

A Critical Analysis of the Local Biotechnology Industry Cluster In Alameda, Contra Costa, & Solano Counties

Volume I - Executive Summary

June 27, 2002

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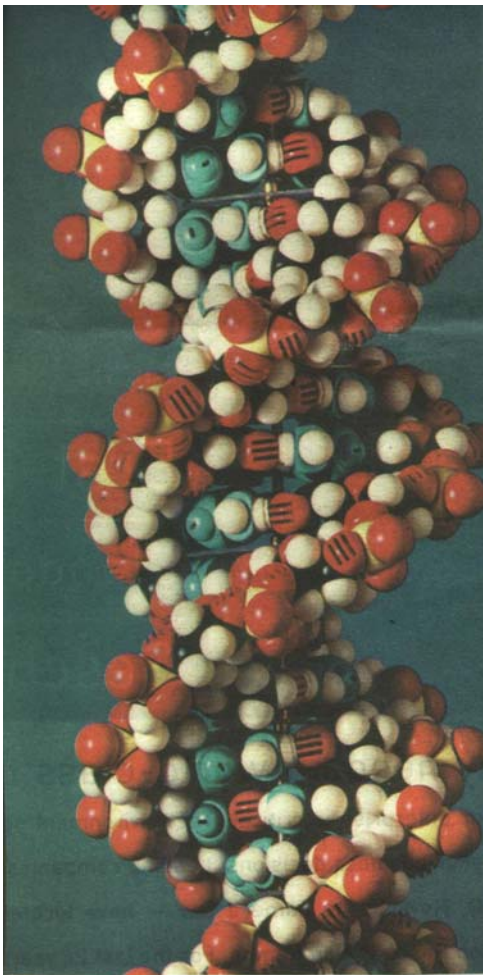
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Volume I – Executive Summary

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I. Introduction

The San Francisco Bay Area is considered to be the birthplace of the biotechnology industry. As the industry developed it expanded to other states and countries. Today, biotechnology is increasingly becoming an important economic development strategy around the world as regions and communities try to capture the economic benefits of this promising industry. With competition to incubate, retain, and attract biotech firms heating up, local economic development and workforce development officials need to understand the issues facing the industry and the factors affecting its continued growth.

This Study examines the Biotechnology Industry cluster in Alameda, Contra Costa, and Solano Counties and its importance to local economies. Specifically, the study analyzes the structure of the biotechnology industry, its employment base, prospects for future growth, impediments to growth, and opportunities for sustaining the industry in the three-county region. The study also identifies job opportunities for local residents, the types of jobs available, workforce qualifications, and the availability of training and education programs. Industry trend data along with survey results and company interviews have been used to identify economic development and workforce development strategies that will help grow this vital industry in the coming years.

In summary, the report has two key objectives:

First, to develop public policies those sustain and enhance the biotechnology industry in the three county study area.

Second, to develop workforce development strategies that create appropriate job opportunities for local residents in the industry.

The executive summary follows the same sequence of topics as the main report (Vol. II). For details on any of the topics in the Executive Summary (Vol. I), please see the corresponding part in Vol. II.

II. Biotechnology Market Trends

Merger and acquisition (M&A) activity in the biotechnology industry during the past several years will continue as big pharmaceutical companies gets bigger with the top companies taking an increasingly greater share of the market. One-product/service companies will become less viable helping to drive M&A activity as the industry consolidates. However, increasing M&A activity will not mean a shrinkage in the number of biotech firms as the industry continues to expand its boundaries in areas such as systems biology, proteomics, genomics, and bioinformatics.

As the industry moves toward system biology several technologies need to be linked together and biotech firms will continue to acquire companies with different technologies ranging from computational biology to massive data processing.

New firms will emerge in proteomics as the field is expected to increase sales from \$1.6 billion in 2001 to \$5.8 billion in 2005. There is also growing interest in nutraceuticals, organics, and alternative medicine as the public continues to become more aware about the link between diet, disease and preventive medicine. The development of the biomarker industry will gather momentum, as its importance grows in tracking the efficacy of nutraceuticals in achieving desired results.

Increasingly pharmaceutical firms will bring diagnostic capacity into their firms, as drug utilization will be driven by the ability to diagnose disease and monitoring of progress via biomarkers. This trend will result in new business alliances as well as acquisitions.

Major high-tech firms outside the current biotech industry such as IBM, Sun Microsystems, Motorola, and Agilent, will not idly watch as biotech firms begin to intrude into areas where these firms have expertise and competence. These major high-tech companies could become acquirers of biotech firms and become major players in the new biotech industry.

The biotechnology industry will continue to face major challenges. New biotechnology developments, such as genomics based medicine, genetically enhanced organisms, cloning, stem cell, and biomarkers, are often viewed with suspicion. Lack of understanding about these promising techniques will delay and lengthen research as well as the development process for new products.

III. Biotechnology Industry Future

The future for the local biotechnology industry looks bright given the Study Area's competitive advantages related to cost, including land prices and housing, compared to the rest of the Bay Area. The Study Area is also poised to take advantage of the industry's future growth, which is driven by the discovery of new technologies and research, much of which is coming out of local universities, national laboratories, governmental agencies, research organizations.

A. Technology

New technology and research will continue to drive the biotechnology industry. Some of the new research areas include:

Bioinformatics and Computer Science

Genomics and proteomics developments will lead to increased attention in bioinformatics over the next decade. Efforts to establish procedures to handle massive amounts of data will be a priority. Ways to efficiently store, retrieve, annotate, and analyze data will be strongly emphasized. Experts are already predicting that additional information beyond genomics and proteomics will be required to develop a complete understanding of a cell's functioning.

Nanotechnology

Development of increasingly smaller devices to carry out biotechnology procedures will continue, largely driven by cost containment objectives. Miniaturization of biosensors to monitor important clinical analytes (glucose), and multiplexed diagnostics procedures on a chip will follow. Micro-fluidics devices too will constitute an important focus for biotech in the immediate future.

Stem Cell Research

Exciting developments in the past 2-3 years reveal that stem cells, primordial cell precursors of all body tissues and organs, can under appropriate cell culture conditions be coaxed to differentiate into specific cell lineages. Initial experimentation was demonstrated with embryonic stem cells from early stage embryos. Very recently stem cells isolated from adult tissue sources also have been shown to possess totipotential properties. The latter development may help circumvent bioethical concerns of using embryonic stem cells. Experimentation into use of stem cells to generate replacement body organs will constitute an active area of biotech development over the next 5-10 years.

