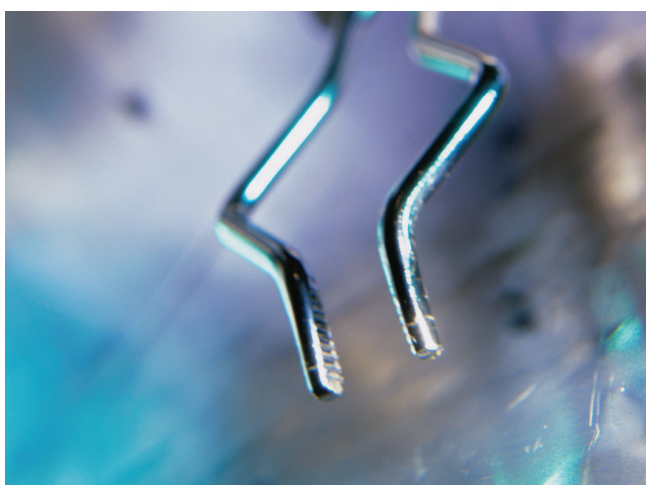


The Economic Impact of San Diego's Research Institutions

Driving San Diego's Innovation Economy



FALL 2015

PRODUCED BY



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RESEARCH INSTITUTIONS

have a **\$4.6B** ECONOMIC IMPACT and are at the center of
SAN DIEGO'S \$14.4B SCIENTIFIC R&D CLUSTER



San Diego's non-profit research institutions are the backbone of scientific innovation. They are the birthplace of groundbreaking advances in biosciences and translational research that yield life-changing discoveries and therapies. They are also the genesis of scientific startups and licensed technologies that play a critical role in San Diego's globally recognized scientific research and development cluster. In total, scientific R&D affects more than 100,000 local jobs and generates over \$14 billion in economic impact—a third of which stems from research institutions.

HIGHLIGHTS

- Research institutions impact roughly **37,000 jobs** and have a combined **\$4.6 billion total impact** on the region's GRP every year.
- The \$4.6 billion economic impact of research institutions equates to that of **4 San Diego Convention Centers**, **34 San Diego Comic-Cons**, **6 aircraft carriers**, or **33 U.S. Open Golf Championships** every year.
- All scientific R&D, including for-profit enterprises, **generates \$14.4 billion annually in economic impact**—roughly equal to the region's visitor industry.
- An estimated **\$1.8 billion in federal and philanthropic research funding** flows to the region's research institutions every year.
- Independent research institutes in San Diego receive **more NIH research funding** and **generate more patents** than counterparts in any metro area of the United States.
- Many of the world's best and brightest scientists perform cutting edge research in San Diego; there are **111 living National Academy of Science** members and more than 2,600 postdocs within research institutions alone.

ECONOMIC IMPACTS

Industry/ Impact Type	Regional Employment	Value Added (GRP)
--------------------------	------------------------	----------------------

Independent Research Institutes

Direct	5,640	\$1,153,865,000
Indirect/Induced	7,950	\$708,809,000
Total Impact	23,670	\$2,730,341,000

University Research Centers

Direct	12,450	\$1,742,437,000
Indirect/Induced	11,220	\$987,905,000
Total Impact	13,590	\$1,862,674,000

Research Institutions (University + Independent)

Direct	18,090	\$2,896,302,000
Indirect/Induced	19,170	\$1,696,714,000
Total Impact	37,260	\$4,593,015,000

= \$4.6B ANNUALLY

34

SAN DIEGO COMIC-CONS



33

U.S. OPEN GOLF CHAMPIONSHIPS



6

AIRCRAFT CARRIERS STATIONED IN SD



4

SAN DIEGO CONVENTION CENTERS



KEY NUMBERS »

#1

Best Place to Launch a Startup, 2014, Forbes

#1

Metro for NIH Research Dollars to Research Institutes, 2014, NIH

#3

Life Sciences Hub, 2015, Business Facilities

#3

Cities for Biotech VC, 2015, Fiercebitech

#3

Most R&D Expenditures on Medical Sciences, 2013, UC San Diego

#4

Global Life Sciences Clusters, 2015, JLL

#4

Most Concentrated STEM Workforce, 2014, BLS

111

Living National Academy of Sciences Members

2,600+

Postdoc Fellows Currently Working in San Diego, EDC

3,542

Patents from NIH Funding, 2013-2014, NIH

A CALL TO ACTION »

The unexpected size, economic impact, and potential growth of the R&D sector in San Diego is astounding, not only in the total economic impact, but in other key indicators, such as the scale of research facilities, the unique global connectivity, and the depth and diversity of employment opportunities. To capitalize on this, we call for the following actions and strategies:

» BUILD SUPPORTING COALITIONS

San Diego's non-profit research institutes and universities have benefitted from large shares of R&D funding, but continuous legislative and community support is critical to the sector.

- Form a coalition with key national R&D centers to collectively advocate for research support.
- Organize quarterly coordinated visits to D.C. with key local leaders, companies, and institutions.
- Establish strategic funding partnerships with universities, philanthropists, foundations, and for-profit enterprises around the world.

» DRIVE THE ECONOMIC DEVELOPMENT OPPORTUNITIES

Given the high return on investment, deliberate strategies across the community to attract, retain, and expand R&D investment, philanthropy, and federal funding are essential.

- Coordinate with EDC's Go Global Initiative to attract more foreign investment and partnerships.
- Organize quarterly open-invitation briefings with public officials.
- Release an annual economic impact report to continually promote messaging.

» ADDRESS WORKFORCE NEEDS

While San Diego has a wealth of high-level talent, it is equally significant to have a labor pool that is extremely adept at a broader range of ongoing support roles.

- Redouble efforts on STEM training by developing short-term, technical training programs.
- Focus efforts on important middle-skill positions, such as lab technicians and assistants.
- Support and develop more interactive laboratories, such as The Salk Mobile Science Lab, JCVI's "Discover Genomics!" program, and Qualcomm's Thinkabit lab to better engage K-12 students in STEM.

COMMERCIAL CONNECTIVITY

San Diego is the most concentrated scientific R&D market in the United States and a global leader in innovation. The business, education, and non-profit communities offer ample resources for company creation and commercialization. Scientists, entrepreneurs, and businesses owners have access to a wide range of assets for commercialization and strategic partnerships, including 16 incubators and accelerators, world-class talent and facilities, and more than 41.8 million square feet of lab and R&D space—more than 3 times the total shopping mall space in the region.

“When it comes to translating scientific discoveries into therapies, there's no place like San Diego. The close proximity of the Salk Institute to numerous biotech firms and academic research institutions makes San Diego the perfect place to start a company.”

- Dr. Ronald Evans, Director of the Gene Expression Laboratory at Salk Institute and Founder of Metacrine



Cypher Genomics grew out of the Scripps Translational Science Institute in 2012. Today, they employ 13 staff members and have partnered with San Diego-based companies including Celgene, Illumina, and Sequenom.



Sense4Baby, a wireless heart rate monitor system for babies and their mothers, was the first company in the West Health Incubator. The product is now licensed to AirStrip and is distributed across the globe.



Metacrine was founded in 2015 on technology licensed from the laboratory of Dr. Ronald Evans at the Salk Institute. Metacrine develops therapies that target diabetes, non-alcoholic steatohepatitis, and other metabolic and liver disorders.

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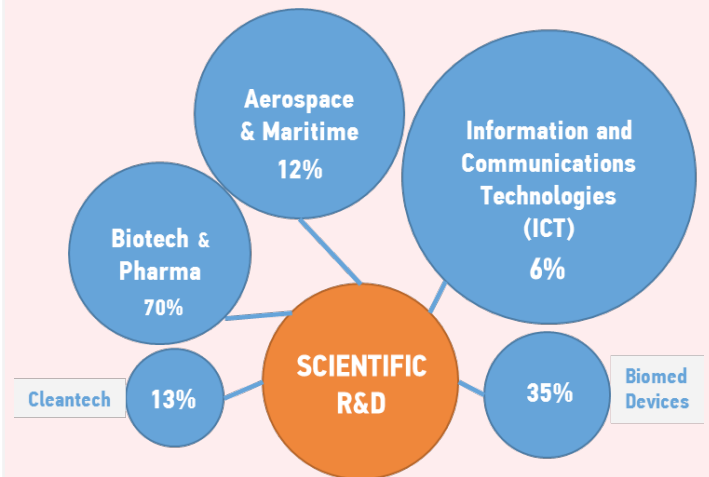
PART I: INTRODUCTION



The San Diego region is recognized globally as a center of scientific breakthroughs and discoveries. The region's innovative research and development (R&D) activities have produced cures for diseases, algorithms in billions of cell phones worldwide, and state-of-the-art medical devices for treatment and care. At the heart of innovation lie San Diego's research institutions—the independent research institutes and universities that anchor the region's R&D ecosystem. Research institutions are the genesis of discoveries that benefit the global scientific and technology communities. They also generate massive impacts on the economy as a whole. Furthermore, these institutions are centers for collaboration with private industry. They are the source of new commercializable technologies and companies that spin out and generate significant economic impacts.

This study documents the role and impact of independent and university research institutions to San Diego's larger scientific research and development cluster. In total, this cluster contributes more than \$14 billion to the region's economy—the approximate impact equivalent of the region's tourism and visitor industry.¹ It is one of the most robust R&D clusters in the world, and one which merits broad-based community support because of its significance to the San Diego economy.

FIGURE 1.1: Scientific R&D and San Diego's Traded Employment Clusters



Scientific R&D is a critical part of the region's innovation economy. For instance, 70 percent of all biotech and pharma cluster employment is from the scientific R&D industry.

Bubble size represents total cluster employment. Percentage = share of cluster employment that is from the scientific R&D industry.

Sources: California Employment Development Department; the SANDAG Traded Clusters Report; Employment updated to 2014 by San Diego Regional EDC.

A BRIEF HISTORY OF RESEARCH IN SAN DIEGO

The independent research institutes in San Diego owe their existence to the vision of civic leaders and the voters of San Diego. Before the University of California, San Diego (UC San Diego) was even established, San Diego deeded hundreds of acres for research and development near Torrey Pines with the goal of catalyzing a research cluster on the mesa.² As early as 1907, the well-known Scripps Institute of Oceanography was founded. In 1924, San Diego philanthropist Ellen Browning Scripps founded a small clinic and research center focused on metabolic diseases. Although she did not know it at the time, she was also laying the foundation for San Diego's research institutions. In the 1950s, General Atomics was given land on the Torrey Pines Mesa to explore the peace time use of nuclear technologies. The City of San Diego later deeded 27 acres to develop what is now known as The Scripps Research Institute (TSRI). Today, it is one of the largest independent research institutes in the country.

After World War II, the City of San Diego zoned and deeded more space on the Torrey Pines Mesa for the development of science and technology, including space for a new prolific research university—UC San Diego, which is presently one of the highest ranked universities in the world.³ Today, the Torrey Pines Mesa is home to the largest concentration of independent research institutes in the nation. The

¹ San Diego Tourism Authority, San Diego Tourism Industry Research: <http://www.sandiego.org/industry-research.aspx>

² Bradley J. Fikes, "San Diego's shows path to biotech success," San Diego Union-Tribune. September 13, 2015. <http://www.sandiegouniontribune.com/news/2015/sep/13/what-makes-a-biotech-hub-la/>

³ UC San Diego Rankings

Salk Institute, Sanford Burnham Prebys Medical Discovery Institute, The Scripps Research Institute, J. Craig Venter Institute, West Health Institute, and La Jolla Institute of Allergy and Immunology—along with numerous others—form a dense concentration of research and development that has contributed to the creation of hundreds of companies that form the life sciences and technology sectors in San Diego. More than 26,000 workers now congregate around the Torrey Pines Mesa, which has become a scientific mecca for the world’s best researchers.⁴

THE SCOPE OF THIS STUDY

This study illuminates three critical points. (1) It delineates and articulates the economic impacts of the region’s research institutions on the San Diego regional economy. (2) It describes the role of research institutions in the region’s broader scientific R&D cluster. (3) It documents and highlights the comparative advantages of doing research in the San Diego region.

The scientific research and development ecosystem is characterized by two basic types of entities: commercial, for-profit R&D businesses and non-profit research institutions. Non-profit institutions include both university-based research and independent research institutes. For the purposes of this study, independent research institutes represent non-profit entities that primarily perform basic research and receive their funding primarily through federal government funding, foundation grants, and individual donations. Both commercial and non-profit entities can secure revenue through philanthropic and government grants, but commercial businesses are those that are explicitly for-profit and have the goal of generating their revenue through product sales or government contracts. This study describes the role the region’s independent institutes and university research activities within the context of the entire research ecosystem, including commercial entities.

Understanding the economic impacts of research institutes and university research, how these institutions are funded, and what makes R&D in San Diego exceptional should inspire policymakers, economic developers, and other stakeholders to more actively support and advocate for the R&D ecosystem in San Diego.

NOTES ON TERMINOLOGY

- **Research institutions** refers to *all* non-profit research entities in the region, including the region’s **independent, non-profit research institutes** (e.g. The Salk Institute for Biological Studies) *and* **research and development activities at universities**.
- **R&D** for the purposes of this study refers to **scientific research and development**. The U.S. Census Bureau defines the scientific research and development industry as: “establishments engaged in conducting original investigation undertaken on a systematic basis to gain new knowledge (research) and/or the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes (experimental development). The industries within this industry group are defined on the basis of the domain of research; that is, on the scientific expertise of the establishment.”⁵ Note that this definition includes for-profit enterprises and non-profit research institutes.
- Unless specifically noted, “**San Diego**” will refer to the region, not the city. It may be used synonymously with terms like San Diego County, the San Diego region, the San Diego MSA or “the region” to mean the greater San Diego region. This region is defined as the San Diego-Carlsbad-San Marcos Metropolitan Statistical Area, which covers San Diego County.

