

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

## **Volume III -- Appendix**

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## Appendix A: Tri-County Database of Biotechnology Firms

Company	City	Website	Location
Dynavax Technologies Corp	Berkeley	dynavax.com	Headquarters
BioMedicines, Inc.	Emeryville	biomedicines.inc.com	Headquarters
Abed Laboratories Inc	Berkeley		Headquarters
Aventis Pharmaceuticals Inc (Gencell)	Hayward	aventispharma-us.com	Branch
Aeron Biotechnology (Lifecycles Laboratory)	San Leandro	aeron.com	Headquarters
Allozyme	Oakland		Headquarters
Avigen, Inc	Alameda	avigen.com	Headquarters
Berkeley Advanced Biomaterials	Berkeley		Headquarters
Baxter Healthcare Corporation (Hyland Division)	Hayward	baxter.com	Branch
Baxter Novacor	Oakland		Branch
Bexel Biotechnology Inc	Union City	bexelbiotech.com	Headquarters
Biex Inc	Dublin	biex.com	Headquarters
Bio Medical and Services	Alameda	biomed.com	Headquarters
Biochain Institute	Hayward	biochain.com	Headquarters
Biolog Inc	Hayward	biolog.com	Headquarters
Biologix	Hayward		Headquarters
Biosics	Berkeley		Headquarters
BiosPacific, Inc.	Emeryville	biospacific.com	Headquarters
Biotica Research Corp	Alameda		Headquarters
Biotime, Inc.	Berkeley		Headquarters
Cal Semi, LLC	Fremont	calsemi.com	Headquarters
Calypte Biomedical Corporation	Alameda	calypte.com	Headquarters
California Recombinant Antibody (Cara)	Berkeley		Headquarters
Calyx Therapeutics Inc	Hayward	calyxther.com	Headquarters
Chiron Corporation	Emeryville	chiron.com	Headquarters
Ciphergen Biosystems	Fremont	ciphergen.com	Headquarters
Gene Logic Inc (Data Logic)	Berkeley	genelogic.com	Branch
Diagnostic Biosystems	Pleasanton	dbiosys.com	Headquarters
Discoverx Corporation	Fremont	discoverx.com	Headquarters
DNA Plant Technology Corp. (Empresas La Moderna)	Emeryville	dnap.com	Headquarters
Genmatrix Com Incorporated	Oakland	genmatrix.com	Headquarters
Quantum Dot Corporation	Hayward	qdots.com	Headquarters
Etel Inc	Berkeley		Headquarters
Fusion Medical Technologies	Fremont	fusionmed.com	Headquarters
Gel Sciences	Hayward		Headquarters
Genetrol Biotherapeutics, Inc	Oakland	genetrol.com	Headquarters
Genteric, Inc.	Alameda	genteric.com	Headquarters
Xoma Corp	Berkeley	xoma.com	Headquarters
Immunoscience Inc	Pleasanton	immunoscience.com	Headquarters
Impax Laboratories, Inc.	Hayward	impaxlabs.com	Headquarters
Insite Vision Incorporated	Alameda	insitevision.com	Headquarters
Investigen Incorporated	Alameda	inwestigen.com	Headquarters
Lab Tools	Berkeley		Headquarters
Lumicyte, Inc	Fremont	lumicyte.com	Headquarters
Mallinckrodt Baker, Inc.	Hayward	mallbaker.com	Branch
Matrix Pharmaceutical, Inc.	Fremont	matrix.com	Headquarters
Medical Methods Research	Oakland		Branch

Mendel Biotechnology, Inc.	Hayward	mendelbio.com	Headquarters
Mergen, Ltd (formerly Pacron)	San Leandro	mergen-ltd.com	Headquarters
Micro Polymer Systems Inc	Hayward	research.ibm.com	Headquarters
Microgenics Corp (Subsidiary Boehringer Mannheim)	Fremont	microgenics.com	Headquarters
Nelson Biotech	Union City		Headquarters
Nzym Inc	San Leandro		Headquarters
Onox Inc	Fremont	onox-inc.com	Headquarters
Penta Biotech Inc	Union City	pentabiotech.com	Headquarters
Peptide Laboratory	San Pablo	peptidelab.com	Headquarters
PIC International Group, PLC	Berkeley	pic.com	Headquarters
Powderject Technologies Inc	Fremont	powderjecttech.com	Headquarters
Protein Design Labs, Inc.	Fremont	pdl.com	Headquarters
Protein Research Associates, Inc	Hayward	proteinresearch.com	Headquarters
Prozyme, Inc.	San Leandro	prozyme.com	Headquarters
Roche Diagnostics Systems Inc (Hoffman-LaRoche)	Pleasanton	roche.com	Branch
Roche Molecular Systems	Alameda	roche.com	Branch
SangStat Medical Corp., Inc.	Fremont	sangstat.com	Headquarters
Schering Plough	Pleasanton	Schering-plough.com	Headquarters
Therasense Inc	Alameda	therasense.com	Branch
Thoratec Laboratories Corp	Pleasanton	thoratec.com	Headquarters
Triton Laboratories	Alameda		Branch
Xenogen Corporation	Alameda	xenogen.com	Headquarters
Zyomyx Inc	Hayward	zyomyx.com	Headquarters
AgBioChem, Inc.	Orinda		Headquarters
Syngenta (formerly Zeneca AG/Norvartis)	Richmond	syngenta.com	Branch
American Asia United Biotechnology	San Pablo		Headquarters
Applied Human Biomechanics	El Cerrito		Headquarters
Bayer Corporation	San Ramon	bayerus.com	Branch
Berlex Biosciences, Inc (Subsidiary of Schering AG)	Richmond	berlex.com	Branch
Biocare Medical LLC	Walnut Creek	biocar.net	Headquarters
BioGenex Laboratories	San Ramon	biogenex.com	Headquarters
Biothermodynamics International	El Cerrito		Headquarters
Bioupdate, LLC	Pleasant Hill	bioupdate.com	Headquarters
Biozone Laboratories, Inc.	Pittsburg	biozone.com	Headquarters
Blackhawk Biosystems Inc	San Ramon	blackhawkbiosystems.com	Headquarters
Cerus Corp	Concord	cerus.com	Headquarters
Covance Research Products, Inc. (formerly Babco)	Richmond	crpinc.com (babco.com)	Branch
Fresenius Medical Care - North America	Walnut Creek	fmc-ag.com	Headquarters
HRI Research Inc	Concord		Headquarters
Innogenex Corporation	San Ramon	innogenex.com	Headquarters
Innovex Biosciences, Inc.	Richmond	innvx.com	Branch
Jenner Biotherapies, Inc.	San Ramon	jennerbio.com	Headquarters
Mederm Research	Lafayette		Headquarters
Microbiological Media	Concord		Headquarters
Onyx Pharmaceuticals, Inc.	Richmond	onyx-pharm.com	Headquarters
Pro Form Labs	Orinda	proformlabs.com	Headquarters
Novartis (formerly Sandoz Pharmaceuticals)	San Ramon	novartis.com	Branch
Sangamo Biosciences Inc	Richmond	sangamo.com	Headquarters
Sanofi Synthelabo Inc	Walnut Creek	sanofi-synhelabo.com	Branch
Serological Research Institute	Richmond	serological.com	Headquarters

SuperGen, Inc.	Dublin	supergen.com	Headquarters
Total Validation Services, Inc.	San Ramon		Headquarters
Zeneca Inc	Richmond	wrenet.com	Branch
Alza Corporation	Vacaville	alza.com	Branch
Biosar	Vallejo		Headquarters
Chiron Corporation	Vacaville	chiron.com	Branch
Genentech Inc	Vacaville	gene.com	Branch
Hemostat Laboratories Inc	Dixon	hemostat.com	Headquarters
Large Scale Biology Corp	Vacaville	lsbc.com	Headquarters
Proguard Inc	Suisun City		Headquarters
Xenograft Technologies	Benicia		Headquarters
Abgenix, Inc. (subsidiary of Cell Genesys, Inc.)	Fremont	abgenix.com	Headquarters
Aradigm Corporation	Hayward	aradigm.com	Unknown
Alkami Biosystems	Berkeley	alkami.com	Unknown
Metabolex, Inc.	Hayward	metabolex.com	Headquarters
Bayer Corporation	Berkeley	bayerus.com	Branch
Hitachi Genetic System (MiraiBio, Inc.)	Alameda	mirabio.com	Headquarters
ClinPro International	Union City	clinpro.com	Headquarters
Operon Technology	Alameda	operon.com	Branch
Alpha Innotech Corp	San Leandro	alphainnotech.com	Headquarters
AlphaOne Pharmaceuticals, Inc.	Alameda	alpha-one.com	
Bio-Rad Laboratories, Inc.	Benicia	bio-rad.com	Branch
AcroMetrix	Benicia	acrometrix.com	Branch
Biosentients	Emeryville	biosentients.com	
Cardima, Inc	Fremont	cardima.com	Headquarters
Cholestech Corporation	Hayward	cholestech.com	Branch
DoubleTwist, Inc (formerly Pangea Systems)	Oakland	doubletwist.com	
Advanced Bioscience Resources	Alameda		Headquarters
Austral Biologicals	San Ramon	austrabiologicals.com	Headquarters
Bay Bioanalytical Laboratory	Hercules	baybiolab.com	Headquarters
Bio-Rad Laboratories, Inc	Hercules	bio-rad.com	Headquarters
Bio-Rad Laboratories, Inc	Richmond	bio-rad.com	Branch
Biolytic Lab Performance Inc.	Fremont	biolytic.com	Headquarters
GeneTrace Systems Inc. (spinoff of SRI)	Alameda	genetrace.com	Headquarters
Octamer Inc.	San Leandro	octamer.com	Headquarters
Sepragen Corporation	San Leandro	sepragen.com	Headquarters
Synpep Corporation	Dublin	synpep.com	Headquarters
Versicor, Inc	Fremont	versicor.com	Headquarters
Advantec MFS, Inc. (formerlyToyo Roshi Int.)	Dublin	advantecmfs.com	Branch
Cortex BioChem, Inc.	San Leandro	cortex-biochem.com	Headquarters
CytoCulture Environmental Biotechnology	Richmond	cytoculture.com	Headquarters
Enzyme System Products	Livermore	enzymesys.com	Headquarters
Invivo Corp (Invivo Research, Inc.)	Pleasanton	invivocorp.com	Branch
Lab Vision Corporation (Richard Allen Scientific)	Fremont	labvision.com	
LXR Biotechnology	Richmond		
Lynx Therapeutics, Inc.	Hayward	lynxgen.com	
Neurobiological Technologies, Inc.	Richmond	ntii.com	Headquarters
Praxsys Biosystems, Inc.	San Ramon	praxsysbiosystems.com	
Questcor Pharmaceuticals, Inc. (formerly RiboGene)	Union City	ribogene.com	Headquarters
Signature BioScience, Inc.	Hayward	signaturebio.com	Headquarters
Kosan Biosciences, Inc.	Hayward	kosan.com	

Signature BioScience, Inc. (formerly Cambridge Dis	Richmond	signaturebio.com	Branch
Applera Corp (Applied Biosystems/Celera Genomics)	Pleasanton	applera.com	Branch
Celera Genomic Group (Applera Corporation)	Alameda	celera.com	
Pharmaceutical & Toxicology Research Labs (PTRL)	Hercules	ptrlwest.com	Headquarters
Research & Diagnostics Antibodies	Benicia	rdabs.com	Headquarters
Biovir Laboratories	Benicia	biovir.com	
Hematronix, Inc.	Benicia	hematronix.com	
Setec, Inc.	Livermore		
Biomeda Corporation	Hayward	biomeda.com	Headquarters
CodeGrok, Inc.	Berkeley	codegrok.com	
Northview Pacific Labs	Hercules	northviewlabs.com	Headquarters
Plexxikon, Inc.	Berkeley	plexxikon.com	
Glycomed, Inc. (Ligand)	Alameda	glycomed.com	
Somatix Therapy Corporation	Alameda		
Target Therapeutics (acquired by Boston Scientific	Fremont	tget.com	
Chronix Biomedical	Benicia	chronixbiomedical.com	Research Lab

## **Appendix B: Biotechnology Job Descriptions**

Many of the entry-level biotechnology jobs described herein are the first of several tiers within the same general areas of responsibility. Successful entry-level employees can advance into these higher positions later in their careers.

Source: California Employment Development Department, Labor Market Information, “*California Occupational Guide Number 2007 for the Biotechnology Industry*”, 1996.

### **Research and Development**

#### Laboratory Support Worker

Laboratory Support Workers are responsible for washing and caring for glassware and distributing it to appropriate locations within the laboratory. They operate and maintain the glass-washing equipment and keeps the work area clean. They may sterilize glassware and other laboratory items using an autoclave. They keep and inventory of supplies and perform routine maintenance of glass-washing equipment and other related duties as required.

#### Laboratory Assistant

Laboratory assistants are responsible for performing a wide variety of tasks in the laboratory including weighing and measuring compounds and solutions, making detailed observations, analyzing data, and interpreting results. They may also write reports and summaries regarding experiments. They may maintain laboratory equipment and inventory levels for laboratory supplies. Laboratory Assistants perform limited troubleshooting and calibration of instruments and also care for and handle animals in animal laboratories.

#### ***Education***

- High school diploma or equivalent

#### ***Experience***

- Up to two years of work experience preferred.

#### ***Skills/Knowledge***

- Ability to maintain accurate records.
- Good written and oral communication skills.
- Ability to understand and follow directions.

#### ***Education***

- High school diploma or equivalent.

#### ***Experience***

- Up to 2 years of work experience preferred.

#### ***Skills/Knowledge***

- Ability to maintain accurate records.
- Good written and oral communication skills.
- Ability to understand and follow directions.

### Greenhouse Assistant

Greenhouse Assistants perform a variety of greenhouse research tasks and experiments. They may be required to make detailed observations, detecting horticultural or pest problems and instituting corrective action. Greenhouse Assistants determine optimal cultural requirements and perform tasks relating to disease and pest prevention. They may collect, record, and analyze data and interpret results. They may also be called upon to perform troubleshooting and equipment maintenance.

### Plant Breeder

Plant Breeders work with research staff in designing, developing, executing, and implementing plant breeding research projects. They may be responsible for project planning and personnel management within the project. They work on projects to improve crop characteristics such as size, yield, and resistance to disease, weather, and insect pests. Plant breeders may use exotic germ plasma and work with various mating systems and integrate with biotechnology as needed to enhance selection methods and accelerate product development.

