some employers may prefer applicants with specialized certificates.

For more information about this occupation, view the [California Occupational Guide](#).

Biologists in California

Common Biotechnology Occupational Titles: Environmental Analysts, Environmental Specialists, Research Biologists, Research Scientists, and Scientists.

What Would I Do?

Biologists study living organisms from plants to animals to single cell organisms that are only visible under powerful microscopes. They often specialize in specific areas of biology such as botany or zoology, although there is often overlap between the specialized areas. They may research specific ecosystems, like a forest or river, and work to preserve native plant life or breeding grounds for native animals.

Biologists in the biotechnology field may work in areas such as cellular and molecular immunology, immunohistochemistry, enzymology, and regenerative medicine. Some may apply new knowledge of cancer biology to transform cancer therapy. Others may discover innovative biotherapeutic medicines to treat autoimmune diseases and related complications. Biologists may also develop products for medical equipment manufacturers and pharmaceutical companies.

Job Outlook and Wages

Biologists should enjoy favorable job prospects, with strongest employment growth in biotechnology firms and the health care industry. Stronger competition among drug and medical technology companies along with an aging population are contributing to the need for advancements in the medical field through scientific research.

A formal salary survey for Biologists is not available; however, their earnings are typically comparable to the broader group of Biological Scientists, All Other. The median wage in 2012 for Biological Scientists, All Other was \$73,431 annually or \$35.30 hourly. The median is the point at which half of the workers earn more and half earn less.

How Do I Qualify?

- For some entry-level positions a bachelor's degree in biology is sufficient, but many employers require a master's or doctoral degree.
- Biologists with a master's degree usually qualify for applied research positions and teaching positions in two-year colleges.
- Many employers require at least five years of relevant experience.

For more information about this occupation, view the [California Occupational Guide](#).

Biomedical Engineers in California

Common Biotechnology Occupational Titles: Bioengineers, Biomedical Research Engineers, Clinical Engineers, and Medical Research Engineers.

What Would I Do?

Biomedical Engineers develop devices and procedures that solve medical and health-related problems by combining their knowledge of biology and medicine with engineering principles and practices. Many conduct research together with life scientists, chemists, and medical scientists, to develop and evaluate systems and products such as artificial organs, prostheses, instrumentation, medical information systems, and health management and care delivery systems.

Biomedical Engineers may also design devices used in various medical procedures, imaging systems such as magnetic resonance imaging (MRI), and devices for automating insulin injections or controlling body functions.

In the biotechnology field, Biomedical Engineers work to better human lives by developing new innovations in regenerative medicine. For example, Biomedical Engineers have advanced the technology in artificial limbs and biocompatible prostheses using stem cells, which lessens immune rejection and are more effective in the repair of injured nerves.

Job Outlook and Wages

With increased focus on biotechnology research and development, robust job growth is expected for Biomedical Engineers.

The median wage in 2012 for Biomedical Engineers in California was \$97,876 annually or \$47.05 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in biomedical engineering or a related field is generally the minimum educational requirement.
- Advanced computer skills are also necessary for this occupation.

For more information about this occupation, view the [California Occupational Guide](#).

Chemical Engineers in California

Common Biotechnology Occupational Titles: Chemical Research Engineers, Process Engineers, Refinery Engineers, and Refinery Process Engineers.

What Would I Do?

Chemical Engineers apply the principles of chemistry and related sciences to solve problems involving the production or use of chemicals and biochemicals. They design equipment and processes for large-scale chemical manufacturing, plan and test methods of manufacturing products and treating byproducts, and supervise production.

Chemical Engineers, in the biotechnology industry, may assist with the research and design of energy-efficient systems, such as fuel cells and batteries. Some may work in the renewable energy generation field developing and testing products using energy sources such as solar and biomass. Other Engineers may work with traditional non-renewable resources (oil, coal, natural gas, and nuclear energy) that are undergoing technological changes. Chemical Engineers may also be involved in environmental protection, such as remediation, air quality, and climate change adaptation.