4 Gary Robbins, “Science mecca blooms on La Jolla mesa,” San Diego Union-Tribune. August 1, 2015. <http://www.sandiegouniontribune.com/news/2014/aug/09/torrey-pines-mesa/>

5 U.S. Census Bureau. <https://www.census.gov/econ/isp/sampler.php?naicscode=5417&naicslevel=4#>

PART II: THE ECONOMIC IMPACT OF RESEARCH INSTITUTIONS



Scientific research and development (R&D) services is one of the largest and most impactful industries in the region. San Diego's 700 commercial R&D firms and independent research institutes directly employ 42,720 people, and the impacts of this activity reverberate throughout the economy.¹ All Scientific R&D, including for-profit firms, non-profit research institutes, and university research, affects 107,270 jobs in the region, with a total economic impact of \$14.4 billion on the region's gross regional product (GRP)²—roughly equating to the impact of the region's tourism industry.³

RESEARCH INSTITUTIONS IMPACTS

Research institutions include the activities of both the independent research institutes and the R&D activities at the region's universities (see figure 2.1). With indirect and induced impacts, research institutions have a total impact of \$4.6 billion on the region's economy. The comparative economic impact of research institutions is astounding. The annual total impact of \$4.6 billion is four times the annual impact of the San Diego Convention Center.⁴ This also compares to hosting 34 San Diego Comic-Cons or 33 U.S. Open Golf Championships every year.^{5, 6} This activity impacts 37,260 jobs in the region—about the same amount as all direct jobs around the Port of San Diego.⁷

- 1 California Employment Development Department, Quarterly Census of Employment and Wages (QCEW)
- 2 Including direct, indirect and induced impacts. See Appendix A for details.
- 3 San Diego Tourism Authority, Industry Facts: <http://www.sandiego.org/industry-research.aspx>
- 4 San Diego Convention Center, About Us: <http://visitsandiego.com/about/regional-impact>
- 5 Lisa Halverstadt, "Tourism Boosters Are Expecting Less Money from Comic-Con." Voice of San Diego, June 30, 2015. <http://www.voiceofsandiego.org/topics/economy/tourism-boosters-are-expecting-less-money-from-comic-con/>
- 6 Darren Heitner, "U.S. Open: A \$140 Million Bump For Chambers Bay." Forbes, June 15, 2015. <http://www.forbes.com/sites/darrenheitner/2015/06/15/business-of-golf-2015-u-s-open-championship/>
- 7 2015 Port of San Diego Economic Impact Study: <https://www.portofsandiego.org/about-us/general-press-releases/3839-port-of-san-diego-generates-7-6-billion-in-regional-economic-impact.html>

FIGURE 2.1: Breakdown of the Economic Impacts of Scientific R&D on the San Diego Regional Economy

Industry/ Impact Type	Regional Employment	Value Added (GRP)
Independent Research Institutes		
Direct	5,640	\$1,153,865,000
Indirect/Induced	7,950	\$708,809,000
Total Impact	13,590	\$1,862,674,000
University Research		
Direct	12,450	\$1,742,437,000
Indirect/Induced	11,220	\$987,905,000
Total Impact	23,670	\$2,730,341,000
.....		
Research Institutions (Independent Research Institutes + University Research)		
Direct	18,090	\$2,896,302,000
Indirect/Induced	19,170	\$1,696,714,000
Total Impact	37,260	\$4,593,015,000
For-Profit Enterprises		
Direct	24,630	\$5,671,436,000
Indirect/Induced	45,380	\$4,150,748,000
Total Impact	70,010	\$9,822,184,000
.....		
All Scientific R&D (For Profit Enterprises + Research Institutions)		
Direct	42,720	\$8,567,738,000
Indirect/Induced	64,550	\$5,847,462,000
Total Impact	107,270	\$14,415,199,000

Source: IMPLAN Group, LLC

COMMERCIAL CONNECTIONS >>

SPAWAR

The Space and Naval Warfare Systems Command (SPAWAR) of the United States Navy is one of the most important research assets in the region. SPAWAR generated more than \$2.5 billion in GRP in 2014 and impacted nearly 19,000 jobs, including the 4,900 individuals who work within the facility.

SPAWAR connects the Navy's sea, land, air and cyber information and communication networks. In 2014, SPAWAR accounted for approximately half of the cybersecurity industry in San Diego.

SPAWAR's impacts are not entirely included in the figures on the left due to the complex system of federal dollars. SPAWAR is both a major contractor and an R&D facility. SPAWAR delivered approximately \$1 billion in contract awards to commercial firms in the region in 2014. It also acts as an R&D facility through technology transfers to commercial enterprises.

The contract awards are captured in Part III and largely reflected in the commercial R&D activity to the left, but tech transfer activities at SPAWAR are more challenging to quantify. Nonetheless, SPAWAR is an important generator of R&D, intellectual property, and economic impact in the San Diego region.

Source: San Diego Military Advisory Council

INDEPENDENT RESEARCH INSTITUTES

The region's 36 major non-profit independent research institutes directly employ more than 5,600 employees and represent about \$1 billion in R&D expenditures. When accounting for indirect and induced impacts, these activities have a total economic impact of about \$1.9 billion on the San Diego economy and affect approximately 13,600 jobs in the region.

We were able to identify 116 non-profit medical and scientific research institutes in San Diego County using a census methodology (see detailed methodology in Appendix A). However, many of these institutions are now defunct, did not actually participate in R&D activity, or their expenses and employment were so low that we could neither track down their 990 tax form nor find any information about them through other sources. As a result, we compiled data on 36 independent non-profit institutes, half of which employ more than 50 individuals. As such, it is possible that we missed some marginal amount of employment and expenditures from the remaining institutes that were not accounted for, but the sum would likely be minor or negligible to the overall result given the lack of information on these institutions.

UNIVERSITY RESEARCH

We also assessed the economic impact of university research activities. To compile this information, we used data from the National Science Foundation, which reports research employment and R&D spending for higher education institutions, delineating the R&D activity from other university activities, such as training or teaching. From this data, we found that higher education institutions in San Diego employ more than 12,400 staff for R&D activities and spend \$1.1 billion on R&D. When including indirect and induced impacts, these activities have a total economic impact of \$2.7 billion and affect more than 23,600 jobs.

PART II: THE ECONOMIC IMPACT

TECHNOLOGY TRANSFER AND COMMERCIALIZATION

As impressive as these figures are, they fail to completely capture the impacts of new technologies and technology transfer that lead to new commercial enterprises. Nearly every major institute now has a staff of industry-minded professionals who help translate basic science research into commercializable technologies. The Salk Institute alone developed technologies that led to 33 spin-off firms.⁸ The Scripps Research Institute (TSRI) has spun out more than 50 companies and has more than 950 active patents.⁹ UC San Diego's Technology Transfer Office processes more than 600 agreements every year.¹⁰ The office has helped more than 200 startups, going from university research to independent companies. Sanford Burnham Prebys Medical Discovery Institute (SBP) has been responsible for more than 760 patents and 90 licensing agreements, since its inception.¹¹ Though nearly impossible to quantify, institutions such as Salk, TSRI, SBP, JCVI, the West Health Institute, and UC San Diego have easily led to hundreds of new life sciences and technology firms that collectively employ thousands. Every 100 new scientific R&D jobs results in an estimated \$40 million in economic impact for the region.

One common avenue for technology commercialization is SBIR/STTR funds. The Small Business Administration (SBA), in conjunction with fifteen federal departments and agencies, administers the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, also known as SBIR/STTR. These programs distribute more than \$2 billion every year to small businesses to incentivize engagement in federal R&D programs.¹² The San Diego region is a major recipient of these funds, accounting for about 4.5 percent of all SBIR/STTR funds distributed. To put this in perspective, San Diego MSA only represents about one percent of all U.S. employment.¹³ Approximately \$93 million in SBIR/STTR funds flow to the San Diego region every year, generating more than \$100 million of economic impact from these funds alone.

8 Salk Institute, About: <http://www.salk.edu/about/>

9 Scripps, About: <http://www.scripps.edu/about/facts.html>

10 UC San Diego, Technology Transfer Office, FY 2013 Annual Report: http://invent.ucsd.edu/invent/wp-content/uploads/2015/01/FY13ARTTO_sml.pdf

11 SBP Office of Technology Management and Commercialization: <http://www.sbpdiscovery.org/technology/otmc/Pages/License%20Our%20Technology.aspx>

12 SBIR.gov: <https://www.sbir.gov/>

13 Bureau of Labor Statistics, Quarterly Census of Employment and Wages, 2014.

COMMERCIAL CONNECTIONS >>

CYPHER GENOMICS

"San Diego is and should continue to be the capital of genomics. There's no reason to leave."

- Adam Simpson
President and CEO of Cypher Genomics

Cypher Genomics exemplifies the collaborative ecosystem that leads to commercial success in San Diego. Cypher Genomics grew out of the Scripps Translational Science Institute (STSI) in 2012 in an effort to make genome sequencing more affordable, practical, and sustainable.

STSI is a joint effort of the bioscience and medical research at TSRI and the patient care and clinical research at Scripps Health. Cypher and STSI agreed to exclusive licensing of STSI's Welllderly Cohort, comprising of 700+ genomes of healthy elderly patients, an ideal reference population for clinical and pharmacogenic use.

Today, Cypher still maintains its partnership and licensing agreement with STSI and has also partnered with three other scientific R&D firms: Celgene, Illumina, and Sequenom. Founded by four genomics experts, Cypher now employs 13 staff members and expects to reach a staff of about 40 in the next three to five years.

In an interview for this study, the President and CEO of Cypher Genomics Adam Simpson made it clear that the partnership with TSRI and STSI was critical to their success. "You need great science to start great companies," said Simpson, adding, "Scripps absolutely qualifies, and that's the basis of Cypher."

Simpson also noted that San Diego was the place for collaboration in genomics, stating, "Whether it's Illumina or Thermo Fisher or other companies that are local that we want to work with, the partnerships we've announced are here."

SECTION HIGHLIGHTS

- The robust cluster of scientific research and development is one of the largest and most significant economic contributors to the region, generating \$14.4 billion in gross regional product (GRP).
- Research institutions account for a significant portion of these impacts on the region's economy, representing \$4.6 billion in total economic impact on the region every year—four times the annual impact of the San Diego Convention Center, 34 times the impact of Comic-Con, and 33 times the impact of the U.S. Open Golf Championship.
- In addition to these impacts, we know that universities and research institutes develop thousands of patents and enter into licensing agreements that lead to new companies and products.
- Commercial dependence on institution research accounts for a significant portion of the scientific R&D impacts. In 2014, 446 new science and technology startups accounted for 1,860 new jobs created in San Diego. Many of these new companies used technologies or discoveries from one of the region's research institutes or universities.¹⁴

COMMERCIAL CONNECTIONS >>

SYNTHETIC GENOMICS, INC.

"We believe that synthetic genomic advances hold the key to transforming many industries and one of the most important will be in advanced vaccines that have the power to help prevent public health threats such as influenza pandemics."

**– J. Craig Venter, Ph.D.,
CEO and Founder of JCVI and Synthetic Genomics, Inc.**

Synthetic Genomics, Inc. (SGI) is a privately-held company founded by J. Craig Venter, Ph.D. dedicated to developing and commercializing genomic-driven solutions to address a wide range of global challenges. SGI was built on scientific breakthroughs in the field of synthetic biology by Dr. Venter, Hamilton Smith, Clyde Hutchison and other scientists at the J. Craig Venter Institute (JCVI). JCVI is a not-for-profit research institute in San Diego, CA and Rockville, MD dedicated to the advancement of the science of genomics; the understanding of its implications for society; and communication of those results to the scientific community, the public, and policymakers.

SGI now employs more than 200 people and is focused on several key commercialization programs including developing new synthetic DNA products, tools and instruments through its subsidiary, SGI-DNA; synthetically-derived vaccines and anti-microbials through Synthetic Genomic Vaccines Inc. (SGVI), bio-based food and chemicals, and clean water technologies using microbial fuel cells.

Through subsidiaries SGVI founded in 2010, and SGI-DNA founded in 2013, SGI has continued to develop new technologies to rapidly and accurately synthesize genes and genomes of any size.

"Our teams have been working hard to put our expertise to work toward the development of next generation synthetic biology solutions," said Dr. Venter, CEO and Founder of both JCVI and SGI. "We believe that synthetic genomic advances hold the key to transforming many industries and one of the most important will be in advanced vaccines that have the power to help prevent public health threats such as influenza pandemics."

PART III: ANALYSIS OF FUNDING FOR RESEARCH AND DEVELOPMENT



The work of non-profit research institutes and universities is funded primarily by grants and philanthropic contributions. In this section, we elucidate the flow and impact of federal and philanthropic dollars to the region. The ratio of funding sources varies by research organization. Figure 3.1 shows an example of the funding sources provided by the Salk Institute for Biological Studies in which in their case, 11 percent of the annual budget comes from investments. Among the research institutes analyzed for this study, the majority of funding for research comes from federal grants and philanthropic support, as the following aggregate data analysis reveals.

FEDERAL FUNDING ¹

From 2012 to 2014, the San Diego region received approximately \$11.6 billion in federal contracts and grants per year, with roughly \$2.4 billion earmarked specifically for scientific research and development. This funding was awarded across a number of industry verticals, with most of the funding going to defense and life sciences R&D (see figure 3.2).

In all, research institutes and universities received about \$1.1 billion in federal funds for research and development, 98 percent of which came from federal grants. Of the \$61.8 million in research contracts received by institutes and universities from 2012 to 2014, five organizations accounted for 84.4 percent of those dollars. The La Jolla Institute for Allergy and Immunology was the only for which the contract funding comprised more than 10 percent of their R&D spending. While a small number of institutions may receive large government contracts, federal contracts represent a small part of the funding picture for research institutions, who primarily receive grants for basic research purposes.