### Media Prep Technician

Media Prep Technicians are responsible for media preparation in the research and development area. They perform experiments as required and develop and maintain records of the procedures and experiments performed.

### ***Education***

- High school diploma, associate degree or equivalent.

### ***Experience***

- Up to 2 years relevant greenhouse or plant experience.

### ***Skills/Knowledge***

- Attention to detail.
  - Good written and oral communication skills.
  - Ability to understand and follow directions.
- Good computer skills

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years of plant breeding or agronomics experience and/or training in plant breeding or plant science.

### ***Skills/Knowledge***

Attention to detail.

- Good written and oral communication skills.
- Ability to maintain accurate records.
- Good computer skills

### ***Education***

- High school diploma or equivalent.

### ***Experience***

- Up to 2 years related experience and/or completion of a company's on-the-job training program.

### ***Skills/Knowledge***

### Research Assistant

Research Assistants do experiments, but under more supervision and with less responsibility than an experienced worker.

### Research Associate

Research Associates are typically responsible for performing research and laboratory tasks for projects and products in collaboration with others. They assist in the design and execution of experiments, make detailed observations, analyzes data, and assist in the interpretation of the results of the scientific investigation. Their work requires the preparation of technical reports, summaries, protocols, and the analyses of quantitative data. They must maintain familiarity with the current scientific literature and contributes to the process of a project. They may also be responsible for identifying patentable inventions and acting as principal investigator in conducting their own experiments.

### ***Education***

- Bachelor of Science degree, AA degree in biology or chemistry, or biotech certificate with special training.

### ***Experience***

- Six months experience at the lab assistant level or required education.

### ***Education***

- Bachelor of Science or Master's degree in a discipline such as biology, biochemistry, chemistry, molecular biology, or biotechnology.

### ***Experience***

- Have a minimum of 2 years of laboratory experience with an MS or 2-5 years with a BS.

### ***Skills/Knowledge***

- Good oral, written, and computer communication skills.
- Ability to maintain accurate records
- Ability to read and understand relevant scientific literature.
- Strong observational and computational skills.

## **Clinical Research**

### Clinical Research Administrator/Coordinator

Clinical research administrators are responsible for clinical data entry and validation to ensure legibility, completeness, and consistency of data. They assist users with requests for clinical documents and are responsible for working with physicians and their staffs to clarify any questionable information. They may be responsible for auditing internal patient files and studies and for assisting with the development and evaluation of clinical record documents.

### Clinical Programmer

Clinical programmers are responsible for coordinating and monitoring the flow of clinical data into the computer database. They analyze and evaluate clinical data, recognizing inconsistencies, and initiating resolutions to data problems. They implement data management plans designed to meet project and protocol deadlines and consult in the design and development of clinical trials, protocols, and case report forms. They also act as liaison between clinical management and subcommittees and project teams on an as-needed basis.

### Clinical Data Specialist

Clinical data specialists are responsible for collaborating with various departments on the design, documentation, testing, and implementation of clinical data studies. They develop systems for organizing data to analyze, identify, and report trends. A clinical data specialist also analyzes interrelationships data and defines logical aspects of data sets.

### ***Education***

- High school diploma or equivalent

### ***Experience***

- Minimum of 2 years' related experience.

### ***Skills/Knowledge***

### ***Education***

- Entry-level positions require a BS degree, although a Master of Science degree is often preferred.

### ***Experience***

- A minimum of 2 years experience in pharmaceutical programming in the clinical research area is also required.

### ***Skills/Knowledge***

### ***Education***

- Bachelor of Science degree or equivalent

### ***Experience***

- Minimum of 2 years related experience.

### ***Skills/Knowledge***

### Clinical Research Associate

Clinical Research Associates are responsible for the design, planning, implementation and overall direction of clinical research projects. They evaluate and analyze clinical data and coordinate activities of associates to ensure compliance with protocol and overall clinical objectives. They may also travel to field sites to supervise and coordinate clinical studies.

### Animal Handler

An animal handler is responsible for the daily care of research animals for experimental purposes. Animal handlers clean animal cages and racks, maintain records to comply with regulatory requirements and standard operating procedures, and perform preventive maintenance on facility equipment. They may also perform animal observation, grooming and minor clinical tasks.

### Animal Technician

Animal technicians are responsible for the daily care of research animals for experimental purposes. They also coordinate with vendors and supervisors on operational, administrative, and technical responsibilities. They perform some surgery and post-operative care as directed and are responsible for overseeing procurement of animals and supplies, preventive maintenance of facility equipment, cleaning of animal cages and racks, daily rounds and observation to check animal health status. They develop standard operating procedures and maintain records to comply with regulatory requirements.

### ***Education***

- Bachelor of Science, a registered nurse degree or equivalent.

### ***Experience***

- Minimum of 2 years clinical experience in medical research, nursing or the pharmaceutical industry.

### ***Skills/Knowledge***

- Knowledge of FDA regulatory requirements is preferred

### ***Education***

- High school degree or equivalent experience with a scientific background.

### ***Experience***

- Up to 2 years relevant laboratory experience is expected.

### ***Skills/Knowledge***

### ***Education***

- High school degree or equivalent experience with a scientific background.

### ***Experience***

- Up to 2 years related laboratory experience.

### ***Skills/Knowledge***

## I. Manufacturing and Production

### Product Development Engineer

Product development engineers are responsible for the design, development, modification, and enhancement of existing products and processes. The position is involved in new product scale-up, process optimization, technology transfer and process validation. He or she ensures that processes and design implementations are consistent with good labor and manufacturing practices. A product development engineer may also be responsible for contact with outside vendors and for the administration of contracts.

### Production Planner Scheduler

A production planner scheduler is responsible for planning, scheduling, coordinating and/or the final approval of products through the production cycle. He or she coordinates production plans to ensure that materials are provided according to schedules to maintain production and provides input to management. When necessary, a production planner scheduler works with the Customer Service, Marketing, Production, Quality Control, and Sales departments to review back order status, prioritize production orders, and deal with other potential schedule interruptions or re-scheduling.

#### *Education*

- Bachelor of Science degree or equivalent experience with a scientific background.

#### *Experience*

- Up to 2 years related experience.

#### *Skills/Knowledge*

#### *Education*

- Bachelor's degree or equivalent experience with a scientific background.

#### *Experience*

- Up to 2 years related.

#### *Skills/Knowledge*

### Manufacturing Technician

Manufacturing technicians are responsible for the manufacture and packaging of potential and existing products. They operate and maintain small production equipment; weigh, measure and check raw materials, and ensure that manufactured batches contain the proper ingredients and quantities. They maintain records and clean production areas to comply with regulatory requirements, good manufacturing practices, and standard operating procedures. A manufacturing technician may also assist with in-process testing to make sure that batches meet product specifications.

### Packaging Operator

A packaging operator uses manual and/or automated packaging systems to label, inspect and package final container products. He or she also enters data and imprints computer-generated labels, maintains records and maintains the manufacturing/production area to comply with regulatory requirements, good manufacturing practices and standard operating procedures. A packaging operator may also perform initial checks of completed documents for completeness and accuracy.

### Manufacturing Research Associate

A manufacturing research associate is responsible for the implementation of production procedures to optimize manufacturing processes and regulatory requirement, and he or she may be involved in packaging and distribution processes. He or she may also help maintain production equipment.

#### ***Education***

- High school degree or equivalent experience.

#### ***Experience***

- Up to 2 years related experience in a manufacturing environment.

#### ***Skills/Knowledge***

#### ***Education***

- High school degree or equivalent.

#### ***Experience***

- Up to 2 years experience in a manufacturing environment.

#### ***Skills/Knowledge***

#### ***Education***

- Bachelor of Science degree or equivalent.

#### ***Experience***

- Up to 2 years experience in a manufacturing environment.

#### ***Skills/Knowledge***

### Instrument/Calibration Technician

An instrument/calibration technician is responsible for performing maintenance, testing, troubleshooting, calibration, and repair on a variety of circuits, components, analytical equipment and instrumentation. They calibrate instruments, perform validation studies and specify and request purchase of components. He or she analyzes results, may develop test specifications and electrical schematics and maintains logs and required documentation. An instrument/calibration technician also maintains spare parts inventories and may prepare technical reports with recommendations for solutions to technical problems.

### Biochemical Development Engineer

A biochemical development engineer is responsible for the design and scale-up of processes, instruments and equipment from the laboratory through the pilot plant and manufacturing process. He or she assists the manufacturing operation in problem solving with regard to equipment and systems and participates in the design and start-up of new manufacturing facilities and equipment. He or she develops and recommends new process formulas and technologies to achieve cost effectiveness and product quality. A biochemical development engineer establishes operating equipment specifications and improves manufacturing techniques.

### ***Education***

- A.A. degree in electronics technology or equivalent.

### ***Experience***

- Up to 2 years related experience.

### ***Skills/Knowledge***

### ***Education***

- Bachelor of Science degree in biological, chemical or pharmaceutical engineering or a related discipline.

### ***Experience***

- Up to 2 years experience is required, preferably in the areas of pharmaceutical processes or research product development.

### ***Skills/Knowledge***

### Process Development Associate

A process development associate is responsible for the implementation of production procedures to optimize manufacturing processes and regulatory requirements. He or she may also assist in process development in creating scalable processes with improved product yield and reduced manufacturing systems costs. A process development associate, at the entry level, may also be involved in packaging and distribution processes and in the maintenance of production equipment. He or she may research and implement new methods and technologies to enhance operations.

### Assay Analyst

An assay analyst is responsible for doing cell cultures and performing assays and tests on tissue and cell cultures following standard protocols. He or she prepares glassware, reagents and media for cell culture use. He or she also performs, prepares and maintains tissues and cell cultures and maintains records required by good manufacturing procedures. An assay analyst also participates in the modification of assay procedures for routine implementation.

#### ***Education***

- Bachelor of Science degree in a scientific discipline or equivalent.

#### ***Experience***

- Up to 2 years.

#### ***Skills/Knowledge***

#### ***Education***

- High school diploma or equivalent.

#### ***Experience***

- Up to 2 years' related experience.

#### ***Skills/Knowledge***

## Manufacturing Engineer

A manufacturing engineer is responsible for developing, implementing, and maintaining methods, operation sequences and processes in manufacturing. He or she works with the engineering department to coordinate the release of new products. He or she estimates manufacturing costs, determines time standards and makes recommendations for process requirements of new or existing product lines. As required, a manufacturing engineer also maintains records and reporting systems for the coordination of manufacturing operations.

## Quality Control

### Quality Control Analyst

Quality control analysts conduct routine and non-routine analysis of raw materials, in process, and finished formulations according to standard operating procedures. They compile data for documentation of test procedures, prepare reports, and review data to determine if the products are being produced in accordance with specifications and report any abnormalities. They are also responsible for revising and updating company standard operating procedures and may calibrate and maintain laboratory equipment and instruments.

### ***Education***

- Bachelor of Science degree in a scientific discipline or equivalent.

### ***Experience***

- Up to 2 years' related experience, preferably in research product development or a manufacturing environment.

### ***Skills/Knowledge***

### ***Education***

- Entry-level positions require a Bachelor of Science degree in biological sciences or another scientific discipline.

### ***Experience***

- Must have a minimum of 2 years experience in a research environment in chemistry or biochemistry.

### ***Skills/Knowledge***

- Knowledge of statistical flow diagrams and process flow diagrams.
- Familiarity with regulations pertaining to good manufacturing and good laboratory practices.

### Quality Control Engineer

Quality control engineers are responsible for developing, applying, revising, and maintaining quality standards for processing materials into partially finished or finished products. He or she designs and implements methods and procedures for inspecting, testing, and evaluating the precision and accuracy of products and prepares documentation for inspection testing procedures. Depending on the job level, a quality control engineer is responsible for ensuring conformance to in-house specifications and good manufacturing practices and may conduct training programs.

### Environmental Health and Safety Specialist

A safety specialist is responsible for developing, implementing, and monitoring industrial safety programs within the company. He or she inspects plant areas to ensure compliance with Occupational Safety and Health Administration (OSHA) regulations. He or she evaluates new equipment and raw materials for safety and monitors employee exposure to chemicals and other toxic substances. A safety specialist, depending on the job level, may also conduct training programs in hazardous waste collection, disposal and radiation safety regulations.

### Quality Assurance Auditor

A quality assurance auditor is responsible for performing audits of production and quality control. He or she ensures compliance to in-house specifications/standards and good manufacturing practices.

#### ***Education***

- Bachelor of Science degree or equivalent.

#### ***Experience***

- Up to 2 years' experience in quality control systems.

#### ***Skills/Knowledge***

#### ***Education***

- Bachelor of Science degree or equivalent.

#### ***Experience***

- Up to 2 years' related experience.

#### ***Skills/Knowledge***

#### ***Education***

- Bachelor of Science degree in a scientific discipline or equivalent.

#### ***Experience***

- Up to 2 years' related experience, preferably in biological or pharmaceutical manufacturing.

#### ***Skills/Knowledge***

### Validation Engineer

A validation engineer is responsible for the calibration and validation of equipment and systems and for assisting in the selection, specification, and negotiation of competitive pricing of equipment. He or she maintains all of the documentation pertaining to qualification and validation and serves as an information resource for validation technicians, contractors and vendors.

### Validation Technician

The entry-level validation technician is responsible for developing, preparing the installation of and revising test validation procedures/protocols to ensure that a product is manufactured in accordance with appropriate regulatory agency validation requirements, internal company standards, and current industry practices. A validation technician compiles and analyzes validation data, prepares reports and makes recommendations for changes and/or improvements. He or she may also investigate and troubleshoot problems and determine solutions. He or she maintains appropriate validation documentation and files.

### Technical Writer

An entry-level technical writer is responsible for writing and editing standard operating procedures, laboratory procedure manuals and other related documents. He or she edits and/or rewrites various sources of information into a uniform style and language for regulatory compliance and assists in developing documentation for instructional, descriptive, reference and/or informational purposes.

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years' related experience.

### ***Skills/Knowledge***

### ***Education***

- High school diploma or equivalent.

### ***Experience***

- Up to 2 years' related experience.

### ***Skills/Knowledge***

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years' related experience, preferably in writing technical documentation.