Job Outlook and Wages

Most job openings will be created by the need to replace Chemical Engineers who retire, transfer to supervisory positions, or leave the field for other reasons. However, with increased focus on environmentally sustainable business practices, the strongest demand will most likely be in the areas of biofuel technology, energy efficiency, nanotechnology, and pharmaceuticals.

The median wage in 2012 for Chemical Engineers in California was \$96,992 annually or \$46.63 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in chemical engineering is generally the minimum educational requirement.
- Some employers may require a master's or Ph.D. degree along with five or more years of experience.

For more information about this occupation, view the [California Occupational Guide](#).

Chemical Technicians in California

Common Biotechnology Occupational Titles: Analytical Lab Technicians, Environmental Lab Technicians, Formulation Technicians, Laboratory Analysts, and Research and Development Technicians.

What Would I Do?

Chemical Technicians may work in laboratories, assisting chemists and chemical engineers with practical, hands-on duties related to laboratory work like maintaining an inventory of lab equipment or producing chemical compounds through complex organic synthesis. They may also perform quality control duties at manufacturing facilities. These technicians, also known as Process Control Technicians, are responsible for designing and testing product packaging and checking the integrity of the manufactured materials before their shipment to retailers and consumers, including any environmental or human threat the product may pose.

Chemical Technicians, within the Biotechnology Industry, may assist with the research and development of natural and sustainable manufactured products. They also take into consideration the health and environmental concerns that are posed by different chemicals and their potential risks to consumers.

Job Outlook and Wages

Demand will most likely be highest in biotechnology and pharmaceutical firms, as well as in the area of environmental research.

The median wage in 2012 for Chemical Technicians in California was \$44,018 annually or \$21.16 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- An associate degree in chemistry or a related science is generally the minimum educational requirement.
- It is possible for job seekers with a high school diploma to enter the field as trainees and work under the direct supervision of an experienced technician as they continue with school.

For more information about this occupation, view the [California Occupational Guide](#).

Chemists in California

Common Biotechnology Occupational Titles: Research and Development Chemists and Research Chemists.

What Would I Do?

Most Chemists are involved in research and development, production, or chemical analysis. Chemists typically work in laboratories and study the composition, structure, and properties of substances and the interactions between them. Chemists also work in production and quality control in manufacturing plants. They prepare instructions for plant workers that specify ingredients, mixing times, and temperatures for each stage in the manufacturing process.

Chemists in the biotechnology industry may design and conduct complex research experiments such as for cancer therapies, applications of protein synthesis, and development of new biofuels technologies. Some Chemists may develop bioassays to understand how therapeutic proteins function. Other activities Chemists may be involved in include analyzing samples generated at various stages of bioprocesses, method troubleshooting, project life-cycle optimization, preparing and submitting regulatory documentations, and the interpreting and communicating scientific results to research associates and other scientists.

Job Outlook and Wages

Most job openings will be created by the need to replace Chemists who retire or leave the field for other reasons. Demand will most likely be highest in pharmaceutical and biotechnology firms.

The median wage in 2012 for Chemists in California was \$76,659 annually or \$36.85 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in chemistry or a related science is usually the minimum educational requirement.
- Many research positions require a master's degree or a Ph.D.

For more information about this occupation, view the [California Occupational Guide](#).

Compliance Officers in California

Common Biotechnology Occupational Titles: Compliance Analysts, Compliance Coordinators, Regulatory Affairs Managers, Regulatory Affairs Specialists, and Regulatory Associates.

What Would I Do?

Compliance Officers coordinate and document internal regulatory processes, such as internal audits, inspections, license and permit renewals, or registrations. They develop procedures to make certain that regulatory compliance is followed.

Compliance Officers prepare or review regulatory submissions for marketing new or modifying existing products for domestic and international use. They interact with and respond to regulatory agencies requests concerning submitted paperwork. Depending on the area of the biotechnology industry, Compliance Officers must also be very knowledgeable in the relevant state and federal regulations. For example, Compliance Officers are often found in pharmaceutical companies, where they may need to know Food and Drug Administration (FDA) regulations to assist the company in getting clearance for clinical trials or product approvals.