FIGURE 3.1: Salk Institute's 2015 Funding Breakdown

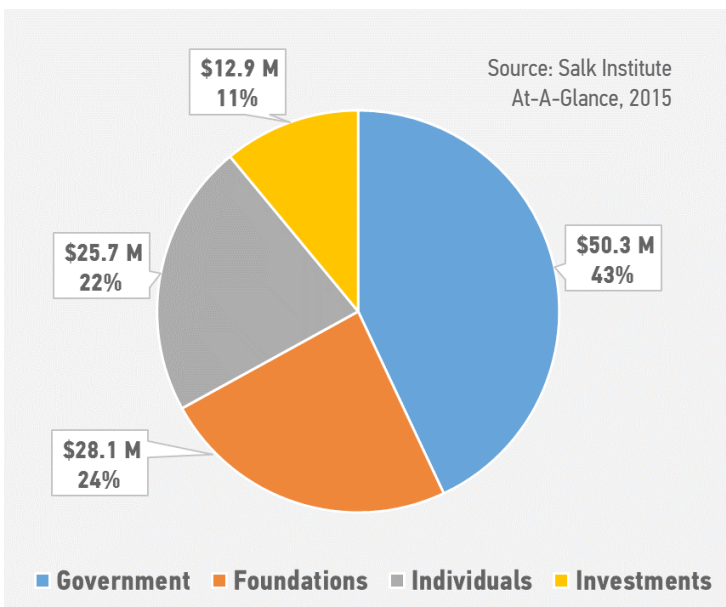


FIGURE 3.2: Federal R&D Funding Breakdown (in Millions)

	Grants	Contracts	All Federal R&D Funding
By Organization Type			
Research Institutes	\$412.6	\$10.2	\$422.8
Universities	\$628.8	\$14.2	\$643.0
For-Profit	\$176.1	\$1,130.0	\$1,306.1
All Other	\$16.9	\$0.0	\$16.9
By Industry Vertical			
Defense	\$8.8	\$945.0	\$953.8
Life Sciences	\$891.7	\$90.3	\$982.0
Environment	\$270.7	\$115.2	\$385.9
All Other	\$63.2	\$3.9	\$67.1
Total Funds	\$1,234.4	\$1,154.4	\$2,388.8

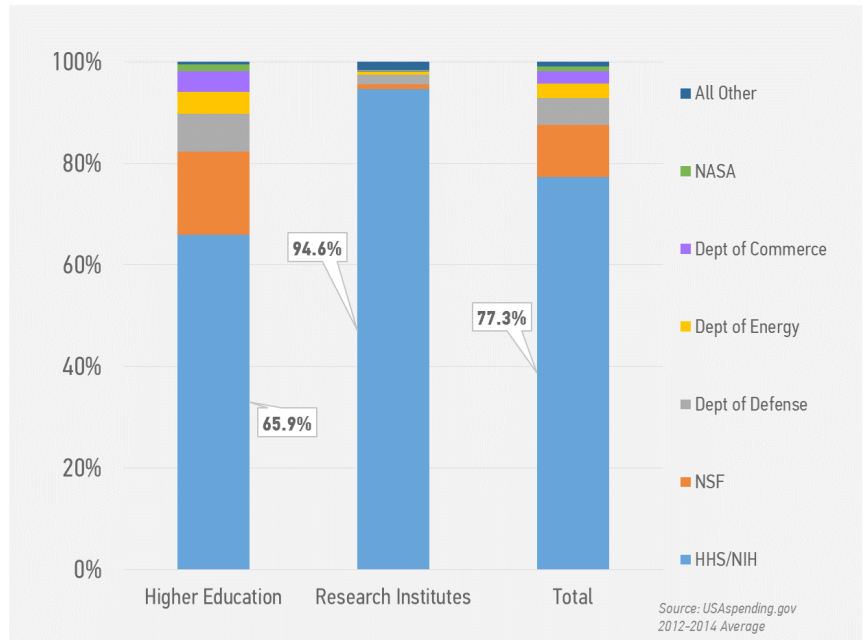
Source: USAspending.gov; 2012-2014 average

¹ For details on sources and methodology, see the notes section at the end of Part III.

KEY FACTS

- The \$2.4 billion awarded for research in the region was split roughly 50/50 between grants for basic research and contracts for applied research.
- Similarly, about 54 percent of this total in the region went to for-profit entities, while nearly the entire remainder (46 percent) was awarded to research institutes and universities in the region (see figure 3.2 on page 8).
- About 2.1 percent of the \$1.2 billion in federal R&D contracts were awarded to non-profit research institutes and universities. The remaining 97.9 percent went to commercial, for-profit businesses, primarily in defense-related R&D.
- On the other hand, 84.4 percent of all basic research grants were awarded to research institutes and universities, the majority of which was in life sciences and environmental sciences.
- Of all the federal basic research dollars received by independent research institutions in the region, 94.6 percent came from the National Institutes of Health (NIH). University research funding sources were more diverse, with only 65.9 percent of their federal grants coming from NIH (see figure 3.3). Of course, these aggregate figures vary for each institute, with NIH constituting significantly less funding than the aggregate in certain circumstances.

FIGURE 3.3: Grant Funding by Federal Department



PART III: ANALYSIS OF FUNDING



PHILANTHROPIC SUPPORT

Revenue from donors and foundations accounted for a high percentage of non-profit research institutions' annual funding. Research institutes and universities collectively received approximately \$730 million in philanthropy in 2013. San Diego institutions are commonly the recipients of some of the largest philanthropic donations, according to the Million Dollar List compiled by the Indiana University Lilly Family School of Philanthropy. An anonymous donation of \$275 million to Sanford-Burnham Medical Research Institute in 2014 is the second highest donation in the health sector since 2008. More recently, Conrad Prebys donated \$100 million to the now titled Sanford Burnham Prebys Medical Discovery Institute in June 2015—one of the largest health contributions in recent history.

From 2000 to 2014, benefactors and foundations have made at least 420 donations of \$1 million or greater to San Diego institutions for health research, public benefit, the environment, or higher education. These donations total approximately \$2.5 billion in support to regional institutes and universities. Many of these major donations come from local benefactors, such as Joan and Irwin Jacobs, the Sanford Foundation, the Gary and Mary West Foundation, and the Rady Family. Major donations to San Diego institutions also come from across the country, with more than one hundred donations of \$1 million or greater gifts to the region from 24 states other than California. Many come from major national foundations, such as the John D and Catherine T MacArthur Foundation, Bill & Melinda Gates Foundation, and the Carnegie Foundation.

While these larger gifts can be game-changing for our institutions, there is a substantial steady flow of smaller philanthropic gifts to our region. We estimated that the region's research institutions collectively received approximately \$730 million in philanthropic donations in 2013, split almost evenly between universities and non-profit research institutes. Considering that major donations can vary significantly from year-to-year, this figure is an average approximation. For instance, there were 38 major donations totaling \$222 million to San Diego institutions in 2010, while in 2012, there were 12 major donations totaling \$46 million.

COMMERCIAL CONNECTIONS >>

AIRSTrip/SENSE4BABY

San Diego provides a perfect location to easily connect globally, and is known for many biotech startup companies. The region provides access to a number of world-class research institutes.

– Alan Portela, CEO, AirStrip

Sense4Baby is a wireless heart rate monitor system for babies and their mothers, combining smart wireless devices through cloud technology to enable clinicians to remotely monitor activity.

The Sense4Baby platform was originally researched at the West Health Institute, who then licensed the technology to Sense4Baby, Inc. The Institute is part of West Health, which is funded by philanthropists Gary and Mary West. Along with the West Health Policy Center, the Institute is dedicated to pioneering new and smarter technologies, policies and practices to make high-quality healthcare more accessible at a lower cost to all Americans.

Sense4Baby was featured in the September 2015 Apple product launch to showcase how wireless devices like the Apple Watch can utilize Airstrip-developed platforms to enable doctors to remotely monitor patients. The Sense4Baby system includes a wireless monitor that attaches to the mother's chest that connects to an iPhone and Apple Watch to send the signal to the patient's doctor.

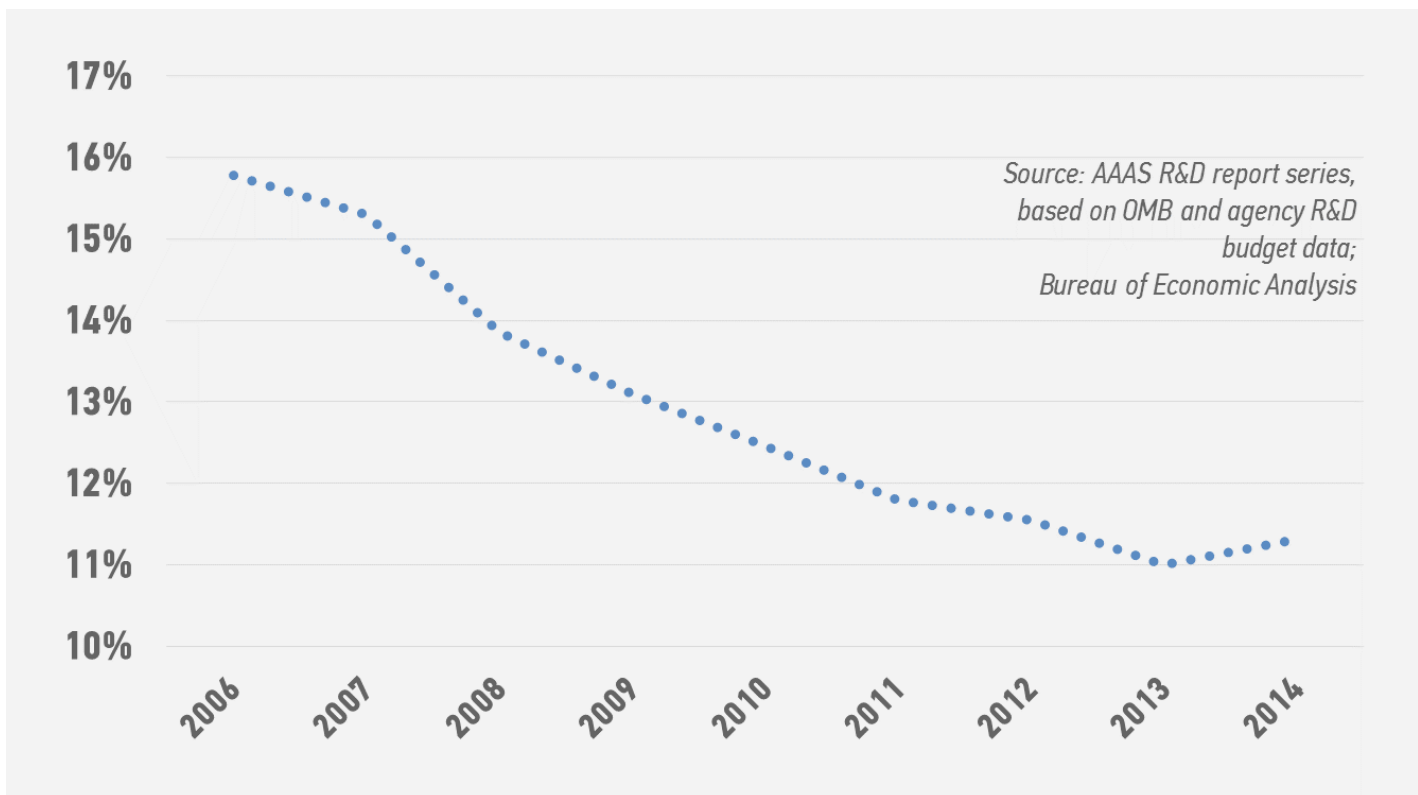
In 2014, AirStrip acquired the assets of Sense4Baby. In 2015, AirStrip has announced distribution agreements with partners in the U.S., Europe, Africa, Australia, and New Zealand.

BUDGET CONCERNS

Considering the importance of federal funding to the region's robust R&D cluster, federal budget constraints and sequestration could potentially have negative impacts on the region. For instance, San Diego received 17 percent of all NIH research funding that went to independent research institutes in 2014. These funds awarded by NIH dropped nationally by 11 percent from 2013 to 2014—a \$200 million decline. On average, NIH research dollars have fallen across the country by 3.7 percent per year since 2009, with 2013 and 2014 being the years with most extreme declines. San Diego institutions thus far have continued to do well, but could lose tens of millions of research dollars per year if this trend continues. A hypothetical drop of \$20 million in federal research funding to the region would result in roughly 180 lost jobs and \$16 million in lost wages for San Diego's labor force, assuming these funds are not offset by other contributions.²

Beyond NIH, aggregate federal R&D support has been stagnant or declining in recent years—most heavily in the defense sector. Figure 3.4 shows the percentage of all federal government spending that went to R&D from 2006 to 2014. This ratio fell from 15.8 percent in 2006 to 11.0 percent in 2013. While much of this is due to cuts in defense spending, total non-defense spending for R&D also fell during that period.

FIGURE 3.4: Federal R&D Support as a Percentage of All Federal Spending, by Year (2006 to 2014)



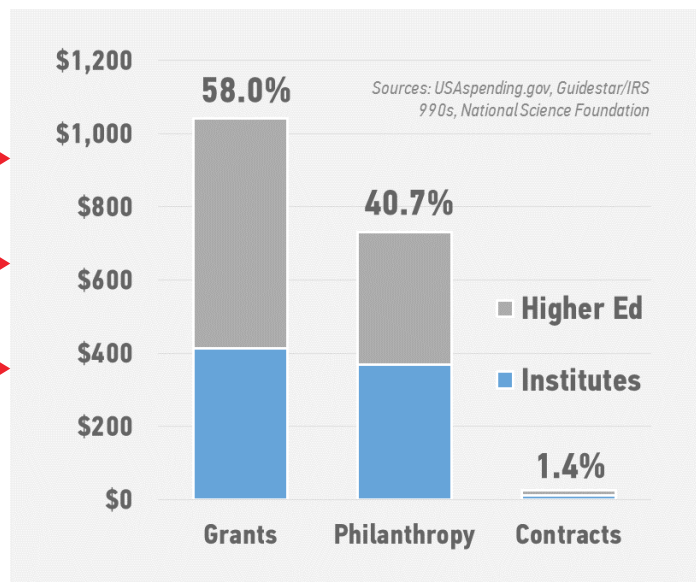
² Estimated impact of \$20 million in lost scientific R&D revenue using IMPLAN Group, LLC data.