### ***Skills/Knowledge***

## Regulatory Affairs

### Regulatory Affairs Specialists

A regulatory affairs specialist, at the entry level, coordinates and prepares document packages for submission to regulatory agencies, internal audits and inspections. He or she compiles all material required for submissions, license renewals and annual registrations. An incumbent monitors and improves tracking and control systems and keeps abreast of regulator procedures and changes. He or she may work with regulatory agencies and recommends strategies for earliest possible approvals of clinical trial applications.

### Documentation Coordinator

A documentation coordinator provides clerical and administrative support related to a company's documentation system requirements. He or she audits all documentation manuals to ensure that they are accurate and up-to-date and available to appropriate personnel. A documentation coordinator also files and retrieves master documents.

### Documentation Specialist

An entry-level documentation specialist is responsible for coordinating all activities related to providing required documentation and implementing related documentation systems. He or she coordinates the review and revision of procedures, specifications and forms. He or she also assists in compiling regulatory filing documents and in maintaining computerized files to support all documentation systems.

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years' related experience.

### **Skills/Knowledge**

### ***Education***

- High school diploma or equivalent.

### ***Experience***

- Up to 2 years' related experience.

### **Skills/Knowledge**

### ***Education***

- Bachelor of Science degree in a related field or equivalent.

### ***Experience***

- Up to 2 years' experience in documentation, quality assurance, technical writing or the equivalent.

### **Skills/Knowledge**

## Information Technology

### Data Entry Clerks

Data entry clerks are responsible for using a keyboard or mouse to enter clinical research data into a computer statistical database. They may operate on-line terminals, personal computers, and scanners.

### Scientific Programmer Analyst

Scientific programmer analysts design, develop, evaluate, and modify computer programs for the solution of scientific or engineering problems and for the support of research and development efforts. Documents new or existing programs and determines systems specifications, input/output processes, and working parameters for hardware/software compatibility.

### *Education*

- High school diploma or AA degree with training in word processing, data entry, spreadsheets.

### *Experience*

- Some job experience.

### *Skills/Knowledge*

- Ability to enter data at a high speed and with accuracy.
- Familiarity with technical language and terminology.

### *Education*

- Bachelor's degree in a related discipline or equivalent.

### *Experience*

- Two years experience.

### *Skills/Knowledge*

- Ability to program and devise logical procedures, perform coding, tests, and debug programs.

## Sales & Marketing

### Market Research Analyst

A market research analyst is responsible for researching and analyzing the company's markets, competition, and product mix. They perform literature research, analyze and summarize data. They analyze the competitive environment, as well as future market trends.

### Sales Representative

### Customer Service Representative

### Technical Services Representative

### *Education*

- Bachelor's degree or equivalent.

### *Experience*

- Two years experience in market research, competitive analysis, and product planning.

### *Skills/Knowledge*

- Excellent writing and research skills

## Administration

### Technical Recruiter

A technical recruiter is responsible for recruiting, interviewing and screening applicants for technical exempt and non-exempt positions. He or she coordinates pre-employment physicals, travel, reporting dates, security clearances and employment processing for new hires. He or she also conducts employee advertising, and reviews employment agency placements. In addition, a technical recruiter maintains college recruiting, affirmative action and career development programs.

### Human Resources Representative

A representative in human resources is responsible for a variety of activities in personnel administration, including employment, compensation and benefits, employee relations, equal employment opportunity, and training programs. He or she conducts job interviews, counsels employees, maintains records and conducts research and analyzes data on assigned projects.

### Patent Agent

A patent agent is responsible for preparing, filing and processing patent applications for the company. He or she negotiates and drafts patent licenses and other agreements. A patent agent also conducts state-of-the-art searches and may assist with appeal and interference proceedings.

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years' related experience.

### ***Skills/Knowledge***

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years' related experience.

### ***Skills/Knowledge***

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years' related experience. It also requires registration to practice before the U.S. Patent and Trademark Office.

### ***Skills/Knowledge***

### Buyer

A buyer is responsible for obtaining materials, scientific equipment and services. He or she checks requisitions, obtains price quotations, examines bids, and awards contracts. A buyer develops new supply sources where vendors and suppliers are inadequate. He or she coordinates purchasing activities with other departments to maintain inventory at planned levels. As required, a buyer also monitors the cost, schedule and scope of assigned subcontracts to ensure the quality and value of the contract.

### Patent Administrator

A patent administrator is responsible for preparing and coordinating all procedural documentation for patent filings and applications. He or she tracks in-house research studies and recommends the need for and timing of patent filings. A patent administrator also assists attorneys with the drafting and editing of patent applications and collects and evaluates supporting data.

His or her job includes maintaining a tracking system to comply with trademark regulations. He or she may also be called upon to assist with determining the necessity and approach to contracts to ensure protection of the company's proprietary technology. A patent administrator is also typically responsible for tracking and paying legal fees.

### ***Education***

- Bachelor of Science degree in a scientific discipline or equivalent.

### ***Experience***

- Up to 2 years' experience in purchasing, preferably in a scientific area.

### ***Skills/Knowledge***

### ***Education***

- Bachelor of Science degree or equivalent.

### ***Experience***

- Up to 2 years' related experience.

### ***Skills/Knowledge***

## Appendix C: Wage and Salary Levels

Table 1: Typical Wage & Salary Levels

Classification	Low	Median	High
<b>Research &amp; Development</b>			
Lab Technician	29,819	34,599	38,425
Research Assistant	35,313	39,078	42,964
Research Associate	47,072	51,078	55,805
Research Scientist	67,917	76,374	82,959
Microbiologist	34,686	39,691	45,392
<b>Regulatory Affairs/Clinical</b>			
Documentation Clerks	35,000	40,000	45,260
Regulatory Affairs Specialist	42,643	48,367	53,735
Project Manager	50,000	55,000	60,000
<b>Quality Control</b>			
QA/QC Analyst	35,783	39,182	43,727
QC Engineer	51,890	56,513	62,427
QC Inspectors	35,000	38,000	42,000
QA Specialist	40,192	45,064	51,153
<b>Engineering/Facilities</b>			
Engineering	\$45,000	60,000	70,000
Facility Management	\$50,000	60,000	80,000
Lab Manager	38,000	50,000	70,000
Stock Room Clerk	22,880	35,000	50,000
Calibration Technician	23,257	31,653	41,393
Instrumentation Technician	23,257	31,653	41,393
Glass Washer	24,524	27,376	32,260
<b>Information Technology</b>			
Data Entry Clerks	22,651	32,000	40,000
Programmer I	46,439	51,326	70,000
Systems Analysts	60,000	64,000	75,000
Library Assistants	28,392	50,000	60,000
Biostatistician	\$54,089	\$61,712	\$70,000
Software Development	48,133	70,000	80,000
Bioinformatics	60,000	70,000	80,000
<b>Process Manufacturing</b>			
Process Engineer	54,607	60,350	64,052
Manufacturing Technician	26,516	33,280	35,000
Production Planners	54,000	60,000	65,000
Fermentation Assistants	40,000	45,000	50,000
Process Associate	38,133	40,929	43,725

<b>General Administration</b>			
Technical Writer	44,005	49,831	56,990
Financial Managers	60,000	71,344	80,000
Human Resource Managers	45,000	63,024	80,000
Administrative Assistant	28,000	40,000	55,000
Sales Representative	55,907	62,549	70,000

Source: Information about salary levels was obtained from several sources including the survey of local biotechnology firms, Salary.com, and the Bureau of Labor Statistics, 1999 Metropolitan Area Occupational Employment and Wage Estimates, Oakland, CA PMSA

## Appendix D: List of Occupations in Drug Research & Manufacturing

### OES

<u>Code</u>	<u>Occupational Title</u>
24000	Natural Scientists & Related Workers
24100	<u>Physical Scientists</u>
24105	Chemists, except Biochemists
24199	Physical Scientists, nec
24300	<u>Life Scientists</u>
24308	Biological Scientists
24311	Medical Scientists
24399	Life Scientists
24500	<u>Physical, Life Science Technicians</u>
24502	Biological, Agricultural, & Food Technicians, except health.
24505	Chemical Technicians and Technologists
24599	Physical & Life Science Technicians, and Technologists, nec
25000	<u>Computers, Math, Operations Research &amp; Related</u>
25102	Systems Analysts
25104	Computer Support
29990	<u>Other Professional &amp; Technical Workers, nec</u>
32999	<u>Health Professionals, Paraprofessionals and Technicians, nec</u>
39000	<u>Misc. Professionals, Paraprofessionals, Technical</u>
39999	
41000	<u>First Line Supervisors, Management</u>
49000	<u>Sales</u>
49005	Sales
49008	Sales Representatives – Scientific & Related Products & Services
49999	Sales & Related Workers, nec
51000	<u>First Line Supervisors</u>
53123	Adjustment
55000	Secretarial

55108	Secretaries, except legal and medical
55323	Order Clerks
55335	Customer Service Representatives
55347	General
58008	Production, Planning, and Expediting Clerks
58023	Stock Clerks
58028	Shipping, Receiving, and Traffic Clerks
59000	Clerical and Administrative, nec
59999	
67007	
69999	Misc Service Workers
79999	
81002	First Line Supervisors and Managers
81008	First Line Supervisors and Managers
81011	First Line Supervisors and Managers
81099	All other First Line Supervisors and Managers
83002	Precision Inspectors, Testers, and Graders
83005	Production Inspectors, Testers, Graders, Sorters, Samplers, and Weighers
85118	
85119	All Other Machinery Maintenance Mechanics
85132	Maintenance Repairers, General Utility
87502	Plumbers, Pipefitters, and Steamfitters
89999	All Other Precision Workers
92935	
92562	Separating, Filtering, Clarifying, Precipitating, Still Machine Operators/Tenders
92965	Crushing, Grinding, Mixing, Blending Machine Operators/Tenders
92968	Extruding, Forming, Pressing, Compacting Machine Setters/Set-up Operators
92971	
92974	Packaging & Filling Machine Operators/Tenders
92997	All Other Machine Setters/Set-up Operators
92998	All Other Machine Operators/Tenders
93956	Assemblers & Fabricators, Ex Machine, Electrical, Electronic, Precision
93999	All Other Hand Workers

95008

98799 All Other Freight, Stock, Material Movers - Hand  
98902 Hand Packers and Packagers  
99999 Occupations Not Classified

Life scientists comprise the largest occupation among the industry's scientific and technical workers. Most of these are biological scientists who use biotechnology to recombine the genetic material of animals or plants, thus producing new drugs. Biological scientists normally specialize in a particular area. Biochemists study the action of drugs on body processes, by studying the chemical combinations and reactions involved in metabolism, reproduction, and heredity. Microbiologists grow strains of microorganisms that produce antibiotics. Physiologists investigate the effect of drugs on body functions and vital processes. Pharmacologists and zoologists study the effect of drugs on animals. Virologists grow viruses, develop vaccines, and test them in animals. Botanists, with their special knowledge of plant life, contribute to the discovery of botanical ingredients for drugs. Chemists are also important in the research and development of new drugs. Organics chemists combine new compounds for biological testing. Physical chemists separate and identify substances, determine molecular structure, and help create new compounds.

At the manufacturing stage, chemical engineers design equipment and devise manufacturing processes while bioprocess engineers design fermentation vats and various bioreactors for microorganisms that will produce a given product. Industrial engineers plan equipment layout and workflow to maintain efficient use of plant facilities. Mechanical engineers coordinate the installation and maintenance of sterilizing, heating cooling, humidifying, and ventilating equipment. <sup>1, 2</sup>

## References

### Employment and Career Information

1. California Employment Development Department, "*California Occupational Guide Number 2007*", 1996.
2. North Carolina Biotechnology Information Center, "Careers in Biotechnology", May 1993.
3. Biotech Job Descriptions – Part 1 & 2, "Biotechnology: The Choice for Your Future. A Resource Guide", Biotechnology Industry Organization, Washington, D.C., <http://www.gene.com>.

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<sup>1</sup> Bureau of Labor Statistics

<sup>2</sup> Occupational Outlook Handbook

## **Appendix E. Biotechnology Industry Interview and Survey Results:**

### **1. Location Factors**

***Promises were given that all responses would be kept confidential.*** Only summary information is included in this report. Information reflects the comments of the 10 companies that responded to the survey and/or Interview. In several cases the respondent offered multiple comments and yet in some cases declined to answer other questions. In view of this fact, the results are shown as a percent of responses of companies answering specific questions. For more open-ended questions the percent of times a specific issue was raised is shown.

#### **1. Knowing what you know today would your company make the same decision to locate here in (Alameda [6 companies], Contra Costa [3 companies] or Solano [1 company] County. If so, why? What factors make the local community attractive to your company?**

A: YES 90% —Reasons:

- a. 77%-Proximity to leading research centers i.e. ready supply of skilled scientists/knowledge workers, close to innovation, new technology etc.
- b. 55%-CEO wants to live in area
- c. 44%-Lower costs (housing/space/wages etc.) relative to San Francisco, Peninsula, Silicon Valley.
- d. 11%-(re. City of Alameda)-airports are close

B: NO 10% —Reasons:

- a. Alameda county has gotten too expensive
- b. Berkeley is anti-business.
- c. Contra Costa and Solano have advantages over Alameda

#### **2. Would you consider locating your company in some other region? If yes, then where and why? (If no, why not?)**

A. NO 50%—Reasons:

- a. Concentration of leading research centers in the Bay Area
- b. Critical mass of biotechnology companies in the Bay Area

B. Possibly 40%—Reasons:

- a. Lower costs (housing, space, wages etc.)
- b. Less congestion/commuting
- c. Incentives offered by other areas. (Areas mentioned: San Diego 100%, Boston 25%, Colorado 25%, Seattle 25%, Scotland 25%)

- C. YES 10%—Reasons:
- a. High Costs of housing, space, wages
  - b. Would consider San Diego and Colorado

**3. The Bay Area has been extraordinarily successful in biotech since the inception of the industry. In the next few years do you think that leadership position will change? If so, in what way and why? What other regions are serious challengers and why?**

- A. YES 20%—Reasons:
- a. Both U.S. and Bay area will lose leadership positions in some new areas of technology if regulations become too constraining (stem cell, cloning etc.) and pressure groups (against "bio-engineered" animals/foods/crops etc.) are not controlled and/or gain too much influence.
  - b. Other regions in the U.S. are becoming more attractive because of the Bay Area's increasing costs (housing/space/wages etc.), congestion (commuting time etc) and lack of incentives (incubators and research parks with subsidized space/infrastructure/space/telecommunications etc.).
  - c. Other areas offer tax relief programs as well as strong active support from state and regional universities, colleges, high schools (vocational training, mentoring/visiting teachers/teacher seminars/teacher and student internships) and service providers.

