MILKEN INSTITUTE

Florida Life Sciences Road Map

June 2007

By Perry Wong, Ross DeVol,
Kevin Klowden, and Benjamin Yeo

With contributions by Armen Bedroussian,
Daniela Murphy, Anna Babayan, and Meggy Frye

Prepared for Enterprise Florida, Florida High Tech Corridor Council, and Workforce Florida

MILKEN INSTITUTE

Florida Life Sciences Road Map

By Perry Wong, Ross DeVol, Kevin Klowden, and Benjamin Yeo

With contributions by Armen Bedroussian, Daniela Murphy,
Anna Babayan, and Meggy Frye

Milken Institute

June 2007

Acknowledgements

The Milken Institute would like to thank the three sponsors of the study:

Enterprise Florida Inc.
Florida High Tech Corridor Council Inc.
Workforce Florida Inc.

The sponsors and the Institute would also like to thank the following organizations for additional support:

Broward Alliance
Business Development Board of Palm Beach County
Central Florida Development Council of Polk County
eSouthwest Florida (Charlotte, Lee, Collier counties)
Florida's Great Northwest
Greater Tampa Bay Chamber of Commerce
Jacksonville Regional Chamber of Commerce/Cornerstone Regional Development
Metro Orlando Economic Development Commission
Pinellas County Economic Development
St. Lucie County
Tampa Bay Partnership

As part of this study, five regional focus groups of hundreds of life sciences stakeholders were held: in the Great Northwest (Destin); Alachua/Gainesville, Tampa Bay (Clearwater); Central Florida (Orlando); South Florida (Boca Raton); and Northwest Florida (Jacksonville). In addition, a Florida Life Sciences Advisory Committee was established to help guide this effort, and it provided feedback and suggestions at major milestones. The study sponsors and the Institute would like to thank all of these stakeholders for their help in guiding this effort.

Finally, the authors would like to extend their appreciation to all the organizations that provided valuable information in support of this research. These include: Regeneration Technologies, Oragenics Technology, the University of Florida, Cardinal Health, NDH Medical, Andrews Institute/Baptist Hospital, the University of Central Florida, the University of South Florida, Florida Atlantic University, Essentia Biopharmaceuticals, Mercury Medical, Applied Genetic Technologies Corporation, Florida Space Research Institute, Florida State University, Mayo Clinic of Jacksonville, the University of Miami, Tequesta Marine Biosciences, H. Lee Moffitt Cancer Center & Research Institute, Gury Consulting, the Florida Institute for Human and Machine Cognition, Medtronic ENT and Neurological Technologies, Sitmar Biotechnology Incubator, Florida Medical Manufacturers Consortium, Biodelivery Sciences International, Black Knight Ventures, BioVest, and Metro Orlando Economic Development Corporation.

The Milken Institute is an independent economic think tank whose mission is to improve the lives and economic conditions of diverse populations in the United States and around the world by helping business and public policy leaders identify and implement innovative ideas for creating broad-based prosperity. We put research to work with the goal of revitalizing regions and finding new ways to generate capital for people with original ideas.

We do this by focusing on human capital—the talent, knowledge, and experience of people and their value to organizations, economies, and society; financial capital—innovations that allocate financial resources efficiently, especially to those who ordinarily would not have access to such resources, but who can best use them to build companies, create jobs, and solve long-standing social and economic problems; and social capital—the bonds of society, including schools, health care, cultural institutions, and government services that underlie economic advancement.

By creating ways to spread the benefits of human, financial, and social capital to as many people as possible—the democratization of capital—we hope to contribute to prosperity and freedom in all corners of the globe.

We are nonprofit, nonpartisan, and publicly supported.

© 2007 Milken Institute

Table of Contents

Executive Summary

Florida's life sciences industry has the potential to develop a robust innovation pipeline that links universities and research institutions with incubators, intellectual property firms, and venture capital. The industry has the capacity as well to develop a competitive edge nationally and in foreign markets, due to its well-established mix of sectors. One aim of this study is to explore synergies among these sectors that can generate stronger regional clusters and foster networks to capitalize on cluster strengths. Beyond the numbers of new workers directly employed in the sectors, we see positive impacts on the state's wider economies.

The Milken Institute has produced a road map for developing the industry. We begin with a general discussion of the components of a vibrant life sciences economy and Florida's strengths and weaknesses. We target areas in which the state is most likely to achieve economic growth—developing and leveraging its industry infrastructure (the full spectrum of its life sciences employment base), and optimizing research and industry assets.

We also analyze Florida's performance against ten benchmarked states: five peer states (Illinois, Michigan, Minnesota, North Carolina, and Texas) whose economic makeup and industry histories resemble Florida's; and five states that lead the nation in life sciences development (California, Massachusetts, New Jersey, New York, and Pennsylvania).

The Florida life sciences industry comprises service sectors that pertain to health-care delivery and treatment, and knowledge-intensive sectors, which include R&D, biotechnology, drugs and pharmaceuticals, and biotech and medical devices manufacturing.

Florida has an immense network of health-care facilities and some of the country's finest hospitals and research parks. Its medical devices manufacturing sector ranks No. 2 nationwide, based on the number of FDA-approved firms. It also serves a rapidly growing global market and benefits from a large employment pool and strong support policies. Eleven state universities and other private colleges and universities are available to support training and research, and Florida has begun an aggressive promotion of life sciences curricula, scientific/technical centers of excellence, and technology transfer offices that facilitate commercialization and licensing opportunities.

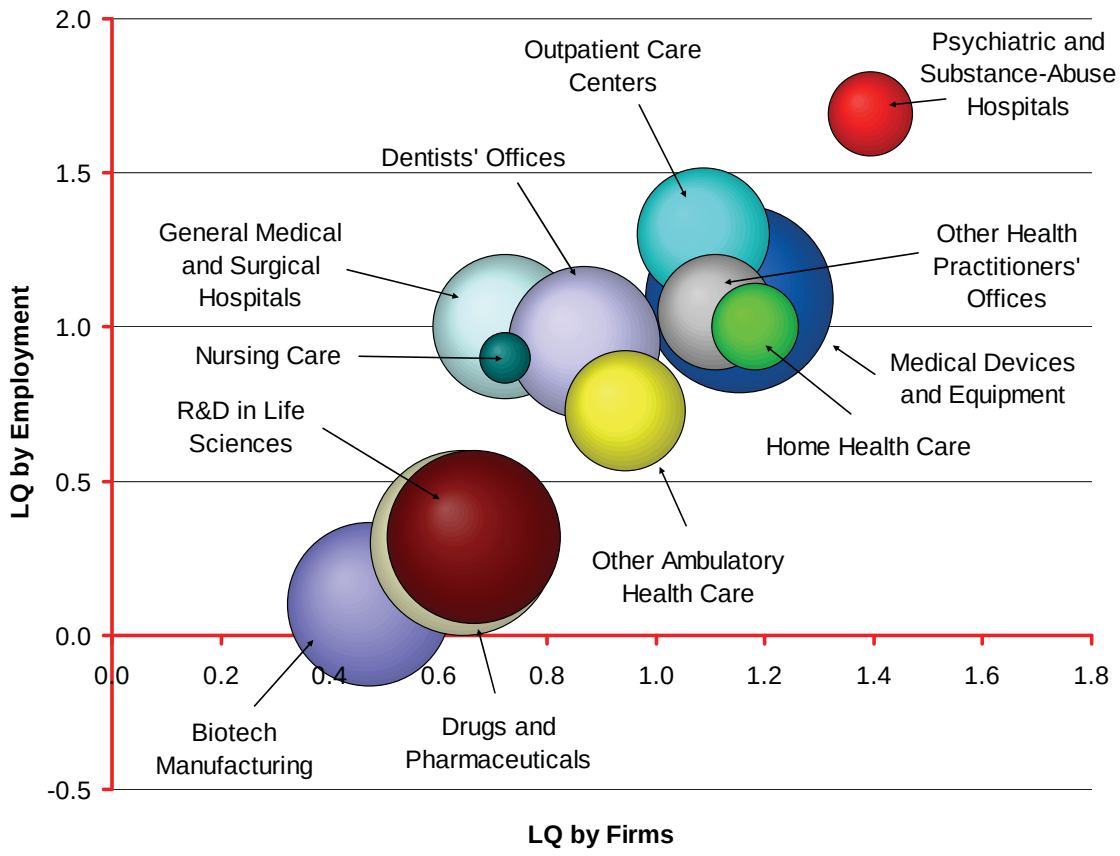
At the same time, the state's strong health-care services sector, which enjoys a large employment base, adds little so-called "high-value" growth to the economy. And the manufacturing sector, while robust in certain specialties, lacks the skilled technical employee base to develop fully. To stay competitive, the sector must depend increasingly on technological and scientific advances. Yet these advances likely will take place elsewhere unless the state takes immediate steps to bolster its small but growing research infrastructure, and attract and support the necessary human capital: researchers, engineers, and skilled technicians.

Compared to the benchmarked states, Florida has lower employment and firm concentrations in the cutting-edge life sciences sectors, such as biotech manufacturing, pharmaceuticals, and R&D. The state must direct its efforts toward developing the human capital and infrastructure to produce and recruit the best workers possible. A region

that lacks a scientific and knowledge-based work force, and a qualified administrative support base will not grow, attract, or nurture technology-based startups, and will likely experience economic decline.

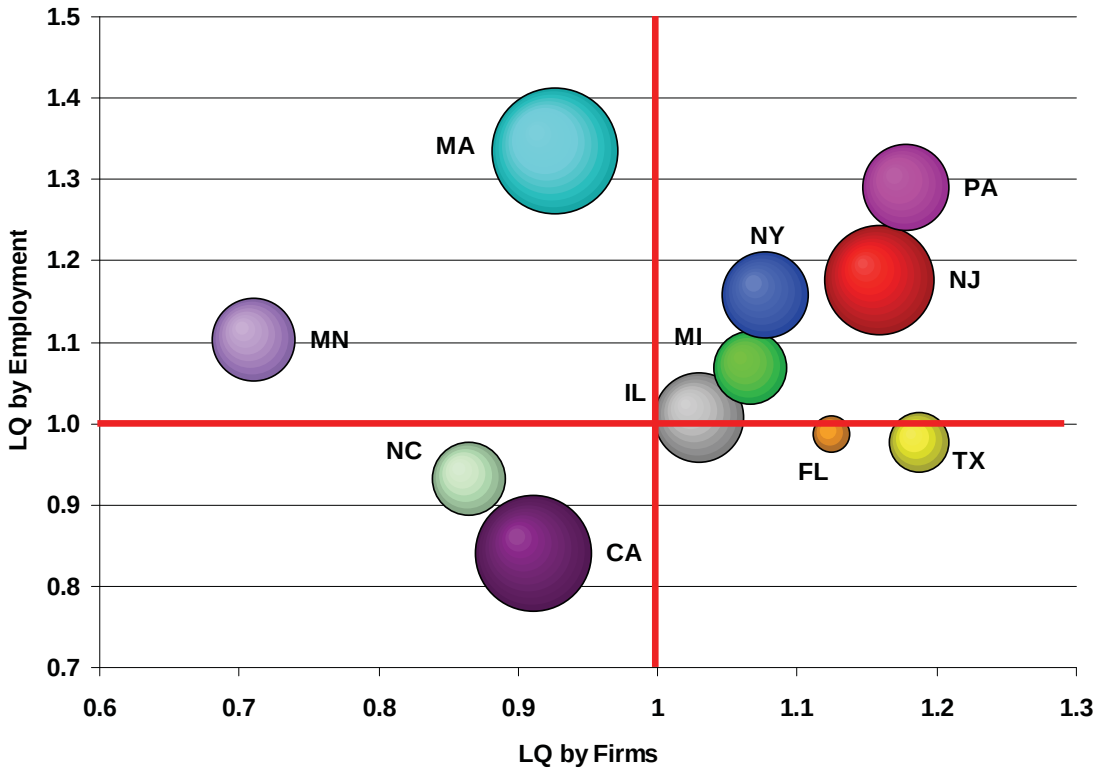
The following chart illustrates Florida's life sciences industry, broken into sectors defined by employment location quotient (LQ). Location quotient is calculated as a measure of the state's life sciences economic base relative to the life sciences economy of the United States as a whole. Three factors—employment, concentration of firms, and wages per worker—are accounted for. The relative size of the bubbles represents the wages per worker in each sector. As shown, workers in nursing care receive the lowest wages, while those in the drugs and pharmaceuticals sector receive among the highest. An LQ value of 1.0 represents the national average.

Wages per Worker in Florida's Life Sciences Industry



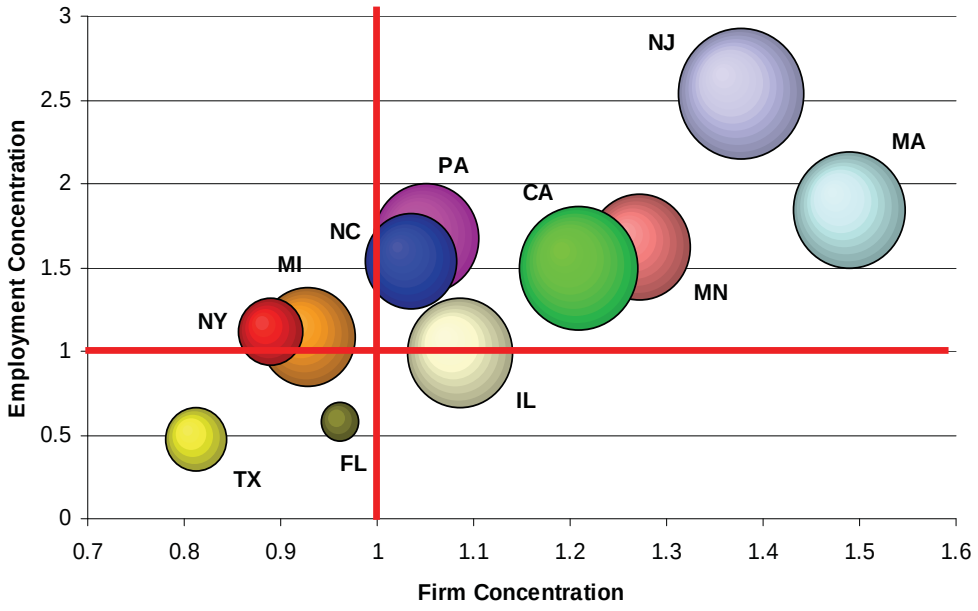
The next chart uses the same three measures and illustrates Florida's life sciences position relative to the ten benchmarked states, and to the national average. Florida's employment concentration is slightly lower than the national average, while its firm concentration is slightly higher, the result of the high number of hospitals. Most important, the value of its life science work, as evidenced by its wages per worker, is lowest among the benchmarked states.

Comparative Wages per Worker in Florida's Life Sciences Industry



The following chart examines Florida's standing in the knowledge-intensive sectors within the life sciences sectors, again relative to the benchmarked states. For this study, these sectors collectively are termed as *therapeutics and devices*. Leading states (with the exception of New York) all have high concentrations of employment, firms, and wages per worker. Again, Florida's concentration falls below the national average.

Comparative Wages per Worker in Florida's Life Sciences Therapeutics and Devices Industry



In summary, Florida's life sciences industry is skewed toward health-care services and delivery, which exploit but rarely generate innovation. Furthermore, they fail to provide value sufficient to give the state a competitive edge.

A competitive life sciences economy requires a sophisticated and adaptable innovation pipeline. We define the life sciences innovation pipeline as the support and process infrastuctures that buttress the production and creativity in a region's life sciences industry. Under this definition, a strong innovation pipeline plays a critical role in the growth potential of a region's life sciences industry.[1]

The pipeline consists of five components:

1) R&D (knowledge assets)
2) Risk capital and entrepreneurial infrastructure
3) Industry infrastructure (the industry's full employment base and supports)
4) Work force (human capital)
5) Innovation output

The following table depicts Florida's innovation pipeline relative to the benchmarked states. Overall, Florida's innovation pipeline fares poorly. On a composite basis (all five components of the pipeline), only Michigan ranks lower.

Innovation Pipeline Composite Index

State	Composite Score	Rebased Composite Score	Rank
MA	98.77	100.00	1
CA	95.56	97.77	2
NJ	87.05	88.14	3
A	86.71	87.79	4
NY	81.51	82.52	6
MN	79.93	80.92	8
NC	78.37	79.34	9
IL	77.93	78.90	10
TX	75.73	76.67	11
FL	71.08	71.96	16
MI	69.45	70.32	19

To develop the Florida life sciences road map, we:

- address two areas of focus: industry infrastructure enhancement (I) and industry optimization (II).
- offer five broad strategies: two under industry infrastructure enhancement, three under industry optimization. The strategies are:
    1) Recruit and retain highly skilled workers.
    2) Increase the R&D base.
    3) Optimize the life sciences industry mix.
    4) Lay the foundations for innovative industry clusters.
    5) Enhance early-stage funding and VC support.
- present an overview of current industry conditions.
- list statewide and regional recommendations.

Statewide recommendations for Focus I, industry infrastructure enhancement, follow here. The recommendations are summarized in two tables on pages xiv and xv by state and region. More detailed discussion appears in the main body of the study.

1) Establish competitive research grants for targeted regional programs.

We recommend statewide coordination to target and match competitive research grants to regions with the most appropriate specialization and sector concentration. Research grants for medical device manufacturing, for example, would target the northern regions, while grants for biotechnology manufacturing and pharmaceuticals research would target Tampa Bay and southeastern regions. The regions must develop true cluster strengths, in which manufacturing and related sectors would locate around research firms and institutes, building up local economies.

2) Recruit established intellectual property firms from outside Florida.

VC firms in cities such as Boston, San Diego, San Francisco, and Washington, D.C., would reduce their business expenses and staff travel time if they established branches in Florida. The state currently has little ease of access to such firms and services, and risks having its life sciences companies relocate nearer the large sources of venture capital and counseling.

3) Facilitate H1-B visa application process for foreign workers.

School and visa application fees could be covered through employment organizations, including private companies, universities, and research institutions. International students, as well as workers and specialists, constitute a major and growing source of human capital, especially for rapidly expanding firms or those with short-term expansion plans.

4) Initiate an industry liaison program to promote life sciences research.

A problem in Florida is the lack of sustainability of innovation. An industry liaison program will enable life sciences research to be transferred to market through links among R&D institutions, faculty, and local firms.

5) Establish recommendations for employer-provided medical care and housing subsidies for foreign workers.

To enhance the recruitment of postdoctoral scientists, the state should establish guidelines for employer-provided medical care and subsidized housing rentals in the face of rising real estate costs.

Quality of life, including medical care and accommodations, is an important consideration in migration.[2] Such benefits are key attractions to foreign workers in the short term; in the longer term, the strength of Florida's life sciences innovation pipeline will determine the need for foreign expertise.

The following recommendations enhance Florida's life science R&D base. They target three basic needs: 1) facilities to foster collaborative R&D; 2) programs and incentives to foster participation based on regional attributes; and 3) increased support for R&D centers.