PART III: ANALYSIS OF FUNDING



FIGURE 3.5: Total Funding Breakdown (in Millions)

Funding Type	Institutes	Higher Ed	Total
Grants	\$412.6	\$628.8	\$1,041.4
Philanthropy	\$369.2	\$361.3	\$730.5
Fed. Contracts	\$10.2	\$14.2	\$24.4
Total	\$792.0	\$1,004.3	\$1,796.3



SECTION HIGHLIGHTS

- Research institutions receive approximately \$1.8 billion in federal funding and philanthropy per year, allowing some variation year-to-year in major awards and donations.
- Universities typically represent about 56 percent that funding, and non-profit research institutes received 44 percent.
- Federal funds and philanthropic donations do not make up the entirety of R&D funding, but evidence indicates that on the whole, it covers more than 90 percent of it.
- Other sources, such as non-federal project contracts from private businesses can vary by institution. The data suggests that this is a small percentage on the aggregate.
- From 2012 to 2014, grant funding for research and development ebbed and flowed by at least \$70 million each year. Unless these aggregate flows are offset by investments, savings, endowments, commercial partnerships, or donations, the economic impact on the region could threaten hundreds of jobs and millions of dollars.
- A 2012 study from the Milken Institute revealed that for every \$1.00 a region receives from the National Institutes of Health (NIH)—a primary source of research funds—the region can expect anywhere from \$1.70 to \$3.20 of economic output.³ San Diego receives a significant portion of these funds, which generates substantial economic impacts for the region.

³ Anusuya Chatterjee and Ross C. DeVol. "Estimating Long-Term Economic Returns of NIH Funding on Output in the Biosciences." 2012. <http://www.milkeninstitute.org/publications/view/535>

COMMERCIAL CONNECTIONS >>

ROSE CANYON FISHERIES

“San Diego is the perfect location for the first-ever finfish farm in federal waters in the U.S. We have an ideal climate, are sheltered from major storm events, have existing (albeit underutilized) commercial fishing infrastructure and are proximate to a major market, as well as being near Hubbs-SeaWorld Research Institute’s headquarters.”

– Don Kent, Interim President/CEO
Rose Canyon Fisheries

Rose Canyon Fisheries (RCF) is a partnership between Hubbs-SeaWorld Research Institute (HSWRI) and Cuna del Mar (CdM). RCF plans to establish and operate a commercial-scale fish farm off the San Diego coast—the first operation of its kind in federal waters in the United States. By combining the scientific and environmental expertise of HSWRI with the direct open-ocean aquaculture experience of CdM, RCF will pioneer environmentally and economically sustainable methods for providing healthy seafood to meet growing demand.

A recent EDC economic impact analysis revealed that Rose Canyon Fisheries will eventually sustain more than 300 jobs and generate more than \$50 million dollars in economic impact every year in the San Diego region. Furthermore, the project will serve as a model to address a critical need for sustainable, domestic seafood production. Once fully-scaled, RCF will provide 11 million pounds of product to the market, making healthy seafood more plentiful and affordable.

FIGURE 3.6: Top Donations to San Diego Research Institutions, 2010 to 2015

Donation	Donor	Recipient	Year
\$275M	Anonymous	Sanford Burnham Prebys	2014
\$100M	Conrad Prebys	Sanford Burnham Prebys	2015
\$100M	T Denny Sanford	UC San Diego	2013
\$75M	Joan and Irwin Jacobs	UC San Diego	2010
\$50M	T Denny Sanford	Sanford Burnham Prebys	2010
\$45M	Conrad Prebys	Scripps Health	2011
\$42M	Leona M and Harry B Helmsley Charitable Trust	Salk Institute	2013
\$36M	Laura and John Arnold Foundation	Nutrition Science Initiative	2013
\$25M	Gary and Mary West Foundation	West Wireless Health Institute	2010
\$20M	Conrad Prebys	San Diego State University	2014
\$15M	Sunset Foundation	West Wireless Health Institute	2010

Source: Million Dollar List

PART IV: COMPETITIVE ADVANTAGES IN SAN DIEGO'S R&D ECOSYSTEM



As detailed in Parts II and III, the region's research institutions clearly have astounding impacts on the region's economy. Their combined capabilities and talent also represent competitive advantages when compared with other regions. What follows are some important comparative measures of San Diego's position nationally and internationally.

INDEPENDENT RESEARCH INSTITUTE FUNDING

The most accurate inter-regional comparisons for research capacity are from the NIH Research Portfolio (RePORT) data.¹ Since NIH dollars represent 94.0 percent of all grant funding to research institutes (see figure 3.3 on page 9), the NIH RePORT tool allows for reliable comparisons. The tool also makes it possible to easily differentiate by such things as organization types², geography, and the purposes of funding (e.g. research, training, and construction of facilities and labs).

KEY FACTS ³

- Independent research institutes in San Diego received more NIH funding than institutes in any other metro area of the United States (see figure 4.1).
- The region ranks 8th when including hospital and university research (see figure 4.2). San Diego research institutes, universities, and independent hospitals in total received \$743 million of NIH funding for R&D in 2014.
- In addition to being the top ranked metro overall for independent research institute funding from NIH, San Diego is home to three of the top ten most-funded independent research institutes (see figure 4.3 on page 15).
- Given San Diego's population and workforce, the region is relatively smaller than nearly every other top-funded region. Nonetheless, San Diego received 17 percent of all NIH R&D dollars for independent research institutes.
- Three of San Diego's non-profit research institutes are in the top ten nationally in NIH R&D dollars received.

FIGURE 4.1: NIH Research Funding to Independent Research Institutes by Metropolitan Statistical Area (MSA) 2014

RANK	METRO AREA	NIH FUNDING
1	San Diego	\$341,921,530
2	Seattle	\$338,515,979
3	New York	\$234,329,212
4	San Francisco	\$167,123,292
5	Washington DC	\$107,355,773
6	Boston	\$98,898,172
7	Philadelphia	\$91,527,054
8	Los Angeles	\$55,009,745
9	Durham-Chapel Hill	\$45,939,563
10	Raleigh	\$42,284,458

Source: National Institutes of Health

Note: Excludes hospitals and domestic higher ed organization types. Excludes funding for training and construction.

FIGURE 4.2: NIH Research Funding by Metropolitan Statistical Area (MSA) 2014

RANK	METRO AREA	NIH FUNDING
1	Boston	\$2,045,769,115
2	New York	\$1,712,374,961
3	Philadelphia	\$906,147,803
4	Los Angeles	\$880,967,094
5	San Francisco	\$832,366,733
6	Seattle	\$792,710,072
7	Durham-Chapel Hill	\$762,090,674
8	San Diego	\$742,642,982
9	Baltimore	\$733,003,021
10	Chicago	\$602,106,589

Source: National Institutes of Health

Note: Includes all organization types. Excludes funding for training and construction.

¹ NIH RePORT Tool: <https://projectreporter.nih.gov/reporter.cfm>

² Categorization of applicant organizations to characterize the general kind of organization according to the function, mission, or service. Categories include: institution of higher education; research organization; independent hospital; education organization other than higher education; other health, human resources, environment/community service organization; other. See <http://www.report.nih.gov/glossary.aspx> and <http://www.report.nih.gov/faq.aspx> for more details.

³ All data is from 2014. Metros were aggregated using city-to-metro crosswalk.

FIGURE 4.3: Research Institutes in the United States by NIH Funding and NIH-Backed Patents, 2014

Rank	Institute	MSA	NIH FUNDING	PATENTS RESULTING FROM NIH FUNDS
1	FRED HUTCHINSON CANCER RESEARCH CENTER	Seattle, WA	\$221,517,707	375
2	SCRIPPS RESEARCH INSTITUTE	San Diego, CA	\$187,497,526	422
3	SLOAN-KETTERING INST CAN RESEARCH	New York, NY	\$110,380,718	341
4	SANFORD BURNHAM PREBYS	San Diego, CA	\$59,731,852	177
5	JACKSON LABORATORY	Bar Harbor, ME	\$51,419,886	117
6	KAISER FOUNDATION RESEARCH INSTITUTE	San Francisco, CA	\$48,013,626	93
7	BENAROYA RESEARCH INST AT VIRGINIA MASON	Seattle, WA	\$47,184,153	35
8	FAMILY HEALTH INTERNATIONAL	Durham-Chapel Hill, NC	\$45,939,563	10
9	RESEARCH TRIANGLE INSTITUTE	Raleigh, NC	\$42,284,458	85
10	SALK INSTITUTE FOR BIOLOGICAL STUDIES	San Diego, CA	\$39,387,445	105
15	LA JOLLA INST FOR ALLERGY & IMMUNOLOGY	San Diego, CA	\$30,379,451	74
45	J. CRAIG VENTER INSTITUTE	San Diego, CA	\$11,438,755	15
48	VETERANS MEDICAL RESEARCH FDN/SAN DIEGO	San Diego, CA	\$8,562,993	25
52	LUDWIG INSTITUTE FOR CANCER RES LTD	San Diego, CA	\$7,860,766	19
100-198	8 other SD Institutes	San Diego, CA	\$8,510,497	21

Source: NIH | Note: Excludes funding for training and construction.

*Only patents from NIH-backed projects in 2014.

UNIVERSITY RESEARCH RANKINGS

The San Diego region ranked 12th in terms of NIH R&D funds to universities in 2014, but NIH funding only accounts for 65.9 percent of federal research funding to universities in the region (see figure 3.3 on page 9). To compare overall university R&D funding, we used data from the National Science Foundation's HERD⁴ and NCSES⁵ databases, which report R&D expenditures and federal research obligations of the top universities in the United States.

In FY 2013, UC San Diego ranked fifth among all universities in the country, with about \$1.1 billion in R&D expenditures. All but eight million dollars of this spending was on science and engineering R&D projects, with life sciences accounting for approximately 60 percent of R&D spending. Comparing R&D expenditures in the medical sciences, UC San Diego ranked third in the country.⁶ UC San Diego also ranked fifth in the nation for science and engineering (S&E) R&D, with \$510 million in S&E R&D in 2013. While San Diego State University (SDSU) and University of San Diego engage in less R&D and receive less federal funding, both institutions rank in the top third for federal R&D obligations. In fact, SDSU ranks in the top 25 percent of all universities receiving federal R&D funds.

⁴ National Science Foundation, Higher Education Research and Development Survey, 2013.

⁵ National Center for Science and Engineering Statistics (NCSES), Survey of Federal Science and Engineering Support, 2013.

⁶ NCSES, Table 42

PART IV: COMPETITIVE ADVANTAGES



SAN DIEGO'S UNIQUELY COMPETITIVE R&D ECOSYSTEM

The economic returns of the R&D cluster are attributable in large part to the relationship between for-profit enterprises, business service providers, universities, and research institutes. The region consistently ranks as one of the top life sciences markets in the world.⁷ The region is also one of most concentrated research hubs in the U.S., with five times the share of employees working in scientific R&D compared to the U.S. average. Only Boulder, CO and Durham-Chapel Hill, NC metros have a higher concentration, but these two smaller regions have only a fraction of the scientific R&D employees that San Diego has. In fact, few major markets boast more scientific R&D employees and companies than the San Diego region. The region ranks fifth for total number of scientific R&D employees and sixth for total number of scientific R&D companies.⁸

Proximity to lab space is noted by Jones Lang LaSalle as a critical site selection factor for life science firms.⁹ The Torrey Pines Mesa alone has more than five million square feet of lab space, with a mix of research institutes, UC San Diego facilities, and commercial biotech and pharmaceutical companies.¹⁰ According to CBRE, San Diego has 13.6 million square feet of total lab space in the region—more than all of the region's shopping malls combined. Combining lab and R&D space, the region has about 41.8 million square feet of high-finish space—roughly the equivalent of all Class A and Class C office space in the region.

San Diego also possesses a number of assets essential for commercialization and startup activity. San Diego received \$500 million in venture capital investment in just the biotechnology sector in 2014¹¹ and was named one of the top venture capital markets by Business Facilities in 2015.¹² The region is home to more than 350 contract research organization (CROs) labs and has more CRO labs per employee than any major market in the nation.¹³

7 Examples: Ranked #2, #3 and #4 in Jones Lang LaSalle's Global Life Science Cluster Report in 2013, 2014 and 2015. Ranked #3 by Business Facilities in 2015.

8 Bureau of Labor Statistics, Quarterly Census of Employment and Wages, annual 2014 data. Compares all U.S. metros in size and location quotient in NAICS 5417, Scientific Research and Development Services

9 JLL Life Science Trends: <http://www.us.jll.com/united-states/en-us/services/industries/life-sciences-companies/life-sciences-trends-2015>

10 JLL 2014 Global Life Sciences Report, page 66. <http://www.jll.com/Research/2014-global-life-sciences-report-JLL.pdf?654be919-aef1-45a0-bef3-ab01d0a4ece6>

11 PricewaterhouseCoopers MoneyTree Report.

12 <http://businessfacilities.com/2015/07/metro-and-global-rankings/>

13 Assay Depot. "Contract Research Map." Per employee determined from Bureau of Labor Statistics QCEW data.

COMMERCIAL CONNECTIONS »

METACRINE

"When it comes to translating scientific discoveries into therapies, there's no place like San Diego. The close proximity of the Salk Institute to numerous biotech firms and academic research institutions makes San Diego the perfect place to start a company."

- Dr. Ronald Evans, Director of the Gene Expression Laboratory at Salk Institute and Founder of Metacrine

Metacrine is a privately held biotech company founded in 2015 on technology licensed from the laboratory of Dr. Ronald Evans at the Salk Institute for Biological Studies. Dr. Evans is a world leader in nuclear hormone receptors and Howard Hughes Medical Institute Investigator at the Salk Institute. Metacrine will advance technologies exclusively licensed from Salk to target diabetes, non-alcoholic steatohepatitis, and other metabolic and liver disorders—for some of which there are currently no approved therapies.

In an interview with Dr. Ronald Evans, one of the founders of Metacrine, he highlighted the strengths of doing research and developing companies in the San Diego region. Evans said, "I prefer developing companies that are close to the Salk Institute because interaction is much more intense, the ability to develop the products is more rapid, and it is easier to employ people locally from my lab and other labs to get the company jump-started; so, it is much more preferable for me to have companies be local."