- B. SOMEWHAT 60%—Reasons:
- a. Depends on direction and level of funding of academic research.
  - b. Other factors that will have an impact are quality of K-12 education (particularly communication, math and science skills), costs-housing/space/wages/taxes etc. and level of regional support relative to other geographic locations.

- C. NO 20%—Reasons:
- a. Critical mass of established companies and research centers will keep Bay Area in the lead.
  - b. East Bay/Tri-Valley may gain relative to other parts of the area because of lower costs.
  - c. Other regions that are challengers: San Diego, Seattle, Boston/ Northeast, Texas, Midwest

(Wisconsin, Michigan, Illinois, Indiana, Carolinas-  
Research Triangle, Colorado, International  
(Scotland, UK, France, Switzerland)

Why? -Because they offer:

- a.) Incentives, lower costs, relocation information and introductions to important regional resources, contacts.
- b.) Conduct strong marketing promotional and recruiting efforts

**4. A) Over the next five to ten years, relative to the rest of the Bay Area, how well do you think [Alameda, Contra Costa, Solano] County will do in attracting and growing biotechnology companies? B) Is [Alameda/Contra Costa/Solano] County representative of the Bay Area in the types of biotechnology companies located here? If so, how is it representative? If not, why not?**

A-1)-Alameda: Will gain a little -probably in the Dublin, Pleasanton and Alameda Island. Other areas will see some expansion of existing companies but have cost/congestion problems. Also lacks proximity to amenities of good hotels, restaurants like San Francisco and Silicon Valley.

B-1) Alameda is viewed by the respondents as being representative of Bay Area regarding types of companies and is viewed as having a larger percentage of fully integrated (R&D, Clinical Trials, Manufacturing, Distribution, Marketing and Sales) companies.

A-2) Contra Costa: Should do better than the general area because it has the advantage of lower cost housing, space, wages, shorter commute etc. Availability of public transportation is not as good as Oakland/Emeryville/Berkeley area. A Company in West County commented on lack of good hotels and restaurants nearby.

B-2) Contra Costa is viewed as closely representative of types of biotech companies in the Bay Area but is believed to not having as many large fully integrated companies nor pharmaceutical companies.

A-3) Solano: Should do well. It has lower costs and still is close enough to research centers. Land available for production operations. May not have sufficient skilled work force. Lacks amenities of better hotels, restaurants, entertainment etc.

B-3) Solano is viewed as not representative of all biotech carried on in the Bay Area. It is thought to have diagnostics/controls development and pharma manufacturing companies, but nothing to speak of in genomics, or proteomics. Not nearly as many firms-especially, start-up and early stage firms.

**5. Please discuss the three most critical needs for your business to grow and prosper?**

- A) Financing/equity capital-50%
  - a) Reflects large number of early stage companies in this industry cluster with little or no revenue, the weak IPO market and lack of VC interest in funding Research and Development companies with little or no prospects of strong earnings on the near horizon.
  - b) Relative high costs for space, salaries and operating costs compared to other areas of country. These factors may require more capital investment for the firms in this area to get to positive cash flow than comparable firms may require in other locations.
- B) Well-trained work force-40%

Concern that it will get harder & more expensive to find employees as the industry expands.
- C) Space for expansion-40%

Cost was primary factor but availability of secure, 24/7-availability etc were also mentioned.
- D) Access to new technology-20%

See proximity of leading research centers as important.
- E) Regulations-10%

Concern that limitations on new areas of research may diminish "cutting edge" leadership.
- F) Public Awareness-10%

Concern that lack of awareness as to importance of research in potentially controversial areas may reduce funding -see E above.

**6. How can local economic development organizations assist companies such as yours to locate in (Solano County, Alameda County, and Contra Costa County)**

- A) 70%-Provide financial assistance packages, subsidies, tax advantages, loan guarantees etc. as other areas do for start-ups, facility relocation/expansions etc. Some States have matching program for those companies receiving Phase I SBIR grants –NC and MD are big competitors here.
- B) 70%-Establish Biotechnology Incubators/Research parks with appropriate zoning, infrastructure (un-interruptible power, wet lab space, up-to-date telecom support, 24/7 security), public transportation etc. that would stimulate reaching a "Critical Mass" of related companies. These types of facilities would also

attract service providers, suppliers and support services needed to sustain the continued growth.

- C) 50 %-Promote public awareness i.e. the importance of the Biotechnology industry to the region's future. It is still an emerging industry. While the Bay Area currently enjoys a leading position, there is substantial competition for the new companies that will be formed. The Bay Area needs to actively prepare for and foster the industry's local development or it may be attracted elsewhere.
- D) 40%-Workforce training and continuing education to assist in keeping employees current with changing technology and prepare additional skilled employees to sustain continued growth.
- E) 20%- Improved public transportation
- F) 20%-Assistance in HAZMAT training and streamlining/coordinating the disposal of waste.
- G) 20 %-Attract/support better local hotels and restaurants.

**7. How important is it that your suppliers be located within the same county or within the region? What suppliers would you like to have in this County?**

- A) Important-20%
- B) Somewhat-20%
- C) Not important-60%

No specific category of suppliers was identified.

**9. What specialized service providers (legal, accounting, testing lab, contract manufacturing, customized packaging, specialized warehouse) are critical to the success of your business? Do they need to be located in the same county or within the region?**

- A) Need a broad range of service providers, however, since they are already available in the Bay Area no specific providers were identified.
- B) When pressed to identify any that need to be located in same county or region, the responses were:
  - 1) Important-20% to have infrastructure suppliers i.e. HV/AC, Alarm systems, biohaulers, equipment repair personnel etc close by.
  - 2) Nice-40%
  - 3) Not a problem-40%

**10. What type(s) of relationships does your company have with other firms in the Biotechnology Industry? Having other biotechnology companies nearby an important factor in the success of your company? What types of companies are important?**

- A.) Types of relationships:
- a) Academic 60%
  - b) Contract manufacturers 60%
  - c) Licensees/strategic relationships 60%
  - d) Contract manufacturing 60%
  - e) Service providers 40%
- B.) Is having other Biotech nearby important?
- a) Yes-60 %-attracts better level of services, employee pool etc.
  - b) No-40%-not an issue niche player, specialized early stage etc.
- C.) Type of Company that is important?
- a). Contract manufacturer-40%
  - b) Non-Competitor that will share equipment-20%

**11. What role do research organizations and universities play in your company's success? Is it important that your company locate in close proximity (i.e. within 10-15 miles) of a local academic institution and/or research lab important? If yes, why? (Please identify which institutions or research centers).**

- A) Very 20%—source of emerging technology
- B) Important 60%—source of advice/information/new employees
- C) Little 20%—can get information needed from literature/internet/suppliers

Institutions that are important:

- A) UC Berkeley-60%
- B) Stanford-60%
- C) UCSF-40%
- D) Lawrence Livermore-20%
- E) Others mentioned: U Colorado/ U Louisville, KY/ Pitt U, PA/FBI/Dept of Justice

**12. Are Industry Organizations important to the development and growth of your business? Is it important for them to be located in the same county?**

- A) Very-----20%-accreditation
  - B) Somewhat-40%-industry information and public awareness
  - C) Little-----40%
- They were not viewed as being important to be in same county.

## **2. Public Policy Issues**

### **General Area Advantages:**

- Companies have located in the Bay Area because of the close proximity to leading educational centers, the larger successful companies that helped create the industry, the services provider availability (finance, legal accounting intellectual property, suppliers etc.) and the fact that the founders wanted to live in the Bay Area. No companies were identified that had moved here from outside the area for business reasons.
- Our three-county area offers lower housing, facilities, labor and support costs than San Francisco, the peninsula, or Silicon Valley areas. There were companies attracting employees who continue to live on the peninsula and chose to work in the East Bay because of the reverse commute-a big plus in our transportation congested area.
- As long as much of the focus of the industry remains in the discovery, verification and testing and approval stages of development, these factor will continue to support the Bay Areas edge as a growth leader in the industry. Also the three counties should continue to capture their share of that growth. .

### **Disadvantages:**

- However, as the companies in the area transition through the testing and approval stages and move into the production, distribution and marketing stages, the high costs of operating in the Bay Area will probably become a disadvantage. Lower cost land, construction, taxes, utilities; labor and support costs are major factors in determining location of production and distribution operations. In addition, because of the sophisticated, evolving technology that is used, Biotechnology companies strongly prefer to have these operations as close to the R &D and other critical support functions as possible .In view of these considerations, Other attractive and lower cost areas such as San Diego, Seattle, North Carolina, Texas, and other areas in the north east and mid-west were mentioned. Also, our distance from the corporate centers of many of the dominant pharmaceutical, medical, chemical and agricultural companies (in the mid-Atlantic and central states) may become another negative factor. However, the success of San Diego in spit of the presence of large Pharma, could argue against that.

### **Training Needs:**

- **Scientists & Researchers:** The regional universities and critical mass of other companies doing discovery, verification and testing will continue to supply well trained candidates for many of the needs in these categories. However for individuals with specialized experience in scale-up & manufacturing and in a few new areas of technology that is developed elsewhere there will continue to be a need for some recruiting from outside the area. In these cases, 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 land individuals at these levels.

- As the industry and related technologies continue to evolve and develop rapidly, there is an ongoing need for specialized training to keep existing employees current in their field as well as gain new skills. Much of this "developmental training" is encouraged by the employer but left to the individual to pursue. Often it is supplied by specialized training firms or vendors; both options tend to be expensive and may not well focused.

**Management Skill Development:**

- As most of the companies in this industry are young and growing rapidly there is a chronic need for managerial training and skill development. The scientific background is essential, however, most of the scientists have not been trained in the necessary skills to manage large groups of employees and/or manage effectively across functional departmental lines. It is difficult to find people with these combined skills early in their careers.

**Research Associate/Technician:**

- Several respondents indicated that they must hire employees with M.S. or B.S. degrees for these positions there are not enough candidates with sufficient experience/training coming out of the community college and/or high schools. There appears to be a big lag in these institutions developing programs to meet the hiring need of the rapidly growing companies in the biotechnology area. In larger companies (and often in more mature industries) where these respondents have previously worked, individuals who had graduated from these programs had higher levels of applicable skills than the candidates they see here. Or, the company had more entry level positions where they could try them out and then train them in the specific skills needed. They see this as a continuing problem because the majority of the companies in the cluster will be smaller, early stage and new/rapidly evolving technology. As currently structured, the secondary and community colleges are not able to keep up with the changes. Further, comments we made as to the lack of knowledge and interest in the high school student in acquiring the math, science, computer and communication skills for this level of work. There is a need for greater development and promotion of the skills needed to sustain the growth of this important industry cluster. A better job must be done in communicating the broader range of job opportunities to the entire student population. Not just the top 10-20% of the students that want to pursue advanced degrees.

**Infrastructure Needs:**

- Except for one very early stage firm that had started at the ACET incubator in Alameda (where they rapidly out grew the small facility)

many companies commented that they had experienced difficulties (delays, higher costs and frustration) and could have used help in:

1. Obtaining permitting and zoning changes
2. Finding the right kind of space i.e. wet lab space, or space with the combination of lab, office, development etc with appropriate utilities that include special water/air/un-interruptable power sources with out having to take a lot more space than needed and the spending big \$ to make lease-hold improvements. Also finding good contractors/ vendors to handle these and other local business issues that Scientist are not experienced with.
3. Safe 24/7 access for employees
4. Hi-speed telecom lines
5. Good restaurants and lodging for out of town visitors-potential investors, university faculty, strategic partners for major companies etc. (specific mention made in Richmond and Fremont)
6. Employment/labor/health/fire/safety requirements and ongoing management of issues in these areas
7. Financing

#### **Awareness of Area Resources:**

- Cal works—None of the interviewees had used CAL-Works. Only a couple had a vague notion of what it does. Most were interested in learning more and thought it sounded like a good resource for entry level, clerical, administrative and support personnel. One firm commented that they liked the idea of "on stop shopping" for these needs. Several questioned availability/advisability of hiring technical and lab personnel through it.
- Economic Development—None of the smaller respondents had any knowledge of what might be available.
- Recruiting—Networking, in-house referrals, and then job web sites is the usual progression. Only go to print when have to and recruiters for very special high-level positions.

#### **Educational Institution Meeting Industry Needs:**

- All indicated using faculty and staff at one or more of the big 4(Berkeley, Stanford, UCSF or Davis) for consulting, services advise training & sources for recruiting. Only two had used the community colleges for recruiting and training.
- New Technologies: Genomics/Bioinformatics Company expressed concern that there will be a shortage of people with these skills to fill need in near future.
- High Schools: all expressed concern that there is not enough communication between the industry and the school systems of the job potential /needs/ requirements to meet the future needs. Also, are

concerned that CA is falling behind many of the other biotech cluster areas in primary and secondary education.

**Competitive Areas:**

- All of the interviewees periodically receive inquiries/literature from other areas trying to attract them to move to their area. Two have received specific proposals and personal visits for the same purpose. San Diego, Seattle, the Research Triangle and Scotland offer a variety of attractive financial and infrastructure support as incentives. 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.

**Possible Public Policy Initiatives:**

- A) Establish a Forum for dialogue between the industry and the 3 County Region: While already economically important the industry cluster is at such an early formative stage that has not established the roots and linkages to community commensurate with its current and hopefully future impact. Its needs are diverse and rapidly changing. Many of its educational, job training and infrastructure requirements are very different from the existing industry clusters. Its rate of growth has been rapid and spread among a large number of newly formed companies. Its' future direction is still evolving, thus many of its leaders are not experienced in interacting and planning with the various communities and agencies. Both The industry cluster and the regional community can benefit from focused communication on current and future needs and potential solutions. This forum could explore such alternatives as setting up an East Bay Biotechnology Business Assistance 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. Set up a Task force between the Educational community and the Industry to quantify the current number of job openings, needs for specialized training etc. and develop actions to solve those needs including. Success in this arena will require companies in the Industry Cluster to provide strong leadership, support and direction in working with the community to achieve timely implementation. As a start:
1. 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 tem and long term. Likely oppourtunities will appear that can be solved within the existing framework. Also, oppourtunities will be identified that will require more information and adjustments.
  2. Set up company Job Shadowing, Mentoring, Internships, Work/Study programs and Job Fairs, etc. events aimed from grade school through Community College populations (both students and teachers) where

appropriate. Objective is to create an awareness of the range of future job possibilities and requirements. Mount outreach programs to attract prospective entry level employees – need to go to HS and Community colleges and prosyletize, motivate and promote benefits and attractiveness of biotech – the industry needs a “Guy Kawasaki” as he performed for Apple Computer in the early days. Develop seminar programs, hands-on workshops, at school sites or at companies – expand use of Open Days, invite in public, let them see what a typical biotech company does, above all else, have the younger elements from industry go out into the community to spread the word – prep them for this; nothing convinces youth like their peers!