Job Outlook and Wages

As more companies focus their attention on compliance and ethics programs, demand for Compliance Officers is expected to grow.

The median wage in 2012 for Compliance Officers, Except Agriculture in California was \$72,086 annually or \$34.66 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- Most positions require a bachelor's degree in business or a related field.
- Some employers may only require an associate degree along with several years of experience.

For more information about this occupation, view the [California Occupational Guide](#).

Electrical Engineers in California

Common Biotechnology Occupational Titles: Electrical Design Engineers, Electrical Research Engineers, Research Engineers, and Solar Research Engineers.

What Would I Do?

Electrical Engineers research, design, develop, manufacture, and test electrical equipment and systems. In addition, Electrical Engineers analyze, develop, and propose designs for improving products or processes, such as electric and hybrid vehicles or solar photovoltaic systems. They also use advanced methods, theories, and research techniques to investigate and solve complex technical problems.

In the biotechnology industry, Electrical Engineers may work in the renewable energy generation sector developing, designing, and testing products using energy sources such as solar, wind, geothermal, and biomass. They may also develop biosensors to detect and measure toxins in the environment, which aids in environmental clean-up and homeland security.

Job Outlook and Wages

Most job openings will be created by the need to replace Electrical Engineers who retire, transfer to supervisory positions, or leave the field for other reasons.

The median wage in 2012 for Electrical Engineers in California was \$102,201 annually or \$49.13 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in electrical engineering is generally the minimum educational requirement.
- Advanced computer skills are also necessary for this occupation.

For more information about this occupation, view the [California Occupational Guide](#).

Environmental Scientists and Specialists in California

Common Biotechnology Occupational Titles: Environmental Consultants, Environmental Health and Safety Specialists, Hazardous Substances Scientists, Water Pollution Specialists, and Water Quality Analysts.

What Would I Do?

Environmental Scientists and Specialists protect the health of our environment and population by evaluating activities and identifying pollutants that may cause unsafe conditions. They make sure that environmental laws and regulations requiring environmental permits, review, and compliance are followed.

Environmental Scientists gather, monitor, and assess data from field investigations of air, biological, and cultural resources; food; soil; water; and wetlands to evaluate negative effects and help minimize those effects on the environment and the public's health. However, their main priority is always on environmental issues, such as conservation, degradation, implementation, and pollutants that affect the environment and human health.

In the biotechnology industry, Environmental Scientists may apply microorganisms to detoxify highly contaminated industrial wastes and remove pollutants such as polychlorinated biphenyls (PCBs). They may also be involved with efforts to remove sulfur from coal to decrease air pollution that is released when coal is burned to generate electric power.

Job Outlook and Wages

With increased focus on the environment, demand for Environmental Scientists and Specialists is expected to grow.

The median wage in 2012 for Environmental Scientists, Including Health in California was \$74,978 annually or \$36.04 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in environmental, biological, chemical, or physical science or a related field is usually the minimum educational requirement.
- Research positions may require a master's degree or a Ph.D.

For more information about this occupation, view the [California Occupational Guide](#).

Epidemiologists in California

Common Biotechnology Occupational Titles: Clinical Researchers, Epidemiology Investigators, Medical Epidemiologists, and Research Epidemiologists.

What Would I Do?

Epidemiologists are medical scientists who investigate and describe the causes and spread of disease and other health problems to prevent them from spreading or from recurring. They may also develop the means for prevention or control. Epidemiologists study many different illnesses, often focusing on major infectious diseases such as influenza or cholera.

Epidemiologists who work in biotechnology may work in pharmacoepidemiology providing their expertise in drug development and design statistical models for biotechnology and pharmaceutical firms. Epidemiologists may also lead and advise clinical development teams during all phases of clinical trials. Other Epidemiologists may work in consulting roles at hospitals, informing the medical staff of infectious outbreaks and providing containment solutions.