PART IV: COMPETITIVE ADVANTAGES

The region is home to 16 incubators and accelerators, and most are focused on scientific and high-tech enterprises.¹⁴ For example, JLABS is part of Johnson & Johnson's external R&D engine and offers an innovative no strings attached, lower cost model for startups and scientists to develop and advance their breakthroughs in a state-of-the art shared laboratory space.¹⁵ EvoNexus is a downtown San Diego tech incubator early stage IT and software companies. Edico Genome—an award winning bioinformatics startup—is one of the many EvoNexus success stories.¹⁶ In addition, globally recognized organizations, such as Biocom and CONNECT provide hundreds of enterprises annually with startup support, industry connections and commercialization.

TALENT

“The strongest U.S. clusters have retained their competitive advantages, and continue to thrive as top centers of talent and innovation.”

- Roger Humphrey
Executive Managing Director of JLL's Life Sciences Group¹⁷

San Diego's research institutes, universities and innovative companies represent some of the best and brightest scientists in the world. Talent is a key driver of San Diego's recognition as a research and life sciences hub. In Jones Lang LaSalle's 2015 Life Science Cluster Report, they noted that access to talent and research facilities is what continues to keep regions like San Diego, Boston, and San Francisco at the top of these lists.¹⁸ In 2015, San Diego was one of only nine cities to be named National Geographic's "World's Smart Cities."¹⁹

KEY FACTS

- San Diego is home to 111 living National Academy of Sciences members (NAS)²⁰, more than 2,600 post-doctoral (postdoc) fellows at research institutions²¹, and 5,600 full-time graduate students in science, engineering, and health.²²
- Twenty Nobel Laureates have been affiliated with San Diego institutions, and UC San Diego currently has five Nobel Laureates on staff.^{23 24 25}
- UC San Diego appointed the fifth most postdocs of any university in the nation, with 1,275 appointments in 2013. They had the sixth most appointments in science and the seventh most appointments in health.²⁶ Two San Diego institutes and one global

14 San Diego Venture Group: <http://www.sdv.org/incubators2014/>

15 JLABS, About: <http://jllabs.jnjinnovation.com/about/overview>

16 Visit <http://evonexus.org/> for more information.

17 Quote from JLL Life Science Report: <http://www.us.jll.com/united-states/en-us/news/2939/top-us-life-sciences-clusters->

18 JLL Life Science Trends: <http://www.us.jll.com/united-states/en-us/services/industries/life-sciences-companies/life-sciences-trends-2015>

19 San Diego Regional EDC, "Why Nat Geo Calls Us a Smart City" <http://www.sandiegobusiness.org/blog/uc-san-diego/9-reasons-why-nat-geo-calls-us-%E2%80%9Cworld%E2%80%99s-smart-city%E2%80%9D>

20 NAS Member Directory: <http://www.nasonline.org/member-directory>

21 Census of NSF NCSSES Institution Profiles and web sites of individual institutes. Excludes many working in private firms.

22 Census of NSF NCSSES Institution Profiles

23 UC System, Nobel List: <http://nobel.universityofcalifornia.edu/list.html>

24 Nobel Prize by Institution: http://www.nobelprize.org/nobel_prizes/lists/universities.html

25 UC San Diego Academic Affairs, Nobel List: <https://academicaaffairs.ucsd.edu/faculty/awards/nobel.html>

26 NSF, NCSSES, Table 46: Institutions ranked by total number of postdoctoral appointees in science, engineering, and health, by field: 2013

PART IV: COMPETITIVE ADVANTAGES



firm—La Jolla Institute for Allergy & Immunology, Scripps Institute of Oceanography, and Genentech—were named in the top 10 Best Places to Work for Postdocs by The Scientist Magazine.²⁷

- UC San Diego is ranked seventh in living members of the National Academy of Sciences, while TSRI and Salk are in the top 50 worldwide.²⁸
- The region has the fifth highest concentration of doctoral degree holders in the country.²⁹
- Approximately ten percent of the region's workforce is in STEM occupations, which ranks San Diego fourth among major metropolitan areas.³⁰

In addition to industry-leading and globally influential scientists, the region is home to a robust base of STEM talent. A recent national study by the Coalition of State Bioscience Institutes (CSBI) indicated that the life sciences industry needs more than top-level scientists and Ph.Ds to succeed.³¹ Regions with a broad base of talent will have advantages over those that simply have a concentration of an overspecialized workforce. A recent study by the San Diego Workforce Partnership revealed that approximately half of all life sciences workers in San Diego have less than a bachelor's degree.³² Furthermore, they reported that few regional firms indicated great difficulty finding lab assistants and research associates, which are expected to be two of the most in-demand occupations. When looking at all life and physical sciences occupations, from technicians to medical scientists, San Diego ranks fourth among the 50 largest U.S. metros in terms of percentage of the workforce in science occupations.³³ When you combine science and engineering occupations, the region ranks second, behind only San Jose.

27 The Scientist, Best Places to Work for Postdocs: <http://www.the-scientist.com/?articles.view/articleNo/34849/title/Best-Places-to-Work-Postdocs-2013/>

28 NAS Member Directory: <http://www.nasonline.org/member-directory>

29 Note: Of the 25 most populous U.S. metropolitan areas. Data from the U.S. Census Bureau, American Community Survey, 2014.

30 Note: Of the 25 most populous U.S. metropolitan areas. Data from the Bureau of Labor Statistics (BLS), Occupational Employment Statistics (OES), 2014.

31 CSBI Workforce Report: http://www.csbinstitutes.org/download/files/reports/CSBI_WorkforceReportvFR.pdf

32 San Diego Workforce Partnership, Priority Sector Reports: http://workforce.org/sites/default/files/pdfs/reports/industry/life_sciences_sdwp_2014-10-02.pdf

33 BLS, OES 2014

SD HOME TO 48 OF WORLD'S TOP SCIENTISTS

By Gary Robbins | 6:46 p.m. July 13, 2014

San Diego is home to 48 of the world's most influential scientists and engineers, one of the largest collection of top scholars anywhere, says a new study by the news and information company Thomson Reuters.

The company produced the figure by analyzing how often scientists worldwide were cited by other researchers, mostly between 2002-2012. The list of 3,073 highly cited researchers includes everyone from distinguished biologists at the University of Cambridge to neuroscientists at Harvard to biochemists at the Salk Institute for Biological Studies.

Thomson Reuters says the San Diego-La Jolla area ranks sixth nationally in the number of top scholars across the country, placing behind such clusters as Boston-Cambridge and Stanford-Palo Alto, but ahead of Los Angeles and San Francisco.

All but three of the 48 San Diego researchers work on the Torrey Pines Mesa, a roughly two mile long section of La Jolla that features Salk, UC San Diego, the Scripps Research Institute, the Sanford-Burnham Medical Research Institute and the J. Craig Venter Institute. The University of California San Diego dominated locally, placing 27 scientists on the list. Two scholars appear on the list more than once, in different fields.

The recently-released list also includes a Nobel laureate—Barry Sharpless of Scripps Research—and several local scientists who are considered potential future Nobel winners, including geneticist Craig Venter, neuroscientist Fred Gage and chemist Napoleone Ferrara. The list also includes Scripps Research chemist Carlos Barbas III, who passed away in June.

Source: The San Diego Union-Tribune

GLOBAL ENGAGEMENTS

San Diego's scientific R&D cluster has a long history of international partnerships and investments, and these global connections represent an increasingly important asset for the region. In a March 2015 report by the Brookings Institution and JP Morgan Chase on San Diego's global trade and investment, life sciences was highlighted as one of the particular strengths in foreign direct investment.³⁴ The report stated:

“Foreign investment in advanced industries, including life sciences, is indicative of San Diego’s global leadership in innovation, often fueled by one of 88 research institutions in the region.”

Overall, San Diego ranked 49th in the U.S. in Brookings' foreign direct investment measure; however, the report went on to mention that leveraging and marketing the role of prominent research institutions would be a critical tactic for the region to increase its foreign investment in R&D. The La Jolla Institute of Allergy and Immunology and the Sanford Consortium for Regenerative Medicine provide examples of how this can be successful:

- Kyowa Hakko Kirin California, Inc. (KKC) is a wholly-owned U.S. subsidiary of Kyowa Hakko Kirin Co., Ltd. that operates out of the UC San Diego Science Research Park.³⁵ KKC has had a collaborative relationship with San Diego through the La Jolla Institute of Allergy and Immunology since 1988. In 2013, KKC signed an agreement to extend the partnership through the end of 2018. The partnership is one of the most enduring commercial-noncommercial partnerships of its kind in the world.³⁶
- A 2015 partnership titled the Innovation Alliance between Takeda Pharmaceuticals and Sanford Consortium for Regenerative Medicine offers another example of a large scale global partnership built on San Diego's research strength. The Innovation Alliance is a five-year, \$10 million partnership with the goal of delivering innovative therapeutic products to patients. The partnership will focus on translational research and proof-of-concept research projects.³⁷

In addition to these strategic partnerships, San Diego is the United States host of the prestigious annual Kyoto Prize Symposium—a three-day celebration of the lives and work of recipients of the Kyoto Prize. The Kyoto Prize is Japan's highest private award for achievement, and awards laureates for achievements in advanced technology, basic sciences, and arts and philosophy. The symposium is held across four San Diego universities, and features lectures from recipients and other thought leaders.³⁸ According to David C. Doyle, Chairman of the Kyoto Symposium Organization, the Kyoto Prize serves as a reminder to the international community that “San Diego exemplifies the transformative power of ingenuity.”³⁹

34 “Go Global: San Diego's Global Trade and Investment Initiative” <http://www.sandiegobusiness.org/sites/default/files/Go%20Global%20-%20San%20Diego's%20Global%20Trade%20and%20Investment%20Initiative.pdf>

35 Science Research Park, About: <http://www-srp.ucsd.edu/gemini.htm>

36 Kyowa-Kirin Press Release, 7/30/2013: http://www.kyowa-kirin.com/kkc/news_releases/pdf/liai-and-kkc-sign-major-contract-press-release-7-30-13.pdf

37 UCSD Press Release: http://ucsdnews.ucsd.edu/pressrelease/sanford_consortium_takeda_pharmaceutical_partner_in_10_million_innovation

38 Kyoto Prize Symposium: <http://kyotoprize-us.org/>

39 Kyoto Prize Symposium Brochure: <http://kyotoprize-us.org/wp-content/uploads/2015/07/Kyoto-Prize-Brochure-emailable.pdf>

PART IV: COMPETITIVE ADVANTAGES



CITATIONS AND COLLABORATIONS

Citation and collaboration figures function as a good proxy for the quantity and quality of the output of scientific knowledge and innovation. According to several publication ranking systems, San Diego institutions rank among the best in the world in terms of scientific journal citations and publications. The Scripps Research Institute is number one in the world in the proportion of papers cited by patents.⁴⁰ UC San Diego was ranked 6th in the nation for total research output by the *Nature*, according to their 2014 index.⁴¹

The Leiden Ranking, developed at the Centre for Science and Technology Studies at Leiden University, tracks scientific journal publications and citations across all major universities in the world. In addition, they track publications that are cited most frequently.⁴² According to these rankings, UC San Diego ranks seventh in the world for biomedical and health sciences publications, placing UC San Diego in the top one percent internationally. The Leiden Ranking also tracks collaboration on journal entries. From 2010 to 2013, UC San Diego collaborated with industry partners on more than 2,000 scientific publications, ranking sixth among universities in the world.

The Scimago Institutions Rankings (SIR) provides similar measures to Leiden, but includes independent non-profit research institutes in their rankings.⁴³ According to SIR, San Diego is home to four of the top 30 most cited institutions. When measuring patent citations in health, or as SIR calls it “Innovative Knowledge,” San Diego is home to three independent institutes in the top 50 in the U.S., with TSRI ranking 10th. By this same measure, UC San Diego ranks seventh among 350 U.S. universities. When ranking “Technological Impact,” which takes a percentage of output rather than the total, San Diego has four institutions in the top 15 in the United States.

PATENTS

As briefly discussed in Section II, patenting and licensing activities can play a large role in assuring the economic impact of research. The exact economic impact is not feasible to estimate, but we can compare patent activity from federal dollars in San Diego to other regions in the United States. The NIH ExPORTER database offers an agreed upon base for comparing the total output of patents from NIH grants and contracts for the fiscal years 2013 and 2014. Of course, technology transfer offices within the institutes and universities license and patent many technologies that include other funders. Based on the 2014 CONNECT Innovation Report, San Diego was granted more than 6,500 total patents in 2014—the highest ever recorded for the region.⁴⁴ The NIH patent data includes activities from commercial and non-profit entities, with the vast majority coming from university tech transfer and non-profit research institutes.

KEY FACTS

- San Diego ranks third in the nation in patent intensity (patents per thousand employees) among major markets. In 2013, San Diego was granted 3.6 patents per thousand employees, more than other high-tech regions, such as Boston, Austin, Seattle and New York.⁴⁵

⁴⁰ Scripps Press Release: http://www.scripps.edu/newsandviews/e_20150824/ofnote.html

⁴¹ UC San Diego Campus Profile: <http://ucpa.ucsd.edu/resources/campus-profile/>

⁴² The Leiden Ranking: <http://www.leidenranking.com/ranking/2015>

⁴³ The Scimago Institutions Ranking: <http://www.scimagoir.com/innovation.php>

⁴⁴ CONNECT 2014 Innovation Report: http://live-connect-site.pantheon.io/sites/default/files/Innovation_Report_2014-FINAL-May20_1.pdf

⁴⁵ Based on data from the USPTO and Bureau of Labor Statistics, Current Employment Survey, with calculations by San Diego Regional EDC. Includes only metropolitan areas with more than one million people.



