County of Los Angeles
CHIEF EXECUTIVE OFFICE
Kenneth Hahn Hall of Administration
500 West Temple Street, Room 713, Los Angeles, California 90012
(213) 974-1101
http://ceo.lacounty.gov

WILLIAM T FUJIOKA
Chief Executive Officer

August 5, 2014

To: Supervisor Don Knabe, Chairman
Supervisor Gloria Molina
Supervisor Mark Ridley-Thomas
Supervisor Zev Yaroslavsky
Supervisor Michael D. Antonovich

From: William T Fujioka
Chief Executive Officer

REPORT ON CONSULTANT EVALUATION FOR A POTENTIAL COUNTYWIDE BIOTECHNOLOGY PARTNERSHIP PROGRAM

On July 10, 2012, the Board authorized the Chief Executive Office (CEO) to enter into a contract with the Battelle Memorial Institute (Battelle), a biotechnology consultant, to perform a feasibility assessment and develop a master plan for a public-private biotechnology partnership program with the goal of promoting the public health care system, job creation, and research.

This is to provide your Board with Battelle's feasibility assessment and proposed master plan for a public-private biotechnology partnership program (Attachment).

Summary

Battelle's research and analysis indicates that the biosciences industry in the Los Angeles region has been, and continues to be, a key economic driver for the region and that there is potential to expand this industry to be a top region in the nation. Although the region lags in several key areas (e.g., lack of early-stage venture capital, insufficient wet lab space, etc.), Battelle believes that developing a public-private program is feasible.

To address the Los Angeles region's key weaknesses, Battelle has proposed a master plan that consists of four major initiatives and would require an investment of $11.0 million in one-time capital funding and $1.8-$3.5 million annually in on-going funding, utilizing existing County land and buildings, and other potential incentives, over a five-year pilot period. In addition to County funding, Battelle estimates that more than $300 million could be raised from institutional, private, and foundational investors.

The proposed master plan's four initiatives focus on the following goals:

1. **Biosciences Commercialization** – To facilitate increased levels of commercialization and entrepreneurship opportunities in the biosciences industry, and thereby also encourage promising ventures and companies to stay within the County, Battelle proposes actions to increase venture capital availability, provide commercialization services to entrepreneurs, and other similar activities.

    - Examples of recommended actions: Establish a "Fund of Funds" that would invest in and encourage venture capital firms to locate inside the County; partner with universities to support entrepreneurs with commercialization services, such as business mentoring and proof-of-concept/seed funding; create a Healthcare Delivery Innovation Network, which would invest in ventures focused on innovations in how healthcare is delivered.

    - Estimated costs: $0.5-$1.0 million on-going; $6 million one-time.

2. **Lab Space Development** – Given the shortage of available lab space, Battelle recommends actions to stimulate the establishment of multi-tenant, bioscience-specific lab buildings in the County. Battelle adds that such developments should be concentrated around specifically identified areas to create "bioscience hubs," which are more efficient and conducive to the bioscience industry's needs.

    - Examples of recommended actions: Partner with real estate developers to explore opportunities to create three to five "biosciences hubs;" establish a fund for tenant improvement financing to encourage the development of multi-tenant biosciences facilities.

    - Estimated costs: $0.3-$0.5 million on-going; $5 million one-time.

3. **Biosciences Talent** – The master plan includes recommendations to create programs to attract new biosciences talent, retain the top talent produced by local academic institutions, and improve bioscience workforce development.

    - Examples of recommended actions: Provide career services to high-level management talent; establish a "Bridges to Industry" program to link academic talent to local industry; provide planning resources to assist local educational institutions in competing for workforce development funding.

    - Estimated costs: $0.5-$1.0 million on-going.

4. **Marketing** – Battelle also recommends marketing activities to increase the visibility of the Los Angeles region as a place of great bioscience growth potential to attract companies, talent, and investment.

    - Examples of recommended actions: Establish a marketing alliance with other local stakeholders; attract national and international bioscience conferences to the County; build local awareness and cultivate a "brand" for the County's bioscience industry.

    - Estimated costs: $0.5-$1.0 million on-going.

If your Board chooses to adopt and implement the master plan, Battelle recommends that the County enter into a strategic partnership with the Southern California Biomedical Council (SoCalBio), a local biosciences industry trade association, which is already actively involved in the biosciences industry and has the capacity to bring together key stakeholders. Alternatively, the County could contract with another non-governmental organization with expertise and a proven track record. In addition, funding sources would need to be identified for the estimated master plan costs and additional staffing to oversee the implementation.

If you have any questions or need additional information, please contact me or your staff may contact Gregory Polk, at (213) 974-1160 or via e-mail to gpolk@ceo.lacounty.gov.

WTF:GP:MM
RAL: hd

Attachment

c: Executive Office, Board of Supervisors
County Counsel
Health Services

080514_HMHS_MBS_Biotech Final Report

FINAL DRAFT REPORT

Feasibility Assessment and Master Plan for Advancing the Bioscience Industry Cluster in Los Angeles County

Prepared for:
Los Angeles County – Chief Executive Office

Prepared by:
Battelle Technology Partnership Practice

Contents

Executive Summary

The 21st Century is often referred to as the "Bio Century," and the reasons are straightforward. The biosciences are at the forefront of both creativity and innovation, and represent a convergence point for engineering, information technology, nanosciences and communications/media. In April of 2012 the Obama Administration released its National Bioeconomy Blueprint noting that the bioscience industry is "a large and rapidly growing segment of the world economy that provides substantial public benefit."[1] From a regional economic development perspective, the biosciences are a particularly attractive economic driver because they represent a large, fast-growing, diverse and crosscutting industry cluster involving a wide range of manufacturing, service and research activities that not only promote economic vitality and offer high quality jobs, but also advance public health.

The purpose of this project is to provide an independent, fact-based bioscience industry cluster development strategy to enable Los Angeles County to realize its full potential as a bioscience hub. The specific project objectives are to:

- Identify the specific areas of likely bioscience development that can serve as technology platforms to enable the bioscience industry cluster in Los Angeles County to become a global leader.
- Assess the competitive position of Los Angeles County in key factors driving bioscience development—including the strengths to leverage and the gaps to address. Seven leading regions in the biosciences across the country are used as benchmarks in this analysis. These regions include Boston, Philadelphia, Pittsburgh, Raleigh-Durham (hereafter referred to as Research Triangle), San Francisco, San Diego and Washington, D.C.
- Develop a Master Plan which sets out the key strategies and actions needed to advance the County's bioscience industry cluster.

The Los Angeles County Chief Executive Office retained the services of the Battelle Technology Partnership Practice to assist in advancing this Feasibility Assessment and Strategic Master Plan. The Technology Partnership Practice (TPP) is the technology-based economic development consulting arm of Battelle, the world's largest independent non-profit research and development organization. TPP is one of the nation's premier technology-based economic development consulting organizations in advancing comprehensive bioscience strategies for ten states and nine regions. Battelle TPP is also well recognized as a national thought leader on state and regional bioscience development, having partnered with the national Biotechnology Industry Organization (BIO) to assess the "state of the state" in the biosciences in each of the 50 states on a biennial basis.

[1] Obama Administration, National Bioeconomy Blueprint, April 2012, page 1, at http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf

The Promise and Challenge for Biosciences Development in Los Angeles County

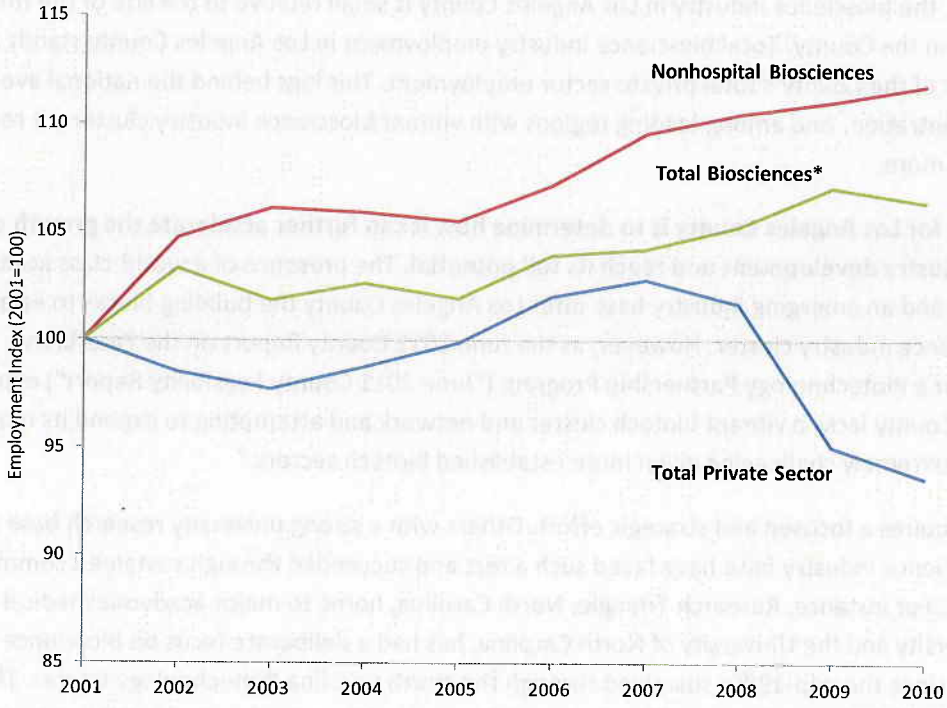
Los Angeles County already has many of the key ingredients necessary for advancing bioscience development. The County has several leading academic medical centers, which in 2012 combined to generate nearly $1 billion in National Institutes of Health funded research, the gold standard of biomedical research. This strong showing in bioscience research places Los Angeles County in the top tier of metropolitan areas. It may also surprise many to learn that there already exists a sizable bioscience non-clinical industry base in Los Angeles County generating high quality jobs. Total bioscience industry employment in Los Angeles County stood at 42,000 in 2010—slightly larger than the bioscience industry employment found in either the San Diego or San Francisco regions. And these are high quality jobs utilizing a broad range of skills—from technicians and skilled production workers to engineers and scientists to clinical research nurses and administrators. Average bioscience industry wages in Los Angeles County reached $72,052/year in 2010, standing well above that of the average private sector wage in Los Angeles County of $52,029/year.

An examination of the bioscience industry trends in Los Angeles County over the decade of 2001 to 2010 points to its growing importance as an economic driver for Los Angeles County. Here are some of the key findings:

Consistent Job Generator: The bioscience industry has been a consistent growth industry in Los Angeles County over the past decade, even through the recession and weak recovery years. In the core bioscience industry sectors (not including hospitals), employment in Los Angeles County rose from 37,759 jobs in 2001 to 42,211 jobs in 2010, an increase of 4,452 jobs, or 11.8 percent. The growth in the County's bioscience industry employment has been so robust and persistent that it grew even through the recession years of 2008 and 2009, and by the end of the second year of the weak national recovery in 2010, bioscience industry employment was significantly higher than in 2007 before the recession took hold.

Key Local Growth Driver: Bioscience industry employment rose even as total private sector employment fell sharply in Los Angeles County. While the County's bioscience industry employment grew by 11.8 percent from 2001 to 2010, total private sector employment in the County fell during the same time period by more than 225,000 jobs, a decline of 6.4 percent. This fall off in private sector employment in the County was most severe through the recession and weak economic recovery years of 2008 to 2010, when total private sector employment fell by 9.0 percent in Los Angeles County from its peak in 2007 and yet grew by 2.2 percent for bioscience industry in the County. Even in the more stable, expansion years of 2001 to 2007, the County's bioscience industry's employment growth of 9.6 percent vastly outpaced the County's total private sector growth of 2.8 percent.

Figure ES-1: Los Angeles County Employment Trends: Bioscience Industry, Total Biosciences (with hospitals) and Total Private Sector, 2001 to 2010



Source: Battelle analysis of Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW) data; enhanced file from IMPLAN.

However, as an industry cluster Los Angeles County does not measure up in the biosciences. The measure of the strength of an industry cluster is its relative concentration in a specific geographic area and its ability to create what might be termed an "industrial commons" within that area. In terms of its concentration, the bioscience industry in Los Angeles County is small relative to the size of the total private sector in the County. Total bioscience industry employment in Los Angeles County stands at just over 1 percent of the County's total private sector employment. This lags behind the national average industry concentration. And among leading regions with vibrant bioscience industry clusters, it reaches 3 percent and more.

The challenge for Los Angeles County is to determine how it can further accelerate the growth of bioscience industry development and reach its full potential. The presence of a world-class academic research base and an emerging industry base offer Los Angeles County the building blocks to establish a leading bioscience industry cluster. However, as the June 2011 County Report on the Feasibility Assessment for a Biotechnology Partnership Program ("June 2011 County Feasibility Report") explains: "Los Angeles County lacks a vibrant biotech cluster and network and attempting to expand its market share will be extremely challenging given more established biotech sectors."

To succeed requires a focused and strategic effort. Others with a strong university research base and a fledgling bioscience industry base have faced such a test and succeeded through sustained commitment and initiatives. For instance, Research Triangle, North Carolina, home to major academic medical centers at Duke University and the University of North Carolina, has had a deliberate focus on bioscience development since the mid-1980s sustained through the North Carolina Biotechnology Center. That effort has paid off handsomely, as the biosciences today account for over 4 percent of the private sector employment in the Raleigh-Durham region, among the highest concentrations of any major metropolitan area in the country.

Key Findings on the Technology Position and Competitive Assessment of Los Angeles County in Biosciences Development

The in-depth analysis of bioscience development in Los Angeles County found that the substantial bioscience research and innovation activities across the County's industry and research institutions positions the County for future growth in three specific technology platforms:

- **Novel therapeutics and diagnostics**
- **Bioengineering solutions for treating diseases and other medical conditions**
- **Innovations in healthcare delivery**

(See text box for more details on these three technology platforms)

Details on Technology Platforms for Bioscience Growth in Los Angeles County

Novel Therapeutics and Diagnostics

Core competencies upon which to draw:

- Biologics for Therapeutics and Diagnostics; Genetics and Genomics; Protein Sciences; Stem Cell Biology; Multiple Disease Areas

Insights from data analysis and discussions with industry and university leaders:

- There is significant industry growth occurring across a range of industries in biopharmaceuticals, including biological products, biotechnology commercial research and development, in vitro diagnostics and pharmaceutical manufacturing.
- Growth in industry activities involves new and emerging companies as demonstrated by venture-backed companies in diagnostics and therapeutics.
- The key focus is on innovations in biologics to advance therapeutics and diagnostics, with an established research capacity to advance therapeutic proteins, active industry efforts in diagnostics and the emergence of stem cell research for advancing therapies and delivery mechanisms.
- Cancer is the leading area of development from investigator-initiated drug/biologics trials—but other active areas include psychiatric disorders and cardiovascular treatments.

Bioengineering Solutions for Treating Diseases and Other Medical Conditions

Core competencies upon which to draw:

- Electro-medical Devices; Surgical Instruments and Devices; Biomedical Imaging; Dental Materials, Implants and Devices; Cardiovascular Treatments and Devices

Insights from data analysis and discussions with industry and university leaders:

- Los Angeles County is unique in having industry strengths across Electro-Medical, Musculoskeletal and Surgical Devices as well as Biomedical Imaging, and specialization in Dental Materials and Devices.
- The strengths of the County's universities in engineering is a major competitive advantage and driver. This reinforces how important it is to keep the focus on devices and the application of microelectronic systems and nanotechnology.

Innovations in Healthcare Delivery

Core competencies upon which to draw:

- Health Informatics; Public Health and Healthcare Services; Biomedical Imaging; Genomics and Genetics

Insights from data analysis and discussions with industry and university leaders:

- The research institutions in Los Angeles County stand out in healthcare sciences and policy, with more than ten NIH funded research centers focused on quality of care, health promotion, health disparities and community participatory research.
- There has been a recent emergence of innovative health services and health informatics companies. Over the period 2009 to 2012(Q3), $165 million in venture capital was invested in 13 emerging healthcare IT and digital innovation companies in the County.
- Los Angeles County has one of the nation's most developed public healthcare systems. It is a $3.5 billion enterprise with a network of outstanding hospitals and outpatient facilities across the County.
- Los Angeles County is taking a leadership position in seeking innovative approaches to healthcare delivery. The Department of Health Services in Los Angeles County has partnered with MedPOINT Management to launch an eConsult platform, an electronic primary care-to-specialist consultation and referral system.

To realize the full potential of the market opportunities identified through evaluation of the County's bioscience technology competencies, the County must maintain a strong competitive position, not only against other regions in the U.S. but increasingly against global competition. Leading regional bioscience industry clusters have common ingredients, such as a robust bioscience innovation infrastructure and existing industry excellence. Other key common ingredients include: availability of commercial biosciences lab space; access to venture capital through well-functioning markets for all stages; a pool of high-skilled talent that spans the bioscience industry's skill needs—from lab technicians and precision production up through Ph.D. level scientists, engineers and top management; a strong and growing regional academic research and development base and a university technology transfer and commercialization infrastructure that nurtures and promotes new product and firm formation. This critical continuum of regional factors must work in combination in order for the industry cluster to realize its full potential.

Below are key findings on the competitive position of Los Angeles County across these key factors.

Commercial Biosciences Lab Space

There is no identifiable commercial bioscience real estate market in Los Angeles County and no single area of the County that has a high share of bioscience company locations...so, there is no equivalent to a "Hollywood" for the bioscience industry despite its need for specialized lab space and highly skilled talent pools. The locations of 168 bioscience firms in the County were identified, involving 205 buildings and 4.982 million total square feet leased—a very sizable footprint. But a mapping of these bioscience firm locations suggests that bioscience firms are highly scattered across the County.

There is no clearly identified inventory of bioscience lab space that is being either bought/sold or leased to bioscience tenants. Outside of two small bioscience incubators found near research institutions with a total area of 12,000 square feet, there is only one advertised multi-tenant bioscience lab space found in the County, with 34,000 square feet that are close to fully occupied. This lack of available lab space is reinforced by the analysis which shows that among the 168 bioscience firms tracked only 18 of them are located in buildings that house another bioscience firm. This suggests that bioscience companies are not only widely distributed geographically across Los Angeles County but also that the County has virtually no multi-tenant bioscience-dedicated buildings.

A key competitive issue for Los Angeles County is that bioscience companies have to bear the cost of fitting out their own wet lab spaces with required air handling needs and can face long delays and uncertainties with permitting. This cost to retrofit existing commercial real estate for wet labs can run well in excess of $150 per square foot, placing a significant economic burden on bioscience companies in Los Angeles County and creating delays and uncertainties that take them away from their primary business activities. In all seven of the benchmark regions there is an available inventory of bioscience wet lab space being leased.

Venture Capital

Los Angeles County is clearly lagging the leading bioscience regions in both venture capital investment dollars and the number and efficiency of investment deals flow in bioscience-related ventures. In addition, the data analysis confirms the challenge raised in conversations with local stakeholders--seed and early stage VC investing is indeed lacking in the region. While it is anecdotal in nature, there is

evidence that this limited access to capital is one of several factors driving companies to locate their new or emerging bioscience startups in other regions. Indeed this capital issue must be addressed if Los Angeles County is to realize its full potential in bioscience industry development.

Talent and Workforce

Viewing demand and supply of bioscience talent together, Los Angeles County is generating a large number of entry-level degree graduates in life science fields, though is not yet generating the level of demand—in terms of jobs—needed to specialize in bioscience workforce development. Instead, Los Angeles County is a net exporter of talent from its world-class universities to other regions or countries.

The County's higher education institutions represent a significant competitive advantage, and a resource that other regions covet. If the bioscience sector can offer good jobs and exciting opportunities, many of these graduates would likely remain in the region, but this is a major challenge that requires strong and steady demand for workers and a better awareness of the Los Angeles County bioscience cluster as a whole. It is particularly important, as an emerging cluster, that strong connections between industry and students be forged since it is easy to overlook the opportunities for bioscience talent that do exist in the County. The industry must engage the universities, and vice versa, in order to promote successful talent pipelines and an understanding of the opportunities in the region.

Los Angeles County has been unable to effectively tap into more senior-level talent, as the same unawareness of its strong but scattered bioscience industry creates uncertainty as to career paths available in the County. That, combined with its relatively high cost of living, makes relocating to Los Angeles County for a career in the biosciences appear too risky for some.

Bioscience University Commercialization and Research Environment

Los Angeles County maintains a strong position in bioscience research and development and technology transfer and commercialization. Despite this, underlying concerns remain. Universities are successfully spinning out new technologies and companies in the life sciences, though there is strong anecdotal evidence that these spin-outs have little attachment to the County and are migrating out, attracted by capital and experienced management talent they cannot find in the region. Separately, R&D expenditure data suggest a relative loss in competitive share as the County's institutions have flattened their rate of increase in spending on research while other regions are thriving.

Summarized Findings: SWOT Analysis

To summarize the overall findings, a strengths, weaknesses, opportunities and threats framework (SWOT) was developed. This SWOT analysis reflects not only the quantitative analyses completed, but the situational assessment involving more than 50 one-on-one interviews with key bioscience industry executives, university and research institution officials, angel and venture capital investors, commercial real estate brokers and developers, education and training providers and government officials. This SWOT assessment was reviewed by and discussed with the Project Advisory Committee, comprised of leading executives and officials from bioscience industry, university and research organizations, venture capital, commercial real estate and education and training institutions drawn from across the County. It should be noted that in some cases perceptions are included in this SWOT, whether accurate or not, since they reflect the climate within which progress can be made in advancing the bioscience industry cluster in Los Angeles County.

Summary of Strategic "SWOT" Assessment

STRENGTHS: **Biosciences Industry Growth:** The bioscience industry cluster over the past decade—including through the recession and weak national recovery—has been a growing sector and economic driver for Los Angeles County.

Breadth of Growth Across Multiple Industry Sectors: The growth of Los Angeles County's bioscience industry base, though focused on biomedical activities, is broadly based across several sectors and not reliant on just one or two sectors.

Base of Bioscience Research and Innovation Activities: The depth of the research and innovation base found in Los Angeles County is substantial and offers a key leverage point for future growth. Three specific technology platforms emerge that offer a clear alignment of industry presence with research activities in the county: Novel Therapeutics and Diagnostics; Bioengineering Solutions for Treating Diseases and Other Medical Conditions; and Innovations in Healthcare Delivery.

Commercialization Track Record: In the technology transfer and commercialization activities of its major research drivers, Los Angeles County not only significantly outperforms the U.S. average, but also stands out among the benchmark regions.

Sizeable and Capable Pool of Local Graduates: Generation of bioscience talent stands out across the college and university base found in the region.

First-rate Business Support Services: Los Angeles County already has the presence of business services and an international position.

WEAKNESSES: **Institutional and Geographic Fragmentation and Lack of Cohesion:** There is no identifiable commercial bioscience real estate market in Los Angeles County and no single area of the county that has a high share of bioscience company locations...so, no equivalent to a "Hollywood" for the bioscience industry despite its need for specialized lab space and tapping talent pools.

No Pre-Fitted Lab Space Available: A key competitive issue for Los Angeles County is that bioscience companies have to bear the cost of fitting out their own wet lab spaces with required air handling needs, and can face long delays and uncertainties with permitting.

Insufficient Venture Capital: Los Angeles County is lagging in venture capital funding, particularly at the critical early stages.

Commercialization Startups Go Elsewhere: A "leaky bucket" phenomenon is happening in Los Angeles around bioscience commercialization despite the strong technology transfer and commercialization performance of its major research drivers.

No Regional Draw for Bioscience Workers: The demand for bioscience workforce in Los Angeles County is lower than in benchmark regions, and creates a challenge to recruit top talent to the region given the lack of broader opportunities.

OPPORTUNITIES: Focus on deepening the connections of commercialization of local biomedical advances to Los Angeles County to grow a more entrepreneurial bioscience community in Los Angeles County.

Advance a healthcare delivery innovation network in Los Angeles County.

Leveraging ongoing and planned investments by Los Angeles County in its public hospital campuses to address stimulating a commercial bioscience real estate market in the county.

Targeting more extensive partnerships for local universities with multinational biomedical companies.

Raising the profile and branding of Los Angeles County in bioscience development. Given the size and dynamics of Los Angeles County, its emerging bioscience industry cluster is not well recognized, even within the county.

Advancing a local entrepreneurial bioscience talent base.

THREATS: High cost of living and congestion in Los Angeles County.

Potential slowdown and reductions in federal bioscience research and development.

High state taxes and strict regulatory climate.

Strong competition from other regions

Recommendations for Master Plan Strategy, Actions and Implementation

The comprehensive Master Plan set out is focused on enabling Los Angeles County to realize its full potential as a leading bioscience hub. A close examination of the situation reveals that Los Angeles County has been held back in bioscience development by significant hurdles, which if not addressed will continue to hamper future growth. In order for Los Angeles County to take its place among the leading U.S. regions, four Strategic Initiatives must be addressed:

- **Bioscience Commercialization Initiative** – The goal of this initiative is to facilitate increased levels of commercialization and development of high growth potential new and emerging biosciences companies in Los Angeles County. The preceding feasibility assessment identified the strength of the local research base, yet many new bioscience venture spin-outs from local research institutions are being located outside of the county due to the lack of locally based biosciences venture capital and an insufficient pool of entrepreneurs and top managerial talent to advance these promising technologies. This initiative would involve attracting early stage biosciences venture capital firms—critical for local new venture formation—to set up offices in Los Angeles County. It would also increase the pipeline of new bioscience startups through collaboration with university technology transfer offices and the industry supported SoCalBio organization to augment existing commercialization services, including supporting Entrepreneurs-in-Residence and establishing a proof-of-concept/seed fund to substantiate and advance promising technologies. Another major component would be the establishment of a healthcare delivery innovation network that works collaboratively with stakeholders (providers, payers, and technology companies) to invest in ventures focused on innovations in healthcare delivery and to support the piloting and demonstration of promising opportunities created from those ventures. Any successful healthcare delivery innovations could potentially greatly benefit the County health system as it continues to transform under healthcare reform.
- **Commercial Bioscience Laboratory Space Development Initiative** – The goal of this initiative is to stimulate the establishment of commercial multi-tenant bioscience-specific lab buildings in Los Angeles County. Today, there is a paucity of dedicated commercial bioscience lab space in the County, which is particularly a burden for new and emerging bioscience companies due to the significant cost and time to get government approvals for lab tenant improvements. It is recommended that the County partner with private developers to establish 3–5 "signature biosciences innovation hubs" to serve the needs of startup and emerging bioscience firms, exploring sites on County owned land including the hospital campuses with academic partners (UCLA-Harbor, USC-County, MLK-Drew) and non-hospital sites near UCLA and City of Hope. Each hub would involve the initial development of approximately 50,000 gross square feet of commercial biosciences lab space. (Note: Based on past trends, it is estimated that there will be an annual absorption of over 42,000 gross square feet for startup and emerging companies). In addition, it is recommended that a revolving biosciences tenant improvement loan fund be established by the County in partnership with local municipalities for creating multi-tenant biosciences facilities across the County for growing companies beyond the startup and early stages of development, which would be sustained by tenant repayments over a 5–10 year period as part of their lease payments.

- **Bioscience Talent Initiative** – The goal of this initiative is to attract senior scientific and management biosciences talent, retain the top talent produced by local academic institutions, and improve the technical skills of the County's bioscience workforce in areas such as regulatory affairs, quality control and advanced manufacturing skills. It is recommended that career services be provided to high-level management talent, academic talent be linked to local industry, and planning resources be provided for consortiums of local education providers in the County to compete for federal, state and philanthropic workforce development funding. (Note: this builds upon a recent successful LA Valley College award from the U.S. Department of Labor as part of a national consortium for biomanufacturing training.)

- **Bioscience Marketing Initiative** – The goal of this initiative is to increase the visibility of the Los Angeles region as a place of great bioscience growth potential and thereby attract companies, talent and investment. A County-wide marketing effort is recommended, to be developed in collaboration with SoCalBio, a local biosciences industry trade association, and other local economic development organizations. This effort would focus on raising local awareness of the jobs and growth found in the bioscience industry in the County, creating a widely shared brand and image campaign involving leading institutions and businesses, systematically generating leads for attracting industry investment and location in the County, attracting national and international bioscience conferences and advancing strategic bioscience partnering programs with major multinational bioscience companies as well as with key international regions and nations.

These four Strategic Initiatives incorporate the specific priorities which the Los Angeles County Biosciences Master Plan must address in order for the County to realize its substantial growth potential in bioscience industry development.

A number of basic principles should guide Los Angeles County as it advances a programmatic Master Plan to address these four Strategic Initiatives:

- Seek to engage private sector participation and leadership in advancing sustainable public-private partnerships.
- Make use of limited county resources as a catalyst for change.
- Build on successful activities to date.
- Focus on leveraging private sector investments, including those from philanthropic sources.

The County's commitment in terms of resources is estimated to be roughly $19.75–$28.50 million over a five-year period. This is comprised of the following:

- Operating Costs: Funding support of $1.75–$3.50 million annually ($8.75–$17.5 million over five years) for technical resources to support the Strategic Initiatives, including costs for: attracting local venture capital funds to the County; supporting Entrepreneurs-in-Residence; facilitating the innovation network for healthcare delivery; establishing the signature bioscience innovation hubs; providing workforce services and planning grants and managing the marketing outreach.

- Capital Costs: Matching funding of approximately $11 million in one-time capital costs over a five-year period for venture development, tenant improvement financing, proof-of-concept/seed funding, a revolving loan fund for tenant improvements and a matching investment Fund of Funds to further attract local venture capital funds.

County resources will also be required to facilitate other key efforts, including:

- Transferring or leasing County land for establishing the signature bioscience innovation hubs for startup and emerging bioscience companies.
- Creating a Los Angeles County Biosciences Venture Capital Trust Fund mechanism to encourage institutional funds, high net worth individuals and foundation investment for attracting proven early stage bioscience venture capital funds to locate in Los Angeles County. Some form of incentive and/or matching investment by the County may be required.
- Leveraging the County's ongoing eConsultLA platform as well as broader efforts in improved healthcare delivery.

The major leverage from non-County resources would come from:

- Private developer investments for development of commercial bioscience space. With the potential development of 200,000 square feet of bioscience-dedicated space across multiple bioscience innovation hubs over a five-year period to meet the estimated 42,000+ square feet annual additional demand for startup and emerging bioscience companies, the total private developer investments could reach $40–$60 million.
- Institutional, private investment and foundation investment for bioscience venture investments of $250 million as seed funding for commercialization of high potential technologies and innovative healthcare delivery projects.
- Federal, state and foundation support for consortium-based bioscience workforce development projects.

It is recommended that approximately $20–30 million in County funds be appropriated for these Strategic Initiatives and be consolidated into a newly formed Biosciences Economic Development Fund to be expended over a five-year period and overseen by the Chief Executive Office of Los Angeles County. Given the focus on engaging private sector leadership and private sector resources (including philanthropic sources), it is recommended that a non-governmental organization (NGO) be engaged through the Chief Executive Office of Los Angeles County for advancing bioscience development in the County, with a specific Statement of Work reflecting the Master Plan recommendations. It would have specific milestones and performance requirements that could be monitored annually, and should not require additional County resources for funding if, as part of these performance requirements, it would seek to generate at least compensatory funding from its activities over the five year period.

It is recommended that the industry-led SoCalBio organization be selected as the NGO with which the County partners to bring about the approval of and appropriations for this Biosciences Economic Development Fund. SoCalBio is already actively involved in bioscience commercialization, workforce development and marketing activities, and offers the capacity to bring key stakeholders together to guide the Master Plan as well as to manage the resources to deliver services and generate matching private sector funds. This strategic partnership would involve negotiating a Memorandum of

Understanding with SoCalBio for implementation of the Master Plan, possibly involving the creation of a dedicated non-profit organization set up within SoCalBio specifically for this purpose.

Alternatively, the County Chief Executive Office could seek to contract for services by another NGO with a proven expertise and track record. Although significant efficiencies in staffing and in accountability can be generated by bringing these Strategic Initiatives together under the management of a single NGO, it is possible to engage separate NGO's to undertake each of the specific Strategic Initiatives.

An excellent best practice example of such a dedicated bioscience development organization, which has been a leader in advancing needed development programs and services at a regional level with a strong emphasis on partnership building, is the North Carolina Biotechnology Center (NCBiotech). NCBiotech was formed by the state of North Carolina over 25 years ago just as an awareness of the potential economic development impact of biotechnology was becoming recognized. The Center offers a comprehensive approach to advancing the biosciences, featuring products and services for basic and applied research, new venture development, business recruitment, retention and expansion and education and workforce development. It has succeeded in generating a positive return on investment on state funded support as well as garnering strong stakeholder support. What NCBiotech has successfully done is ensure that the interconnected development chain needed for technology-based economic development is in place to advance biotechnology and the biosciences in North Carolina.

The table below summarizes the key programmatic components for each of the Strategic Initiatives, along with expected private sector resources to be leveraged and the range of cost implications for Los Angeles County government.

Table ES-1: Strategic Initiatives and Actions

Strategic Initiative	Programmatic Elements	Non-County Costs and Leveraging Opportunities	Expected Cost to County Over Next Five Years	
			Annual Operating Budget	**One Time Capital Costs**
Bioscience Commercialization Initiative	• **Attracting proven early stage bioscience venture capital firms to locate in Los Angeles County** • **Establishing a Biosciences Commercialization Collaborative** • **Fostering a Healthcare Delivery Innovation Network**	Investments from state/local pension funds in Fund of Funds with expected 10% rate of return, At least 3:1 leverage for Fund of Funds investments in private venture funds and matching private sector funding of $250 million under management for proof-of-concept/seed stage investments. Also possible to seek philanthropic and federal government sources of investment	Approximately **$500,000 to $1 million annually** for staffing and consultant costs	**Total: $6 million** $5 million for a proof-of-concept/seed fund $1 million for Healthcare Delivery Innovation Network Plus consider a first loss reserve for venture funds to provide an incentive for institutional and high net worth individual fund investments.
Commercial Bioscience Laboratory Space Development Initiative	• **Establishing 3–5 "signature" bioscience innovation hubs** • **Providing incentives to private developers for the creation of multi-tenant bioscience facilities**	Leverage private developer investments for development of commercial bioscience-dedicated space Repayment of tenant improvement costs from lease payments of tenants.	Approximately **$250–$500,000 annually** for staff to package deals with private developers and to market hubs	**Total: $5 million** Long term leases of county land at nominal costs to establish hubs Possibly use toward the cost of a shell building, to be recouped from future tenant lease payments $5 million ($1 million/year for 5 years) for tenant improvement incentives or financing—lease payments from tenants used to fund ongoing improvement efforts.
Bioscience Talent Initiative	• **High Skills Biosciences Career Service** • **Postdoctoral and Doctoral Level "Bridges to Industry"** • **Bioscience Skills Development in such areas as technical production, mid-level management and marketing.**	Leverage resources from state, federal and philanthropic sources Also potential user fees from companies for High Skills Biosciences Career Services	Approximately **$500,000 to $1 million annually** for staffing, database development, internship costs and planning grants	

Strategic Initiative	Programmatic Elements	Non-County Costs and Leveraging Opportunities	Expected Cost to County Over Next Five Years	
			Annual Operating Budget	One Time Capital Costs
Bioscience Marketing Initiative	• **Creating and sustaining an active alliance marketing program** • **Building local awareness and a positive image and brand for the bioscience industry cluster** • **Attracting national and international bioscience conferences to Los Angeles County** • **Advancing strategic bioscience partnering programs with major multinational bioscience companies as well as key international regions and nations.**	Leverage local economic development and industry group funding	Approximately **$500,000 to $1 million annually** to be matched by local economic development organizations to allow for shared staff capacity, outreach to prospects and potential conferences and seeding strategic partnerships in conjunction with local university and academic medical centers with multinational companies and specific international regions	
Totals			**$1.75–$3.5 million/year over 5 years (total of $8.75–$17.5 million)**	**Approximately $11 million in onetime capital costs (over a 5 year period of time)**

Los Angeles County has the opportunity to join the ranks of thriving top tier global bioscience hubs, but it must first address several challenges that are currently holding it back. The region has key ingredients to leverage including a large, growing, and diverse industry presence in the biosciences adjacent to world-class biomedical research institutions and talent generators that other regions and nations covet. However, despite these assets it has yet to reach its full potential. The County has the opportunity to accelerate the growth of quality, high-paying jobs in the biosciences by allocating the resources and attention required to nurture and truly develop a bioscience cluster. To achieve this, the County must work to advance the four Strategic Initiatives put forth in this study through an effective and focused public-private partnership. These initiatives are intentionally designed to address those challenges and obstacles currently standing in the way of the region's success in the biosciences. Los Angeles County is well positioned to be a leader in a technology-based industry that is a proven job and innovation generator, and herein lies a roadmap for success.

Section 1: Introduction

Los Angeles County faces the economic development imperative of identifying and advancing high growth potential economic drivers to spur jobs and incomes for its residents. These are difficult and uncertain economic times for Los Angeles County, with local unemployment in the County projected to remain high and local employment growth expected to be lackluster.[2] There is also little relief expected from national economic growth, as the country is entrenched in a "muddle-through economy" that continues to limp along at a very sluggish pace.[3] In order to spur future local economic growth it is imperative that Los Angeles County take its economic future in its own hands by determining which industries will drive innovation, job growth and wealth creation and allocating resources to those that fit the bill.

The importance of fostering the growth of such emerging, innovation-based, high growth economic drivers is well understood. Studies have shown that the presence of such robust innovation-based drivers is the critical difference in the economic performance of regions across the United States. A study by the Milken Institute, a private nonprofit research organization, which evaluated the economic growth across 315 regions in the United States from 1975 to 1998, found that the growth and presence of innovation-based, high-technology industries accounted for 65 percent of the difference in economic success for regions. Moreover, the Milken Institute identified that research centers and institutes were "indisputably the most important factors in incubating high-tech industries."[4]

The bioscience industry cluster represents an emerging, economic driver for Los Angeles County with strong growth potential. In April of 2012 the Obama Administration released its National Bioeconomy Blueprint noting that the bioscience industry is "a large and rapidly growing segment of the world economy that provides substantial public benefit."[5] Across the nation, states and regions are focusing on the biosciences as a key economic driver for future growth. The reasons are straightforward—the biosciences represent a large, fast-growing and diverse sector, involving a wide range of manufacturing, service and research activities that promote not only economic vitality but also public health. The biosciences are not only at the forefront of creativity and innovation but also represent a convergence point for engineering, information technology and nanosciences. For these reasons, the 21st century is being dubbed by observers worldwide as the "Bio Century."

What is not as well recognized is that Los Angeles County already has many of the key ingredients necessary for advancing bioscience development. The County has several leading academic medical centers, which combined to generate nearly $1 billion in National Institutes of Health funded research in 2012, the gold standard of biomedical research. This strong showing in bioscience research places Los Angeles County in the top tier of metropolitan areas.

---

[2] See Los Angeles Forecast by Jordan G. Levine, Beacon Economics, page 38, in 2012 Los Angeles Economic Forecast Conference, What's Next LA? Report, June 2012 at https://beaconecon.com/index.php?option=com_event&task=event&id=32

[3] See "UCLA Anderson Forecast Predicts Slow Growth at State and National Levels This Year," September 20, 2012 at http://newsroom.ucla.edu/portal/ucla/ucla-anderson-forecast-predicts-238839.aspx

[4] Milken Institute, America's High-Tech Economy, 1999.

[5] Obama Administration, National Bioeconomy Blueprint, April 2012, page 1, at http://www.whitehouse.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf

It may also surprise many to learn that there already exists a sizable bioscience non-clinical industry base in Los Angeles County generating high quality jobs. Total bioscience industry employment in Los Angeles County stood at 42,000 in 2010. This total number of bioscience industry jobs in Los Angeles County is slightly larger than found in either San Diego or San Francisco regions. And these are high quality jobs utilizing a broad range of skills—from technicians and skilled production workers to engineers and scientists to clinical research nurses and administrators. Average bioscience industry wages in Los Angeles County reached $72,052/year in 2010, standing well above that of the average private sector wage in Los Angeles County of $52,029/year.

Reasons Why States and Regions Are Seeking to Grow Their Biosciences Sectors

According to the Biotechnology Industry Organization (BIO), the biosciences stand as unique growth drivers for states and regions because:

The biosciences are composed of rapidly growing industry sectors. Over the last ten years and through the recession and weak national recovery, biosciences continue to outperform the overall economy in job gains. Looking to the future, the U.S. Bureau of Labor Statistics continues to project that the biosciences industry, including hospitals, will outperform the overall economy, with a number of key industries, such as commercial research and testing, growing much faster than the overall economy.

The biosciences offer high-paying, quality jobs across a range of occupations from lower-skilled technicians and manufacturing workers to high-skilled research scientists and medical doctors. In 2010, biosciences workers, on average, were paid $82,697 compared to $46,317 for all private sector workers—a differential of 79%, which has been growing since 2001.