B. Products

Personalized medicine and pharmacogenomics

With the advent of understanding the genomic and proteomic basis for human disease, both in terms of cause and susceptibility, it will shortly become possible to identify and detect minute genetic differences between individuals exhibiting the same symptoms. Such correlations will in turn lead to better understanding of an individual's response to drugs and thus permit more

effective treatment regimes. As a consequence, the population will become subdivided into smaller and smaller sub-groups each with its own specific preferences for drug intervention.

Gene therapy

Early attempts to correct genetic defects using gene therapy have shown limited success. Well-publicized failures have prompted the public as well as the research community to question whether or not our current biotechnology understanding is adequate. As a consequence more basic work is needed. These efforts will continue throughout the next decade with clinical tests commencing only after bioethical issues have been resolved.

Agricultural biotechnology

Efforts will increase to educate the public about the benefits to the consumer for genetically engineered crop improvements. Increasingly, the emphasis will be on multi-genic quality traits rather than simple single-gene agronomic ones that benefit only the grower. Nutraceuticals, functional food, edible vaccines, and crop improvements carrying benefits to counter heart disease, cancer, viral diseases, will be areas of focus for the industry in the coming years.

IV. Industry Cluster Analysis

A. Structure of Local Biotechnology Industry

There are a total of 164 biotechnology firms located in Alameda, Contra Costa, and Solano counties. Biotech employment trend data for the region indicates the industry has grown rapidly during the past decade. The data for Alameda County shows job growth of nearly 150 % over the 1992 - 2000 time period. Contra Costa County on the other hand saw relatively modest biotech employment growth over the past ten years. Solano County had little biotech employment in 1992 but grew tremendously in the late 1990s. Based on the substantial growth in employment during the last decade, there is little doubt that the biotechnology industry will continue to grow in the three-county region at least for the foreseeable future. The reasons include the regions many positive "biotech friendly" attributes including proximity to major research centers, relatively affordable space cost, and a skilled workforce.

Small firms dominate the region's biotechnology industry. Mid to large sized firms, however, generate the majority of biotech jobs in the region.

New companies will continue to be started within the Study Area because of its proximity to leading research centers and venture capital. Whether the Study Area can fully capitalize on the biotechnology industry's future growth will depend on the region's ability to meet the industry's need for affordable space, trained workforce, competitive cost, adequate infrastructure, and a quality living environment that is affordable to its workforce.

A county-by -county breakdown of biotech jobs reveals a distinct pattern (see Map 1). Alameda County has the lion's share of the region's biotechnology firms and jobs. This is due primarily to the County's favorable location with respect to proximity to research universities as well as its relatively affordable industrial and residential space. In addition, the top three biotechnology firm host cities (in terms of number of firms) include Hayward, Alameda, and Fremont.

The top ten biotech job creating cities in the region in order of importance are Emeryville, Berkeley, Fremont, Hayward, Pleasanton, Richmond, Alameda, Vacaville, Hercules, and Benicia. However, when we rank the cities by jobs per firm the ranking of the cities change and the ranking slightly favors cities in Solano and Contra Costa Counties— Emeryville ranks #1, Hercules ranks #2, Vacaville ranks #3, and Richmond ranks #6. This is because of primary focus in these cities is on manufacturing. The city of Emeryville is unique in that it ranks #1 in terms of total jobs as well as in jobs/firms ratio. This may be explained by Emeryville's favorable location in the East Bay as well as it's proactive economic development policy.

In Alameda County the ranking of the biggest job-creating biotech segments are pharmaceutical and diagnostics production followed by R&D. In Contra Costa County the distribution of jobs is fairly well balanced between production, R&D, and testing. In Solano County the dominant segment is production with the Genentech plant in Vacaville accounting for more than half of the biotech jobs.

**Map 1: Biotechnology Companies in the Three County Region
Ten Largest Employers Identified By Name**



Source: Munroe Consulting Inc, Grubb & Ellis, See also Appendix A.

The three county region has a strong R&D component as well as a production focus. However, in terms of the number of jobs, biotech production leads R&D activities in the region.

It is not surprising to find that the majority of the top ten biotech job creating firms in the region focus on production. The large biotech operations are located in the outlying cities of the region because of less expensive land as well as economic development incentives from host communities. These cities include Pleasanton (Thoratec Labs., Roche Diagnostics), Vacaville (Chiron, Genentech and Alza), Benicia (Bio-Rad), Hercules (Bio-Rad), and Fremont (Target Therapeutics). Richmond (Burlax and Bio-Rad) and Emeryville (Chiron, the largest employer in the region), also have been very successful in attracting large production facilities as well as a large number of diverse biotech companies. Their success is a result of excellent "biotech location" as well as effective economic development strategies.

B. Location Factors

In a survey of local biotech companies, when asked, “*Why did your company choose to locate or relocate here?*” the most common response was:

- a. Lower space costs/land values, ranked # 1 or 2
- b. Housing choices/costs, ranked # 2
- c. Skilled workforce, ranked # 3

Other major factors in choosing to locate in the study area include freeway access, lower wage rates, business climate, and proximity to other biotech firms, academic institutions and research centers.

While biotechnology companies strongly prefer to have their manufacturing operations as close as possible to their R&D centers and other critical support functions, cost considerations such as land, construction, taxes, utilities, and labor become a major factor in determining the location of production and distribution facilities. As biotechnology companies in the region transition through the testing and approval stages and move into production, distribution and marketing, the high costs of operating in the Bay Area compared to other states or countries will become a significant disadvantage.

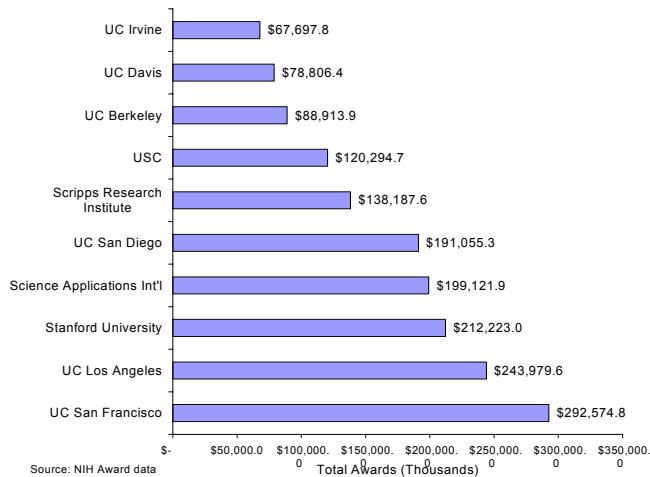
V. Industry Cluster Competitiveness Analysis

The three county region's attributes in terms of sustaining and growing the biotechnology industry is not just what is available in the three counties but clearly a function of the resources of the Bay Area as well as that of the state of California. The three county region's competitiveness depends on:

A. Research

A strong local and regional research presence is critical to the success of the biotechnology industry. The San Francisco Bay Area leads the country in the concentration of research centers and in the number of patents granted. World-class institutions include UC Berkeley, UC San Francisco, Stanford University, and Ernest Orlando Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratories, Sandia National Laboratory, Western Human Genome Project, NASA Ames, and US Department of Agriculture's Plant Genome Center, the California Institute for Bioengineering and Quantitative Biomedical research (QB3). If we go slightly beyond the Bay Area other centers of research excellence include UC Davis, and UC Santa Cruz.