PART IV: COMPETITIVE ADVANTAGES

- In 2013 and 2014, San Diego firms and institutions generated 3,542 patents from NIH-funded projects. This ranked 8th among all U.S. regions.
- UC San Diego represented the highest patent activity among research institutions in the region, accounting for nearly half of all patents during the period.
- Of all organizations in the world receiving NIH funding during that period, UC San Diego generated the ninth most patents from projects.
- The Scripps Research Institute led all non-profit research institutes with 679 patents from NIH-backed projects in 2013 and 2014. SBP was fifth in NIH-backed patents over that period, with 279 patents, followed by Salk at eighth with 189.⁴⁶
- San Diego's independent research institutes definitively led all regions in terms of leveraging NIH dollars to patents.⁴⁷

SECTION HIGHLIGHTS

- Collectively, San Diego's non-profit, independent research institutes received more NIH research funding than any other metro area in the United States. In addition, San Diego had three institutes in the top ten for most funded institutes in the nation.
- UC San Diego research funding hovers around one billion dollars annually and ranks in the top five universities in the United States for R&D expenditures.
- Scientific R&D in San Diego is successfully commercialized in large part because of the connections between the for-profit enterprises and the non-profit research institutes and universities. San Diego is one of the most competitive life sciences markets in the world and the corporate and non-profit communities offer ample resources for discovery, proof of concept, company creation, and commercialization.
- Talent is a key driver of the success of scientific R&D. San Diego is home to many of the world's brightest and best scientists engaged in pioneering research. Additionally, the region has a depth of talent that is becoming increasingly important to growing businesses in the R&D space.
- UC San Diego and the region's top research institutes publish some of the most oft-cited journal articles in the world. San Diego is one of the most collaborative as well, with more than 2,000 publications by researchers and collaborators.
- San Diego is one of the most patent rich regions in the United States. Notably, it is one of the top regions in the world for turning NIH funding into patented technologies. Three San Diego institutes ranked in the top 10 for NIH-backed patents from independent research institutes, and TSRI had the most of any independent institute in the world.

⁴⁶ Note: These institutions develop far more patents from other funding sources. This figure is comparing patents from NIH-backed projects, using the NIH ExPORTER database.

⁴⁷ Independent research institutes only, excluding hospitals and universities.

PART V: PRIVATE SECTOR SURVEY



In order to gain perspective from the private sector, private firms in San Diego County were surveyed to determine their geographic scope of operations and the extent of research and development activities. The survey also collected private sector opinions about the value of the research going on at universities, institutes, and non-profit organizations. The following section highlights the key elements of the primary research.¹

IDENTIFICATION AND CATEGORIZATION OF RESEARCH GRANTS

Another component of San Diego's robust research cluster are the private firms contracted to do specific research or technology development projects. The private firms that received the majority of research grants from 2012 to 2014 were identified using the North American Industry Classification System (NAICS) taxonomy. The following primary private industry clusters were identified as contributors to San Diego's R&D cluster:

- Information and communications technologies (ICT): including hardware and software manufacturing and programming, telecommunications, engineering services, electronic component manufacturing, research and development in physical and engineering sciences, etc.
- Biotech, biomedical and healthcare (life sciences): including pharmaceutical manufacturing, medical instrument supplies manufacturing, testing laboratories, health care and social assistance, research and development in life sciences, etc.
- Professional services: including legal services, accounting services, architectural services, market consulting services, etc.
- Banking and finance: including commercial banks, savings institutions, credit unions, investment services, financial advising, real estate appraisal, etc.

Firms with 50 or more employees were targeted for the survey. Larger businesses were targeted as they were most likely to have working relationships with research institutions in the county. For industry clusters with low establishment counts, firms with as few as 15 employees were also contacted to ensure an adequate response rate. The survey received 100 completed responses out of 612 who were identified and qualified for the survey—a completion rate of 16.4 percent. The remaining 512 either refused, did not finish the survey, or did not set up a callback.

BUSINESS PROFILE AND CUSTOMER AND SUPPLIER CONNECTIONS

Among the establishments surveyed, the largest proportion employ less than 25 workers, while the remaining firms were split between having 25 to 49 employees and 50 or more employees.

¹ For the full survey topline, see Appendix B.

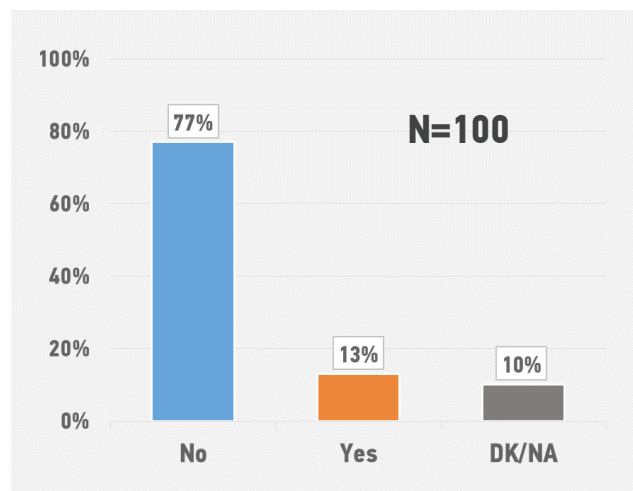
- More than two-thirds of responding businesses indicated that they had two or more locations in San Diego County, just under three-fourths have been located in the region for more than 10 years.
- More than half of all firms indicated that their customers were located nearby, with 31 percent of businesses claiming customers outside of San Diego County, but within Southern California. Eighteen percent of respondents indicated that they served customers internationally.
- Banking and finance, and biotech, biomedical, and healthcare firms were more likely to report customers in San Diego County than professional services and ICT establishments.
- Half of all firms identified having vendors and suppliers that were within San Diego County or within the United States (but outside California). Only 14 percent of surveyed firms said that they had vendors or suppliers outside of the United States (international).
- ICT businesses were the least likely among all industry sectors to identify suppliers or vendors in San Diego County. Few small employers (less than 25 employees) reported suppliers or vendors in Southern California (but outside San Diego County) when compared to medium-sized business (25 to 49 employees) or larger employers (50 or more employees).

RESEARCH INVESTMENT

The survey also documents current research investment activity at San Diego County ICT, life sciences, professional services, and banking and finance firms.

- More than one-third of businesses surveyed employed researchers or comparable analysts who work on internal research and development projects. There were no significant differences in the responses to this question when reviewing separate industry clusters or business size.
- Just more than one-quarter of firms contract with professional or commercial research firms or invest in external research projects that are directly related to products, services, or markets where their business is involved.
- Establishments with 50 or more employees were more likely to hire for or invest in research than average. A smaller proportion of firms had given to or invested in non-profit research.

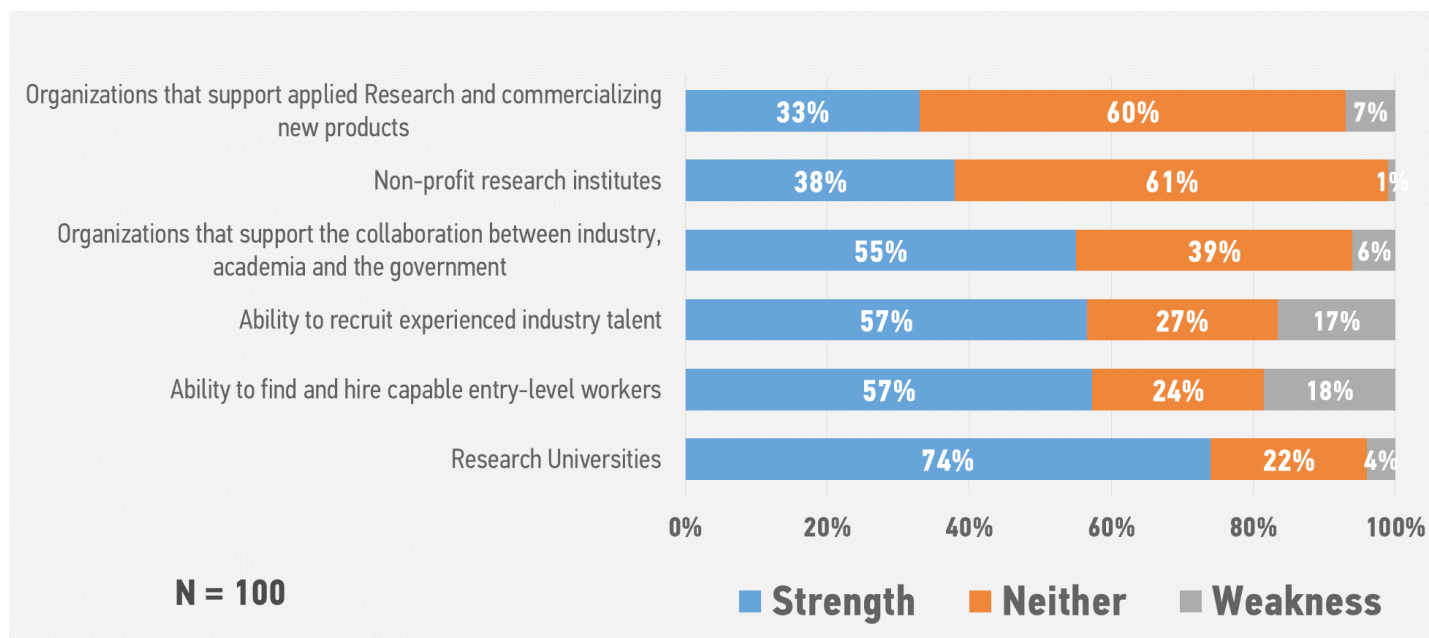
FIGURE 5.1: Given to or invested in Non-Commercial R&D



PART V: SURVEY



FIGURE 5.2: Opinions of San Diego County Resources and Business Opportunities



SAN DIEGO COUNTY RESOURCES AND BUSINESS OPPORTUNITIES

In order to obtain a general sense of how businesses feel about San Diego County's resources and business opportunities, firms were asked to provide a response of "Strength," "Weakness," or "Neither" when presented with various options.

- Research universities garnered the highest "Strength" rating, with just under three-quarters of respondents providing that response.
- The majority of responding firms felt that the ability to find and hire capable entry-level workers, the ability to recruit experienced industry talent, and the presence of organizations that support the collaboration between industry, academia, and government were existing strengths in San Diego County.

Depending on industry cluster and business size, responses varied:

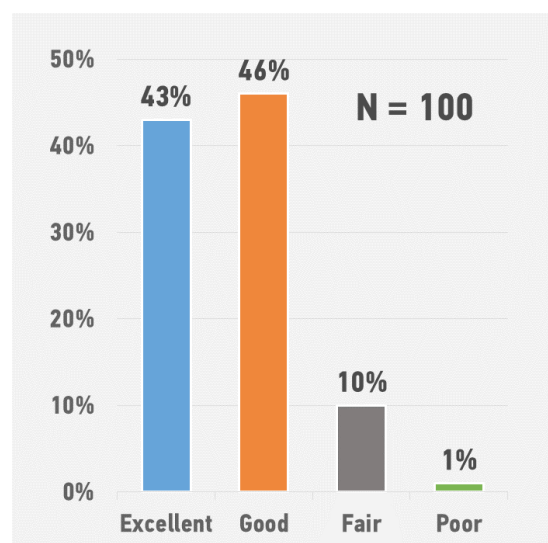
- Large firms (50 or more employees) were most likely to indicate that research universities were a "Strength" when compared to firms with less than 50 employees.
- Biotech, biomedical, and healthcare firms were more likely to indicate that the presence of organizations in San Diego County that support the collaboration between industry, academia, and government was a "Strength" than others.

INDUSTRY VIEW OF SAN DIEGO COUNTY RESEARCH INSTITUTIONS

Finally, responding firms were asked to answer questions directly related to research institutions in San Diego County.

- San Diego County firms have an overwhelmingly positive view of research institutions in the county, with nearly nine in ten indicating that they were either “Excellent” or “Good.”
- When asked to list academic and non-profit research institutions in the County, the largest proportion of businesses mentioned UC San Diego, followed by The Scripps Research Institute and San Diego State University.
- In ranking of overall importance, research universities received the highest rating from firms in the County, with over a third indicating that they were “Extremely important” and 38 percent saying that research universities were “Somewhat important” to their firm and its connections to the regional economy.
- Organizations that support the collaboration between industry, academia and government, non-profit research institutions, and the presence of organizations to support applied research and commercializing new products were all deemed important by a majority of surveyed firms.

FIGURE 5.3: Overall Rating of San Diego County Research Institutes



Perceived importance of resources and organizations to private firms in San Diego County varied between industry clusters and firm size:

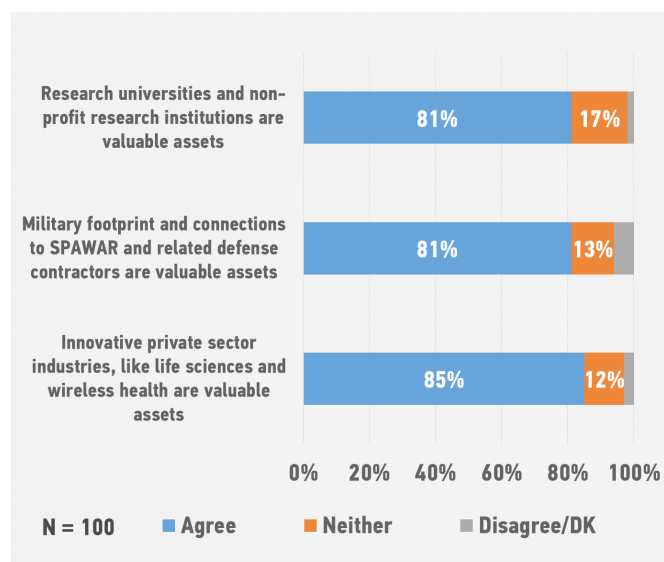
- Not one of the 34 ICT business respondents indicated that the existence of organizations to support applied research and commercializing new products was “Extremely important.”
- Firms with 50 or more employees (28 percent of responses), were more likely to suggest that the presence of organizations to support applied research and commercializing new products was “Extremely important” when compared to businesses with less than 50 workers.
- Surveyed organizations with less than 50 employees (72 percent of responses) were much more likely to say that non-profit research institutions were “Not at all important” than firms with 50 or more employees.

PART V: SURVEY

Responding firms were then asked to report their agreement with a list of statements that were unique to San Diego County.