Job Outlook and Wages

Job prospects should be good for Epidemiologists because of an increasing focus on monitoring patients in hospitals and health care centers to ensure positive patient outcomes. In addition, a heightened awareness of bioterrorism and rare, but infectious diseases such as West Nile Virus or severe acute respiratory syndrome (SARS) should spur demand for these workers.

The median wage in 2012 for Epidemiologists in California was \$79,354 annually or \$38.15 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A master's degree in public health or a related field is the minimum educational requirement, but some employers require doctorate degrees.
- Epidemiologists who work in hospitals and health care centers often must have a medical degree with specific training in infectious diseases.
- Epidemiologists who administer drugs are required to be licensed physicians.
- Strong analytical, communication, and leadership skills are vital in senior-level positions.

For more information about this occupation, view the [California Occupational Guide](#).

Management Analysts in California

Common Biotechnology Occupational Titles: Industrial Analysts, Management Consultants, Program Management Analysts, Process Analysts, Process Management Analysts, and Quality Control Analysts.

What Would I Do?

Businesses rely on Management Analysts to help them stay competitive in a changing world. Frequently referred to as management consultants in the private sector, Management Analysts analyze and propose ways to improve an organization's structure, efficiency, and profits.

In the biotechnology field, Management Analysts may work as process analysts who support a variety of process improvement projects and activities. They may be responsible for analyzing, refining, and developing business processes, identifying process improvement opportunities, disseminating information, and facilitating collaboration efforts. In addition, Management Analysts may develop procedural documents, including process maps, working documents, and clinical study manuals in compliance with regulatory requirements and processes.

Job Outlook and Wages

Strong competition is expected for Management Analyst jobs. Since this is an attractive field with high earnings potential, employers have a good pool from which to select potential candidates.

The median wage in 2012 for Management Analysts in California was \$84,448 annually or \$40.60 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree is sufficient for some entry-level positions.
- A master's degree, such as a Master of Business Administration, is required for higher-level positions, especially in a technical field.
- Specialized experience, such as in Supply Chain Management, may be preferred.

For more information about this occupation, view the [California Occupational Guide](#).

Market Research Analysts and Marketing Specialists in California

Common Biotechnology Occupational Titles: Business Development Specialists, Client Service and Consulting Managers, Communications Specialists, Market Research Consultants, Product Line Managers, and Project Managers.

What Would I Do?

Market Research Analysts are responsible for creating surveys, conducting focus groups, and analyzing the data that is gathered to develop products that will appeal to consumers. Market Research Analysts help their employer or client understand wants and needs of consumers. Consumers can tell them the products they like, the products they want, and how much they would be willing to pay for them. Consumers can also provide Market Research Analysts with feedback on advertising and political campaigns, allowing the Analysts to refine television or print ads in order to appeal to larger audiences.

Market Research Analysts can work in a variety of biotechnology fields applying their knowledge to assess market potential for new and existing products. For example, Analysts working for a pharmaceutical company may study the unmet needs of people with diabetes to guide product development.

Job Outlook and Wages

High employment growth is projected for Market Research Analysts. Job prospects will be best for those with a master's degree or higher. Those with a bachelor's degree and strong quantitative skills may find entry-level positions, but advancement opportunities may be limited.

The median wage in 2012 for Market Research Analysts and Marketing Specialists in California was \$68,104 annually or \$34.74 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in business, social science, or mathematics is generally required.
- A master's degree or higher is usually needed for more technical positions.
- Coursework in research methodology, statistics, and computer science is recommended.

For more information about this occupation, view the [California Occupational Guide](#).

Medical and Clinical Laboratory Technicians in California

Common Biotechnology Occupational Titles: Laboratory Assistants, Laboratory Associates, and Medical Laboratory Technicians (MLT).

What Would I Do?

Medical and Clinical Laboratory Technicians collect, examine, and analyze bodily fluids, tissue samples, blood, and other substances. They use a variety of techniques to detect bacteria, viruses, fungus cells, cancer cells, and other agents of disease. In California, these workers are often referred to as Medical Laboratory Technicians (MLTs). They work under the supervision of a licensed physician, surgeon, doctoral scientist, pathologist, clinical laboratory bioanalyst, clinical laboratory scientist, or a clinical laboratory specialist.