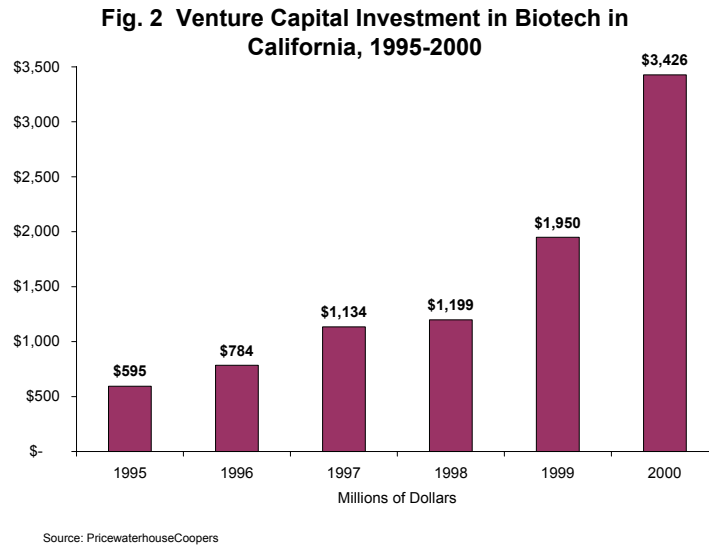
Figure 1 California Research Institutions Receiving Most NIH Grants, 2000.



Federal funding from the National Institutes of Health (NIH) is important for continuing biotech research. Bay Area research institutions received nearly \$593 million of NIH grants with the lions share (\$292 million) going to UC San Francisco (see Figure 1). Bay Area Universities garnered more than a third of the NIH grants in California. Research grants are the key source for funding early stage basic research.

B. Investment Capital

The San Francisco Bay area is home to varied sources of investment capital from angel investors, to venture capital firms (VC's), merchant banks, commercial banks, and major investment houses (see Figure 2). The presence of a variety of investors nearby is a significant advantage for the region's startups as well as mature biotech companies. A considerable amount of advice and business support from biotech-savvy investors is available to new companies and an important source of mentoring.



Despite the presence of VC's in the region, money will continue to be a problem for small- and medium-size biotech ventures, even with viable products because of high cash burn rates and fairly lengthy timeframe for getting products to market.¹ But on the positive side many mid-size biotech firms in the East Bay are flush with cash.

C. Cost Factors

The study area offers relatively lower priced housing, facilities, and labor compared to San Francisco, San Mateo County, or Silicon Valley.

Land costs, construction costs, taxes, utilities, supply of labor, and support costs are major factors in determining location of production and distribution facilities. While biotechnology companies, because of their sophistication and high knowledge content, favor these operations to be close to the R&D and other support functions. The study area's biotech future lies in accommodating production facilities of the companies that have been spawned in the Bay Area as well as encouraging R&D related startups in the region.

¹ Source: East Bay Business Times, April 5, 2002, p.9.

Although cost considerations are very important for siting and success of biotechnology manufacturing plants that is not the case for R&D facilities and start-ups. The primary site location factor contributing to the regional development of the industry is the existence of a critical mass of biotech companies and proximity to major research universities. Start-up companies are focused entirely on R &D and consider traditional economic development incentives such as tax breaks, cost of space, local regulation, and wage rates as marginal inducements.

All of the biotech companies interviewed as part of this study periodically receive inquiries/literature from other areas trying to attract them to move to their area. San Diego, Seattle, the Research Triangle area in North Carolina, and Scotland offer attractive packages of financial and infrastructure support as incentives to relocate. Many other areas in the U.S. are actively promoting locations and incentives to attract new biotechnology companies at industry meetings, trade shows, and industry publications.

When asked, "*What do you consider to be the principle barriers to your company's growth?*" survey respondents indicated the following concerns:

Cost of living (overwhelmingly ranked # 1)
High space costs (generally ranked # 2)

It will be a mistake to think of the Bay Area's lead as a center for biotech R&D companies as insurmountable. Other places have comparable intellectual resources that rival the Bay Region's strength in intellectual capacity. Competing locations include San Diego, Seattle, Research Triangle (N.C.), Austin, and Boston among others.

In this connection it is important to remember that the siting of Genentech, ALZA, and Chiron were the result of much courting of the companies with a host of incentives promised from federal, state, county and city agencies, the Solano Irrigation District, Pacific Gas & Electric Company, and Solano Community College. It is quite likely that local government and economic development agencies need to have a proactive and aggressive role in retaining and attracting manufacturing facilities in the region.

D. Infrastructure Needs

Since the biotechnology industry grows primarily through the growth of small companies, a bioscience incubator will help nurture these small fledgling companies during their early start-up stage. By providing affordable wet lab space, which is often difficult to find within the Study Area, along with business assistance and access to shared equipment, entrepreneurs will be encouraged to start new companies within the region. Development of a bioscience incubator will allow the Study Area to support the formation of new biotechnology companies that are based on the research and technologies coming out of local universities and research laboratories.

When asked: "*What infrastructure can a community provide that would be attractive to the Biotechnology Industry?*" the respondents indicated the following preferences:

Help develop hazardous materials disposal process, help enhance telecommunications infrastructure, help enhance access to public transit system; help enhance/ locate academic research centers, fast-track permit approvals, and workforce training

When asked, "*What can economic development organizations do to help support the growth of the Biotechnology Industry locally?*" the respondents answered:

Establish an incubator; develop public awareness about the value of biotechnology to society and community; identify pre-zoned sites (clustering is very important); help develop workforce training programs; help enhance infrastructure; encourage fast track permit approvals; help improve the business climate; help develop a low interest matching loan program.