6) Build a public database of life sciences R&D specializations.

This database would include specialization, firm, sales, and employment figures, current initiatives and results, key researchers, and ongoing research projects. The database must be accessible by life science firms, research institutions, and universities. It will be useful in the

allocation of research funds. Researchers and businesses will not necessarily compete for the same R&D funding, and R&D efforts would be consolidated and synergized for the common good.

7) Develop an outreach program targeting university faculty and administrations.

An outreach program is a coordinated initiative of activities, such as academic and industry conferences for scientists in the interdisciplinary field of life sciences to showcase knowledge and produce more innovative research.

8) Enhance technology transfer and IP commercialization opportunities.

Direct partnerships between research institutions and industry increase the opportunities for commercialization. Despite its considerable technology assets, Florida has trouble capturing and retaining the commercialization value of their market application. Much of the economic contribution migrates outside the state.

Florida must direct efforts toward long-term partnerships. A key regional partnership in the Florida High Tech Corridor Council is an economic development initiative of the University of Central Florida (UCF), the University of South Florida (USF), and the University of Florida (UF). Its mission is to attract, retain, and expand the high-tech industry, and develop the work force to support that industry in twenty-three counties served by these universities. The state should use successful models to facilitate additional partnerships in other regions.

9) Establish a program to develop R&D centers that maximize the growth of life science clusters.

We see Orlando, Tampa, and Palm Beach County as the strongest contenders for such R&D centers.

Orlando has the potential to serve as a mid-stage commercialization and expansion center for biotech startups, and could facilitate specializations in bioinformatics and biophotonics. An Orlando R&D center would involve the University of Florida, University of Central Florida, and the Florida High-Tech Corridor, as well as local and national commercialization interests.

Tampa has the potential to serve as a center for commercializing intellectual property and startups in medical devices, biomedical and nano-medical devices, and cancer treatments. This center would include the University of South Florida, the Moffitt Cancer Center, and the University of Florida, and would establish partnerships with local medical device companies. Curricula would develop around the sector.

Palm Beach County has the potential to strengthen commercialization and research partnerships among Scripps Florida, Harbor Branch Oceanographic Institution, Florida Atlantic University, and the University of Miami. Partnerships with the region's biopharmaceutical companies would provide direction to developing South Florida as a true life sciences cluster.

The elements of an R&D center program should include:

- An expanded world-class research centers—one each for Orlando, Tampa, and Palm Beach County, areas that have demonstrated the research and commercial potential for life sciences clusters.
- Five-year funding terms at the $25 million level. After five years, each center would undergo review, with an option to expand into new areas or build on results. Additional funding of $20 million would be allocated for five years.
- A focus of two or three specialties, supported by existing local research capacity.
- Partnerships and collaboration with research institutions and/or companies.
- Implementation of the 21st Century World Class Scholars program to tie university recruitment to the centers. This would boost national standings and attract attention from national firms seeking investment opportunities.
- Locations with cluster potential, including: a center of clinical trials and therapeutics at Jacksonville, which could link Shands Jacksonville Medical Center with the Mayo Clinic; and a center of medical devices, material science research, and biomagnetic research in Tallahassee or Pensacola that would develop partnerships with Florida State University, the Institute of Human and Machine Cognition, and the military.

An extension of the current Centers of Excellence program, which calls for funding of $10 million over two to three years, does not by itself demonstrate long-term official commitment. As the program exists, each center is to receive $10 million over a two- to three-year period in order to establish itself and render demonstrable results. The initial three centers demonstrate that tangible results emerge through this framework, but each center is now looking for other means to continue its work. This suggests that state focus will shift at a crucial time in early-stage development.

Focus II addresses industry optimization, an essential step that can occur in parallel to Focus I. This step enables the state, and its various regions, to develop industry mixes, channel capital support, and boost the output from new and existing life science clusters. The state must develop local programs to produce life science workers for the biotech manufacturing, R&D, and pharmaceuticals sectors. This targeted workforce training is essential for boosting regional strengths. Our statewide recommendations follow.

Florida should:

1) Continue to develop training curricula in two-year colleges for biotech manufacturing technicians and specialists.

Elsewhere in the country, biotech manufacturing positions above the level of technician (such as process development associate and manufacturing associate) typically are filled in-house through promotion and training, with few external training programs at these levels. Formal academic programs, however, can both ensure higher-quality training and offer programs tailored to local retraining needs.

Florida could develop these programs to fill the gaps at all skill levels for incoming life science firms, particularly biotechnology manufacturing companies. Programs should be linked to local sectors.

2) Develop training programs for medical device manufacturing technicians in two-year colleges.

Tampa and Jacksonville, in particular, have an immediate demand for a medical device manufacturing work force. Two-year programs work well in meeting this demand quickly and ensuring a constant employment pool. Such programs also could evolve into four-year programs in subfields as the sector grows.

Workforce Florida Inc. currently incorporates these effective elements of training. We recommend continued emphasis by Workforce Florida Inc. on working with employers to develop training curricula.

At the same time, Florida must improve links between its life sciences work force and industries to develop the state's geographic strengths and build in specializations. Clusters can complement key research centers.

3) Establish a workforce development ladder in the life sciences, including the heath-care services, to provide workers with the training they need to hold high-paying, stable positions.

The lack of career ladder training is attributable in part to the job structure, particularly in biotech manufacturing, which offers no clear career paths from the technical level to higher-skilled positions. A directed career path could increase public- and private-sector confidence in the training programs. A workforce development ladder could be established by tracking where jobs are being created statewide. This would complement similar workforce ladder initiatives already in existence.

In conjunction with this ladder, the Incumbent Worker Training (IWT), funded by the federal Workforce Investment Act (WIA), facilitates retraining. The IWT is similar to the Employed Worker Training (at the local level) and Quick Response Training (overseen by the state government in Tallahassee) programs. Retrained workers have a better understanding of their career paths and, to a large extend, are expected to remain within the industry and the state.

Furthermore, Florida must increase graduate degree offerings to produce more workers in the life sciences, particularly in pharmaceuticals, biotechnology manufacturing, and R&D.

4) Establish a life sciences advisory board to develop curriculum synergies.

Because the industry is interdisciplinary, cross-regional R&D collaborations are necessary, and cross-discipline training programs will develop a mobile work force. The result will be an industry mix with long-term optimization.

5) Develop master of science programs in medical devices at the University of Florida and the University of South Florida, with an emphasis on applied research.

With an R&D focus on biotechnology, the University of Florida's College of Medicine is a national leader in research and education. The university is also strong in biological defense. Introducing graduate programs in the study of applied medical devices will augment these strengths.

The need for more advanced-degree programs dovetails with the recommendation to attract industry anchors and key players to the state. By providing labor at the technician, management, and research levels, Florida will be able to leverage its R&D assets.

Florida does not capitalize on its R&D innovation. The following proposals will enhance the business climate to leverage R&D capabilities and retain innovation.

6) Develop tax incentives to enable life sciences startups to carry losses tax-free for ten years to increase chances of survival.

Returns on technology investments are rarely immediate. New tax exemptions would benefit entrepreneurs who might lack sufficient personal collateral while they seek capital.

7) Develop tax incentives for property owners who provide wet lab space.

Incentives could come in the form of tax credits for R&D establishments. Commercial developments typically yield higher profits than do research-related facilities. Not only will this motivate some property owners to provide wet lab space, it can amount to a lucrative investment.

Currently, eleven universities maintain technology transfer offices, but only a few institutions generate effective transfers. Based on the Association of University Technology Managers (AUTM) survey, conducted between 1996 and 2003, all Florida universities executed only 434 licenses for the same period. This constitutes only about 2 percent of the total licenses executed nationwide in the same period.

8) Introduce regional tax incentives for companies that invest in locally generated technologies.

These breaks should be sufficient enough for companies to expand and should target fast-growing metropolitan areas, such as Tampa Bay, Orlando, and Miami.

9) Introduce incentives for companies that set up local operations.

Incentives could include workforce training, assistance on infrastructure building, and tax breaks for firms that complement the industry structure.

Life science clusters in Tampa, greater Miami, Jacksonville, and Gainesville are not strong relative to benchmarked states, but they contribute in small ways to the state's regional economy. Because clusters form around research institutions, we place high priority on the following recommendations to promote cross-pollination between industry and academia through internships, grants and contracts, and adjunct faculty.

10) Develop direct links between medical schools and teaching hospitals in all regions to create placement opportunities for interns and for conducting clinical trials.

Cluster links generally form the bases of R&D synergies that facilitate sustained industry prosperity and longevity. The demand for clinical trials is expected to rise. Hence, such links can leverage Florida's growing population for use in clinical trials.

11) Establish working relationships between large national pharmaceutical companies and local research institutions to host clinical trials and promote IP spin-offs.

These commercialization links enable Florida to retain and attract VC and human capital, and most important, to leverage innovation output.

12) Increase funding of industry-matching research grant programs directed at the life sciences.

Increased funding is necessary to build clusters. Under the current state funding provisions, the state will match private research funding on economic development. Targeting life sciences companies for funding could encourage them to invest in R&D and firm expansion.

Venture capital is a major source of support for the life sciences industry, but Florida currently lacks both local investors and sufficient venture capital. The state should implement initiatives to encourage local investors through tax and loan incentives, as well as promote region-specific life science assets. We propose the following statewide recommendations.

13) Create a database of angel investor networks and life sciences startups to match investors with firms in need of early-stage funding.

Access to venture capitalists is a significant problem. The transparency associated with the statewide database could increase the level of access to investors. This applies especially to startups, which have less experience in the industry.

14) Partner with nationally established VC firms to establish early-stage deal flow.

This recommendation and the next will help establish transparency in the investor-search process, and facilitate partnerships and interest-matching.

15) Promote local up-and-coming technology companies to VC firms outside Florida.

The state can develop programs to keep track of firm performances. Up-and-coming technology firms can apply to state or regional programs that help them link to national and regional VC firms.

A long-term industry development policy is essential for ensuring returns on R&D, VC funding, research grants, and talent recruitment.

16) Develop a policy that promotes incentives for medium-sized companies, as well as their collaboration with universities and research institutions.

This recommendation addresses Florida's lack of medium-sized firms in medical devices, which is its best-performing industry sector (excluding health care). Florida must pair its R&D assets with its industry strengths in order to reap returns on its life sciences investments. Research facilities must partner with firms in order for innovation to reach the marketplace.

To lay the groundwork for this road map, Florida must:

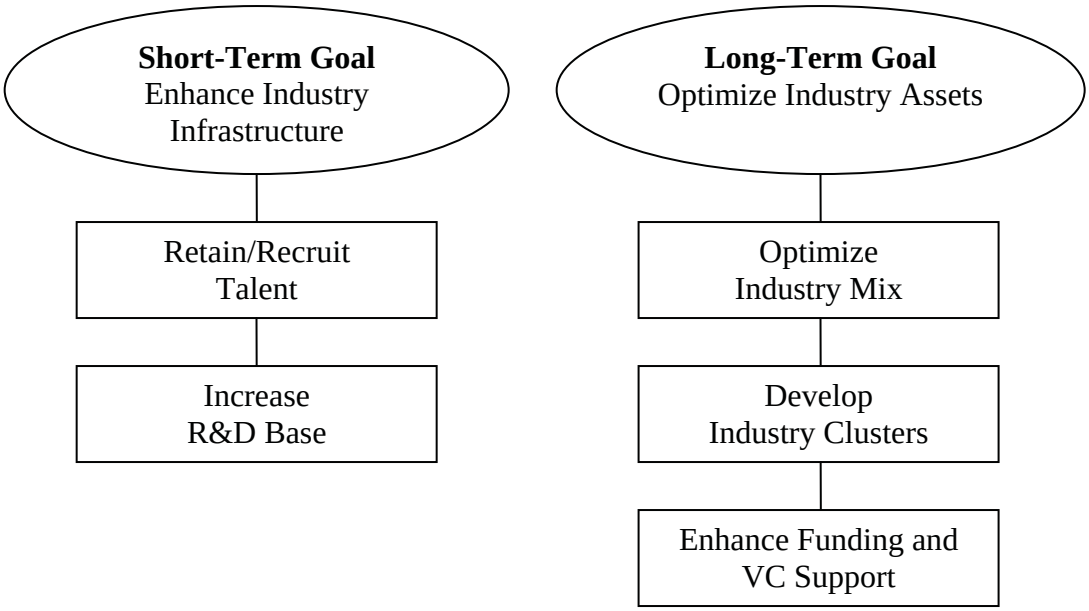
- ***Recognize the importance of the life sciences industry:*** Employment created in the life sciences will benefit wholesale and retail trade, and professional and business services. Revenues generated in the life sciences and related industries will recycle back into the larger regional economy.

- ***Recognize its competitive strengths and weaknesses:*** The five benchmarked peer states (Illinois, Michigan, Minnesota, North Carolina, and Texas) represent where Florida ought to be. The leading states (California, Massachusetts, New Jersey, New York, and Pennsylvania) indicate where Florida could be upon successful implementation of a life sciences economic development plan. Florida's universities are among its greatest strengths in this endeavor.

- ***Define the objective:*** Florida must bolster its life sciences industry infrastructure, including the size of the skilled work force, and optimize its industry mix.

- ***Define short- and long-term goals:*** Boosting the industry infrastructure is a short-term goal that targets existing strengths. Industry optimization is a long-term endeavor. It takes more time, for example, to educate and train personnel than to recruit experienced workers.

Short- and Long-Term Strategies for the Life Sciences Road Map



- ***Implement broad strategies:*** Regional and state governments will need greater collaboration and consolidation of resources to make the life sciences industry more competitive. Universities, hospitals, research institutes, and the private sector will be expected to link within and between state regions.

- ***Execute statewide recommendations:*** The following table illustrates recommendations implemented specifically at the state level.

Statewide Road Map Recommendations Summary

Focus I: Industry Infrastructure Enhancement	Focus II: Industry Optimization
1. Establish competitive research grants for targeted regional programs.	1. Continue to develop training curricula for biotech manufacturing technicians and specialists.
2. Recruit established intellectual property firms from outside Florida.	2. Develop and intensify training programs for medical device manufacturing technicians in two-year colleges.
3. Facilitate the H1-B visa application process for foreign workers.	3. Create and develop a workforce development ladder in the life sciences.
4. Initiate an industry liaison program to promote life sciences research.	4. Establish a life sciences advisory board to develop curriculum synergies.
5. Establish recommendations for employer-provided medical care and housing subsidies for foreign workers.	5. Develop master of science programs in medical devices with an emphasis on applied research.
6. Build a public database of life sciences R&D specializations.	6-8. Develop various tax incentives*
7. Develop an outreach program targeting university faculties and administrations.	9. Introduce incentives for companies that set up local operations.
8. Enhance technology transfer and IP commercialization opportunities.	10. Develop direct links between medical schools and teaching hospitals.
9. Establish a program to develop R&D centers that maximize the growth of life science clusters.	11. Establish working relationships between national pharmaceutical companies and local research institutions.
	12. Increase funding of industry-matching research grant programs targeting the life sciences.
	13. Create a database of angel investor networks and life sciences startups to match interested investors with firms in need of early stage funding.
	14. Partner with nationally established VC firms to establish early-stage deal flow.
	15. Promote local up-and-coming technology companies to VC firms outside Florida.
	16. Develop a policy that promotes incentives for medium-sized companies, as well as their collaboration with universities and research institutions.

*Note: Tax incentives include allowing startups to carry losses for ten years, and targeting property owners who provide wet lab space, as well as companies that invest in locally generated technologies.

- ***Execute regional recommendations:*** The following table lists recommendations for the state's seven regions.

Regional Road Map Recommendations Summary

Region	Focus I: Industry Infrastructure Enhancement	Focus II: Industry Optimization
Southeast	1. Work with the regional tourism authorities to establish specific international recruitment programs for medical tourism. 2. Promote expanded technology commercialization links.	1. Establish a system of regional specialization for workforce programs in pharmaceuticals and biotechnology. 2. Improve county zoning and regulatory processes to facilitate the expansion of research- and production-related firms.
Central	1. Attract and integrate the Burnham Research Institute into regional life sciences development. 2. Increase funding, and funding cycles, for more R&D centers to establish links among growing biotech firms.	1. Establish partnerships to encourage growing location of biotech startups in Orlando. 2. Establish partnerships between a new medical school and area hospitals.
Northeast	1. Promote the new Mayo Clinic hospital and Shands Jacksonville Medical Center in a medical tourism campaign. 2. Facilitate and promote the Mayo Clinic, establishing tech transfer linkages with local firms	1. Increase and improve partnerships for medical device training to establish career ladders. 2. Develop an organized campaign for recruitment of recently discharged military personnel into the life sciences. 3. Establish a neuroscience R&D partnership between the University of Florida and the Mayo Clinic.
Southwest	1. Develop medical tourism programs around local institutions. 2. Promote health care as an export industry.	1. Develop a local network for potential angel investors to connect with local firms. 2. Leverage the New College of Florida for workforce development.
North Central	1. Establish partnerships in medical devices IP with firms in Jacksonville.	1. Promote Shands HealthCare as a site for clinical trials, and establish research partnerships with pharmaceutical companies. 2. Establish partnerships between a new medical school and area hospitals.
Northwest	1. Promote advanced treatments from the Institute for Human and Machine Cognition and from the Andrews Institute.	1. Establish a coordinated regional policy for medical device technology transfer. 2. Create links between the FSU technology transfer office and firms outside Tallahassee. 3. Create infrastructure for R&D activities to target and foster commercialization of specialized medical devices.
Tampa Bay	1. Undertake a major faculty recruitment drive at the University of South Florida. 2. Introduce a life sciences fund to attract large pharmaceuticals and biotechnology firms to Tampa Bay.	1. Coordinate leadership as an extension of the Tampa Bay Partnership for the promotion and development of tech transfer. 2. Facilitate additional Tampa Bay zoning and land acquisition for life science startups. 3. Employ the Florida High-Tech Corridor Council to promote life sciences development along I-4 east of Tampa. 4. Create infrastructure for R&D activities in oncology and to coordinate joint technology transfer efforts.

- ***Evaluate performance:*** Evaluations are essential to ensure progress and long—term sustainability. The three measures from our preliminary assessment-concentration of firms, employment, and wages per worker—are appropriate for benchmarking performance.

Florida can leverage its assets to build life science clusters. Of note, the UCF School of Medicine serves Orlando, which has nine hospitals. The medical school benefits both the region's health-

care system and its R&D base. The Florida State University College of Medicine can play a similar role. The Mayo Clinic, Griffin Cancer Research Building, H. Lee Moffitt Cancer Center & Research Institute at the University of South Florida, and Scripps Florida all represent pieces of the solution to Florida's call for a competitive, knowledge-based economy.

Despite these assets, the state's life sciences industry profile generally is skewed toward health-care services. And despite the great demand for general health-care services, this sector has a relatively small number of sector firms.

The life sciences industry has not fulfilled its potential as a full contributor to the state's economic prosperity. The knowledge-intensive sectors lag behind peer and leading states. In particular, the life sciences R&D sector must show improvement in the employment and firm base even to match the national average.