In the biotechnology industry, Medical Laboratory Technicians may work with clinical scientists to create new processes for converting biomass into fuel and chemical products. They may also work with microorganisms designed for the production of new chemicals and biomolecules.

Job Outlook and Wages

The job prospects for Medical Laboratory Technicians are good. New, increasingly powerful diagnostic tests should encourage additional testing and spur employment growth. In addition, the volume of laboratory tests continues to increase with population growth.

The median wage in 2012 for Medical and Clinical Laboratory Technicians in California was \$40,799 annually or \$19.61 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- An associate degree in chemical, physical, biological, or clinical laboratory science, including a minimum of 36 semester units of physical or biological science from an accredited college or university, is required.
- Additional training or experience is required to become licensed and to work in California.

For more information about this occupation, view the [California Occupational Guide](#).

Medical and Clinical Laboratory Technologists in California

Common Biotechnology Occupational Titles: Clinical Laboratory Scientists, Lab Technologists, Medical Laboratory Scientists, and Medical Technologists.

What Would I Do?

Medical and Clinical Laboratory Technologists perform complex chemical, biological, hematological, and microscopic tests. They prepare specimens for testing and microscopic examination. After testing and examining a specimen, they analyze the results and record the findings into a database. Medical Technologists develop and modify procedures as well as establish and monitor programs to ensure the accuracy of tests.

In the biotechnology industry, Medical and Clinical Laboratory Technologists may work with human genetic information to develop new medicines for serious and life-threatening diseases. They may perform basic and specialized testing of specimens for analysis; processes samples and prepares blood and bone marrow smears. Other Medical and Clinical Laboratory Technologists may work with enzymes from engineered microorganisms that optimize the production processes and environmental conditions required for industrial-scale chemical and fuel production.

Job Outlook and Wages

Employment of Medical and Clinical Lab Technologists will see some growth. This is due to the increasing volume of laboratory tests as the population ages, new types of tests being developed, and health care legislation.

The median wage in 2012 for Medical and Clinical Laboratory Technologists in California was \$81,068 annually or \$38.97 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- Entry-level jobs require a bachelor's degree in medical technology or in a life science.
- To test and analyze human samples, certification by the National Accrediting Agency for Clinical Laboratory Sciences (NAACLS) and licensure by the California Department of Public Health (CDPH) is required.

For more information about this occupation, view the [California Occupational Guide](#).

Medical Scientists, Except Epidemiologists in California

Common Biotechnology Occupational Titles: Clinical Laboratory Scientists, Clinical Research Associates, Clinical Research Directors, Clinical Researchers, Clinical Research Scientists, Senior Scientists, and Statistical Scientists.

What Would I Do?

Medical Scientists deal with the understanding of human diseases, the improvement of human health, and the advancement of knowledge of living organisms. Many scientists conduct biomedical research and development to advance knowledge of life processes and living organisms, including viruses, bacteria, and other infectious agents. Past research has resulted in advances in the diagnosis, treatment, and prevention of many diseases and the development of new vaccines, drugs, and treatment procedures.

Medical Scientists in some biotechnology industry segments may use statistical and bioinformatics tools to process data in the production of therapeutical proteins and other biomedical treatments. They may also devise new experiments and develop improved techniques to conduct innovative research. Senior scientists may provide analytical leadership in the development and execution of medical strategies, plans, and projects.

Job Outlook and Wages

Medical Scientists with both a doctor of philosophy (Ph.D.) degree and a medical degree (M.D.) should find many job opportunities.

The median wage in 2012 for Medical Scientists in California was \$83,430 annually or \$40.12 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A Ph.D. in a biological science is required.
- To administer drug or gene therapy, draw blood, take tissue samples, or perform other invasive procedures, a medical license is required.
- To be licensed, physicians must graduate from an accredited medical school, pass a licensing examination, and complete one to seven years of graduate school.
- Extensive experience in clinical research and statistics or biostatistics may also be required.