The biosciences not only involve a diversity of markets—from biopharmaceuticals to medical devices to agricultural products and biofuels—but cut across manufacturing, service, and research activities.

The biosciences contribute to the growth of other technology sectors, such as information technology, electronics, optics, and advanced manufacturing.

Investment in the biosciences can lead to benefits for a state's citizens in terms of improved healthcare, a cleaner environment, and healthier food.

Adapted from BIO, *Laboratories of Innovation: State Bioscience Initiatives*, 2006.

However, as an industry cluster Los Angeles County does not measure up in the biosciences. The measure of the strength of an industry cluster is its concentration in a specific geographic area and its ability to create what might be termed an "industrial commons" within that area. Gary Pisano and Willy Shih from Harvard's Business School explain: "Once an industrial commons has taken root in a region, a powerful virtuous cycle feeds its growth. Experts flock there because that's where the jobs and knowledge networks are. Firms do the same to tap the talent pool, stay abreast of advances and be near suppliers and potential partners."[6]

In terms of its concentration, the bioscience industry in Los Angeles County is small relative to the size of the total private sector in the County. Total bioscience industry employment in Los Angeles County stands at just over 1 percent of the County's total private sector employment. This lags behind the national average industry concentration. And among leading regions with vibrant bioscience industry clusters, it reaches 3 percent and more. This relatively low concentration has resulted in the absence of an industrial commons for the biosciences in Los Angeles County. So despite the large absolute size of its bioscience industry, Los Angeles County is missing the virtuous cycle that feeds growth and serves as a magnet to attract even more bioscience development. As the June 2011 County Report on the Feasibility Assessment for a Biotechnology Partnership Program ("June 2011 County Feasibility Report") explains: "Los Angeles County lacks a vibrant biotech cluster and network

[6] Ibid.

and attempting to expand its market share will be extremely challenging given more established biotech sectors."

The challenge for Los Angeles County is to determine how it can further accelerate the growth of bioscience industry development and reach its full potential. The presence of a world-class academic research base and an emerging industry base offer Los Angeles County the building blocks to establish a leading bioscience industry cluster. To succeed requires a focused and strategic effort.

Others with a strong university research base and a fledgling bioscience industry base have faced such a test and succeeded through sustained commitment and initiatives. Research Triangle, North Carolina, home to major academic medical centers at Duke University and University of North Carolina, has had a deliberate focus on bioscience development since the mid-1980s sustained through the North Carolina Biotechnology Center. That effort has paid off handsomely, as the biosciences today account for over 7 percent of the private sector employment in the Raleigh-Durham region, the highest level of any major metropolitan area in the country. Similarly San Diego, home to the University of California, San Diego, a fast growing research university, and a strong base of independent research institutes, has established and sustained a world-class entrepreneurial and commercialization initiative (San Diego CONNECT) and a strong bioscience industry organization (BIOCOM) to leverage that research base. By doing so it has succeeded in having a bioscience industry presence that is today more than double the average U.S. level of concentration in its local economy.

Project Purpose, Objectives, Methodology and Consulting Team

The purpose of this effort is to provide an independent, fact-based bioscience industry cluster development strategy to enable Los Angeles County to realize its full potential as a bioscience hub. The specific project objectives are to:

- Identify the specific areas of likely bioscience development that can serve as technology platforms to enable the bioscience industry cluster in Los Angeles County to become a global leader.
- Assess the competitive position of Los Angeles County in key factors driving bioscience development—including the strengths to leverage and the gaps to address.
- Develop a Master Plan which sets out the key strategies and actions needed to advance the County's bioscience industry cluster.

The methodology for addressing these objectives is set out in Figure 1 below. The project is organized into three Phases, which provides for a comprehensive strategic planning approach from analysis and strategic assessment to strategy and Master Plan development. This comprehensive strategic planning process combines both quantitative, objective analysis with engagement of industry, university and other key stakeholders in one-on-one meetings and group sessions.

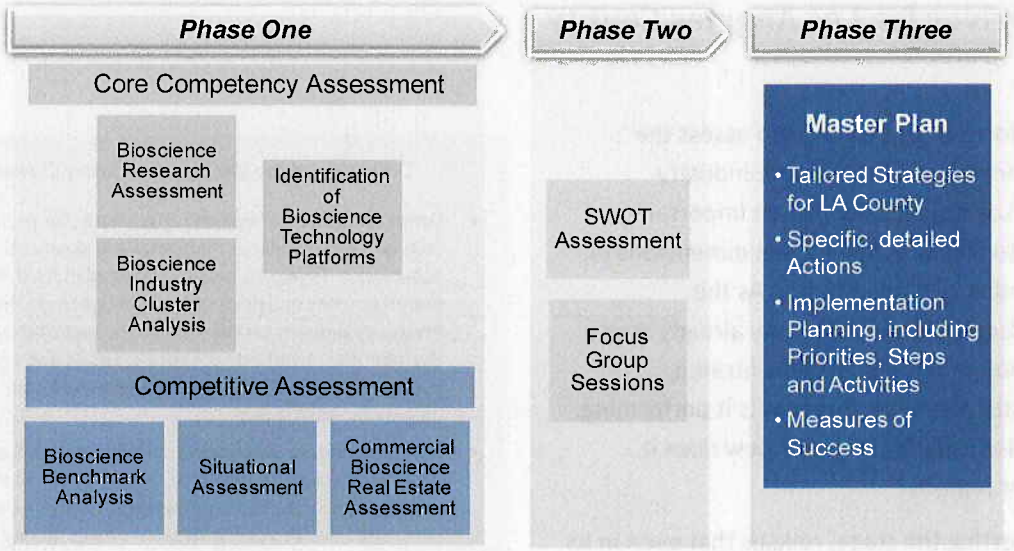
More specifically the analysis undertaken includes:

- **Core Competency Analysis:** A detailed quantitative analysis was performed, looking at industry trends, innovation activity and specific industry strengths and assessing the specific areas of bioscience research strength found across the County's research base. Of particular importance is identifying the bioscience core competency areas found across industry and university

activities in Los Angeles County that suggest promising areas of future bioscience development, as well as linkages to growing market opportunities that can enable the bioscience industry cluster in Los Angeles County to become a global leader.

- **Outreach to Key Stakeholders:** Interviews, discussions and focus groups were conducted involving nearly 60 stakeholders, including industry executives, university and academic health center officials, angel and venture capital investors, commercial real estate brokers and developers and governmental staff. Their valuable insights and perspectives will serve to inform and validate the results of the quantitative assessment of industry and research core competencies and areas of specialization, and to provide a situational assessment of Los Angeles County's current strengths, weaknesses, opportunities and threats (SWOT) within the biosciences.
- **Competitive Benchmarking:** The competitive position of Los Angeles County in the biosciences was assessed relative to seven leading benchmark regions based on key factors including talent and workforce, technology commercialization, new venture development, venture capital availability, and industry-university engagement. These regions include Boston, Philadelphia, Pittsburgh, Raleigh-Durham (hereafter referred to as Research Triangle), San Francisco, San Diego and Washington, D.C. Each benchmark region includes the city and its Metropolitan Statistical Area (MSA), which in some instances crosses borders into neighboring states.
- **Industry Real Estate Analysis:** A specialized analysis of the County's existing commercial bioscience real estate development was performed, with the goal of determining the feasibility of advancing further bioscience business incubator and research park development. The June 2011 County Feasibility Report highlights that "the County can lead the way by developing a master plan that will establish a biotech cluster at the former Medical Center, Rancho, Harbor-UCLA, OVMC and MLK." This is an important insight, and given the specialized nature of research parks, calls for this industry-specific real estate analysis. In that feasibility assessment an in-depth analysis of the current commercial bioscience real estate market in Los Angeles County was undertaken, including the development of a database of existing buildings in which bioscience companies are located and considering a range of issues such as the geographic pattern of where bioscience companies are located, types of facilities, co-location of bioscience companies within buildings, leasing costs, vacancies, etc. That analysis will be used to inform and shape projections for absorption and pricing for the types and amounts of space that could be developed in future bioscience research park developments in Los Angeles County.
- **SWOT Assessment:** The results of the core competency analysis, outreach to key stakeholders, competitive benchmarking and specialized commercial real estate analysis were integrated into a strategic analysis of strengths, weaknesses, opportunities and threats (SWOT) to inform the development of the Master Plan to advance bioscience development in Los Angeles County.

Figure 1: Graphic Depiction of Project Methodology



The Los Angeles County Chief Executive Office retained the services of the Battelle Technology Partnership Practice to assist in advancing this Feasibility Assessment and Strategic Master Plan. The Technology Partnership Practice (TPP) is the technology-based economic development consulting arm of Battelle, the world's largest independent non-profit research and development organization. Battelle created the Technology Partnership Practice in 1991 to focus Battelle's broad experience and capabilities to better serve state and local organizations, universities, non-profit technology organizations and others in the design, implementation and assessment of economic and technology development programs. Today, TPP is one of the nation's premier technology-based economic development consulting organizations in advancing comprehensive bioscience strategies for ten states and nine regions including the states of Arizona, Colorado, Georgia, Iowa, Maryland, Michigan, Missouri, Mississippi, Nebraska and Utah and the regions of Central Indiana, Central Ohio, Memphis, Northern Arizona, Peoria, Oklahoma City, St. Louis, Tucson and Western Massachusetts, dating back to 2000. Battelle TPP is also well recognized as a national thought leader on state and regional bioscience development. Battelle TPP has partnered with the national Biotechnology Industry Organization (BIO) to assess the "state of the state" in the biosciences in each of the 50 states on a biennial basis.

In addition Battelle TPP has been actively involved in the feasibility analysis and development planning for biomedical/biotechnology research parks, including those in Denver, Baltimore, Atlanta, Tampa and Northern New Jersey. Battelle possesses an extensive understanding of leading technology parks and best practices, as demonstrated in its 2007 comprehensive benchmarking and impact assessment study of North American research parks for the Association of University-Related Research Parks, which is currently being updated.

Section II: Setting the Stage – The Bioscience Industry as an Emerging Economic Driver for Los Angeles County

Since a primary focus of this effort is to assess the potential to advance overall bioscience industry development in Los Angeles County, an important starting point is to consider the current dimensions of the bioscience industry in the County. As the Introduction noted, Los Angeles County already starts with a sizable, though not highly concentrated, bioscience industry presence. But how is it performing, what are its key industry focuses and how does it compare to other regions?

This section, in setting the stage, reveals that even in its emerging stage of development, the bioscience industry in Los Angeles County is already a growth industry and a critical economic driver for the region—and worthy of focused attention to consider how to elevate it into a world-class bioscience cluster.

Defining the Bioscience Industry Cluster for Los Angeles County

Within the bioscience industry cluster there is a shared focus on generating and applying the knowledge of how living organisms function. In particular the emergence of biotechnology, dating back to key scientific discoveries in the 1970s, has had a profound impact on the industry and has reshaped all aspects of bioscience development today. Simply put, biotechnology involves techniques to understand and manage the machinery of living things. In human health, biotechnology has changed the way we study medicine, discover and develop therapeutics and diagnose and treat diseases and other medical conditions. Biotechnology has also revolutionized the development of agricultural products and is increasingly important for industrial products, including biofuels and specialized chemicals.

To understand the bioscience industry cluster, the Biotechnology Industry Organization (BIO) has put forward a comprehensive definition to serve as a national standard. This definition encompasses five key

Definition of the Bioscience Industry Cluster

- **Drugs and Pharmaceuticals**. The subsector produces commercially available medicinal and diagnostic substances. Firms are heavily engaged in R&D and manufacturing activities to bring drugs to market. Product examples include: vaccines; targeted disease therapeutics; biopharmaceuticals; tissue and cell culture media; dermatological/topical treatments; and diagnostic substances.
- **Medical Devices and Equipment**. Firms in this subsector produce biomedical instruments and other healthcare products and supplies for diagnostics, surgery, patient care, and laboratories, with close ties to advanced applications in electronics, materials and information technologies. Product examples include: bioimaging equipment; surgical supplies and instruments; orthopedic/prosthetic implants and devices; dental instruments and orthodontics; defibrillators (AEDs): stents and other implantable devices; and walkers, wheelchairs, and beds.
- **Research, Testing, and Medical Laboratories**. The subsector includes a range of activities, from highly research-oriented companies developing and commercializing new drug and biologics discovery/delivery systems to companies involved in seed development to more service-oriented medical or other life sciences testing firms. Product examples include: preclinical drug development; stem cell/regenerative research; biomarkers; contract research; and research/laboratory support services.
- **Agricultural Feedstock and Chemicals**. This subsector applies life sciences knowledge, biochemistry, and biotechnologies to the processing of agricultural goods and the production of organic and agricultural chemicals. The subsector also includes activities around the production of biofuels. Product examples include: ethanol and biodiesel fuels, fertilizers, pesticides, and biocatalysts.
- **Biosciences-related Distribution**. The subsector includes firms that coordinate the delivery of biosciences-related products spanning pharmaceuticals, medical devices and equipment, and the agricultural biosciences. Companies in the subsector increasingly deploy specialized technologies such as cold storage, highly regulated product monitoring, and automated drug distribution systems.

Source: Biotechnology Industry Organization (BIO) – 2012

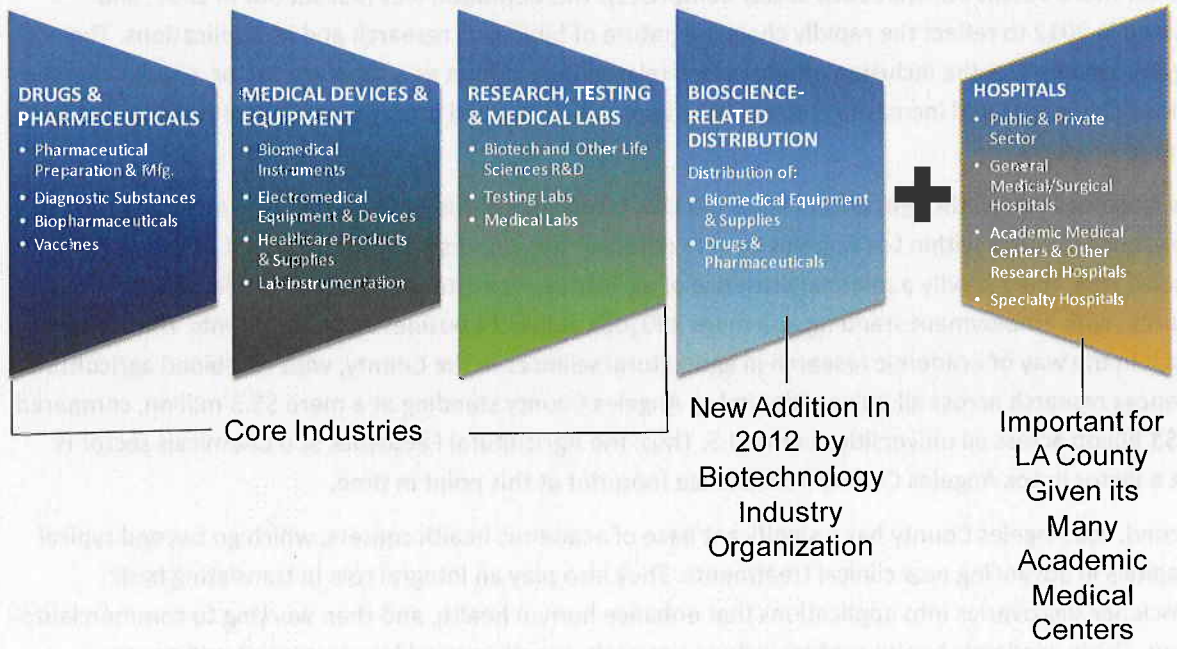
industry sectors: Drugs and Pharmaceuticals; Medical Devices and Equipment; Research, Testing and Medical Laboratories; Agricultural Feedstock and Chemicals and Bioscience-related Distribution (see text box for more details on what each sector comprises). This definition was first set out in 2002, and revised in 2012 to reflect the rapidly changing nature of biological research and its applications. The biggest change was the inclusion of Bioscience-related Distribution as a separate sector, recognizing the unique challenges and increasingly specialized approaches needed to transport and deliver bioscience-related products.

Los Angeles County, though, differs from the U.S. bioscience industry footprint. The makeup of the bioscience industry within Los Angeles County differs in two important ways from that of the nation as a whole. First, there is only a minimal presence of agricultural feedstock and chemicals firms within the County, with employment standing at a mere 280 jobs across 14 business establishments. Nor is there much in the way of academic research in agricultural sciences in the County, with combined agricultural sciences research across all universities in Los Angeles County standing at a mere $5.3 million, compared to $3 billion across all universities in the U.S. Thus, the Agricultural Feedstock and Chemicals sector is not a factor in Los Angeles County's bioscience footprint at this point in time.

Second, Los Angeles County has a significant base of academic health centers, which go beyond typical hospitals in advancing new clinical treatments. They also play an integral role in translating basic bioscience discoveries into applications that enhance human health, and then working to commercialize them. These academic health centers include hospitals directly owned by universities and county-funded hospitals that partner with university medical schools, as well as independent hospital centers, such as City of Hope and Cedars Sinai. These academic health centers are key players in the County's bioscience industry base.

So a more specialized definition for the biosciences for Los Angeles County emerges– encompassing an emphasis on biomedical activities. The core definition builds upon the BIO subsectors, primarily involved in biomedical products and services, and an expanded definition would also include hospitals. Unfortunately, there is currently no way to differentiate academic medical center-affiliated hospitals from more general community hospitals using available industry data. Because of this, many of the analyses in this report will show results with and without hospitals included. These descriptors—"expanded" and "core"—will be used to reference the County's bioscience industry with and without hospital data included, respectively. Figure 2 below graphically shows Los Angeles County's unique bioscience industry definition, and describes the sectors and sub-sectors within it.

Figure 2: A Los Angeles County View of the Bioscience Industry



Emergence of the Bioscience Industry as a Growth Driver for Los Angeles County

An examination of the bioscience industry trends in Los Angeles County over the decade of 2001 to 2010 points to its growing importance as an economic driver for Los Angeles County. Here are some of the key findings:

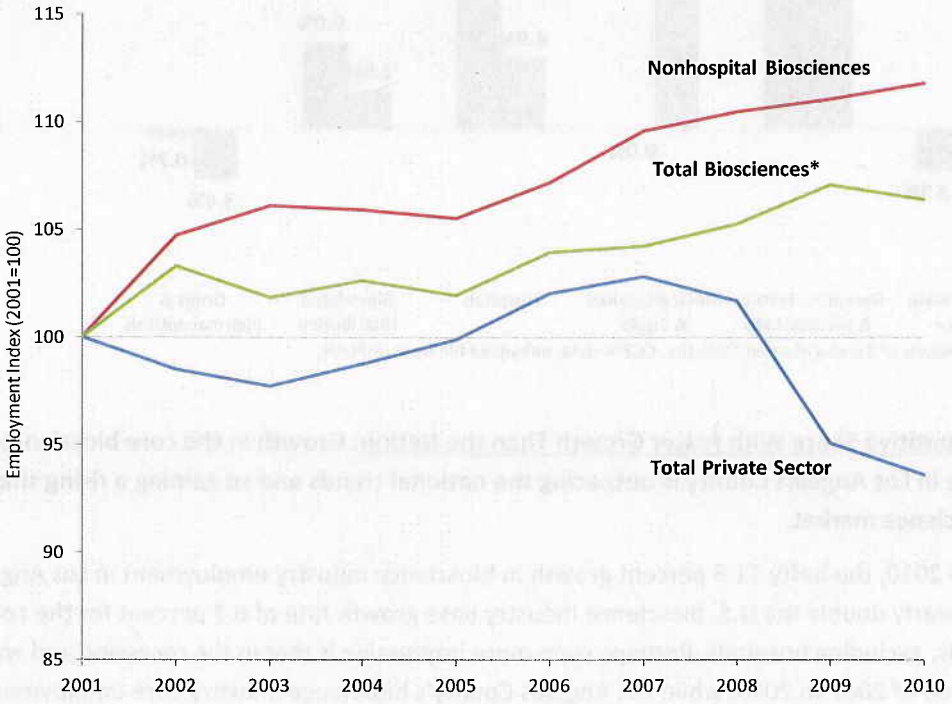
Consistent Job Generator: The bioscience industry has been a consistent growth industry in Los Angeles County over the past decade, even through the recession and weak recovery years.

In the core bioscience industry sectors (as shown in Figure 2 and not including hospitals), employment in Los Angeles County rose from 37,759 jobs in 2001 to 42,211 jobs in 2010, an increase of 4,452 jobs, or 11.8 percent. The growth in the County's bioscience industry employment has been so robust and persistent that it grew even through the recession years of 2008 and 2009, and by the end of the second year of the weak national recovery in 2010, bioscience industry employment was significantly higher than in 2007 before the recession took hold.

Key Local Growth Driver: Bioscience industry employment rose even as total private sector employment fell sharply in Los Angeles County. While the County's bioscience industry employment grew by 11.8 percent from 2001 to 2010, total private sector employment in the County fell during the same time period by more than 225,000 jobs, a decline of 6.4 percent. This fall off in private sector employment in the County was most severe through the recession and weak economic recovery years of 2008 to 2010, when total private sector employment fell by 9.0 percent from its peak in 2007 in Los Angeles County and yet grew by 2.2 percent for the bioscience industry in the County. Even in the more stable expansion years of 2001 to 2007, the County's bioscience industry's employment growth of 9.6 percent vastly outpaced the County's total private sector growth of 2.8 percent.

When the broader expanded base of core bioscience industry plus hospital employment (from Figure 2) is considered, this raises the total number of bioscience jobs in the county from about 42,000 to about 188,000, and though the growth rate for this expanded base was slightly lower than for just the core bioscience base, it continued to post a growth rate over the past decade of 6.4 percent, with a rate of 2.0 percent over the recession and weak recovery years from the peak in 2007 to 2010. The graphic in Figure 3 offers a clear view of the importance of both the core and the expanded bioscience employment base, which includes hospitals.

Figure 3: Los Angeles County Employment Trends: Bioscience Industry, Total Biosciences (with hospitals) and Total Private Sector, 2001 to 2010

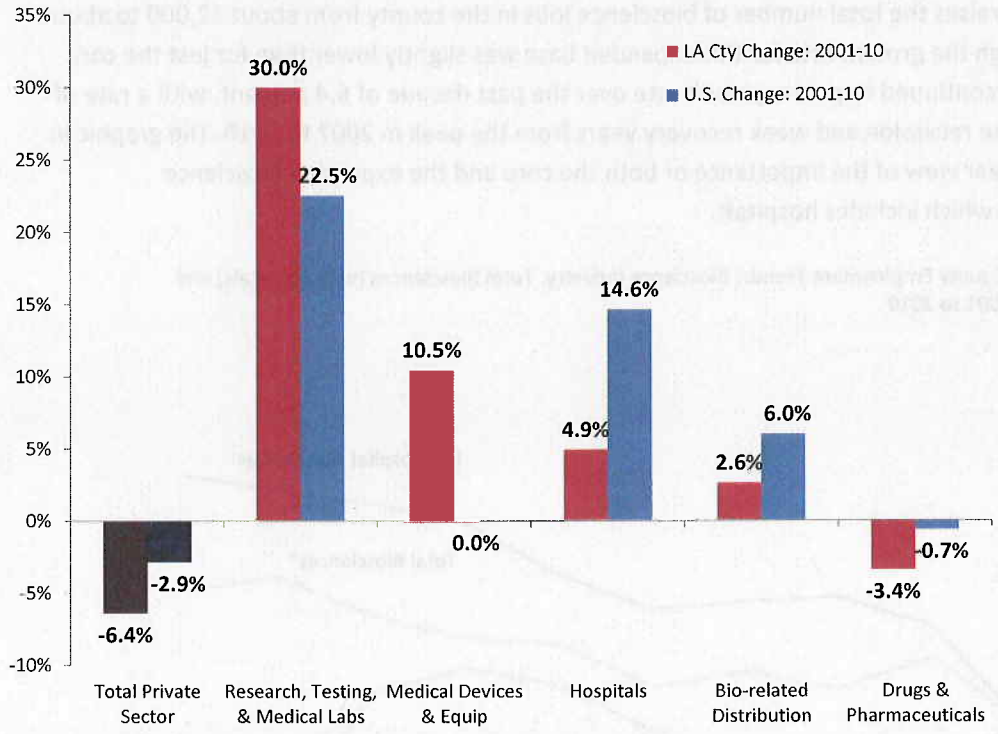


Source: Battelle analysis of Bureau of Labor Statistics, QCEW data; enhanced file from IMPLAN.

Gains Made Across the Bioscience industry Base: The growth of Los Angeles County's bioscience industry base is not simply found in one or two sectors, but is broadly based across four of its five subsectors.

Over the past decade, employment in the County's Research, Testing, and Medical Labs sector grew a hefty 30 percent, while its Medical Devices and Equipment sector grew by over 10 percent. Other growing bioscience sectors in Los Angeles County included Hospitals and Bioscience-related Distribution, though their gains were under 5 percent for the decade. The only bioscience sector losing employment over the 2001 to 2010 period was Drugs and Pharmaceuticals, which had been going through significant structural changes with the rise of generics as well as outsourcing of both research and manufacturing, particularly for clinical trials to contract research firms. (See Figure 4 below.)

Figure 4: Los Angeles County Bioscience Subsector Employment Trends, 2001 to 2010

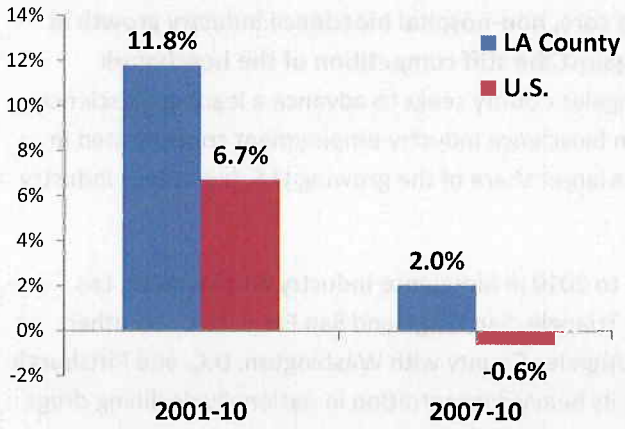


Source: Battelle analysis of Bureau of Labor Statistics, QCEW data; enhanced file from IMPLAN.

Gaining Competitive Share With Faster Growth Than the Nation: Growth in the core bioscience industry base in Los Angeles County is outpacing the national trends and so gaining a rising share of the U.S. bioscience market.

From 2001 to 2010, the hefty 11.8 percent growth in bioscience industry employment in Los Angeles County was nearly double the U.S. bioscience industry base growth rate of 6.7 percent for the core sectors, that is, excluding hospitals. Perhaps even more impressive is that in the recession and weak recovery period of 2007 to 2010, while Los Angeles County's bioscience industry core employment grew by 2.0 percent, the U.S. bioscience industry core employment slightly declined by 0.6 percent. So Los Angeles County has a fast growing bioscience industry in its core sectors compared to the nation.

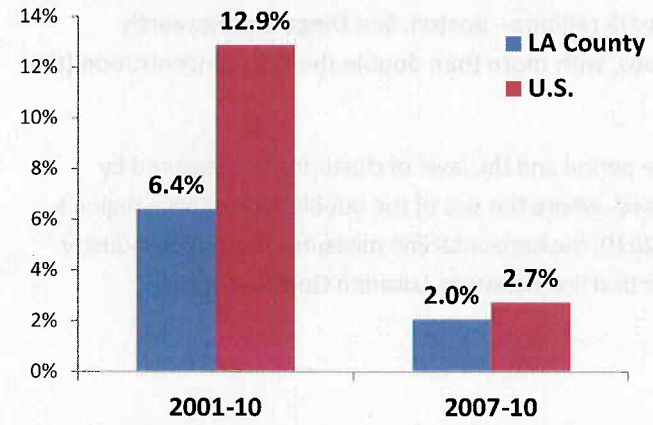
Figure 5: Core Bioscience Industry Employment Trends, Los Angeles County and U.S., 2001 to 2010



Source: Battelle analysis of Bureau of Labor Statistics, QCEW data; enhanced file from IMPLAN.

When hospital employment is taken into account, Los Angeles County's advantage over the U.S. falls away, as the gains in hospital employment nationally well outpaced those of Los Angeles County. With hospitals added to the bioscience industry employment, instead of growing faster than the nation, Los Angeles County grew only at half the rate of the U.S. over the 2001 to 2010 period, and slightly lower than the national rate during the recession and weak economic recovery period of 2007 to 2010.

Figure 6: Expanded Bioscience Employment Trends with Hospitals Added, Los Angeles County and U.S., 2001 to 2010



Source: Battelle analysis of Bureau of Labor Statistics, QCEW data; enhanced file from IMPLAN.

Comparison to Benchmark Regions Puts Los Angeles County Bioscience Growth and Position in a Different Light

While there is much to boast about in terms of the core, non-hospital bioscience industry growth in Los Angeles County, it still does not measure up against the stiff competition of the benchmark regions. This is important to keep in mind as Los Angeles County seeks to advance a leading bioscience industry cluster. Not only is the national footprint in bioscience industry employment concentrated in specific regions, many of these regions are gaining a larger share of the growing U.S. bioscience industry than is Los Angeles County.

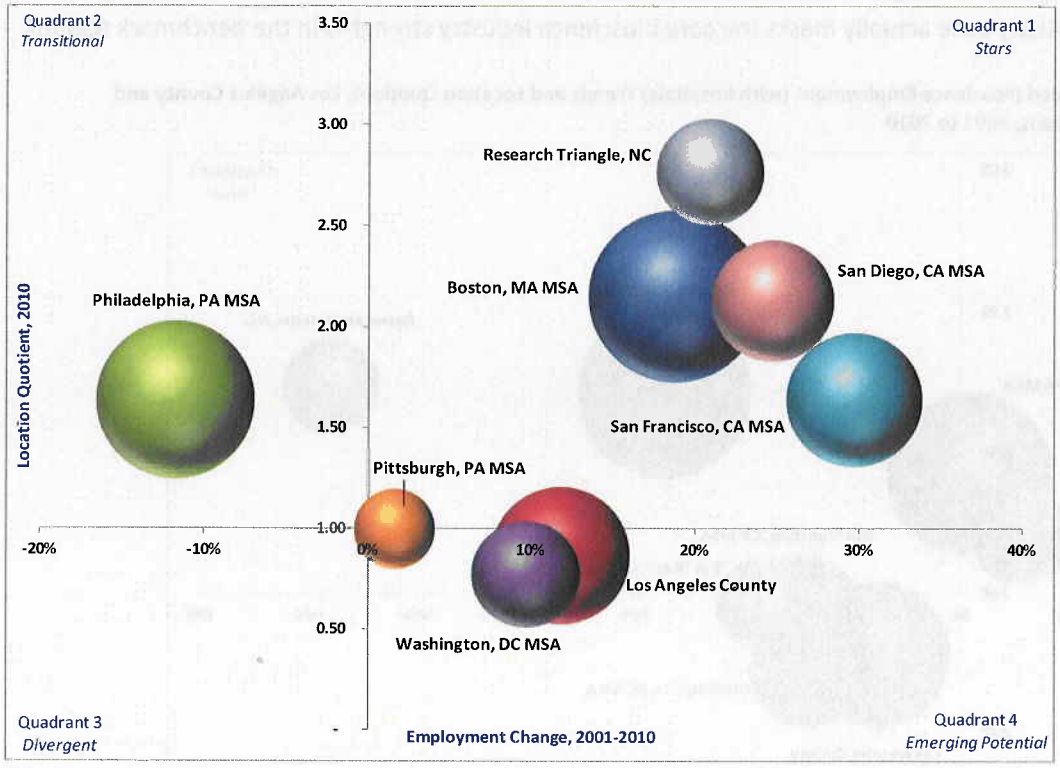
Despite its hefty growth of 11.8 percent from 2001 to 2010 in bioscience industry employment, Los Angeles County was outpaced by Boston, Research Triangle, San Diego and San Francisco. The other three benchmark regions lagged the growth of Los Angeles County with Washington, D.C. and Pittsburgh regions having smaller gains and Philadelphia, with its heavy concentration in nationally declining drugs and pharmaceuticals, recording a significant drop in bioscience industry employment over the past decade.

Also, using the measure of Location Quotient, which measures the degree of job concentration in a region relative to the average concentration seen nationally, the extent to which Los Angeles County must advance its core bioscience industry base if it wishes to be a global leader is apparent.[7] The County's Location Quotient in the core non-hospital bioscience industry base is 0.86, meaning that it has a below-average concentration of bioscience jobs relative to the nation (or 14 percent lower than what you would expect to find in a region of its size compared to the national average). This Location Quotient for Los Angeles County is essentially unchanged when expanded to include hospitals. By comparison, nearly all of the benchmark regions are "specialized" with at least a 20 percent higher level of concentration of bioscience jobs than the national average, with the exceptions of the Washington, D.C. and Pittsburgh regions. Three of the benchmark regions—Boston, San Diego and Research Triangle—are extraordinarily rich in bioscience jobs, with more than double the U.S. concentration (that is, a location quotient of over 2.0).

To capture both the trends in growth rates over the period and the level of clustering as measured by Location Quotients, a "bubble chart" approach is used, where the size of the bubble represents a region's bioscience industry employment (non-hospital) in 2010, the horizontal line measures bioscience industry employment growth from 2001 to 2010 and the vertical line measures Location Quotient in 2010.

[7] A further note on interpreting Location Quotients (LQ): A regional LQ greater than 1.0 is said to have a greater concentration in that industry relative to the overall private sector than the national average. When the LQ is significantly above average, 1.20 or greater, the region is said to have a "*specialization*" in the industry.

Figure 7: Core (Non-hospital) Bioscience Industry Employment Trends and Location Quotient, Los Angeles County and Benchmark Regions, 2001 to 2010



Source: Battelle analysis of Bureau of Labor Statistics, QCEW data; enhanced file from IMPLAN.

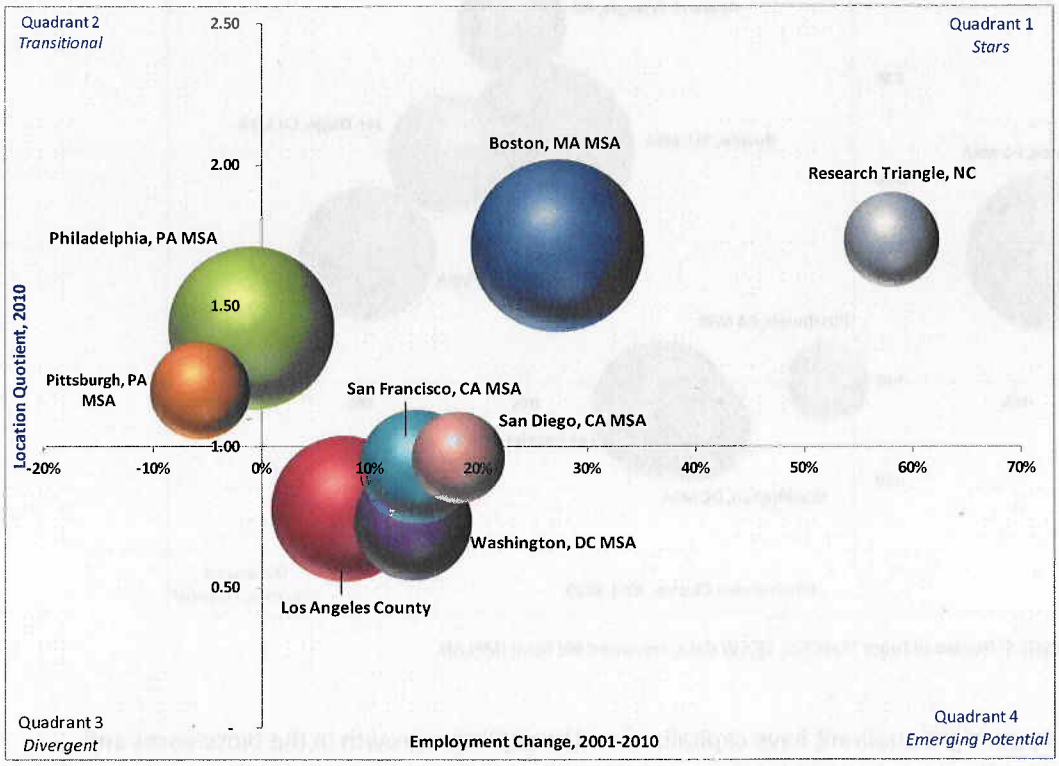
Regions in the upper right quadrant have capitalized on the explosive growth in the biosciences and have established such a high relative density of bioscience jobs that they are considered highly specialized. These regions are truly the stars and are synonymous with bioscience development. The only region in the upper left quadrant, Philadelphia, has defined the quadrant as transitional. It has a significant density of bioscience jobs but is losing them at a rapid rate due to the region's specialization in shrinking markets.

The lower right quadrant, which includes Los Angeles County, comprises regions which are experiencing growth in bioscience employment but still have below-average density of bioscience jobs. If those regions are able to increase bioscience job creation at a faster rate than the national average then they, too, can become stars.

When the expanded industry base is examined, the standings of the regions change, as Figure 8 illustrates. With the inclusion of hospitals in the industry base, virtually all of the other benchmark regions gravitate closer to the middle—and closer to Los Angeles County—in terms of both job growth and specialization, with only Research Triangle showing improved job growth over its non-hospital rate. Only Los Angeles County and Washington, D.C. showed no significant difference between their core and expanded employment on these measures.

If just the expanded industry base were examined only three of the benchmark regions—Philadelphia, Boston and Research Triangle—would be considered specialized in the biosciences. This look at the expanded industry base actually masks the core bioscience industry strengths in the benchmark regions.

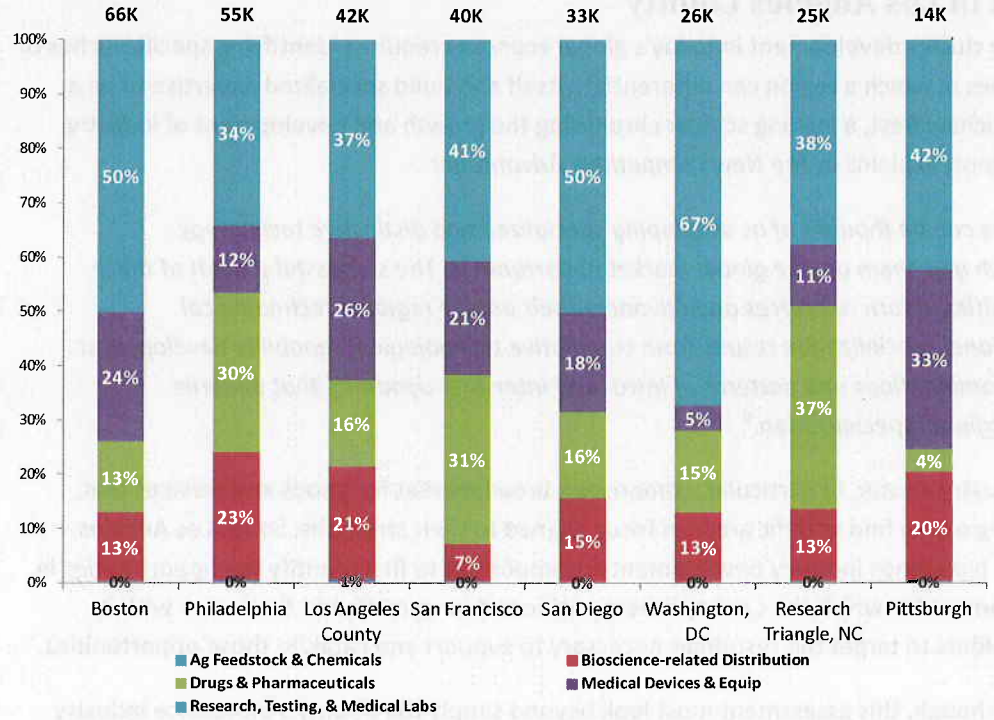
Figure 8: Expanded Bioscience Employment (with hospitals) Trends and Location Quotient, Los Angeles County and Benchmark Regions, 2001 to 2010



Source: Battelle analysis of Bureau of Labor Statistics, QCEW data; enhanced file from IMPLAN.

A closer examination of the distribution of the bioscience sectors within benchmark regions reveals the balance found in Los Angeles County. While the overall performance in employment growth and level of concentration of Los Angeles County lags many of the benchmark regions, Los Angeles County does have a more diverse bioscience industry base. Other benchmark regions are similar to Los Angeles in not having much of a base of Agricultural Feedstock and Chemicals. However within the other sectors many regions are more skewed towards Research, Testing and Medical Labs (Boston, San Diego and Washington, D.C.), Drugs and Pharmaceuticals (Philadelphia, Research Triangle and San Francisco) or Medical Devices (Pittsburgh). Among the benchmark regions Los Angeles County is the most balanced across the core bioscience sectors.