With greater public and private support, and the development of sustainable regional clusters, we believe the industry's value-added sectors can propel the state into a formidable industry player, able to compete in national and global markets.

Florida Life Sciences Road Map Overview

Florida's economy is robust and growing. Six of the state's cities landed among the top ten in the Milken Institute's *Best Performing Cities* in 2005, with another six in the top thirty. Tourism, a strong defense industry, solid trade partnerships, low unemployment, and a growing population that supports expansion in the health-care sectors all suggest a stable economy poised for expansion.

The life sciences industry—composed of health-care services, R&D, medical devices and biotech manufacturing, and drug and pharmaceutical sectors—is also expanding, as evidenced in the past two decades by the establishment of major treatment centers and biotech research institutes. Among these are the H. Lee Moffitt Cancer Center & Research Institute, Mayo Clinic, and M.D. Anderson Cancer Center. More recently on the scene are the state-supported Centers of Excellence programs, and ongoing and planned construction of two research centers, Scripps Research Institute (Scripps Florida) and the Burnham Institute for Medical Research, both tied to renowned California institutes.

In this study, we examine two sector groups within the life sciences industry. One is the mainstay of Florida's life sciences employment, but not a driver of economic growth. The other is an underexploited but critical factor for future prosperity. The health-care services sectors include hospitals and HMOs; physicians, dentists, and health practitioners; home health-care services; ambulance services; and diagnostic labs. They currently anchor the state's life sciences economy. The knowledge-intensive sectors include R&D, high-tech medical and surgical, botanical, biological, ophthalmic manufacturing, and in vitro laboratory equipment. Their growth will determine the state's future as a contender in the national and global life sciences industry.

Florida's health-care services sector comprises more than 34,000 companies and 635,000 employees who provide services to a population of more than 17 million. Eight of the state's hospitals ranked among the best in the nation in 2006, according to *U.S. News & World Report*.[3] Florida's hospitals engage in a broad range of research activities, including treatments and cures for Alzheimer's, numerous cancers, and diabetes.

Florida's life sciences strengths are geographically diffuse. Its medical devices manufacturing sector, for example, is located chiefly in Tampa Bay and in the eastern and northeastern regions. Medical device manufacturing is often linked to specific biotech applications and to firms engaged primarily in R&D activity. But Florida's biotech firms are concentrated in Alachua, Hillsborough, and the Palm Beach and greater Miami areas. Sector concentrations benefit local economies, but the isolated silo effects can work to the detriment of the larger economies and diminish the potential for collaborative discovery and commercialization.

A failure of linkages also deters the development of an innovation pipeline, which we define as the key support and process infrastructures that enable a region to convert its research and creativity into commercially viable intellectual property resulting in patents and licensing. Without an innovation pipeline, support for research and its commercial applications stagnate. Venture capital may never materialize. Groundbreaking research and innovation within the state will be commercialized elsewhere. Startups and small firms will not develop the capacity to grow. A state that cannot attract researchers, sustain diversity of research, or support its knowledge assets through the entire pipeline will not develop into an economic powerhouse.

The state's primary weaknesses lie in its innovation pipeline.

- There is too much concentration in the services sector and insufficient emphasis in higher-value knowledge-intensive sectors, such as R&D and biotech manufacturing.
- Universities and research centers are not converting their work into patents and licenses; technology transfer offices need more funding and support.
- Early-stage funding mechanisms and venture capital support remain undeveloped.
- The insufficient emphasis on knowledge-intensive innovation value makes it difficult to attract star researchers and other highly skilled workers.

This study provides a road map to develop and sustain Florida's life sciences industry. It comprises three main sections: the road map itself, an analysis of the state's innovation pipeline, and an analysis of the state's life sciences industry. As noted previously, we concentrate on the health-care services sector, in which the state has the greatest strengths, and the knowledge-intensive sectors, which must be developed if Florida is to grow and sustain its life sciences industry. We also look at the industry mix in order to recommend links and synergies.

In addition, we analyze Florida wages, establishments, and employment in these sectors relative to data from ten other states. Five of those states—California, Massachusetts, Pennsylvania, New Jersey, and New York—lead the nation in life sciences industry development. The remaining five—Illinois, Minnesota, North Carolina, Texas, and Michigan—are so-called "peer" states that resemble Florida in terms of socioeconomic makeup. We also compare Florida's innovation pipeline to the ten states.

Industry Strengths

As stated above, Florida's health-care services sector consists of more than 34,000 companies and 635,000 employees providing services to a population of 17 million. The state is home to some of the nation's best hospitals. In addition to providing excellent health-care services, Florida's hospitals are engaged in a broad range of research, including treatments and cures for Alzheimer's, numerous cancers, obesity, and diabetes.

The state's medical devices sector constitutes a global market of $200 billion. The demand for medical devices increases with a growing patient population and advances in medical technology.[4]

Florida's medical device manufacturers maintain a competitive edge,[5] ranking third in the United States, based on the number of FDA-registered firms. The sector comprises nearly 400 companies[6] and 20,000 high-paying jobs; it benefits from a strong industry presence, a large employee pool, industry suppliers, and government support policies.

In order to sustain its comparative advantage Florida must pay more attention to the knowledge-intensive sectors, such as biotech manufacturing, pharmaceuticals, and medical device manufacturing. These include electronics and imaging technology, biomaterials, and neural radiology.

Florida has twelve universities with established technology transfer programs,[7] numerous independent colleges and universities, and four major medical schools. In recent years, the state has aggressively pursued development of the life sciences, and education levels have improved, especially in higher education. In 2001, thirteen institutions granted Ph.D.s in the life sciences, the second-highest concentration among the benchmarked states per 10,000 people ages 25-34. The number of graduate students in the life sciences more than doubled in 2002 from the average between 1991 and 2001, and Florida's national ranking that year jumped from 27th to 18th in the number of graduates per 10,000 people ages 25-34. On the downside, during the same period, the number of bachelor and master's degrees awarded in the life sciences leveled off or slightly decreased relative to benchmarked states.

The state government is committed to science and technology development. Then-Governor Jeb Bush's budget allocations for 2006-2007 called for $630 million, the bulk of which would have gone to business development, research initiatives, and education. Florida remains one of the most tax-friendly states.[8]

Industry Weaknesses

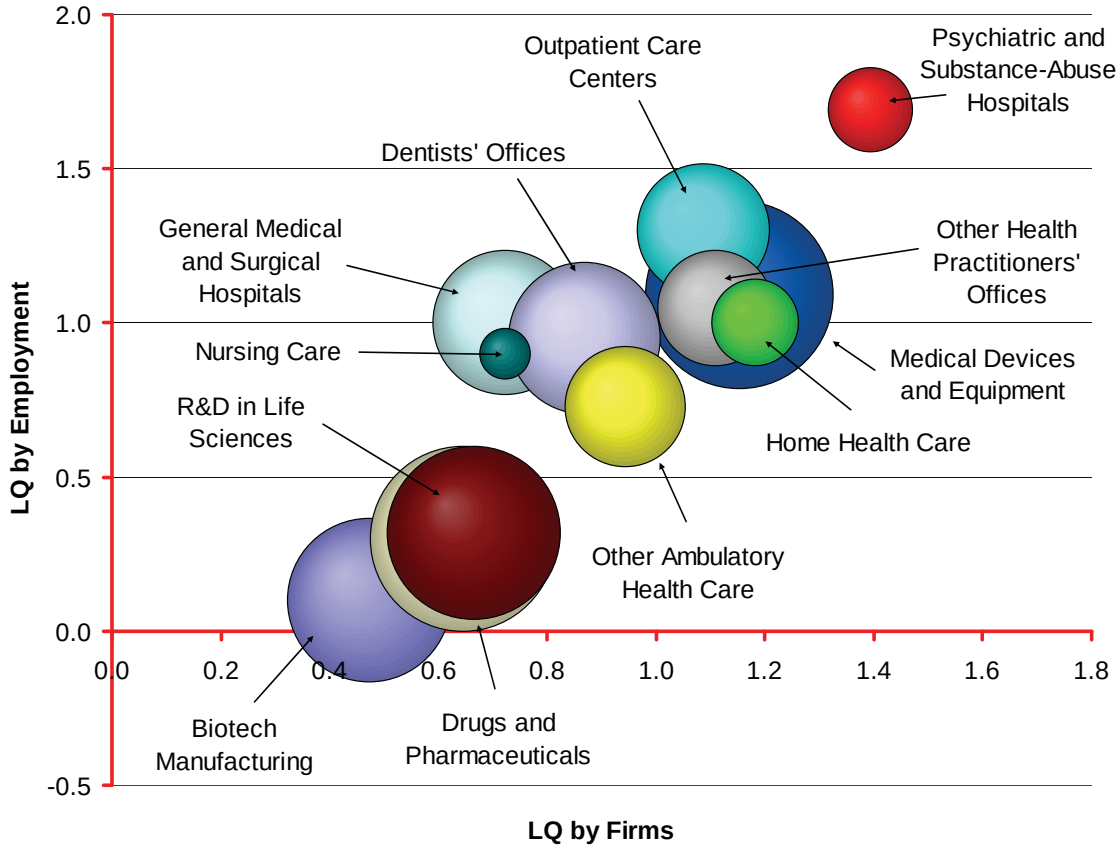
Florida's greatest life sciences economic strength is also a potential Achilles' heel. The health-care services sector reflects the state's reputation as a retirement mecca and growing population, and employs almost 635,000 people. Its largest sub-sector is general/medical and surgical hospitals, including HMOs. But service sectors generally are not known for their knowledge bases, high wages, or sustained economic growth; and Florida's concentration of health-care service jobs reflects a potentially deleterious imbalance that will dilute growth in R&D, pharmaceuticals, and biotech manufacturing investment. Florida lags behind all the benchmarked states in these sectors.

The state's geographically diffuse strengths also pose weaknesses. The medical devices sector, for example, is located in Tampa Bay and the southeastern and northeastern regions. Biotech firms are in Alachua, Palm Beach, greater Miami, and the Hillsborough area. The H. Lee Moffitt Cancer Center & Research Institute at Tampa, ranked No. 11 in the nation for cancer treatment, is partnering its most cutting-edge cancer research, so-called genomic "fingerprinting" for customized treatment, with an out-of-state university.

We find relatively high concentrations in employment and firms, the result of the abundant health-care services companies, but these are not major players. They do not produce high returns or attract investors. Life science wages per worker generally are lower than those in the benchmarked states, suggesting a low-value output in the industry overall.

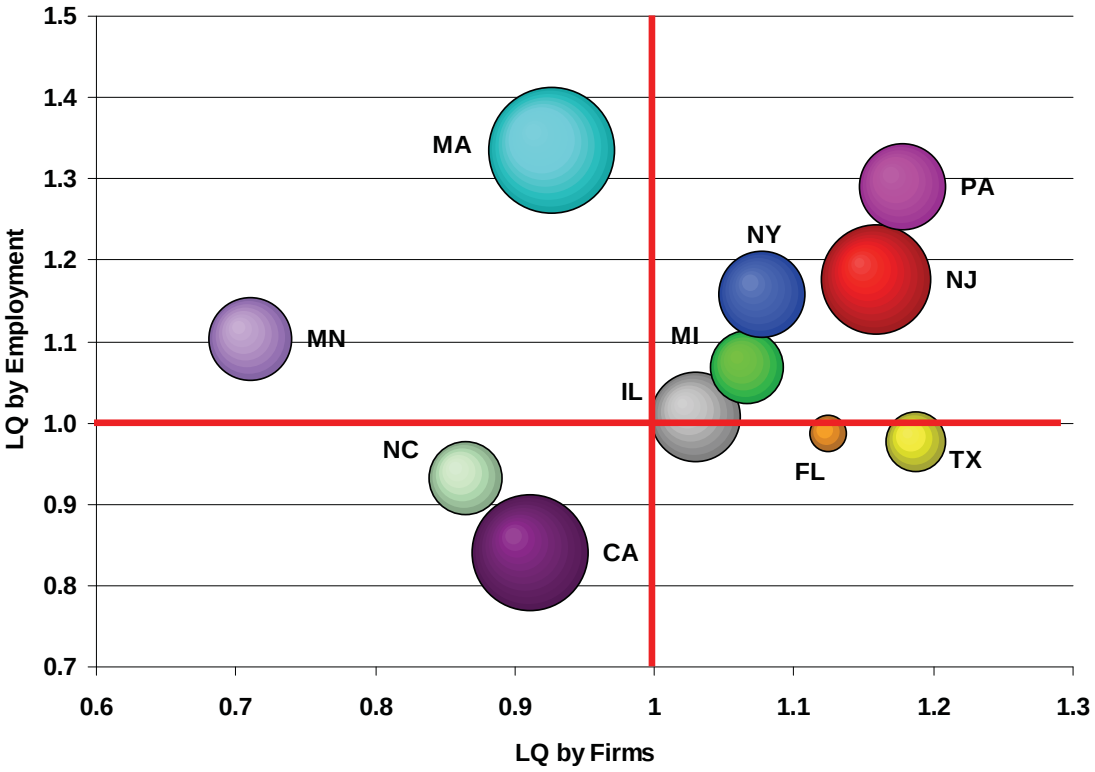
The following charts illustrate this reality. The health-care services sectors have above-average concentration of firms and employment. Employment and firm concentration, and performance in the knowledge-intensive sectors, remain low. The medical devices and equipment sectors, however, perform fairly well; in these sectors, the payout wages per worker are higher than in the health-care sectors.

Wages per Worker in Florida's Life Sciences Industry



Yet as illustrated in the following chart, which compares Florida's wages per worker to the benchmarked states, Florida's life science workers received the lowest wages. The state's firm and employment concentrations, however, are above the national average, suggesting that while the state has high firm and employment concentration, Florida's life sciences payout wages are low.

Comparative Wages per Worker in Florida's Life Sciences Industry



The knowledge-intensive sectors need stronger capital support, a key component in an innovation pipeline. Although the state government has demonstrated a commitment to fund science and technology development, an inadequate venture capital and finance base may mean that startups will look to more favorable destinations.

Current funding commitments may not be sufficient for the state's Centers of Excellence program. Three initial centers have shown that the framework produces tangible research results, but each center is now looking for other means to continue its work.

Key elements for a successful regional model

A region's assets—its climate, population, geographical advantages (such as proximity to ports), and availability of raw materials—have long been considered key determinants of economic

growth. In today's high-tech economy, they are less relevant as innovations in transportation, communication, and production minimize the costs related to labor and the movement of goods.[9] Innovation and creativity—knowledge assets—are now recognized as the essential determinants of industry and regional prosperity.

A region's economic advantage also lies in the ability of its industries to work competitively yet collaboratively in order to lower cross-industry costs. Hence, the most successful regions are those whose firms organize their innovation processes in a collaborative framework of research, development, and production,[10] and where chemists, physicists, microbiologists, physicians, computer scientists, and bio-statisticians compete and supplement one another's research agendas, despite limited operations and budgets. In San Diego, Philadelphia, and the Raleigh-Durham-Chapel Hill Research Triangle, for example, vibrant clusters have taken shape around the strengths of local universities, small startups and large corporations, financial and venture capital flows, and government and nonprofit support.[11]

But a region can go only so far with strong R&D capacity; it also needs a work force skilled in science and technology to enhance innovation and maximize production. Its engineering and production work force should be near R&D centers to enhance R&D capacity.[12]

The quality of the R&D work force affects not just long-term industry performance but also the performance of individual firms. Small firms and startups in particular suffer when they must recruit from great distance or contract out technical or administrative work to consultants. And if small firms and startups fail for lack of nurturing, the region risks decline. Although it makes no significant difference to a firm where its products are made, the same cannot be said of a region. The local economy will receive few benefits if the economic value of research is generated elsewhere.

San Diego and Philadelphia have strong research universities and advanced R&D mechanisms. So it follows that they occupy an advantageous position in attracting technology-based firms and an educated work force, and cluster strength.[13] Institutions that attract research talent are more likely to receive R&D contracts and funding from the National Institutes of Health and National Science Foundation, both of which play major roles in developing research initiatives.[14] Universities therefore constitute a fundamental support infrastructure for intellectual activities.[15] And a university's ability to build intellectual capacity by recruiting world-class scientists lies at the core of this success.

Industry clusters are geographic concentrations of sometimes competing, sometimes collaborating firms and their related supplier networks.[16] Clusters create wealth in a region by supporting the processes of goods and services exported elsewhere. But an industry cluster differs from the traditional definition of an industry group.[17] It consists of the industry's supply chain. This includes related industry sectors, which play various roles in this chain.[18]

Risk capital and entrepreneurial infrastructure are also indicators of how favorable a region is to fostering firm formation and development. A critical source of equity funding for startups, venture capital has a history of funding new technologies and innovations. Of note, these potentially provide the highest returns. They are also, however, investments with the highest risk levels. Genentech and Amgen, for example, are major biotech firms that have reaped advantages from VC investments at early stages.[19]

Diversification of a state's economy is another factor that helps ensure long-term prosperity and competitiveness. Florida's dependence on traditional low-end manufacturing and services sectors must shift to a broader, more knowledge-intensive industry base.

Florida must overcome many challenges before establishing itself as a destination and developer of life sciences clusters.

Florida Life Sciences Road Map

Florida's goal to become a major competitor in the life sciences requires initiatives to develop its industry infrastructure along the research-intensive innovation pipeline, and in general health-care services sectors.

To achieve its goal, Florida must focus on two areas:

1) The state must enhance its life sciences industry infrastructure, which includes work force development and recruitment.
2) The state must optimize its life sciences industry mix.