E. Regulatory Considerations

Most companies in the survey commented that they had experienced facility-related difficulties and could have used help in the following areas:

1. Obtaining permitting and zoning changes.
2. Finding appropriate space (i.e. wet lab space, or space with the combination of lab, office, development, etc) with safe 24/7 access for employees and utilities that include special water/air/uninterruptible power sources, and hi-speed telecom lines.
3. Finding cost-effective project management expertise as well as contractors to handle the facility construction, upgrading, and necessary permits.
4. Finding good restaurants and lodging for out of town visitors, potential investors, university faculty, and corporate partners. (specific mention was made in the case of Richmond and Fremont).
5. Finding people who have the capability of managing public policy issues relating to employment/labor/health/fire/safety requirements.
6. Financing of leasehold improvements, equipment as well as equity financing alternatives.

F. Competitiveness Analysis

The details of the analysis are in Volume II, p. 45. The indicators chosen for the competitive analysis (see Table 1) are based upon the work of Gus Koehler of the California Research Bureau, currently the head of EdNet in Sacramento (see page 43 of Volume II for details).

Table 1: Competitive Analysis of the Study Area Biotechnology Industry Cluster

Ratings are based on a scale of 1 to 5, with 1 as Excellent and 5 as Poor.

	Study Area	San Francisco Peninsula	San Diego	Boston	Research Triangle	Maryland	New York	New Jersey
Local Research Institutions	2	1	2	1	2	3	2	3
Financial Resources								
Research Grants	4	1	3	2	4	4	2	3
Venture Capital	3	1	3	3	3	4	2	3
IPO	4	1	2	2	4	4	4	4
Workforce								
PhD's, College Graduates	1	1	1	1	2	3	2	3
Community College	4	3	3	2	2	3	3	4
High School	4	3	3	3	3	3	3	4
Networks & Mentorship								
Networks & Mentorship	5	1	1	1	2	3	2	3
Infrastructure								
Service Providers	3	1	1	1	2	2	1	3
Physical	2	4	2	2	1	1	4	3
Incubators	5	5	5	5	5	5	5	5
Research Parks	5	5	3	3	3	1	2	5
Biotech Media								
Biotech Media	3	2	3	2	3	3	3	4
Cost Considerations								
Cost Considerations	3	5	3	3	2	2	4	2

(Note: The analysis and ratings in this matrix were developed on the basis of several studies as well as judgmental factors of the authors. The studies include: A.T.Kearney, **The Golden Gap-Opportunities for San Francisco and the Bay Area in the Biotechnology Industry**, 9/99; A.T.Kearney, **The Golden Bridge-Recommendations for San Francisco and the Bay Area**, 9/99;)

Several key conclusions for the study area emerge from the competitiveness analysis (rating in this analysis are 1 to 5, 1 being excellent and 5 being poor):

1. Research

The study area compares favorably with other competing regions except for the San Francisco Peninsula and Boston. Study Area Rating: 2, with 1 being excellent.

2. Financial Resources

The study area rates significantly below the San Francisco Peninsula and ranks slightly below San Diego, Boston, and New York. Study Area Rating: 3.7

3. Work Force

The study area rates poorly in this category except at college and postgraduate level work force. San Francisco Peninsula, Boston, San Diego, and New York all rank higher than the study area in this category. Study Area Rating: 3.7

4. Relationship Network and Mentoring

The study area obtains the lowest rating in this category. Study Area Rating: 5.

5. Infrastructure

The study area does not rank favorably in this category and is comparable to the San Francisco Peninsula in this category. However it ranks significantly lower than other regions such as San Diego, Boston, Research Triangle and Maryland. Study Area Rating: 3.75.

6. Biotech Print and Broadcast Media

The study area appears to be competitive with other regions. Study Area Rating: 3.

7. Cost Considerations

The study area has a definite advantage over the San Francisco Peninsula in this category. However, other regions such as Research Triangle (NC) and Maryland have definite cost advantage over the study area. Study Area Rating: 3.

Overall, the Study Area has a clear-cut advantage over the San Francisco Peninsula in terms of cost, which disappears when we consider other regions in the United States. Finally, it is clear that there are several regions in addition to the San Francisco Peninsula that have high quality research institutions including San Diego, Boston, the Research Triangle, and New York. Hence, the case for the study area's complacency in this matter is unwarranted.

While cost considerations are very important for siting and success of biotechnology manufacturing plants that is not the case for R&D facilities and start-ups. The primary site location factors contributing to the regional development of the biotechnology industry is the existence of a critical mass of biotech companies and proximity to major research universities. Start-up companies are focused almost entirely on R&D and consider traditional economic development location incentives such as tax breaks, cost of space, local regulation, and wage rates, are marginal inducements. The availability of scientists, a nearby research university, and quality of life considerations are important for start-up companies. In addition, start-ups value the availability of bank financing and venture capital as pluses for siting their companies. These considerations explain to a great extent the formation of the biotech belt, mostly consisting of small to medium sized companies, from Richmond to Fremont in the study area.

VI. Labor Market Analysis

A. Supply-Demand Assessment

Fifty-six percent (56%) of the respondents to the study survey indicated that employment in their company had increased during the past 12 months while 33% of the companies saw no change in their employment levels. Sixty-seven percent (67%) of the survey respondents indicated that they currently had at least one job opening. Over the next 12-24 months approximately 68% of the firms indicated that they expected the level of employment in their company to increase.

Finding the necessary talent to fill job openings has not been an easy task for employers in the region. Several respondents to the study survey indicated that they had to hire employees with a masters or bachelors degree for some entry-level positions because there were not enough candidates with sufficient experience and training coming out of the community colleges and/or high schools.

When asked “*How difficult is it for you to find applicants with the types of skills needed by your company?*” seventy-five percent of the survey respondents felt that it was more difficult to recruit experienced workers than entry-level workers. Several companies also found it difficult to recruit adequately trained entry-level workers.

The lack of skilled workers with a high school or AA/AS degree has meant a constant turnover and training problem in technician positions. According to Jim DeKloe, Director of Solano Community College’s biotech program, local biotechnology companies have found that “the bachelor’s level biology majors would stay about a year and then go off to graduate school. As a result companies have to train someone new. Most companies have undergone a change in philosophy. They prefer students trained at the community college because they have a more realistic view of what they’re getting in to.”²

According to HR Directors of local biotechnology companies as more products are brought to market there will be an increase in the demand for workers who are trained in manufacturing processes. Most of these positions will be for skilled technicians with two years of higher education and production experience.

When local biotechnology companies were asked about the minimum qualification for entry-level positions, forty-five percent of them indicated a high school degree, while 10% required an AA/AS degree, and forty-five percent required a bachelor’s degree. In addition to the applicant’s education, sixty-seven percent also required at least 1-2 year’s experience. Only sixteen percent required no experience. Forty percent required some level of technical skills.