3. Determine current, on site and off site training requirements for supervisory/management training and develop potential solutions. Evaluate current methods and \$ cost of maintaining the technical skills of current employees and explore more cost effective methods using shared and/or Community Hire an independent group of consultants to develop a master plan for solving the shortage of entry level employee prospects. Minimize bureaucracy.
4. Stimulating step 2 so the East Bay has an ardent advocate for biotech promotion jointly supported by all 3 Counties.

#### **Economic Development:**

- B) Set up joint industry/regional ED task force to identify with the Davis experience a four-step program as a workable solution to this economic development problem:
  - a. Establish a source of intellectual property already achieved).
  - b. Establish a business assistance/promotional center (BARTA has part of this).
  - c. Establish an Incubator of wet labs.
  - d. Establish research.
- Parks for businesses emerging from incubators. We are somewhere between step 1 and 2, with efforts as well being expended in 3. Resources might be better directed at needs and solutions for:
  1. Biotech Incubator.
  2. Evaluation of Econ. Dev. practices in other competitive areas such as San Diego, Seattle, Texas, Research Triangle, Atlantic and Mid Western states to identify areas for improvement/vulnerability/countermeasures.
  3. Evaluate opportunities of immediate assistance.

### 3. WORKFORCE ISSUES

1. What percentage of your workforce is classified as?

Full-Time Employees 95%      Part-Time 3%      Temporary 0.5%      Independent Contractors 1.5%

2. During the past 12 months has employment in your company been increasing, decreasing, or remained Stable?

Increased 56%      Decreased 11%  
Remained Stable 33%

3. What percentage of your workforce has [indicate % below] in the past year?

Voluntarily Quit? 13%      Been Laid off? 10%      Retired? 0%

4. Over the next 12-24 months do you expect the level of employment in your company to

Increase 67%      Decline 0%      Remain Stable 33%

5. Which occupational categories are changing (increasing or decreasing)?

Occupational Category	Increase	Decrease
Management	40%	20%
Technical/Scientific	100%	
Professional (legal, accounting, etc)	40%	
Production/Process Workers	40%	
Administrative Support/Clerical	20%	
Sales and Marketing	60%	
Services	40%	

What are the minimum educational requirements for each occupational category?

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

6. Which category of worker is more difficult to recruit (select one of the following)

Entry-level workers 10%      Both entry-level & experienced workers 10%  
 Experienced workers 60%      Neither, skilled workforce readily available 10%  
 No response 10%

7. How difficult is it for you to find applicants with the types of skills needed by your company?

Occupational Category	Very Difficult	Difficult	Moderately Difficult	Somewhat Difficult	Not Difficult
Management				X	
Technical/Scientific			X		
Professional			X		
Product & Process Development				X	
Administrative/Clerical					X
Sales & Marketing			X		
Services			X		

**Entry Level Positions:**

8. What are the minimum qualifications for entry-level positions? (Please identify both the level of education, experience, and skills).

High School Degree 63%      Community College Degree 13%      Bachelor's Degree 63%  
 No Experience 13%      Some Experience (1-2 years) 50%      Experienced (3+ years) 13%  
 Technical 25%      Physical \_\_\_\_\_ Personal \_\_\_\_\_      Basic 13%      Computer 25%

9. Do you currently use CalWorks recipients?      Yes \_\_\_\_      No 100%

10. Would you consider hiring CalWorks recipients if they have the necessary training required by your company? Yes 100% No \_\_\_
11. Are soft skills more important than prior experience or hard skills? Yes \_\_\_ No 100%
12. Do you know that CalWorks provides training for entry level workers? Yes 12% No 88%
13. May we have someone contact you regarding employment opportunities with your firm for CalWorks recipients? Yes 78% No 22%

### Typical Recruiting Practices:

14. What percentage of your workforce is recruited from?

Alameda County 24%% Contra Costa County 23%% Solano County 0%  
 Other Bay Area Counties 31% Central Valley 0% Southern California 1%  
 Out-of-State 11% International 10%

15. What recruitment methods does your company use? [Please check all that apply and rank the top three]

<u>Administrative</u>	<u>Scientific</u>	<u>Management</u>	<u>Production</u>		
Newspaper	67%	56%	56%	78%	
In-house hiring or promotion	67%	56%	44%	56%	
Referrals/word-of-mouth	78%	67%	56%	78%	
Unsolicited walk-ins	11%	___	___	___	
State Employment Services	11%	___	___	___	
Colleges/Universities	56%	33%	22%	44%	
Private Vocational/Technical Schools		11%	11%	22%	22%
Recruiters	44%	33%	11%	22%	
Internet		67%	44%	44%	
44%					
Trade Publications	22%	11%	22%	11%	
Job Fairs	11%	11%	11%	11%	
Corporate Personnel Dept.	11%	11%	11%	22%	
Conference/Conventions	11%	11%	11%	___	

## Appendix F. Annotated Bibliography

### General – State of the Industry, Cluster Studies, & Infrastructure

1. A.T. Kearney, *The Golden Bridge: Recommendations for San Francisco and the Bay Area*, prepared for San Francisco Partnership and Bay Area Council, 2001.

Although the Bay Area is the world leader in biotech, it must develop a more suitable business environment for biomanufacturing to remain competitive in the industry. The report provides a number of recommendations for regional action.

2. A.T. Kearney, *The Golden Gap: Opportunities for San Francisco and the Bay Area in the Biotechnology Industry*, prepared for San Francisco Partnership and Bay Area Council, 2001.

Identifies general needs of biotech companies in site selection and measures eight regions by those criteria including the Bay Area. A survey of biotech companies is used to generate the data. The report identifies the need for greater operational sustainability infrastructure factors in the Bay Area as the industry is maturing. It also points out that biotech firms are expanding in regions other than the Bay Area because these factors are missing.

3. A.T. Kearney, *The Golden Industry: Biotechnology in San Francisco and the Bay Area*, prepared for San Francisco Partnership and Bay Area Council, 2001.

A description of the history of biotechnology in the Bay Area. The report is based largely on secondary research. It portrays how the industry has moved from being young to maturing.

4. "Biotech Eden," *Chemical and Engineering News*, Vol. 79: 10, 2001, p. 41.

Describes growth of biotech industry in San Diego. Examines role played by the CONNECT Program (a UCSD virtual incubator), the extraordinary aggregation of academic centers of excellence, the generations of companies spawned by earlier established parental startups, and a progressive environment that fosters aggressive entrepreneurship.

5. "Biotechnology Europe: Leveling the Playing Field," *Science*, Vol. 291: 5507, 2001, p. 1373.

Progress report on biotechnology industry in Europe. Although Germany, the UK and France still lead Europe in stimulating domestic biotechnology industries, other nations are racing hard to catch up. Government and corporate incentives schemes are proving their worth in stimulating startup activities.

6. Burrill & Co, *Biotech 2000: Life Sciences, Changes and Challenges*, 2000

Steve Burrill's annual biotechnology industry report. Reviews and summarizes industry financials, valuations, and market caps. Updates on various sectors including, healthcare, agbio, animal health, biomaterials, genomics and nutraceuticals. Provides 'The Year in Review': product news, new technologies, M&A/strategic partnering activity, finance and capital markets, the European scene and regulatory affairs.

7. California Healthcare Institute, *The Millennium Report 2000: Report on the Bay Area Biomedical R&D Industry*, 2000.

The report indicates that nearly one-third of Bay Area biomedical companies are spin-offs of academic institutions in the region and two-thirds of companies had clinical research or sponsored research with a California health/academic institution. The balance between risk and promise in the region is helped by the "brain trust" – the cluster of researchers, lawyers, entrepreneurs, venture capitalists, etc.

8. California Healthcare Institute, *The Millennium Report 2000: Report on California's Biomedical R&D Industry*, 2000.

A review of the biomedical industry in California. It reviews many of the significant milestones and trends for the industry. Key facts are given for individual regions in the state. The report points out that there is an imbalance between risk and potential return on investment in the industry. The industry needs more investment, and this imbalance must be addressed to obtain it.

9. California Trade & Commerce Agency, *Biotechnology*, May 2001.

This report attempts to describe the biotechnology industry, but recognizes there is no universal definition, so it relies heavily on CorpTech's database. Brief attention is given to the agriculture, veterinary, bioremediation, infrastructure needs, research resources, and historical investment in the industry.

10. Collaborative Economics, *Networks of Innovation: Regions Collaborating to Compete in the Global Market*, March 27, 2000.

The report utilizes primary and secondary data for 13 regions. It finds that economics and business models for biotech companies are changing, and that those changes are challenging the regions that have traditionally led the industry. The study encourages collaborative regional networks as part of the solution.

11. Craft Consulting Group, *Biotechnology Business Incubator: Market Feasibility Study*, prepared for the Contra Costa Economic Partnership, February 1998.

This study reviews the feasibility of a biotech business incubator. It provides a definition of the industry and reviews industry trends including financing, projected growth, partnering and collaboration, and entry barriers. It also reviews size and spatial distribution in the East Bay and identifies the I-80 corridor as a key area. It analysis the demand for an incubator among young biotech companies and the associated costs and risks involved.

12. Craft Consulting Group and Hutton Associates, *Davis Biotechnology Incubator Feasibility Study and Business Plan*, prepared for the City of Davis, Yolo County, and UC-Davis, March 31, 1998.

This study reviews the factors that make a region competitive in fostering biotech companies. It also divides the key factors according to start-up and maturing/manufacturing facilities. The city of Davis is analyzed for its ability to competitively attract biotech companies. The report utilizes primary data from survey results. It finds that Davis needs to develop necessary infrastructure to compete for biotech companies, but may be able to do so if it improves its business environment specific to the needs of biotech companies.

13. *Editor' & Reporters' Guide to Biotechnology*, Biotechnology Industry Organization, 2000.

A guide generated from secondary sources on terms, facts, sub-groupings, issues, history, and policy related to biotechnology.

14. Ernst & Young, *Biotech 99: Bridging the Gap*, 1999.

The report reviews industry trends. For 1999, it identified that funding had fallen for biotech companies, although alliances between companies were rising and FDA approval was beginning to move faster including 17 new products in previous year. Technology advances, such as cloning, were accelerating along with the public policy debate, which regularly captured headlines.

15. Ernst & Young, *Convergence: Ernst & Young's Biotechnology Industry Report*, 2000.

This study looks at the financial data for the industry with some comparison between major US regions. It focuses largely on how bio technologies are converging to create new promise and products. It has several interviews and roundtable discussions with CEOs from leading companies, researchers from the academia, and others speak to the amazing developments in genomics, market trends, and scientific discoveries that are transforming the industry. It also reviews recent public policy trends.

16. Ernst & Young, *Evolution: Ernst & Young's Seventh Annual European Life Sciences Report 2000*, 2000.

Highlights include a review of the key events that shaped 1999; statistics on the industry performance in 1999; perspectives from industry leaders; and thought leadership articles on topical issues such as creative financing, e-commerce and knowledge management.

17. "German Biotech: Spectacular growth vaults the industry to top European tier," *Chemical and Engineering News*, Vol. 78: 24, 2000, p. 19.

General report commenting on growth of industry, highlighting factors responsible, spinoffs from academia and industry, areas of focus and funding. Three developments largely responsible: (i) 1993 law amending genetic engineering law, (ii) large national companies substantially boosted investment

domestically, and (iii) “Bio-Regio”, national biotech competition among Germany’s several regions for government funding.

18. Institute for Biotechnology Information, *Growth of Commercial Biotechnology in Monterey County*, prepared for the County of Monterey, California, December 1999.

The report analyzes those factors that would make Monterey County attractive to more biotech companies. It identifies several key success factors for developing a commercial biotechnology center. It also outlines strategies for Monterey County to expand their biotech presence.

19. Markusen, Ann, Peter Hall, Amy Glasmeier, *High Tech America: The What, Where and Why of the Sunrise Industries*, Allen & Unwin: Boston, 1986.

This book reviews how and why high-tech companies locate in certain regions. Although it does not directly analyze the biotech industry, it does arrive at several conclusions regarding the formation of high-tech regional centers. Chapter eight examines as theory of location, the principles of which apply to the biotech industry.

20. McKinsey & Company, *The Bay Area: Leading the Transition to a Knowledge-Based Economy*, Bay Area Economic Forum, 1996.

A study comparing the economic performance of the Bay Area with other regions in the US. It notes the success of the Bay Area economy and attributes it to the rise of the knowledge-based industries, of which bioscience is one. Although the Bay Area is leading, it faces challenges in maintaining its prosperity.

21. McKinsey & Company, *The Bay Area: Winning in the New Global Economy*, Bay Area Economic Forum, September 1999.

An updated study comparing the economic performance of the Bay Area with other regions in the US. Bay Area strengths such as worker productivity, overall business performance, and quality of life are rated, as well as weaknesses such as the high cost of living, high cost of labor, and traffic congestion. Bioscience is considered as one of several industries where the Bay Area leads other regions nationally.

22. “New Home for Biotech,” *Contra Costa Times*, July 30, 2000.

Describes burgeoning biotech industry in Fremont, California. Discusses reasons for growth: affordable real estate, nearby Silicon Valley and venture capital networks, Fremont’s proactive solicitation of emerging and startup ventures, reverse commutes for employees is highly desirable, and well educated work force.

23. Pellerito, Peter M., and Michelle M. Ragozzino, Ph.D., *Bioscience in San Mateo County: An Industry Study*, prepared by the Bay Area Bioscience Center, July 1997.