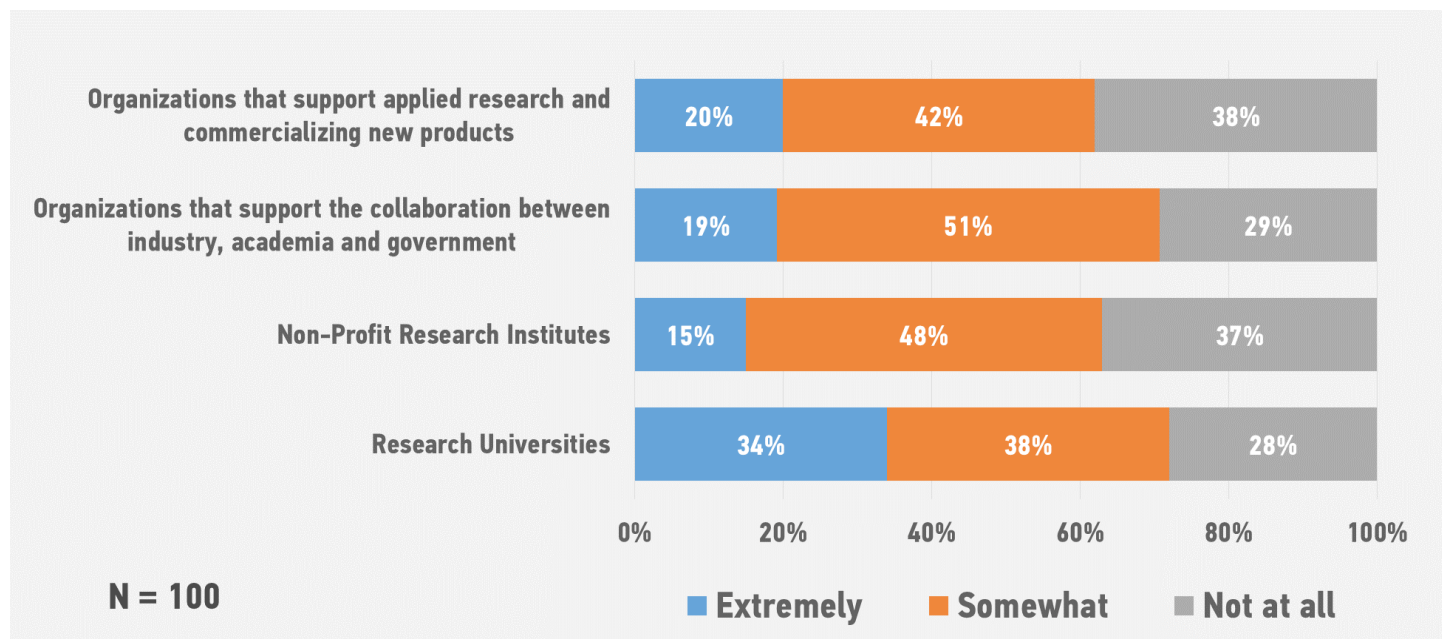
- Overall agreement was strongest for “San Diego County’s innovative private sector industries, like life sciences and wireless health, are a valuable asset to the regional economy and its business community,” with 60 percent indicating that they “Strongly agree” and a quarter saying that they “Somewhat agree” with the statement.
- Sixty-two percent of businesses said that they “Strongly agree” with “San Diego County’s military footprint and connections to SPAWAR and related defense contractors are a valuable asset to the regional economy and its business community.”
- Reviewing industry clusters, ICT firms were most likely to “Strongly agree” with “San Diego County’s innovative private sector industries, like life sciences and wireless health are a valuable asset to the regional economy and its business community.”

FIGURE 5.4: Agreement with Statements Attributable to San Diego County



SECTION HIGHLIGHTS

- Eighty-nine percent of employers rated San Diego’s research institutions as good or excellent.
- Eighty-one percent of respondents agreed that San Diego County’s research universities and non-profit research institutions are valuable assets to the regional economy and business community.
- The majority of respondents viewed research universities and non-profit research institutes as extremely or somewhat important to private industry.
- The majority of firms responded that research universities as a resource in finding and hiring capable entry-level workers was a strength of the region, as is the ability to recruit experienced industry talent.
- Despite the generally positive views of research institutes and universities, responses were weaker to prompts that specifically called out the independent, non-profit research institutes. Less than a third of respondents expressed that they were a strength, while sixty-one percent responded that they were neither a strength nor a weakness (see figure 5.2 on page 24). When respondents were asked to name the region’s major institutes, The Scripps Research Institute was the only non-profit research institute (non-university) identified by over 10 percent of businesses (21 percent). These responses reinforce that the private sector is largely unaware of the role of independent research institutes.

FIGURE 5.5: Importance of Resources and Organizations

PART VI: CALL TO ACTION



CONCLUSIONS

Research institutions undoubtedly form the cornerstone of the research and development activity in San Diego and drive the region's globally recognized scientific R&D ecosystem. More than \$4 billion of economic impact stems from the region's research institutes and universities—which is 34 times the impact of San Diego Comic-Con, 33 that of the U.S. Open Golf Championship, and the equivalent of having six additional aircraft carriers stationed in San Diego harbor. The unexpected size, economic impact and potential growth of the R&D sector in San Diego is astounding, not only in the total economic impact, but in the depth and strength of the entire ecosystem. Key advantages and opportunities include:

- The amount of lab space exceeds the total square footage of shopping malls, which has profound implications for construction jobs, maintenance jobs, and an array of service jobs that tend to aggregate around industrial and science parks.
- The large and growing number of high-wage jobs are dispersed across the education spectrum because of the need for technical, clerical, and other support staff in the operation of research enterprises at the scale we have discovered.
- The number of science, engineering, and technical superstars who are second to none in quality of work and global reputation make San Diego a magnet for companies and talent.
- Foreign investment in R&D presents an opportunity to improve San Diego's global connectedness. Research institutions in San Diego already perform on the global stage, and they can be the catalyst for attracting more global attention and funding to the region's scientific R&D ecosystem.

Even though San Diego's non-profit research institutes and universities have generally enjoyed large and growing shares of funding for R&D, continuous legislative and community support is critical going forward. To capitalize on the global investment opportunities and weather the potential federal budget concerns illuminated in this study, research institutions need a much broader base of local institutional and philanthropic support.

This study also underscores the importance of very deliberate strategies across the community to attract, retain, and expand the capacity of the research institutes, companies, and high-level talent that are operating in this global R&D center. This industry generates a very high return on investment, as demonstrated by the enormous economic impacts, but it lacks a deliberate focus from public agencies and economic developers in the region.

The critical role of talent in enabling the growth and sustainability of this sector cannot be overstated. While San Diego has a wealth of talent in the high-level scientific, engineering and medical professions, it is equally significant to have a labor pool that is extremely adept at technical, lab management, communications, maintenance and related ongoing support roles, such as lab assistants, technicians, and other middle-skill occupations.

A CALL TO ACTION

Research institution leaders must coordinate with key stakeholders to support the continued growth and impact of research institutions and R&D. Success will require a coalition of economic development agencies, workforce organizations, public and elected officials, education institutions, and leaders from the scientific R&D cluster. We recommend that the community come together to develop a more thorough action plan to address the issues and strategies outlined below.

BUILD SUPPORTING COALITIONS

San Diego's non-profit research institutes and universities have benefited from large shares of R&D funding, but continuous legislative and community support is critical to the sector. The region will need to:

- **Form a coalition with mayors, congressional leaders, and other stakeholders from key nationwide R&D centers to collectively advocate for research support.** The federal budget and philanthropic constraints affect regions around the United States. While national industry associations exist, no such coalition of elected officials and policy leaders exists for these issues. San Diego can lead a coordinated effort that includes local and national elected officials from key peer cities and university chancellors and presidents from other high-profile research universities to focus on influencing federal leaders and large philanthropic foundations for increased support across all key research hubs.
- **Organize quarterly coordinated visits to D.C. with key local leaders, companies, and institutions.** Organizations like CONNECT, San Diego Regional Chamber of Commerce, and San Diego Regional EDC already attend or organize coordinated visits on behalf of other interests in the community, but there is little coordinated effort between these organizations around research funding and support. Biocom currently advocates and lobbies on behalf of Southern California's life science companies, with a program working with other regional and national partners that calls for increasing NIH, FDA, and DOE funding, as well as specific legislation that impacts federally-funded health and medical research projects. Other San Diego organizations, firms, and institutes should both support Biocom's efforts in this area as well as work with Biocom to integrate these points strongly into their own messaging to present the strongest cohesive effort for the region.
- **Establish strategic partnerships with universities, philanthropists, foundations, and for-profit enterprises around the world.** While many of these partnerships already exist, it will remain important to seek out new avenues both in the region and around the world. Partnerships with major firms, such as the KKC and Takeda examples on page 19, provide years of sustained funding and access to facilities and talent. Similar partnerships could be formed with for-profit enterprises or non-profit research universities and institutes to leverage complementary resources.

PART VI: CALL TO ACTION



DRIVE THE ECONOMIC DEVELOPMENT OPPORTUNITIES

Given the high return on investment, deliberate strategies across the community to attract, retain, and expand R&D investment, philanthropy, and federal funding are essential. The region will need to:

- **Coordinate with EDC's Go Global Initiative to attract more foreign investment and partnerships.** Many key stakeholders in the region have already rallied around San Diego's Go Global Initiative, which seeks to maximize San Diego's economic competitiveness through increased global engagement. It will be important for both research institutions and for-profit R&D enterprises to have their interests integrated in the initiative to form new partnerships and attract investment from around the world.
- **Organize quarterly open-invitation briefings with public officials.** These meetings are intended to give research institution leaders a forum to express their concerns and highlight their recent accomplishments, with the ultimate goal of opening continued lines of communication between political leadership and research institutions.
- **Release an annual economic impact report to continually promote messaging.** While the messaging in this study is impactful, it will be important to continue to drive the message. This study highlighted that the importance of this industry is still relatively unrecognized by private industry. As the scientific R&D sector grows and evolves, a regular report that documents the ongoing challenges and advantages will be important in engaging the region's leaders and community.

ADDRESS WORKFORCE NEEDS

While San Diego has a wealth of high-level talent, it is equally significant to have a labor pool that is extremely adept at a broader range of ongoing support roles. The specific talent needs of research institutions and life science firms may vary, but research institutions can play a critical role in implementing education programs that benefit both basic and applied research. The region will need to:

- **Redouble efforts on STEM training by developing short-term, technical training programs.** As the needs in laboratories evolve, the workforce and education institutions need to keep up. New skills and occupations are arising in areas like bioinformatics, data mining, and data analysis that are often lost between fields of study in traditional education. The region will need to assess and adapt their education and training programs and offer new certifications or credentials in these new areas as they arise.
- **Focus efforts on important middle-skill positions, such as lab technicians and assistants.** While these positions may be less important to research institutions themselves, they have become challenging positions for life science firms to fulfill. The region needs to invest in STEM at the middle and high school levels to expose students about the opportunities in broader career pathways in the field—beyond Ph.D. level careers.



- **Support and develop interactive and innovative programs to better engage K-12 students in STEM.** San Diego has already developed interactive laboratories, such as the Salk Mobile Science Lab, JCVI's "Discover Genomics!" program, and Qualcomm's Thinkabit lab. While these programs have been successful, they are limited in the number of students they can reach. Scholarship programs focused around STEM can also increase the interest from high school students. San Diego could come together to create a "San Diego Scholars Program," akin to the Intel Science Challenge Search, which awards \$1 million in prizes to students who present the best original research projects.¹ A San Diego-focused competition would increase student interest in scientific research and expose them to the world-renowned scientists who perform research at our research institutions and firms. Increased investment from research institutions, foundations, and public sources to develop more programs like these will be essential in engaging the next wave of STEM workers.

¹ <https://student.societyforscience.org/intel-sts>

APPENDIX A – METHODOLOGY AND NOTES



ECONOMIC IMPACTS

To determine the impact of institutes in the region, we collected as much available data as possible to aggregate information on employment, revenue, expenditures, and wages. Often this data came from a variety of sources, but most notably from USASpending.gov, IRS Form 990s (through Guidestar), and the National Science Foundation's Higher Education R&D Survey.

We calculated annual averages from 2012 to 2014 when possible to account for funding swings (see Part III), but occasionally we could only find data for one of those years.

CENSUS OF KNOWN RESEARCH INSTITUTES

We began building a list of known research institutes by identifying those non-profit research institutes that received federal grants from 2012 to 2014, using USASpending.gov (See Appendix A, Funding Analysis for more info on the USASpending database). We built this list out further by looking at lists from Hoover's/D&B, ReferenceUSA, Guidestar, Inside Prospects, and other available online search sources.

Once we identified a sizeable list and were confident that we had captured most of the economic activity, we obtained IRS Form 990s from Guidestar to get employment records and expenditures. We we could not track down a Form 990, we used data directly from the organization's web site or through one of the business listing databases mentioned. We adjusted some counts based on direct interviews with the institute.

We identified more than 100 medical and scientific research institutes, but many did not have a Form 990 for any year or did not report any employment or spending on their Form 990. We then sought other resources for employment, sales or expenditure data, but many did not have a web site, did not have any recent presence in web searches, or did not receive any federal funding recently. In total, we compiled complete data on 36 independent institutes.

UNIVERSITY RESEARCH¹

For universities, we analyzed data from Institution Profiles from the National Science Foundation, National Center for Science and Engineering Statistics, Higher Education R&D Survey.² For employment counts, we used the "Headcount of R&D Personnel" tables for each university in the region to delineate the research employment from general university employment.³

IMPLAN MODEL

We used MIG IMPLAN⁴, a widely accepted tool for economic impact assessment, to asses the indirect and induced impacts on employment and value added (gross regional product). Indirect impacts are the effects of local industries buying goods and services from other industries. For instance, management consultants, law firms, market research, and other scientific R&D establishments generate local impacts through their buying and selling activities with research institutions. Induced impacts are a result of employees at research institutions spending their dollars in the local economy, usually on food services, medical services, housing, and leisure.⁵

1 For more information on questions and definitions from NSF, see: http://www.nsf.gov/statistics/srvyherd/surveys/srvyherd_2013.pdf

2 <http://ncesdata.nsf.gov/profiles/site>

3 UC San Diego example: <http://ncesdata.nsf.gov/profiles/site?method=report&fice=1317&id=h4>

4 IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 www.IMPLAN.com

5 http://www.implan.com/index.php?option=com_glossary&task=list&letter=&Itemid=1866



Employment count and employee compensation inputs came from the census of known independent research institutes and the university research counts from NSF. The IMPLAN model will impute missing figures for industry sales, employment and employee compensation, if you have any one of the following inputs: sales, employment, and employee compensation. When possible, we used the Form 990 figures, but occasionally employee compensation model values were used when we did not have reliable data. We also adjusted the industry sales down based on the expenditures data from the 990s on each research institute. We used the expenditure data from the “Total R&D Expenditures by Field” table from NSF to scale down the industry sales input in the IMPLAN model for universities.⁶ We assumed that the IMPLAN model was over-estimating the output because it is based on data that includes the for-profit sector. Therefore, for a more conservative estimate, we used an adjusted sales input based on NSF data.