The local biotechnology industry tends to hire permanent employees even though their needs change as they move from research into manufacturing. Based on the survey results, approximately two-thirds of the study areas biotech firms hire 85% or more of their workforce as full-time employees with 10% - 15% in the part-time category. Some companies also utilize

² San Francisco Chronicle, March 3, 2002, p.13.

temporary workers and independent contractors to provide flexibility as the company workload changes.

Locally, the number of technical and scientific positions within biotech firms varies widely. They range from 50% to 80% depending on the type of company, stage of development, and size of firm. Management positions in most local biotechnology companies range between 5% and 14%. Smaller companies with less than 25 employees tend to have a higher proportion of management staff.

The sales and marketing staffs of local biotechnology companies range between 15%-40%. Administrative and clerical positions made up 3%-5% of a company’s workforce. Biotechnology firms engaged in research and development typically have a small number of clerical and entry level positions, while large established bioscience companies have a need for support staff, laboratory technicians, administrative personnel, and production assistants (see Table 2).

Table 2: Percent of Workforce by Occupation

<u>Occupation</u>	Study Area Companies	San Diego Bioscience Cluster	National Drug Manufacturing Companies
Management	5% - 14%	12.4%	12.3%
Professional	5% - 12%		12.1%
Scientific/Technical	50% - 80%	43.2%	9.6%
Marketing & Sales	15% - 40%	4.9%	2.2%
Clerical & Administrative Support	3% - 5%	17.8%	10.1%
Service	2.0%	2.1%	2.0%
Production/Process Workers	10% - 20%	19.5%	51.4%
Other	2.0%	0.3%	0.3%

Source: Survey Responses

Comparing the occupational make-up of the local biotechnology industry in Table 2 with the composition of the study area’s resident labor force (see Table 3) there appear to be gaps in the resident labor force to adequately meet the needs of the local biotechnology industry. While Alameda and Contra Costa counties have a resident labor force with the management background that meets the needs of the local biotechnology industry, Solano County does not have a sufficient number of experienced managers with scientific backgrounds to meet industry needs.

If the local biotechnology industry is expected to grow and expand then local workforce and economic development officials will need to ensure that a qualified workforce is available to meet the industry’s needs.

Table 3: Composition of Resident Labor Force

OES Code		Alameda	Contra Costa	Solano
10000	Management	6.5%	6.2%	4.5%
21000-22000	Professional	2.3%	1.9%	1.1%
24000-39000	Scientific/Technical	4.3%	3.9%	3.1%
40000	Marketing & Sales	3.6%	3.0%	3.4%
50000	Clerical & Administrative Support	10.8%	12.4%	9.3%
60000-70000	Service	1.9%	2.1%	2.3%
80000-90000	Production & Process Workers	8.9%	7.2%	8.2%

Source: California Employment Development Department, County Occupational Employment Projections, 1997-2004; Craft Consulting Group analysis

B. Typical Job Categories

Careers in the bioscience industry include opportunities in research, clinical trials, product development, regulatory compliance, manufacturing, quality assurance/quality control, sales and marketing, engineering, technical support, information services, finance, administration, public relations, administrative support functions, and management. The local biotechnology industry also has a significant number of positions, including support staff, laboratory technicians, production assistants, and service personnel that do not require a four-year degree. Many of these jobs are entry-level positions that require only a high school or an AA/AS degree and can serve as stepping-stones to more senior positions with additional training and experience.

C. Career Paths

Biotechnology companies are a hybrid of science and business. Individuals with skills and experience in either area can make a career in the biotechnology industry. The most common method for getting a job in the biotechnology industry is to acquire a technical background in the life sciences with good laboratory experience. Entry-level positions for someone with an AA/AS degree include laboratory media prep technicians, lab technicians, data entry clerks, and manufacturing technicians. A four-year college degree in the biological sciences or chemistry is a logical starting point for most research positions. Further advancement in the research field usually requires additional formal education. Advancement opportunities are most limited in R&D where senior scientist positions require a Ph.D.

Advancement to higher salary and responsibility levels varies by the type of company and its stage of development. In small, early-stage companies most employees are involved in research where the principal investigator has a Ph.D. and is supported by other researchers with either a Bachelors or Masters Degrees. Laboratory technicians with an AA/AS degree conduct many of the required tests and analysis. The best opportunity for someone without an advanced degree in the biological sciences to advance their career is outside of the research and development field.

Many of the large established biotech companies have two separate career paths, one for science, and the other for business and management. Small startups generally have little need for such arrangements since the founding team (usually Ph.D. scientists) often ends up running the company.

Based on the survey most local biotech firms prefer employees with at least a bachelor's degree. Production/process workers require a high school degree, although many local biotech firms would like a four-year degree. College graduates with degrees in the life sciences have the basic knowledge required for entry-level positions in the biotechnology industry, but often lack specific laboratory skills and industry experience (see Table 4).

Table 4: Minimum Level of Education Required By Local Bioscience Companies

Occupational Category	High School	Technical Training	AA Degree	4 Year Degree	MBA	Masters Degree	Ph.D.
Management				X			
Technical/Scientific				X			
Professional (legal, accounting)				X			
Production/Process Workers	X						
Administrative/Clerical	X						
Sales & Marketing				X			
Services	X						

While there are entry-level positions for candidates with just a high school diploma, employers routinely find that only about 10 to 20 percent of applicants for entry-level positions have the basic skills and experience to be considered. Good basic skills - reading, writing, speaking, and mathematics - are absolutely essential. People with high school diplomas may be hired as glassware washers, laboratory assistants. People working in biotechnology-related jobs with only a high school diploma are generally trained on the job. Opportunity for advancement is limited without a college degree or specialized training.

D. Biotechnology Education and Training Programs

Colleges and universities within the study area and greater Bay Area educate and train a large number of college graduates with bachelors, masters, and doctorates in the biological sciences and chemistry. Although the local colleges and universities are producing graduates with the basic educational backgrounds, they apparently do not adequately prepare them with the proper skills for entry-level positions. HR Directors for local biotechnology companies remarked that recent graduates often lack certain laboratory skills and experience.

Local Bay Area colleges awarding bachelor's degrees in the biological sciences and chemistry include UC-Berkeley, UC-Davis, Stanford University, CSU-Hayward, Mills College, and St. Mary's College (see Table 5).