Figure 9: Distribution of Core Bioscience Employment Across Nonhospital Subsectors, Los Angeles County and Benchmark Regions, 2010



Source: Battelle analysis of Bureau of Labor Statistics, QCEW data; enhanced file from IMPLAN.

Summing Up: On the Brink of Being a Top Region, But the Competition Continues to Make Strides

Perhaps the best way to sum up Los Angeles County's position in its bioscience industry development is "on the brink." It has greatly exceeded the industry's growth nationally over the past decade and demonstrated particular robustness in growing through the recession years.

Still the competition is relentless and Los Angeles County lags behind the top regions. What is important to recognize is that the top regions are not simply holding their own, but continuing to make significant strides in their bioscience industry development, fulfilling the notion of what a high performing "industry commons" can engender.

However, compared to the highly regarded emerging regions of Washington, D.C. and Pittsburgh, Los Angeles County is holding its own and belongs clearly in their company, and the sheer size of the County's existing industry base gives it a leg up as it works to gain prominence. But Los Angeles County has not kept up with the long-standing star regions of Boston and San Francisco, and also lags behind more recently developed bioscience regions of San Diego and Research Triangle on multiple fronts.

So to rise to the top tier will require that Los Angeles County build upon its past decade of growth and create that virtuous cycle where growth feeds on itself. Like the more recently developed bioscience regions of Research Triangle and San Diego, this will not happen by itself...it requires strategic initiatives and sustained commitment.

Section III: Assessing the Growth Potential Areas for Bioscience Development in Los Angeles County

Advancing industry cluster development in today's global economy requires identifying specific niches or market opportunities in which a region can differentiate itself and build specialized expertise to be a world leader. As Michael Best, a leading scholar chronicling the growth and development of industry clusters across regions, explains in *The New Competitive Advantage:*

> *...industry clusters can be thought of as developing specialized and distinctive technology capabilities, which give them unique global market opportunities. The successful pursuit of these market opportunities in turn reinforces and advances their unique regional technological capabilities. Regional specialization results from cumulative technological capability development and the unique combinations and patterns of intra- and inter-firm dynamics that underlie enterprise and regional specialization.*[8]

The bioscience industry cluster, in particular, comprises a broad market for goods and services that allow bioscience regions to find specific areas of focus aligned to their strengths. So for Los Angeles County to advance bioscience industry development it is important to first identify the opportunities in bioscience development for which the County is best positioned for growth and then work with its bioscience stakeholders to target the resources necessary to support and catalyze those opportunities.

Most importantly, though, this assessment must look beyond simply the County's bioscience industry base to consider also how the region's research drivers are positioning it for growth, and to understand the alignment between industry and research capacities and objectives.

Importance of Aligning Strengths and Capacities across Industry and Research Drivers for Bioscience Development

More than most other technology-based industry clusters, bioscience industry development has a deeply rooted and integral relationship with academic research and development. Perhaps the most distinguishing characteristic of bioscience development is the major commitment of industry to R&D, and the especially close ties between industry, clinical care and academic research and development communities. An extensive study in the late 1990s found that 31 percent of new drugs and medical products would not have been developed (or would have been substantially delayed) if not for academic research, more than twice the rate found for all technology industries.[9] A National Academy of Engineering report entitled *The Impact of Academic Research on Industrial Performance* found that "one of the defining characteristics of the medical devices and equipment sector is a strong dependency between universities and industry...Academic research has had a substantial impact on the industry's performance...including a high degree of involvement in product development, product evaluation and introduction and product modification."[10] This points to the importance of innovation to bioscience development, and especially biotechnology, and to the academic roots of that innovation.

---

[8] Michael Best, *The New Competitive Advantage*, Oxford University Press, 2001.

[9] Edwin Mansfield, "Academic Research and Industrial Innovation," Research Policy, 1998, 26: 773-776.

[10] National Academy of Engineering, The Impact of Academic Research on Industrial Performance, 2003, page 102.

Given the importance of research drivers to bioscience development, it is not surprising that the past 25 years of developments in the biosciences throughout the U.S. show that bioscience firms both emerge from and are concentrated around university centers and non-profit research institutions. Major university and non-profit research institutions are not only the key to basic research discoveries that generate product leads for bioscience companies but, more importantly, they create an environment in which bioscience companies can flourish, because they offer a strong talent pool of graduates, access to clinical sites and shared-use facilities.

In the biomedical sector the close ties between academic health centers and industry in the biosciences create the critical connection of "bench to bedside," or what is often referred to as translational science. In high functioning biomedical clusters, the link between biomedical product advancement and clinical care is not simply one of a supplier/buyer relationship. Instead, there is a close and needed interface of "bench and bedside" for biomedical innovation, both in terms of physicians providing insights into unmet medical needs or protocol refinements and researchers working with medical providers to move innovations out of the lab and into the medical community. Those involved in research and product development often find insights for applications from epidemiological studies and conversations with leaders in clinical practice. Indeed, clinical excellence is often an enabler of new medical product development, not just a result of deploying new medical products.

In light of these close ties to research in advancing bioscience development, it is essential that a region seek out competitive advantages by leveraging its bioscience research and development base found across both its industry and academic institutions. In doing so, it is important for a region to differentiate itself and identify specific opportunity areas where it can be a world leader in the biosciences.

Assessment of Core Bioscience Competencies in Los Angeles County and Line of Sight to Market Opportunities

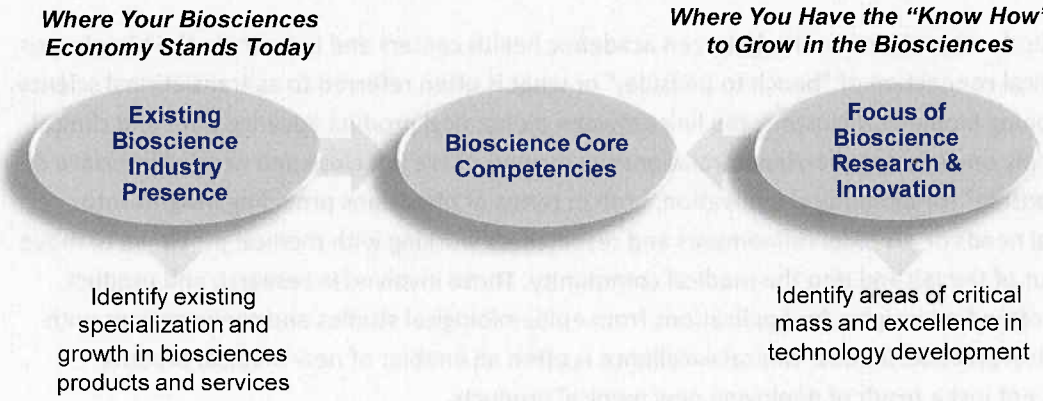
Identifying the specific growth niches or opportunity areas for bioscience development in Los Angeles County requires going beyond traditional industry targeting approaches and looking more closely at the specific core bioscience competencies found across the region's industry, academic and other research drivers from a technology and innovation perspective. As defined by Gary Hamel and C.K. Prahalad in *Competing for the Future*,[11] a competency is a "bundle of skills and technologies representing the sum of learning across individual skill sets and organizational units."

From a regional economic development perspective, core competencies represent specialized know-how where there is a critical mass of expertise and activities across research, innovation and specific markets served. These core competencies help in defining a region's development assets and opportunities and, in so doing, offer a unifying thread for economic development efforts. It is these same core competencies that inform and guide a region's specific opportunities for home-grown development strategies to retain and grow emerging industries, as well as its outreach marketing to attract industries to locate in the region. When guided by core technology competencies, a region's home-grown development and business attraction efforts are highly compatible and reinforce each other.

[11] G. Hamel and C.K. Prahalad. Competing for the Future. Harvard Business School Press: Boston, MA, 1994, pp. 90 and 217.

A rigorous and well-proven methodology is used to assess Los Angeles County's bioscience core competencies. This methodology links together an understanding of Los Angeles County's current areas of strong industry presence in bioscience products and services with an assessment of the areas in which the County has the know-how to grow its bioscience efforts based on research and innovation activities across research drivers and industry.

Figure 10: Methodology for Assessing Core Competencies



The specific steps of the analysis undertaken to identify growth opportunities within the Los Angeles County bioscience cluster included:

- A detailed analysis of specific product and service focus areas found in the biosciences in Los Angeles County in order to identify existing industry specializations and growth areas.
- An analysis of publications and patent activities to identify the focused areas of bioscience know-how with critical mass in Los Angeles County, along with other key measures of research capacity and innovation, including:
    - The focus of scholarly excellence in Los Angeles County based on both the performance of research universities and institutes in peer-reviewed publications and citation analysis. This considers the share of U.S. publications—which measures publications activity—and the average number of citations per publication compared to the national average—which measures publications excellence. This data is drawn from the Thomson Reuters University Science Indicators database and covers all of the major research universities and institutes in Los Angeles County, including California State University – Long Beach; California State University – Los Angeles; California Institute of Technology; Pepperdine University; University of California – Los Angeles; University of Southern California and City of Hope National Medical Center, among others. In addition, publications by faculty at other research institutions (including MLK-Drew University and Medical Center) that hold joint appointments at County institutions are also included.
    - The identified major research grants from the National Institutes of Health (NIH) and the National Science Foundation (NSF) in the biosciences across Los Angeles County's research universities and institutes, based on data available from those institutions.

- The extent to which there are investigator-initiated clinical trials—as a measure of the presence of translational research activities—from discoveries taking place at institutions in Los Angeles County based on data available from ClinicalTrials.gov maintained by NIH.

- The presence of innovative emerging technology firms, as measured by the number of firms receiving venture capital funding between 2006 and 2012 (2nd quarter) based on Thomson Reuters VentureOne database.

The final step in identifying the promising bioscience growth opportunities within Los Angeles County involved considering the alignment of its know-how capacities—identified by the patent and publications cluster analysis and broader research and innovation measures—with the presence and strengths of existing and emerging bioscience activities in the County.

Detailed Analysis of Targeted Industry Strengths

Within the bioscience industry sectors, there are more detailed industry categories under the North American Industry Classification System (NAICS) that comprise each of the sectors. Altogether there are 25 industries at the most detailed (6-digit) level that make up the definition of the bioscience industry and its sectors. Appendix A lists these detailed industries comprising the biosciences

Each of these detailed bioscience industries was evaluated based on three criteria relating to its performance, including whether the detailed industry was:

- *Specialized in Los Angeles County*, as defined by having a 20 percent or higher employment concentration than found in the nation (Location Quotient of 1.2 or higher).

- *A Job Generator in Los Angeles County*, as measured by having increased its employment levels from 2001 to 2010.

- *Outpacing National Growth*, which points to the industry gaining market share, by having the growth rate in jobs from 2001 to 2010 exceed the national average.

Twelve of the 25 detailed bioscience industries in Los Angeles County met one or more of these criteria.

Figure 11: Leading Detailed Biosciences Industries in Los Angeles County, by Key Criteria

Classification	Measuring Detailed Bioscience Industry Strengths in Products and Services			Los Angeles County Biosciences Industry Product & Services (Non-Hospital)
	Specialized (20% or higher employment concentration than found in the nation)	Job Generator (Generated new jobs over the 2001 to 2010 period)	Outpacing National Job Growth (Growth in jobs from 2001 to 2010 exceeded the national average)	
Current Strength	✓	✓	✓	▪ Electro-Medical Devices ▪ Surgical Appliances & Supplies ▪ Medical Labs
Emerging Strength		✓	✓	▪ Biotech Commercial R&D ▪ Pharmaceutical Mfg ▪ Surgical & Medical Instruments ▪ Drug Distribution ▪ Testing Labs ▪ Biological Products ▪ In Vitro Diagnostics
Specialized/ Retention Target	✓			▪ Medicinal/Botanical Mfg ▪ Dental Equip & Supplies

Taken together, these three key criteria can help in evaluating each detailed industry's potential for advanced development:

- A *Current Strength in Los Angeles County* represents those detailed industries that meet all of three criteria and so represent robust targets for industry development. Only three detailed industries reached this designation:
  - Electro-Medical Devices
  - Surgical Appliances & Supplies
  - Medical Labs
- *An Emerging Strength in Los Angeles County* represents those detailed industries that were job generators and outpaced national growth, but still do not have a significant employment concentration within the county, with industry job density generally well below the national average and thus nowhere near specialized. Seven detailed industries reached this designation:
  - Biotechnology commercial research and development
  - Pharmaceutical manufacturing
  - Surgical and medical instruments
  - Drug distribution
  - Testing labs
  - Biological products
  - In vitro diagnostics
- *Specialized/Retention Targets in Los Angeles County* represents those detailed industries that are specialized (LQ>1.2), and so have a high level of concentration in the county pointing to past success, but are not generating new jobs and therefore could be in danger of becoming irrelevant in the future unless efforts are made to stabilize and retain them. Two detailed industries are in that designation:

- Medicinal and botanical manufacturing
- Dental equipment and supplies

The other detailed industries are low prospects because they are neither specialized nor have they shown growth in Los Angeles County over the past ten years.

Table 1 below presents the 12 detailed industries within the core biosciences that offer promising targets for development in Los Angeles County.

Table1: Core Bioscience Employment Performance of Selected Leading Detailed Bioscience industries in Los Angeles County

Bioscience Detailed Industry Product or Service	2010 Jobs in LAC	Higher/Lower Level of Specialization in 2010 Compared to U.S.	Job Growth in LAC from 2001–10	Higher/Lower Job Growth Compared to U.S. 2001–2010
CURRENT STRENGTH				
Electro-Medical Devices	2,904	+102%	+27%	+ 186 pts
Surgical Appliance & Supplies	3,750	+24%	+13%	+ 6 pts
Medical Labs	7,817	+58%	+31%	+0.4 pts
EMERGING STRENGTH				
Biotech Commercial R&D	1,312	-69%	+24% since '07	+24 pts since '07
Pharmaceutical Mfg	3,902	-41%	+2% (+14% since '07)	+4 pts (+20% since '07)
Surgical & Medical Instruments	2,042	-43%	+34%	+26 pts
Drug Distribution	4,818	-3%	+10%	+16 pts
Testing Labs	283	-26%	+11%	+9 pts
Biological Product	678	-17%	+23% since '07	+18 pts since '07
In Vitro Diagnostics	634	+7%	+6% (+23% since '07)	-39 pts (+16 pts since '07)
SPECIALIZATION				
Medicinal/Botanical Mfg	1,446	+135%	-5%	+14 pts
Dental Equip & Supplies	1,241	+157%	-21%	-17 pts

Cluster Analysis of Patents and Publications

To consider the critical mass of know-how across research and innovation activities, a cluster analysis was conducted of peer-reviewed publications generated by organizations in Los Angeles County, as well as of patents issued or applied for by inventors living in the County. The peer-reviewed publications represent research activities, and are primarily generated by universities and non-profit research institutions. Patents issued and applied for can represent innovation activities all the way through to the creation of intellectual property to be protected, and are primarily generated by industry.

This cluster analysis used a proprietary software tool to examine the relationships found across the abstracts of both the peer-reviewed publications and the patents issued or applied for by Los Angeles County inventors. This text analysis of the abstracts from publications and patents allows for a high-level objective understanding of the possible technology focus areas across academia and industry in the County. This methodology eliminates the "*a priori*" bias which is often present in standard analyses of publications, research trends and reputational rankings where the research field categories are predetermined by those collecting the data.

Altogether, 30,245 peer-reviewed publications and patents issued and applied for, covering the period of January 2009 through August 2012, were analyzed. This was made up of 21,982 peer-reviewed publications and 8,263 patents issued or applied for.

Twenty-four theme areas or cluster groupings emerged from the cluster analysis, focused across biomedical applications, disease areas and basic biological sciences. The breadth of these cluster groupings points to the extensive bioscience research and innovation capacity found in Los Angeles County:

Biomedical Applications:

- Musculoskeletal Research and Implant Devices
- Biologics for Therapeutics and Diagnostics
- Electro-medical Devices
- Surgical Instruments and Devices
- Biomedical Imaging
- Dental Materials, Implants and Devices
- Public Health and Healthcare Management
- Health Informatics

Disease Areas:

- Cancer
- Psychological Disorders and Human Behavior
- Neurodegenerative/Neurological Diseases
- Infectious Diseases
- Cardiovascular Diseases
- Ophthalmology
- Inflammatory Diseases
- Transplantation
- Nephrology and Urological Diseases

- Respiratory Disorders
- Drug Development and Delivery

Basic Biological Sciences:

- Genetics and Genomics
- Protein Sciences
- Endocrinology, Metabolic Biology and Nutritional Sciences

County Research Presence by Cluster Group: While the size of the cluster group—the number of publications and patents—is a strong indicator of bioscience research activity in the County, there are other important measures of research presence as well, including scholarly excellence, presence of major federal grants and investigator-initiated clinical trials. Table 2 summarizes the breadth of research capacity, activity and innovation across the cluster groups based on key factors, each of which are described below, along with its scoring criteria:

- Cluster Grouping Size:
  √√√ = 2000+ publications/patents
  √√ = 500–1999 publications/patents
  √ = <500 publications/patents

- Scholarly Excellence (2006–10):
  √√√ = >5% share of U.S. publications and 10% higher citation rate than average
  √√ = either >5% share of U.S. publications or >10% higher rate than average
  √ = >4% share of U.S. publications or 1%–9% higher citation rate than average

- Presence of Major Federal Grants:
  √√√ = >10 major grants
  √√ = 4–9 major grants
  √ = 1–3 major grants
  0 = none

- Active Investigator-Initiated Clinical Trials:
  √√√ = >40 active clinical trials
  √√ = 15–39 active clinical trial
  √ = 1–15 active clinical trials
  0 = none, except "n/a" for basic sciences

The results suggest that the larger cluster groupings have a significant breadth of strong research and innovation capacities in addition to their strong record of publications and patents. Even among the smaller cluster groupings (i.e., those with fewer publications and patents) there are strengths in other measures of research capacity.

Table 2: Cluster Analysis - Summary of Cluster Grouping Size and Broader Research Presence

Biomedical Competency Areas Including Industry and Research Institutes	Cluster Grouping Size (Publications & Patents	Broader Research Presence		
		Scholarly Excellence (2006–10)	Presence of Major Federal Grants	Active Investigator-Initiated Clinical Trials
Cancer Research & Treatments	√√√	√√√	√√√	√√√
Psychological Disorders & Human Behavior	√√√	√√√	√√√	√√√
Neurodegenerative Diseases & Neurological Disorders	√√√	√√√	√√√	√√
Infectious Diseases	√√√	√√	√√	√√
Cardiovascular Research, Treatments & Devices	√√√	√√	√√	√√
Musculoskeletal Research & Implant Devices	√√	√	√	√√
Electro-Medical Implants and Devices	√√	√	√	√
Ophthalmology Research & Treatments	√√	√√	√	√
Biologics for Therapeutics and Diagnostics	√√	√√	√√	√√√
Genetics & Genomics	√√	√√	√√√	n/a
Autoimmune & Inflammatory Disorders	√√	√√√	√	√√
Biomedical Imaging	√√	√√√	√√	n/a
Transplant Surgery, Outcomes & Complications	√√	√√√	0	√
Protein Sciences	√√	√√	√√	n/a
Nephrology & Urology	√√	√√	√	√
Endocrinology, Metabolic Biology & Nutritional Sciences	√√	√√	0	n/a
Surgical Instruments, Devices & Supplies	√√	√√	0	√
Respiratory Disorders Research & Treatments	√√	√√	√	√
Stem Cell Biology and Therapies	√	√√	√	√
Dental Materials, Implants and Devices	√	√√√	0	√
Public Health and Healthcare Services	√	√√√	√√√	n/a
Diabetes and Obesity Research & Treatments	√	√√	√	√√
Drug Development and Delivery	√	√√√	√	√√√
Health Informatics	√	√	√	n/a

Appendix B presents the detailed results for each of these twenty-four patents and publications cluster analysis areas, breaking down the number of patent and publications records in the cluster grouping, the distribution between patents and publications (to indicate innovation versus research focus) and illustrative examples of the activities undertaken in each cluster grouping. This appendix also considers which, if any, of the detailed industry strengths apply to each cluster grouping. It also provides details into the other quantitative measures of activity mapped into the cluster groupings, including: the extent of scholarly excellence across specific Los Angeles County institutions; the presence of major federally funded research centers; the number of investigator-led clinical trials and the number of venture capital funded companies, the details of which will be discussed later.

County Industry Presence by Cluster Group

When the detailed industries are compared to the patent and publications cluster groupings in order to determine the level of industry strength in each cluster grouping, it is immediately apparent that the clusters do not always align one-to-one with the detailed bioscience industries already identified. It works well for some of the cluster groupings, but for others it is difficult to know if the strength in an industry is specific to a particular cluster disease area, particularly in the Drugs and Pharmaceuticals and Medical Devices clusters. To get a more accurate picture of true industry strengths in the County in the specific cluster groupings, the presence of venture capital backed companies was also considered, as well as the degree to which patents (as opposed to publications) made up a significant component of the cluster grouping.

Table 3 presents the findings, which map the cluster groupings' size to the expanded factors of industry strength in Los Angeles County. The scoring by key factor is as follows:

- Strength of Corresponding Detailed Industry:
  - √√√ = Current Strength
  - √√ = Emerging Strength
  - √ = Specialized
  - n/a = No Direct Mapping to a Defined Detailed Industry
- Presence of Patents:
  - √√√ = >50% of Cluster Grouping made up of patents
  - √√ = 20%–40% of Cluster Grouping made up of patents
  - √ = 10%–19% of Cluster Grouping made up of patents
  - 0 = <10%
- Venture Capital Backed Companies:
  - √√√ = 5+ companies
  - √√ = 3–4 companies
  - √ = 1–2 companies
  - 0 = None

Table 3: Summary of Cluster Grouping Alignment with Industry Presence and Strengths in Los Angeles County

Biomedical Competency Areas Including Industry and Research Institutes	Industry Presence		
	Presence of Detailed Industry Strengths	Presence of Patents	Venture Capital Backed Companies
Cancer Research & Treatments	n/a	√	√√
Psychological Disorders & Human Behavior	n/a	0	√
Neurodegenerative Diseases & Neurological Disorders	n/a	√	√
Infectious Diseases	n/a	√	√
Cardiovascular Research, Treatments & Devices	√√	√√	0
Musculoskeletal Research & Implant Devices	√√	√√	0
Electro-Medical Implants and Devices	√√	√√	√
Ophthalmology Research & Treatments	n/a	√√	√
Biologics for Therapeutics and Diagnostics	√√	√√	√√
Genetics & Genomics	√√	√√	0
Autoimmune & Inflammatory Disorders	n/a	√	√
Biomedical Imaging	√√	√√	√√
Transplant Surgery, Outcomes & Complications	n/a	0	0
Protein Sciences	n/a	√√	0
Nephrology & Urology	n/a	√	√
Endocrinology, Metabolic Biology & Nutritional Sciences	n/a	0	0
Surgical Instruments, Devices & Supplies	√√	√√	0
Respiratory Disorders Research & Treatments	n/a	√√	0
Stem Cell Biology and Therapies	n/a	√√	√
Dental Materials, Implants and Devices	√	√√	0
Public Health and Healthcare Services	√√	0	√√
Diabetes and Obesity Research & Treatments	n/a	√	√
Drug Development and Delivery	√√	√√	√
Health Informatics	n/a	√√	√√

Alignment of Core Competency Areas

The current alignment in Los Angeles County of industry presence and strengths with the know-how to grow in the biosciences appears quite robust. In fact, from this analysis, it appears that only two of the patent and publications cluster analysis groupings do not have some industry linkages in Los Angeles County, those being Transplant Surgery, Outcomes and Complications and Endocrinology, Metabolic Biology and Nutritional sciences. Even those cluster grouping areas that are focused on disease areas—as opposed to applications—have some alignment with industry activities in Los Angeles County.

Based on the alignment of industry and research strengths and the breadth and depth of the activities and capacities within the County, the broad categories that have been identified as having the best

potential for explosive and sustainable growth are Biopharmaceuticals, Medical Devices and Healthcare Delivery. The categories encompass the following cluster groupings:

Biopharmaceuticals: Cancer Research and Treatments; Biologics for Therapeutics and Diagnostics

Medical Devices: Cardiovascular Research, Treatments and Devices; Musculoskeletal Research and Implant Devices; Electro-medical Implants and Devices; Surgical Instruments, Devices and Supplies, Medical Imaging

Healthcare Delivery: Health Informatics; Public Health and Healthcare Services

For each of these cluster groupings, they stood at the top of the rankings for one of the three factors used to assess industry alignment.

Building Upon Core Competencies to Identify a Line of Sight to Market Opportunities

With an understanding of the core bioscience competencies found in Los Angeles County, it is then possible to develop a "line of sight" to strategic opportunities. Strategic opportunities result from linking together multiple core competencies into technology platforms to take advantage of expanding and emerging market niches in biosciences in the County.

Extensive interviews were conducted with industry and university leadership, and valuable input was gathered from the Project Advisory Committee. These discussions both validated the assessment of core competencies and determined how these core competencies could best be grouped into broader technology platforms of growth opportunities.

Figure 12: Illustration of Line-of-Sight from Core Competencies to Strategic Opportunities

Three specific technology platforms emerge:

- **Novel therapeutics and diagnostics**
- **Bioengineering solutions for treating diseases and medical conditions**
- **Innovations in healthcare delivery**

Each of these technology platforms is discussed below, with the applicable core competencies identified. Relevant insights from both the analysis and the high level discussions with industry and university leadership and the Project Advisory Committee are included.

Novel Therapeutics and Diagnostics

Core competencies upon which to draw:

- Biologics for Therapeutics and Diagnostics
- Genetics and Genomics
- Protein Sciences
- Stem Cell Biology
- Multiple Disease Areas

Insights from data analysis and discussions with industry and university leaders:

- There is significant industry growth occurring across a range of industries in biopharmaceuticals, including biological products, biotechnology commercial research and development, in vitro diagnostics and pharmaceutical manufacturing.

- Growth in industry activities involves new and emerging companies as demonstrated by venture backed companies in diagnostics and therapeutics.

- The key focus is on innovations in biologics to advance therapeutics and diagnostics, with an established research capacity to advance therapeutic proteins, active industry efforts in diagnostics and the emergence of stem cell research for advancing therapies and delivery mechanisms.

- Cancer is the leading area of development from investigator-initiated drug/biologics trials—but other active areas include psychiatric disorders and cardiovascular treatments.

Bioengineering Solutions for Treating Diseases and Medical Conditions

Core competencies upon which to draw:

- Electro-medical Devices
- Surgical Instruments and Devices
- Biomedical Imaging
- Dental Materials, Implants and Devices
- Cardiovascular Treatments and Devices

Insights from data analysis and discussions with industry and university leaders:

- Los Angeles County is unusual in having industry strengths across Electro-Medical, Musculoskeletal and Surgical Devices as well as Biomedical Imaging, and specialization in Dental Materials and Devices.

- The strengths of the County's universities in engineering is a major competitive advantage and driver. This reinforces how important it is to keeps the focus on devices and the application of microelectronic systems and nanotechnology.

Innovations in Healthcare Delivery

Core competencies upon which to draw:

- Health Informatics
- Public Health and Healthcare Services
- Biomedical Imaging
- Genomics and Genetics

Insights from data analysis and discussions with industry and university leaders:

- The research institutions in Los Angeles County stand out in healthcare sciences and policy, with more than ten NIH funded research centers focused on quality of care, health promotion, health disparities and community participatory research.

- There has been a recent emergence of innovative health services and health informatics companies. Over the period 2009 to 2012(Q3), $165 million in venture capital was invested in 13 emerging healthcare IT and digital innovation companies in the County.

- Los Angeles County has one of the nation's most developed public healthcare systems. It is a $3.5 billion enterprise with a network of outstanding hospitals and outpatient facilities across the County.

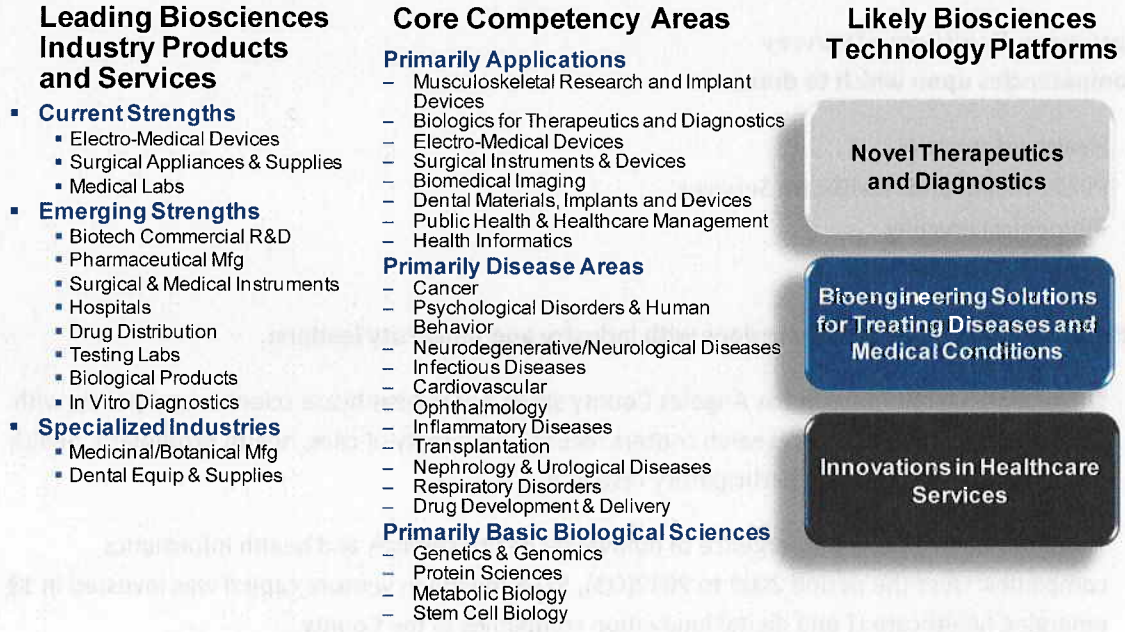
- Los Angeles County is taking a leadership position in seeking innovative approaches to healthcare delivery. The Department of Health Services in Los Angeles County has partnered with MedPOINT Management to launch an eConsult platform, an electronic primary care-to-specialist consultation and referral system.

Summary

The large biomedical research base found in Los Angeles County, along with the strong growth in its bioscience industry over the past decade, has put the County in an excellent position with a robust set of research and innovation capacities that are well aligned with its specific industry presence and strengths. Three significant bioscience technology platforms offer opportunities for growing biosciences in Los Angeles County in the years ahead.

This line of sight to market opportunities is summarized below:

Figure 13: Specifics of the Line of Sight Found in Los Angeles County



Section IV: The Geography of Bioscience Development in Los Angeles County

Increasingly, leading and aspiring regions are facilitating the development of physical environments in which research and technology-based industries can grow. In today's global, knowledge-based economy, the factors driving location decisions are rapidly shifting, with the paradox that in a globally distributed business and innovation environment, idea and talent-rich places have competitive advantage. In the past, a region's natural resources and physical access to markets were critical location factors. But with the rising importance of knowledge workers and innovation, a region's competitiveness for technology-based business growth depends on its ability to generate, attract and retain technology-related companies and talent, and to create physical environments that foster synergy among industry and research institutions.

Physical environments are particularly important for bioscience industry development, since basic laboratory and clinical research activities are integrally linked with product development. From Boston to Pittsburgh to Minneapolis to St. Louis to San Francisco and beyond, metropolitan regions along with research universities and major medical centers are developing broader environments in which bioscience companies can flourish, because they offer strong talent pools of graduates, access to clinical sites and shared-use facilities.

Not surprisingly, metropolitan regions across the nation are developing research parks or other forms of biomedical districts associated with their academic medical centers and other technology-oriented development complexes as key components in creating the physical environments that can generate, attract and retain technology companies and talent for biosciences. In particular, a new wave of strategically planned "mixed-use" campus expansions is taking place across academic medical centers in urban settings. Such leading urban centers as Seattle, Portland (Oregon), Baltimore, New York City, Atlanta, Denver, Chicago and San Francisco are engaged in these significant, new mixed-use campus expansions for their leading bioscience research drivers.

For bioscience development, the presence of a signature development complex is especially important. Such a nexus enables seedling ventures to take root in a more seamless manner and serves as a meeting place and connecting vehicle for more distributed ventures which still have a need to stay abreast of and connect with new talent and ideas. Having a bioscience research park or biomedical district with space for private ventures adds value to a region by accomplishing the following:

- **Creating a focus and image of the biosciences in a region.** One key element for advancing a region's bioscience base is to create a sense of place. Even within regions with significant bioscience activity its profile may be minimal or nonexistent because that activity occurs within major institutions, such as medical schools, research universities and hospitals, or is scattered across a region in individual locations. Research parks and other types of bioscience-focused development complexes can serve to create a sense of focus and momentum for a bioscience community by serving as a meeting place and outreach point for the different sectors of a bioscience cluster.

- **Enabling access to specialized lab space.** Bioscience product development often requires highly specialized lab space with wet lab facilities that meet clean room requirements for sterility. This specialized lab space is expensive to construct and is usually not adequately supported by the commercial real-estate market because of its perceived specialized use. By offering available wet lab space, bioscience-focused research parks and other development complexes can be important resources for attracting and supporting commercial bioscience development.

- **Offering close physical proximity and linkages between bioscience product development and venture development and research.** Unlike many other technology fields, product development in the biosciences draws more frequently on advances in the basic sciences generated by research institutions. For the biosciences, this might include such things as advances in new drug targets, advances in biomedical instrumentation for imaging or diagnostics and identification of improved medical approaches for treating diseases. Moreover, because of the strict regulatory environment surrounding the introduction of new therapies and devices for medical treatment, bioscience research institutions are necessary—even critical—partners when undertaking clinical research. Therefore, having physical locations with close ties to bioscience research organizations can provide the important competitive advantage of proximity for bioscience product development.

- **Nurturing and fostering new bioscience startups.** Combining the proximity to research drivers with the availability of bioscience wet lab space can foster new bioscience venture formation that helps move research discoveries with high commercial potential into the marketplace with a variety of assistance—such as market analysis, proof of concept, business planning, management team recruitment and venture financing attraction.

- **Providing for a continuum of physical spaces as firms grow from virtual and incubation stages to larger ventures.** In locales where early stage bioscience ventures are concentrated and visible, it is easier for developers and others to economically provide for "next stage" development in adjacent or connected locations. In this manner, firms can smoothly move from 500-2500 square feet of initial startup space to units of 5,000, 10,000 and 20,000+ square feet prior to growing to the point where a more free standing facility is needed. At each growth milestone, the risk of a region or community losing that firm to a competing area increases if there is not readily available space, which frequently involves wet lab and other specialized infrastructure. While "bricks and mortar" availability is not the only determinant in a location decision, the lack of readily available local facilities at an expanding firm's key growth inflection points can be enough to cause it to relocate, and therefore is a factor making the region a "leaky bucket," whereby growing firms formed in one region continually migrate to another with the resources to support its continued growth.

- **Accessing talent.** An important ingredient in the success of a region in the biosciences is to have an environment that generates, attracts and retains talent pools of specialized workers in the biosciences. Bioscience-focused research parks and other development complexes that are close to university and academic health centers can serve as important intersections of complementary talents, from bioscience researchers to bioscience company managers to technicians. More directly, they can both access students for internships and provide valuable

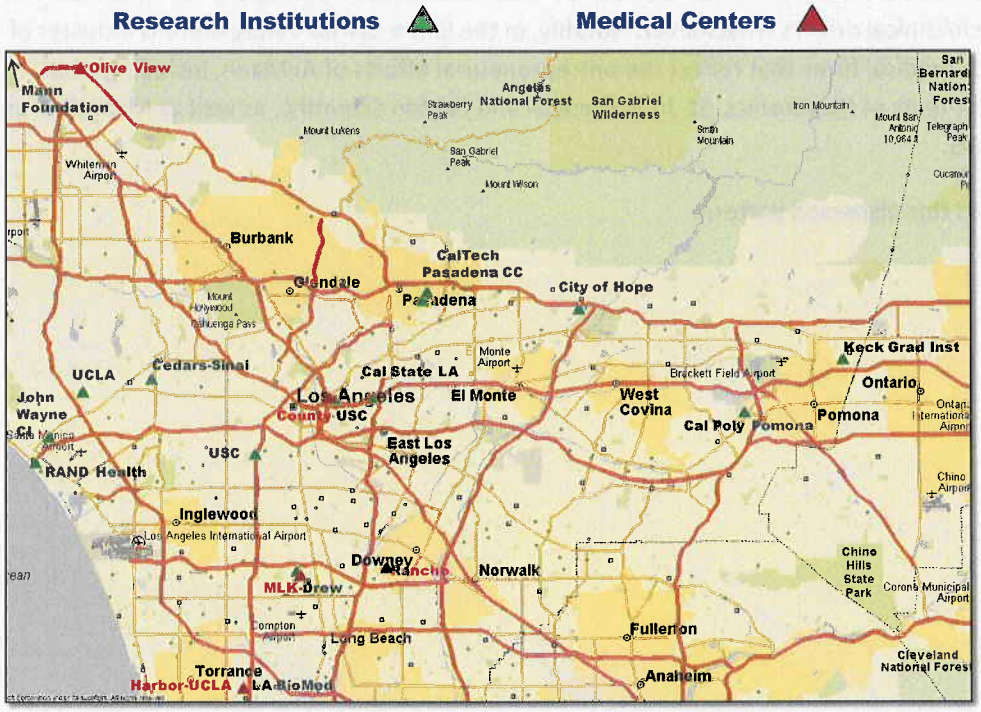
hands-on experiences to complement classroom experiences. Increasingly, research parks are also becoming sites for advanced training programs and specialized educational programs in the biosciences. Finally, through their innovation support activities—from incubators to testing and applied research facilities—these bioscience-focused facilities can be places where more senior faculty and postgraduate researchers can interface with bioscience entrepreneurs, and with existing and emerging companies, and form mutually beneficial relationships.

In considering how best to advance bioscience development complexes, whether research parks or mixed-use campus developments, it is critical to assess both the geographic footprint of the region's research drivers and the development of the commercial real estate market serving the region's bioscience companies.

Situational Analysis of Los Angeles County's Geographic Footprint and Development of its Commercial Real-Estate Market

The geography of bioscience research activities and medical centers in Los Angeles County offers a broad footprint, which presents both an opportunity and a challenge for advancing the bioscience industry cluster in the County. To gain an appreciation of the breadth of the bioscience footprint in Los Angeles County one need only consider the locations of research institutions and major hospital centers across the County, as shown in Figure 13. The geographical range is significant. To take a few examples, in the northeast there is City of Hope, CalTech and Pasadena Community College, to the west lies UCLA and Cedars-Sinai, to the south there is Harbor-UCLA Hospital and LABioMed and in the center of the County is found USC, County Hospital, MLK-Drew University and Medical Center and Rancho Hospital.

Figure 14: Geographic Location of Research Drivers and Major Hospital Centers in Los Angeles County



Not only are the distances significant, but the driving times (especially in rush hour) and lack of public transportation between these "hubs" of bioscience research/clinical activities means these bioscience research/clinical hubs are geographically distinct entities. Of particular importance for advancing the bioscience industry cluster in Los Angeles County is examining how having such a broad footprint across the County's research and major medical centers shapes and influences bioscience industry location.