24. Prevezer, Martha, "Dynamics of Industrial Clustering in Biotechnology," *Small Business Economics* 9:255-271, 1997.

A study of how the clustering process occurs in biotechnology. A model is used to consider the degree of attraction between new firms and the existing firms at a particular location. The study finds the main degree of attraction is the level of a science base at a location. It also concludes that different sectors of the biotech industry are affected differently by attraction. Therapeutics, diagnostics, and equipment/research tools tend to have a positive attraction, while chemicals, food, and some agriculture do not.

25. Swann, Peter and Martha Prevezer, "A Comparison of the Dynamics of Industrial Clustering in Computing and Biotechnology," *Research Policy*, Vol. 25, 1996, p. 1139.

A comparison of the clustering patterns in biotechnology and computing. The paper finds that for biotechnology firms the science base in a region plays a important role in promoting entry and that the growth of incumbent firms is promoted by the strength of a business' own sector. It also finds that the role of a region's science base in other high-tech industries in promoting the growth of incumbent firms is minimal.

26. The California Council on Science and Technology, *California Report on the Environment for Science and Technology*, November 1999.

Examines why high-tech industries, including biotech, are important to the state economy. Outlines a need to continue government supported research. Infrastructure to support the growth and research in high-tech industries must continue. Also outlines several policy recommendations to help other parts of the workforce take part in high-tech California.

27. The Regent's of the University of California, *The University's of California's Relationships with Industry in Research and Technology Transfer*, June 1997.

The proceedings of a retreat to discussion the University of California system's continued efforts to transfer technologies into marketable products. The speakers included several biotech experts. It also demonstrates the importance of biotech research to the university and the importance of transferring that research in ways that allow it to reach the marketplace quickly.

28. Willoughby, Kelvin W., and Edward J. Blakely, *The Economic Geography of Biotechnology in California*, Working Paper No. 90-176, Center for Real Estate and Urban Economics, UC Berkeley, 1990.

This study reviews the biotech clusters in California, the Bay Area, and the East Bay. It analyzes the factors determining location decision and the importance of location to biotech firms. It determines that the interorganizational linkages between biotech companies and universities and other research institutions are key.

## Employment & Labor Market Analysis

29. "Biotechnology," *California Occupational Guide Number 2007*, California Employment Development Department, 1996.

The guide describes the biotech industry and gives a number of industry subgroups. It focuses largely on the employment in the industry. It lists several occupations within biotech and the necessary training and skills needed as well as the likely wage range for each.

30. Conner, Amy, *Bay Area Biotech Employment: How Bay Area Scientists and Biotech Corporations Find One Another*, Bay Area Bioscience Career Center, April 24, 2001.

Reviews the Bay Area biotech market for scientists. Biotech companies continue to find it difficult to find employees. Scientists tend to rely on networking by necessity to seek out new job opportunities. Companies, however, use a wide variety of methods to bring in new workers and these are reviewed citing specific examples from Bay Area businesses. Local businesses tend to focus on the local market because relocation costs to the Bay Area are extremely high.

31. Craft Consulting Group, *Contra Costa Bioscience Incubator: Employment Analysis*, prepared for the Contra Costa Economic Partnership, July 1998.

The report describes general characteristics of the biotech industry in California and the Bay Area. It identifies the types of jobs needed in the industry with a special emphasis on the need for a skilled workforce. The report includes an appendix on the education and training requirements for occupations in the bioscience industry. It also focuses on the potential job impact from a bioscience business incubator in Contra Costa.

32. San Diego State University, *San Diego's Biosciences Industry Cluster: A Regional Employment Study*, prepared for San Diego Workforce Partnership, August 2000.

Secondary and primary data was used to create an analysis of the workforce issues in the biotech industry in San Diego. Information on employment levels by industry sector, occupation patterns, wages, skills gap, and needed education/training improvements are reported on.

33. Yund, Mary, *Bioscience in Silicon Valley 2000*, NOVA Private Industry Council, 2000.

The report reviews the bioscience industry in general in the Bay Area. It then focuses on the skills and experience needed to work in the industry. It covers likely career paths, possible points of entry, how companies recruit and hire, occupational descriptions, and the importance of career shifts within the industry. Education and training requirements and opportunities in the Bay Area are also touched upon.

## Pharmaceutical, Diagnostics, & Medical Devices

34. "BioMaterials Firms Exploit Range of Techniques," *Genetic Engineering News*, Vol. 21: 8, 2001, p. 9.

Biosurgery research may lead to new solutions within the operating room. Discusses synthetic bio-liver, cartilage, and platelets, the companies involved, and status of current research. Looks at one company in the area of developing biomaterial supports for body tissues. Also offers a critical appraisal of problems remaining to be addressed.

35. "Biosensors – Sense and Sensitivity," *Science*, Vol. 290: 5495, 2000, p. 1315.

Reviews biosensor development through to the present time. Covers enzyme electrodes, affinity biosensors, monitoring the environment, and use of synthetic receptors. Looks into pros and cons of various transducers, the readout part of the biosensor – earlier ones such as electrochemical, optical, thermometric, later ones based on piezoelectric effects and magnetic transducers. Mass fabrication techniques have reduced costs substantially for glucose analyzers.

36. "Deciphering Diseases," *Chemical and Engineering News*, Vol. 77:35, 1999, p. 19.

Large and small companies are creating new ways to diagnose, monitor and find genetic predisposition to human diseases. Much consolidation in the industry has taken place over the past three years; diminishing profit margins is a major driver. Techniques covered include use of monoclonal antibodies, radioactive and nonradioactive detectors, DNA probes, and biosensor development. Benefits center around decreasing assay times, miniaturization, and automation.

37. "Custom-Made Biomaterials," *Genetic Engineering News*, Vol. 79: 6, 2001, p. 31.

Applying engineering, materials, and chemistry principles, researchers produce safe, smart, and effective implantable devices. Reviews biodegradable polymers, modified natural substances designed for use in a wide range of implantable applications including orthopedic and dental devices, drug delivery systems, and tissue engineering scaffolds.

38. "Life Sciences," *Chemical and Engineering News*, Vol. 79: 17, 2001, p. 25.

Widely touted business strategy of the past decade (amalgamating pharmaceutical and agricultural divisions) has diminished substantially as companies now split their drug and agriculture operations. Poorly performing ag biotech interests have accelerated trends among large corporations to spin these off and thus capture the true value of the pharma operations by boosting stock prices.

39. "Nutraceuticals: Fad or Trend?" *Chemical and Engineering News*, Vol. 77: 48, 1999, p. 42.

Efforts are under way to provide more scientific basis for health claims about nutraceuticals and functional foods. Addresses existing regulatory framework, what is involved in getting a claim approved, new regulation advocates and industry initiatives, and ultimately summarizes what consumers want.

40. "Nutraceuticals: Separating the wheat from the chaff," *California Agriculture*, Vol. 54: 5, 2000, p. 26.

Discusses expanding knowledge base of foods and their component vitamins, minerals, protein, carbohydrate and fat and associated health benefits. Points to how biotechnology can be used to boost health value of crop plants. Cautions about interactions of plant extracts with human metabolism.

41. "Pharmacogenomics and Diagnostics," *Nature Biotechnology*, Vol. 16: 8, 1998, p. 791.

The field of pharmacogenomics addresses the issues of gene sequence variation and its effects on drug-response variability as a platform for the discovery of novel, highly effective therapies. Article reviews historical perspective through to current state – contribution of the Human Genome Project and other human genome sequencing efforts has revealed links between gene variability and drug susceptibility among the population.

42. "The Challenges of *in silico* Biology," *Nature Biotechnology*, Vol. 18: 11, 2000, p. 1147.

Addresses issue of moving from a reductionist paradigm to one that views cells as systems; this will necessitate changes in both culture and practice of research. Looks into implications of handling massive amounts of gene expression data - storing, mining, and correlating. Investigates how *in silico* techniques will replace biological testing.

43. "The End of the Beginning for Genomic Medicine," *Nature Biotechnology*, Vol. 19: 3, 2001, p. 207.

The human genome sequence yields several surprises for researchers seeking to exploit genomic data in drug discovery. Only approximately 30,000 true genes appear coded for in the genome – expanded diversity originates in the way splicing is used in transcribing genes. Next hurdles will be gene and protein expression profiling and associated needs for bioinformatics tools and computer storage capacity.

44. "The Next Decade of Drug Discovery Research," *Genetic Engineering News*, Vol. 20: 21, 2000, p. 8.

Talks about predicted trends in development and screening technologies for novel drugs. Reviews contributions to be made by improved high throughput screening techniques, structural biology and bioinformatics tools, automation

and micro-miniaturization, and larger and larger combinatorial libraries of small molecules drug candidates.

45. "The Pharmaceutical Century," *Chemical and Engineering News*, Vol. 78: 43, 2000, p. 85.

Experts predict that genomics, gene therapy, and rejuvenative therapy will play major roles in curing and preventing disease. Report examines parts played by human genome project and gene sequencing, drug target identification, turning 'hits' into 'leads', the advent of protein therapeutics, the notion of 'personalized' medicine and pharmacogenomics, and utility of stem cell research.

46. "The Reengineering of Drug Development in the Genomics and Proteomics Era," *American Clinical Laboratory*, Vol. 20: 2, 2001, p. 55.

Talks about two recent novel developments (combinatorial chemistry, human genome project) and their impact on new drug discovery. Makes predictions that more work will be shifted towards drug discovery. Requirements for faster throughput will lead to more parallel experimentation and higher levels of automation.

## **Agricultural & Food**

47. "Accepting Agbiotech," *Chemical and Engineering News*, Vol. 78: 40, 2000, p. 21.

Industry is gambling on an information campaign, continued farmer acceptance and promises for the future. Article looks into public's perception of genetically engineered foods, the activist community and its anti-industry campaigns, the changing regulatory scene, and an undeniable call for science-based discussion and review.

48. Barefoot, Michele, "The Outlook for Ag and Biotech Business in the Regional Economy," *Data News*, June 2001.

A review of ag and biotech growth in the Davis region. It cites a study by agAccess/Ceres Corporation that found the need for a critical mass to be developed so that ideas, facility space, etc. could be shared. It reviews a few efforts to promote the region through the local schools and development organizations.

49. "Biotech Bears Fruit for Farmers, Not Consumers," *Los Angeles Times*, April 8, 2001.

Deterred by public resistance to genetically engineered foods, firms are concentrating on staple crops that make money. A critical review of many of the missteps made by the emerging biotech industry in its early days and prognosis for the future. Flavr-Savr tomatoes to golden rice.

50. "Bombing Biotech' – Review and Outlook," *Wall Street Journal*, June 1, 2001.

Contrary to the title, this Op Ed piece is very sympathetic to the ag biotech industry. Deplores "eco-terrorism" tactics of activist fringe groups where emphasis is frequently on political and ideological issues rather than on safety. Cites benefits of "golden rice" engineered with elevated levels of anti-cancer fighting carotenes, of high flavanoid containing cardiac friendly tomatoes, and approaches to minimize phosphate pollution in the environment by farm animals.

51. "Production of Therapeutic Proteins from Transgenic Animals," *American Biotechnology Laboratory*, Vol. 19: 2, 2001, p. 60.

Excellent and current review of the field – describes types of transgenic animals that have been created, methods used in their creation, the kinds of products (biopharmaceuticals) produced, companies involved, and regulatory status of products. Primary impetus for approach (costs) mentioned, but cautionary note added regarding safety (pathogenic virus entrainment into products).

52. "Predictions on the Future of Rapid Methods in Microbiology," *Food Testing and Analysis*, Vol. 5: 3, 1999, p. 19.

Assesses current state of the art in food microbiology and its role in ensuring safety of what we eat. Looks into the future and anticipates developments in the evolving technology. Integrates predictions with HACCP (Hazard Analysis Critical Control Point) systems in future food safety developments. Specifically, enhancements in viable cell counts, real-time monitoring of hygiene, PCR genetic tests, fully automated ELISA immunological testing, dip stick testing, biosensors, instant pathogen detection, microbiological alerts in food packaging and consumer rapid test kits, are all anticipated.

53. "Making Forest Biotechnology a Commercial Reality," *Nature Biotechnology*, Vol. 17: 1, 1999, p. 27.

A critical appraisal of the status of forest biotechnology and what it will take to turn it into a commercial success. Points up shortcomings of present understandings of plant genome as represented by academic curiosity, *Arabidopsis*, and complexity of perennial forest trees. Benefits anticipated include: increased yields, shorter generation times, earlier selection age, enhanced cold, drought tolerance, and disease and pest resistance.

54. "The Ecological Risks and Benefits of Genetically Engineered Plants," *Science*, Vol. 290: 5499, 2000, p. 2088.

Nicely balanced critique on pros and cons of genetically engineered plants. A review of scientific literature reveals that key experiments on both environmental risks and benefits are lacking. Addresses issues of invasiveness of transgenes migrating to crop wild relatives, direct effects on non-target organisms, indirect effects on populations of organisms that depend on pests controlled, creation of new viral diseases through

recombination events. Benefits include: reduced impacts from spraying pesticides, increased crop yield, phytoremediation of soils.

55. "Transgenes are revolutionizing crop production," *California Agriculture*, Vol. 54: 4, 2000, p. 36.

A review of the controversy highlighting plant transformation, environmental and health biosafety, ecological biosafety, and food biosafety. Evaluates the basic logic behind the controversy, summarizes plant transformation techniques, assesses biosafety in terms of impacts on environment, ecology, health and food.

56. "Transgenic Animals for Production of Proteins," *Genetic Engineering News*, Vol. 19: 9, 1999, p. 1.

Transgenic animals (genetically engineered to produce specific human proteins/peptides in milk) perform function of a bioreactor. Article describes benefits and advantages over use of microorganisms to produce biopharmaceuticals – requirements for specific post-translational modifications, less expensive than mammalian cell culture methods, easier purification protocols. Activities of leading companies described.

57. "Transgenic Plants and Biosafety: Science, Misconceptions and Public Perceptions," *BioTechniques*, Vol. 29: 4, 2000, p. 832.

Good discussion of benefits to be derived from engineering crop plants. Technology, regulatory affairs, and pest resistance topics addressed. Looks into advantages of transgene-based and traditional pest control, impacts on the environment, and future plant improvement technologies (co-suppression and programmed cell death).

## **Industrial & Environmental**

58. "Companies Turn to Biocatalysis," *Chemical and Engineering News*, Vol. 77: 29, 1999, p. 87.