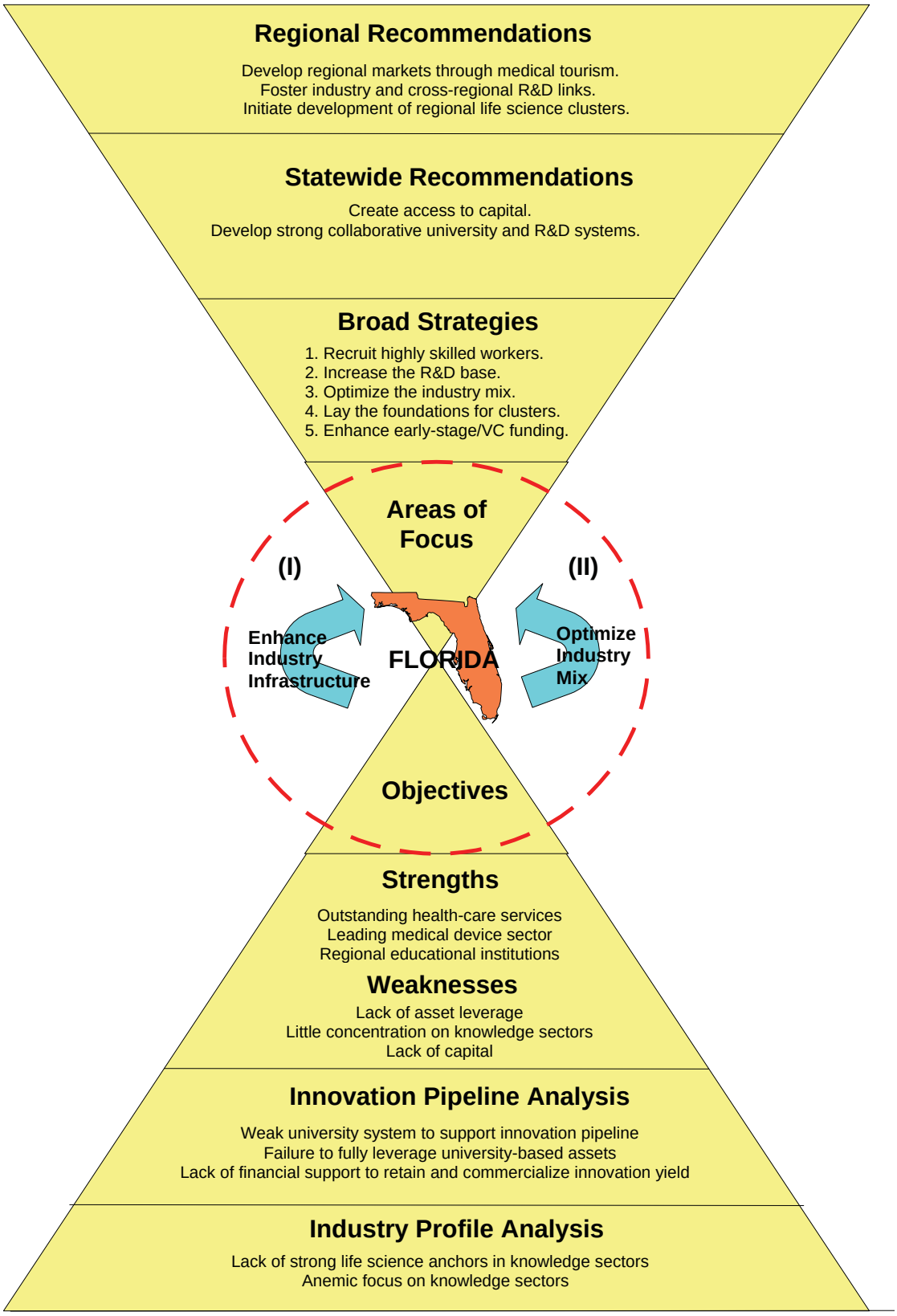
The first can be achieved in the short term and would put Florida on a par with its peer states in the benchmarked group. The state would develop a life sciences work force that is well balanced in five life science specializations (biotechnology manufacturing, drugs and pharmaceuticals, medical devices manufacturing, life science R&D, and health care). This would increase the work force in the knowledge sectors while maintaining its strength in its health-care sectors. The result would be a well-balanced industry mix.

The second builds on the success of the first. If Florida optimizes its industry mix, it has the potential to match the long-term performance of the leading states. Target areas include enhancing technology transfer mechanisms and access to capital, and developing higher-value industry clusters.

Within the two areas of focus, we recommend five broad strategies: two under Focus I (industry infrastructure enhancement), and three under Focus II (industry optimization). For each strategy, we offer an overview of current industry conditions. The five strategies are:

1) Recruit and retain highly skilled workers.
2) Increase the R&D base.
3) Optimize the life sciences industry mix.
4) Lay the foundations for innovative industry clusters.
5) Enhance early-stage funding and VC support.

The following chart illustrates the flow of the roadmap. The industry profile and innovation pipeline analyses highlighted the strengths and weaknesses of Florida's life sciences industry. From these, we developed two areas of focus that stem from the two objectives—to enhance and optimize the state's life sciences industry.


Regional Recommendations
Develop regional markets through medical tourism.
Foster industry and cross-regional R&D links.
Initiate development of regional life science clusters.
Statewide Recommendations
Create access to capital.
Develop strong collaborative university and R&D systems.
Broad Strategies
1. Recruit highly skilled workers.
2. Increase the R&D base.
3. Optimize the industry mix.
4. Lay the foundations for clusters.
5. Enhance early-stage/VC funding.
Areas of Focus
(I)
Enhance Industry Infrastructure
FLORIDA
(II)
Optimize Industry Mix
Objectives
Strengths
Outstanding health-care services
Leading medical device sector
Regional educational institutions
Weaknesses
Lack of asset leverage
Little concentration on knowledge sectors
Lack of capital
Innovation Pipeline Analysis
Weak university system to support innovation pipeline
Failure to fully leverage university-based assets
Lack of financial support to retain and commercialize innovation yield
Industry Profile Analysis
Lack of strong life science anchors in knowledge sectors
Anemic focus on knowledge sectors

The next tables include state and regional recommendation summaries for Florida's life sciences road map. Detailed explanations follow.

Statewide Road Map Recommendations Summary

Focus I: Industry Infrastructure Enhancement	Focus II: Industry Optimization
1. Establish competitive research grants for targeted regional programs.	1. Continue to develop training curricula for biotech manufacturing technicians and specialists.
2. Recruit established intellectual property firms from outside Florida.	2. Develop and intensify training programs for medical device manufacturing technicians in two-year colleges.
3. Facilitate the H1-B visa application process for foreign workers.	3. Create and develop a workforce development ladder in the life sciences.
4. Initiate an industry liaison program to promote life sciences research.	4. Establish a life sciences advisory board to develop curriculum synergies.
5. Establish recommendations for employer-provided medical care and housing subsidies for foreign workers.	5. Develop master of science programs in medical devices with an emphasis on applied research.
6. Build a public database of life sciences R&D specializations.	6-8. Develop various tax incentives*
7. Develop an outreach program targeting university faculties and administrations.	9. Introduce incentives for companies that set up local operations.
8. Enhance technology transfer and IP commercialization opportunities.	10. Develop direct links between medical schools and teaching hospitals.
9. Establish a program to develop R&D centers that maximize the growth of life science clusters.	11. Establish working relationships between national pharmaceutical companies and local research institutions.
	12. Increase funding of industry-matching research grant programs targeting the life sciences.
	13. Create a database of angel investor networks and life sciences startups to match interested investors with firms in need of early stage funding.
	14. Partner with nationally established VC firms to establish early-stage deal flow.
	15. Promote local up-and-coming technology companies to VC firms outside Florida.
	16. Develop a policy that promotes incentives for medium-sized companies, as well as their collaboration with universities and research institutions.

*Note: Tax incentives include allowing startups to carry losses for ten years, and targeting property owners who provide wet lab space, as well as companies that invest in locally generated technologies.

Regional Road Map Recommendations Summary

Region	Focus I: Industry Infrastructure Enhancement	Focus II: Industry Optimization
Southeast	1. Work with the regional tourism authorities to establish specific international recruitment programs for medical tourism. 2. Promote expanded technology commercialization links.	1. Establish a system of regional specialization for workforce programs in pharmaceuticals and biotechnology. 2. Improve county zoning and regulatory processes to facilitate the expansion of research- and production-related firms.
Central	1. Attract and integrate the Burnham Research Institute into regional life sciences development. 2. Increase funding, and funding cycles, for more R&D centers to establish links among growing biotech firms.	1. Establish partnerships to encourage growing location of biotech startups in Orlando. 2. Establish partnerships between a new medical school and area hospitals.
Northeast	1. Promote the new Mayo Clinic hospital and Shands Jacksonville Medical Center in a medical tourism campaign. 2. Facilitate and promote the Mayo Clinic, establishing tech transfer linkages with local firms	1. Increase and improve partnerships for medical device training to establish career ladders. 2. Develop an organized campaign for recruitment of recently discharged military personnel into the life sciences. 3. Establish a neuroscience R&D partnership between the University of Florida and the Mayo Clinic.
Southwest	1. Develop medical tourism programs around local institutions. 2. Promote health care as an export industry.	1. Develop a local network for potential angel investors to connect with local firms. 2. Leverage the New College of Florida for workforce development.
North Central	1. Establish partnerships in medical devices IP with firms in Jacksonville.	1. Promote Shands HealthCare as a site for clinical trials, and establish research partnerships with pharmaceutical companies. 2. Establish partnerships between a new medical school and area hospitals.
Northwest	1. Promote advanced treatments from the Institute for Human and Machine Cognition and from the Andrews Institute.	1. Establish a coordinated regional policy for medical device technology transfer. 2. Create links between the FSU technology transfer office and firms outside Tallahassee. 3. Create infrastructure for R&D activities to target and foster commercialization of specialized medical devices.
Tampa Bay	1. Undertake a major faculty recruitment drive at the University of South Florida. 2. Introduce a life sciences fund to attract large pharmaceuticals and biotechnology firms to Tampa Bay.	1. Coordinate leadership as an extension of the Tampa Bay Partnership for the promotion and development of tech transfer. 2. Facilitate additional Tampa Bay zoning and land acquisition for life science startups. 3. Employ the Florida High-Tech Corridor Council to promote life sciences development along I-4 east of Tampa. 4. Create infrastructure for R&D activities in oncology and to coordinate joint technology transfer efforts.

Focus I: Industry Infrastructure Enhancement

Again, we define industry infrastructure as the full employment base, including the skilled researchers and knowledge workers (life sciences human capital) who must be recruited and retained to build a larger R&D base.

Two Strategies

1) Recruit and retain highly skilled workers

Workforce recruitment involves attracting highly skilled employees to key innovation sectors, such as R&D, pharmaceuticals, and biotechnology manufacturing. This is the most crucial intangible asset to a region's economy, leading to continuous innovation and increased returns.[20]

Aggressive recruitment returns fairly rapid benefits through escalating industry yield. Key regions for this initiative are Tampa Bay, Orlando, and southeast Florida. We recommend recruitment campaigns that reach beyond the state's borders.

2) Increase the R&D base

Florida's emerging research infrastructure has made advances in medical devices manufacturing (ophthalmic goods, surgical appliances and medical instruments, electrometrical and irradiation apparatus, and lab equipment). The sector has produced state-of-the-art facilities and university-engaged research.

This strategy focuses on enhancing the R&D bases in medical devices. Southeast Florida already has a strong industrial base in medical devices, so we focus on other regions that can develop their own medical device bases. Tampa, Miami, Jacksonville, and Orlando employ nearly 20,000 people within this sector, but they have few anchor firms. In the Miami-Dade metro, only two firms—Cordis Corp. and Symbiosis Corp.—anchor the sector, employing 1,600 and 1,000 workers, respectively. Cordis specializes in the manufacturing of medical instruments, surgical appliances, and supplies. Symbiosis specializes in manufacturing disposable laparoscopic and endoscopic devices. Other sector companies have 60 or fewer employees.

In the Gainesville area, Regeneration Technologies, a manufacturer of surgical appliances and supplies, employs just 260 employees. Exactech, which manufactures surgical implants, is the second-largest employer, with just 173 employees. Other companies typically employ fewer than 50 workers.

Orlando has only two firms—Invacare Florida Corp. and Invivo Research Inc.—with more than 100 employees. Invacare manufactures surgical appliances and supplies, and Invivo Research manufactures medical diagnostic equipment and commercial physical research laboratories.

It could be argued that the sector's performance depends on its anchor firms. Few medium-sized firms exist, although these are important contributors to regional growth, especially when they augment the impact of relatively few anchor firms. Small firms run the risk of instability, but medium firms help boost regional development through clustering.

Medical device manufacturing is often linked to specific biotech applications and to firms engaged primarily in R&D activity. But Florida's statewide biopharmaceutical employment ("biotech and pharmaceutical MFG," represented by NAICS code 3254) amounts to just 4,000 employees.

Florida has substantial university-based knowledge assets in medical devices. The University of Central Florida has developed lasers/optics and bioinformatics; the University of Florida concentrates on gene therapy; and Florida International University has strengths in biomedical engineering, especially with its new College of Medicine, which will begin operations in 2009. These can be exploited to Florida's advantage in life sciences development.

As noted previously, Florida shows considerable weaknesses in its innovation pipeline. The universities produce innovative research, but the state does not often see direct and tangible returns. The state has done well in establishing technology transfer programs, but the actual state/university funding of Florida's life sciences programs remains low, as do relative to the benchmarked states, as do private investments (either to the tech transfer offices or the universities).

In several cases, we find that the revenues generated by technology transfer programs are considered by their universities to be discretionary funds rather than funds to be reinvested in the technology transfer and industry partnership infrastructure. Florida State has failed to reinvest revenues from Taxol in the technology transfer office or to life sciences programs. Other institutions with more diversified licensing programs also neglect expansion of their technology transfer capabilities. Directed leadership from state government would help universities work around internal politics to facilitate a more engaged process.

Some clear efforts have been made to expand licensing and increase partnerships with venture capital companies. The University of Florida holds seminars to educate professors and administrators about research commercialization, and a coordinated statewide policy could provide opportunities to attract greater investment.

A region with a high absorptive capacity is one in which knowledge is the raw material for its industry base. It will draw high-tech industries and foster links with universities. Unlike Orlando, which is directly accessible via two major highways along the east and west coasts of Florida, Gainesville is not directly accessible by major air routes and highways. It is less appealing to venture capital sources.

Statewide Recommendations

Florida must promote itself beyond its borders and recruit post-doctoral scientists with research, financial, and technology transfer experience.

1) ***Establish competitive research grants for targeted regional programs.***

We recommend statewide coordination to target and match competitive research grants to regions with the most appropriate specializations and sector concentrations. Research grants for medical device manufacturing, for example, would target the northern regions, while grants for biotechnology manufacturing and pharmaceuticals research would target Tampa Bay and southeastern regions. The regions must develop cluster strengths in which manufacturing and related sectors locate around research firms and institutes and strengthen local economies.

2) ***Recruit established intellectual property firms from outside Florida.***

VC firms in cities such as Boston, San Diego, San Francisco, and Washington, D.C., would reduce their business expenses and travel time if they established branch IP and related legal services firms in Florida. The state has little ease of access to such firms and services, and risks having its life sciences companies relocate out of state, nearer to large sources of venture capital and counseling.

3) ***Facilitate the H1-B visa application process for foreign workers.***

School and visa application fees could be covered by employment organizations, and promoted by public bodies, to ease the cost and time involved in the application process. This should be a particular focus for Orlando, with its proximity to universities and a planned medical school. International students, in particular, as well as experts and specialists, constitute a growing source of human capital, especially for rapidly expanding firms or those with short-term expansion plans.

4) ***Initiate an industry liaison program to promote life sciences research.***

Unsustained innovation remains a problem. An industry liaison program should enable life sciences research to be transferred more effectively to the market through links among R&D institutions, faculty, and local firms.

5) ***Establish guidelines for employer-provided medical care and housing subsidies for foreign workers.***

To enhance the recruitment of post-doctoral scientists, the state should establish guidelines for employer-provided medical care and subsidized housing rentals to address the rapid increase in

real estate costs. Quality of life, including medical care and accommodations, is an important consideration in migration.[21] Such benefits become key attractions to foreign workers in the short term; in the longer term, the strength of Florida's life sciences innovation pipeline will determine the need for foreign expertise.

The following recommendations address ways to enhance Florida's life sciences R&D base. They target three basic needs: 1) development and expansion of facilities to encourage collaborative R&D; 2) programs and incentives to invite participation based on regional strengths and potential for collaboration; and 3) increased support and cultivation of existing research centers.

6) ***Build a public database of life sciences R&D specializations.***

Such a database would include specialization, firm, sales, and employment figures, current initiatives and results, key researchers, and ongoing research projects. The database must be accessible by life sciences firms, research institutions, and universities. It would be useful in the allocation of research funds; researchers and businesses would not necessarily have to compete for the same R&D funding, and R&D efforts would be consolidated and synergized for the common good.

7) ***Develop an outreach program targeting university faculty and administrations.***

A periodic outreach program is a coordinated initiative of activities, such as academic and industry conferences for scientists in interdisciplinary fields, to showcase and share their knowledge.

8) ***Enhance technology transfer and IP commercialization opportunities.***

Promote direct partnerships between research institutions and industry to increase commercialization opportunities. Florida has considerable technology assets but has trouble capturing the commercial value of their application in the market. Much of the full economic contribution migrates outside the state.

Florida must direct efforts toward long-term partnerships. A key regional partnership in the Florida High Tech Corridor Council is an economic development initiative of the University of Central Florida, the University of South Florida, and the University of Florida to attract and support the high-tech industry, and to help develop the work force to support it in the counties the universities serve. The state should use proven models to facilitate partnerships in other regions. The Metro Orlando Economic Development Commission includes more than twenty local and regional economic development organizations (EDOs), fourteen community colleges, and numerous organizations serving the twenty-three-county region. The council is co-chaired by the presidents of the University of Central Florida, the University of South Florida, and the University of Florida; and the presidents of two community colleges serve on a rotating basis,

along with the president of Florida Institute of Technology (FIT) and as many as twenty-four representatives of high-tech industry.

9) ***Establish a program for developing R&D centers that maximize the growth of life sciences clusters.***

We see Orlando, Tampa, and Palm Beach County as the strongest contenders for such R&D centers.

Orlando has the potential to serve as a mid-stage commercialization and expansion center for biotech startups, and could facilitate specializations in bioinformatics and biophotonics. An Orlando R&D center would involve the University of Florida, University of Central Florida, and the Florida High-Tech Corridor, as well as local and national commercialization interests.

Tampa has the potential to serve as a center for commercializing intellectual property and startups in medical devices, biomedical and nano-medical devices, and cancer treatments. This center would include the University of South Florida, the Moffitt Cancer Center, and the University of Florida, and would establish partnerships with local medical device companies. Curricula would develop around the sector.

Palm Beach County has the potential to strengthen commercialization and research partnerships among Scripps Florida, Harbor Branch Oceanographic Institution, Florida Atlantic University, and the University of Miami. Partnerships with the region's biopharmaceutical companies would provide direction to developing South Florida as a true life sciences cluster.

The elements of an R&D center program should include the following:

- Three expanded world-class research centers—one each for Orlando, Tampa, and Palm Beach County, areas that have demonstrated the research and commercial potential for life sciences clusters.
- Five-year funding terms at the $25 million level. After five years, each center would undergo review, with an option to expand into new areas or build on results. Additional funding of $20 million would be allocated for five years.
- A focus of two or three specialties, supported by *existing local* research.
- Partnerships and collaboration with research institutions and/or companies.
- Implementation of the 21st Century World Class Scholars program to tie university recruitment to the centers. This would boost national standings and attract attention from national firms seeking investment opportunities.
- Locations with cluster potential, including: a center of clinical trials and therapeutics at Jacksonville, which could link Shands Jacksonville Medical Center with the Mayo Clinic; and a center of medical devices, material science research, and biomagnetic research in Tallahassee or Pensacola that would develop partnerships with Florida State University, the Institute of Human and Machine Cognition, and the military.

An extension of the current Centers of Excellence program, which calls for funding of $10 million over two to three years, does not by itself demonstrate long-term official commitment. As the program exists, each center is to receive $10 million over a two- to three-year period in order to establish itself and render demonstrable results. The initial three centers demonstrate that tangible results result through this framework, but each center is now looking for other means to continue its work. This suggests that the state focus will shift at a crucial time in potential early-stage development.