For more information about this occupation, view the [California Occupational Guide](#).

Microbiologists in California

Common Biotechnology Occupational Titles: Agricultural Microbiologists, Clinical Microbiologists, Industrial Microbiologists, and Medical Microbiologists.

What Would I Do?

Microbiologists study the growth, structure, development, and other characteristics of microscopic organisms, such as bacteria, algae, or fungi. They also study the relationship between organisms and disease or the effects of antibiotics on microorganisms.

Microbiologists can apply their expertise in a variety of biotechnology fields. Those who work in a medical or clinical setting, work with physicians, dentists, and medical researchers studying the interactions between microorganisms and humans to determine how and why diseases occur. They work in the industrial sector developing new methods of preservation for food and pharmaceutical supplies. Microbiologists working in the agricultural industry study the effects of microorganisms on soil and agricultural products and the use of microorganisms as agents of insect control. They also investigate the nutritional role played by microorganisms such as those found in cattle and sheep.

Job Outlook and Wages

Many factors contribute to the demand for Microbiologists. These include a growing and aging population, the increase in potential health hazards, additional wastewater plants, and the need for more efficient methods of wastewater disposal treatment.

The median wage in 2012 for Microbiologists in California was \$77,332 annually or \$37.18 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in microbiology, biology, or the equivalent is required.
- Depending on the job, a master's or Ph.D. degree may be preferred.
- Licensure with the California Department of Public Health may be required.

For more information about this occupation, view the [California Occupational Guide](#).

Natural Sciences Managers in California

Common Biotechnology Occupational Titles: Clinical Operation Program Leaders, Clinical Research Coordinators, Laboratory Managers, Research Science Managers, and Scientific Managers.

What Would I Do?

Natural Sciences Managers may oversee the work activities of scientists by coordinating production, quality control, or testing. Their job may also involve administrative and supervisory procedures. Some Natural Sciences Managers who work in research and development plan, design, assist, and manage projects.

Natural Sciences Managers in the biotechnology industry ensure research activities are performed in accordance with state and federal regulations, lab policy, and compliance requirements. They may implement laboratory procedures, including quality control, validation, and instrumentation methods and documentation. Others may be involved in maintaining laboratory accreditation and quality assurance programs.

Some Natural Sciences Managers lead research teams in clinical trials or studies. They may assist in advancing scientific research, developing new products, and improving manufacturing and production processes. Some Natural Sciences Managers may train research associates on specific protocols and instruments including mass spectrometers, liquid handlers, and other clinical apparatuses.

Job Outlook and Wages

With the increased focus on the environment, additional opportunities are expected for Natural Sciences Managers. California leads the nation in terms of its support of environmental practices, thus creating a strong market for Natural Sciences Managers.

The median wage in 2012 for Natural Sciences Managers in California was \$143,098 annually or \$68.79 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree in the natural sciences such as biological science, chemistry, geology, physics, and mathematics, or a related field is required.
- Advanced computer skills are also vital.

For more information about this occupation, view the [California Occupational Guide](#).

Statisticians in California

Common Biotechnology Occupational Titles: Biostatisticians, Clinical Data Analysts, Clinical Statistics Managers, Research Analysts, Research Associates, and Statistical Analysts.

What Would I Do?

Statisticians collect large amounts of statistical data and interpret the information so they can provide insight or offer possible solutions. They work in a variety of fields such as government, marketing, health care, and manufacturing. Statisticians working in government agencies may help guide government policy. Insurance companies may employ them to calculate risk. Manufacturing companies may hire Statisticians to design experiments to test their products.

Statisticians working in the biotechnology field may specialize in the design of studies or clinical trials. Their work may involve different problems such as testing new drug treatments on different viruses or learning new factors that cause certain diseases. Some Statisticians develop protocol for data collection. They may also supervise teams to ensure that all members are trained and follow procedures for collecting data. They may also review study protocols, author statistical sections of protocols, and develop statistical and data analysis plans.