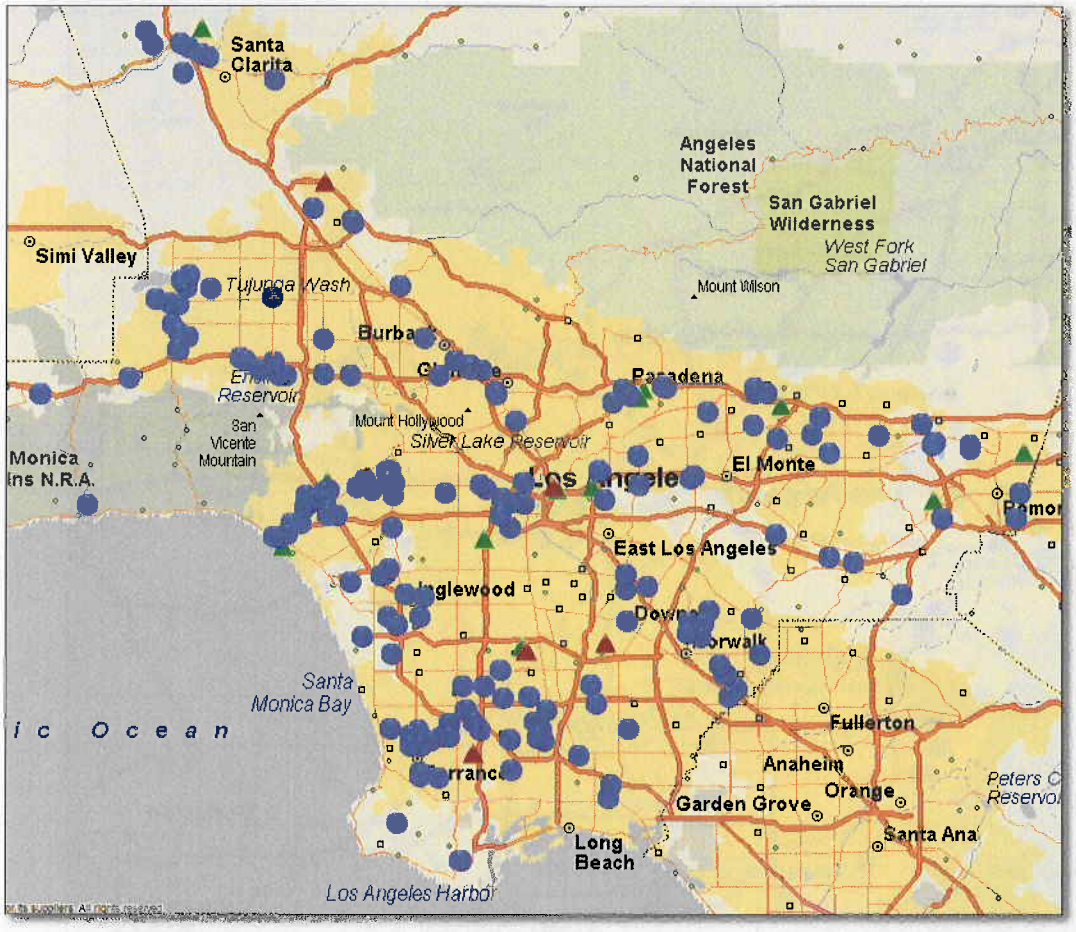
To examine both the geographic footprint and other dimensions of bioscience commercial real estate development in Los Angeles County, the locations for 168 bioscience firms in Los Angeles County have been identified, with many having multiple locations. The CoStar database of commercial real estate buildings and tenancies, which is the largest in the nation, was then tapped to gather data for each bioscience firm located in Los Angeles County. Specific data collected included the type of building in which they are located (office, industrial or flex), the amount of space leased, whether it is a single occupancy or multi-tenant building, the leasing rate and the level of vacancy in the facilities in which bioscience firms are located. Because Los Angeles County is no longer considered by national realtors to be a leading life science real estate market, CoStar has been a unique and very valuable resource as the only database of commercial real estate database for the biosciences in the County.

Below are the main findings on the geographic footprint and the development of the commercial bioscience real estate market in Los Angeles County.

Today there is no single area of the County that has a high share of bioscience company locations—no equivalent to a "Hollywood" for the bioscience industry—despite its need for specialized lab space and talent pools. The maps of individual bioscience firm locations suggests that bioscience firms are even more distributed across the County than are bioscience research/clinical institutions, with bioscience firms even located around Santa Clarita, Torrance and Santa Fe Springs, areas which have no bioscience research/clinical drivers whatsoever. Notably, in the Santa Clarita Valley there is a cluster of implantable-device medical firms that reflect the entrepreneurial efforts of Al Mann, including what have become major units of Medtronics, St. Jude Medical and Boston Scientific, as well as MannKind and affiliated companies.

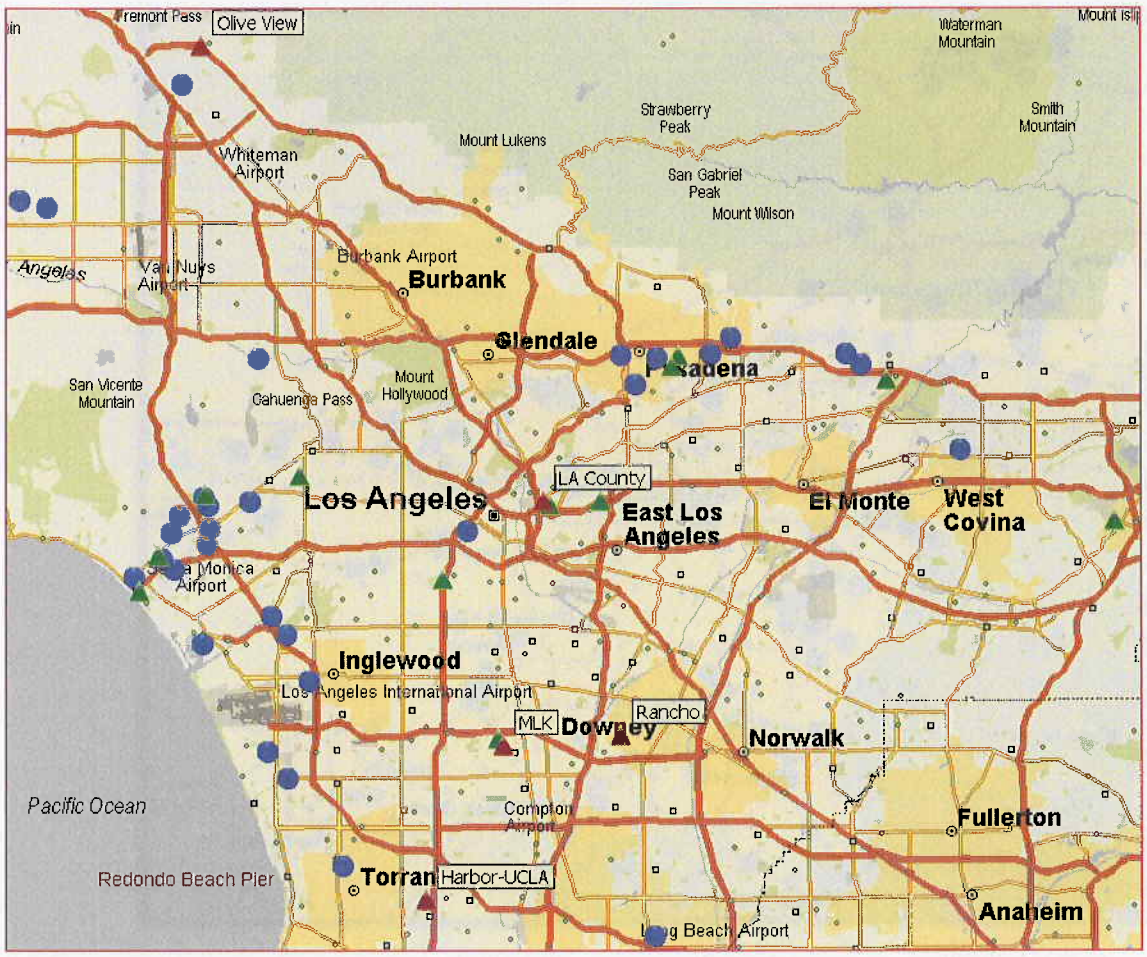
Figure 15 illustrates this dispersed pattern.

Figure 15: Geographic Location of Bioscience Firms in Los Angeles County



When one considers more emerging bioscience firms—defined here as those receiving venture capital—a more focused development around bioscience research/clinical hubs is revealed. Both the Westside of the city around UCLA and heading towards Santa Monica, and the northeast around Pasadena and heading towards City of Hope are the locations around which emerging, venture backed bioscience companies are locating. These areas are more proximate to a bioscience university or research institutions, and this makes good sense since emerging bioscience companies are likely to need proximity to the scientific generators of their innovations, and are more likely than established firms to need to tap the scientific talent as well as the specialized lab equipment and facilities found at research institutions.

Figure 16: Geographic Location of Only Venture-Backed Bioscience Firms in Los Angeles County



But a close look at the other dimensions of the locations for bioscience firms suggests that there is "no identifiable commercial bioscience real estate market" in Los Angeles County despite its significant size. Overall, the locations of 168 bioscience firms in the County were tracked, involving 205 buildings and 4.982 million total square feet occupied, as shown in Table 4 below. The largest industry segment of commercial biosciences is found among 43 firms involved in Drugs and Pharmaceuticals Those firms occupy slightly over 2.2 million square feet and have the largest average square feet per location of 44,231. But the real estate occupied by the other segments—Medical Device firms and Commercial Research and Testing Labs—is also quite significant, at over 1 million square feet for each, though the average size per location for the latter is significantly smaller than the other two segments, with an average under 11,000 square feet per location.

Table 4: Geographic Location and other Dimensions of Bioscience Firms in Los Angeles County

Industry Segment	#Firms	# Buildings Occupied	Total Square Feet	Average Square Feet per Address	Average Square Feet per Firm
Drugs & Pharmaceuticals	43	50	2,211,551	44,231	51,431
Medical Devices	50	54	1,688,302	30,696	33,766
Research & Testing Labs	75	101	1,082,541	10,718	14,434
Totals	**168**	**196***	**4,982,394**	**24,070**	**29,657**

*Note, since there are 9 pairs of firms that have occupancy in the same building, the individual subtotals for #buildings occupied exceeds the total #buildings by 9.

Despite the significant size of the space occupied by bioscience firms in Los Angeles County, there are many indications of a lack of an identifiable commercial real estate market. These include:

- Among all of the 168 bioscience firms in the dataset, only 18 of them are located in buildings that house another bioscience firm. In fact, there are only 9 buildings that house more than one bioscience firm, and these house just two firms each. This suggests that bioscience companies are not only widely distributed geographically across Los Angeles County but also that the County has virtually no multi-tenant bioscience-dedicated buildings.
- According to discussions with commercial real estate brokers, there is no clearly identified inventory of bioscience lab space that is being either bought/sold or leased to bioscience tenants. Outside of two small bioscience incubators found near research institutions, with a total area of 12,000 square feet, the only advertised multi-tenant bioscience lab space found in Los Angeles County is at the Alexandria-Innovation Center in Pasadena, with 34,000 square feet that is close to fully occupied.
- All of the biopharmaceutical and diagnostics emerging companies interviewed had difficulty in finding suitable post-incubator, multi-tenant wet lab space, and viewed it as a significant development challenge for Los Angeles County.

A key competitive issue for Los Angeles County is that bioscience companies in the County have to bear the cost of fitting out their own wet lab space with required air handling needs, and can face long delays and uncertainties with permitting. This cost to retrofit existing commercial real estate for wet labs can run well in excess of $150 per square foot, placing a significant economic burden on bioscience companies in the County and creating delays in focusing on their business activities. In each of the benchmark regions—Boston, Research Triangle, Philadelphia, Pittsburgh, San Diego, San Francisco and Washington, D.C.—there is an available inventory of bioscience wet lab space being leased.

Multi-tenant Biosciences Wet Lab Buildings start with a core infrastructure sized to provide for a mix of wet lab and associated office tenant spaces in a flexible manner.

The core systems provide the capacity for enhanced systems to meet the needs of a range of biosciences tenant firms in an economical manner relative to renovating an existing building incrementally. This supports enhanced HVAC systems, upgraded electrical, telecommunications, mechanical, plumbing and life safety systems, waste treatment systems, backup/emergency generation power for house / life safety systems with additional capacity for tenant equipment Further, these buildings are designed to adapt to different types and sizes of bioscience, medical and contract research tenants, thereby saving time and cost.

This lack of available bioscience wet lab space within the Los Angeles County commercial real estate market is a particular burden on emerging bioscience companies. Based on the interviews with these firms, they not only had to deal with the cost of fitting out wet lab space, but they also faced significant issues with permitting that created long delays and uncertainties for them. Beacon Economics, in their 2012 Los Angeles Economic Forecast Conference, suggests that these permitting issues are not unusual for industrial companies in Los Angeles, and perhaps across California: "With both the California Environmental Quality Act, which requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts if feasible...California is pursuing some of the most stringent environmental quality standards in the nation."[12] The issue is not the soundness of these permitting requirements, but the fact that without having an existing base of multi-tenant commercial bioscience facilities with an inventory of available space to be leased, emerging bioscience companies have to wrestle with these permitting issues and bear the costs of the wet lab fit outs on their own.

Implications for Research Park Development

The diverse geographic footprint of both research/clinical institutions and bioscience company locations, together with the lack of a base of available multi-tenant facilities with bioscience wet lab space, makes bioscience space a critical issue for advancing a bioscience industry cluster in Los Angeles County.

The issue of stimulating a commercial bioscience real estate market is not an unusual one for emerging bioscience industry clusters. Given the specialized nature of bioscience wet lab space with its costly air handling, water treatment, higher load bearing and specialized laboratory fit outs, it is not surprising that commercial real estate does not typically produce this type of facility on a speculative basis. Yet without a ready inventory of such space, emerging bioscience companies are held back, having to spend

[12] Jordan G. Levine,"Los Angeles Forecast," 2012 Los Angeles Economic Forecast Conference Compendium, Beacon Economics and Pepperdine University, April 2012, page 34.

considerable resources and time in ensuring adequate space. For many bioscience startups, this lack of readily available, suitable space can be a barrier to locating in the County in the first place, or a major inducement to leave the region at a critical point in their growth. Unfortunately, the most promising startups are the ones most likely to leave, since they are the most likely to have attracted financing from outside the state.

A key point to be learned from other regions with emerging bioscience industry clusters, and particularly from the benchmark regions, is the important role that local government can play in stimulating the growth of such commercial bioscience space. Typically this is done through research park developments involving public-private partnerships. But it is important to recognize that there is no one-size-fits-all approach to research and technology park developments. What are emerging are development models that can fit a variety of regional settings, including:

- **University and Medical Center-affiliated Research Parks**, which embody close relationships with the research and technology commercialization capacities of local universities, and also create ties with the talent pools associated with those universities from faculty expertise, to graduate, post-doctoral and undergraduate students. Examples of these university-affiliated research parks include Centennial Park in Raleigh, NC, Mass Biotech Research Park in Worcester, MA and University of Colorado Health Sciences Park in Aurora, Colorado.

- **Stand-alone Technology Accelerators** that offer support services and access to specialized lab space for firms, from incubation through to post-incubation, enabling emerging companies to take root and grow. The Emerging Technology Center in St. Louis and the Seattle Technology Accelerator are good examples of this type of technology accelerator program.

- **More Industry-related Technology Parks** that build upon specific growth sectors and create strong regional agglomeration through high value infrastructure and activities, such as access to multi-tenant facilities, incubation services and technology networking, among other high value activities, to accelerate new company formation and growth and concentration of existing technology-related companies. Examples of these more industry-related technology parks include the Shady Grove Research Park in Maryland and Research Triangle Park in North Carolina.

Going forward, Los Angeles County needs to consider how to accommodate continued growth of its bioscience industry cluster. Over the ten year period of 2001 to 2010—encompassing one of the deepest recessions since the Great Depression—Los Angeles County experienced significant bioscience employment growth of 11.8%, resulting in an additional 4,452 bioscience jobs for the County. With an average of 300 gross square feet per job, this equates to over 1 million square feet of new bioscience space over the 2001 to 2010 period.

It seems prudent for Los Angeles County to help stimulate the creation of multi-tenant buildings across Los Angeles County over the next ten years, so that this issue of available bioscience space is not an impediment to the further growth and the maturation of this cluster and the jobs that it can create. From past history in the County, it is apparent that the private market alone will not address this without a partnership with government and research institutions.

Section V: Competitive Assessment of Los Angeles County in the Biosciences

To realize the full potential of the market opportunities identified through evaluation of the County's bioscience technology competencies, the region must maintain a strong competitive position, not only against other regions in the U.S. but increasingly against global competition. Leading regional bioscience industry clusters have common ingredients. Some of these—such as a robust bioscience innovation infrastructure and existing industry excellence—were fully examined in previous sections. Other key common ingredients include access to venture capital through well-functioning markets for all stages; a pool of high-skilled talent that spans the bioscience industry's skill needs—from lab technicians and precision production up through Ph.D. level scientists, engineers and top management; a strong and growing regional academic research and development base and a university technology transfer and commercialization infrastructure that nurtures and promotes new product and firm formation. This critical continuum of regional factors must work in combination in order for the industry cluster to realize its full potential.

When assessing the competitive environment in which Los Angeles County's bioscience activities occur, the "competition" is defined as other regions in which promising bioscience firms may choose to form or expand. Thus, this competitive assessment not only evaluates the County on each of the key ingredient factors, but compares the County's performance to the performance of other regions. Los Angeles County is therefore held up to a group of peer regions as well as to the national leaders it aspires to emulate. Gaps in the continuum are identified through a process that includes both data analysis and discussions with a varied set of local bioscience stakeholders to uncover key ground truths, identifying strengths, opportunities and challenges.

The competitive assessment involves a multi-faceted process:

- Data analysis across the continuum of key factors for Los Angeles County, and comparison to performance of regional benchmarks, including:
    - Bioscience venture capital (VC) investments
    - Bioscience talent and workforce
    - Bioscience commercialization and research environment
- Interviews with key stakeholders including:
    - CEOs of established and emerging bioscience companies (23)
    - SoCalBio members (the industry trade association of the bioscience industry in Greater LA) (approximately 40)
    - University research and administrative leaders (17)
    - University technology transfer staffs (4)
    - Community college staff (2)
    - Real estate developers and professionals (3)
    - Venture capitalists, other private investors and attorneys (5)
    - Local government stakeholders (5)

Venture Capital

Most people realize that the discovery of new knowledge resulting in the development of novel technology can be a very expensive process costing, in some cases, millions of dollars. What many people do not realize is that the costs associated with developing and taking a technology product or service to market can also be very substantial. Major costs incurred after the research has been completed include the costs of: assessing the market to determine the competition, the likely market and the price points for competitive advantage; developing a prototype; preparing a business plan to address and plan for all aspects of production, regulation, marketing, sales and more and scaling up for manufacturing. Finally, actual product distribution, sales and marketing must be undertaken.

While these needs apply to all technology-based companies, bioscience companies need to access larger amounts of capital, for longer time periods, to cover the efforts needed to complete clinical trials and obtain regulatory approvals before products can be introduced into the market. It is not just the higher costs of developing new therapeutics and devices that make bioscience venture investing more challenging. There is often significant uncertainty as to how long clinical trials, testing and regulatory approval will take and a significant probability, especially for novel therapeutics and devices, of failure.

The risk inherent in bioscience business development is therefore steep, and attracting funding, particularly at the critical seed and early stages, is a major challenge for commercial development. Startup biopharmaceutical firms often experience a capital shortfall while generating the necessary pre-clinical safety data for an Investigational New Drug (IND) application as well as during clinical trials and regulatory approval process.

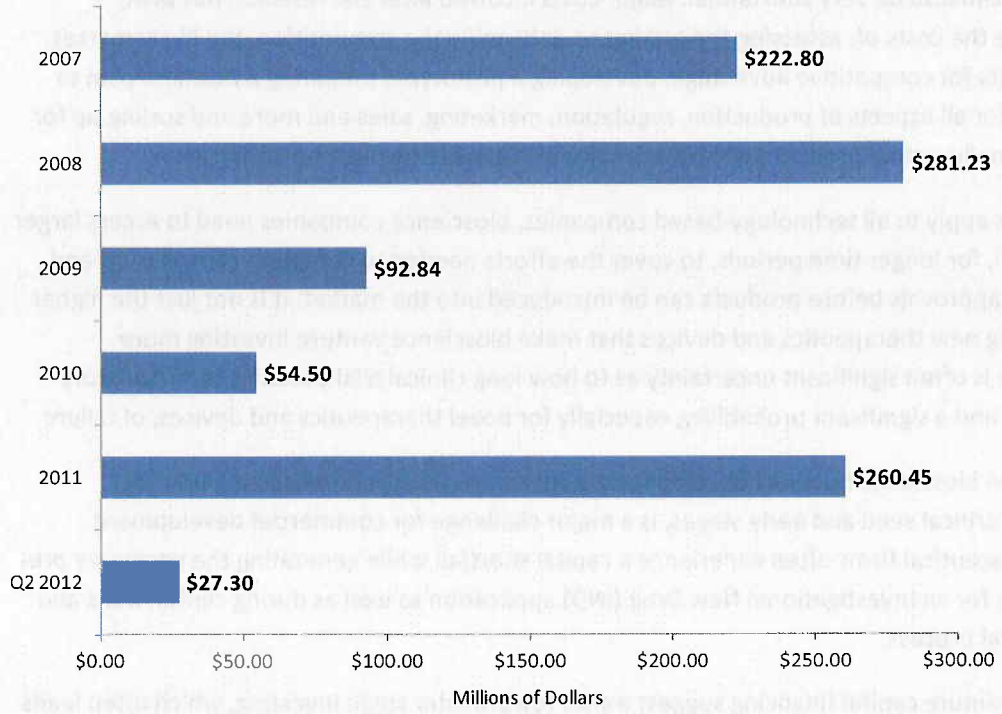
Recent trends in venture capital financing suggest a shift toward later stage investing, which often leads to a shortfall in the critical early rounds. Ernst & Young, in their 2011 report on trends in global venture capital, found that in the U.S., while the seed and early stage pools still remain active, there is a trend toward later stage investing, with companies in the expansion to later stages receiving the majority of VC dollars.[13] In Los Angeles County, these gaps in seed to early stage financing are apparent from the venture capital deals and dollars flow, especially when compared to other leading regions in the biosciences. Before getting to company stage investing, however, an overview of bioscience-related VC investing sets the context.

During the most recent five and a half year period, from 2007 through the first half of 2012, bioscience firms in Los Angeles County received $939 million in VC funding. The recent trend in these local investments has largely mirrored that for the U.S. bioscience industry as a whole during this same period (see Figures 17 and 18). Following a growth year in 2011, both the nation and Los Angeles County have been on pace for a downward overall trend in bioscience investing in 2012. This represents a difficult road currently and ahead for the nation, and particularly for the region, as the total received in 2011 never quite reached the previous peak of $281 million in Los Angeles County bioscience-related funding from back in 2008. The County's VC funding fell even more steeply, as a percentage of its total, than that

[13] Ernst & Young, *Globalizing Venture Capital, Global Venture Capital Insights and Trends Report, 2011*, page 15. See: http://www.ey.com/Publication/vwLUAssets/Globalizing_venture_capital_-_Global_venture_capital_insights_and_trends_report_2011/$FILE/Globalizing_venture_capital_Global_venture_capital_insights_and_trends_report_2011.pdf

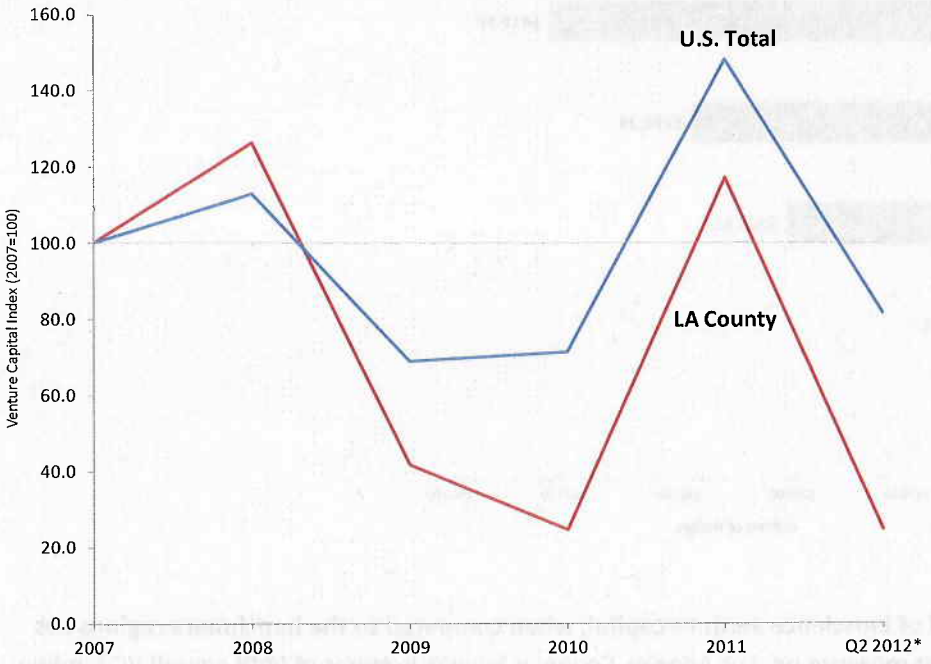
of the nation during the time period examined, and thus it has a longer way to go to reestablish robust relationships with funders.

Figure 17: Venture Capital Investments in Bioscience-related Companies, Los Angeles County, 2007–2012(Q2)



Source: Battelle analysis of Thomson Reuter's ThomsonOne database.

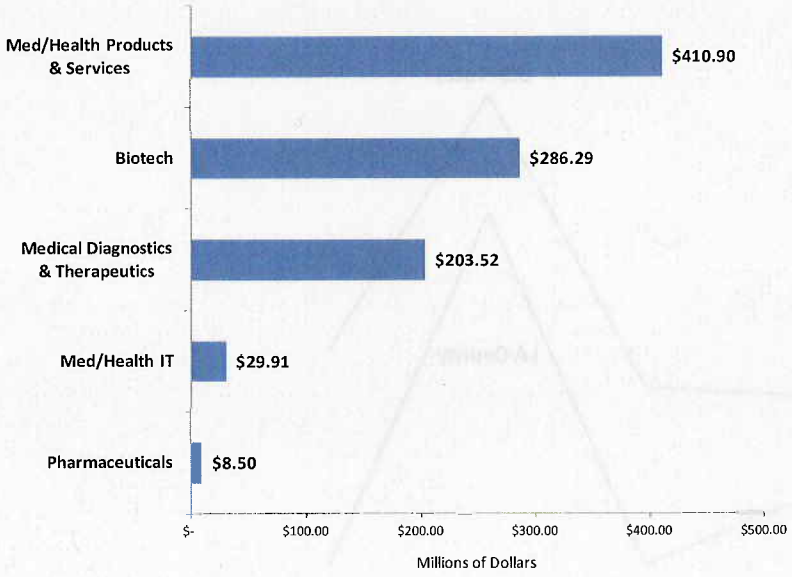
Figure 18: Trends in Bioscience-related Venture Capital Investments, Los Angeles County and U.S., 2007–Q2:2012*



*Note: data for 2012 uses the dollar figure through 2nd quarter and projects that forward (value is multiplied by 2) to project the current trend through year end.

Los Angeles County has a broad base of deal activity with respect to specific sectors within the biosciences, and as expected these largely reflect its key industry subsector strengths within medical devices, diagnostics and biotech R&D (see Figure 19). Venture firms have invested the largest amounts—$411 million or about 44 percent of all sector dollars—in medical/health products and services.

Figure 19: Bioscience-related Venture Capital Investments by Sector, 2007-Q2:2012

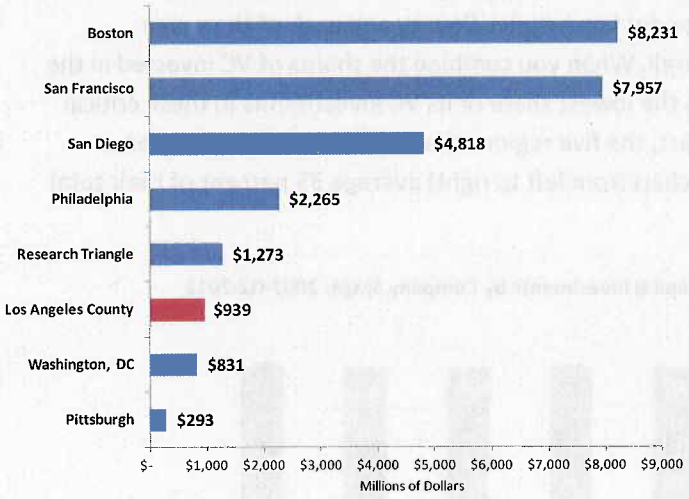


Despite this active level of bioscience venture capital, when compared to the benchmark regions Los Angeles County does not measure up. Los Angeles County is lagging in terms of both overall VC funding and number of individual deals (see Figure 20).

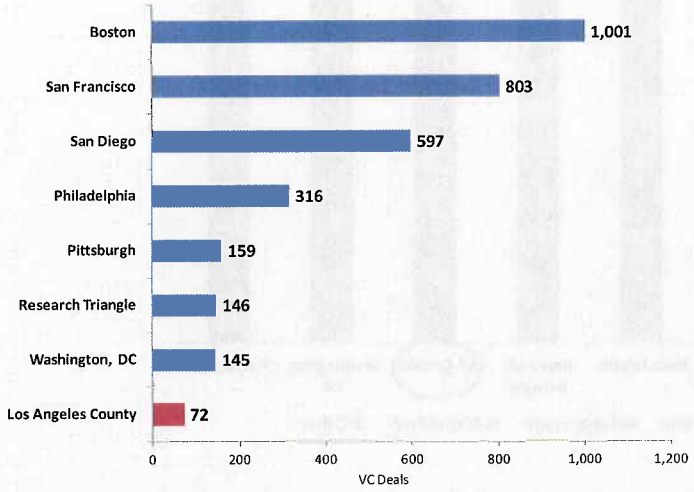
- The County's $939 million of VC funding during the 5½ year period is 6th among the group of benchmark regions, with Boston ($8.2 billion), San Francisco ($8 billion) and San Diego ($4.8 billion) far and away the leading regions.
- In number of VC deals, Los Angeles County is last among the group in overall activity, with just 72 deals since 2007. During this same time period Boston had just over 1,000 individual VC deals.

Figure 20: Bioscience-related Venture Capital Investments and Deals, 2007-Q2:2012

INVESTMENT

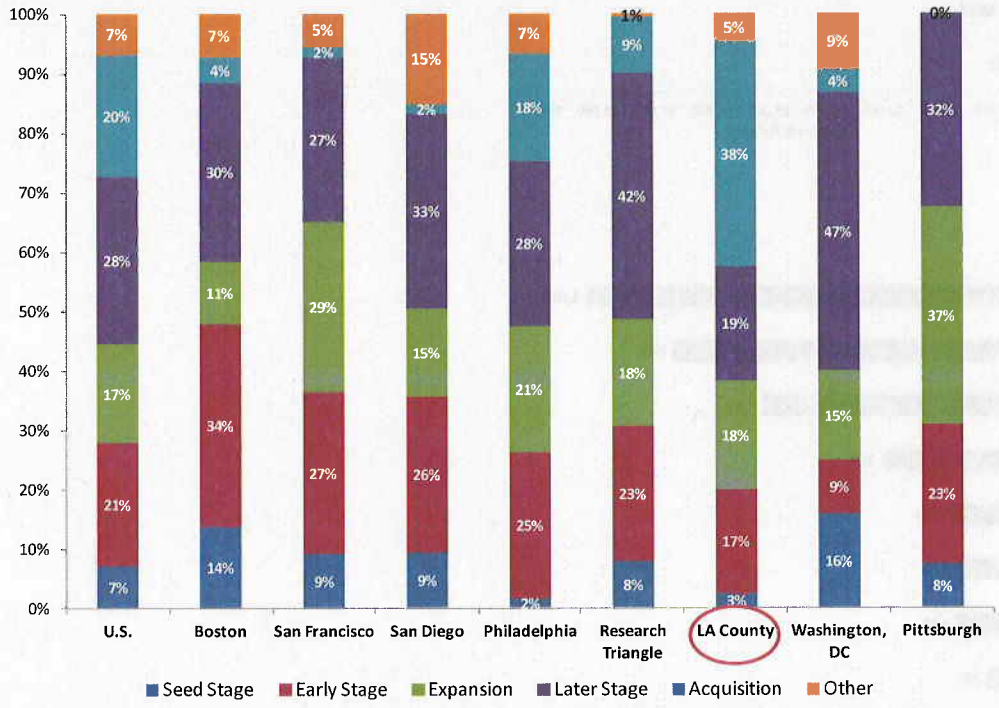


DEALS



Los Angeles County's industry leaders often site a lack of seed and early stage venture capital in the biosciences as a factor constraining regional industrial growth. Analysis of venture funding by company stage reveals this is a significant issue for the County. Figure 21 shows the distribution of venture capital investments, by company stage, for Los Angeles County and each of the seven benchmark regions, as well as for the U.S. overall. When you combine the shares of VC invested in the seed and early stages, Los Angeles County has the lowest share of its VC investments in these critical stages, at just 20 percent of its total. By contrast, the five regions that attract the most bioscience venture capital overall (ordered in size in the chart from left to right) average 35 percent of their total VC in these first stages.

Figure 21: Distribution of Bioscience-related Venture Capital Investments by Company Stage, 2007-Q2:2012



Local stakeholders, including industry leaders, university technology transfer officers and angel and venture capital investors in the region, site several challenges with respect to bioscience-related VC investments. Unlike other leading bioscience regions there is a lack of a locally-based "national" bioscience venture capital presence. This poses a major challenge, in their view, to growing the sector and overcoming early-stage challenges inherent in starting a bioscience enterprise. Specific additional themes and implications of this raised from various perspectives include:

- Among emerging industry players, many are forced to look outside of the region for formal rounds of VC; in addition, they have serious concerns about their ability to then attract future VC funding.

- Among university technology transfer officers, the lack of locally-based national bioscience VC drives companies outside of LA for better access to capital markets and therefore brighter overall prospects of success.
- Angel and other venture investors note that there is already a flow of deals in Los Angeles County, albeit small. At issue is that there is not follow-on formal venture capital funding to co-invest with local angel groups.

Summary – Venture Capital

Los Angeles County is clearly lagging the leading bioscience regions in both venture capital investment dollars and the number and efficiency of investment deals flow in bioscience-related ventures. In addition, the data analysis confirms the challenge raised in conversations with local stakeholders: seed and early stage VC investing is indeed lacking in the region. While it is anecdotal in nature, there is evidence that this limited access to capital is one of several factors driving companies to locate their new or emerging bioscience startups in other regions. Indeed this capital issue must be addressed if Los Angeles County is to realize its full potential in bioscience industry development.

Talent and Workforce

A varied and successful bioscience industry base requires, at its core, a mix of specialized skill sets unique to the industry and spanning the continuum of talent from laboratory technicians and precision production workers to Ph.D. level scientists, engineers and other researchers. In addition, the importance of talented management teams with experience in the biosciences cannot be overstated. It is these teams that often take the reins from scientists or post-doctoral researchers, who have developed the initial technology, and take the company on to success.

Meeting the needs of industry for a talented bioscience workforce must include both nurturing local home-grown talent and competing in the national and international markets for top-level bioscience scientific and experienced management talent. In particular growing, retaining and attracting entrepreneurial talent for bioscience startups is critical for leveraging the innovations being generated by academic medical centers.

To fully understand the region's position relative to its talent and workforce requires considering both the demand and the supply side of the equation.

Talent and Workforce Demand

To track demand and compare the skill sets found in the bioscience workforce requires focusing on occupational employment. The broad bioscience industry employs individuals across a wide spectrum of often vastly different occupations—from administrative staff and IT professionals to finance and accounting workers to scientists and lab technicians. A framework has been developed that identifies the key non-clinical occupations that typically span the bioscience industry (life scientists, biomedical engineers, etc.). These are presented in this section to profile the Los Angeles County bioscience workforce and used to make comparisons with other regions. Unlike the industry employment data presented earlier, these data include not only private sector workers but also the talent base across government.

Los Angeles County employed just over 20,000 workers in bioscience-related jobs across all industries in 2011. Among the major groupings of occupations developed by Battelle, the largest employment in the region is within the Medical and Clinical Lab Technicians group, at just over 10,000 jobs in 2011 (see Table 5). This group spans a broad technician workforce, including those in dental and ophthalmic labs. The group is typically the largest in most states and regions in the biosciences, though in leading innovation regions like Boston, San Diego, San Francisco and Washington, D.C., these jobs are actually outnumbered by those in the occupational group Biological Scientists and Technicians.

The next largest in Los Angeles County is this Biological Scientists and Technicians occupation group, which employ more than 8,100. With a concentration of this occupational group in the County that is 23 percent greater than the national average (a Location Quotient of 1.23) it is considered specialized. A major asset for the region, this group includes microbiologists, epidemiologists, medical scientists and biological scientists and technicians. This significant presence reflects the strong base of academic research found in the County.

Table 5: Bioscience-related Occupational Employment, Los Angeles County, 2011

Bioscience-related Occupational Groups	LA County Employment, 2011	LA County Location Quotient, 2011
Total Bioscience-related Occupations	**20,020**	**0.95**
Medical & clinical laboratory technicians	10,060	0.84
Biological scientists & technicians	8,110	1.23
Biomedical & biochemical scientists & engineers	1,110	0.89
Agricultural, food, & nutrition scientists & technicians	740	0.57

Source: Battelle analysis of BLS, Occupational Employment Statistics

Overall, the region's concentration of employment in these key bioscience jobs is about average, with a concentration equal to 95 percent of that typically seen around the U.S. with only the Biological Scientists and Technicians group having a substantially higher concentration of its workforce than the national average.

While Los Angeles County has one of the largest bioscience workforces compared to the benchmark regions, it is the only one that does not have a higher concentration than the national average in its bioscience workforce (see Figure 22 and Table 6). The County's 20,000 jobs are just behind the overall employment level seen in Boston (nearly 28,000 jobs) and also behind greater Washington, D.C. (nearly 21,000 jobs) which includes the substantial federal biomedical complex reaching out to the National Institutes of Health in suburban Maryland.

In contrast, the level of concentration—a measure of the clustering in the biosciences—stands much stronger in the benchmark regions. Each of the regions except Pittsburgh has a specialized (LQ>1.2) concentration in its bioscience talent base, compared to Los Angeles County, which has an LQ of .95, lower than all of the benchmark regions and lower than the national average. The leading smaller regions are the most highly concentrated in their bioscience workforce, with Research Triangle and San Diego having LQs of 2.2. Boston is impressive in its large and highly specialized workforce with a LQ just

over 2. So although Los Angeles County has an impressive number of bioscience jobs, much of this employment can be attributed to the large population base in the region, where there are more of almost any kind of job than in other metropolitan areas. When it comes to bioscience employment, the County actually has fewer jobs than would be expected given the size of its population.

The diverse set of specialized occupational groups, as shown in Table 7, are impressive in regions such as Boston, Research Triangle and others that clearly have advantages in their talent pools from which businesses can draw. Those two regions, in particular, are specialized in three of the four major bioscience occupational groupings, compared to only one area of specialization for Los Angeles County.

So in talent development, as in overall bioscience industry development, Los Angeles still does not measure up in its bioscience industry cluster to leading bioscience regions.

Figure 22: Bioscience-related Occupational Employment, Los Angeles County and Comparison Regions, 2011

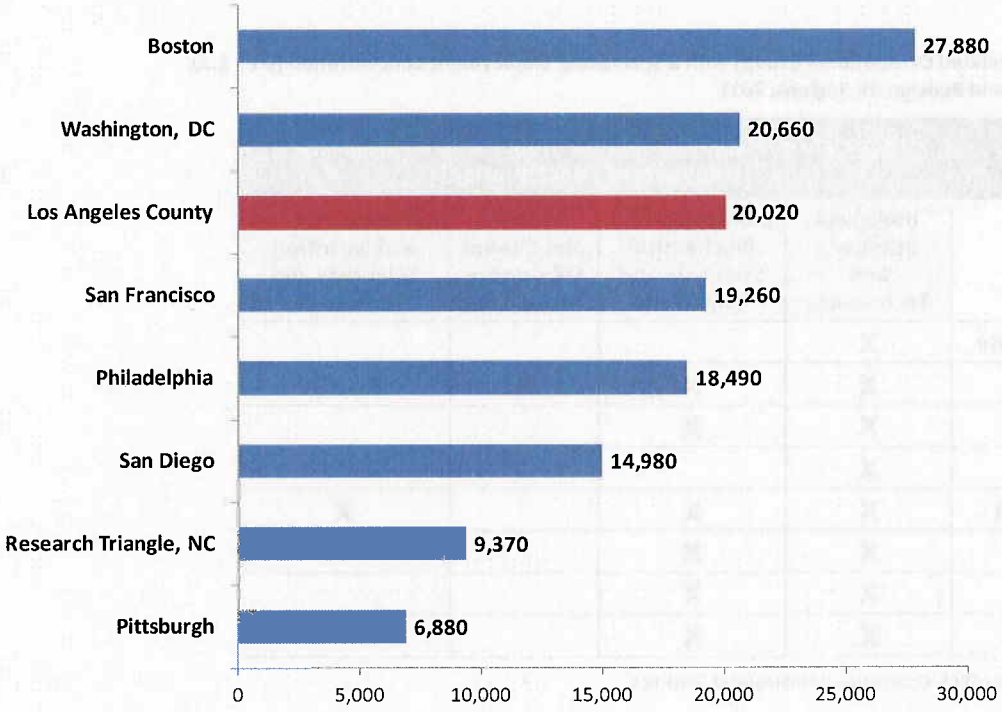


Table 6: Bioscience-related Occupational Location Quotients, Los Angeles County and Benchmark Regions, 2011

Region	Bio-related Occupations: Location Quotient, 2011
Research Triangle, NC	2.21
San Diegio, CA	2.20
Boston, MA	2.07
San Francisco, CA	1.83
Washington, DC	1.31
Philadelphia, PA	1.28
Pittsburgh, PA	1.12
Los Angeles County	**0.95**

Source: Battelle analysis of BLS, Occupational Employment Statistics

Table 7: Bioscience-related Occupational Groups with a Specialized Employment Concentration (LQ > 1.2), Los Angeles County and Benchmark Regions, 2011

Region	Bioscience-related Occupation Groups with a Specialized Employment Concentration			
	Biological Scientists and Technicians	Biomedical and Biochemical Scientists and Engineers	Medical and Clinical Laboratory Technicians	Agricultural, Food and Nutrition Scientists and Technicians
Los Angeles County	X			
Boston	X	X	X	
Philadelphia	X	X		
Pittsburgh	X			
Research Triangle	X	X		X
San Diego	X	X		
San Francisco	X	X		
Washington, D.C.	X	X		

Source: Battelle analysis of BLS, Occupational Employment Statistics

This overall weakness in the concentration of bioscience talent development reflects a challenge, noted often in the discussions with local industry leaders in Los Angeles County, that recruiting talent is made difficult by the lack of similar firms and talent needs across the County. When high-skilled individuals are looking at job opportunities in Los Angeles County they see a lack of other industry opportunities as alternatives if the current position is not a good fit or if they want to advance their careers. These individuals don't just want the job they're being offered, they want to know that they can continue their career paths in the region in which they settle. This creates a downward spiral. The lack of a large number of bioscience firms in the area results in a lower number of available jobs, and this lower number of jobs negatively influences decisions by high-skilled bioscience talent to accept offers of

employment in the biosciences in the region. Unless action is taken to create a critical mass of bioscience firms and employment opportunities in the County, this cycle will continue.