Regional Recommendations

Southeast Florida

1) ***Work with the regional tourism authorities to establish specific international recruitment programs for medical tourism.***

Medical tourism is a growing global industry that encompasses medical spas, nontraditional treatment centers, and lower-cost dental and surgical procedures. The industry includes the established spas at Bath, England, or Baden-Baden, Germany, folk remedies in the Arkansas Ozarks,[22] established and cutting-edge surgical procedures in countries as diverse as France, Thailand, China, and Brazil. While the surge of U.S. patients traveling overseas grabs headlines, medical tourism also occurs here. In fact, wealthy foreigners who seek medical treatment in the United States spend more than $1 billion a year, according to "The Healthcare Business Market Research Handbook."[23]

Florida can promote medical tourism at Mayo Clinic, Jackson Memorial Hospital, and other centers with direct links to research institutions. The high level of bilingualism in the region should attract patients from Spain and Latin America.

2) ***Promote expanded technology commercialization links among Florida Atlantic University (FAU), Harbor Branch Oceanographic Institution, and regional firms.***

Harbor Branch could receive incentives to engage in technology transfer ventures with local firms. These incentives should be aimed at easing the cost and time required to initiate technology transfer processes.

The state awarded Florida Atlantic University $10 million in 2003 to develop the Center of Excellence in Biomedical and Marine Biotechnology. Collaboration with the university appears to be a strategic move to capitalize on research funding for technology ventures and commercialization possibilities. This will mean better utilization of FAU as an asset toward commercialization.

In September 2006, the Torrey Pines Institute for Molecular Studies in San Diego unveiled a proposed site in St. Lucie County for expansion, a move that will position the region to develop its biotechnology presence. The institute has also announced partnership plans with FAU and Indian River Community College to give residents access to training programs.[24] By enhancing the life science presence in the Southeast region, this institute brings world-class R&D capabilities and human capital to the other institutes, universities, and firms. The geographical proximity of Scripps to life sciences establishments in the region also constitutes a pivot for the southeast region to expand its links.

Central Florida

1) ***Attract and integrate the Burnham Research Institute into regional life sciences development, and establish partnerships with the University of Central Florida (UCF) technology transfer office.***

The UCF is exploring areas in biotechnology, such as exploiting its optics program for medical applications. The newly designated medical school in Orlando is another asset. These partnerships will enhance the region's life sciences industry in the short term.

The full operation of the UCF College of Medicine, as well as the research yield from the UCF College of Biomedical Science, also will become a major asset in this partnership.

2) ***Increase funding, and funding cycles, for more R&D centers to establish links with growing biotech firms in Gainesville with those in Orlando.***

This linkage, via institutions as well as market opportunity, should benefit firm growth and industrial expansion.

The current three-year COE funding terms are inadequate for reaping substantial economic benefits. Increasing the terms to ten years, with fixed annual funding, would create a stable structure. Safeguards, such as five-year reviews, would evaluate additional funding needs during the term.

This is relevant especially to the central region because of Orlando's growing biotech and pharmaceutical sector concentration. From 2000 to 2005, employment concentration of biotech and pharmaceutical sectors has grown about 50 percent relative to the state as well as the U.S. Establishing more R&D centers will allow the region to leverage its knowledge base further.

Northeast Florida

1) ***Promote the new Mayo Clinic hospital and Shands Jacksonville Medical Center in a medical tourism campaign to reach out to a customer base beyond the immediate southeast United States.***

2) ***Facilitate and promote the Mayo Clinic, establishing technology transfer links with local firms for locally based IP, as well IP derived from other Mayo Clinic locations.***

The Mayo Clinic boasts more than 100 specialties and subspecialties in medical and surgical research. Enhancing technology transfers through these links will boost regional strengths.

Southwest Florida

1) ***Develop medical tourism programs around local institutions.***

Like the Mayo Clinic in Jacksonville, the Health Management Associates Inc. (HMA) at Naples operates acute-care hospitals. These include the Cleveland Clinic, which was sold to HMA in 2006. The Cleveland Clinic was originally a leading medical research facility in Florida and is poised to continue operating under HMA. As such, leveraging its knowledge base will boost southwest Florida's attraction to national and foreign talents.

2) ***Promote health care as an export industry.***

This can leverage the regional health-care services industry concentration in the southwestern part of the state.

North-Central Florida

1) ***Establish partnerships in medical devices IP with firms in Jacksonville, which include means for establishing acreage for such startups in Jacksonville.***

The medical devices sector is strong in this region. Therefore, allocating land for new startups is a strategic initiative.

Northwest Florida

1) ***Promote advanced treatments from the Institute for Human and Machine Cognition (IHMC) and the Andrews Institute to establish Pensacola as a significant destination for medical tourism.***

The IHMC is a nonprofit institute affiliated with the Florida University system, as well as several other universities. The Andrews Institute is a health-care service provider and R&D center with a multi-specialty ambulatory surgery center, outpatient rehabilitation, diagnostic imaging center, athletic performance center, a research and education institute, and an office park for physicians. The strong R&D resulting from these two institutes can strengthen the northwest region for treatment and R&D.

Tampa Bay

1) ***Undertake a major faculty recruitment drive at the University of South Florida.***

The University of South Florida can play a key role in life sciences development in Tampa Bay, given its proximity to the H. Lee Mofitt Cancer & Research Institute. In 2007, M2GEN, a company of the Moffitt Cancer Center will be created and based in Tampa. M2GEN is the product of R&D partnership and financial support from Merck.

But USF lags behind U.S. universities in terms of biotech research. Between 1998 and 2002, USF's biotechnology publications ranked 87th nationwide. This suggests that there is room to increase the number of high-profile faculty members. This would boost the region's R&D base and leverage regional assets, such as the H. Lee Mofitt Cancer & Research Institute, and M2GEN.

2) ***Introduce a life sciences fund to attract large pharmaceuticals and biotechnology firms to Tampa Bay.***

Tampa Bay's pharmaceuticals and biotechnology assets are exemplified by the H. Lee Mofitt Cancer & Research Institute. Although the region's employment concentration in these two sectors is nearly twice that of the state's average concentration, it is only about 50 percent of nationwide concentration between 2000 and 2005.

Thus, Tampa Bay claims a majority of the pharmaceutical and biotechnology sectors in Florida, but the state still cannot compete nationally with its peer and leading states. One reason might be the lack of anchor firms in these sectors. In 2005, only Baxter employed more than 1,000 people. As a result, innovation from life sciences R&D could migrate to regions outside Florida.

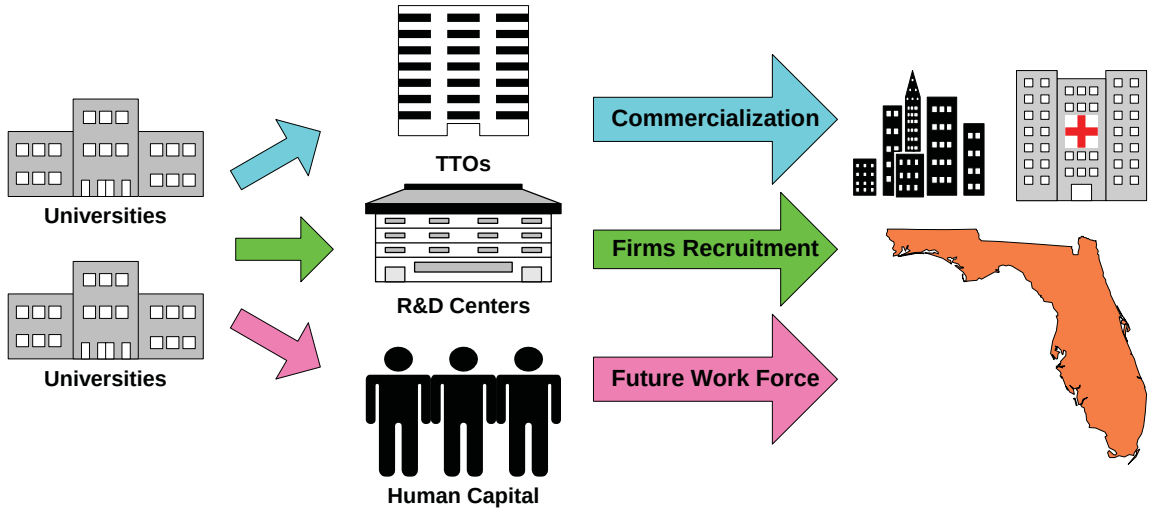
Anchor firms are critical generators of new companies. They also serve to attract talent. The use of anchor firms to leverage its current and upcoming R&D assets is a strategic move for the region.

Focus II: Industry Asset Optimization

Because Florida's life sciences strengths are dispersed across seven regions, we would like to see the state leverage its industry mix, channel capital support, and boost the output from new and existing life science clusters.

The following chart depicts three links—commercialization, firm recruitment, and future work force—between universities and the industry. These links are keys to industry optimization.

Commercialization, Firm Recruitment, and Future Work Force



Commercialization is facilitated by technology transfer offices. Firm recruitment comprises the attraction, creation, and retention of life science firms in the state. R&D centers are pivotal to developing and sustaining research activities among firms and institutes, and universities. The recruitment and development of a skilled work force will ensure that Florida's life sciences industry has an adequate employment base to support cluster formation and growth.

As earlier, we present an overview of current industry conditions for each strategy. Statewide and regional recommendations follow.

Three Strategies

1) Optimize the life sciences industry mix

Again we stress that Florida must begin with the addition of educational curricula that meet the interdisciplinary needs of the life sciences industry.

The industry has insufficient new workers in its R&D, drugs and pharmaceuticals, and biotechnology sectors. Florida has tremendous potential with respect to innovation but does not match the peer and leading benchmarked states in performance.

Among Florida's key research facilities, much of the R&D is conducted in the life sciences. The laser/optics program at the University of Central Florida, the Bascom Palmer Eye Institute at the University of Miami, and Florida State's emphasis on bio- and nano-materials and devices may attract medical devices firms to the state, but the impact of other innovation, particularly in the areas of biotechnology and pharmaceuticals, has yet to be realized fully. The UF's McKnight Brain Institute, College of Medicine, and Interdisciplinary Center for Biotech Research, along with Gainesville's Sid Martin Biotech Development Incubator, must work closely with industry to leverage R&D assets or risk losing them outside the state.

Of course, different university programs target different aspects of life science—from the Moffitt Cancer Center (affiliated with USF) to Florida Atlantic University's Center of Excellence in Biomedical and Marine Biotechnology. But they must develop their respective expertise for long-term prosperity by local industry. If a program does not consider its effect on regional long-term industry development, then its efforts will be futile. Worse, the state and industry will have invested research dollars that deliver returns outside Florida.

2) Lay the foundations for innovative industry clusters

Once the state has enhanced its employment base by attracting students, faculty, and skilled workers, it must establish an environment for cluster growth. Strong clusters support continuous and sustained innovation.

Florida must employ current incubators and collaborative R&D links to boost its life science clusters. Regional strengths must be taken into account, and the state must promote them as it offers incentives for firms and venture capital to move into appropriate regions.

With more than thirty collaborative research projects, Scripps Florida is exemplary of collaborative R&D. The presence of Scripps will present local opportunities to strengthen Florida's weak knowledge-driven sectors. There are two potential benefits: 1) The state's research agenda (which drives the life sciences industry mix) could shift toward these sectors; and 2) Scripps creates an opportunity for startups to evolve directly from university or research center work. Life science firms will find it advantageous to locate within an industry-related R&D network. With appropriate strategies, the Scripps impact could complement medical schools, research centers, and hospitals throughout Florida, and attract skilled workers to the region.

The one consistent example of a successful partnership is the Florida High Tech Corridor Council (FHTCC), an economic development initiative of the University of Central Florida (UCF), the University of South Florida (USF), and the University of Florida (UF) to attract, retain, and grow

high-tech industry, and to help develop the work force to support it in twenty-three counties served by these three world-class universities. This partnership includes more than twenty local and regional economic development organizations (EDOs), fourteen community colleges, and numerous organizations serving the twenty-three-county region. This cooperation has yielded several technology-related companies, particularly in optics and photonics, but life science startups have not been among them. In contrast, ongoing state and local funding and incentives in Minnesota have spurred remarkably successful cluster growth. This has allowed for cluster development in cities such as Rochester that, on the surface, might not appear populous enough to provide the necessary infrastructure and human capital.

Direct partnerships between research institutions and industries remain relatively rare or are created on an ad hoc basis. The University of Central Florida has negotiated contracts with the military and various optics companies, but is weakly linked to large-scale industrial partners. The potential involvement of the University of South Florida with medical device manufacturers suffers because local companies have sought alliances with out-of-state institutions.

The Institute of Human and Machine Cognition has established successful partnerships with the federal government and military. But IHMC links usually are formed at government sites and thus fail to attract companies and operations to Florida. Florida Atlantic University has developed a working relationship with Panavision in optics, but its main links have been recent ones with Harbor Branch in Ft. Pierce and Scripps. While Scripps has developed a number of links to industry in San Diego, it has not yet found partners of a similar scope in Florida.

The problem is exacerbated by land-use and zoning regulations that often impede the ability to develop wet lab space, new research parks, and industrial production facilities. County and city officials only recently have begun to understand the needs of R&D facilities.

Historically, Florida has performed well as a center of technological R&D, spurred by high levels of government funding, particularly around the Kennedy Space Center. This kind of funding, however, has done little to push the creation of life sciences industrial clusters, and the state requires a significant increase in corporate investment.

In the Tampa area, efforts at partnerships have been made with medical device companies; and the Scripps/Florida Atlantic University partnership provides a reasonable foundation for attracting related firms. But no true life sciences clusters have developed around the sector. Several schools, including the University of Florida, University of Miami, University of South Florida, and the University of Central Florida, have established incubators, but these do not attract investment income on the scale associated with life science centers in the Research Triangle, San Diego, or Minneapolis.

The University of South Florida is located near the center of medical device manufacturing establishments, and has a developing tech transfer program and links to the Moffitt Cancer Center. A more aggressive effort will promote growth tremendously in the life sciences industry.

Startups rarely have capital to invest in sophisticated infrastructure and must rely on local governments and research institutions. Universities, meanwhile, are under pressure to generate licensing revenue, and their technology transfer offices will shop their most lucrative properties out of state. As noted by David Day, director of the technology transfer office at the University of Florida, a successful technology transfer office must balance its licenses between startups and established companies to ensure the greatest chances of return.

To attract industry investment, cities and universities must provide existing infrastructure, incentives, and local partners. Most Florida universities cannot provide all three. The University of Florida clearly has the infrastructure, faculty and resources, but its distance from a large employment and financial center is problematic.

The University of Miami has helped develop one of the strongest research hospital clusters in the nation by linking with Jackson Memorial Hospital, the university hospital, the Miller School of Medicine, and the local Veterans Administration hospital, and by negotiating a land swap agreement with the city to obtain space for wet lab/incubator facilities. Yet the university lacks the overall R&D scope of the University of Florida, and space and cost concerns in central Miami remain problematic.

The University of Central Florida (UCF) has shown a clear ability to partner with the industry and government, and has developed a technology infrastructure. Addressing its lack of resources in life sciences curricula, the university has recently approved development of a medical school.

By developing partnerships, universities, business, and metropolitan areas could attract a major pharmaceutical company's research or clinical-testing arm in Florida, much like GlaxoSmithKline's operations in North Carolina. Often, the reputations of high-flying researchers attract investment and offers of partnerships to a region.[25]

3) Enhance early-stage funding and VC support

Innovation requires incentives, in the form of capital funding, tax breaks, favorable regulations, and promotion. Florida's risk-capital and entrepreneurial infrastructure falls short of expectations and fairs poorly compared to its peer benchmarked states. Nor does it fare well against many of the leading states.

Florida's life sciences growth is constrained by limits to available capital. These constraints are caused by several factors, including the historic underdevelopment of the state's funding

infrastructure; low levels of local venture capital and development assistance; limited long-term funding by the state; a lack of industry R&D funding.

Until recently Florida has focused on specific locations and projects rather than working to construct an overall strategy. That has resulted in relatively low human capital scores in the innovation pipeline, and a disconnect between the few prominent research institutions, such as Mayo and Moffitt, and the rest of the state. It is important to coordinate efforts under a statewide strategy while keeping the regional focus through local initiatives.

Former Gov. Bush's efforts to support the life sciences included luring Scripps to Palm Beach County, funding the first three centers of excellence (and planning for three more), and providing funds to recruit research talent. Unfortunately, most of those efforts are of conditional or limited duration. Even the agreement with Scripps provides a preferential status for Florida for only five years.

The most significant way to ensure industry development is to establish a stable source of funding and of venture capital investment. Several states, particularly California, have designated a discretionary portion of the state pension fund, around 5 percent to 6 percent, for venture capital investment. This is a significant capital source, particularly for establishing fully funded "stage zero" Small Business Innovation Research Program (SBIR) awards, providing gap funding, and matching early VC funds invested by private firms.

If pension funds are unavailable, another source of funding would be state bonds with a structure akin to the stem cell initiative in California. With bond funding, centers of excellence could remain in operation for as long as ten years, a period that would allow them to attract more investment and industrial activity and serve as proper cluster anchors. Longer-term state investment would send an encouraging message to the private sector, which could incorporate those efforts into its own long-term planning.

Florida has a significant number of potential angel investors who could provide financial support, as could universities. Some efforts have been made to establish angel investor networks, particularly around the University of Florida, but the organization for these networks has not come close to the level necessary for support of the life sciences throughout the state. The state must develop sophisticated networks, particularly among active retirees living along the Gulf and Atlantic coasts, where we find some of the highest concentrations of wealth in the country.

Florida's primary weakness lies not in its ability to create startups, but to ensure the growth and longevity of the industry through viable clusters. The short life expectancy of life sciences and technology startups suggests to investors—who prefer known markets or the more stable returns of local real estate markets—that they have a high risk of losing their investments in as few as three to five years.

Statewide Recommendations

Three areas are of primary interest in the execution of the Focus II strategies: the work force, the business climate, and technology transfer.

The Work Force

The state must develop local programs to produce life science workers for the biotechnology manufacturing, R&D, and pharmaceuticals sectors. Targeted workforce training is essential for boosting regional strengths. Florida should:

1) ***Continue to develop training curricula for biotech manufacturing technicians and specialists.***

Gainesville and Miami have developing biotech presences. Developing programs to foster industry links in these regions will produce a work force to support local businesses.

Elsewhere in the country, biotech manufacturing positions above the level of technician (such as process development associate and manufacturing associate) typically are filled in-house through promotion and training, with few external training programs at these levels. Formal academic programs, however, can both ensure higher-quality training and offer programs tailored to local retraining needs.

Florida could develop these programs to fill the gaps at all skill levels for incoming life science firms, particularly biotechnology manufacturing companies. Programs should be linked to local sectors.