Drive to meet customer demands for single-isomer intermediates takes on urgency. More and more frequently pharmaceutical manufacturers are finding that only one of several chiral isomers in a chemically synthesized products is the molecule which possesses the therapeutic properties desired. A range of biocatalytic approaches are being increasingly used: immobilized cross linked enzymes, salt/enzyme complexes, selective immobilization on polymers, thermally stable enzymes, and thermophilic microbes.

59. "Getting a Grip on Bacterial Slime," *Business Week*, September 13, 1999, p. 98.

Science has declared war on biofilms, which play a part in 65% of all infections – and resist antibiotics. Basic research is uncovering how these films are established and the purposes microorganisms design them for. Areas of importance include drinking water pipes, household drains, dental

plaque, contact lenses, catheters and stents, and physiological organs such as ears and lungs.

60. "Green Chemistry Yields a Better Plastic," *Nature Biotechnology*, Vol. 17: 10, 1999, p. 960.

Analytical piece on production of plastics in plants. Emphasis on generating plastics from renewable resources. Plastics produced are more eco-friendly (biodegradable) than their chemically synthesized counterparts. Pricing still remains as the major hurdle to acceptance. Strategically, such engineered crops would deliver increased value to more conventional end-products such as oils and protein rich meal for animals.

61. "Harnessing Biotech Production Power of Plants," *Genetic Engineering News*, Vol. 20: 15, 2000, p. 62.

Corporate profile on ProdiGene and the company's focus on using plants as production vehicles for pharmaceuticals, and fine chemicals and biologicals. Major crop plant employed is corn. Products pursued include, avidin, beta-glucuronidase, laccase, antibodies, a sweetener brazzein, and edible vaccines for hepatitis virus and transmissible gastroenteritis virus.

62. "Microbes with a Mettle for Bioremediation," *Nature Biotechnology*, Vol. 18: 6, 2000, p. 600.

Describes a recent development in improving soil microorganism's capabilities to take up and remove heavy metals in situ. Bacteria engineered to express a key mammalian protein (metallothionein) on cell surface; protein is an avid binder of heavy metals. Discusses some of the drawbacks to earlier engineered microbes designed for heavy metal bioremediation purposes.

63. "Phytoremediation Applications," *Genetic Engineering News*, Vol. 18: 16, 1998, p. 17.

An Emerging Market for the Introduction of Specialty Crops and Transgenic Plants. Reviews uses of plants to counter environmental pollution. Some approaches use specific plants' innate ability to accumulate toxic materials; in others, plants metabolize materials to less toxic forms; and transgenically engineered plants. Discuss companies active in the area and estimates of market sizes.

64. "Transgenic Plants as Factories for Biopharmaceuticals," *Nature Biotechnology*, Vol. 18: 11, 2000, p. 1151.

Reviews potential of plants as factories for producing high value products such as vaccines, antibodies, biopharmaceuticals (anticoagulants, recombinant hormones, enzymes and nutraceuticals). Mentions oleosin-fusion technology as a highly efficient, simple extraction and purification method, and that such vaccines and biopharmaceuticals can be stored and distributed as seeds, tubers or fruits, very cheaply.

65. "Transgenic Phytoremediation blasts on the Scene," *Nature Biotechnology*, Vol. 17: 5, 1999, p. 428.

Addresses bioremediation approaches to aid in cleaning up explosives sites. Particularly addresses TNT contamination. While use of microbes have also been employed costs have not proven favorable. Development of transgenic plants capable of metabolizing toxic materials to less toxic forms are described.

## Technology

66. "Bioinformatics," *Chemical and Engineering News*, Vol. 79: 8, 2001, p. 29.

Making sense of information mined from the human genome is a massive undertaking for the fledgling industry. Article covers issues of definition, what is needed, the challenges, standardization especially in annotation, history of the field, software tools, and business models. Looks into signs of market acceptance and ways the industry must evolve to survive.

67. "Combinatorial Chemistry: Redefining the Scientific method," *Chemical and Engineering News*, Vol. 78: 20, 2000, p. 53.

Recent concepts and advances in this dynamic field involve combinatorial animals, target-guided ligand assembly, fluoruous mixtures, microencapsulation, and nanospray technology. Article examines how such approaches will be used in developing products of the future. Many will form the focus of tools employed by R&D chemists in the next generation.

68. "DNA Chips and Microarrays," *Science*, Vol. 289: 5481, 2000, p. 965.

Reviews basics of microarrays, key components (media and pre-made chips, applicators, labeling and detection and analytical software), early adopters (basic research communities), seamless integration among instrumentation manufacturers for adding value (eg. manufacturers of applicators, chips and readers), applications to protein expression and SNP chips.

69. "Functional Genomics: Genomic Revolution Phase 2," *Science*, Vol. 291: 5504, 2001, p. 681.

Having successfully sequenced the genomes of humans and other organisms, life scientists plan to use sequence data to understand precisely how genes operate. Their vehicle: a group of technologies that goes under the collective name of functional genomics. Looks into application of microarrays, SNP databases and enhanced computer capabilities to analyze data in establishing links between specific genes and the functions they control.

70. "Lets Get Small – Lab-on-a-chip devices attract growing interest for a wide range of applications," *Chemical and Engineering News*, Vol. 79: 14, 2001, p. 51.

Looks at increasing emphasis on micro-miniaturization of analytical/diagnostic operations. Emphasis on solutions that provide automation from sampling through to final results output. Microfluidics, a growing academic and industry expertise. Major benefits are speed and low cost.

71. "Proteomics: Taking Over Where Genomics Leaves Off," *Chemical and Engineering News*, Vol. 78: 31, 2000, p. 31.

Researchers use a variety of tools to probe protein function and interactions, with drug discovery the major goal. The field includes transcriptional profiling, high throughput expression, protein profiling, protein-protein interactions, pathway analysis, large-scale protein folding and bioinformatics analysis.

72. "The Changing Marketplace of Bioinformatics," *Nature Biotechnology*, Vol. 18: 12, 2000, p. 1247.

The demand for more sophisticated bioinformatics solutions is expanding opportunities for biotechnology startups, but traditional IT companies are also moving into the market. Discusses the target marketplace is split among several industry sectors, impacts of bioinformatics patents and market size.

## **Appendix G: Biotechnology Glossary**

### **II. ANTISERUM**

Serum (blood from which all red and white cells have been removed) from an animal that contains antibodies against a particular immunogenic antigen.

### **III. BIOINFORMATICS**

The assembly and analysis of large amounts of biological data, using networks of computers and databases. Historically, bioinformatics concerned itself with the analysis of the sequences of genes and their products (proteins), but the field has since expanded to the management, processing, analysis and visualization of large quantities of data from genomics, proteomics, drug screening and medicinal chemistry.

### **IV. BIOSENSORS**

Sensors that utilize biological principles to detect substances; detection methods include use of enzymes, antibodies, receptor proteins, etc.

V.

### **VI. DIAGNOSTICS**

Test reagents that measure the presence or absence of an important analyte, eg. thyroxine, uric acid, triglycerides, cholesterol, pesticides, pathogens, etc.

VII.

### **VIII. COMBINATORIAL CHEMISTRY**

The use of a small number of chemical building blocks, combined together in multiple ways, using standard chemistries, to create large libraries of medicinally relevant compounds that may be screened for potential new drugs. Combinatorial chemistry is used in tandem with high-throughput screening to identify compounds that bind to a therapeutic target protein and are thus potential new drugs.

### **IX. DNA (DEOXYRIBONUCLEIC ACID)**

The molecule that forms the basis of the genetic material in virtually all living organisms. Structurally, DNA is composed of two strands that intertwine to form a spring-like structure called the double helix.

### **X. DNA BIO-CHIP OR MICROARRAY**

DNA micro-array is a small glass surface to which has been fixed an array of DNA fragments, each with a defined location. A typical DNA chip would contain 10,000 discrete spots (each containing a different DNA fragment) in an area of

just a few square centimetres. When a solution of fluorescently labelled DNA fragments is hybridized to the chip, spots to which hybridization occurs are visible as fluorescence.

## **XI. ENZYME**

A protein produced in living cells, which, even in very low concentration, catalyses specific chemical reactions but is not used up in the reaction. Different classes of enzymes catalyze different kinds of chemical reactions.

## **XII. FUNCTIONAL GENOMICS**

Applying genomic information to determine gene function, commonly using microarrays and model organisms. An important part of target validation.

## **XIII. GENE**

A unit of inheritance; a working subunit of DNA. Each of the body's 50,000 to 100,000 genes contains the code for a specific product, typically, a protein such as an enzyme.

## **XIV. GENOME**

All the genetic material in the chromosomes of a particular organism; its size is generally given as its total number of base pairs.

## **XV. GENOMICS**

The identification and functional characterization of genes within the genome.

### **HTS (High-Throughput-Screening)**

The use of miniaturized, robotics-based technology to screen large compound libraries against an isolated target protein, cell or tissue in order to identify binders that may be potential new drugs. High-throughput screening depends on the development of a quantitative, pharmacologically relevant assay for the identified target, which can then be reproduced across a large number of samples. Recently, advances in miniaturization and microfluidics have allowed screening of up to 100,000 compounds against a target on a single chip daily, thus permitting very large numbers of samples to be screened.

## **XVI. METABOLOME**

Refers to the entire complement of all the small molecular weight metabolites inside a cell suspension (or other sample) of interest.

## **XVII. MICROFLUIDICS**

Microfluidics is the miniaturization of fluid-based biochemistry to very small volumes such that a large series of chemical reactions can be performed in parallel in a microarray format. Microfluidics devices are also known as “labs-on-a-chip”.

## **XVIII. MONOCLONAL ANTIBODIES**

A single type of antibody that is directed against a specific epitope (antigen, antigenic determinant) and is produced by a single clone of B cells or a single hybridoma cell line, which is formed by the fusion of a lymphocyte cell with a myeloma cell. Some myeloma cells synthesize single antibodies naturally.

## **XIX. NANOTECHNOLOGY**

The microscopically small technology used to create micro-devices such as a gene chip or a “lab on a chip.”

## **XX. NUTRACEUTICALS**

Drugs produced by recombinant DNA methods in edible plants or vegetables, allowing their delivery within the body by simple consumption.

### **PCR (Polymerase Chain Reaction)**

Biochemical method that permits rapid multiplication (amplification) of a short piece of DNA, thereby rendering its detection easier.

## **XXI.**

## **XXII. PHARMACOGENOMICS**

Refers to the use of genetic information to predict the safety, toxicity and/or efficacy of drugs in individual patients or groups of patients.

## **XXIII. PHYTOREMEDIATION**

The use of green plants to remediate contaminated soils through accumulation of toxic materials within themselves.

## **XXIV. PROTEOME**

The set of proteins encoded by a genome.

## **XXV. PROTEOMICS**

The study of gene expression at the protein level, by the identification and characterization of proteins present in a biological sample. By comparing samples from healthy and diseased tissues, it is possible to identify proteins that

are specific to diseased cells. These may be potential diagnostic markers for particular diseases, or targets for drug development.

## **XXVI. RECOMBINANT PROTEINS**

Proteins made from recombinant DNA technology by which engineered DNA coding for a specific therapeutic protein of choice facilitates the protein's mass production often by fermentation of recombinant microorganisms.

## **XXVII. SNPS (SINGLE NUCLEOTIDE POLYMORPHISM).**

**XXVIII. A SNP IS A PLACE IN THE GENETIC CODE WHERE DNA DIFFERS FROM ONE PERSON TO THE NEXT BY A SINGLE LETTER. THESE SLIGHT GENETIC VARIATIONS BETWEEN HUMAN BEINGS MAY PREDISPOSE SOME PEOPLE TO DISEASE AND EXPLAIN WHY SOME RESPOND BETTER TO CERTAIN DRUGS.**

## **XXIX. STEM CELLS**

The cells from which all blood cells develop.

## **XXX. SYSTEMS BIOLOGY**

Unlike traditional biology that examines single genes or proteins in isolation, systems biology simultaneously studies the complex interaction of many levels of biological information – genomic DNA, mRNA, proteins, functional proteins, informational pathways and informational networks – to understand how they all work together.

## **XXXI. TOTIPOTENTIAL, TOTIPOTENCY**

Having the potentiality of forming all the types of cells in the body. The diploid zygote formed at fertilization is a single cell, which is capable of division and differentiation to give rise to the total range of cell types found in the adult organism. In theory all cells are totipotent since they all contain the same DNA. While such differentiation occurs naturally with zygotic cells, for mature fully-differentiated cells, it is only now that biotechnologists are unraveling the processes by which one can convert or induce a stem cell or nerve cell, for instance, to differentiate into any other cell form.

**Appendix H: Best Practices – Regional Biotechnology Initiatives**

State and regional governments are becoming more active and involved in identifying the opportunities presented by the growing biotechnology industry. Forty-two out of fifty states have at least one biotechnology company. Most of these states also have adopted statewide biotechnology initiatives to promote and support the local biotechnology industry. Thirty-four states have developed biotechnology centers and 14 states have developed biotechnology incubators as a way to support the formation of new companies, provide a vehicle for technology transfer, and to attract new biotechnology companies to the area. The following sections discuss biotechnology initiatives that have been adopted by various states and regions. The types of activities that have led to the successful attraction and development of the local biotechnology industry throughout the country include:

### **Strong Academic Research Institutions Conducting Basic Research in the Biosciences**

Boston and the San Francisco Bay Area are strong in biotechnology research. These regions have about five times as much research activity as the U.S. mean. Boston gets more NIH funding (about \$1.4 billion in 2000) than any other metropolitan area in the country. The Bay Area and Boston each have three of the nation's 20 top-ranked medical research institutions, and each region accounts for more than 3,000 biotechnology-related patents in the past decade. The New York metropolitan area granted the most life sciences PhDs (519) in 1999, followed by Boston (355), Washington/Baltimore, Los Angeles, and San Francisco Bay Area each with more than 200 life sciences PhD degrees in the same year. (The Brookings Institution)

### **Access to Early-Stage Capital (Seed and Venture Financing)**

**California** Public Employee's Retirement System (CalPERS) created the California Biotechnology Program in late 2000. To date, five investments have been approved for a total of \$285 million. Other financings are Biotechnology Strategic Targets for Alliances in research (BioStar) Program that provides matching funds for basic to proof of concept research in the field of biotechnology, and California Technology Investment Partnership (CalTIP) program that provides matching grants of up to \$250,000 to California companies that receive federal funding.