Talent and Workforce Supply

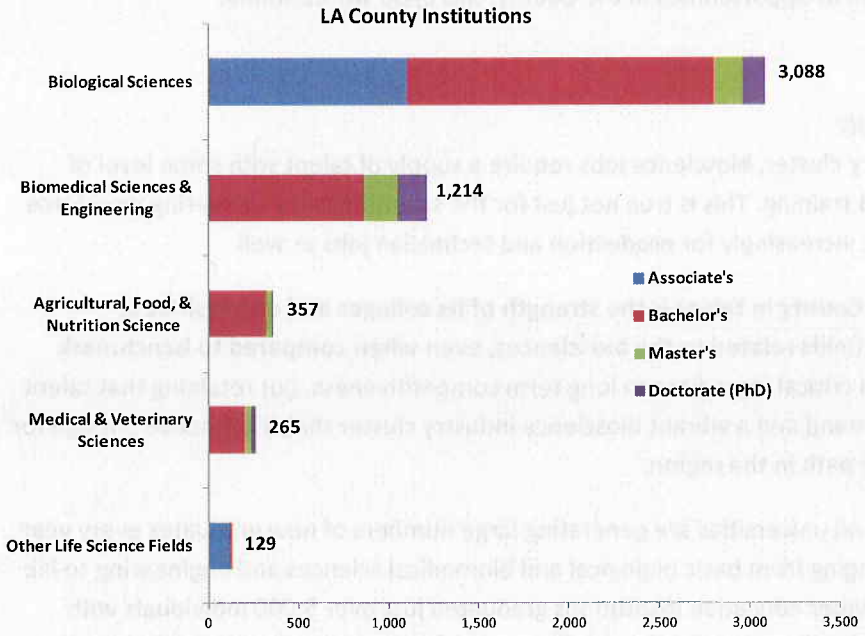
As a knowledge-based industry cluster, bioscience jobs require a supply of talent with some level of post-secondary education and training. This is true not just for the scientific and engineering workforce needs of bioscience firms, but increasingly for production and technician jobs as well.

A bright spot for Los Angeles County in talent is the strength of its colleges and universities in generating new graduates in fields related to the biosciences, even when compared to benchmark regions. Generating talent is a critical ingredient to long term competitiveness, but retaining that talent requires having strong job demand and a vibrant bioscience industry cluster that is attractive enough for new graduates to see a career path in the region.

Los Angeles County colleges and universities are generating large numbers of new graduates every year in bioscience degree fields ranging from basic biological and biomedical sciences and engineering to lab technicians. In 2010 County higher education institutions graduated just over 5,000 individuals with bioscience-related degrees at the Associate's level or higher, not including clinical professional degrees such as MD, DDS, DVM, or nursing. (See Figure 23).

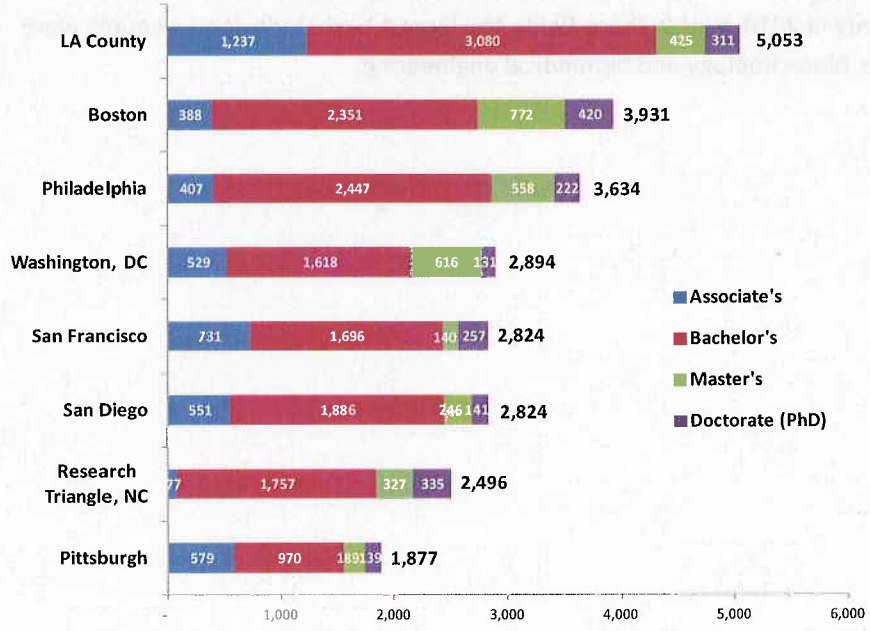
Compared to the U.S., Los Angeles County is producing a greater share of biosciences graduates with Associate's degrees at 24 percent of its total compared with 20 percent nationally. Los Angeles County also has a slightly higher share at the Doctorate level as well at 6 percent of all graduates versus 5 percent nationally. In terms of degree fields, Los Angeles County awards a larger share of its total bioscience degrees in the Biological Sciences as well as in Biomedical Sciences and Engineering fields, with these groups also accounting for the most master's and doctoral degrees, at more than 600 combined in Los Angeles County in 2010. Within those fields, the largest bachelor's degree counts were in biochemistry, neuroscience, biotechnology and biomedical engineering.

Figure 23: Bioscience-related Postsecondary Degrees, Los Angeles County and U.S., 2010



Los Angeles County colleges and universities generate the most college graduates with bioscience-related degrees among all benchmark regions, with 5,053 in 2010. Boston and Philadelphia follow with about 3,900 and 3,600 graduates, respectively. (See Figure 24.) The County has an above-average share of graduates at the Associate's level relative to the benchmarks regions; in addition, its combined share of graduates at the Master's and Doctorate degree levels is below average.

Figure 24: Bioscience-related Postsecondary Degrees, Los Angeles County and Comparison Regions, 2010



It is clear from the analysis that there is an excellent and large pool of appropriately trained individuals graduating each year from outstanding Los Angeles County institutions and ready to work in the bioscience industry. Interviews with industry confirm this, but do raise significant challenges:

Nearly all of the companies interviewed agree that entry-level technicians and life scientists are plentiful in the region. This end of the workforce spectrum is viewed as a key asset in the region and speaks to the quality of graduates.

Still, industry is concerned that the "best and brightest" among the recent bioscience graduates are leaving for more established or dynamic bioscience regions.

Although there is a steady stream of entry-level graduates in the area, finding more experienced staff to manage and guide companies to success is a challenge. County bioscience industry leaders indicate that talent and workforce are seen as critical, and issues and challenges can vary depending on the major subsector in which they operate or the experience and skill level of the worker(s). Along these lines, common themes have been raised regarding talent:

- For the biopharmaceuticals and diagnostics sectors, companies routinely say it is difficult to find and recruit experienced, senior-level scientific and management talent to Los Angeles County.
- From the workers perspective, they are concerned about finding other job opportunities in Los Angeles County. At the core of this issue is that the Los Angeles County bioscience cluster is not well recognized or is seen as widely dispersed.
- Workers have concerns about the high cost of living in Los Angeles County.
- These are major drawbacks for newly established and/or emerging biopharmaceutical or diagnostics companies trying to operate in Los Angeles County.
- Among medical device firms and more established bioscience companies these challenges around senior management and scientific talent are less of an issue.

Summary - Talent and Workforce

Viewing demand and supply of bioscience talent together, Los Angeles County is generating a large number of entry-level degree graduates in life science fields, though is not yet generating the level of demand—in terms of jobs—needed to specialize in bioscience workforce development. Instead, Los Angeles County is a net exporter of talent from its world-class universities to other regions or countries. The County's higher education institutions represent a significant competitive advantage, and a resource that other regions covet. If the bioscience sector can offer good jobs and exciting opportunities, many of these graduates would likely remain in the region, but this is a major challenge that requires strong and steady demand for workers and a better awareness of the Los Angeles County bioscience cluster as a whole. It is particularly important, as an emerging cluster, that strong connections between industry and students be forged since it is easy to overlook the opportunities for bioscience talent that do exist in the County. The industry must engage the universities, and vice versa, in order to promote successful talent pipelines and an understanding of the opportunities in the region.

LA Valley College Awarded U.S. Dept. of Labor Grant to Expand Bioscience Workforce Training

Los Angeles Valley College is one of 12 U.S. community colleges to receive a portion of a $15 million DOL grant designed to develop and expand the bioscience workforce under the Department's Trade Adjustment Assistance Community College Career Training effort. The program is focused on developing career pathways in the biosciences for individuals displaced from other industries.

The project looks to develop credentials and certificates in lab skills, biomanufacturing and medical devices, and offers "stackable" credentials to help individuals impacted negatively by trade find new jobs in the industry.

Los Angeles County is also not able to effectively tap into more senior-level talent, as the same unawareness of its strong but scattered bioscience industry creates uncertainty as to career paths available in the County. That, combined with its relatively high cost of living, makes relocating to Los Angeles County for a career in the biosciences appear too risky for some.

Bioscience University Commercialization and Research Environment

What stands out about bioscience industry development is that while research is critical, it is not sufficient to advance innovations to the market place. Research and development capabilities by themselves do not generate economic development results. There must be established strong links between universities and industry to advance bioscience industry development, and mechanisms to foster the commercialization of university-based research and the startup of new businesses.

Below the standing of major universities in Los Angeles County in terms of both technology transfer—the process of bringing research innovations and technology out of the lab and into the commercial market—and bioscience research and development funding trends is discussed.

Technology Transfer and Commercialization

Available data regarding the success of transferring technology out of universities addresses all fields and disciplines at a given university. The Association of University Technology Managers (AUTM) conducts an annual survey of its member institutions but does not differentiate between fields of study; therefore, these data cannot speak directly to technology transfer outcomes in the biosciences. Nevertheless, the data speak to the broad climate and success (or lack thereof) for universities in working to commercialize research generally.

To better understand the extent to which bioscience activity contributes to technology transfer data, the county's three largest research universities—UCLA, CalTech and USC—were contacted, and discussions held with their technology transfer offices. Using the data received from UCLA as an example, it is apparent that the biosciences are a major part of the overall commercialization of university research. Among these metrics for UCLA, the biosciences represent:

- 89 percent of research expenditures
- 93 percent of license income
- 50 percent of patents issued
- 68 percent of startups initiated

Table 8 presents technology transfer metrics for these three largest research universities individually and in total and indicates positive outcomes for research including: invention disclosures; startups initiated; patents applied for and issued; licenses executed and income received. Normalizing these data per $10 million in total research expenditures allows for a comparable measure of the relative return on each dollar of research in terms of successful outcomes and for a comparison against all U.S. institutions responding to the AUTM annual survey.

Compared with national averages, Los Angeles County's major research universities perform well above-average in nearly all of the normalized metrics—generation of invention disclosures, initiating startups, patents applied for and issued and licensing income. (They lagged only in licenses/options executed.) Compared to the national averages, the differences were significant, standing at 59 percent higher in both disclosures and new patent applications, and nearly double the national average level for startups. And the absolute level of activity found in technology transfer by the major research universities in Los Angeles County is substantial, combining to generate over 1,000 disclosures and to initiate 43 startups in 2010.

Table 8: Technology Transfer Metrics for Los Angeles County Universities and all U.S. AUTM Member Institutions, 2010

University	Total Research Expenditures	Invention Disclosures	Start-ups	Metrics per $10M in Research Expenditures					
				Invention Disclosures	Start-ups	New Patent Applications	U.S. Patents Issued	Licenses & Options Executed	License Income
Total U.S. Universities Reporting to AUTM	**$ 52,331,287,808**	**18,346**	**606**	**3.51**	**0.12**	**3.17**	**0.76**	**0.89**	**$ 337,457**
Los Angeles County	**$ 1,996,944,001**	**1,118**	**43**	**5.60**	**0.22**	**5.07**	**1.22**	**0.62**	**$ 483,578**
UCLA	$ 899,677,000	379	27	4.21	0.30	3.52	0.52	0.58	$ 363,342
USC	$ 592,790,873	166	6	2.80	0.10	3.49	0.98	0.40	$ 207,437
Caltech	$ 504,476,128	573	10	11.36	0.20	9.67	2.74	0.93	$ 1,022,489

Source: Battelle analysis of AUTM U.S. Licensing Survey; University of California System data from Technology Transfer Annual Report, 2010.
Note: not all regional institutions complete the AUTM survey.

The strength of the County's major research universities in technology transfer is further confirmed by comparison to the seven benchmark regions. The major universities in Los Angeles County lead the group in invention disclosures (1,118) and startups (43) in 2010 (see Table 9). Even with having the second-largest research base, on a per expenditure basis the County is productive and well ahead in these and other measures including patents and license income. There is clearly a large and productive innovation engine with a major focus on technology transfer among the Los Angeles County institutions.

Table 9: Technology Transfer Metrics for Los Angeles County and Benchmark Regions, 2010

Metro Region	Total Research Expenditures	Invention Disclosures	Start-ups	Metrics per $10M in Research Expenditures					
				Invention Disclosures	Start-ups	New Patent Applications	U.S. Patents Issued	Licenses & Options Executed	License Income
Total U.S. Universities Reporting to AUTM	**$ 52,331,287,808**	**18,346**	**606**	**3.51**	**0.12**	**3.17**	**0.76**	**0.89**	**$ 337,457**
Boston	$ 2,901,204,540	1,001	29	3.45	0.10	3.98	0.90	0.68	$ 305,238
Los Angeles County	**$ 1,996,944,001**	**1,118**	**43**	**5.60**	**0.22**	**5.07**	**1.22**	**0.62**	**$ 483,578**
Research Triangle, NC	$ 1,925,380,334	463	14	2.40	0.07	2.47	0.53	1.10	$ 173,725
San Francisco	$ 1,595,081,000	294	13	1.84	0.08	1.32	0.46	0.29	$ 225,142
Philadelphia	$ 1,217,303,114	626	11	5.14	0.09	4.31	0.94	0.88	$ 107,803
San Diego	$ 1,089,017,732	395	16	3.63	0.15	2.99	0.69	0.44	$ 236,331
Pittsburgh	$ 970,511,000	333	16	3.43	0.16	2.82	0.59	1.32	$ 102,192
Washington, DC	$ 336,067,330	114	2	3.39	0.06	4.20	0.83	0.48	$ 242,965

Source: Battelle analysis of AUTM U.S. Licensing Survey; University of California System data from Technology Transfer Annual Report, 2010.
Note: not all regional institutions complete the AUTM survey.

A "leaky bucket" phenomenon is happening in Los Angeles around bioscience commercialization. Strong performance in university technology transfer and commercialization, unfortunately, does not always translate into gains for the local region. Discussions with technology transfer staff at CalTech, City of Hope, UCLA and USC suggest that many of the bioscience startups are finding investors and management talent outside of the region and thus putting down roots outside of Los Angeles County. These offices all confirm that bioscience spin-outs that receive significant venture capital funding tend to migrate to other regions when they reach the stage in which seasoned management talent and later investment rounds are necessary. This is an example of the interrelationship between VC funding and talent needs, and firm evidence that Los Angeles County is a leaky bucket with respect to losing promising startups.

One bright spot has been the ongoing collaboration efforts of SoCalBio with university and biomedical research institutes in their technology commercialization efforts. SoCalBio, the industry trade association of the bioscience industry in the Greater Los Angeles region, has helped match qualified serial entrepreneurs and technology experts with the technology transfer offices of universities and biomedical research institutes to commercialize promising technology advances. Examples of success stories include finding entrepreneurs to work with recent spin-out companies, including ImmunoCellular Therapeutics (a spin-out from Cedars Sinai) and Pagnani Bipharma (a spin-out from UCLA). In addition, SoCalBio's annual investor conference is an important networking event that has helped introduce promising new start-up bioscience companies from the Greater Los Angeles region, many of which are spin-outs from universities and biomedical research institutes, to angel and formal venture investors. But this effort from SoCalBio is constrained by having only limited resources for matching services, ongoing mentoring and outreach to angel financing and formal venture capital.

Another positive note is that the universities' strength in technology transfer activities does offer existing industry a competitive advantage by being in Los Angeles County and partnering with local universities. In the biosciences this means gaining access to university resources for pre-clinical studies and clinical research. University technology transfer leaders note that this advantage could be further

bolstered and solidified through greater awareness of new discoveries across institutions, improved contracting processes with institutions and more proof of concept funding to advance promising discoveries to the stage where its commercial value can be evaluated.

This strength in technology transfer and commercialization can also be a boon for broader bioscience economic development by attracting major biopharmaceutical and medical device industry partnerships. These types of efforts are growing across the nation, but there are no significant major bioscience company partnerships comparable to what Pfizer has established in Cambridge, Massachusetts, Gilead in New Haven, Jackson Labs in Hartford or Lilly in Indianapolis.

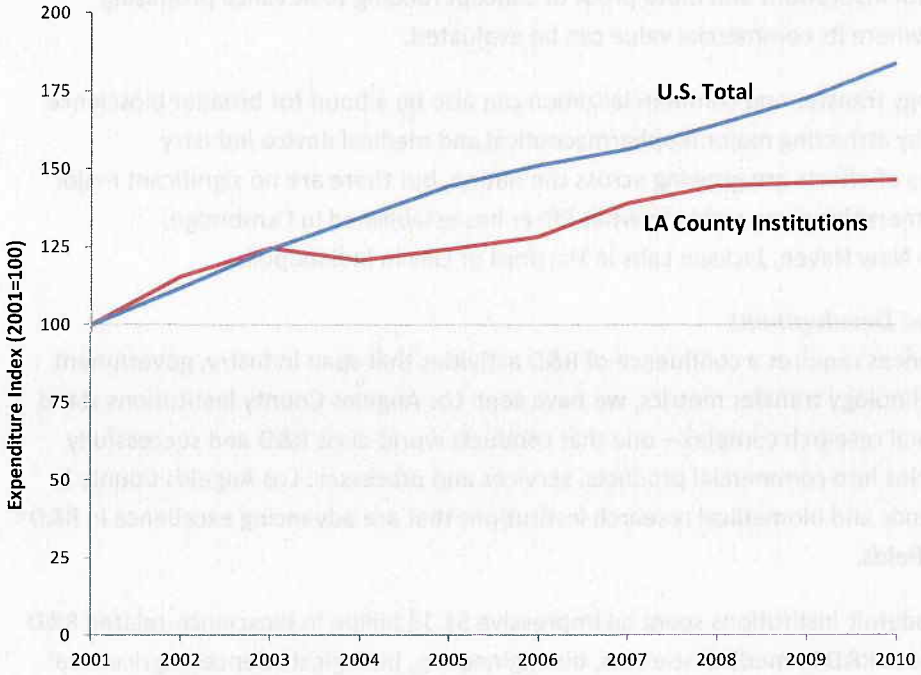
Academic Research and Development

Innovation in the biosciences requires a confluence of R&D activities that span industry, government and academia. In the technology transfer metrics, we have seen Los Angeles County institutions stand out as a successful regional research complex—one that conducts world-class R&D and successfully translates these discoveries into commercial products, services and processes. Los Angeles County is home to premier bioscience and biomedical research institutions that are advancing excellence in R&D in numerous bioscience fields.

Los Angeles County's academic institutions spent an impressive $1.13 billion in bioscience-related R&D in 2010. This figure includes R&D in medical sciences, bioengineering, biological sciences, agricultural sciences and other life sciences. Los Angeles County's universities are major players in the biosciences, particularly UCLA and USC. Bioscience-related academic R&D expenditures at UCLA reached $660 million in 2010, making it among the top ten largest institutions in bioscience research in the nation. USC, meanwhile, reached $365 million in 2010. Together, these two leading biomedical schools account for 91 percent of total County R&D.

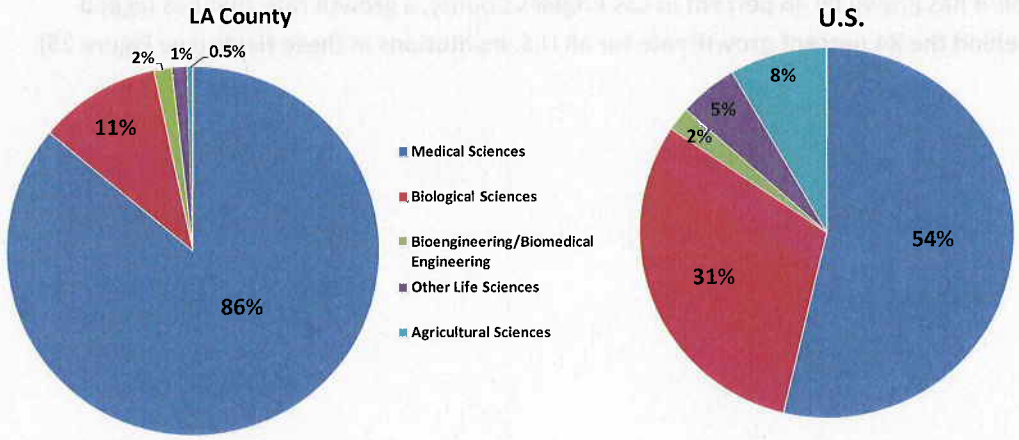
While still growing in university bioscience research and development, Los Angeles County lags far behind the growth found nationally over the past decade. Since 2001, university bioscience research and development has grown by 46 percent in Los Angeles County, a growth rate that has lagged significantly behind the 84 percent growth rate for all U.S. institutions in these fields (see Figure 25).

Figure 25: Trends in Bioscience-related Academic R&D Expenditures, 2001–10 (Current $)



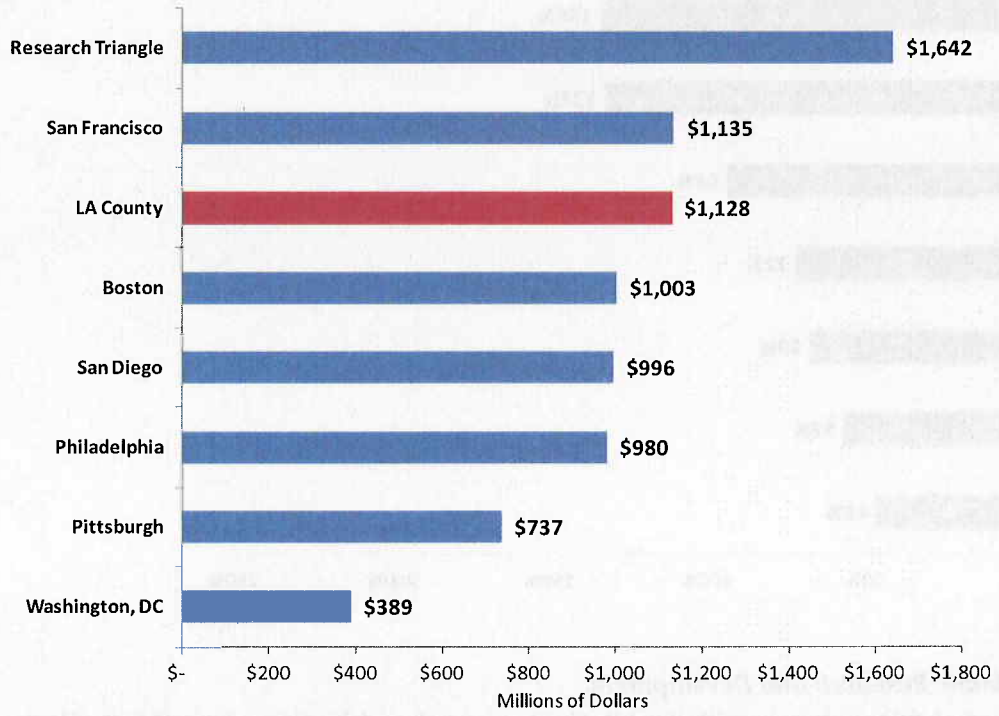
Bioscience university R&D in Los Angeles County is much more concentrated in the medical sciences compared with the nation (see Figure 26), reflecting the strength of its medical schools and other academic biomedical research centers. This is in line with the bioscience industry development found in Los Angeles County, which is primarily focused on biomedical activities.

Figure 26: Distribution of Bioscience-related R&D Expenditures by Field, Los Angeles County and U.S., 2010



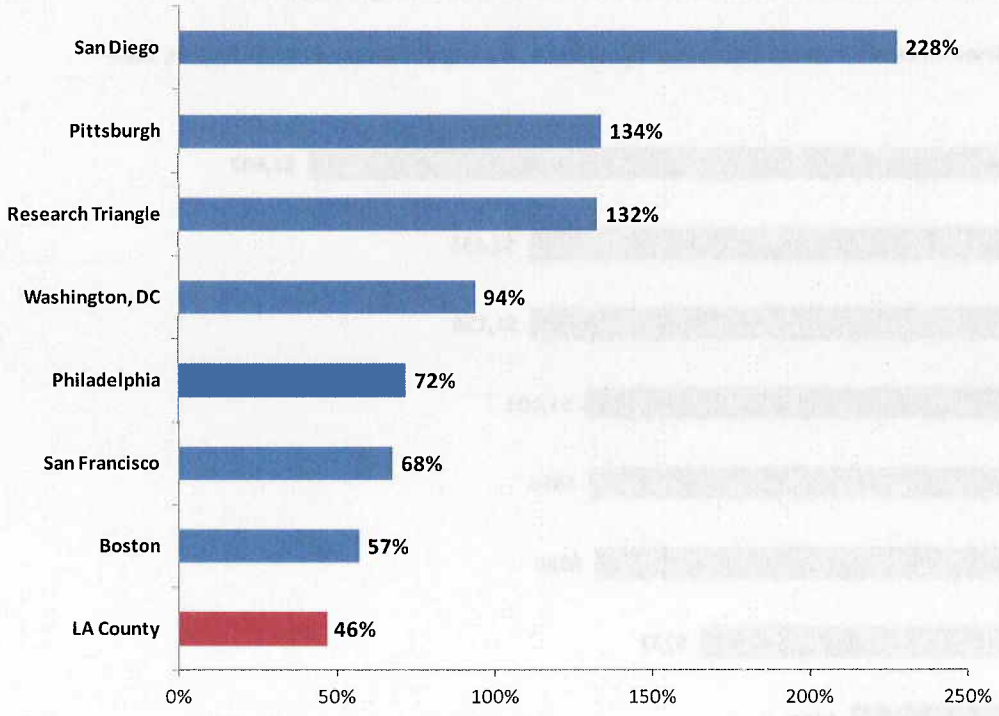
Compared with the benchmark regions, Los Angeles County stands out among the top in terms of total R&D expenditures in 2010 (Figure 27). Expenditures essentially match those for San Francisco; though lag just behind the academic research base in the Research Triangle region.

Figure 27: Academic Research Expenditures in Bioscience-related Fields, Los Angeles County and Benchmarks, 2010



Comparing the recent growth trends in academic R&D in the biosciences reveals just how slow the growth rate has been for Los Angeles County. **Against the seven benchmark regions, the County's growth rate in R&D expenditures ranks last, and while it is recognized that this rate of change is on a large research base, it is notable that all the other large metro regions have outpaced it.** The concern here is that the County's position as a top bioscience research hub is eroding while others gain competitive share.

Figure 28: Academic R&D Expenditure Trends in Bioscience-related Fields, Los Angeles County and Benchmarks, 2001–10 (Current $)



Summary – Academic Research and Development

Los Angeles County maintains a strong position in bioscience research and development and technology transfer and commercialization. Despite this, underlying concerns remain. Universities are successfully spinning out new technologies and companies in the life sciences, though there is strong anecdotal evidence that these spin-outs have little attachment to the County and are migrating out, attracted by capital and experienced management talent they cannot find in the region. Separately, R&D expenditure data suggest a relative loss in competitive share as the County's institutions have flattened their rate of increase in spending on research while other regions are thriving.

Section VI: Strategic Position of Los Angeles County in Bioscience Industry Development: A Strengths, Weaknesses, Opportunities and Threats Assessment

This Feasibility Assessment offers an in-depth, fact-based examination of Los Angeles County's bioscience industry position and trends. This includes specific areas of likely bioscience development, geographic footprint and commercial bioscience real estate development issues as well as its competitive position in the key factors of capital, talent and technology transfer and research environment driving bioscience development.

To advance a comprehensive Master Plan to enable Los Angeles County to realize its full potential as a bioscience hub, it is critical to translate these findings into a strategic framework that can guide the development of specific strategies and actions needed to advance the County's bioscience industry cluster.

An approach often used by businesses to support their own strategic business planning is to undertake a SWOT analysis, identifying its internal strengths and weaknesses, and taking account of and addressing external factors, including opportunities and adverse events and threats. Below such a SWOT analysis of the bioscience industry cluster in Los Angeles County is presented much like a business would examine itself.

This SWOT analysis reflects not only the quantitative analyses completed, but the situational assessment involving more than 50 one-on-one interviews with key bioscience industry executives, university and research institution officials, angel and venture capital investors, commercial real estate brokers and developers, education and training providers and government officials.

This SWOT assessment was reviewed by and discussed with the Project Advisory Committee, comprised of leading executives and officials from bioscience industry, university and research organizations, venture capital, commercial real estate and education and training institutions drawn from across the County (see Appendix C for a listing of the Project Advisory Committee members). It should be noted that in some cases perceptions are included in this SWOT, whether accurate or not, since they reflect the climate within which progress can be made in advancing the bioscience industry cluster in Los Angeles County.

Strengths

The strengths found in bioscience industry development in Los Angeles County largely reflect the promise that this emerging industry cluster holds for the County as an economic driver. This promise is more than just a hope...it reflects real economic performance as well as research and innovation activities already rooted in the County.

The bioscience industry cluster over the past decade—including through the recession and weak national recovery—has been a growing sector and economic driver for Los Angeles County. From 2001 to 2010, core bioscience industry employment, not including hospitals, grew in Los Angeles County by 4,452 jobs or 11.8 percent, at a time when total private sector employment in Los Angeles County fell by more than 225,000 jobs, a decline of 6.4 percent. This fall off in private sector employment was severe through the recession and weak economic recovery years of 2008 to 2010, when total private sector employment fell by 9.0 percent from its peak in 2007 in Los Angeles County. In contrast, bioscience industry employment from 2007 to 2010 grew by 2.0 percent for bioscience industry in the County. Even in the more robust expansion times of 2001 to 2007, bioscience industry employment growth of 9.6 percent outpaced the total private sector growth in Los Angeles County of 2.8 percent.

Not only has the bioscience industry become an important economic driver within Los Angeles County's economy, on the national stage it is gaining market share by outpacing overall U.S. growth in the biosciences. From 2001 to 2010, the hefty 11.8 percent growth in bioscience industry employment in Los Angeles County was nearly double the U.S. bioscience industry growth rate of 6.7 percent. And while the U.S. biosciences declined slightly in the recession and weak national recovery years from 2007 to 2010, Los Angeles County continued to gain bioscience jobs.

But it is important to keep the bioscience industry growth in Los Angeles County in perspective. While the job gains are impressive, four of the seven benchmark regions—Boston, Research Triangle, San Diego and San Francisco—all outpaced Los Angeles County's growth rate. In addition, these same regions have a higher degree of industry clustering as reflected by a higher concentration of employment in the biosciences than the nation. Los Angeles County is still lagging in its concentration of jobs in the bioscience industry.

On a positive note, Los Angeles County has done well compared to other benchmark regions with emerging bioscience clusters, including the Washington, D.C. and Pittsburgh regions, which had smaller gains in employment and, like Los Angeles County, do not yet have higher concentrations in bioscience industry employment than the nation. (The seventh benchmark region, Philadelphia, has an impressive concentration of bioscience employment, but has experienced a huge loss of jobs due to its reliance on markets that are now shrinking.)

The growth of Los Angeles County's bioscience industry base, though focused on biomedical activities, is broadly based across several sectors and not reliant on just one or two sectors. Across the major subsectors comprising the biosciences, Los Angeles County grew in four of the five sectors, led by Research, Testing, and Medical Labs, with a hefty 30 percent growth rate from 2001 to 2010 and Medical Devices and Equipment, which grew by over 10 percent from 2001 to 2010. Other growing bioscience sectors in Los Angeles County include Hospitals and Bioscience-related Distribution, though

their gains were under 5 percent for the decade. The only bioscience industry sector losing employment over the 2001 to 2010 period was Drugs and Pharmaceuticals, which has been going through significant structural changes with the rise of generics and outsourcing of both research and manufacturing, particularly for clinical trials.

A closer examination of detailed industries found in the biosciences identified twelve specific, detailed industries that stood out. Three industries are identified as being current strengths in the region being specialized, consistent job generators and outpacing national economic growth. They were: Electro-medical Devices; Surgical Appliances and Supplies and Medical Labs. Another seven detailed bioscience industries are identified as emerging strengths in the region, with job growth at a pace faster than the U.S. They were: Biotechnology Commercial Research and Development; Pharmaceutical Manufacturing; Surgical and Medical Instruments; Drug Distribution; Testing Labs; Biological Products and In-Vitro Diagnostics. Two detailed industries were not job generators over the past decade, but do have a high level of concentration in the County pointing to past success and are targets for retention efforts. They are: Medicinal and Botanical Manufacturing and Dental Equipment and Supplies.

What stands out about the breadth of Los Angeles County's bioscience industry base is its focus on biomedical activities. In this regard, Los Angeles County has a significant base of academic health centers, which go beyond typical hospitals in advancing new clinical treatments. They also play an integral role in translating basic bioscience discoveries into applications that enhance human health, and then working to commercialize them. For this reason, it is also important to consider how hospitals, along with the core bioscience industries, can contribute to growing the bioscience industry cluster in the County.

The depth of the research and innovation base found in Los Angeles County is substantial and offers a key leverage point for future growth through commercialization. The overall bioscience research base found in Los Angeles County is among the top tier of regions in the U.S. A close examination of this research and innovation base through a cluster analysis of peer-reviewed publications and patents issued and applied for identified twenty-four theme areas or cluster groupings focused across biomedical applications, disease areas and basic biological sciences. The breadth of these cluster groupings points to the extensive bioscience research and innovation capacity found in Los Angeles County. This extensive range of cluster groupings was further validated by examining scholarly excellence, presence of major federally funded research centers and investigator-led clinical trials. What also stands out is the close alignment of industry presence and strengths in Los Angeles with these research and innovation cluster groupings based, on the detailed bioscience industry strengths, the presence of venture backed companies and the large share of patents (which are largely driven by industry) represented in each cluster grouping. Even those cluster groupings focused on disease areas and basic sciences as opposed to applications have some alignment with industry activities in Los Angeles County.

Extensive interviews were conducted with industry and university leadership, and valuable input was gathered from the Project Advisory Committee These discussions both validated the assessment of core competencies and determined how these core competencies could best be grouped into broader technology platforms with a line of sight to growth opportunities.

Three specific technology platforms emerge with a clear alignment of industry presence with research and innovation clusters in Los Angeles County:

- **Novel therapeutics and diagnostics**, with a focus on cancer research and treatments and biologics for therapeutics and diagnostics.
- **Bioengineering solutions for treating diseases and medical conditions** with a broad base of activity across cardiovascular devices, musculoskeletal implants, and other electro-medical/bioimaging/surgical devices.
- **Innovations in healthcare delivery** with a focus on health informatics and public health and healthcare services innovations.

In the technology transfer and commercialization activities of its major research drivers, Los Angeles County not only significantly outperforms the U.S. average, but also stands out among the benchmark regions. This includes the generation of invention disclosures, initiating startups, patents applied for and issued and licensing income, all standardized by the size of the research base for comparison purposes.

The strengths found in technology transfer activities does offer existing industry a competitive advantage to being in Los Angeles County and partnering with local universities. In the biosciences this means gaining access to university resources for pre-clinical studies and clinical research. These same leaders note that this advantage could be further bolstered and solidified through greater awareness of new discoveries across institutions, improved contracting processes with institutions and more proof of concept funding to advance promising discoveries to a stage where its commercial value can be evaluated.

Generation of bioscience talent stands out across the college and university base found in the region. Los Angeles County colleges and universities are generating over 5,000 new graduates in bioscience degrees fields, ranging from basic biological sciences and biomedical sciences and engineering to lab technicians. This is the most among the benchmark regions. Nearly all companies interviewed agree that entry-level technicians and life scientists are plentiful in the region. This broad talent pipeline is viewed as a key asset in the region and speaks to the quality of graduates.

Los Angeles County already has the presence of business services and an international position. From interviews with bioscience industry executives, including those from emerging bioscience companies, Los Angeles County offers full access to the types of professional services in business planning, accounting, patent law, mergers and acquisitions and regulatory compliance needed to advance a bioscience industry cluster. One distinguishing aspect of Los Angeles County is that many of its business service providers bring a strong international expertise which along with the County's strong air service, distribution and logistics, especially to Asia, offers a strong position for advancing international connections and business relationships.

Weaknesses

There is no identifiable commercial bioscience real estate market in Los Angeles County and no single area of the County that has a high share of bioscience company locations...so, no equivalent to a "Hollywood" for the bioscience industry despite its need for specialized lab space and tapping talent pools. The locations of 168 bioscience firms in the County, were identified, involving 205 buildings and 4.982 million total square feet leased—a very sizable footprint. But a mapping of these bioscience firm locations suggests that companies are highly scattered across the County.

According to discussions with commercial real estate brokers, there is no clearly identified inventory of bioscience lab space that is being either bought/sold or leased to bioscience tenants. Outside of two small bioscience incubators found near research institutions with a total area of 12,000 square feet, there is only one advertised multi-tenant bioscience lab space found in the County, with 34,000 square feet that are close to fully occupied. This lack of available lab space is reinforced by the analysis which shows that among the 168 bioscience firms tracked only 18 of them are located in buildings that house another bioscience firm. This suggests that bioscience companies are not only widely distributed geographically across Los Angeles County but also that the County has virtually no multi-tenant bioscience-dedicated buildings.

A key competitive issue for Los Angeles County is that bioscience companies have to bear the cost of fitting out their own wet lab spaces with required air handling needs and can face long delays and uncertainties with permitting. This cost to retrofit existing commercial real estate for wet labs can run well in excess of $150 per square foot, placing a significant economic burden on bioscience companies in Los Angeles County and creating delays and uncertainties that take them away from their primary business activities. All of the biopharmaceutical and diagnostics emerging companies interviewed had difficulty in finding post-incubator, multi-tenant wet lab space, and viewed it as a significant development challenge for Los Angeles County. In all seven of the benchmark regions—there is an available inventory of bioscience wet lab space being leased.

Los Angeles County is lagging in venture capital funding, particularly at the critical early stages. Despite an active level of bioscience venture capital that generated $939 million in venture funding over 72 deals from 2007 through the first half of 2012 , when compared to the benchmark regions, Los Angeles County does not measure up, standing last in overall deal activity and third from the bottom in total venture capital funding.

Los Angeles County's industry leaders often site a lack of seed and early stage venture capital in the biosciences as a factor constraining regional industrial growth, and their insights were confirmed by further analysis. Los Angeles County has the lowest share of VC investments in these critical stages, at just 20 percent of its total, while the five benchmark regions with the most VC had 35 percent of their bioscience venture capital in these first stages.

A "leaky bucket" phenomenon is happening in Los Angeles around bioscience commercialization despite the strong technology transfer and commercialization performance of its major research drivers. Strong performance in university technology transfer and commercialization, unfortunately, does not always translate into gains for the local region. Discussions with technology transfer staff at the

County's largest research institutions suggest that many of the bioscience startups are finding investors and management talent outside of the region and thus locating elsewhere. These offices all confirm that bioscience spin-outs that receive significant venture capital funding tend to migrate to other regions when they reach the stage in which seasoned management talent and later investment rounds are necessary. This is an example of the interrelationship between VC funding and talent needs and provides evidence that Los Angeles County is a leaky bucket with respect to losing promising startups.