2) ***Develop training programs for medical device manufacturing technicians in two-year colleges.***

Tampa and Jacksonville, in particular, have an immediate demand for a medical device manufacturing work force. Two-year programs meet this demand quickly and ensure a constant employment pool. Such programs also could evolve into four-year programs in sub-fields as the sector grows.

Efforts by Workforce Florida, Inc. incorporate these elements of effective training. We recommend continued emphasis by Workforce Florida, Inc. on working with employers to develop training curricula.

Florida must improve links between its life sciences work force and industries to develop the state's geographic strengths and build in specializations. Clusters can complement key research centers.

3) ***Develop a workforce development ladder in the life sciences, including heath-care services, to provide workers with the training sufficient to hold high-paying, stable positions.***

Such programs will eliminate the need for employers to recruit out of state. The current lack of career ladder training is attributable in part to job structure, particularly in biotech manufacturing, which offers no clear career paths from the technical level to higher-skilled positions. Some employers may prefer to promote via in-house training and do not want to participate in a formal training program. Advancement from technician positions to higher-level jobs is not likely to occur in the short term.

A career education/advancement system would enable workers to improve their skills; workers would be informed individually of their career mobility and offered direction for advancement.

Having a directed career path could increase public- and private-sector confidence in the training programs. A workforce development ladder could be implemented by a task force that would track where jobs are being created statewide.

In conjunction with this ladder, the Incumbent Worker Training (IWT), funded by the federal Workforce Investment Act (WIA), facilitates retraining. Retrained workers have a better understanding of their career paths and can be expected more predictably to remain within the industry and within the state.

Florida must increase graduate degree offerings to produce more knowledge workers in the life sciences, particularly in pharmaceuticals, biotechnology manufacturing, and R&D.

4) ***Establish a life sciences advisory board to develop curriculum synergies.***

Because the industry is interdisciplinary, cross-regional R&D collaborations are critical, and cross-discipline training programs will develop a mobile work force. This enables the industry mix to realize long-term optimization.

5) ***Develop master of science programs at the University of Florida and the University of South Florida in medical devices, with an emphasis on applied research.***

With an R&D focus on biotechnology, the University of Florida's College of Medicine is a national leader in research and education. The University of South Florida is strong in biological defense. Introducing applied medical devices graduate programs will augment this strength, thus, linking advanced research to production.

The need for more advanced-degree programs dovetails with the recommendation to attract industry anchors and key players into the state. By providing labor at the technician, management, and research levels, Florida will be able to leverage its R&D assets.

Business Climate

To benefit from policies to retain its R&D innovation, Florida should:

6) ***Develop tax incentives to enable life sciences startups to carry losses tax-free for ten years in order to increase chances for survival.***

Returns on technology investments are rarely immediate. New tax exemptions would benefit entrepreneurs who might lack sufficient personal collateral but who seek capital. Massachusetts, for example, provides a 10 percent R&D tax credit, California offers a 15 percent (in-house) and 24 percent (outsourced) R&D tax credit, and North Carolina has a 5 percent R&D tax credit.

7) ***Develop tax incentives for property owners who provide wet lab space.***

These incentives might come in the form of tax credits for R&D establishments. Commercial developments typically yield higher profits compared to research-related facilities. Not only would incentives motivate some property owners to provide wet lab space, they could also prove to be lucrative investments.

Technology Transfer

Currently, twelve universities maintain technology transfer offices, but only a few institutions consummate effective transfers. Based on a survey by the Association of University Technology Managers (AUTM), between 1996 and 2003 Florida universities in total executed only 434 licenses. This constitutes only about 2 percent of the total licenses executed nationwide in the same period.

8) ***Introduce regional tax incentives for companies that invest in locally generated technologies.***

These breaks should be sufficient to promote company expansion and should target fast-growing metropolitan areas, such as Tampa Bay, Orlando, and Miami.

The Qualified Target Industry (QTI) Tax Refund, an incentive for high value-added businesses (those paying more than 50 percent above the average state average wage), could be extended to life sciences companies specializing in locally generated technologies.

9) ***Introduce incentives for companies that establish local operations.***

Such incentives could include industry-specific workforce training, assistance for infrastructure building, and tax breaks for firms that complement current industry structure. These firms must be high-impact, fast-growing, and strongly related to the industry.

Some life sciences cluster formations exist in Tampa, greater Miami, Jacksonville, and Gainesville. These are not strong compared to Florida's peer and leading states, but they contribute in small ways to the state's regional economy. Because clusters form around research institutions, we place high priority on the following recommendations to promote cross-pollination of industry and academia through internships, grants and contracts, and adjunct faculty.

10) ***Develop direct links between medical schools and teaching hospitals in all regions to create placement opportunities for interns and for conducting clinical trials.***

Cluster links form the basis of R&D synergies. In the long run, such synergies facilitate industry prosperity and longevity. The demand for clinical trails is expected to rise. These links can leverage Florida's growing population for use in clinical trials.

11) ***Establish working relationships between large national pharmaceutical companies and local research institutions to host clinical trials and promote IP spin-offs.***

These commercialization links enable Florida to retain and attract VC and human capital, and most important, to leverage innovation output.

12) ***Increase funding of industry-matching research grant programs directed at the life sciences.***

Additional funding is necessary to build clusters. Under existing state funding provisions, the state matches private research funding for economic development. Targeting life sciences companies could encourage them to invest in R&D and firm expansion.

Venture capital is a major source of support for the industry. Currently, Florida lacks local investors and sufficient venture capital. The state should implement initiatives to encourage local investors through tax and loan incentives, as well as communicate the quality of regional life science assets.

13) ***Create a database of angel investor networks and life sciences startups to match investors with firms in need of early-stage funding.***

Access to venture capitalists is a significant problem. The transparency associated with the statewide database could increase the level of access to investors. This applies especially to startups, which have less experience in the industry.

14) ***Partner with nationally established VC firms to establish early-stage deal flow.***

Partnerships must include incentives for the establishment of Florida-based offices of such companies with staff fully empowered to execute deals.

15) ***Promote local up-and-coming technology firms to VC firms outside Florida.***

Scripps is a key resource in this regard, attracting venture capital investors from California and elsewhere. The state can develop programs to track firm performance. Up-and-coming technology firms can apply to the state or regional programs that help them link to national and regional VC firms.

Following these recommendations will establish transparency and facilitate partnerships.

A policy for long-term industry development is essential to ensure returns on R&D, VC funding, research grants, and talent recruitment.

16) ***Develop a policy that promotes incentives for medium-sized companies, as well as their collaboration with universities and research institutions.***

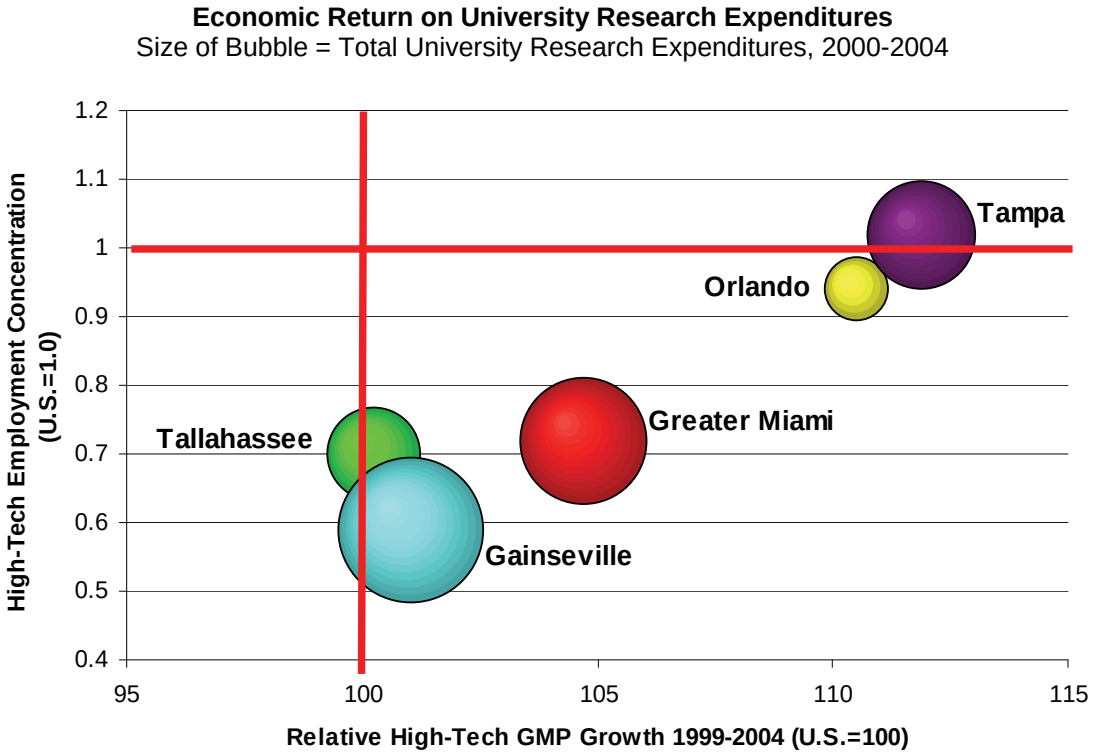
This recommendation addresses Florida's lack of medium-sized firms in medical devices, its best-performing industry sector (excluding health care). As a by-product, Florida medium-sized firms can develop from existing startups because this policy establishes an enduring and lucrative environment for firms to grow.

Although research institutes such as Scripps will lure more R&D and top-notch scientists, Florida's primary focus should be on long-term job creation and production. The state must pair its R&D assets with its industry strengths in order to reap returns on its life sciences investments.

Without a strong industry presence, R&D facilities will not be able to invigorate the state's life sciences industry effectively. In other words, firms need research to power marketable ideas.

The next chart illustrates high-tech employment concentrations and gross metro product (GMP) growth of state metropolitan areas relative to the national average. The size of the bubble represents the research expenditure from universities in each metro.

Gainesville clearly spends more than most areas on research. But its high-tech employment concentration is almost 40 percent less than the national average. Orlando's GMP grew nearly 11 percent faster than the U.S. average between 1999 and 2004, but its high-tech employment concentration is still below the national average. Tampa is the only Florida metro area whose high-tech employment and GMP growth exceed the national average. The state's weak industry presence is depicted by its relatively low employment concentration in knowledge-intensive sectors.



Regional Recommendations

Southeast Florida

1) ***Establish a system of regional specialization for workforce programs, with particular emphasis in pharmaceuticals and biotechnology.***

These programs should include partnerships with established local firms, such as Nabi and Ivax, as well as firms reaching critical mass as defined by their impact on product development and production.

2) ***Improve county zoning and regulatory processes to facilitate the expansion of research- and production-related firms.***

Similarly, create regionally based incentive packages to the Ft. Pierce and Vero Beach areas, where they can maintain ties to resource pools in Palm Beach County and farther south.

This region has land that can be allocated for industry expansion. Scripps serves as a key node in this up-and-coming cluster. But a strong cluster depends on more than just one anchor, and it is crucial for the state to exploit Scripps' presence to lay the foundation for greater industry development.

Collaboration between FAU and the University of Miami has led to a program in medical sciences. This program serves as a key asset in the Southeast region to expand commercial research and development. Furthermore, the planned teaching hospital at FAU and the Jackson Memorial Hospital are catalysts for regional growth.

Central Florida

1) ***Establish partnerships to encourage growing location of biotech startups in Orlando.***

Because Gainesville exhibits low unemployment and a resistance to development, we recommend the creation of partnerships that encourage growing biotech startups to locate in nearby Orlando, where the resource base is stronger.

2) ***Establish partnerships between a new medical school and area hospitals.***

In 2006, the state university system's board of governors approved the creation of a medical school at the University of Central Florida, where biomedical research will be built around the genomic and molecular basis of diseases and therapeutics. The university's Burnett College of Biomedical Sciences is strengthening its basic research programs in cancer, heart disease, and neurodegenerative and infectious diseases. Core biomedical science technologies under development include bio-imaging, adult stem cell and tissue engineering, and 3-D computer simulation of gene expression profiles in the brain. UCF is also home to a wide range of life sciences-related programs. A medical school will enhance the college's ability to attract scientists, entrepreneurs, and federal funding through the National Institutes of Health.

UCF's research and commercialization program serves as a liaison among faculty, industry leaders, and government, and is essential to the region's life sciences and high-tech economic viability.

Northeast Florida

1) ***Increase and improve partnerships for medical device training between Jacksonville Community College and medical device manufacturing firms to establish career ladders.***

Florida's community colleges and businesses offer two-year programs in biomedical equipment engineering. These programs can be focused more toward R&D, enhancing knowledge intensiveness in the sector.

In other states, community college provide most biotech training, vocational and pre-vocational, either directly through state funds or indirectly on a contract basis. In Florida, the latter occurs through Workforce Florida. As biotech vocational training classes are incorporated into community college curricula, college districts will receive increased per-pupil instructional funds to offset training costs.

Given this region's low employment concentration in R&D-focused sectors, community college programs might be precursors to bachelor's and graduate programs, or enhance the current training at higher levels.

2) ***Develop an organized campaign for recruitment of recently discharged military personnel into the life sciences with local training and placement programs.***

Former military personnel with a science background and familiarity with government documentation can be a good source of labor for the life sciences industry. This initiative should include assistance in finding housing and training programs at local two-year schools that prepare them for employment. It must be coordinated and executed statewide and aimed specifically toward the life sciences.

3) ***Establish a neuroscience R&D partnership between the University of Florida and the Mayo Clinic.***

The university's Center of Excellence in Regenerative Health Biotechnology and Martin Biotechnology Development Incubator (BDI), paired with Mayo Clinic's medical and surgical facilities, could prove strategic for economic expansion in the northeast and southeast regions, and eventually statewide.

In addition, the Florida Banner Centers' recent $500,000 award to the University of Florida for biotechnology employment training makes the university a driving force for the region. Florida Banner Centers, a Workforce Florida initiative to facilitate skills training for workers, is part of the state's economic development plan.[26]

Southwest Florida

1) ***Develop a local network for potential angel investors to connect with local firms, as well as those in the Tampa and Miami regions.***

Tampa and Miami are strong in medical device technology. A network of southwest investors would help sustain existing companies. In addition, these regions have a relatively high presence of the biotechnology and pharmaceuticals sectors. Thus, they have the potential to develop biotechnology and pharmaceutical clusters as the life science mix is optimized.

2) ***Leverage programs at the New College of Florida for workforce development.***

The college specializes in undergraduate programs in the life sciences and could produce the technical work force required. This speaks to the proposed workforce development ladder programs through which undergraduates could be assured of jobs upon graduation.

North-Central Florida

1) ***Promote Shands HealthCare as a site for clinical trials, and establish research partnerships with pharmaceutical companies seeking access to research/teaching hospitals.***

Shands is a comprehensive academic health center with a R&D focus in biotechnology. With the concentration of hospitals and pharmaceutical companies in the north-central region, Shands could become the nucleus of a biotechnology cluster.

Florida has good facilities for performing clinical trials but lacks the talent and commercialization links that would enable the state to leverage its facilities. As a result, the state risks losing its university R&D output to competitors beyond its borders. Shands could fill the gap, but its promotion must be tied into appropriate statewide recruitment and industry optimization initiatives.

2) ***Establish partnerships between a new medical school and area hospitals.***

Establish partnerships between the newly approved medical school at the University of Central Florida and key local hospitals within the decade to develop nationally recognized teaching and research hospital facilities.

These partnerships should enhance life sciences education in the state and in time could draw medical tourism from neighboring states and overseas.

Northwest Florida

1) ***Establish a coordinated regional policy for medical device technology transfer involving the Institute for Human and Machine Cognition, the University of West Florida, and the military to promote military advances in medical devices, particularly in Pensacola and Panama City.***

The northwest region has a considerable concentration of medical devices firms, but few biotech businesses. So rather than developing an optimized industry mix in this region, we recommend a focus on existing strengths and buildup of the medical devices sector. Tampa Bay and eastern regions have higher concentrations of medical devices firms, but the northwest region can contribute substantially to the state's overall industry mix.

2) ***Create links between the FSU technology transfer office and firms outside Tallahassee.***

The National Science Foundation and National Institutes of Health have funded FSU's research in structural biology and nuclear magnetic resonance. The university's Institute for Molecular Biophysics and Center for Nanomagnetic Biotechnology demonstrate excellence in clinical research. The missing link is commercialization.

3) ***Create infrastructure for R&D activities at the University of West Florida (UWF) to target and foster commercialization of specialized medical devices.***

This recommendation is tailored toward UWF. It is aimed at exploiting UWF to create another channel for the flow of innovation. This will enhance the technology transfer links for the whole region.

Tampa Bay

1) ***Coordinate leadership as an extension of the Tampa Bay Partnership for the promotion and development of tech transfer from H. Lee Moffitt Cancer Center & Research Institute and the University of South Florida.***

The university has developed a deserved reputation in R&D for cancer treatment and prevention through the Moffitt Cancer Center. The Tampa Bay Partnership is key to supporting and promoting IP technology transfer. Over time, this optimization will give Tampa Bay a competitive edge.

In 2005, the Byrd Alzheimer's Institute and the University of South Florida received an Alzheimer's Disease Research Center (ADRC) grant funded by the National Institute on Aging.[27] Their collaboration is a regional asset that can be exploited further.

2) ***Facilitate additional Tampa Bay zoning and land acquisition for life science startups.***

Tampa Bay possesses a relatively high concentration of life science activities. Additional zoning and land acquisition would allow the region to exploit existing strengths and extend them to the state.

3) ***Employ the Florida High-Tech Corridor Council to promote life sciences development along I-4 east of Tampa.***

The Florida High-Tech Corridor has initiatives directed at life sciences and medical technologies, as well as other sectors, such as information technology. Their grant-matching programs with UCF, USF, and UF are indications of the high levels of R&D activities. Therefore, the establishment can serve as an opportunity not only to the region, but also to the state.

4) ***Create infrastructure for R&D activities in oncology at the University of South Florida (USF) to expand links with Moffitt Cancer Center and coordinate joint technology transfer efforts.***

The USF Connect program provides intellectual property management expertise and capital partners to support collaborations between businesses and entrepreneurial communities. It includes the Tampa Bay Technology Incubator (TBTI), whose mission is to accelerate economic development in Florida.[28] With these resources, a collaboration between USF and Moffitt Cancer Center will enable USF to play a vital role in cancer research.

Florida's Life Sciences Innovation Pipeline

Overall, Florida ranks 16th nationwide in effectiveness of its innovation pipeline. It trails both peer and leading states, and scores lower than expected, considering its population and resources. To understand the state's relative underperformance, we examine the gap between innovation and industry in several categories.

An innovation pipeline comprises five areas: 1) R&D presence; 2) risk capital and entrepreneurial infrastructure; 3) human capital; 4) the work force; and 5) innovation output. The following table summarizes these metrics, which we use in our analysis.