We used Quarterly Census of Employment and Wages (QCEW) data from the California Employment Development Department (EDD) to estimate employment for for-profit scientific R&D enterprises. We pulled the employment and wage data for the NAICS 5417 sector. This sector also includes independent research institutes in the data, so we subtracted the employment number aggregated from our census not to double count economic impacts. This is why the direct figure listed in figure 2.1 on page 4 is lower than the number reported by EDD. The EDD figure also does not include R&D portions of the universities, which is then added to determine the count of all scientific R&D activity in the region. For employee compensation for universities, we used the model’s average wage.

We used IMPLAN sector 456, Scientific Research and Development Services, for all estimates and analysis.

To find out more about how IMPLAN works, visit the IMPLAN product page⁷, glossary⁸, and FAQ pages⁹. The University of Florida IFAS Extension also provides a helpful summary on how the IMPLAN model is used in economic analysis.¹⁰

FUNDING ANALYSIS

The flow of federal dollars to the region is based on data from USAspending.gov. This source provided data for the analysis of all grant and contract awards for San Diego County from 2012 to 2014. By sorting through Product Service Codes (PSC), Federal Supply Codes (FSC) and the Catalog of Federal Domestic Assistance (CFDA), we determined which dollars were specifically earmarked for scientific research and development, as opposed to dollars for training programs, facilities, general education, or non-scientific purposes.

Information from IRS Form 990s were used to determine philanthropic contributions to research institutes. Form 990s report donor contributions separate from federal grants, making it possible to aggregate all philanthropic support to institutes in the region.

For universities, data from the Higher Education Research and Development (HERD) Survey and National Center for Science and Engineering Statistics (NCSES) from the National Science Foundation (NSF) was used. Table 18 breaks down higher education R&D expenditures by source of funds. We included data from non-profit organizations, institution funds, all other sources columns.¹¹

For major contributions, data from the Million Dollar List compiled by the Indiana University Lilly Family School of Philanthropy was used. It can be found at <http://www.milliondollarlist.org>.

6 <http://ncesdata.nsf.gov/profiles/site?method=report&fice=1317&id=h1>

7 http://www.implan.com/index.php?option=com_content&view=article&id=330&Itemid=1747

8 http://www.implan.com/index.php?option=com_glossary&task=list&letter=&Itemid=1866

9 http://www.implan.com/index.php?option=com_content&view=article&id=348&Itemid=1791

10 <https://edis.ifas.ufl.edu/fe168>

11 http://ncesdata.nsf.gov/herd/2013/html/HERD2013_DST_18.html



APPENDIX B - SURVEY TOPLINES



**SDREDC – Research Institutions
Private Sector Large Businesses
July 2015
Preliminary Toplines (n=100)**

.....
Introduction:

Hello, my name is _____. May I speak to _____ [IF NO NAME IS DETERMINED USE] May I please speak to a manager or a decision maker who is involved in planning, research or budgeting at [firm name]?

I am calling on behalf of BW Research, an independent research organization working on behalf of the San Diego Regional Economic Development Corporation.

The survey will take a few minutes of your time and will help us better understand how to support businesses in our region.

(If needed): This survey has been commissioned by the San Diego Regional Economic Development Corporation, which is committed to supporting the businesses in the County.

(If needed): The survey is being conducted by BW Research, an independent research organization, and should take approximately ten minutes of your time.

(If needed): Your individual responses will **not** be published; only aggregate information will be used in the reporting of the survey results.

.....
Screener Questions

A. Are you involved or leading the planning, research or budgeting at your firm?

100% Yes [CONTINUE]
0% No [TERMINATE]
0% Not sure [TERMINATE]

B. How many business locations does your company or organization have in San Diego County? (Recoded into categories)

73% 1 location in San Diego County
11% 2 locations in San Diego County
16% 3 or more locations in San Diego County

[PART 1 – BUSINESS PROFILE AND CUSTOMER AND SUPPLIER CONNECTIONS]

1. How many years have you had at least one business location in San Diego County?
(Recoded into categories)

7% 0 to 2 years
9% More than 2 up to 5 years
11% More than 5 up to 10 years
24% More than 10 years up to 20 years
48% More than 20 years
1% [DON'T READ] DK/NA

Next I would like to ask about the industries that are most important to your firm.

2. What industry or industries best describes the work that your firm is involved in and connected to? (DO NOT READ, ALLOW MORE THAN ONE RESPONSE) (Multiple responses permitted – percentages may sum to more than 100%)

37% Professional and technical services
30% Life sciences and healthcare
11% Banking and finance
9% Technology or information technology
4% Internet or communications
3% Telecommunications or telecom, including wireless communication
3% Software or non-cyber security software publishing
3% Defense or aerospace
3% Manufacturing
3% Non-profit organization
2% Cyber security or information technology (IT) security or encryption
2% Information technology hardware development
2% Networking
2% Utility or energy
1% Communications or wireless, including mobile devices
5% Other

3. Are your customers primarily local - within San Diego County, regional - within Southern California, Statewide – within California, national – within the Country, or international - outside the Country? [ALLOW MULTIPLE RESPONSES] (Multiple responses permitted – percentages may sum to more than 100%)

55% Local - San Diego County
31% Regional - within Southern California
20% Statewide - within California
31% National - within the United States
18% International - outside the United States
1% [DON'T READ] Don't know

4. Are your suppliers and vendors primarily local - within San Diego County, regional - within Southern California, Statewide – within California, national – within the Country, or international - outside the Country? [ALLOW MULTIPLE RESPONSES] (Multiple responses permitted – percentages may sum to more than 100%)

49% Local - San Diego County
22% Regional - within Southern California
22% Statewide - within California
51% National - within the United States
14% International - outside the United States
2% Do not have suppliers or vendors
0% [DON'T READ] Don't know

[PART 2 – RESEARCH PROFILE AND FUNDING]

Now, I would like to ask you about your firm's research investments,

5. Does your firm employ researchers or comparable analysts, who work on internal research and development projects? [IF NEEDED: THESE WOULD BE INDIVIDUALS THAT SPEND AT LEAST HALF OF THEIR TIME ENGAGING IN RESEARCH AND DEVELOPMENT PROJECTS DIRECTLY RELATED TO THE PRODUCTS, SERVICES AND/OR MARKETS THAT YOUR FIRM IS ENGAGED IN].

34% Yes
61% No
5% [DON'T READ] DK/NA

6. Does your firm hire professional or commercial research firms or invest in research projects that are directly related to products, services or markets that your firm is involved in?

26% Yes
69% No
5% [DON'T READ] DK/NA

Next, I want to ask you about public, academic and what we will call non-profit research that may be related to the industries your firm is involved with, but not specific to the products or services that your firm is examining or developing. [IF NEEDED: NON-PROFIT RESEARCH WOULD INCLUDE DONATIONS TO UNIVERSITIES, FOUNDATIONS, OR INSTITUTIONS OR OTHER NON-PROFIT ORGANIZATIONS TO FUND RESEARCH THAT IS NOT SPECIFIC TO A PRODUCT, MARKET OR SERVICE THAT YOUR FIRM IS RESEARCHING]

7. Has your firm given or invested in non-profit research, like what was just described? [IF NEEDED REREAD INFORMATION IN THE ABOVE PARAGRAPH]

13% Yes
77% No
10% [DON'T READ] DK/NA

IF Q7 = "Yes" ASK Q8 AND Q9 OTHERWISE SKIP

8. How much money has your firm given in the last 12 months, to all non-profit research that we have described? [IF NEEDED REREAD INFORMATION IN THE ABOVE PARAGRAPH]
(Recoded into categories) (n=13) *Careful generalizing results, low sample size*

8% None in the last 12 months
54% \$1 to \$100,000
8% More than \$100,000 and up to \$1 million
31% [DON'T READ] DK/NA

SKIP Q9 IF Q8="None in the last 12 months"

9. Approximately, what percentage of the money given by your firm for non-profit research was given to San Diego County Organizations? [IF NEEDED REREAD INFORMATION IN THE ABOVE PARAGRAPH] (Recoded into categories) (n=12) *Careful generalizing results, low sample size*

8% All of it (100%)
8% More than half of it (50% to 74%)
17% Less than a quarter (1% to 24%)
25% None of it (0%)
42% [DON'T READ] DK/NA

[PART 3 – BENEFITS OF RESEARCH]

Next, I want to ask a few quick questions about the resources and business opportunities in San Diego County

10. Please tell me if you think the following resources in San Diego County are a strength of the region or if they are a weakness, in comparison to other regions your business could be located.

Are San Diego County's _____ a strength, a weakness or neither a strength nor weakness, when compared to other regions?

RANDOMIZE

	<u>Strength</u>	<u>Neither</u>	<u>Weakness</u>	(DON'T READ) <u>DK/NA</u>
A. Research universities	60%	18%	3%	19%
B. Ability to find and hire capable entry-level workers	50%	21%	16%	13%
C. Organizations to support applied research and commercializing new products	24%	44%	5%	27%
D. Non-profit research institutions	25%	40%	1%	34%
E. Ability to recruit experienced industry talent	51%	24%	15%	10%
F. Organizations that support the collaboration between industry, academia and government	45%	32%	5%	18%

Q10 with DK/NA removed

	<u>Strength</u>	<u>Neither</u>	<u>Weakness</u>
A. Research universities (n=81)	74%	22%	4%
B. Ability to find and hire capable entry-level workers (n=87)	57%	24%	18%
C. Organizations to support applied research and commercializing new products (n=73)	33%	60%	7%
D. Non-profit research institutions (n=66)	38%	61%	2%
E. Ability to recruit experienced industry talent (n=90)	57%	27%	17%
F. Organizations that support the collaboration between industry, academia and government (n=82)	55%	39%	6%

11. Overall how would you rate San Diego County's research institutions, including its research universities, institutions and those non-profit organizations that are involved in academic, public or non-profit research?

35% Excellent
37% Good
8% Fair
1% Poor
19% [DON'T READ] DK/NA

Q11 with DK/NA removed

43% Excellent
46% Good
10% Fair
1% Poor

12. When I ask you about San Diego County's public, academic and non-profit research institutions, what are the first organizations that come to mind? [DO NOT READ, ALLOW UP TO THREE RESPONSES]

45% University of California, San Diego
21% Scripps Research Institute
12% San Diego State University
11% Universities, general
9% University of San Diego
7% Salk Institute
17% Other – No single category over 3%
19% DK/NA

13. Please tell me how important the following resources and organizations are to your firm and its connections to the regional economy.

RANDOMIZE

	<u>Extremely important</u>	<u>Somewhat important</u>	<u>Not at all important</u>	<u>(DON'T READ) It depends</u>	<u>(DON'T READ) DK/NA</u>
A. Research universities	31%	35%	25%	0%	9%
B. Organizations to support applied research and commercializing new products	18%	38%	34%	0%	10%
C. Non-profit research institutions	14%	44%	34%	0%	8%
D. Organizations that support the collaboration between industry, academia and government	18%	49%	28%	1%	4%

Q13 with DK/NA removed

	<u>Extremely important</u>	<u>Somewhat important</u>	<u>Not at all important</u>	<u>(DON'T READ) It depends</u>
A. Research universities (n=91)	31%	35%	25%	0%
B. Organizations to support applied research and commercializing new products (n=90)	18%	38%	34%	0%
C. Non-profit research institutions (n=92)	14%	44%	34%	0%
D. Organizations that support the collaboration between industry, academia and government (n=96)	18%	49%	28%	1%

14. Now I'm going to read a list of statements that describe attitudes or opinions regarding San Diego County as a place to do business

Here is the (first/next) one: _____ Do you generally agree, disagree, or neither agree nor disagree with the statement? (GET ANSWER IF AGREE OR DISAGREE ASK:) Would that be strongly (agree/disagree) or somewhat (agree/disagree)?

RANDOMIZE

	<u>Strongly agree</u>	<u>Somewhat agree</u>	<u>Neither agree nor disagree</u>	<u>Somewhat disagree</u>	<u>Strongly disagree</u>	<u>(DON'T READ) DK/NA</u>
A. San Diego County's research universities and non-profit research institutions are a valuable asset to the regional economy and its business community	49%	32%	17%	0%	0%	2%
B. San Diego County's military footprint and connections to SPAWAR and related defense contractors are a valuable asset to the regional economy and its business community	62%	19%	13%	1%	4%	1%
C. San Diego County's innovative private sector industries, like life sciences and wireless health are a valuable asset to the regional economy and its business community	60%	25%	12%	1%	0%	2%

15. Lastly, is there anything you would like to see San Diego County improve as it relates to its public and non-profit research institutions and capabilities?

Verbatim responses to be provided

16. What city is your firm headquartered in?

41.0% San Diego
 6.0% Escondido
 5.0% Carlsbad
 3.0% Oceanside
 3.0% Poway
 18.0% Other cities in San Diego
 9.0% Southern California, but outside San Diego County
 15.0% United States, but outside of California

17. Would you be willing to be contacted by researchers and/or educators who are developing new strategies and regional plans to support the San Diego County business community?

40% Yes

58% No

2% [DON'T READ] DK/NA

Since it sometimes becomes necessary for the project manager to call back and confirm responses to certain questions, I would like to verify your contact information.

A. First and Last Name _____

B. Position _____

C. Phone _____

D. Email _____

E. Company Name _____

**Those are all of the questions I have for you.
Thank you very much for participating!**

F. Company Name _____

G. Company location _____

H. Date and time of Interview _____

I. Name of Interviewer _____

J. PRIMARY NAICS CODE (ACCORDING TO DATA FILE) _____

K. SECONDARY NAICS CODE (ACCORDING TO DATA FILE) _____

L. NUMBER OF EMPLOYEES (ACCORDING TO DATA FILE) _____