Job Outlook and Wages

Job prospects should be good for Statisticians because of the continuing expansion of scientific and technical information. Large increases in available data from the Internet have also opened up new areas for statistical analysis.

The median wage in 2012 for Statisticians in California was \$89,712 annually or \$43.13 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A bachelor's degree may be sufficient for some entry-level Statistician jobs.
- Many employers require a master's degree in statistics or another closely related field, such as mathematics.
- Research and academic jobs generally require a Ph.D.
- A background in biology, chemistry, or health science is essential in the biotechnology field.
- Knowledge of statistical programming packages is also important.

For more information about this occupation, view the [California Occupational Guide](#).

Technical Writers in California

Common Biotechnology Occupational Titles: Documentation Writers, Handbook Writers, Manual Writers, Scientific Writers, Specifications Writers, and Technical Communicators.

What Would I Do?

Technical Writers put technical information into easily understandable language for their intended audience. They must write in a concise and easy-to-read manner for consumer publications or in highly specialized language for experts. They also prepare product documentation, such as operating and maintenance manuals, catalogs, assembly instructions, project proposals, and training materials.

In the biotechnology industry, Technical Writers may be involved in writing laboratory manuals, marketing brochures, research and project reports, and other publications for pharmaceutical companies, and other biotechnology firms, such as those involved in agricultural, energy, and environmental research.

Job Outlook and Wages

The demand for Technical Writers is expected to increase because of the continuing expansion of scientific and technical information, especially in California, and the need to communicate it to others.

The median wage in 2012 for Technical Writers in California was \$81,101 annually or \$38.99 hourly. The median is the point at which half of the workers earn more and half earn less.

For additional information on job growth and wages, view [projected growth and wages](#).

How Do I Qualify?

- A four-year college degree in communications, journalism, or English is preferred, or a degree in another field and a certificate in technical writing.
- Some firms will only hire experienced writers who specialize in one field of technology.
- A strong background of technical knowledge and experience, combined with writing skills, is also important.

For more information about this occupation, view the [California Occupational Guide](#).

Biotechnology Resources

Below is a list of selected biotechnology organizations and online resources. Please note that this is not a comprehensive list; it is provided to encourage the reader's further research for opportunities in biotechnology.

California

BayBio: Northern California's Life Science Association
www.baybio.org

BayBio Institute: Northern California's Life Science Institute
www.baybioinstitute.org

BIOCOM: A large regional life science association in Southern California
www.biocom.org

Bio-Community: BayBio Institute's science education and outreach program
www.bio-community.org

California Biotechnology Foundation
www.cabiotech.org

California Community College Biological Technologies Initiative
www.cccbitech.org

California State University Program for Education and Research in Biotechnology
www.calstate.edu/csuperb

Los Angeles/Orange County Economic and Workforce Development Biotechnology Center
www.pasadena.edu/LAOC-biotech/index.cfm?dept=laocbiotech

North Valley Biotechnology Center
arc.losrios.edu/~biotech

Northern California Bay Area Biotechnology Center
www.ohlone.edu/instr/biotech/biotechcenter/services.html

San Diego Biotechnology Education Consortium
www.sdbiotechcareers.org

The Southern California Biotechnology Center
faculty.sdmiramar.edu/biotech/index.html

Teen Biotech Challenge at UC Davis
teenbiotechchallenge.ucdavis.edu/index.html

University of California Davis Biotechnology Program
www.biotech.ucdavis.edu

University of California Division of Agriculture and Natural Resources Statewide
Biotechnology Workgroup
www.ucbiotech.org

National

Biotech Careers (The Bio-Link Career Site)
www.biotech-careers.org

Biotechnology Industry Organization
www.bio.org

Biotechnology Institute
www.biotechinstitute.org

The National Advanced Technological Education (ATE) Center of Excellence for
Biotechnology
www.bio-link.org

National Center for Biotechnology Information
www.ncbi.nlm.nih.gov

Project on Emerging Nanotechnologies
www.nanotechproject.org

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