Innovation Pipeline Matrix of Analysis

Metric	Description	Operationalization
R&D Presence	The presence of cutting-edge R&D is essential to a region's ability to commercialize innovation. This transfer process is carried out by universities, institutes, and firms facilitated by R&D funding. The transfer success, along with awards received, reflects the quality of these innovations in a given region.	NIH funding to independent hospitals
		Industry R&D to life sciences
		Academic R&D to life sciences
		NSF research funding
		STTR awards to life science firms
		STTR awards measured by dollar amounts
		SBIR awards to life science firms
		SBIR awards measured by dollar amounts
		Competitive NSF funding rate in life sciences
		NIH funding to medical schools
		NIH funding to research institutes
Innovation Output	This component captures the ability of a region to leverage its life sciences assets. Innovation output is dependent on new drug development, and approval and commercialization processes, which are often long and expensive.	FDA drug approval
		FDA new medical devices premarket approval
		Clinical trials (Phase I)
		Clinical trials (Phase II)
		Clinical trials (Phase III)
		Life sciences patents issued
		Weighted life sciences patent growth percentage
		Weighted percentage of life sciences patents in area
		Current Impact Index (CII): number of cited patents
		Weighted life sciences technology strength
		Weighted life sciences technology cycle time
		Weighted life sciences science linkage
		Weighted life sciences strength
Risk Capital and Entrepreneurial Infrastructure	Startups, key companies, and entrepreneurs constitute the entrepreneurial infrastructure. Venture capital is essential to business development and growth.	Early-stage seed capital
		Life sciences VC investment
		Life sciences VC investment growth
		Life sciences VC investment to companies
		Growth in companies receiving life sciences VC investment
		Business starts in life sciences
		Academic degrees awarded in entrepreneurship
		Number of Tech Fast 500 companies in life sciences
Human Capital Analysis	The ability of a region to excel in knowledge-intensive sectors depends on its capacity to produce a highly skilled work force.	Number of life sciences Ph.D.-granting institutions
		Number of life sciences bachelor's degrees awarded
		Number of life sciences graduate students
		Number of life sciences master's degrees awarded
		Number of life sciences Ph.D.s awarded
		Number of medical doctor degrees
		Number of life sciences postdoctorates
		Recent bachelor's degrees awarded in life sciences
		Recent master's degrees awarded in life sciences
		Recent Ph.D.s awarded in life sciences
		Recent medical doctor degrees awarded
Workforce Analysis	The competitive advantage of a region's knowledge industry is dependent on its ability to leverage talent to support the commercialization and production of innovation.	Intensity of biomedical engineers
		Intensity of medical and health services managers
		Intensity of chemical engineers
		Intensity of materials engineers
		Intensity of electro-mechanical technicians
		Intensity of biochemists and biophysicists
		Intensity of microbiologists
		Intensity of medical scientists, except epidemiologists
		Intensity of chemists
		Intensity of materials scientists
		Intensity of biological technicians
		Intensity of chemical technicians
		Intensity of sales representatives, wholesale and manufacturing, technical, and scientific products

State Findings

Using results from these areas, we compile a Life Sciences Innovation Pipeline Composite Index to benchmark Florida's life sciences innovation pipeline against peer and leading states. We also provide a national comparison. The composite score is obtained by taking the average composite scores of each research area and standardizing it to a 100-point scale. The results:

Innovation Pipeline Composite Index

State	Composite Score	Rebased Composite Score	Rank
MA	98.77	100.00	1
CA	95.56	97.77	2
NJ	87.05	88.14	3
A	86.71	87.79	4
NY	81.51	82.52	6
MN	79.93	80.92	8
NC	78.37	79.34	9
IL	77.93	78.90	10
TX	75.73	76.67	11
FL	71.08	71.96	16
MI	69.45	70.32	19

Florida's performance places it solidly in the second quartile of U.S. states. With a number of renowned universities, Massachusetts and California lead the national rankings. New Jersey follows after a gap of nearly 10 points. Florida scores 72 percent nationally.

Despite its strength in health-care services, Florida falls short in R&D. Its performance lags behind the benchmarked leading states, which rank within the top quartile nationally. And compared to peer states, Florida has not demonstrated its potential. Among both peer and leading states, only Michigan had a lower score.

Florida's best score was for innovation output (14th nationally); it scores lowest in human capital (27th).The state does not produce sufficient human capital to leverage its available assets, forcing growing life science companies to recruit out of state and at higher cost.

Summary of Individual Innovation Pipeline Indexes

	Life Sciences R&D		Risk Capital		Human Capital		Workforce Composition		Innovation Output	
	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
MA	100.00	1	94.51	2	100.00	1	99.33	2	100.00	1
CA	95.97	2	100.00	1	93.11	7	100.00	1	93.74	2
PA	87.08	3	77.88	5	99.43	2	32.21	4	76.92	8
NY	86.24	4	56.52	20	98.04	3	91.11	5	75.64	9
NJ	82.65	7	77.91	4	88.25	15	95.38	3	91.08	3
NC	82.09	9	68.94	12	86.95	18	87.08	7	66.78	12
IL	79.10	12	62.92	13	94.81	4	83.94	9	68.89	11
TX	76.78	15	69.51	10	84.36	24	84.81	8	63.16	15
MN	74.14	17	76.02	6	86.65	19	80.63	13	82.19	5
FL	72.70	19	59.34	17	83.33	27	76.44	16	63.58	14
MI	71.02	20	60.43	14	90.70	9	70.10	22	55.02	24

Florida also faces stiff competition in building its R&D presence and work force; other states, such as Massachusetts and California, have better developed and more established clusters. The weaknesses in the state's innovation pipeline are summarized in three areas.

1) *Florida lacks a sufficiently strong university system to support its innovation pipeline.*

Florida has four medical schools, but according to the most recent rankings of research medical schools by *U.S. News & World Report*, only the University of Florida scores among the top 50. Harvard ranks first. In California, five universities in the University of California system, as well as Stanford and the University of Southern California, are among the top 50. The other leading and peer states also score higher than Florida.[29] The result? Florida does not produce enough higher-quality workers for its life sciences industry, compounding the difficulty of developing vibrant life science clusters.

2) *Florida fails to leverage its university R&D assets fully.*

Although Florida's universities as a whole are not highly ranked for R&D, when they develop and execute licenses, the results can be remarkable, particularly in the case of Gatorade, Taxol, and Trusopt. Florida's university R&D output generated considerable licensing income between 1996 and 2003; in fact, the state ranked No. 1 among leading and peer states in revenue per license, with approximately $1.35 million from universities.

This means that Florida's universities are heavily dependent on blockbuster licenses—unlike universities in other states, such as California, whose university system sustains licensing annually. The patent for Taxol has just expired, depriving the state of most of its licensing revenue. The following table illustrates the rankings among benchmarked states.

Licensing Income per License Executed
Florida versus peer and leading states

State	Income
FL	$1,347,898
NY	$571,683
MI	$377,856
MA	$280,619
CA	$268,975
MN	$198,205
TX	$187,903
IL	$180,415
PA	$168,164
NJ	$139,571
NC	$58,808

Sources: Milken Institute, AUTM

As shown earlier, Florida ranks low among the ten states in terms of innovation output, suggesting that innovation is not leveraged or transferred effectively to the market. Where technology has been commercialized effectively, Florida has done very well in terms of revenues, but the value created from the production of those licenses consistently has moved out of state. Although Florida performed well in the number of life science startups, the potential for these companies to grow and remain within the state is hindered by the limits of the local human capital base, both technicians and researchers.

3) ***Florida lags in financial support to grow its knowledge assets.***

The state's life sciences do not attract significant financial support from either the private sector or federal government. Florida rates below most of its peer and leading states in VC and R&D funding for the life sciences. One reason might be its limited ability to sustain innovation, which has restricted (with the exception of general health care) the number of large home-grown life sciences companies.

Given these conditions, Florida runs the risk of experiencing a chronic life sciences brain drain as its well-educated and skilled graduates leave the state for employment with higher wages and multiple job prospects.

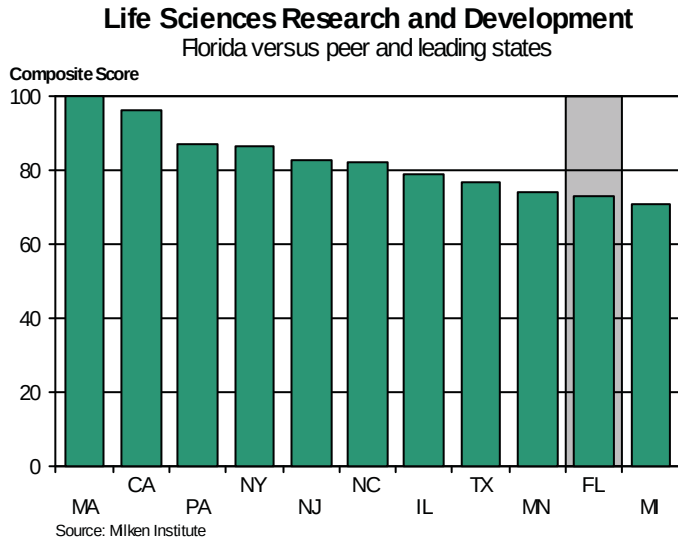
Analysis: Florida's Life Sciences Innovation Pipeline

This sections examines the state's innovation pipeline in the five essential areas noted previously: 1) R&D presence (knowledge assets); 2) risk capital and entrepreneurial infrastructure; 3) industry infrastructure (industry employment base); 4) the work force; and 5) innovation output (patents and licenses).

R&D Presence

The presence of R&D in a region is crucial for technology transfer, which ensures that innovative ideas reach the marketplace. Universities and colleges are responsible for a significant portion of the nation's scientific research. Federal R&D investment helps these institutions advance knowledge, educate scientists, and contribute to economic growth in the regions where they operate.[30] A region with a sophisticated R&D infrastructure that fosters cluster development and attracts tech-based companies and an educated work force has a competitive edge.

The life sciences R&D composite index encompasses eleven components, such as NIH funding to independent hospitals and industry funding to the life sciences. Out of the fifty states, Florida ranked 19th on the index and does not perform well against its peer and leading states, falling behind North Carolina by about 10 percent.



Florida's statistical outcome reflects a weakness across the state, where R&D has been restricted to a few locations. Because future job growth depends on public funds invested in university-based research, the state must increase the levels of both federal and state funding to be competitive.

Sue Washer, CEO and president of Applied Genetic Technologies in Gainesville, contends that Florida has a firm foundation for a life sciences cluster, with increased public recognition given to startups. We suggest that Florida's ranking lies in solid but unremarkable levels of NIH and industry R&D funding that significantly lag behind funding in the leading states. The low number of innovation awards and academic R&D funding hampered the state's overall score in this category. Therefore, the public recognition of startups does not reflect their potential for sustainability and growth.

The University of California system's Biotechnology Research and Education Program provides training grants in support of biotechnology research.[31] The annual $50,000 Graduate Research and Education in Adaptive bioTechnology (GREAT) training grants, developed in 2003, rank among the highest individual awards provided for graduate education and training nationwide.[32]

Florida's best-performing R&D measure (16th nationwide) relative to peer and leading states was NIH funding to independent hospitals, which received $8.6 million in 2003. Florida's score of 55.7 is almost 10 percent behind its closest competitor, Illinois.

NIH Funding to Independent Hospitals, 2003

Rank	State	US$ Millions	US$ Per Capita	Score
1	MA	925.9	144.2	100.0
3	NY	133.1	6.9	78.7
4	PA	91.9	7.4	77.4
8	CA	63.8	1.8	69.9
11	IL	18.9	1.5	63.7
16	FL	8.6	0.5	55.7
21	MI	3.5	0.3	50.3
22	NC	2.8	0.3	49.2
23	NJ	2.7	0.3	48.8
29	TX	1.5	0.1	39.9
37	MN	0.0	0.0	15.5

Data on private-industry life sciences R&D funding show that the leading states, with significant laboratory facilities, score well above Florida. In 2002, Florida's life sciences industry funding for R&D was responsible for $560.4 million, or $33.6 per capita, ranking 16th in the nation. In contrast, industry-funded R&D in New Jersey totaled almost $4.8 billion in R&D, or $555.2 per capita.

Florida has made some improvements in its R&D facilities, but Bob Weiss, a board member for Biovest International, a subsidiary of Accentia Biopharmaceuticals, notes that East Coast-based companies, including Merck (New Jersey) and GlaxoSmithKline (Pennsylvania) that invest huge amounts in R&D and serve as important anchors for the broader life sciences cluster, have little presence in Florida. Weiss contends that attracting larger institutions is essential because they have financial resources to fuel R&D.

Industry R&D to Life Sciences, 2002

Rank	State	US$ Millions	US$ Per Capita	Score
1	NJ	4,762.0	555.2	100.0
2	CA	4,516.4	129.1	91.3
4	MA	1,627.3	253.8	90.5
5	PA	2,026.0	164.3	89.0
6	MN	1,110.6	221.0	87.9
7	IL	1,414.5	112.4	85.1
8	NY	1,318.6	68.9	81.9
11	NC	542.5	65.3	77.5
14	TX	762.4	35.1	75.5
16	FL	560.4	33.6	73.8
22	MI	218.7	21.8	66.9

Academic funding for life sciences R&D does not fare so well in Florida, compared to the benchmarked states. Florida has increased efforts to support research in its public universities (Scripps Research Institute, for example, is supported in part by state and county economic development funds) but scores below both peer states and—with the exception of New Jersey—well below the leading states (nationally ranked 29th).

The recent Centers of Excellence initiative has provided some redress, but only for institutions fortunate enough to receive the awards. Organized and ongoing funding is less common, and its absence is a barrier to Florida's ability to compete.

Academic R&D Funding to Life Sciences, 2002

Rank	State	US$ Millions	US$ Per Capita	Score
1	CA	3,004.2	85.9	100.0
2	NY	1,985.0	103.6	99.2
4	MA	909.9	141.9	97.3
5	TX	1,774.1	81.7	96.0
6	NC	975.8	117.4	95.8
7	PA	1,205.3	97.8	95.3
11	IL	902.9	71.7	90.1
13	MI	764.9	76.2	89.6
19	MN	386.1	76.8	85.1
29	FL	595.2	35.7	80.0
33	NJ	365.7	42.6	78.6

With an annual budget of about $5.5 billion, the National Science Foundation funds about 20 percent of all federally supported basic research conducted by U.S. colleges and universities. In 2004, Florida was awarded almost $15 million in NSF research funding to the life sciences, placing last in among peer and leading states (and ranking 32nd nationally). When averaged per $100,000 of GSP, Florida was awarded only $2.7 versus Massachusetts' $9.9 and Minnesota's $8.6.

NSF Research Funding to Life Sciences, 2004

Rank	State	US$ Millions	Per $100,000 GDP	Score
1	CA	79.8	5.5	100.0
3	MA	29.5	9.9	97.8
4	NY	49.0	5.8	96.4
6	MN	17.9	8.6	92.1
9	NC	21.2	6.9	91.1
16	IL	21.6	4.5	86.6
19	PA	18.8	4.4	85.3
22	MI	14.6	4.2	82.6
28	NJ	14.2	3.7	81.0
30	TX	20.7	2.6	80.2
32	FL	14.9	2.7	78.1

The Small Business Technology Transfer Program (STTR) reserves a share of federal R&D funding for small business and nonprofit research institution partners. The program targets cooperative R&D between small firms and federal research institutions with potential for commercialization. In our ranking system, Florida placed 29th overall, scoring well below the benchmarked states. In 2002, twelve companies in Florida received STTR awards to life sciences firms (2.7 per 100,000 businesses). In contrast, thirty-seven companies (or 21.0 per 100,000 businesses) in Massachusetts received STTR awards.

Number of STTR Awards to Life Science Firms, 2002

Rank	State	Number of Awards	Per 100,000 Businesses	Score
1	MA	37	21.0	100.0
3	CA	71	8.6	92.5
4	NC	20	9.6	78.3
7	PA	18	6.1	68.7
14	NJ	13	5.5	62.8
15	TX	19	3.9	61.8
16	MI	12	5.1	60.3
19	NY	17	3.4	57.8
21	IL	12	3.9	55.6
25	MN	7	4.9	52.8
29	FL	12	2.7	49.0

Looking at STTR awards measured by dollar amounts granted to life sciences firms, Florida ranked 28th nationally, with $2.3 million, or $5 per every million dollars of GSP. Florida's score of 64 places it about 10 percent above that of Minnesota; otherwise, the state trails the benchmarked states by large margins.

STTR Dollar Awards to Life Science Firms, 2002

Rank	State	US$ Thousands	Per $ Mil. GDP	Score
1	MA	8,957.76	32.20	100.0
3	NC	4,911.74	17.12	87.5
8	CA	11,786.52	8.90	82.7
12	PA	3,748.53	9.26	77.1
18	NJ	2,810.59	7.74	72.9
23	NY	4,277.88	5.50	70.2
24	IL	2,878.22	6.18	69.7
25	MI	2,226.10	6.67	69.5
26	TX	3,754.27	4.97	68.0
28	FL	2,319.91	4.66	64.4
35	MN	659.43	3.44	53.2

Federal R&D funds are set aside for small businesses through the Small Business Innovation Research Program (SBIR), which helps fund critical startup and development stages. In 2002, Florida received 160 SBIR Awards to life sciences firms, averaging 36 per 100,000 businesses. Although Florida placed in the middle among peer states, it scores well behind the leading states and ranks 22nd nationally.

Number of SBIR Awards to Life Science Firms, 2002

Rank	State	Number of Awards	Per 100,000 Businesses	Score
1	MA	922	524	100.0
2	CA	1440	175	94.1
9	PA	246	83	75.4
10	NJ	200	84	74.1
15	TX	262	54	72.4
16	NY	264	53	72.2
18	MN	105	73	68.3
19	MI	134	56	68.0
22	FL	160	36	65.4
23	NC	84	40	61.9
26	IL	93	30	60.2

Focusing on SBIR awards measured by dollar amounts granted to life sciences firms, Florida performed worse than the five leading states and most of its peer states. Only Illinois scored below Florida. Receiving $33.5 million in 2002 and averaging $6.7 per $100,000 GSP, Florida ranked 23rd nationally. Receiving more than $235 million in 2002, which corresponds in $84.6 per $100,000 GSP, Massachusetts scored highest.

SBIR Dollar Awards to Life Science Firms, 2002

Rank	State	US$ Millions	Per $100,000 GDP	Score
1	MA	235.5	84.6	100.0
2	CA	336.5	25.4	95.0
11	PA	60.5	15.0	83.6
13	NJ	51.0	14.1	82.4
14	NY	69.6	9.0	81.4
15	TX	61.4	8.1	80.3
17	MN	28.5	14.8	79.9
21	NC	27.9	9.7	77.4
22	MI	28.2	8.5	76.7
23	FL	33.5	6.7	76.2
29	IL	20.3	4.4	71.3

The National Science Foundation funding rate in the life sciences is indicative of the number of competitive awards during a year as a percentage of total proposals reviewed. It shows the probability of winning an NSF award. In 2004, the foundation funded thirty-nine awards in Florida, yielding a funding rate of 19 percent versus 164 funded awards and a funding rate of 25 percent obtained by top-ranked California. Florida's competitive NSF funding rate has been outpaced by most of the peer and leading states, placing the state 23rd in the nation.