**Massachusetts** has privately managed venture fund, which is supported by Massachusetts Biomedical Initiatives (MBI). The plan invests in the biotechnology, healthcare, medical devices, bioinformatics, and genomics, health-related services, drug discovery and other related technologies.

**North Carolina** Bioscience Investment Fund created by the Northern Carolina

Biotechnology Center provides seed capital to bioscience companies. The fund was capitalized with \$10 million in appropriations from the North Carolina General Assembly. The Innovation Research Fund (IRF), which is founded 1984, provides flexible financing to emerging technology-oriented businesses in North Carolina. North Carolina has other financing programs including Collaborative Funding Assistance Grants Program, and the North Carolina Biotechnology Center. Moreover, the North Carolina Technological Development Authority (NCTDA), a state-sponsored, non-profit corporation, sponsors technology incubators and is leasing and improving an incubator facility for life science companies in Research Triangle Park.

**New Jersey** has not publicly supported seed or venture dedicated exclusively to bioscience companies. However, it has different types of funding structures only for early-stage technology companies. These include Early State Enterprises (ESE), New Jersey Technology Council Venture Fund, and Seed Capital Program supported by the New Jersey Economic Development Authority. Other financing providers include the New Jersey Commission on Science and Technology, Business Employment Incentives Program (BEIP), and Technology Funding Program that offers facilities financing.

**Pennsylvania** Early Stage Partners makes investments in seed, start-up, and early stage technology-based companies. The first fund of \$50 million was launched in January 1998, and was a collaborative effort of the Commonwealth of Pennsylvania, the Pennsylvania Public School Employees' Retirement Systems (PSERS), and Safeguard Scientifics Inc. Other financing includes Ben Franklin Technology Partners (BFTP) that provides small amounts of pre-seed capital for start-up and young technology companies.

**Maryland** has no publicly supported venture fund, however, there are different investment program that are administrated by the Maryland Department of Business and Economic Development (DBED). The Challenge Investment Program (CIP) makes small, high-risk investments in start-up firms. CIP funds help offset the costs of final testing and market development. The Enterprise Investment Fund (EIF) makes direct equity investments in emerging high technology companies. EIF investments, which range from \$150,000 to \$500,000, can be used for start-up costs including hiring operating costs and product marketing.

**New York** has two investments program to support start-up bioscience companies. The Biotechnology Industry Growth Fund is a \$10 million fund established by the state to provide capital to start-up bioscience companies. The Small Business Technology Investment Fund (SBTIF) provides venture capital funding for New York's emerging high tech and biotechnology firms. Typical investments range from \$50,000 to \$500,000. In addition, the NYS Common Retirement System, Prospect St. NYC Discovery, and Emerging Industries Fund also support the start-up and emerging biotechnology firms.

## **Technology Transfer for Product Commercialization (Commercialization and Business Development Support)**

**Massachusetts:** The MBIdeals Innovation Centers provide commercialization and business development support to start-up bioscience companies. MBI's Technology commercialization Center provides academic institutions and entrepreneurs with technical expertise needed to commercialize new technologies, including negotiating licensing, commercialization, and business consulting.

**North Carolina** Biotechnology Center (NCBC) Business and Technology Development Program helps entrepreneurs with technology assessment business plans, networking, referrals, lab space, procurement and financing.

**New Jersey:** The Entrepreneurial Training Institute consists of an eight-sessions workshop during which students develop a business plan for their own business. Their plans are subsequently submitted to a panel of banking, accounting, law, marketing, and economic development professionals for a through review.

**Pennsylvania:** The Ben Franklin Technology Partners Centers assist companies with commercialization and link those companies to sources of management and technical expertise.

MDBIO assists **Maryland** bioscience companies with marketing and regulatory issues and provides financing for management of strategic planning. The Maryland Technology Development Corporation, and the University Technology Development Fund helps universities conduct pre-commercial feasibility research on very early stage technologies.

**New York** Cornell University's Center for Biotechnology and the Center for Biotechnology at SUNY-Stony Brook provide access to university researchers and feasibility for bioscience companies. Also, New York's Regional Technology Development Centers provide entrepreneurial and business assistance, training, and venture capital information and Federal Research grant information and assistance to employers across the state.

## **Networking**

**California.** The Bay Area Bioscience Center brings together Northern California's bioscience community to promote its culture and important biology-based discoveries. BIOCUM is San Diego's association for the life sciences community. It seeks to promote the growth of the bioscience industry in the region.

**North Carolina** Bioscience Organization (NCBIO) is a statewide association of biotechnology companies. Also, the North Carolina Biotechnology Center sponsors grants programs to fund meetings on the science, business, and educational issues of biotechnology.

The Biotechnology Council of **New Jersey** serves as a voice to create a positive climate for the state's biotechnology companies, and the Health Care Institute of New Jersey acts as a unified voice for the state's research-based pharmaceutical and medical technology industry. Also, the New Jersey Technology Council's Life Sciences Industry Network provides New Jersey-based life sciences companies with access to expertise in marketing and regulatory affairs.

**Pennsylvania** Biotechnology Association (PABIOTECH) helps to advance the life sciences in Pennsylvania by creating commercial opportunities and public policy strategies that lead to greater understanding, growth, and community support of biotechnology. The Pittsburgh Technology Council serves as a point of connection for companies from four primary clusters of the technology industry, and Eastern Technology Council provides members with contacts, capital, and information with a broad variety of events, publications, and innovative services.

**Maryland** Bioscience Alliance (BIOAlliance) is a statewide membership organization that addresses issues such as government regulations and workforce.

The **New York** Biotechnology Association (NYBA) offers networking opportunities and represents the industry in matters of public policy at the legislative level. The Health Care Industry Association of Western New York is a regional association serving bioscience companies in the Rochester and Buffalo region. Moreover, the Academic Medicine Development Corporation helps to develop large-scale basic science and clinical research projects, and to expand New York's research infrastructure, and recruit researchers to New York's scientific institutions.

## **Tax Policy**

**California** has Manufacturer's Investment Credit (MIC), Research and Development Tax Credit (RDTC), and Net Operating Loss Carryover (NOLC). Certain manufacturers operating in California are eligible for a six percent MIC. It can be claimed against the tax and can be carried forward for eight years. The RDTC allows companies to receive a credit of 15 percent for qualifying research expenses, and biotechnology and biopharmaceutical companies are allowed preferential treatment on their NOLs. The entire amount of the NOL (100 percent) may be carried over for up to eight years.

**Massachusetts** offers several tax credits to business engaged in R&D, including bioscience companies. Under the credit against corporate excise tax, a

manufacturing corporation, or a business corporation engaged primarily in research and development, may claim a credit against the corporate excise tax of three percent. A manufacturing corporation or a business corporation engaged primarily in research and development may also claim a credit against excise tax for leased credit against excise tax for leased personal property. Moreover, R&D tax credit is available for foreign and domestic corporations engaged in research and development in the state.

**North Carolina** tax policy offers credit for investing in machinery and equipment. Taxpayers who purchased or leased eligible machinery and equipment placed in service in the state are allowed a credit equal to seven percent of the excess of the eligible investment amount over the applicable threshold. A taxpayer also is allowed a credit equal to five percent of the state's apportioned share of the taxpayers' expenditures for increasing research activities. Also, the William S. Lee Quality Jobs and Expansion Act of 1996 provide various tax credits to encourage economic development effort including job creation and worker training.

**New Jersey:** A corporation business tax benefit certificate transfer program is available to allow new or expanding emerging technology and biotechnology companies with unused amounts of research and development tax credits. A taxpayer also is allowed a credit of 10 percent of the excess of the qualified research expenses for the fiscal or calendar accounting year over the base amount. The amount of the credits applied under this section can not exceed 50 percent of the tax liability. High technology business investment tax credit (ten percent of the qualified investment made in each of three tax years - \$500,000 per year cap) is available for business engaged in advanced computing, advanced materials, biotechnology, electronic device technology, environmental technology, or medical device technology, with less than 225 employees. New Jersey also has sales tax exemption on tangible personal property for use in R&D.

**Pennsylvania:** R&D tax credit can be used against a taxpayer's personal income tax, corporate net income tax, or capital stock/franchise tax for those businesses that incur expenses for qualified research and development activities performed in the state. Capital stock and foreign franchise tax exemption are available for manufacturing, processing, or research and development corporations.

**Maryland** has tax abatement for locating/expanding in qualified distressed areas. A tax credit may be claimed for a business involved in research and development or testing, biotechnology, computer programming, data processing or other computer related services. This business also may benefit from job creation tax credit if it creates at least 25 qualified positions. Newly established R&D tax credits for qualified research and development expenses incurred by individuals are available. The credit is three percent of the Maryland research and

development expenses paid during the taxable year.

R&D investment tax credit is available for **New York** individuals and corporations engaged primarily in research and development activities. The R&D investment credit is equal to nine percent of states regular investment tax credit. Qualified emerging technology company (QETC) employment credit and QETC capital tax credits are available for qualified emerging technology companies that increase employment in New York State. Also, sales tax exemptions for production, research, and development are also available for purchase of production machinery and equipment, and research and development property.

### **Workforce Development**

The Biotechnology Education Consortium is an organization led by community colleges and universities within the state to promote better education of students in the biotechnology field. The consortium establishes ties with industry for economic development purposes and to fulfill the need for job market surveys to identify workforce needs of the state's biotechnology industry. The San Joaquin Biotechnology Center links the 13 community colleges, biotechnology industries, high schools, and universities in a five-county area. The Central Cost Biotechnology Center (CCBC) aids biotechnology businesses in the Central Coast region by developing training for faculty, students, and employees in community colleges. The University of California System-wide Biotechnology Research and Education Program receives \$1.5 million annually in state funds to foster and provide support for research in biotechnology and training. The rest of the states also have different program for educational and training development in the area of bioscience field.

**XXXII.**

**XXXIII. Industry Promotion/Information Resource Center**

### **North Carolina Biotechnology Center**

The North Carolina Biotechnology Center (NCBC, Research Triangle Park) created in 1981, receives an annual appropriation from the North Carolina General Assembly and employs around 50 people. Although the Center conducts business, rather than scientific research, it has attracted several firms conducting agricultural and pharmaceutical biotechnology research. Since 1984, it has awarded more than \$20 million in grants and financial assistance to start-up companies, universities, and other institutions.

The Center serves as a catalyst for the development of biotechnology in North Carolina by helping to nurture entrepreneurial companies, recruit and attract new

firms, and through funding educational programs, faculty recruitment, and university research.

Through its various financial assistance programs, the NCBC has provided 46 North Carolina biotech-related companies a total of \$5.8 million for product research and development. These companies have attracted an additional \$332 million from federal grants, venture capital, stock offerings, and, public and private sources. The Collaborative Funding Assistance Program funds university-industry interaction that generates bioscience discoveries leading to commercial products. Center funding has also enabled North Carolina universities to recruit 38 outstanding researchers considered to be at the top of their respective fields.

The Center also has provided seed grants totaling \$11.4 million to North Carolina faculty to support innovative biotech-related research with potential for commercial application.

The Center has awarded funds totaling more than \$2.4 million to North Carolina high schools and post-secondary institutions to enhance their biotechnology teaching and training capabilities. Through Center-sponsored workshops, more than 800 North Carolina middle and high school teachers have received training in biotechnology. These high school and community college instructors have gone on to reach more than 500,000 students with lessons on the science, applications and issues of biotechnology. The Center has also helped train more than 50 post-secondary instructors in biotechnology.

The Center's Business and Technology Development Program assists companies of all sizes and in all stages of development. Program staff annually helps some 50-plus companies with business plan development, marketing surveys, venture financing referrals, federal grant applications, site location, technical problems, technology transfer, and industry-university partnerships. The Program also provides growing companies with financial assistance, usually at early stages when funding from traditional sources such as venture capital firms is more difficult to obtain.

More than half of North Carolina's biotechnology companies are start-ups or growing firms. To support entrepreneurial endeavors, the center and the Council for Entrepreneurial Development in Research Triangle Park co-sponsor the Biotechnology Roundtable. The monthly roundtable series provides an ideal networking opportunity for members of North Carolina's biotechnology community. In addition, the Program sponsors and supports conferences, trade shows and workshops to encourage networking and entrepreneurial development.

## **XXXIV. Specialized Facilities (including Incubators and Research Parks)**

### **Virginia Biotechnology Research Park**

The Virginia Biotechnology Research Park was founded in 1992 when the General Assembly of the Commonwealth of Virginia established the Virginia Biotechnology Research Park Authority. The Research Park was launched by a public/private partnership of university, government and industry leaders.

The Research Park, adjacent to the Medical College of Virginia Commonwealth University in Richmond, is a prime catalyst and provides for scientific interaction. It is located with the Eastern U.S. Pharmaceutical/biotechnology corridor that is home to 52% of the nation's pharmaceutical industry and 40% of its young and dynamic biotechnology industry.

The Research Park's long-term strategy is to attract life-science research companies through support of start-up companies and organizations involved in research, development, and commercialization. The Park's mission is to develop Virginia's biotechnology and biomedical industries, and to foster technology transfer from life-science research at Virginia's universities.

Many of the companies located in the Park have sprung from research work at the state's universities, where over \$200 million in life science research is conducted annually.

A state-funded, 27,000 square foot Biotechnology Incubator is located in the Research Park. The Incubator has office/laboratory suites for start-up ventures, on-site business services, a library, meeting rooms and access to common equipment. Other facilities in the Research Park include:

- Fiber optic telecommunications
- Biotechnology library
- Meeting and conference rooms
- Networking activities
- Public relations
- Talent bank

Ventures locating in the Research Park also enjoy a special affiliation with Virginia Commonwealth University's Medical College. Through this affiliation companies can access:

- Animal resources
- Controlled waste disposal
- Special equipment
- Library services

Adjunct faculty appointments  
Graduate student employment  
MCV health club

## **Massachusetts Biotechnology Research Park**

The Massachusetts Biotechnology Research Park, a non-profit corporation founded in 1983, was the first research park dedicated to meeting the real estate needs of the biotechnology industry. Master planned to accommodate the future needs of rapidly expanding biotech companies, the Biotech Park has sufficient land to allow for the development of approximately 2,500,000 square feet of research facilities. Specific plans and advantages include:

- The establishment of zoning ordinances that follow the standards established by the National Institutes of Health for biotechnology research to assure tenants of appropriate regulation.
- Speculative multi-user R&D buildings with laboratory and office space.
- Land readily available for development at costs below comparable market projects.
- Strategically located with good freeway access.

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