Table 5: Number of Undergraduate Degrees Awarded in Life Sciences By Local Colleges & Universities

Undergraduate Degrees Awarded	College/University (1)							
	UCD	UCB	UCSF (3)	Stanford	UCSC	CSU Hayward	Mills College	St. Mary's College
"Biological Sciences" (2)	198	363	-	135	166	83	4	13
"Biochemistry"	174	93	-	-	34	7	7	3
Biotechnology	61	-	-	-	-	-	-	-
Bioengineering	53	46	-	-	-	-	-	-
"Molecular Biology"	-	636	-	-	105	-	-	-
Neurobiology	38	87	-	-	-	-	-	-
Genetics	48	73	-	-	-	-	-	-
"Microbial Biology"	-	28	-	-	-	-	-	-
Entomology	1	-	-	-	-	-	-	-
Microbiology	49	-	-	-	-	-	-	-
"Plant Sciences"	43	-	-	-	-	-	-	-
Cell Biology	13	275	-	-	-	-	-	-
Chemical Engineering	15	109	-	18	-	-	-	-
Chemistry	33	120	-	15	35	8	1	-
"Food Biochemistry"	91	41	-	-	-	-	-	-
"Computer Sciences"	72	-	-	124	92	107	2	3
"Veterinary Sciences"	104	-	-	-	-	-	-	-
TOTAL	993	1871	0	292	432	205	14	19

1. Except for UCB for which data represents 1999-2000, other institution data is for 2000-2001.

2. Degree descriptions enclosed in quotes represent collections of similar degrees.

3. Graduate School only.

Source: Hutton Associates research

Table 6: Bioscience Programs at Local Community Colleges

Community Colleges In Study Area	Bioscience Majors			Certificate Program
	Biology AA/AS Degree	Chemistry AA/AS Degree	Biotechnology AA/AS Degree	Biotechnology Certificate
College of Alameda	1	-	-	-
Chabot Community College	1	-	-	-
Laney Community College	-	-	-	23
Vista Community College	-	-	4	3
Merritt Community College	-	2	-	-
Las Positas Community College	4	1	-	-
Contra Costa Community College	48	-	9	-
Diablo Valley Community College	-	-	-	-
Los Medanos Community College	-	-	-	-
Solano Community College	7	1	2	9
Ohlone College	-	-	-	21
TOTAL	61	4	15	56

1. Except for Solano Community College for which data represents 1999-2000, all other institutions are for 2000-2001.

2. AA/AS degrees awarded are not broken out by discipline.

Source: Hutton Associates research

There is a need for greater development and promotion of the skills needed at the high school and community college level to sustain the growth of this industry cluster. HR Directors emphasized the importance of acquiring the math, science, computer and communication skills for jobs in the biotechnology industry. Individuals with a high school diploma and general education that have not taken any science courses lack the basic skill set to enter the biotechnology industry. Several local community colleges offer AA/AS degrees for majors in biology and chemistry (see Table 6), but few high school districts have developed specialized biotechnology programs at the high school level. A better job must be done in communicating the broad range of job opportunities in the biotechnology industry to the entire student population.

As the industry and related technologies continue to evolve and develop rapidly, there will be an ongoing need for specialized training to keep workers current in their field as well as gain new skills.

E. Firms Willing to Hire CalWorks

None of the biotech companies that were interviewed or that responded to the survey used CalWorks candidates. On the other hand, 100% of companies would consider hiring CalWorks candidates if they have the necessary training. Only a couple of companies surveyed had even a vague notion of what CalWorks does. Most were interested in learning more and believed it sounded like a good resource for entry-level, clerical, administrative, and support personnel. Several companies did question the advisability of hiring technical and lab personnel through CalWorks.

Hard skills were their primary consideration in hiring. All of the firms surveyed indicated that prior experience and hard skills were more important than soft skills. Although the question was not asked, it is assumed that an applicant had to have the appropriate soft skills to be hired or they would be terminated before completing their probationary period.

F. Typical Recruiting Practices

Proximity is a factor when local biotech companies hire. Alameda and Contra Costa County biotech firms generally hire within the same county or from the adjacent county. Survey respondents reported having to pay housing allowances of up to \$20,000 to \$30,000 phased out over 2 to 3 years on top of competitive salaries and relocation costs to attract qualified scientists, managers, and executives from outside the Bay Area.

Local biotechnology companies utilize all forms of recruitment, but the leading sources are referrals and the Internet. Other primary recruitment methods include newspaper ads, internal hiring or promotion, and local colleges. Some of the local biotech firms use outside recruiters to find scientific personnel and management talent.

Word of mouth, Internet searches, and advertising are common ways the Internet job seeker can learn about websites posting biotech jobs. Additionally, local college and university career centers often have knowledge of these websites and can be a valuable resource. Most local colleges and university career centers post job information on their own websites. All of the medium and large companies have their own websites and the majority of them have job openings posted. Temporary and staffing agencies will post some jobs on their website and allow for resume submission. Staffing agencies tend to rely more on contact by phone than by e-mail. The bioscience-specific websites tend to be more comprehensive than the general job sites.

VII. Public Policy Recommendations

Public Policy Recommendations are based on the Study's findings and reflect best practices from around the country. According to a recent report by the California State University Program for Education and Research in Biotechnology, "the nation's biotech industry is now "in play" and will remain so for many decades, especially as the fruits of the genome projects are harvested to address the many problems of human disease, the food supply, and the environment." Although the Bay Area is the birthplace of the biotechnology industry it cannot take early success for granted. Other communities throughout the United States and the world are aggressively pursuing strategies to attract, nurture, and grow this promising new industry. To avoid losing what could be a primary industry for the Study Area in the 21st century, local decision-makers need to adopt strategies recommended in this report to maintain the region's competitiveness. In addition, if the region wants to maximize biotechnology opportunities in the Study Area, then local decision-makers need to implement some of the best practices employed by other biotechnology regions in the United States.

A. Economic Development Programs

The types of activities that have led to the successful attraction and development of a local biotechnology industry include a variety of programs to improve the areas competitiveness, as well as support the growth and expansion of existing companies. The following strategies, if implemented, are designed to help attract, retain, and nurture the growth of the local biotechnology industry.

1. Improve the Study Area's Competitiveness

- a. Set up regional business assistance/promotional center that could take an active role providing centralized direction and support to implementing improvements that will foster the continued growth of this industry cluster. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).
- b. Maintain the Study Areas cost competitiveness by addressing transportation and housing cost issues. (Study Findings – see Vol. II, Section 4, p. 21 & 26).
- c. Identify local city, county, and business resources for biotechnology companies on a common website promoting the region's biotechnology industry. (Best Practices).
- d. Identify local resources and link the region's Centers of Excellence engaged in life science/biotechnology related research. (Best Practices).