The demand for bioscience workforce in Los Angeles County is lower than in benchmark regions, and creates a challenge to recruit top talent to the region given the lack of broader opportunities. While the number of bioscience jobs in Los Angeles County jobs is high, for a region the size of Los Angeles County it should be higher and compared to the benchmark regions, it is the only one that does not have a higher concentration than average in its bioscience employment. This overall weakness in the concentration of bioscience opportunities reflects a challenge noted often in the discussions with local bioscience industry leaders in Los Angeles, that recruiting talent is made difficult by the lack of similar firms and talent needs across the County. When high-skilled individuals are looking at job opportunities in Los Angeles County they see a lack of other industry opportunities as alternatives if the current position is not a good fit or if they want to advance their careers. This lack of a perceived career path within the County affects the retention and attraction of talent not just for senior level management, but also for entry level employees. As a result Los Angeles County is a net exporter of talent from its world-class universities to other regions or countries

Opportunities

Strengthening the geographic connections of bioscience innovators to the Los Angeles area to develop a home-grown and more entrepreneurial local bioscience community. The depth of the bioscience research and innovation base in Los Angeles County, together with the active engagement of its major research drivers in technology transfer, offers a significant but not sufficient base of activity for advancing high potential startups in the County. The "leaky bucket" phenomenon of Los Angeles County university spin-outs being located in, or relocated to, other regions demonstrates this fact. Best practice suggests that universities alone cannot drive technology commercialization—new business startups are critical, but they must have compelling reasons to stay in a region.

An effective way to connect the technology transfer efforts of universities and other research institutions to the broader technology and entrepreneurial business community is through the use of intermediary organizations. These intermediary organizations should be closely aligned with research institutions, but stand outside of the traditional technology transfer offices so they can advance entrepreneurial growth in a more concerted manner. Experience in the last 20 years has shown that generating entrepreneurial growth is not an accident, but reflects the capacities and support mechanisms in place to work with entrepreneurs to be successful. Communities that have effectively advanced robust entrepreneurial environments are distinguished by the following activities: mentoring and providing technical assistance to entrepreneurs, connecting emerging companies with investors, supporting the growth of indigenous local capital and tapping qualified business service providers. Examples of organizations that have sustained entrepreneurial development and technology commercialization services and realized significant results includes San Diego CONNECT, Oklahoma's I2E and the Innovation Center of the Rockies.

Advance a Healthcare Delivery Innovation Network in Los Angeles County. The concept of an innovation network in healthcare delivery is being suggested as a means for Los Angeles County to stand out as a national leader in addressing quality, access and affordability in healthcare delivery. The County has a unique opportunity to lead a new approach in bringing together the worlds of evidence-based and collaborative medicine with the cutting edge development of digital applications.

Los Angeles County has one of the nation's most developed public healthcare systems. It is a $3.5 billion enterprise with a network of hospitals and outpatient facilities across the County, and it is taking a leadership role in seeking innovative approaches to healthcare delivery. An excellent example is its partnership with MedPoint Management and the resultant launching of a comprehensive eConsult platform. Los Angeles County also possesses leading academic medical centers—UCLA, USC, Drew University, Cedars Sinai, and City of Hope—who stand out in healthcare sciences and policy, with well over ten National Institutes of Health funded research centers focused on quality of care, health promotion, health disparities and community participatory research. Most importantly, Los Angeles County has a growing base of innovative health services and health informatics companies.

Leveraging ongoing and already planned investments by Los Angeles County in its public hospital campuses to stimulate a commercial bioscience real estate market in the county. The huge geographic footprint of both research/clinical institutions and bioscience company locations, together with the lack of a base of available multi-tenant facilities with bioscience wet lab space, makes bioscience space a critical issue for advancing a bioscience industry cluster in Los Angeles County.

The issue of stimulating a commercial bioscience real estate market is not an unusual one for emerging bioscience industry clusters. Given the specialized nature of bioscience wet lab space with its costly air handling, water treatment, higher load bearing and specialized laboratory fit outs, it is not surprising that commercial real estate does not typically produce this type of facility on a speculative basis. Yet without a ready inventory of such space, emerging bioscience companies are held back, having to spend considerable resources and time in ensuring adequate space. For many bioscience startups, this lack of readily available, suitable space can be a barrier to locating in the County in the first place, or a major inducement to leave the region at a critical point in their growth. Unfortunately, the most promising startups are the ones most likely to leave, since they are the most likely to have attracted financing from outside the state.

A key point to be learned from other regions with emerging bioscience industry clusters is the important role that local government can play in stimulating the growth of such commercial bioscience space. Typically this is done through research park developments involving public-private partnerships. But it is important to recognize that there is no one-size-fits-all approach to research and technology park developments.

As the June 2011 County Feasibility Report highlights: "The County can lead the way by developing a master plan that will establish a biotech cluster at the former Medical Center, Rancho, Harbor-UCLA, OVMC and MLK."

This can best be done by seeding the development of initial multi-tenant commercial bioscience facilities as part of an integrated medical district development approach at several of the public hospital campuses, especially those which have research partnerships in place.

Raising the profile and branding of Los Angeles County in bioscience development. The emerging bioscience industry cluster within Los Angeles County is not well recognized, even within the County. Efforts to raise its profile and brand must begin with internal marketing. A pro-active marketing campaign should be considered that might include efforts such as:

- Establishing a public relations initiative to place news articles about bioscience activities in Los Angeles County in traditional, social media and other distribution channels both locally and nationally.
- Creating an active alliance marketing program in concert with research drivers so that a consistent message and united front, focused on bioscience industry development in Los Angeles County, can be undertaken.
- Creating a bioscience ambassadors program to have leading industry executives assist in the outreach to and welcoming of potential company prospects and top talent prospects.
- Bringing national and international bioscience conferences to Los Angeles County.
- Advancing a strategic bioscience partnering program with firms located in the Pacific Rim to focus on exchanges and business development related to research, supply chain and access to markets.

Targeting one or more extensive partnerships between local universities and a prominent multinational biomedical company. The strength in technology transfer and commercialization found among Los Angeles County's major research drivers can also be a boon for broader bioscience economic development by attracting a major biopharmaceutical and medical device industry partnership. These types of efforts are growing across the nation, but there are no significant major bioscience company partnerships in Los Angeles today such as what Pfizer has established in Cambridge, Massachusetts, Gilead in New Haven, Jackson Labs in Hartford or Lilly in Indianapolis. Typically these partnerships reflect a public-private effort, and active involvement and support from local governments is critical in streamlining development processes, ensuring access to land and facilitating broader collaborations. In addition, by partnering with a leading multinational firm, the name/brand recognition and bioscience research reputation attached to the firm will accrue to both the partner universities and to Los Angeles County as a whole, significantly improving their profiles.

Advancing a local entrepreneurial bioscience talent base. Along with the strong efforts already present in Los Angeles related to bioscience talent generation should be an active effort to create more emphasis on entrepreneurial education and training, especially for graduate level bioscience students, for Los Angeles County to grow its own bioscience entrepreneurs. Much of the potential to create spin-outsfrom university research rests with having such entrepreneurial minded graduate and post-doctoral fellows interested in extending the work they are doing with leading faculty. Other institutions across the nation are actively advancing such efforts and Los Angeles County can seek to work beyond the silos of individual institutions to reach to breadth of bioscience top talent being advanced in the region. A

local business planning competition and access to other sources of pilot/seed funding would help anchor these entrepreneurially minded graduate students to the County.

Threats

High cost of living and congestion in Los Angeles County. Industry interviews consistently touched upon the difficulties of retaining and attracting bioscience talent in light of the high costs of living in Southern California and the limitations congestion places in having a workforce that can live and work across the County. These quality of life issues are magnified in Los Angeles County because of the diverse geographic footprint of bioscience development. Many competing regions for bioscience development can offer lower cost of living and more compact development of its bioscience industry and research drivers, such as a number of the benchmark regions, including Research Triangle, Pittsburgh and Philadelphia.

Potential slowdown and reductions in federal bioscience research and development. The federal fiscal cliff and longer term federal deficit issues may have a chilling impact on bioscience development, if there are substantial cutbacks in federal research funding for the biosciences. The hallmark of the U.S. medical innovation ecosystem has been federal research and development funding to prime the pump on bioscience innovations, with many promising new initiatives to bridge the translational research gap between bench and bedside just recently underway including new Clinical and Translational Science Institutes in Los Angeles County. Just how extensive the damage to even temporary setbacks in federal funding is unclear.

High state taxes and strict regulatory climate. California faces its own fiscal difficulties, and is raising tax levels at a time when many other states are working to lower their taxes. At the same time, California is placing strict regulations and tough permitting standards on industrial activities. As Beacon Economics in their 2012 Los Angeles Economic Forecast Conference explains: "With both the California Environmental Quality Act, which requires state and local agencies to identify the significant environmental impacts of their actions and to avoid or mitigate those impacts if feasible...California is pursuing some of the most stringent environmental quality standards in the nation."[14] Numerous bioscience industry executives raised concerns about the state tax and regulatory climate as a general business issue, though for Los Angeles County the big concern relating directly to bioscience development is that in combination with the burdens placed on emerging companies to develop their own lab space rather than having commercially available lab space, they must wrestle with these permitting issues and the delays and uncertainties they create making moves out of the County and state all the more appealing.

Strong competition from other regions. Other regions of the nation, including those in California, are continuing to improve their own attractiveness in bioscience industry development. These efforts pose continued challenges for Los Angeles County, particularly in keeping its base of high growth potential start-up companies.

[14] Jordan G. Levine,"Los Angeles Forecast," 2012 Los Angeles Economic Forecast Conference Compendium, Beacon Economics and Pepperdine University, April 2012, page 34.

Summary of Strategic "SWOT" Assessment

STRENGTHS: **Biosciences Industry Growth:** The bioscience industry cluster over the past decade—including through the recession and weak national recovery—has been a growing sector and economic driver for Los Angeles County.

Breadth of Growth Across Multiple Industry Sectors: The growth of Los Angeles County's bioscience industry base, though focused on biomedical activities, is broadly based across several sectors and not reliant on just one or two sectors.

Base of Bioscience Research And Innovation Activities: The depth of the research and innovation base found in Los Angeles County is substantial and offers a key leverage point for future growth. Three specific technology platforms emerge that offer a clear alignment of industry presence with research activities in the county: Novel Therapeutics and Diagnostics; Bioengineering Solutions for Treating Diseases and Other Medical Conditions; and Innovations in Healthcare Delivery.

Commercialization Track Record: In the technology transfer and commercialization activities of its major research drivers, Los Angeles County not only significantly outperforms the U.S. average, but also stands out among the benchmark regions.

Sizeable and Capable Pool of Local Graduates: Generation of bioscience talent stands out across the college and university base found in the region.

First-rate Business Support Services: Los Angeles County already has the presence of business services and an international position.

WEAKNESSES: **Institutional and Geographic Fragmentation and Lack of Cohesion:** There is no identifiable commercial bioscience real estate market in Los Angeles County and no single area of the county that has a high share of bioscience company locations...so, no equivalent to a "Hollywood" for the bioscience industry despite its need for specialized lab space and tapping talent pools.

No Pre-Fitted Lab Space Available: A key competitive issue for Los Angeles County is that bioscience companies have to bear the cost of fitting out their own wet lab spaces with required air handling needs, and can face long delays and uncertainties with permitting.

Insufficient Venture Capital: Los Angeles County is lagging in venture capital funding, particularly at the critical early stages.

Commercialization Startups Go Elsewhere: A "leaky bucket" phenomenon is happening in Los Angeles around bioscience commercialization despite the strong technology transfer and commercialization performance of its major research drivers.

No Regional Draw for Bioscience Workers: The demand for bioscience workforce in Los Angeles County is lower than in benchmark regions, and creates a challenge to recruit top talent to the region given the lack of broader opportunities.

OPPORTUNITIES: Focus on deepening the connections of commercialization of local biomedical advances to Los Angeles County to grow a more entrepreneurial bioscience community in Los Angeles County.

Advance a healthcare delivery innovation network in Los Angeles County.

Leveraging ongoing and planned investments by Los Angeles County in its public hospital campuses to address stimulating a commercial bioscience real estate market in the county.

Targeting more extensive partnerships for local universities with multinational biomedical companies.

Raising the profile and branding of Los Angeles County in bioscience development. Given the size and dynamics of Los Angeles County, its emerging bioscience industry cluster is not well recognized, even within the county.

Advancing a local entrepreneurial bioscience talent base.

THREATS: High cost of living and congestion in Los Angeles County.

Potential slowdown and reductions in federal bioscience research and development.

High state taxes and strict regulatory climate.

Strong competition from other regions

Section VII: Strategic Priorities and Actions for Los Angeles County Biosciences Master Plan

The in-depth analysis of bioscience development in Los Angeles County reveals great promise as well as the significant challenge of accelerating growth across its research and industry drivers. This analysis revealed the growing size and competitiveness of the County in the fast-growing bioscience sector compared to the nation. It also identified and validated the know-how found in the County's bioscience research and innovation activities and positions the County in specific technology platforms for future growth. What particularly stands out is the close alignment of industry presence and strengths with the focus of research activities in the County.

But this promise has not placed Los Angeles County among the leading regions of the nation in bioscience industry growth or prominence. A close examination of the situation reveals that Los Angeles County has been held back in bioscience development by significant hurdles, which if not addressed will continue to hamper future growth. In order for Los Angeles County to take its place among the leading U.S. regions four Strategic Initiatives must be addressed:

- **Bioscience Commercialization Initiative** – to address the need for locally-based bioscience venture capital and commercialization resources in order to foster high growth potential new startup companies and to leverage the extensive base of bioscience research and innovation found in Los Angeles County, particularly in the area of healthcare delivery.
- **Commercial Bioscience Laboratory Space Development Initiative** – to stimulate the establishment of commercial multi-tenant bioscience-specific lab buildings in Los Angeles County.
- **Bioscience Talent Initiative** – to focus on talent generation, retention and attraction across the spectrum of skills required to sustain a vibrant bioscience industry cluster in Los Angeles County.
- **Bioscience Marketing Initiative** – to raise the recognition of Los Angeles County bioscience assets and growing industry cluster and translate that recognition into business development and strategic partnering opportunities.

These four Strategic Initiatives incorporate the specific priorities which the Los Angeles County Biosciences Master Plan must address in order for the County to realize its substantial growth potential in bioscience industry development.

A number of basic principles should guide Los Angeles County as it advances a programmatic Master Plan to address these four Strategic Initiatives:

- Seek to engage private sector participation and leadership in advancing sustainable public-private partnerships.
- Make use of limited county resources as a catalyst for change.
- Build on successful activities to date.

- Focus on leveraging private sector investment, including those from philanthropic sources.

As shown in Table 10, the major leverage from non-County resources would come from:

- Private developer investments for development of commercial bioscience space. With the potential development of 200,000 square feet of bioscience-dedicated space across multiple bioscience innovation hubs over a five year period to meet the estimated 42,000 square feet demand for space for start-up and emerging bioscience companies, the total private developer investments could reach $40–$60 million.
- Institutional, private investment and foundation investment for bioscience venture investments of $250 million, including funding to attract proven early stage bioscience venture capital funds to locate in Los Angeles County, along with seed funding for commercialization of high potential technologies and innovative healthcare delivery projects.
- Federal, state and foundation support for consortium-based bioscience workforce development projects.

The County's commitment in terms of resources is estimated to be roughly $19.75–$28.50 million over a five-year period. This is comprised of the following:

- **Operating Costs:** Funding support of $1.75–$3.50 million annually ($8.75–$17.5 million over five years) for technical resources to support the Strategic Initiatives, including costs for: attracting local venture capital funds to the County; supporting Entrepreneurs-in-Residence; facilitating the innovation network for healthcare delivery; establishing the signature bioscience innovation hubs; providing workforce services and planning grants and managing the marketing outreach.
- **Capital Costs:** Matching funding of approximately $11 million in one-time capital costs over a five year period for venture development, tenant improvement financing, proof-of-concept/seed funding, a revolving loan fund for tenant improvements and a matching investment Fund of Funds to further attract local venture capital funds.

Resources will also be required to facilitate other key efforts, including:

- Transferring or leasing County land for establishing the signature bioscience innovation hubs for startup and emerging bioscience companies.
- Creating a Los Angeles County Biosciences Venture Capital Trust Fund mechanism to encourage institutional funds, high net worth individuals and foundation investment for attracting proven early stage bioscience venture capital funds to locate in Los Angeles County. Some form of incentive and/or matching investment by the County may be required.
- Leveraging the County's ongoing eConsultLA platform as well as broader efforts in improved healthcare delivery.

It is recommended that approximately $20–30 million be appropriated for these Strategic Initiatives. and be consolidated into a newly formed Biosciences Economic Development Fund to be expended over a five year period and overseen by the Chief Executive Office of Los Angeles County. Given the focus on engaging private sector leadership and private sector resources (including philanthropic sources), it is recommended that a non-governmental organization (NGO) be engaged through the Chief Executive Office of Los Angeles County for advancing bioscience development in the County, with a specific Statement of Work reflecting the Master Plan recommendations. It would have specific milestones and performance requirements that could be monitored annually, and should not require additional County

resources for funding if, as part of these performance requirements, it would seek to generate at least compensatory funding from its activities over the five year period.

It is recommended that the industry-led SoCalBio organization be selected as the NGO with which the County partners to bring about the approval of and appropriations for this Biosciences Economic Development Fund. SoCalBio is already actively involved in bioscience commercialization, workforce development and marketing activities, and offers the capacity to bring key stakeholders together to guide the Master Plan as well as to manage the resources to deliver services and generate matching private sector funds. This strategic partnership would involve negotiating a Memorandum of Understanding with SoCalBio for implementation of the Master Plan, possibly involving the creation of a dedicated non-profit organization set up within SoCalBio specifically for this purpose.

Alternatively, the County Chief Executive Office could seek to contract for services by another NGO with a proven expertise and track record. Although significant efficiencies in staffing and in accountability can be generated by bringing these Strategic Initiatives together under the management of a single NGO, it is possible to engage separate NGO's to undertake each of the specific Strategic Initiatives.

An excellent best practice example of such a dedicated bioscience development organization, which has been a leader in advancing needed development programs and services at a regional level with a strong emphasis on partnership building, is the North Carolina Biotechnology Center (NCBC). NCBC was formed by the State of North Carolina over 25 years ago just as an awareness of the potential economic development impact of biotechnology was becoming recognized. NCBC offers a comprehensive approach to advancing the biosciences, featuring products and services for basic and applied research, new venture development, business recruitment, retention and expansion and education and workforce development. It has succeeded in generating a positive return on investment on state funded support as well as garnering strong stakeholder support. What NCBC has successfully done is ensure that the interconnected development chain needed for technology-based economic development is in place to advance biotechnology in North Carolina.

The table below summarizes the key programmatic components for each of these Strategic Initiatives, along with expected private sector resources to be leveraged and the range of cost implications for Los Angeles County government. Details on each of the proposed Strategic Initiatives follow in the sub-sections below.

Table 10: Strategic Initiatives and Actions

Strategic Initiative	Programmatic Elements	Non-County Costs and Leveraging Opportunities	Expected Cost to County Over Next Five Years	
			Annual Operating Budget	One Time Capital Costs
Bioscience Commercialization Initiative	• **Attracting proven early stage bioscience venture capital firms to locate in Los Angeles County** • **Establishing a Biosciences Commercialization Collaborative** • **Fostering a Healthcare Delivery Innovation Network**	Investments from state/local pension funds in Fund of Funds with expected 10% rate of return, At least 3:1 leverage for Fund of Funds investments in private venture funds and matching private sector funding of $250 million under management for proof-of-concept/seed stage investments. Also possible to seek philanthropic and federal government sources of investment	Approximately **$500,000 to $1 million annually** for staffing and consultant costs	**Total: $6 million** $5 million for a proof-of-concept/seed fund $1 million for Healthcare Delivery Innovation Network Plus consider a first loss reserve for venture funds to provide an incentive for institutional and high net worth individual fund investments.
Commercial Bioscience Laboratory Space Development Initiative	• **Establishing 3–5 "signature" bioscience innovation hubs** • **Providing incentives to private developers for the creation of multi-tenant bioscience facilities**	Leverage private developer investments for development of commercial bioscience-dedicated space Repayment of tenant improvement costs from lease payments of tenants.	Approximately **$250–$500,000 annually** for staff to package deals with private developers and to market hubs	**Total: $5 million** Long term leases of county land at nominal costs to establish hubs Possibly use toward the cost of a shell building, to be recouped from future tenant lease payments $5 million ($1 million/year for 5 years) for tenant improvement incentives or financing—lease payments from tenants used to fund ongoing improvement efforts.
Bioscience Talent Initiative	• **High Skills Biosciences Career Service** • **Postdoctoral and Doctoral Level "Bridges to Industry"** • **Bioscience Skills Development in such areas as technical production, mid-level management and marketing.**	Leverage resources from state, federal and philanthropic sources Also potential user fees from companies for High Skills Biosciences Career Services	Approximately **$500,000 to $1 million annually** for staffing, database development, internship costs and planning grants	

Strategic Initiative	Programmatic Elements	Non-County Costs and Leveraging Opportunities	Expected Cost to County Over Next Five Years	
			Annual Operating Budget	One Time Capital Costs
Bioscience Marketing Initiative	• **Creating and sustaining an active alliance marketing program** • **Building local awareness and a positive image and brand for the bioscience industry cluster** • **Attracting national and international bioscience conferences to Los Angeles County** • **Advancing strategic bioscience partnering programs with major multinational bioscience companies as well as key international regions and nations.**	Leverage local economic development and industry group funding	Approximately **$500,000 to $1 million annually** to be matched by local economic development organizations to allow for shared staff capacity, outreach to prospects and potential conferences and seeding strategic partnerships in conjunction with local university and academic medical centers with multinational companies and specific international regions	
Totals			**$1.75–$3.5 million/year over 5 years (total of $8.75–$17.5 million)**	**Approximately $11 million in onetime capital costs (over a 5 year period of time)**

Biosciences Commercialization Initiative for Los Angeles County

The Challenge Facing Los Angeles County:

In order for Los Angeles County to realize its potential to become a leading region in bioscience cluster development key steps must be taken to ensure that a high-performance bioscience commercialization and entrepreneurial development ecosystem is in place in the County.

Bioscience new product development is closely tied to the basic research advances in biotechnology that are reshaping all aspects of biomedical development—including the way we study medicine, discover and develop therapeutics and diagnose and treat diseases and other medical. And looking forward, it is the convergence of biotechnology with other new and emerging fields, such as Big Data, digital media and nanotechnology, which holds much promise in advancing new biomedical discoveries and technology solutions, not only in new therapeutics, but in medical devices and new medical informatics products and services.

Given this emphasis on moving academic research through commercialization for bioscience development to take place, leading bioscience regions must have a vibrant segment of their industry cluster found in startups firms that are formed to bring new academic discoveries and technologies forward. As Harvard Professor Gary P. Pisano explains:

> *"From its conception, biotechnology was different. In biotechnology, the science is the business. That was true in 1976, when Genentech, the first biotechnology firm, was founded by a venture capitalist and a Nobel Prize-winning scientist. It remains true today, as universities ally with venture capitalists to development new drugs [plus medical treatments, diagnostics and instrumentation]....Perhaps in no other industry have science and business been as tightly interwoven as they have become in biotechnology. Over the past century, of course, science has played a critical role in a number of industries (e.g., semiconductors, computers, advanced materials). But it remained outside of the boundaries of the business system. Science was a tool, an input, or a foundation for creating new products and services; it was not the business [like in biotechnology]."*[15]

[15] Gary P. Pisano, Science Business: The Promise, The Reality, and The Future of Biotech, Harvard Business Press, 2006, page 1.

The hallmarks of a high-functioning bioscience commercialization and entrepreneurial development system include:

- **Active technology transfer functions** at the university and academic medical centers in the County, capable of handling the management of intellectual property—involving disclosure of research advances, patent protection and licensing—in a manner that is timely and conducive for doing business, while simultaneously taking the critical first steps towards commercialization of promising bioscience advances through technology and market assessment, proof-of-concept applied research to validate the commercial viability and facilitation of outreach and networking to engage potential management and investors.
- **Presence of locally-based bioscience entrepreneurial talent** able to lead the initial formation and growth of new startup ventures. These entrepreneurs must be regularly in contact with leading faculty involved in promising research discoveries and university and academic medical center technology transfer offices, as well as be actively engaged in forming, mentoring and advancing new bioscience startups through the presence of formal or informal networks. Entrepreneurs who have been successful in the past would serve as initial angel investors.
- **Sources of locally-based venture financing** at all stages of firm formation and growth, including pre-startup funding for proof-of-concept and reduction to practice, angel and seed funding to form the initial management and scientific team and finally formal venture capital for the early stages from lead investors who can attract additional growth capital as needed.
- **A rich and connected networking environment**—whether formal or informal—that is able to bring together communities of interest across academia, existing firms, entrepreneurs and key potential customers around broader technology platforms to pro-actively identify opportunities for new product and venture development.

Key Findings from SWOT Assessment

STRENGTHS:

The depth of bioscience research and innovation found in Los Angeles County is substantial and offers a key leverage point for future growth through commercialization.

In technology transfer activities of its major research drivers, Los Angeles County not only outperforms the U.S. average, but stands out among the benchmark regions.

WEAKNESSES:

Los Angeles County is lagging in venture capital funding, particularly at the critical early stages.

A "leaky bucket" phenomenon is happening in Los Angeles around bioscience commercialization despite the strong technology transfer and commercialization performance of its major research drivers.

OPPORTUNITIES:

Focus on deepening the connections of commercialization of local biomedical advances to Los Angeles County to grow a more entrepreneurial bioscience community in Los Angeles County.

Advance a healthcare delivery innovation network in Los Angeles County.

The Feasibility Assessment found that some of the elements of this system are in place in Los Angeles County, especially in university technology transfer, but the gaps are significant. In particular, two gaps stand out:

- There is insufficient locally-based venture capital to propel bioscience commercialization forward in the County.

- There is an inadequate infrastructure for networking and actively engaging entrepreneurial talent in identifying, forming, mentoring and advancing new bioscience startups in the County. This is despite the activities of SoCalBio which simply does not have significant capacity due to limited resources.

The result is what we have termed a "leaky bucket" in commercialization and entrepreneurial development that holds Los Angeles County back. This leaky bucket results in many promising new startup firms that emerge based on academic research taking place in Los Angeles County leaving the County and taking root in other regions, or opportunities for startup firms not being realized at all. This lack of commercialization opportunities chokes off the growth potential of Los Angeles County in the biosciences.

Proposed Approach for Los Angeles County:

Three inter-related capacity-building actions are proposed as part of the Biosciences Commercialization Initiative for Los Angeles County to address the "leaky bucket" in the County's commercialization and entrepreneurial ecosystem and make it possible for Los Angeles County to realize its potential in new areas of bioscience commercialization. These three inter-related actions would build upon the ongoing collaboration efforts of SoCalBio with university and biomedical research institutes in their technology commercialization efforts, by focusing on:

- ***Attracting proven early stage bioscience venture capital firms to locate in Los Angeles County*** which is critical in order for the County to have more of the new bioscience venture spin-outs from university research locating in the County. A proven mechanism would be to establish a "Fund of Funds" to invest in creating more locally-based, bioscience venture capital firms physically resident in the County, particularly those focused on early stage investments. More direct relocation support to proven early stage bioscience venture capital firms might also be effective.
- ***Advancing a Biosciences Commercialization Collaborative*** to engage serial entrepreneurs and senior scientific experts in the commercialization of research, as well as to mentor emerging bioscience companies and network with investors.
- ***Fostering a Healthcare Delivery Innovation Network*** leveraging the presence of county hospitals and their strategic academic medical center partners.

Below are the details of these key action steps:

Attracting Proven Early Stage Bioscience Venture Capital Firms to Locate in Los Angeles County

Despite an active level of bioscience venture capital that generated $939 million in venture funding over 72 deals from 2007 through the first half of 2012, when compared to the benchmark regions Los Angeles County does not measure up, standing last in overall deal activity and third from the bottom in total funding. Los Angeles County also has the lowest share of investments in the combined seed and early stages, with just 20 percent of the total funds invested in the County, while the largest five benchmark regions had, on average, 35 percent of their bioscience venture capital in these stages.

Los Angeles County must find ways to raise the level of formal venture capital investments for the bioscience. A big part of the problem is the lack of locally-based venture capital in the biosciences. There are only seven bioscience venture capital firms based in Los Angeles which had investment activity in the County over the 2007 to 2012(2Q) period. A closer examination reveals that of the $939 million in venture funding received by bioscience companies in Los Angeles County during that 5½ year time period, 98 percent came from venture capitalists outside of the region. Even for seed and early stage investment, which requires very active investor involvement, nearly all venture capital investment originated from outside the region—again at 98 percent.

It is proposed that Los Angeles County should seek to encourage 3 to 4 proven early stage bioscience venture capital firms to open offices in Los Angeles County. Altogether the funds attracted to Los Angeles County should have at least $250 million under management so that they can be lead investors in early rounds and continue to invest in later rounds with other venture capital investors. This assumes that the investment by the venture capital firm over different rounds, from startup to expansion stages, will average $4-5 million per new company, and thus at least 50 new startup bioscience companies in Los Angeles County can be assisted over the life of the venture capital firm's limited partnership fund (typically runs 10 years).

A mechanism that has proven effective in other regions to stimulate more locally-based venture capital presence and activity is creating a Fund of Funds to persuade venture capital to invest in bioscience companies in the region. Rather than investing in one private venture capital fund, the Fund of Funds approach involves a general fund manager investing in several venture funds, which in turn make the investments in fledgling bioscience companies. By pooling funds across many venture firms, risk is reduced which enables a region to support a pool of venture capital managers who are knowledgeable and attuned to that area's existing and emerging innovation opportunities.

Maryland offers an excellent example of how a Fund of Funds approach can work. Created in 1990, the Maryland Venture Capital Trust channeled just over $19 million in appropriations and investments from state and city pension funds into a series of eight venture partnerships that ***agreed to open active local offices***. The sources include:

- $2 million appropriation from state government
- $15 million from the Maryland State Retirement and Pension System
- $840,000 from the Employees Retirement System of the City of Baltimore
- $1.26 million from The Fire and Police Employees Retirement System of the City of Baltimore

The Maryland Venture Capital Trust generated an annual return of 10 percent, and from the $19 million in appropriations and investments ended up attracting $327 million in venture capital under management, a 1:17 ratio for investments by the Trust.

Notably, the Maryland Venture Capital Trust avoided many of the pitfalls that can plague Fund of Funds approaches. One pitfall is that venture funds in which the Fund of Funds invests may not make many investments locally. The Maryland Venture Capital Trust avoided this risk by taking a more aggressive negotiating approach than typical fund managers, including requiring the venture capitalists to open and staff local offices, and was able to provide preferences to those venture funds that were able to explain how they would "match the money invested by the Trust with money invested by private investors in at least a 1:3 ratio" and "ensure that a majority of the money invested by the Trust be for seed-capital financing in Maryland."

But Maryland also ensured that it had in place a means to fill a pipeline of quality startup companies to bring forward to the venture funds receiving investment capital from the Fund of Funds. In Maryland's case, this was done through their economic development agency, which maintained a Challenge Investment Program to provide matching grants of up to $150,000 to seed companies seeking to advance new products and build out their management teams, as well as an Enterprise Investment Fund which offered matching equity funding of up to $500,000 to invest in the first round of formal venture capital alongside that of the venture fund. In many cases, the Enterprise Investment Fund would issue its letter of intent ahead of the decision by venture funds to invest and make the venture fund investment a contingency for its investment.

More recently, Indiana's industry-led bioscience development organization, BioCrossroads, put in place a Fund of Funds approach targeted to developing formal venture capital for bioscience companies in the state. In 2003, BioCrossroads established the Indiana Future Fund I as a leading source of venture financing for Indiana opportunities. The Indiana Future Fund I is a $73 million Fund of Funds that is managed by Credit Suisse. It has invested $40 million directly and leveraged an additional $170 million from national VCs into more than 24 life sciences startup firms. In 2009, BioCrossroads established the $58 million INext Fund as a successor fund to the Indiana Future Fund I. As with the Indiana Future Fund I, the INext Fund is organized as a return-driven Fund of Funds, and is also managed by Credit Suisse.

Similar to Maryland, Indiana BioCrossroads ensures an active deal flow of new startup companies to be considered for follow-on formal rounds of venture capital. BioCrossroads has also advanced its own managed seed funds to help companies achieve milestones that would better position them for later stage venture funding. The first seed fund was started in 2005 with $6 million of funding, and once it was fully invested a second seed fund of $8 million was created in 2012.

It is crucial that Los Angeles County make this a key policy priority by creating the mechanism of a Los Angeles County Bioscience Venture Trust Fund in which a wide range of institutional and high net worth individuals can pool their investments,. An investment committee must be created, and should be led by representatives of the investors along with at-large members drawn from the bioscience industry community. Learning from successful models in other regions, the County should identify state and local pension funds as candidate investors. The County should also provide the operating resources for retaining a consultant with expertise in venture capital whose role would be assisting in the outreach

necessary for bringing in institutional and high net worth individual investments, assisting the investment committee in the selection of venture funds for investment and providing oversight to ensure that key requirements are being fulfilled.

Another valuable contribution by the County would be to consider providing direct appropriations as a loss reserve up to a certain total amount. This has been done in the Fund of Funds managed by the Arkansas Development Finance Authority (ADFA) which makes use of contingency tax credits and provides the incentive of ADFA having a first loss position[16] of up to $10 million. Alternatively, County appropriations might be of great value in offsetting relocation costs incurred by the proven early stage bioscience venture capital investors when establishing an office in Los Angeles County.

In order for this Fund of Funds approach to be effective, the next action on forming a Biosciences Commercialization Collaborative would be ensuring that a qualified deal flow is in place for the Fund of Funds.

Priority: **Near Term** (implemented in 1–2 years)

Lead Organizations: Los Angeles County Executive Office working together with local public pension funds in the County

Private Sector Leverage Opportunity: Local institutional and high net worth individual investments. Investment funds of at least $250 million from local institutional sources and high net worth individuals should be sought. Seek to have this local venture capital funding further leverage resources from venture capital and other investors outside of the region.

Los Angeles County Government Resources: Operating funds for consulting services for assisting in outreach to institutional and high net worth individuals, as well as assisting the investment committee in the selection and oversight process for Fund of Funds investments in private venture capital funds. Consider a first loss reserve of up to 10 percent of the investment in the Fund of Funds or to provide relocation assistance to the venture funds attracted to Los Angeles County.

Advancing a Los Angeles County Biosciences Commercialization Collaborative

Technology commercialization is concerned with developing, producing, selling and delivering new products and processes through existing or new firms. It involves a number of activities, such as assessing the technology and its potential markets against current products in the marketplace (i.e., technology and market assessments). It involves developing the product itself, and optimizing its engineering and design to meet the price points of the marketplace if sales and growth are to occur. It involves putting the business and management team in place and securing the sources of equity and working capital that will carry the product/company through various stages of maturity until it becomes an established product/company in larger domestic and global markets.

[16] First loss means that ADFA's investment is the first dollars going towards any loss of investment value.

University-based technology transfer efforts alone cannot accomplish all that is needed to advance technology commercialization. At best universities can take some of the initial steps. For technology commercialization to be successful there needs to be a broader level of engagement with serial entrepreneurs, angel investors and technology domain experts, particularly to address the issues with forming new companies.

Currently, SoCalBio, the industry trade association of the bioscience industry in the Greater Los Angeles region, has helped match qualified serial entrepreneurs and technology experts with the technology transfer offices of universities and biomedical research institutes to commercialize promising technology advances. But this effort from SoCalBio is constrained by having only limited resources for matching services, ongoing mentoring and outreach to angel financing and formal venture capital.

Los Angeles County needs to ensure that the opportunity to advance technology commercialization is maximized across all of the universities and academic medical centers found in the County, and that as the technology commercialization process moves forward there are mechanisms to firmly root new company startups in the County.

An excellent example is found quite close to Los Angeles County with San Diego CONNECT, which for nearly three decades has served as an intermediary commercialization organization to help in leveraging the presence of major research institutions in San Diego County with great success. Particularly in its early days, CONNECT played a major role in creating a systematic way for researchers to meet with entrepreneurs, investors and the other stakeholders critical to advancing commercialization and creating a culture of collaboration and technology commercialization among industry, capital sources, professional service providers and research organizations. This has been a critical success factor for San Diego's bioscience industry development. The flagship program of San Diego CONNECT is called Springboard and is a **business creation and development service that assists technology-based companies and entrepreneurs in refining their business and financial strategies through a group mentoring process. Innovators receive hands-on mentoring by a team of roughly 500 successful CEOs, CFOs and CMOs who volunteer their services through CONNECT's Entrepreneurs-in-Residence (EIR) and Domain Expert Programs.** At any given time approximately 200 companies are receiving assistance through Springboard, with about 50 companies graduating annually. Since its inception, the program has assisted over 1,000 companies in starting and funding their operations. Over 300 companies have graduated from the program and raised more than $700 million in funding.

Another fine example is the efforts of the Innovation Center for the Rockies. Started in 2005, it is now an indispensable part of the university commercialization process, according to David Allen, who led technology transfer at the University of Colorado for the past ten years (and recently left to take a senior position at the University of Arizona). The Innovation Center brings expert teams of entrepreneurial mentors and advisors together to assess and advance university technology transfer as well as to mentor local early stage companies. It has developed a database of more than 1,000 screened and qualified advisors with specific technology domain expertise to support local early stage companies and to inform the commercial assessment of university technology and guide its commercialization approach, including connecting it with investors and management teams. To help directly support the commercialization of high potential technologies, the Innovation Center has organized an angel

network. In addition to its critical role in supporting university technology assessments, the Innovation Center has worked with more than 80 research teams to commercialize its technologies, which have resulted in 8 new startup companies that have generated $75 million in new capital raised and have so far created over 400 jobs.

There is a clear foundation upon which to build in advancing bioscience commercialization in Los Angeles County. There are active technology transfer and commercialization efforts underway at the major university and non-profit research institutions in the County. Also, SoCalBio has organized an annual bioscience investor conference in the region for the past 15 years and has developed an active network of qualified serial entrepreneurs and technology experts that are currently used for mentoring, shepherding new technologies and leveraging angel financing. Examples of success by SoCalBio include supporting entrepreneurial assistance and matching for Kythera Biopharmaceutical spun out of LABioMed, ImmunoCellular Therapeutics spun out of Cedars Sinai and Pagnani Biopharmaceutical spun out of UCLA. There are also active angel investor networks in the County, such as Tech Coast Angels.

It is proposed that Los Angeles County establish its own Biosciences Commercialization Collaborative, affiliated with SoCalBio, to accelerate the commercialization efforts already underway. This effort should be modeled as a virtual business incubation program with the following activities:

- Establishing an Entrepreneurs-in-Residence (EIR) – This program that would build relationships with university technology transfer offices to "troll" the halls and identify promising technology opportunities for commercialization in ongoing research efforts as well as provide mentoring services to bioscience startups. The EIRs associated with the Los Angeles County Biosciences Commercialization Collaborative would serve as project managers for emerging bioscience companies and tap the broader network of expertise found among serial entrepreneurs and technology domain experts, as well as knowledgeable business service providers, to bring more focused skill sets in finance, marketing, operations and product development to meet the needs of emerging bioscience companies.
- Establishing Proof-of-Concept and Seed Funding – A strong complement to the Los Angeles County Biosciences Commercialization Collaborative would be having resources for funding proof-of-concept projects to allow them to conduct studies to test the commercial viability of a new discovery, and seed investments for advancing the formation of a new business venture. Together, proof-of-concept and seed investments comprise what is typically noted as the "valley of death" or the time gap between when discoveries are made and when private venture capital will get involved in commercializing a new technology venture. This funding would be open to all bioscience research institutions and startup companies and would be competitively assessed. The funding would require matching funds from the institutional partners and private sector, and would seek an overall return on investment through the use of contingent grants for proof-of-concept funding that are convertible to equity upon formal venture capital investments and investing alongside angel investors on the seed funding.
- Advancing ongoing networking on a greater scale – Efforts should include making use of more on-line referral tools and host more regular networking events and matchmaking workshops to bring together promising university technology opportunities, serial entrepreneurs and the

investment community (augmented by the new early stage bioscience venture capital funds attracted to Los Angeles). Currently there is an annual investor conference held by SoCalBio and periodic events such as "First Look LA," which brings together the university technology transfer offices and allows them to put forward three to four pitches of promising technologies to seek funding from angel investors. But more frequent and extensive outreach can pay dividends for Los Angeles County in filling its pipeline of promising commercialization opportunities.

While matchmaking events are important, a more efficient and sustained mechanism is needed to bring key serial entrepreneurs, angel investors and domain technical experts together with the university technology transfer offices to facilitate assessing the technology and markets and help inform follow-on proof-of-concept to address issues related to the commercial viability of a promising new technology. It is proposed that the Los Angeles County Biosciences Commercialization Collaborative serve as an honest broker to advance a qualified network of key serial entrepreneurs, angel investors and domain technical experts which university technology offices can tap on a confidential basis for assessment of their technology portfolios.

Priority: **Immediate (within 1 year); Near Term (1–2 years); Long Term (3–5 years)**

Lead Implementation Organizations: SoCalBio affiliated non-profit

Private Sector Leverage Opportunity: Ongoing efforts of SoCalBio; Matching investments by institutions and angel investors, plus philanthropic and federal government funding sources for operations.

Los Angeles County Government Resources: $500,000 to $1 million annually from Los Angeles County for operations of the Los Angeles County Biosciences Commercialization Collaborative, plus one time funding for Proof-of-Concept/Seed Funding of $5–$10 million with some level of County support (could be a partial contribution with the rest raised from broader stakeholder community).

Fostering a Healthcare Delivery Innovation Network leveraging the presence of county hospitals and their strategic academic medical center partners

The development of a Health Delivery Innovation Network is a means for Los Angeles County to stand out as a national leader in addressing quality, access and affordability in healthcare delivery.

Los Angeles County has one of the nation's most developed public healthcare systems. It is a $3.5 billion enterprise with a network of hospitals and outpatient facilities across the County, and it is taking a leadership role in seeking innovative approaches to healthcare delivery. The Department of Health Services (DHS) of Los Angeles County has partnered with MedPOINT Management to launch an eConsult platform, an electronic primary care-to-specialist consultation and referral system. Through this innovative Web-enabled system and process, primary care providers and specialty physicians are able to communicate, share clinical information and consult electronically to better coordinate patient care. The system also processes referral requests and authorizations, thus reducing the specialty referral and appointment process to a few days and increasing the speed with which a patient's care is delivered. For the primary care providers and their staffs, the benefit also includes using a single web portal (eConsultLA.net) instead of accessing multiple and disparate referral systems.

Los Angeles County possesses leading academic medical centers—UCLA, USC, MLK- Drew University and Medical Center, Cedars Sinai and City of Hope—that stand out in healthcare sciences and policy. The County also has over ten National Institutes of Health funded research centers focused on quality of care, health promotion, health disparities and community participatory research. Many of these academic medical centers are both competitors and collaborators with the County's public healthcare system. As collaborators, these academic medical centers provide physicians, residents and medical students to the County's public hospitals. As competitors, they operate their own healthcare facilities, but they all have a shared interest in sustaining the County public healthcare system to ensure that there is sufficient capacity to serve all patients.

Most importantly, Los Angeles County has a growing base of innovative health services and health informatics companies. Over the 2009 to 2012(Q3) period, a total of $165 million of venture capital was invested in 13 emerging healthcare IT and digital innovation companies.

While the area where health and IT overlap promises to be a growth opportunity for California, and for Los Angeles in particular, informed investors believe that sustainable business growth will be driven by the small subset of health IT ventures that provide applications that go beyond those serving individual consumers by delivering decision support solutions that benefit providers, payers and patients. Thus, following on the initial experience of the New York eHealth Digital Accelerator, Los Angeles County has the opportunity to engage major healthcare systems and providers, as well as payers and investors, to vet, guide and provide test beds to advance the most promising solutions for the system—not just for individual consumers.

Emerging Best Practice Example: New York eHealth Digital Accelerator

Establishing a test-bed environment and virtual business accelerator, this effort is part of a larger initiative underwritten by the New York eHealth Collaborative (NYeC), The NY eHealth Digital Accelerator is based upon a collaboration of the state and 22 healthcare providers, including Mt. Sinai Medical Center, New York-Presbyterian Hospital, Albany Medical Center and Stony Brook University Medical Center. It promotes and leverages a shift from the costly fee-for-service model to a more effective and efficient managed care approach, with the expected public benefit **of better care—at lower cost—for patients across the continuum of care.**"

With support from the Empire State Development Corporation, selected health IT and software development companies are creating the next generation of healthcare applications to help transform the healthcare delivery system. These firms receive:

- Seed capital provided by a syndicate or venture firms
- Direct access to the technology platform that is connecting electronic health records across New York State
- Mentorship and feedback from senior-level executives of the participating providers.

The objective is to help these companies create efficient tools that the medical community will want to use to streamline the sharing of electronic medical records, thus improving coordination of care through entrepreneurial ventures.

In order to do so, key stakeholders must come together and form a public-private collaborative of key providers, payers and investors who would then solicit, select and support ventures that offer promising value propositions. Non-profit, governmental and foundation support could be used to underwrite the cost of running evidence-based trials of selected solutions to determine cost savings, quality improvements and other benefits. Private investor funding would be used to support initial investments and mentoring for promising ventures in health IT that offer the potential of increasing both the efficiency and the quality of care in measurable and impactful ways.

Priority: Immediate (Start within 1 year but multi-year effort)

Lead Organizations: Private-Public Partnership Los Angeles with foundation/governmental/institutional funds to underwrite cost of trials

Private Sector Leverage Opportunity: Use public funding as a challenge to raise matching funds from philanthropic and private industry sources.

Los Angeles County Government Resources: Leverage presence of County hospitals; $1 million from County.

Commercial Biosciences Laboratory Space Development Initiative for Los Angeles County

The Challenge Facing Los Angeles County:

It is not unusual for regions with emerging bioscience industry clusters to face significant challenges in creating a bioscience commercial real estate market. The reasons are straightforward. There is a general reluctance in the commercial real estate community among developers and financing sources to support the specialized tenant improvements needed for bioscience wet labs. These specialized improvements can add a premium of $100 per square foot in tenant improvements to provide laboratory benches, hoods and casings, enhanced air handling systems, chilled water and waste treatment and handling. In some circumstances, these tenant improvements can even require retrofitting basic building systems, including HVAC, plumbing and electrical systems which can cost $150 per square foot or more.

Even when the industry growth prospects are strong and there is a trend of growth, the commercial real estate community can be slow to respond. This often reflects concerns about whether there will be a bioscience tenant ready to move into the space if these wet laboratory improvements are made, since bioscience may represent a small share of the total market of potential tenants. Moreover, many of the prospective bioscience tenants are not viewed as credit-worthy based on traditional measures of having net profits or strong balance sheets, even when they are amply supported by venture capital financing.

Key Findings from SWOT Assessment Relevant for this Initiative

STRENGTHS:

The biomedical industry cluster over the past decade and through the recession and weak national recovery has been a growing sector and economic driver for Los Angeles County.

WEAKNESSES:

There is no identifiable commercial bioscience real estate market in Los Angeles County and no single area of the county that has a high share of bioscience company locations.

A key competitive issue for Los Angeles County is that bioscience companies have to bear the cost of fitting out their own wet lab space and can face long delays and uncertainties with permitting.

High land costs in some areas otherwise attractive for bioscience company tenancy.

OPPORTUNITIES:

Leverage the ongoing and planned investments by Los Angeles County in its public hospital campuses and affiliated research institutions to address stimulating a commercial bioscience real estate market in the county.

THREATS:

High cost of living and congestion in Los Angeles County.

State tax and regulatory climate.

In Los Angeles County, the problems for biosciences firms from the general reluctance by the commercial real estate community to create specialized bioscience wet lab space is further exacerbated by the wide geographic dispersion of the industry across the County and the almost complete lack of bioscience tenants occupying the same buildings. The result, as was pointed out in the Feasibility Assessment, is that Los Angeles County has no equivalent to a "Hollywood" for the bioscience industry despite its need for specialized lab space. Indeed, Los Angeles County is a desert for multi-tenant established bioscience lab space. Outside of two small bioscience incubators found near research institutions with a modest total area of 12,000 square feet, there is only one advertised multi-tenant bioscience lab space found in the entire County, with 34,000 square feet that are close to fully occupied.

Given these dynamics, there is a strong case for the public sector to assist in stimulating the market for commercial bioscience space in order to advance economic development of the biosciences. Startup and emerging bioscience companies are of particular concern since these young companies do not have the resources to invest in costly tenant improvements, yet they hold the promise of generating substantial employment if they can take root in a region.

In fact, these startup and emerging bioscience companies also have different space needs than more mature companies. Startup and emerging bioscience firms frequently want to be located close to university and academic medical center scientific resources, and particularly to their scientific founders, and seek buildings that offer shared services such as conferences rooms, business services, etc. Though expanding firms may continue to locate in multi-tenant facilities, they are more independent and not as concerned about being close to universities and academic medical centers. Established firms, meanwhile, are more likely to be in single occupancy buildings. Table 11 below presents these differences.

Many states and localities are involved in addressing this gap in commercial bioscience laboratory space, particularly at the startup and emerging stages of development. Often this happens as part of a focused research park development, where public resources to advance bioscience space development can be integrated into broader efforts to advance economic development through innovation and industry-university collaborations. Typically, state and local governments have used traditional economic development programs, including loan, loan guarantee and other public financing programs, to fund tenant improvements for bioscience companies.

What is important for bioscience industry cluster development is not simply to have a general stock of commercial bioscience lab space, but to have available and permitted commercial bioscience laboratory space pre-fitted and ready so that new startups and emerging firms do not have lengthy waits required for tenant improvements to be completed before they can access the space. This means that in growing bioscience regions, there is a continual need to have a build-out of bioscience lab space in order to stay ahead of demand. Thus, while space availability does not in itself create demand and growth, analysis and field interviews have shown that the lack of readily available and permitted space is an impediment which contributes to growing firms looking outside the County for growth and expansion.

Table 11: Facility Needs by Development Stage of Bioscience Companies

Company Development Cycle Stage	Typical Employment Size	Facility Needs	Typical Space Required
Startups	1–5 employees	Access to shared space starting at 500 sq. ft. with flexible lease terms and shared support services. Proximity to scientific founders at nearby universities/academic medical centers and to shared-use facilities at universities important	500–1,500 sq. ft.
Emerging companies within an active product development phase such as clinical trials, beta testing or regulatory approval	6–19	Post-incubator space with value in having some shared services. Proximity to scientific founders and shared-use facilities still important. Multi-tenant dedicated "life science/tech" facility with some shared services	3–15,000 sq. ft.
Growing companies in later stages of clinical trials or having just launched new products or services	20–99	Often require multiple floors. May need own scale-up facilities. Typically wants to have R&D and production close to each other. Not critical to be close to universities/academic medical centers.	15–30,000 sq. ft.
Mature Stage (established company with commercial products and services)	100+	Major, stand-alone facilities. May be dedicated by specific function—headquarters/R&D and production Seeking long term financing at favorable rates.	100,000+ sq. ft.

Estimating Annual Demand for Commercial Bioscience Lab Space in Los Angeles

The lack of an identifiable commercial bioscience real estate market in Los Angeles County makes it difficult to judge the size of the market for bioscience lab space and likely absorption using conventional real estate trends. Instead, one needs to rely on the bioscience employment growth patterns, in recognition that increases in bioscience jobs translate directly into new space demands.

One rough indicator of the growth in space for bioscience industry is to consider the total growth of jobs, on average, over the 2001 to 2010 period. This is a very conservative period to consider because it involved a total business cycle over the 2001 to 2007 growth period and then a severe recession and weak overall recovery period from 2007 to 2010. Overall, non-clinical employment rose by nearly 4,500 jobs over this 9-year period, or an average increase of 495 jobs annually. Using a conservative rule of thumb of 300 square feet per bioscience job created, the average annual increased real estate usage due to bioscience job creation over the 2001 to 2010 period is 148,397 square feet per year. This figure assumes almost the lowest possible case of space absorption during that time period, since it is based on all conservative assumptions.

This total bioscience industry figure however, also includes growing and established companies which often do not require the presence of commercially available biosciences-dedicated space since they often have the resources to finance their own tenant improvements, or seek to be in their own dedicated, single occupancy buildings.

Therefore, a more refined examination of the annual space demands among bioscience firms at the critical startup and emerging stages is required. The focus needs to be on commercial bioscience R&D firms, since having no products in the marketplace means these startup and emerging firms are not yet classified in other more product-oriented bioscience industry classifications. Since there is no available database to track this at the detail of bioscience industries, the changes in number of firms by size of firm were used to get a rough estimate of likely trends between startup and emerging firms. This data is available through the U.S. Census County Business Patterns. From 2001 to 2010, on average, there were 12 new bioscience firms in commercial R&D at the 1–5 employee size, which aligns to the startup phase, and an average of 4 new bioscience firms in commercial R&D at the 6 to 19 employee size, which aligns with the typical emerging phase of development. Together, it is likely that this average annual increase of 16 additional startup and emerging companies would require an average of 42,000 square feet a year.[17]

So, in summary, a conservative estimate of the average absorption of new space generated by the growing bioscience industry base in Los Angeles County is at roughly 148,000 square feet annually, and a more refined estimate of likely growth from just startup and emerging companies—those most likely to take advance of readily available bioscience-dedicated space—is at about 42,000 square feet annually.

[17] This assumes 1,000 square feet on average for each new startup and 7,500 square feet for each emerging company—see Table 11.

Actions for Commercial Bioscience Lab Space Development

Two important steps can be taken by Los Angeles County to support the growth of commercial bioscience space. These are:

- Creating 3–5 "signature bioscience innovation hubs" to create more critical mass through focused developments.
- Providing incentives for creation of multi-tenant bioscience facilities in targeted areas, either directly or through mechanisms that leverage county or other publicly owned land.

Below are the details of these key action steps:

Creating 3–5 "signature bioscience innovation hubs"

Los Angeles County should be focused on startup and emerging bioscience companies seeking bioscience-dedicated facilities with support services and proximity to universities and academic medical centers. Based on the recent trends in average annual space demand, and the likely increase in the number of firms at the startup and emerging stages, it is estimated that approximately 42,000 square feet of additional bioscience-dedicated multi-tenant space is needed each year.

This is a significant level of development, and given the size of the geographic footprint of bioscience research drivers found across the County and the need for startup and emerging bioscience companies to be located near their scientific founders, the preferred locations of these young firms are not likely to be highly geographically concentrated.

Therefore, it best to consider a series of developments across the County, for what might be best termed "technology accelerators," of approximately 50,000 square feet each that offer incubation to post-incubation space from 500–7,500 square feet per company. By placing multiple hubs or accelerators strategically near major research drivers the County increases the likelihood that a particular startup or emerging bioscience company can find suitable bioscience-dedicated space within Los Angeles County, rather than having to look outside of the region.

An excellent example of such technology accelerators being found at multiple sites within in a region is Cleveland's Health Tech Corridor, which has a set of bioscience incubators and multi-tenant facilities around major research and higher education institutions, including: BioEnterprise which has a 44,000 square foot facility and has accelerated over 100 companies, attracting over $1B in investment; Cleveland Clinic Innovations, which maintains a 15,000 square foot incubator for emerging companies; Global Cardiovascular Innovation Center, which provides 50,000 square feet of customizable lab, office and conference space; and MidTown Tech Park, with 10 acres and 230,000 square feet with access to Cleveland Clinic, University Hospitals and Case Western and Cleveland State Universities.

There are other examples, as well. Pittsburgh also has a distributed footprint of bioscience hubs with a stand-alone wet lab building at the Pittsburgh Technology Center, plus a converted Westinghouse Research Lab building now focused on multi-tenant bioscience lab space uses. As Greater Boston has grown and added major anchors to complement its dynamic entrepreneurial ecosystem, development nodes have grown and emerged in the Longwood Medical area and the South Boston Innovation District

as well as in more established centers in East Cambridge (MIT-Kendall Square) and suburban Route 128 locations.

In Los Angeles County, the most likely sites for this development are as part of an integrated medical district development approach at several of the public hospital campuses, especially those which have research partnerships in place, such as USC-County Hospital and UCLA-Harbor Medical. As the June 2011 County Feasibility Report suggests, "the County can lead the way by developing a master plan that will establish a biotech cluster at the former Medical Center, Rancho, UCLA-Harbor, OVMC and MLK/Drew."

Based upon local market conditions and the County's position relative to land assets and clinical activities, different paths will need to be followed at the different hubs in response to growth opportunities.

In three cases, development can proceed around County-owned and controlled centers with existing County Healthcare Centers and affiliates, contingent upon demand over time:

UCLA Harbor: The recent analysis associated with the Master Plan for the UCLA-Harbor campus identified several private sector firms with nearby operations and direct relationships with the UCLA-Harbor campus, including two LA BioMed spin-outs. Therefore the study recommended that the Master Plan effort seek to better leverage the UCLA-Harbor assets and improve the local "value capture" from its programs and activities.

USC-County: There has already been interest in developing a biomedical park adjacent to County Hospital and the nearby USC medical and pharmacy schools and hospital. In addition, there have been initial efforts to establish a small incubator that could provide further focus as USC invests significantly in the capital development of its campus. Such an initiative would require the engagement with the surrounding community as well as the City of Los Angeles.

MLK-Drew: While this site has virtually no proximate private bioscience industry, there is some potential to develop industry partnering programs associated with the Drew-UCLA Clinical and Translational Science Institute with a focus on addressing healthcare disparities and other clinical and translational research.

In two other cases, there are opportunities to create nodes around significant growth engines. One approach might be to identify existing county land that can be targeted for development; another approach would involve working with other governmental entities to acquire adjacent properties compatible with the opportunity.

UCLA-Westside: Here it is also important to consider how to create a hub close to the UCLA campus, perhaps as part of the redevelopment of its old hospital, and perhaps with linkages to another site—including either a portion of the VA site or other to ensure the capture of firms that spin-out of the UCLA campus.

City of Hope: There is an opportunity to leverage its dispersed but significant industry relationships, its molecule therapeutics biomanufacturing facility and capabilities and its proximity to Caltech and others.

The model to advance the creation of these hubs would involve establishing a non-profit bioscience research park organization which would focus on packaging development projects with private developers at each of the hubs and serve as a marketing arm for all of the bioscience hubs.

More specifically, the development model could have a variety of components, including:

- Institutional agreements with academic medical centers for them to become "tenants of last resort."
- Partnerships with commercial bioscience real estate development companies in which the County underwrites the cost of the facility shell while the developer is responsible for the tenant improvements. The County would get repaid once the developer recoups the cost of the tenant improvements.
- Transferring land at sections of hospital campuses that are not needed for healthcare uses to a non-profit corporation which would then be able to pledge the land as collateral to advance facility development.

For marketing, there would need to be Los Angeles County government support in the initial years, but over time as part of contributing the land, the non-profit could generate operating support from leased space.

Priority: **Near Term (1–2 years); Long Term (3–5 years)**

Lead Organizations: Los Angeles County in partnership with either a master developer, or a collection of individual developers, with mechanisms to utilize proceeds across the County, as merited.

Private Sector Leverage Opportunity: Leverage private developer investments for development of commercial bioscience space.

Los Angeles County Government Resources: County land; $250,000–$500,000 annually in first five years to support deal packaging and marketing by non-profit organization formed. Plus long term land leases from the County to the non-profit organization.

Providing incentives for creation of multi-tenant bioscience facilities

In order to leverage private sector investments and increase the supply of wet lab and other specialized multi-tenant space in the County, a two tiered approach could be taken. More immediately, such incentives—funded through long term debt with mechanisms for repayment to the County—could be focused directly in the signature sites. Such investment could be shared with the host municipality, with the condition that the municipality would commit to expedited permitting of the overall building, as well as pre-permitting for multi-tenant spaces. Over time, as demand increased and companies sought to grow beyond the hubs, such incentives could be extended to developers willing to share the risk and maintain the availability of such specialized facilities for certain periods beyond initial tenancies.

An alternative approach is for Los Angeles County Government to create a dedicated pool of tenant improvement financing for bioscience wet lab space. This pool of funds would then be awarded to developers willing to build out wet lab space, with an agreement from the developer to repay the tenant improvement financing over a 5 to 10 year period through a portion of the leasing costs to bioscience tenants as well as to maintain the wet lab space for up to 1 to 2 years if the space goes unleased for bioscience purposes. This tenant improvement financing approach has been used in Connecticut through its Biotechnology Facilities Fund initiative, which offers developers and companies a flexible source of tenant improvement financing. To date, Connecticut's BioScience Facilities Fund has assisted in creating 350,000 square feet of laboratory and support space through the state and committing over $37 million in financing. This has included 10,600 square feet of transitional wet laboratory space in New Haven's Science Park at Yale.

Priority: **Short Term (1 year) and Long Term (3-5 years)**

Lead Organizations: Los Angeles County in partnerships with local municipalities and private developers

Private Sector Leverage Opportunity: Repayment of tenant improvement costs from lease payments by tenants.

Los Angeles County Resources: $1M financing per year for five years, potentially with local government match required.

Bioscience Talent Initiative for Los Angeles County

The Challenge Facing Los Angeles County:

Like many emerging bioscience industry clusters, Los Angeles County shares some serious challenges in bioscience talent generation, retention and attracting including:

- Trouble recruiting experienced, senior-level bioscience scientific and management talent, particularly those with clinical trial and business development experience in the biopharmaceutical and diagnostics sectors.
- Lack of entrepreneurial talent with serial experience in the bioscience to lead and grow promising new startups.
- Difficulty retaining the "best and brightest" among recent bioscience graduates seeking careers in bioscience industry.
- Gaps in other skills needed across the bioscience workforce in areas such as regulatory affairs, quality control and bioprocessing.

Key Findings from SWOT Assessment

STRENGTHS:

Generation of biosciences talent stands out across the college and university base found in the region.

Higher on concentration of biological scientists and technicians than the U.S. average.

WEAKNESSES:

The relative demand for biosciences workforce in Los Angeles County is lower than in benchmark regions, and creates a challenge to recruit top talent to the region given the lack of broader opportunities.

OPPORTUNITIES:

Advancing a local entrepreneurial biosciences talent base across a longer spectrum of commercialization and business growth stages.

Yet in many ways Los Angeles has significant advantages over the vast majority of other emerging industry clusters in that it has:

- One of the largest bioscience workforces in the nation, with just over 20,000 workers in bioscience-related occupations, standing only behind Boston and Washington, D.C.
- A particularly high concentration of biological scientists and technicians that exceeds the national average by 23 percent in large part because of the extensive bioscience research base in the region.
- The highest number of bioscience-degrees at the bachelor's level and above awarded compared to the benchmark regions, with over 5,000 bioscience degrees awarded annually across post-secondary institutions, including 425 master's level and 311 doctorates in biological sciences, pharmaceutical sciences and bioengineering.
- Nineteen emerging high growth potential ventures receiving seed and early stage investments from venture capitalists over 2007 to 2012(Q2), suggesting the presence of a significant number of entrepreneurial management teams already in the County.

The crosscutting issue that Los Angeles County faces is more about the scale of its biosciences cluster and geographic density relative to the size of its overall economy, and less about opportunities for bioscience workers in the County. ***To address its bioscience talent and workforce challenges Los Angeles County needs to focus on more deliberate connecting activities to match the supply and demand for bioscience workers right within the region.***

Proposed Approach for Los Angeles County

Los Angeles County can work to overcome its challenges in bioscience talent and workforce through establishing an integrated multi-pronged approach involving:

- Creating a High Skills Bioscience Career Service
- Developing doctoral and postdoctoral level "Bridges to Industry"
- Facilitating bioscience skills development in such areas as technical production, mid-level management and marketing.

These three approaches on talent are described below. They can most effectively be brought together and managed through a Los Angeles County mechanism similar to Memphis' BioWorks Initiative, in which industry and post-secondary institutions can be engaged across the talent pipeline of skills including technician-level skills development, retention of top graduates and attracting experienced, senior scientific and management workers.

High Skills Bioscience Career Service

The High Skills Bioscience Career Service will be a "high-touch" matching service allowing existing scientific and management workers facing job changes to more easily learn about opportunities in bioscience firms across the County. It will also seek to maintain connections with alumni from Los Angeles County research and higher education institutions that are working in the bioscience industry

across the nation and world, and enable them to also learn about these job opportunities. Finally, it will seek to raise the local profile of successful bioscience careers found in the County.

The value of the High Skills Bioscience Career Service is to make it easier for local experienced, senior bioscience scientific, technical and management workers to stay in the County, and for those considering relocating for positions elsewhere to resolve issues that would otherwise become impediments to staying. This could include arranging meetings with industry peers to understand the breadth of the established workforce or assisting "trailing spouses" who also need to find suitable quality positions in the County.

The High Skills Bioscience Career Service will not be a full-service executive search firm for employers, since these are commercially available and this could create conflicts in situations where regional employers are recruiting talent from each other. Instead, it would seek to partner with executive search firms working with local employers to better reach those existing workers or alumni seeking new positions.

This effort will be informed by successful efforts in other states to recruit and retain high skilled workers. This includes Project Boomerang in Oklahoma and the Iowa Careers Consortium, a public-private partnership created to meet Iowa's need for highly-skilled workers. In addition, it builds on the past experiences of organizations such as Pittsburgh's Digital Greenhouse, which in its early years focused on helping in talent recruitment for firms coming to Pittsburgh to pursue lab-on-a-chip technology development, and later focused more broadly on electronics and robotics. What has been learned from these efforts is the importance of creating a public-private partnership which develops and maintains dynamic databases of jobs and skilled workers, conducts outreach marketing and serves as a key point of access for job seekers and employers in selected areas.

The activities for the Los Angeles County High Skills Bioscience Career Service can include the following:

- Maintaining an up-to-date database of available high skilled positions among the County's bioscience firms, created in concert with SoCalBio.

- Providing a single point of contact for senior scientific and management workers seeking new positions in Los Angeles County.

- Serving as an honest broker to match interested senior bioscience workers with bioscience county employers either through their HR departments or executive search firms.

- Developing a cadre of trained, volunteer peer career mentors to consult with those senior scientific and management workers in the County facing job changes to facilitate their transitions to new job opportunities in the County, as well as those from outside of the County being recruited by or seeking to relocate to the County.

- Working with trailing spouses of senior scientific and management workers being recruited to Los Angeles County—many of whom are also involved in the biosciences—to ensure that they can also find quality jobs in the County.

- Partnering with university alumni and career services offices to identify Los Angeles area alumni working in the biosciences elsewhere who would be interested in learning about opportunities in Los Angeles County.

Postdoctoral and Doctoral Level "Bridges to Industry"

Accompanying the large base of university research activities in the biosciences in Los Angeles County is a highly valuable and significant talent pool of doctoral level graduate students and post-doctoral fellows. While many of these doctoral students and post-doctoral fellows may be interested in remaining in academia, there are also opportunities to connect them with industry and to broaden their training and education to learn more about bioscience business and entrepreneurial development. Currently, there are multiple institutional-led efforts found across universities in the County. For instance, the Keck Graduate Institute of Applied Life Sciences in Claremont offers both a certificate and professional science master's that is specifically geared toward preparing life science post-doctoral students for careers in industry. This includes courses in entrepreneurship, finance, organizational behavior and other key business disciplines, along with experiential learning experiences including working on industry sponsored projects and networking. UCLA, meanwhile, offers a specialized course in the "The Business of Science" to Ph.D. candidates and post-doctoral fellows through its Business of Science Center as well as through its Venture Team Program, giving graduate students hands-on experience in market and intellectual property research, business plan development, effective communication strategies for securing funding from venture capital and more. And USC, through its Stevens Institute, provides for mentorship for new businesses, an Innovation Intern Program to graduate students who wish to gain experience in technology assessment, market research and new venture planning and a Student Innovator Showcase competition with cash prizes, along with entrepreneurial student clubs hosted through the Business School. Occasionally USC, Cal Tech and UCLA have collaborated on showcasing emerging bioscience and other ventures coming out of research institutions through "First Look LA," which was launched in 2007.

But more can be done to build bridges to industry for these doctoral level graduate students and post-doctoral fellows as well as to top undergraduates.

One opportunity is to create a Bioscience Industry Exploration program for doctoral students and post-doctoral fellows, as is being done in Massachusetts and the Bay Area.[18] This effort involves day-long site visits to bioscience companies and interaction with industry scientists to learn from their experiences.

Another opportunity is to create a bioscience internship program. A 2010 survey of the 884 industry members of the National Association of Colleges and Employers found that 50 percent of interns accept full-time employment with the company for which they interned. Leading technology development initiatives such as the Ohio Third Frontier and the Massachusetts Life Sciences Center feature internships as a key means to connect area students with local employers. Making grants available of up to 50 percent of the internship salary or up to $5,000 can pay significant dividends in building relationships between top science talent in the region and local bioscience businesses and can help in the effort to retain this top talent locally. In the Massachusetts Life Sciences Center internship effort the host companies commit to providing a dedicated mentor and project, with subsidies used as a human

[18] See Tracy Vence, "Industrial Explorations," Genome Technology, October 3, 2011.

capital subsidy program for small and early stage companies, while larger companies can hire from the pool of student candidates. Since the program was first started in 2009, nearly 1,000 interns have been placed in 290 companies in Massachusetts.

Another opportunity is to build upon the interest of post-doctoral fellows to pursue new startup companies. This can be advanced along the lines of the Kauffman Foundation's Entrepreneur Postdoctoral Fellows program to assist recent Ph.D. graduates in preparing their research for commercialization, with a salary stipend for one year and support through mentors, a customized industry internship and access to entrepreneurial development classes.

Using such bridging initiatives to bring together research institutions with post-doctoral fellows and doctoral students with industry will help to fill gaps and create opportunities for connecting activities.

Bioscience Skills Development

Successful industry cluster initiatives typically focus on addressing specialized workforce development skills needed for that cluster. According to the Cluster-based Strategies for Growing State Economies report developed by the National Governors Association and Council on Competitiveness, having a focus on industry-specific skills development through specialized centers connected to local post-secondary institutions "can offer a resource to industry that can understand a cluster's particular needs and interests, solve problems, assure a continued flow of qualified workers and serve as a source of skill upgrading for the incumbent workforce. It also allows students access to better and deeper programs ("know what"), better employment information and more rungs on career ladders ("know who"), deeper understanding of industry context ("know why") and more informal learning opportunities ("know how")." [19]

For existing employees and job seekers looking to add management skills, three regional California State University Campuses—CSU-Fullerton, CSU-Los Angeles and Cal Poly-Pomona—recently launched a collaborative professional management master's program in bioscience. This Program for Applied Biotechnology Studies (PABS) Master's of Biotechnology prepares graduates for challenging and rewarding careers in the biomedical device, biocomputing and biopharmaceutical industries. In this program students take paid summer internships in industry.

Los Angeles County has already had success advancing such bioscience skills development efforts. Recently, Los Angeles Valley College was one of only 12 U.S. community colleges to receive a portion of a $15 million Department of Labor grant designed to develop and expand the bioscience workforce under the Department's Trade Adjustment Assistance Community College Career Training effort. The program is focused on developing career pathways in the biosciences for individuals displaced from other industries. The project looks to develop credentials and certificates in lab skills, biomanufacturing and medical devices, and offers "stackable" credentials to help those individuals impacted negatively by trade find new jobs in the industry.

In addition, the Los Angeles/Orange County Economic and Workforce Development Biotechnology Center has been established to advance core life science workforce skills. The Center, with grant funding

[19] Council on Competitiveness and National Governor's Association, Cluster-based Strategies for Growing State Economies, November 2007, page 16.

from the California Community College Chancellor's office, promotes science education and hands-on lab training partnerships across the continuum from K-12 through community colleges, to universities and on through to industry.

There are other specialized areas of bioscience skills development that can be addressed in similar ways. Interviews conducted with bioscience industry representatives revealed gaps in skills regarding regulatory affairs and quality control, along with bioprocessing manufacturing. Planning resources are required to better document the needs and to pursue state, federal and philanthropic grants to fund these efforts. A small investment of $25,000 to $50,000 annually for planning resources can go a long way towards seeding these efforts.

Priority: **Immediate** (for Planning grants) and **Near Term** (for High Skilled Bioscience Career Service and Bridges to Employment)

Lead Organizations: Partnership with SoCalBio

Private Sector Leverage Opportunity: Leverage resources from state, federal and philanthropic sources. Also potential for user fees from companies for access to recruitment services.

Los Angeles Government Resources: $500,000 to $1 million annually in County support with additional funds raised through industry, university, philanthropic and federal and state grants.

Biosciences Marketing Initiative for Los Angeles County

The Challenge Facing Los Angeles County:

As the Feasibility Assessment identified, Los Angeles County's emerging bioscience industry cluster is not well recognized locally, nationally or internationally despite the size and growth of the County's bioscience industry base and the world class research and innovation activities taking place there. This is aggravated by the broad geographic footprint of bioscience research institutions, academic medical centers and industry across Los Angeles County.

From an economic development perspective, this lack of recognition and visibility undercuts the bioscience development of Los Angeles County in retaining and attracting talent, generating home-grown companies and attracting bioscience companies from outside of the region to invest and expand in the County. It also negatively impacts the needed public-private partnerships to address the critical industry development issues facing the biosciences such as early stage capital, commercial bioscience lab space and bioscience talent and workforce development.

Key Findings from Feasibility SWOT Assessment

STRENGTHS:

Biosciences industry growth.

Base of biosciences innovation and research activities.

The presence of business services and international position of Los Angeles County.

WEAKNESSES:

No equivalent to a "Hollywood" for the biosciences cluster in Los Angeles despite its size.

Institutional and geographic fragmentation and lack of cohesion.

OPPORTUNITIES:

Raise the recognition of Los Angeles County for its existing base of biosciences industry and research activities.

Targeting more extensive partnerships for local universities with multinational biomedical companies.

THREATS:

High cost of living and congestion.

State tax and regulatory climate.

The purpose of marketing and building recognition is not to sugar-coat the real development issues facing the County in bioscience development, but to build awareness so that the County can realize the potential of the considerable assets and advantages for bioscience development in that it has.

Other leading regions and their bioscience industry clusters have made marketing a key element of their industry growth strategies. In North Carolina, under the stewardship of a dedicated bioscience development organization—the North Carolina Biotechnology Center (NCBC)—an active campaign was undertaken not only to attract new industry investment in bioscience industries, primarily to the research intensive Research Triangle region, but also to build the awareness and support for bioscience industry development among a broader set of key stakeholders, including other business, educators, elected officials and the general public. The local awareness-building has included outreach to local schools in promoting life science careers, as well as regular and proactive news and feature stories on new life science innovation and industry developments. This local awareness-building supported what has become a very successful external marketing effort by NCBC.

One of the great success stories in biotechnology economic development in North Carolina has been the attraction and expansion of major biomanufacturing plants. Biomanufacturing involves the production

of biological products from living cells, and North Carolina has quite rapidly developed into one of the leading locations in the world for this type of manufacturing activity. In an era when so many traditional manufacturing jobs (such as those in textiles) have moved overseas, the successful growth of the biomanufacturing sector in North Carolina reflects the foresight of the founders of the NCBC who saw biotechnology production as a new pathway to creating and retaining manufacturing jobs in the state. Today 16 multinational companies have major biomanufacturing plants in North Carolina including market leaders such as Wyeth (making pediatric vaccines), Novozymes (producing industrial enzymes) and Biogen (producing recombinant drugs). The state has also become a hub for contract biomanufacturing companies serving the production needs of pharmaceutical companies, with examples including KBI BioPharma and Biolex among others.

The North Carolina Biotechnology Center performs multiple functions that contribute to the attraction, retention and expansion of biopharmaceutical and associated companies in the state. Activities of the NCBC include:

- Proactive marketing of the state as a biomanufacturing center through promotional and outreach programs, development of media and other communications materials.
- Participation in industry trade-shows and events worldwide, as well as the hosting of visiting international and domestic companies, with the provision of information and matchmaking on the North Carolina biotechnology sector to prospective inward investors.
- Provision of specialized biotechnology and bioscience education and information to state, regional and local economic development agencies in support of their work with inward investors and local biotechnology companies.
- Proactive tracking of leads and careful development of company and potential inward investor relationships. The NCBC economic development staff is currently tracking the development of 35 prospect cases.
- Providing advice and direction to governmental bodies to develop and maintain a positive business climate for biotechnology companies.
- Coordinating programs and services that support the provision of a world-class workforce to meet biotechnology company needs.

NCBC actively coordinates its work in this regard with other key partners in the state, such as the North Carolina Department of Commerce. Indeed, the senior vice president for business development at NCBC is employed in a shared position funded by both NCBC and the North Carolina Department of Commerce. This type of seamless relationship between NCBC and other key economic development organizations in the state has made the North Carolina Biotechnology Center the go-to institution for companies seeking assistance and connections across the state.

A more recent effort involved in bioscience marketing is being undertaken in one of the other benchmark regions that one would not imagine needing targeted marketing for bioscience development—Boston. As part of the ten year $1 billion Massachusetts Life Sciences Initiative enacted by the state in June of 2008 was the creation of the Massachusetts Life Sciences Center (MLSC), which

now views itself as a key hub for that state's bioscience community, principally found in the Boston region. While the Massachusetts Life Sciences Initiative is primarily focused on supporting new and expanding bioscience businesses, research infrastructure and workforce development, it has played an active role in marketing, particularly through building global partnerships. Among the key nations and international regions targeted are Brazil, Northern Ireland, Spain, Denmark, Sweden and Israel. These partnerships include creating scientific ties as well as joint industry development projects. The MLSC also established a neurosciences consortium to engage seven global pharmaceutical companies to work on pre-clinical development of neuroscience treatments. It has made an active effort in media and communications, involving nearly 5,000 stakeholders in regular communications, plus assisted in attracting the BIO International Convention to Boston.

These examples show that having a targeted marketing strategy for the biosciences must be an essential element of the Los Angeles County Biosciences Master Plan.

Proposed Approach for Los Angeles County:

A pro-active marketing initiative should be considered for Los Angeles County and would include:

- Creating and sustaining an active alliance marketing program in concert with research institutions, local and county government and industry, so that a consistent message and united front that is focused on bioscience industry development in Los Angeles County can be communicated to target audiences.
- Building local awareness and a positive image and brand for the Los Angeles County bioscience industry cluster.
- Attracting national and international bioscience conferences to Los Angeles County, while participating as a region in key international conferences elsewhere.
- Advancing strategic bioscience partnering programs with major multinational bioscience companies as well as key international regions and nations.

Active Marketing Alliance

Economic development marketing for the biosciences is very complicated due to the specialized characteristics of bioscience development, including close collaborations with research drivers, clinical connections, specialized facility requirements and needs for multi-stage venture financing. In turn, it requires a new set of techniques and approaches termed "alliance marketing."

Alliance marketing involves all of the key institutions supporting the biosciences—including existing companies, serial entrepreneurs, university faculty and departments, specialized research centers, utility companies, venture capitalists, real estate developers, professional services providers, local government and many more. In order to be successful, all these key constituencies must be incorporated in generating marketing leads, developing industry-specific marketing materials that positively position the County and generally selling potential business prospects on the advantages of Los Angeles County as a location.

There are a wide range of targets—and opportunities—for bioscience business attraction:

- International companies who are seeking a key foothold for the U.S. market and access to the U.S. innovation base
- The existing local bioscience industry base—whether locally owned or part of a multinational company—that may be expanding and can benefit from the depth of the resources the region has to offer
- Those out-of-state companies that are already commercializing technology generated by research institutions in Los Angeles County, as well as those that maintain ongoing relationships with Los Angeles County-based faculty and research centers
- Out-of-state bioscience companies that are strategic partners of or suppliers to existing Los Angeles County bioscience companies
- CEOs and other key management employees of bioscience companies located outside the region who are alumni of local universities
- Bioscience companies that are actively recruiting graduates of colleges and universities in Los Angeles County.

Similar to the way that the North Carolina Biotechnology Center works, there must be staff capacity to identify these opportunities in collaboration with the broader economic development organizations in Los Angeles County. In the case of Los Angeles County, a consortium of economic development organizations should be brought together to support this staff capacity to identify, qualify and help manage business development leads in the biosciences. The value proposition is that by working cooperatively, a larger base of opportunities will be generated than by competing individually.

Building a Local Awareness and Brand for the Los Angeles County Bioscience Industry Cluster

The image of Los Angeles County's bioscience cluster starts at home. An active internal marketing effort is needed to build the needed community support and enable all segments of the diverse Los Angeles County community to participate in as well as become "ambassadors" for the County's continued bioscience industry growth.

This effort was critical in North Carolina and actually started with students and their parents back in the early days of biotechnology moving into industry applications. In Maryland, the internal marketing started around focused economic development strategies. First, the Greater Baltimore Committee developed a Life Science Vision for its region that was highly publicized and reached out widely to businesses, universities and local community groups. Then the State of Maryland, in concert with industry, developed a Commercial Biotechnology Strategy that was strongly embraced by the state's industry, universities and elected officials with key initiatives continuing decades after the completion of the strategy.