2. Support Local Research & Commercialization of New Technologies

- a. Expand and strengthen local research base. Funding for education and basic research. (Best Practices).
- b. Funding for biotechnology research that can be commercialized. (Best Practices).
- c. Facilitate the technology transfer process from local research institutions to local biotechnology companies. (Best Practices).
- d. Develop a searchable Internet database of regional biotechnology research expertise. Seek foundation grants to fund the project. (Best Practices).
- e. Maintain competitiveness in grant funding and in attracting leading researchers. (Study Findings – see Vol. II, Section 5, p. 34-35; Best Practices).
- f. Strengthen and encourage the commercialization of biotechnology-based research in local universities, government agencies, national labs, and research institutions. (Best Practices).
- g. Meet with local universities to discuss economic development efforts and research needs to support the local biotechnology industry. (Best Practices).

3. Monitor Emerging Technologies

- a. Much of the growth in biotechnology comes from new technologies and drug discovery. Local economic development agencies should survey local universities and research organizations as to the type of research being conducted locally. (Best Practices).
- b. Explore legislation similar to the New Jersey law that allows new and emerging biotechnology companies to sell allowable net operating losses and unused research and development tax credits to profitable companies to get the cash they need to go to the next level without incurring debt or dilution. (Best Practices).
- c. Assist local companies with technology transfer from local research institutions. (Best Practices).
- d. Assist local companies with applying for Federal and State research grants in emerging technologies. (Best Practices).
- e. Inventory biotechnology related research within the region and support emerging specialties where the region has a competitive edge. (Best Practices).

4. Encourage the Formation of New Biotech Firms

- a. Develop a Bioscience Incubator(s) within the three county region to support new start-up companies. The availability of affordable wet laboratory space and specialized equipment are very important to startup companies. (Study Findings – see Vol. II, Section 5, p. 39; Best Practices).
- b. Attract sources of investment capital (public and private) for start-up companies. (Study Findings – see Vol. II, Section 5, p. 37; Best Practices).

5. Support the Growth and Expansion of Biotech Firms Within The Region

- a. Develop a Science and Technology Research Park to house and support biotechnology companies emerging from incubators as well as later stage companies. As industrial parks supported the growth of the manufacturing sector, technology research parks can play a similar role in supporting the biotechnology industry. (Best Practices).
- b. Facilitate the clustering of newly formed companies through the construction of new facilities around research institutions or in science and technology research parks. (Best Practices).
- c. Pre-zone development sites with the proper infrastructure and telecommunication capabilities to meet the needs of biotechnology companies. Locate development sites near public transit and freeway access. (Study Findings – see Vol. II, Section 5, p. 41; Best Practices).
- d. Promote the development of pilot manufacturing plants and contract manufacturing facilities (bio-processing, fermentation, and cell culture). The lack of investment capital makes it very difficult for many small companies to build their own manufacturing facilities. (Study Findings; Best Practices).
- e. Assist expanding and relocating firms with site selection and permitting. (Best Practices).

6. Improve Regulatory Environment

- a. Review list of land use regulations including permitted and conditional uses to allow for biotech labs and manufacturing facilities in appropriate zoning categories. Minimize the level of discretionary review required for uses that meet relevant industrial performance standards. (Study Findings – see Vol. II, Section 5, p. 41; Best Practices).

- b. Develop a common or standard set of land use, environmental, and building code regulations for the three county study area that addresses the needs of the Biotechnology Industry. (Best Practices).
- c. Establish an Ombudsman similar to San Diego County that can assist biotechnology companies with land use, environmental, and building permit approvals. (Best Practices).
- d. Train local building and planning officials about the biotechnology industry. Hold meetings with facilities managers, local architects, engineers, contractors, and building code and planning officials involved in designing, approving, and constructing bioscience facilities. Provide annual recognition to local cities and counties that develop best practices similar to the Contra Costa Economic Partnership's program. (Best Practices).
- e. Review list of hazardous materials and chemicals that are typically used in a biotech research laboratories and manufacturing facilities and develop standard storage, handling, and disposal procedures based on the National Institutes of Health bio-safety standards. (Best Practices).

7. Improve and Facilitate Networking Among Industry Participants

- a. Establish a Forum for dialogue between the industry and local economic development officials, and academia in the three county region: the local biotechnology industry has not established the roots and linkages to the community commensurate with other industries. Its needs are diverse and rapidly changing. Many of its educational, job training and infrastructure requirements are very different from other industry clusters. (Study Findings – see Vol. II, Section 5, p. 38; Best Practices).
- b. Forums for networking and developing relationship between the industry, government, university, and investment communities. (Best Practices).
- c. Create better networks by strengthening links between researchers, local industry, academia, professional service providers, economic development, and workforce training officials. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).

8. Establish Marketing and Business Attraction Programs

- a. Develop a region-wide marketing program and materials to provide information about the region and its resources to biotechnology companies interested in relocating to the area. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).

- b. Attend trade fairs and conferences to market the region. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).
- c. Promote the region through newspaper articles, trade journals, and other publications. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).
- d. Link each economic development agency website with a common website focused on the region’s biotechnology industry. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).
- e. Setup a website to market the region similar to www.biopoint.org. Other websites to review include www.bioability.com, www.wabio.com, and www.ebtc.org. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).
- f. Encourage complementary industries that support and service the biotechnology industry to locate within the region. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).
- g. Jointly fund a position focused on promoting and marketing the region as a location for the biotechnology. Consideration should be given to whether this position is best located within an existing organization such as the Bay Area Bioscience Center, EDAB, or a new stand alone organization representing the three county region. (Study Findings – see Vol. II, Section 4, p. 43; Best Practices).

9. Identify and Develop Funding Sources For Local Biotechnology Firms

- a. Assist local firms with finding funding. (Study Findings – see Vol. II, Section 4, p. 37; Best Practices).
- b. Hold venture capital fairs on the biotechnology industry. (Study Findings – see Vol. II, Section 4, p. 37; Best Practices).
- c. Develop local sources of funding and loan programs. (Study Findings – see Vol. II, Section 4, p. 37; Best Practices).
- d. Develop database of venture capital firms focused on the life sciences and biotechnology. (Study Findings – see Vol. II, Section 4, p. 37; Best Practices).

B. Workforce Development

Hearings by the State of California have pointed to the most critical short-term and long-term industry workforce needs being skill sets associated with the transition of companies from the discovery, basic research mode into FDA approval, commercialization and manufacturing. Surveys of local biotechnology firms and interviews with human resource directors of local

biotechnology firms point to similar concerns. Training is required in the areas of regulatory affairs and FDA compliance, bio-pharmaceutical and medical device quality control and quality assurance, current good manufacturing practice, clinical affairs, clinical biostatistics, technology management, project management, data management, management of drug development, bio-pharmaceutical marketing, and biotechnology entrepreneurialism and business development. The proposed actions address the workforce needs of the local biotechnology industry.

1. Improve Communication Between Industry and Local Schools

- a. Develop a program for the local biotechnology industry to interact with local high school and community college teachers and students regarding the job potential and opportunities within the local biotechnology industry. The program should also allow development of curriculum to meet the basic educational needs of the biotechnology industry. There is concern that California is falling behind many of the other biotech cluster areas in primary and secondary education. (Study Findings – see Vol. II, Section 4, p. 38; Best Practices).
- b. Set up meeting with Biotech HR Directors, Work Force Development officials, and Education and Training Providers. Biotechnology is a knowledge-based industry that requires a supply of qualified and trained workers. Education, skills, training, experience. Local economic development and workforce development officials need to work closely with local community college and high school officials. (Study Findings – see Vol. II, Section 4, p. 38; Best Practices).
- c. Invite the Human Resources heads of each member of the cluster to participate in development of a dialogue with the education/social services community to identify specific needs that can be addressed both short term and long term. Likely opportunities will appear that can be solved within the existing framework. Also, opportunities will be identified that will require more information and adjustments. (Study Findings – see Vol. II, Section 4, p. 38; Best Practices).

2. Improve and Expand Workforce Training Programs

- a. Expand Berkeley Biotechnology Education Inc program into other high schools. Provide internship programs and specialized laboratory training for high school and community college students. There is a need for greater development and promotion of the skills needed at the high school and community college level to sustain the growth of this industry cluster. (Study Findings – see Vol. II, Section 6, p. 46; Best Practices).
- b. Set up company sponsored programs such as Job Shadowing, Mentoring, Internships, Work/Study and Job Fairs. Help sponsor events aimed at grade school through Community College populations (both students and teachers)

at appropriate locations in the Study Area with the objective of creating awareness of future job possibilities and requirements in the biotechnology industry. (Study Findings – see Vol. II, Section 6, p. 46; Best Practices).

- c. Establish outreach programs focused on local high school and community colleges to attract prospective entry-level employees. Develop seminar programs and hands-on workshops at school and business sites. Increase the number of business Open Day and let the public see what a biotech company does. In addition, encourage younger employees to go out into the community to spread the word on biotechnology career opportunities. (Study Findings – see Vol. II, Section 6, p. 49; Best Practices).
- d. Create scholarship programs and internships for local high school and community college students to work in the biotechnology industry. (Study Findings – see Vol. II, Section 6, p. 47; Best Practices).
- e. Set up biotechnology workforce training center similar to that proposed for the Pasadena Bioscience Innovation and Training Center offering applied, industry-oriented workforce training (see www.pasadenabiotech.com). (Study Findings – see Vol. II, Section 6, pp. 55-58; Best Practices).

3. Management Skill Development

Develop training programs at local community and four-year college levels for scientists that need managerial training and business managers that need courses in understanding biotechnology and managing the scientific research and development process. Most scientists have not been trained in the necessary skills to manage large groups of employees and/or manage effectively across functional departmental lines. Managers with business experience generally do not have the science background that is essential to running a biotech company. It is difficult to find people with the combination of skills required by the biotechnology industry. (Study Findings – see Vol. II, Section 6, p. 47; Best Practices).

C. Subregional Policies

In addition to adopting region-wide strategies, specific actions are needed to enhance the competitiveness of the individual counties.

1. Solano County

- a. Support and encourage new startups in Solano County. Vacaville has a critical mass of large established biotechnology companies and Solano Community College is located in Fairfield. Dixon, Vacaville, and Fairfield could attract start-up companies coming out of UC Davis.

- b. Expand education and training programs at Solano Community College for training laboratory technicians, manufacturing process workers, quality control/quality assurance, development of science management skills. Encourage local high schools to offer classes in biotechnology and laboratory practices similar to the ROP Career Development Program in Contra Costa County or the Berkeley Biotechnology Education program in Alameda County.
- c. Develop the physical infrastructure, including affordable wet lab space and broadband telecommunications networks with freeway access and in close proximity to other biotech firms. Ensure that the sites are properly zoned and building officials are familiar with the unique requirements of the biotechnology industry.
- d. Encourage the development of contract manufacturing facilities to locate in Solano County. Develop economic incentives to attract both contract manufacturing and contract research organizations.
- e. Develop a Technology Business Park at Mare Island in Vallejo.

2. Contra Costa County

- a. Support the development of a bioscience incubator in West County to house start-up and early-stage bioscience companies that need affordable wet lab space and business assistance.
- b. Pre-zone sites for and support the development of a science and technology research park to house young biotechnology companies. Provide the appropriate infrastructure, including white tablecloth restaurants and hotels, broadband telecommunication networks, and other amenities to attract companies looking to expand in the East Bay.
- c. Develop a Science & Technology Research Park in west Contra Costa County to take advantage of the proximity of UC Berkeley and Ernesto Orlando Lawrence Berkeley National Laboratory in Berkeley and the USDA Plant Genome Center in Albany.
- d. Expand the biotechnology education and laboratory training programs being offered at Contra Costa Community College.
- e. Encourage the development of more biotechnology and laboratory science classes at local high schools similar to the ROP Career Development Program at Concord High, Richmond High, Northgate High, and other local high schools.

- f. Setup biotechnology workforce training center similar to that proposed for the Pasadena Bioscience Innovation and Training Center offering applied, industry-oriented workforce training (see www.pasadenabiotech.com).
- g. Promote opportunities for the clustering of biotechnology research companies around the Joint Genome Institute in Walnut Creek.
- h. Cooperate with Alameda County in expanding the growing number of medical device and bioscience companies in the Tri-Valley area.

3. Alameda County

- a. Develop funding programs to support the construction of biotechnology facilities.
- b. Expand education and training programs similar to what is being offered at Berkeley Biotechnology Education program at both the high school and community levels.
- c. Support the development of a science and technology research park to house young biotechnology companies. Pre-zone sites for biotechnology industrial parks. Provide the appropriate infrastructure, including white tablecloth restaurants and hotels, broadband telecommunication networks, and other amenities to attract companies looking to expand in the East Bay.
- d. Facilitate the clustering of newly formed companies through the construction of new facilities in the Oakland, Emeryville, Berkeley area to take advantage of the proximity of UC Berkeley and the existing cluster of biotechnology companies in the area.
- e. Develop a Technology Business Park in the Hayward/Fremont area to take advantage of the proximity of CSU-Hayward and its bioinformatics program and the growing number of biotechnology and high tech companies in southern Alameda County.
- f. Cooperate with Contra Costa County in expanding the growing number of medical device and bioscience companies in the Tri-Valley area. Develop relationships with Lawrence Livermore and Sandia National Laboratories to help promote the Tri-Valley area as a biotechnology location.