A cornerstone to advancing local awareness is using public relations to place local stories of bioscience industry developments, new scientific breakthroughs, economic development initiatives and high visibility projects, as well as real life stories of workers, in local newspapers, magazines and social media outlets. This was the case in places where the biosciences were still emerging, such as Arizona, where genomics and the state's activities to advance this new science into jobs for the state captured the

public imagination. And in this regard, placing stories in national magazines and news outlets also helps shape internal understanding and awareness of local assets and possibilities. The placement of such articles and news stories requires an active public relations outreach to key traditional and social media outlets and the active development of news stories.

Places that establish a "brand name" can generate additional attention. No doubt this approach can be helpful - it has been used effectively in communities such as St. Louis with its BioBelt brand or Memphis with its BioWorks brand. But what really stands out is having a consistent and shared message about the County's assets and advantages for bioscience development, supported by collateral materials and messaging that can be deployed through multiple channels. Currently, bioscience organizations in the County—from local universities, companies, medical centers, local government and economic development organizations—are in fact already marketing, but solely around their own identity and focus, often lacking a broader message about Los Angeles County in the biosciences. What a quality branding campaign can bring is a cohesive message that connects Los Angeles County with its bioscience organizations—raising the awareness and reputation of both—and offers an online toolkit that provides all the necessary visual and communications elements for organizations to use.

Finally, in order to effectively respond to inquiries and leads generated by this effort, there must be an enhanced site identification and related research service. Due to confidentiality issues, such a function is also best conducted by a public-private partnership, outside the bounds of government. A good example of this is the MassEcon's site finder service.

> *This statewide Site Finder Service is an economic development resource for companies seeking a Massachusetts location within which to expand or relocate. MassEcon works cooperatively with real estate brokers, site location consultants and state, regional and local economic development officials to enable companies and their exclusive agents to access property information that matches their real estate needs. The service covers all regions of the state and serves a broad range of industry sectors. The Research and Information Service assists companies in conducting research about Massachusetts during the site selection process. The service has proved particularly useful when companies are comparing Massachusetts to other states. Not only data-based, the service also helps link companies with the people and resources on the state, regional and local levels.*[20]

Attracting National and International Bioscience Conferences to Los Angeles County

One excellent means to demonstrate the assets of Los Angeles County in the biosciences is to attract conferences that bring leading life science researchers and industry executives to the County. It is particularly useful to target those conferences that highlight the leading market opportunities in the bioscience technology platforms found in Los Angeles County such as healthcare delivery innovation or cardiovascular medical devices or stem cell therapies.

An excellent example is the annual Musculoskeletal New Ventures Conference held annually in Memphis, building on its core of orthopedic implant companies and now in its tenth year. Utah's

[20] See http://massecon.com/services/site-finder

National Summit on Personalized Health Care has been held annually for the past 4 years in Deer Valley, Utah. This conference brings together top leaders from throughout the world who are working to build a roadmap for developing and integrating individualized/personalized healthcare approaches, technologies and practices into patient care.

Among the more broadly known international conferences, BIO has periodically been hosted in Boston, Washington, D.C., Chicago, San Francisco and San Diego—but not Los Angeles. Though requiring a large coordinated effort, capturing and hosting such a venue, which attracts 20–25,000 leading biopharma and other industry leaders, would also contribute to repositioning Los Angeles as a bioscience center.

While large international conferences can help Los Angeles County stand out, even smaller regional and national conferences in more niche areas can offer benefits in raising the profile of Los Angeles County. A focused effort to attract bioscience conferences to the County by connecting with groups of industry and research centers would make sense. Ways to advance this action could include surveying existing life science companies, research centers and medical centers to identify national trade association memberships they maintain and then launching a recruiting campaign to attract their national conferences to Los Angeles County.

Advancing Strategic Bioscience Partnering Programs with Multinational Bioscience Companies as well as International Regions and Nations

As the Massachusetts Life Sciences Center has been emphasizing, the world of the biosciences is now all about global partnerships. Partnerships, or strategic collaborations, matter because of the changing terms of competition reflecting the need to innovate faster to meet heightened international competition, a greater reliance on external sources of innovation, rather than on internal corporate laboratories and the convergence of technologies to advance innovations, which requires capabilities not typically possessed in a single organization.

Within the biosciences, these drivers for strategic collaborations are truly pronounced in light of the rise of generics with patent expirations of major blockbuster drugs placing financial strains on major biopharmaceutical companies as well as the rising cost and decline in productivity in the development and commercialization of new medical products. As Battelle and *R&D Magazine* report in a recently released 2012 Global R&D Funding Forecast:

> *"The retrenchment of pharma's conventional model has created significant R&D opportunities for universities, non-profits and governments...consider the Pfizer example, while reducing internal R&D, it has expanded its presence in Cambridge, MA, specifically to have better collaborative access to the great research institutions of the area and to adopt an open innovation posture. In a larger example intended to accelerate drug development, GlaxoSmithKline, Novartis, Pfizer and Eli Lilly have joined the Structural Genomics Consortium, a public-private partnership that supports the discovery of new medicines through open access research..."*

Los Angeles County needs to leverage its extensive university and academic medical centers to tap this need for strategic partnering with multinational bioscience companies and to build more active

ties to specific regions of the world. In the case of Massachusetts, they are doing this by working to locate major international consortiums locally as well as to spur scientific and development projects between Massachusetts organizations and international organizations with pilot funding. In Los Angeles, this can include working with each of the universities in the County to identify where key relationships exist and to create more active collaborations. For instance, USC has close ties with South Korea, which is seeking to build up its own bioscience base. Los Angeles County can seek to partner with USC to launch a major bioscience initiative that has a presence both in Los Angeles and Korea, possibly in concert with the U.S. Health Department's emphasis on healthcare delivery innovation. Further, much more could be done to advance strategic alliances and market development opportunities in the broader Pacific Rim including the China as well, where several bioscience firms and investors are establishing ventures.

Priority: **Immediate**

Lead Organizations: SoCalBio in collaboration with local economic development organizations

Private Sector Leveraging Opportunities: Raise matching funds from local economic development organizations would allow for shared staff capacity, outreach to prospects and potential conferences and seeding strategic partnerships in conjunction with local university and academic medical centers with multinational companies and specific international regions.

Los Angeles County Government Resources: Annual funding of $500,000 to $1 million.

Appendix A: Defining the Detailed Industries in the Biosciences

NAICS Code	NAICS Description	Included in Prior Battelle-BIO Definition	Included in Updated Industry Definition, 2012
AGRICULTURAL FEEDSTOCK & CHEMICALS			
311221	Wet Corn Milling	●	●
311222	Soybean Processing	●	●
311223	Other Oilseed Processing	●	●
325193	Ethyl Alcohol Manufacturing	●	●
325199	All Other Basic Organic Chemical Manufacturing	●	
325221	Cellulosic Organic Fiber Manufacturing	●	●
325311	Nitrogenous Fertilizer Manufacturing	●	●
325312	Phosphatic Fertilizer Manufacturing	●	●
325314	Fertilizer (Mixing Only) Manufacturing	●	●
325320	Pesticide and Other Agricultural Chemical Manufacturing	●	●
DRUGS & PHARMACEUTICALS			
325411	Medicinal and Botanical Manufacturing	●	●
325412	Pharmaceutical Preparation Manufacturing	●	●
325413	In-Vitro Diagnostic Substance Manufacturing	●	●
325414	Biological Product (except Diagnostic) Manufacturing	●	●
MEDICAL DEVICES & EQUIPMENT			
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	●	●
334516	Analytical Laboratory Instrument Manufacturing	●	●
334517	Irradiation Apparatus Manufacturing	●	●
339112	Surgical and Medical Instrument Manufacturing	●	●
339113	Surgical Appliance and Supplies Manufacturing	●	●
339114	Dental Equipment and Supplies Manufacturing	●	●
339115	Ophthalmic Goods Manufacturing	●	
339116	Dental Laboratories	●	
RESEARCH, TESTING, & MEDICAL LABORATORIES			
541380*	Testing Laboratories	●	●
54171*	Research and Development in the Physical, Engineering, and Life Sciences	●	●
621511	Medical Laboratories	●	●
621512	Diagnostic Imaging Centers	●	
BIOSCIENCE-RELATED DISTRIBUTION			
423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers		●
424210*	Drugs and Druggists' Sundries Merchant Wholesalers		●
424910*	Farm Supplies Merchant Wholesalers		●

Source: Battelle/BIO State Bioscience Industry Development 2012.

Appendix B: Profiles of Core Competency Areas

Cancer Research & Treatments

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 4984 or 17%**			
	Distribution: 81% Publications; 19% Patents			
	Illustrative Applications: • **Basic Cancer Biology** including: Cancer biomarkers; Epigenetics of cancer tumors; Cancer inhibitor therapies (involving protein kinases); Early phase cancer clinical trials; Cancer relationships to smoking, alcohol use and diet; • **Key cancer areas of focus in cluster analysis:** Breast cancer; Prostate cancer; Brain cancer; Leukemia & Lymphoma • **Wide Range of Cancer Treatment Approaches**: Adioprotective agents; Aromatase inhibitors; Radiation oncology therapies and radioimmunotherapy targeting; Re-engineered T-cell therapy			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Oncology	3,079	5.8%	23% higher
Presence of Major Federal Center or Program Project Grant	Three NCI funded Cancer Centers (City of Hope, UCLA & USC); Two Special Programs of Research Excellence (Prostate @ UCLA and Lymphoma @ USC); 11 other NCI funded Center & Program Project Grants involving imaging, brain cancer, lung cancer, surgical oncology, cancer viruses, and health disparities. Plus major NSF funding from the Office of Emerging Frontiers in Research and Innovation on Signaling in Colon Cancer Stem Cells.			
Active PI Initiated Clinical Trials	132 active clinical as of 9/30/12			
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010 ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized Specialized Industry: Specialized, but lost jobs from 2001 to 2010		Not applicable	
VC Activity (2007 to 3Q, 2012)	5 – Puma Biotech ($60m); Vantage Oncology ($63m); Agensys ($41m); North American Scientific ($15.5m); Kite Pharma ($12.5m)			

Psychological Disorders and Human Behavior

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 3503 or 12%** **Distribution: 95% Publications and 5% Patents** **Illustrative Applications**: ***Biopolar Disorders***, including neurocognitive performance, outpatient treatment of bipolar disorders, genome wide association studies, impulsivity and risk taking behavior, frontal cortex activation and deficits; ***Schizophrenia,*** including epidemiology, genetic variants; ***Others psychological disorders***, including: obsessive compulsive disorders, Attention deficit disorder, Anxiety and depression, Alcohol and drug abuse, Post traumatic stress disorders, Eating disorder research, Psychopathic personality in children; ***Human Behavior,*** including: Marital commitment behavior; Psychological studies of grief and empathy; Sexual behavior of adolescents; Factors involved in school engagement, student-teacher interactions and relationships			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Neurosciences	3114	4.9%	20% higher
	Clinical Psychology	726	4.7%	15% higher
	Psychiatry	1,599	5.8%	26% higher
	Psychology	539	5.0%	22% higher
Major Federal Center or Program Project Grant	Over ten NIH funded Centers and Program Project grants including: several in drug abuse, schizophrenia, trauma & mental health, neuropsychiatric "phenomics" on behavioral disorders; neuroanatomical basis of cognition and behavior; social/financial decisionmaking, rewards processing. Plus several NSF major grants involving neurobiology of human behavior, including modeling communicative and affective interaction dynamics in couples and family therapy, neural basis of active perception, role of consciousness on decision-making, neural mechanisms of inference, neural mechanisms of incentives on performance and neural mechanisms of causal cognition.			
Active PI Initiated Clinical Trials	42 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010) ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized Specialized Industry: Specialized, but lost jobs from 2001 to 2010		Not Applicable	
VC Activity (2007 to 3Q, 2012)	1 -- Elements Behavioral Health ($62.8m)			

Neurodegenerative Diseases & Neurological Disorders

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 2842 or 10%** **Distribution: 89% Publications; 11% Patents** **Illustrative Applications**: ***Alzheimer's Disease,*** including biomarkers, amyloid beta-protein structure, assembly dynamics and inhibitors, mechanisms of neurotoxic pathology, risk associated with cardiovascular diseases; ***Broader Dementia***, including behavioral problems, therapeutic interventions for cognitive decline, care management interventions, adult neural stem cells for working memory and brain repair, memory enhancement through deep brain stimulation; ***Broader Neurodegeneration***, including: neural death inhibitors; biomarkers, DNA damage in pathology of neurodegenerative disease, neuro-endocrine processes, neurological basis for movement disorders; ***Epilepsy,*** including treatments, risks for seizures after medical procedures, cognition and language impacts, genetic variants associated with juvenile myoclonic epilepsy, neuroimaging, neurobiology; ***Autism research***; ***Stroke research***, including diagnosis, recovery and rehab approaches, ethnic differences in recovery, endovascular treatments, use of novel neurotrophic compounds.

Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Neurosciences	3114	4.9%	20% higher
	Clinical Neurology	1,891	5.2%	32% higher

Major Federal Center or Program Project Grant	Over 10 Center and Program Project grants from NIH, including two Alzheimer's Centers (UCLA and USC), gene environment for Parkinson's, Autism, ALS, neurogenetics/neurogenomics, aging brain, genetics of cortical plasticity, among others. Plus, major NSF Frontiers in Biosciences Research grant to CalTech on how brains regulate simple motor actions to generate complex behaviors.
Active PI Initiated Clinical Trials	39 active clinical trials as of 9/30/12
Presence of Detailed Industry Strength	Not Applicable
VC Activity (2007 to 3Q, 2012)	1 – Dakim, Inc. ($10m)

Infectious Diseases

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 2816 or 10%** **Distribution: 84% Publications; 16% Patents** **Illustrative Applications**: HIV testing approaches; Molecular analysis of HIV; Genome variants involved in HIV control; Vaccine development for Human Papillomavirus (HPV); Influenza rapid testing; Bacterial infection research; Multi-drug resistant infection research; Inhibitors of Hepatitis C; Detection of pathogens; Infections in immune compromised patients; Prevention of pandemics; Cardiovascular implantable electronic device infections; Immune system modulation in response to pathogen; Host-pathogen interactions; Bacterial skin infections
Academic Publishing Data	Field: Infectious Diseases; # of Pubs (2006-2010): 639; Share of U.S.: 3.7%; Citation Rate Compared to U.S.: 13% higher Microbiology: 736; 2.9%; 22% higher Virology: 392; 3.0%; 21% lower Immunology: 1,526; 3.8%; 5% higher
Major Federal Center or Program Project Grant	Several NIH funded Center and PPGs with focus on AIDS, including AIDs Research Center @ UCLA. Plus major NSF grant to UCLA to study the self-assembly and packaging processes of viruses, which will further fundamental understanding of viral infectivity.
Active PI Initiated Clinical Trials	21 active clinical trials as of 9/30/12
Presence of Detailed Industry Strength	Not Applicable
VC Activity (2007 to 3Q, 2012)	1-Janus Pharmaceuticals ($8.5m)

Cardiovascular Research, Treatments & Devices

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 2381 or 8%**			
	Distribution: 76% Publications; 24% Patents			
	Illustrative Applications: Cardiopulmonary resuscitation techniques; Cardiac function and monitoring devices; Cardiac arrhythmia treatment; Cardiac output monitors; Echocardiography; New therapeutic approaches to heart failure; Systems biology of vascular calcification; Hormone replacement and heart disease; Genetic variants in coronary artery disease; Blunt cardiac trauma; Heart failure treatments; Calcium signaling in cardiac cells; Cardiac muscle formation; Myocardial ischemia research; Coronary heart disease factors; Congenital heart deficit screening; Cardia stem cells; Cardiac resynchronization therapy; Heart pacing devices; Cardiac stimulation devices; Drug-eluting stent developments; Stenting techniques; Risk factors associated with use of stents; Novel stent developments			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S
	Cardiac & Cardiovascular	1,153	4.1%	13% higher
Major Federal Center or Program Project Grant	Several NIH funded Center and PPG grants, involving atherosclerosis, cardiac fibrillation and acute and cardiomyoplasty.			
Active PI Initiated Clinical Trials	35 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	**Part of Competitive Industry Strength in Surgical Appliance & Supplies Manufacturing** • 3,750 Jobs in LAC for 2010 • Specialized with 24% higher concentration than nation • Growing with 13% growth from 2001 to 2010, including 12% from 2007 to 2010 • Gaining Competitive Share: Outpaced national growth (13% vs. 7.5% from 2001 to 2012)		**Competitive Strength: Electromedical & Electrotherapeutic Apparatus Manufacturing:** • 3,701 jobs in LAC for 2010 • Highly Specialized: 102% higher concentration than nation • Growing in Jobs -- 27.4% growth from 2001 to 2010 (though lost jobs from 2007 to 2010) • Gaining Competitive Share – Outpaced national growth (27.4% for LAC vs 9.8% for nation from 2001-2010	
VC Activity (2007 to 3Q, 2012)	None			

Musculoskeletal Research and Implant Devices

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 1749 or 6%** **Distribution: 52% Publications; 48% Patents** **Illustrative Applications**: Hip fractures; Bone regeneration; Cartilage regeneration and repair; Bone density measurements; Bone sensors; Kidney bone disease research; Bone grafting methods; Surgical technique for soft tissue repair; Fracture fixation devices; Surgical guides for hip replacement; Spinal injuries; Spinal fixation devices; Spinal and vertebrate fusion; Neural pathways for walking and locomotion
Academic Publishing Data	Field: Orthopedics; Biomedical Eng. # of Pubs (2006-2010): 468; 441 Share of U.S.: 3.1%; 3.4% Citation Rate Compared to U.S.: 38% higher; 7% lower
Major Federal Center or Program Project Grant	Not extensive in NIH funding, though PPG in Skeletal Dyslasias and Muscular Dystrophy. One major NSF grant to USC on understanding how to achieve dextrous, optimal control of a hand, which may advance development of prosthetics.
Active PI Initiated Clinical Trials	20 active clinical trials as of 9/30/12
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010) ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized **Specialized Industry**: Specialized, but lost jobs from 2001 to 2010 **Part of Competitive Industry Strength in Surgical Appliance & Supplies Manufacturing** • 3,750 Jobs in LAC for 2010 • Specialized with 24% higher concentration than nation • Growing with 13% growth from 2001 to 2010, including 12% from 2007 to 2010 • Gaining Competitive Share: Outpaced national growth (13% vs. 7.5% from 2001 to 2012)
VC Activity (2007 to 3Q, 2012)	None

Electro-Medical Implants and Devices

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 1672 or 6%** **Distribution: 10% Publications; 90% Patents** **Illustrative Applications**: Surgical stimulators; Implantable sensors; Deep brain stimulation; Pancreatic pain stimulation; Implantable pumps; Monitoring devices

Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Biomedical Eng.	441	3.4%	7% lower
	Electrical Eng.	2,267	5.0%	57% higher

Major Federal Center or Program Project Grant	Longstanding NSF Engineering Research Center for Biomimetic Microelectronic Systems @ USC focused on creating novel interventions primarily for ophthalmic disorders, which has received more than $30 million in NSF funding since its award and involves an extensive industry consortium.
Active PI Initiated Clinical Trials	7 active clinical trials as of 9/30/12
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010) ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized Specialized Industry: Specialized, but lost jobs from 2001 to 2010 **Competitive Strength: Electromedical & Electrotherapeutic Apparatus Manufacturing:** • 3,701 jobs in LAC for 2010 • Highly Specialized: 102% higher concentration than nation • Growing in Jobs -- 27.4% growth from 2001 to 2010 (though lost jobs from 2007 to 2010) • Gaining Competitive Share – Outpaced national growth (27.4% for LAC vs 9.8% for nation from 2001-2010)
VC Activity (2007 to 3Q, 2012)	2- Bioness ($136.7m); Microfabrica ($25.6m)

Ophthalmology Research & Treatments

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 1074 or 4%**			
	Distribution: 70% Publications; 30% Patents			
	Illustrative Applications: Detecting retinal detachments; Retinal cell biology and regeneration; Gene mutations in eye diseases; Mechanisms of glaucoma; Processes of diabetic retinopathy; Biological mechanisms of eye lens function; Dry eye syndrome research; Relationships of blood and perfusion pressure in glaucoma; Mechanisms of cataract formation; Genes associated with congenital ocular defects; Surgical instruments and approaches for intraocular surgery; Headaches and disorders of the eye			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Ophthalmology	950	6.8%	2% lower
Major Federal Center or Program Project Grant	NIH Center grant for Jules Stein Eye Institute @ UCLA. Longstanding NSF Engineering Research Center for Biomimetic Microelectronic Systems @ USC focused on creating novel interventions primarily for ophthalmic disorders, which has received more than $30 million in NSF funding since its award and involves an extensive industry consortium.			
Active PI Initiated Clinical Trials	7 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	Not applicable			
VC Activity (2007 to 3Q, 2012)	2 – Replenish ($10m); Second Sight Medical Products ($9m)			

Biologics for Therapeutics and Diagnostics

Cluster Analysis of Publications and Patents (Omniviz)

# of Records: 1036 or 4%

Distribution: 21% Publications; 79% Patents

Illustrative Applications: Isolating RNA from biospecimens; rapid assays for protein detection; Assays to evaluate antibody interactions; Monoclonal antibody development for disease treatments; Targeted gene delivery; Engineered antibodies and nanoparticles; Cell detection by carbon nanotube biosensors; Biomarker sensors; Glucose sensors; Biosensors to control biosynthetic pathways; Cell detection by carbon nanotube biosensors; Biomarker sensors; Glucose sensors; Biosensors to control biosynthetic pathways

Academic Publishing Data

Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
Biotechnology & Applied Molecular Biology	817	2.9%	46% higher
Med Lab Technologies	109	2.6%	12% higher
Organic Chemistry	505	2.7%	41% higher

Major Federal Center or Program Project Grant

In cancer, there is an NIH funded PPG focused on immunotherapy for treating solid tumors @ City of Hope. Several major NSF grants involving novel technologies to advance lab-on-a-chip technologies, advance small interfering RNA as gene-silencing therapeutics, advance how we analyze and manipulate molecular systems and advance biomolecular sensing of chemical and biological agents.

Active PI Initiated Clinical Trials

Large number of active clinical trials as of 9/30/12 (>180 involved in biologics and drug interventions though not sure how many are large vs. small molecule)

Presence of Detailed Industry Strength

Current Industry Strength: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010)

Emerging Industry Strength: Growing in jobs from 2001 to 2010, but not specialized

Specialized Industry: Specialized, but lost jobs from 2001 to 2010

Part of Current Industry Strength in Medical Labs (develop and deploy clinical diagnostics)

- 7,817 Jobs in LAC in 2010; ***Specialized*** – 58% higher than the nation; ***Growing in Jobs*** – 30.7% growth from 2001 to 2010; ***On Par with National Growth*** – 30.7% for LAC vs 30.3% for nation from 2001-2010

Part of Emerging Industry Strength since 2007 in Biological Products

- 678 jobs in LAC in 2010; ***Not specialized*** – 17% lower concentration than nation; ***Growing in Jobs since 2007***: Gained 23% from 2007 to 2010, but lost jobs over 2001 to 2010 period; ***Gaining Competitive Share since 2007***: LAC grew 22.8% vs 5.3% for nation from 2007-2010

Part of Emerging Industry Strength in Vitro Diagnostics

- 634 jobs in LAC in 2010; ***Higher concentration, but not specialized*** – 7% higher concentration than nation; ***Growing in Jobs*** : Gained 6.3% from 2001 to 2010, with strong growth from 2007 to 2010 period; ***Gaining Competitive Share since 2007***, but not over 2001 to 2010 period: LAC grew 23.3% vs. 7.8% for nation from 2007-10

VC Activity (2007 to 3Q, 2012)

6 – Kythera Biopharmaceuticals ($78m); Pathology, Inc ($45m); Xencor ($19m); Pathway Diagnostics ($2m); HydroDx ($0.5m); Genome Diagnostics ($0.2m) + 3 from cancer therapeutics – Puma, Agensys, Kite Pharma

Genetics & Genomics

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 851 or 3%** **Distribution: 77% Publications; 23% Patents** **Illustrative Applications**: DNA replication and repair; Transcript processing; Structure and flexibility of DNA binding sites; Gene expression processes and regulation; DNA mutations; DNA binding molecules; Genetic variant analysis of diseases; Gene-gene interactions in pharmacogenomics; Genome wide association studies			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Genetics & Heredity	1,509	4.4%	37% higher
Major Federal Center or Program Project Grant	Several focused NIH Center and PPG awards for gene libraries and genotype-phenotype mapping, plus genetics/genomics well represented across disease research in cancer and neuroscience. Plus several major NSF grants involving integrated approaches to mapping genome to phenome, computational analysis of metagenomic sequencing data, probabilistic modeling of how genetic circuits allow identical cells to choose their fate randomly,			
Active PI Initiated Clinical Trials	Not Applicable			
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010) ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized Specialized Industry: Specialized, but lost jobs from 2001 to 2010		**Part of Emerging Industry Strength in Biotech Commercial R&D** •1,312 jobs in LAC in 2010; ***Not Specialized*** – 69% lower than the nation; ***Growing in Jobs*** – 24.4% growth from 2007 to 2010; ***Gaining Competitive Share since 2007*** – 24.4% for LAC vs 0.9% for nation from 2007-2010	
VC Activity (2007 to 3Q, 2012)	None			

Autoimmune & Inflammatory Disorders

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 785 or 3%** **Distribution: 81% Publications; 19% Patents** **Illustrative Applications**: Genetic factors of human autoimmunity; Role of T cell activation in disease progression; Vaccine development and testing; Role of gut microbiota in shaping intestinal immune response; Role of regulatory T-cells in autoimmunity; Immune system processes of inflammatory bowel diseases; Pathways of neuroinflammatory disorders; Immune response and inflammation in cardiovascular diseases; Regulation of acute inflammatory responses			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Immunology	1,526	3.8%	5% higher
	Rheumatology	319	6.0%	22% higher
Major Federal Center or Program Project Grant	NIH Center and PPG grants for inflammatory bowel disease @ Cedars Sinai and developing and understanding interventions that reduce inflammation for elderly @ UCLA Claude Pepper Older American Center. Plus, a major NSF Emerging Frontiers in Research and Innovation @ CalTech to advance the development of "microbiome" particles to prevent and treat human diseases associated with microbial imbalance that trigger autoimmune responses and inflammation.			
Active PI Initiated Clinical Trials	18 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	Not Applicable			
VC Activity (2007 to 2011)	1- Ritter Pharmaceuticals ($5.8m)			

Biomedical Imaging

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 783 or 3%**			
	Distribution: 71% Publications; 29% Patents			
	Illustrative Applications: Broad modalities of medical imaging research including ultrasonography, computed tomography, positron emission tomography, magnetic resonance imaging, etc; In vivo molecular and cell imaging involving advanced uses of microscopy			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Radiology, Nuclear Med & Medical Imaging	1,176	4.3%	36% higher
	Neuroimaging	306	7.4%	22% higher
Major Federal Center or Program Project Grant	Major focus in cancer research and neuroscience research with stand alone NIH funded Centers and PPG grants, plus NIH Center in ultrasound imaging. One major NSF grant at CalTech for advancing imaging of chemical and physical properties to enable direct visualization of proteins in diseases.			
Active PI Initiated Clinical Trials	Not Applicable			
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010) ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized Specialized Industry: Specialized, but lost jobs from 2001 to 2010			**Part of Electromedical and Electrotherapic** • 3,701 in LAC in 2010 • Highly Specialized: 102% higher concentration than nation • Growing in Jobs – 27.4% growth from 2001 to 2010 (though lost jobs from 2007 to 2010) • Gaining Competitive Share – Outpaced national growth (27.4% for LAC vs 9.8% for nation from 2001-2010) **Part of Small and Declining Industry in Irradiation Apparatus Manufacturing**: LAC had only 249 jobs in 2010 with steep decline of 28% from 2001 to 2010
VC Activity (2007 to 3Q, 2012)	5- Gamma Medica-Ideas ($24m); ImaginAb, Inc ($12.5m); Advanced Molecular Imaging ($3.35m); Tribogenics ($2.5m); Sofie Biosciences ($2m)			

Transplant Surgery, Outcomes and Complications

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 719 or 3%** **Distribution: 93% Publications; 7% Patents** **Illustrative Applications:** Surgical approaches and devices for transplantation; Heart and lung transplant outcome studies; Cellular processes of transplant rejection; Risk factors for mortality after heart transplants; Managing hepatitis B in liver transplants; Surgical approaches to liver transplant; Pulmonary hypertension in liver transplant patients; Kidney transplant complications and recurrence; Mineral and bone disorder after kidney transplant			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Transplantation	421	5.5%	33% higher
Major Federal Center or Program Project Grant	None identified			
Active PI Initiated Clinical Trials	6 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	Not Applicable			
VC Activity (2007 to 3Q, 2012)	None			

Protein Sciences

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 671or 2%** **Distribution: 67% Publications; 33% Patents** **Illustrative Applications**: Protein structure and function; Molecular mechanisms for RNA recognition; Methods for identifying gene-environment interactions; Anti-microbial peptides; Cell penetrating peptides; Iron regulating peptides (hepcidin); Role of hepcidin in chronic kidney disease; Novel peptides for blood clot formation			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Biochemistry & Molecular Biology	3,349	3.5%	30% higher
	Organic Chemistry	505	2.7%	41% higher
Major Federal Center or Program Project Grant	Many major NSF grants across USC and UCLA involving advanced research into detection of protein-protein interactions, structure and function of G-proteins, mechanisms of protein folding, structural studies of telomerase involved in preventing chromosomal instability, structural analysis and computational modeling of why some proteins transition from soluble to insoluble structures.			
Active PI Initiated Clinical Trials	Not Applicable			
Presence of Detailed Industry Strength	Not Applicable			
VC Activity (2007 to 3Q, 2012)	None			

Nephrology & Urology

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 656 or 2%**			
	Distribution: 87% Publications; 13% Patents			
	Illustrative Applications: Minimally invasive surgery (laparoscopic) approaches; Acute kidney injury diagnosis and treatment; Renal cell therapy and regeneration; Renal tumor gene expression analysis; End-stage renal disease treatment; Urinary incontinence; Urinary disorders in women; Treatment of bladder syndrome (intestinal cystitis); Techniques for radical pelvic surgery			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Urology & Nephrology	841	4.6%	24% higher
Major Federal Center or Program Project Grant	Major prostate cancer grants			
Active PI Initiated Clinical Trials	7 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	Not Applicable			
VC Activity (2007 to 3Q, 2012)	1- DSI ($47.5m)			

Endocrinology, Metabolic Biology and Nutritional Sciences

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 588 or 2%**			
	Distribution: 96% Publications; 4% Patents			
	Illustrative Applications: Intestinal absorption processes; Lipid metabolism; Molecular nutrition and food research; Medicinal foods; Role of hormones in risk factors of cancer; Growth hormone deficiencies; Regulation of hormone secretion; Systems biology of metabolic mechanisms			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Endocrinology & Metabolism	1,064	4.3%	26% higher
	Nutrition & Dietetics	308	2.7%	35% higher
Major Federal Center or Program Project Grant	None identified			
Active PI Initiated Clinical Trials	Not applicable			
Presence of Detailed Industry Strength	Not Applicable			
VC Activity (2007 to 3Q, 2012)	None			

Surgical Instruments, Devices & Supplies

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 536 or 2%** **Distribution: 8% Publications; 92% Patents** **Illustrative Applications**: Catheter ablation for atrial fibrillation; Catheter delivered therapies and drug pumps; Pulmonary artery catheters; Urinary catheters; Sinus balloon catheters; Guide catheter for valve repair; Catheter tips and other components; Infusion devices for drug delivery; skin patch with pump for drug delivery; Wearable device for infusing anti-coagulants into blood; Syringes; biopsy needles; needle devices with sensors; automated syringe systems			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Surgery	1,991	4.3%	26% higher
	Biomed Engineering	441	3.4%	7% lower
Major Federal Center or Program Project Grant	None identified			
Active PI Initiated Clinical Trials	11 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010) ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized Specialized Industry: Specialized, but lost jobs from 2001 to 2010		**Emerging Strength in primarily focused Surgical and Medical Instrument Mfg:** • Not Specialized – 43% below national average for industry concentration • Growing Strongly in Jobs – 33.8% from 2001 to 2010, with major gains since 2007 • Gaining Competitive Share – Well outpaced national growth – 33.8% for LAC vs. 7.9% for U.S.	
VC Activity (2007 to 3Q, 2012)	None			

Respiratory Disorders Research & Treatments

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 494 or 2%** **Distribution: 75% Publications; 25% Patents** **Illustrative Applications**: Use of beta-agonists to treat chronic obstruction pulmonary disease (COPD); Predicting functional decline in COPD; Role of exercise in COPD progression; Biomarkers of acute lung injury; Signaling genes in pathogenesis of impaired lung function in asthma; Inflammatory processes of lung disease; Developmental cell biology of lung development; Asthma research; Genotyping asthma patients; Predicting exercise induced broncho-constriction; Responses to long-acting agonists; Upregulation of nitric oxide in pulmonary disease; Therapeutics to treat asthma; Pathogenesis of asthma; Assessment of antihistamine use for allergic rhinitis; Effects of secondhand smoke on asthma control; Mediation of allergic lung inflammation; Pharmaokinetic studies of antibiotics to treat cystic fibrosis; Assessment of asthma and lung cancer risk			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Respiratory System	470	3.7%	14% higher
	Allergy	119	3.5%	24% higher
Major Federal Center or Program Project Grant	NIH Center and PPG grants for Children's Environmental Health Center @ USC focused roles of the environment and susceptibility in children's respiratory health and Center for Lung Biology @ USC focused on advance understanding of pathogenic mechanisms of pulmonary disease.			
Active PI Initiated Clinical Trials	6 active clinical trials as of 9/30/12			
Presence of Detailed Industry Strength	Not Applicable			
VC Activity (2007 to 3Q, 2012)	None			

Stem Cell Biology and Therapies

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 425 or 2%** **Distribution: 71% Publications; 29% Patents** **Illustrative Applications**: Inducing and improving stem cell differentiation; Growth factors and gene expression of stem cells; Wide use of stem cell therapies for acute kidney injury, traumatic brain injury, CNS repair, urinary incontinence, etc; Gene regulatory networks that control development; Modeling of gene regulatory circuits; Functional evolution of regulatory genes; Methods for controlling the differentiation state of the cell			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Developmental Biology	466	4.5%	16% higher
	Cell Biology	1,471	3.3%	12% higher
Major Federal Center or Program Project Grant	Several NIH funded Centers and PPG focused on gene regulatory circuits, complex cell signaling networks that control the cell phenotype and gene therapy using hematopoietic (bone marrow) stem cells.			
Active PI Initiated Clinical Trials	1 active clinical trial as of 9/30/12			
Presence of Detailed Industry Strength	Not Applicable			
VC Activity (2007 to 3Q, 2012)	2 – Advanced Cell Technology ($5m); StemCyte ($1.83m)			

Dental Materials, Implants and Devices

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 315 or 1%** **Distribution: 44% Publications; 56% Patents** **Illustrative Applications**: Ceramic materials for dental crowns; Tooth enamel proteins; Bioactive materials for endodontics; Advanced devices for orthodontics; Dental imaging			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Dentistry, Oral Surgery	482	5.7%	19% higher
	Biomaterials	101	2.1%	14% lower
Major Federal Center or Program Project Grant	None Identified			
Active PI Initiated Clinical Trials	1 active clinical trial as of 9/30/2012			
Presence of Detailed Industry Strength	***Current Industry Strength***: both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010 ***Emerging Industry Strength***: Growing in jobs from 2001 to 2010, but not specialized Specialized Industry: Specialized, but lost jobs from 2001 to 2010		Specialized Industry in Dental Equipment and Supplies Mfg • Highly speciali	
VC Activity (2007 to 3Q, 2012)	None			

Public Health and Healthcare Services

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 287 or 1%** **Distribution: 96% Publications; 4% Patents** **Illustrative Applications:** Health literacy; Health promotion research; Health behavior; Willings of patients to participate in clinical research; Assessing patient care; Evaluating electronic referrals for specialty care; Quality of care; Healthcare decision making; Evidence-based practice; Uses of IT to improve patient safety; Epidemiology research; Comparative effectiveness research

Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Health Care Sciences	568	4.5%	35% higher
	Health Policy	574	5.8%	31% higher
	Public, Env & Occ Health	1,962	5.0%	18% higher

Major Federal Center or Program Project Grant	Over 10 NIH funded Center and PPG grants focused on quality of care, health promotion, health policy and health disparities research involving Charles Drew University, UCLA, USC and RAND.
Active PI Initiated Clinical Trials	Not applicable
Presence of Detailed Industry Strength	***Current Industry Strength:*** both specialized (greater than 20% higher industry employment concentration in 2010) and growing in jobs from 2001 to 2010) ***Emerging Industry Strength:*** Growing in jobs from 2001 to 2010, but not specialized **Specialized Industry:** Specialized, but lost jobs from 2001 to 2010 **Hospitals represent an emerging opportunity:** • 146,328 jobs across all types of hospitals (incl. public sector) • No type of hospital – general, specialty and psychiatric – is specialized in LAC • Generally growing in jobs: General Hospitals by 5.8% from 2001 to 2010; Specialty Hospitals by 42%; and Psychiatric Hospitals declining by a slight 3.6% (growth figures are private sector only). • Not keeping pace with national growth in any type of hospital
VC Activity (2007 to 3Q, 2012)	5 – U.S. HealthWorks ($25m); SeeChange Health ($20m); Futuredontics ($16.4); FitOrbit ($12.2); DailyStrength ($4.2m); iChange Network (n/a)

Diabetes (Type 2) & Obesity Research and Treatments

Cluster Analysis of Publications and Patents (Omniviz)	**# of Records: 282 or 1%**			
	Distribution: 86% Publications; 14% Patents			
	Illustrative Applications: Insulin resistance processes; Pathogenesis of Type 2 diabetes; Metabolic syndrome risk factors; Modulators of glucose metabolism; Aging effects on metabolic processes of high fat diet; Regulation of lipid metabolism genes; Biological mechanisms of insulin-expressing beta cells; Natural products for diabetes treatment; Ethnic differences in insulin action; Progression of diabetes-related diseases; Dietary approaches to controlling Type 2 diabetes; Appetite reduction; Mechanisms of obesity; Role of obesity on chronic heart failure, asthma, liver diseases, among other complications; Biological regulation of obesity; Measuring obesity; Social-cognitive studies of obesity; Genetic processes of obesity; Metabolic pathways and networks for genes related to obesity; Role of exercise and obesity.			
Academic Publishing Data	Field	# of Pubs (2006-2010)	Share of U.S.	Citation Rate Compared to U.S.
	Endocrinology & Metabolism	1,064	4.3%	26% higher
Major Federal Center or Program Project Grant	A couple of NIH funded Center and PPG grants for obesity in minority youth focused on mechanisms of high sugar diets, early identification of at risk through imaging and use of resistance training for improving insulin sensitivity and research uncovering the mechanisms and identifying new potential drug interventions for regulating plasma lipid metabolism, fuel delivery to cells, and adipogenesis.			
Active PI Initiated Clinical Trials	20 active clinical trials as of 9/30/2012			
Presence of Detailed Industry Strength	Not applicable			
VC Activity (2007 to 3Q, 2012)	1 – FitOrbit ($12.2)			

Appendix C: Project Advisory Committee

George Ayoub
President & CEO
One Lambda

Bruce Blomstrom
President
Pasadena Bioscience Collaborative

Joseph Boystak
President & CEO
Brightwaters Capital

David Carlisle, MD, PhD
President and CEO
Charles R. Drew University of
Medicine and Science

Larry A. Couture, PhD
Sr. Vice President
Center for Applied Technology Development
Beckman Research Institute, City of Hope

Roy Doumani
Executive Director
UCLA Business of Science Center

Ahmed Enany
President & CEO
Southern California Biomedical Council

Robert Greenberg
President & CEO
Second Sight Medical Products

Randolph W. Hall, PhD
Vice President of Research
University of Southern California

Tracy Holcombe
Chief Executive Office
Capital Projects/Debt Management
Los Angeles County

Wendie Johnston, PhD
Executive Director
LA/Orange County Biotechnology Center
Pasadena City College

Gary Lazar, MD
President & CEO
Paganini BioPharma

Ronald Leeruangsri
Chief Executive Office
Health and Mental Health Services
Los Angeles County

Robert Lieberman, PhD
President & CEO
Intelligent Optical Systems

M. Loreto Maldonado
Chief Executive Office
Health and Mental Health Services
Los Angeles County

David Meyer
President
LA BioMed

James Rosser, PhD
President
Cal State University Los Angeles

Alexander B. Suh
Managing Director
California Technology Ventures, LLC

Sheldon M. Schuster, PhD
President & Professor
Keck Graduate Institute of Applied Life Sciences

Jan Takata
Chief Executive Office
Los Angeles County

Michael J. Wise
Partner
Perkins Coie LLP

Hal F. Yee, Jr., M.D., PhD
Chief Medical Officer
Los Angeles County Department of Health Services

Willie Zuniga
President & CEO
Grifols Biologicals