Competitive NSF Funding Rate in Life Sciences, 2004

Rank	State	Number of Awards	Funding Rate (%)	Score
1	CA	164	25	100.0
2	NY	131	27	98.8
3	MA	62	23	88.7
4	NC	52	26	88.6
5	PA	53	24	87.7
6	TX	59	22	87.5
15	IL	51	19	83.8
21	NJ	29	24	81.4
23	FL	39	19	81.1
28	MI	29	18	77.2
33	MN	20	18	73.3

Funding from the National Institutes of Health to medical schools plays another critical role in the overall life sciences research and development index. On this measure, New York scored second in the nation in 2003 (receiving $1.0 billion, or $53.9 per capita), while Florida ($171.7 million, or $10.1 per capita) ranked a disappointing 31st. Compared to the benchmarked states, Florida's medical schools are falling behind in receipt of NIH funding. While NIH funding levels appear better on an absolute dollar basis, even this measure leaves Florida trailing the leading states and three of five peer states. Such funding alone does not guarantee life sciences leadership (Maryland ranks first in NIH funding but trails the leading states in most other indicators), it significantly adds to the state's research base.

NIH Funding to Medical Schools, 2003

Rank	State	US$ Millions	US$ Per Capita	Score
2	NY	1034.8	53.9	98.3
3	NC	622.5	73.9	98.2
4	MA	526.1	81.9	98.2
5	PA	766.2	61.9	97.7
6	CA	1367.0	38.5	96.5
9	TX	778.0	35.2	91.2
16	IL	376.5	29.8	83.8
17	MI	324.0	32.1	83.6
25	MN	129.7	25.6	74.1
29	NJ	119.2	13.8	66.3
31	FL	171.7	10.1	65.4

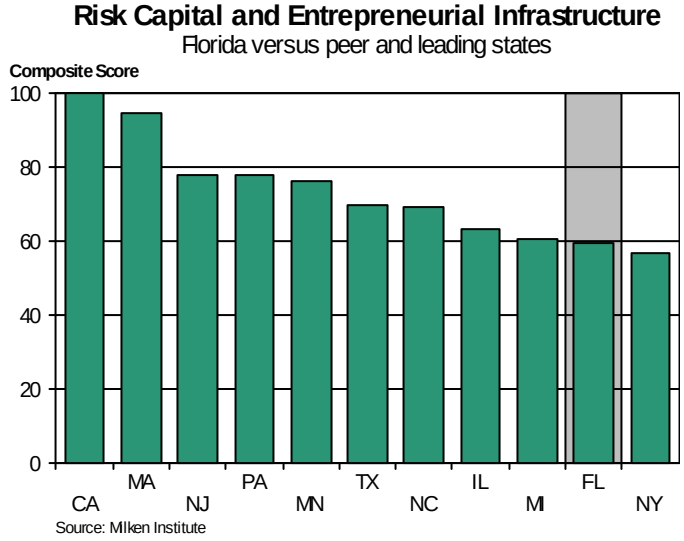
The data on the distribution of NIH funding to research institutes depicts Florida ahead of Minnesota, New Jersey, and Michigan, but still well within the second tier of states. Florida's combined level of funding ($19.5 million) and its average level per capita ($1.1) placed it 19th nationally.

NIH Funding to Research Institutes, 2003

Rank	State	US$ Millions	US$ Per Capita	Score
2	MA	255.7	39.8	99.3
3	CA	620.8	17.5	98.4
5	NY	285.4	14.9	93.7
8	PA	96.1	7.8	84.5
9	NC	74.8	8.9	84.2
14	IL	31.5	2.5	72.2
15	TX	42.2	1.9	71.9
19	FL	19.5	1.1	65.1
20	MN	9.6	1.9	65.0
22	NJ	11.7	1.4	63.8
32	MI	2.1	0.2	44.1

Risk Capital and Entrepreneurial Infrastructure

Venture capital is one of the most important sources of startup capital and business expansion, and thus for local and regional economic growth.[33] The Life Sciences Risk Capital and Entrepreneurial Index comprises seven components as listed in the Innovation Pipeline table, such as VC investments and business starts. Here, Florida ranks 17th out of fifty states; its composite score of 59.3 placed it about 17 percent behind Minnesota, the highest-scoring peer state. Florida ranks second to last among all benchmarked states.



Florida is not attracting enough venture capital, says Robert Weiss, a board member for Biovest International in Tampa. At the same time, notes Sue Washer, CEO and president of Applied Genetic Technologies in Gainesville, business startups are not poised to handle large amounts of venture capital. This is the direct result of structural limitations to creating large pools of deals defined as the "critical mass" that attracts larger VC firms. Limited access to venture capital drove Chuck Soponis, a member of the board of directors of Oragenics in Gainesville to remove Oragenics from the university and go public in Toronto, Canada.

Charles Sloan, executive vice president of the Metro Orlando Development Commission, notes that high numbers of angels retire or maintain second homes in Florida, but they tend to maintain ties to their home cities. Therefore, startups have no easy access to them, and local networks for angel investors have not developed fully. As noted in a *St. Petersburg Times* business column in July 2005, "The second-quarter [VC] numbers are laughable. Nationwide, private venture deals rose to $5.8 billion. In Florida, nine deals received a total of $29.4 million. That means Florida received a microscopic 0.5 percent of the venture capital funding doled out in the second quarter. Clearly, Florida lacks the proper tools needed to match venture capital money with its entrepreneurs."[34]

North Carolina ranked seventh nationally and scored about 10 percentage points higher than Florida on the Life Sciences Risk Capital and Entrepreneurial Index. The proximity of firms to North Carolina's research universities and the strength of business support organizations, including the Council for Entrepreneurial Development (CED), helped raise the state's score. The CED and the state Treasurer's Office work together to attract out-of-state investors.[35] State funding of North Carolina's biotechnology initiatives "has triggered more than $2 billion in direct out-of-state investment through venture capital financing," according to a report by the Massachusetts Biotechnology Council.[36]

Looking at better performing states, Pennsylvania invested $20 million from its Tobacco Settlement Investment Board in three venture funds, along with the Commonwealth's pension fund, and in the state's three life sciences greenhouses.[37] Moving down the level of performance in life sciences risk capital and entrepreneurial infrastructure, Michigan's relatively weak performance on the Life Sciences Risk Capital and Entrepreneurial Index is acknowledged by a strategic proposal recommending significant increases in its financial capital.[38]

Apart from attracting low levels of VC investment, Florida also suffers from insufficient seed funding and angel investment. Seed capital is vital for startups when they've finished their business plans but aren't ready for large VC injections. In Pennsylvania, the state-supported Innovation Works assists technology startups by providing risk capital, and strategic business and entrepreneurial expertise.[39] In February 2006, Innovation Works participated in Pittsburgh's first Angel Venture Fair, and offered grants to companies able to raise $100,000 in angel funds within ninety days.[40]

We evaluated Florida's venture capital investment by four factors: average annual amount of VC investment in life science companies; life sciences VC investment growth; the number of companies receiving VC; and growth in life science companies receiving VC.

Florida scored last among its benchmarked states for VC investments. During the 2002–2004 period, the average annual industry investment totaled $33 million, or $6 per $100,000 GSP. The top peer state, North Carolina, scored about 26 percent higher, reaching an average annual amount of $208 million, or $67.6 per $100,000 GSP.

Life Sciences VC Investment

Rank	State	Average Annual 2002-2004 US$ Mil.	Per $100,000 GDP 2004	Score
1	MA	873	292.9	100.0
2	CA	2048	142.3	99.8
3	NJ	299	77.9	85.7
6	NC	208	67.6	82.8
7	MN	167	80.4	82.8
8	PA	201	46.9	80.3
16	TX	103	12.8	68.2
18	NY	72	8.6	63.8
20	MI	36	10.4	61.3
23	IL	38	7.8	59.8
27	FL	33	6.0	57.3

Measuring growth in life sciences VC investment, Florida ranked 25th in the nation, with a score of 38.7. It scores about 50 points below Texas, the top-scoring peer state. This outcome is not productive for spurring sustainable economic growth, and limits Florida's ability to improve its position relative to the benchmarked states.

Life Sciences VC Investment Growth

Rank	State	Absolute Growth 2002-2004 US$ Mil.	Relative Growth 2002-2004 US$ Mil.	Score
1	CA	731	144.9	100.0
2	PA	228	285.1	96.8
3	MA	296	143.4	94.3
6	TX	82	222.9	88.9
9	MI	36	226.4	83.9
10	NJ	48	125.8	82.1
20	IL	-1	96.0	41.7
22	MN	-35	84.5	40.9
25	FL	-15	58.1	38.7
28	NY	-62	46.7	37.3
31	NC	-208	34.7	35.5

During the period 2002–2004, California companies received the largest average annual amount of life sciences VC investment ($192 million). Florida scored next to last against the benchmarked states, ahead of only Michigan. Florida's companies received an annual average of $9 million, while Minnesota, the best-performing peer state, received $18 million. Normalized by businesses, Florida received $2 for every 100,000 businesses, while Minnesota received $12.8 per 100,000 businesses.

Companies Receiving Life Sciences VC Investment

Rank	State	Average Annual 2002-2004 US$ Mil.	Per 100,000 Businesses 2004	Score
1	CA	192	23.4	100.0
2	MA	69	39.5	97.5
5	PA	28	9.3	78.5
6	MN	18	12.8	78.5
7	NC	19	9.3	76.0
11	NJ	16	6.8	72.1
15	TX	19	3.9	68.2
19	IL	9	3.0	61.1
20	NY	12	2.4	61.1
22	FL	9	2.0	57.5
25	MI	6	2.5	56.2

Measuring the growth in companies receiving life sciences VC investment, Florida outperformed all benchmarked states except California. Florida grew by two companies during the period 2002–2004 when measured in absolute numbers (ninth in the nation). This suggests that state efforts to disburse VC funds to a wider audience are working, even during a period of retrenchment among VC investors. Still, the overall level of these funds has not increased at the same pace as elsewhere.

Growth in Companies Receiving Life Sciences VC Investment

Rank	State	Absolute Growth 2002-2004	Relative Growth 2002-2004	Score
5	CA	5	333.3	91.7
9	FL	2	133.3	75.0
14	IL	1	109.1	68.3
16	NJ	0	133.3	57.9
22	MA	-7	74.1	41.3
25	MI	-1	66.7	40.7
26	MN	-1	66.7	40.7
30	NC	-2	53.3	39.3
34	NY	1	0.0	27.6
38	PA	-3	0.0	0.0
43	TX	0	0.0	0.0

Business starts reflects a metro area's entrepreneurial environment and a region's ability to create jobs. Florida scored well above most of its peer states and the leading states, registering thirty-seven business starts since 2000 and ranking fourth in the nation. Note that this measure includes the creation of new branches of existing companies and does not reflect the number of actual startups.

Business Starts in Life Sciences

Rank	State	Startups since 2000	Score
1	CA	126	100.0
2	MA	57	83.6
3	NC	39	75.8
4	FL	37	74.7
5	NY	33	72.3
6	NJ	32	71.7
7	TX	31	71.0
8	MN	28	68.9
10	IL	18	59.8
15	MI	13	53.0
17	PA	12	51.4

The closest peer state, North Carolina, scored approximately 1 percent higher. Local business leaders concurred in interviews that Florida is successful in attracting new companies but that a perception of VC shortage hinders business creation and expansion.

"The state is the largest one by far that has not put in place some sort of gap capital program to help these little businesses get started," said David Day, director of the Florida Office of Technology Licensing and director of the Sid Martin Biotechnology Incubator in Gainesville. Chuck Soponis, a member of the board of directors of Oragenics, also in Gainesville, explained, "The biggest problem we have in this area is that there are not a lot of people with a lot of experience in managing companies or startups."

Measured by the number of bachelor's degrees awarded in entrepreneurship (based on NSF's findings), Florida performs relatively well, compared to New Jersey, California, North Carolina, and New York. Between 1991 and 2001, students earned thirty-seven academic degrees in that field, or 1.8 degrees per 100,000 people ages 25–34. Overall, Florida ranked 20th in the nation.

Academic Degrees Awarded in Entrepreneurship

Rank	State	Number 1991-2001	Per 100,000 People Ages 25-34, 2001	Score
2	PA	977	64.7	97.9
4	IL	463	25.7	87.2
7	TX	473	14.8	83.5
12	MA	96	10.5	71.9
14	MN	46	6.8	64.7
18	MI	42	3.1	58.8
20	FL	37	1.8	54.2
22	NJ	14	1.2	45.9
23	CA	29	0.6	44.7
41	NC	0	0.0	0.0
44	NY	0	0.0	0.0

The Deloitte Tech Fast 500 lists North American companies that have outperformed their competitors over the previous five years. In the life sciences category on the 2004 list, thirty-four companies, or 4.1 per 100,000 businesses, were named. California ranked first in the nation.

The Index's Tech Fast 500 Companies in Life Sciences evaluates innovative, rapidly expanding companies that outperform other companies in terms of revenue growth over five years. With thirty-four companies on the Tech Fast list in 2004, or 4.1 per 100,000 businesses, California again ranked first. Only one company, KOS Pharmaceuticals Inc. in Miami, made the list from Florida. When compared to companies in benchmarked states, Florida's companies lag in innovation and pace of growth.

Tech Fast 500 Companies in Life Sciences, 2004

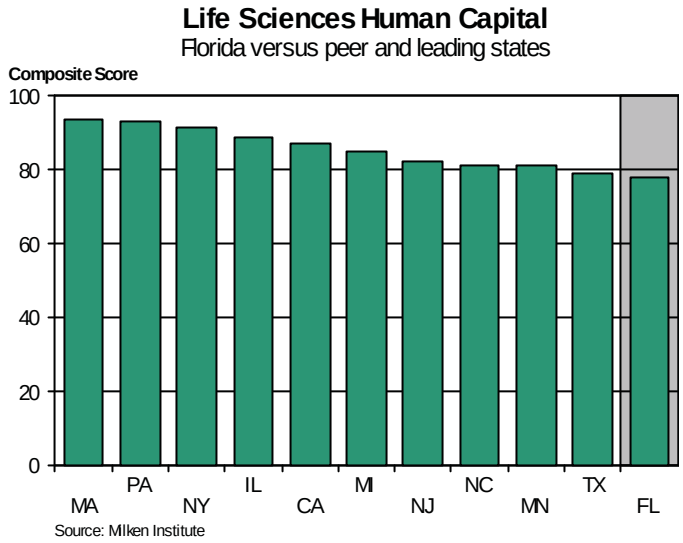
Rank	State	Number, 2004	Per 100,000 Businesses, 2004	Score
1	CA	34	4.1	100.0
2	MA	8	4.5	88.7
5	PA	8	2.7	81.7
7	MN	5	3.5	81.0
8	NJ	5	2.1	74.4
9	NC	4	1.9	71.3
10	TX	6	1.2	69.0
12	NY	5	1.0	64.5
18	MI	1	0.4	39.1
19	IL	1	0.3	35.5
20	FL	1	0.2	30.6

Human Capital

We distinguish human capital—the talent, knowledge, and experience of people, and their value to organizations, economies, and society—from industry infrastructure. Human capital infrastructure includes workforce development and recruitment.

Increasing participation and maintaining high standards in a state's higher-education science and technology are imperative. The return on investment in human capital has never been higher.

The Life Sciences Human Capital Index comprises eleven components and their composite scores. Some of these components are the numbers of life sciences bachelor degrees awarded and life sciences graduate students. Florida trails all benchmarked states in this index, with a composite score below 80. This indicates that there are fewer degree holders in important life sciences specialties.



Florida must invest in strong science education, said Brian Hutchison, president, CEO, and chairman of the board of Regeneration Technologies in Gainesville. Specialized research can help the state leverage its universities into leading specialized life sciences institutions. The state's schools are competing among themselves, and not specializing sufficiently. This lack of synergy wastes research funding, according to James McNulty, chief financial officer and secretary treasurer for a portfolio of companies in Clearwater, including Biodelivery Sciences International. In an effort to address this weakness, Geary Havran, founder and president of NDH Medical and chairman of the Florida Medical Manufacturers Consortium in Clearwater, said he works with community colleges and universities "to try to develop curricula that are directed at the medical devices sector."

In California, the State University Program for Education and Research in Biotechnology (CSUPERB) is a multi-campus program created in 1987 to make awards to campuses for curriculum development. The program links the California State University system, industry, and government, and specializes in joint ventures and creating new training and research facilities.[41] At Stanford University, the interdisciplinary Bio-X program, created with a $150 million donation from Netscape founder Jim Clark, facilitates collaborative research in basic, applied, and clinical sciences.[42]

In Pennsylvania, the Pittsburgh Tissue Engineering Initiative (PTEI) is a research collaborative that sponsors research and educational outreach programs. The Pittsburgh Life Sciences Greenhouse administers an Opportunity Fund to assist universities in faculty recruitment. A research challenge fund and endowment match set up in Kentucky in 1997 facilitates university programs and includes $700 million from the state and donors for endowed chairs and professorships.[44] North Carolina offers excellent university life sciences programs,45 and in California, the University of California, Irvine, has initiated a "Student to Start-up Entrepreneurial Skills Workshop Series."[46]

In the face of this competition from around the country, Florida policy makers must broaden opportunities and support for students to pursue degree programs in life sciences studies. The State University of New York, Buffalo, for example, offers a biotechnology management specialty in its MBA program. [47] A master's degree program in medical devices, such as that proposed for the University of South Florida by Geary Havran and others, would be beneficial.

Measured by the number of institutions granting life sciences Ph.D.s, Florida ranks third in the nation and second among benchmarked states. Per 100,000 people ages 25–34, Florida has 12.4 life science Ph.D.-granting institutions.

Number of Life Sciences Ph.D.-Granting Institutions (with life sciences Ph.D.s in 2001)

Rank	State	Number of Institutions	Per 100,000 People Ages 25-34	Score
2	NY	30	13.0	96.9
3	FL	13	12.4	91.2
5	IL	15	8.8	89.9
6	TX	28	3.4	87.9
8	PA	17	3.5	84.9
9	NJ	9	5.8	84.0
10	MA	18	2.5	82.9
14	CA	27	0.5	75.5
19	MI	9	1.0	72.7
33	MN	5	0.4	62.7
35	NC	7	0.3	62.5

Florida's ranking in the measure of life sciences bachelor degrees awarded is surprisingly low. This is most apparent when Florida is measured against the leading state, Pennsylvania. Florida fell 20 percent behind Pennsylvania in 2001. The difference between Florida's number of life sciences bachelor degrees and the average for the peer states is 825 degrees. When measured per 10,000 people ages 25–34, Florida is still behind by 8 percentage points.

Life Sciences Bachelor's Degrees Awarded, 2001

Rank	State	Number 2001	Per 10,000 People Ages 25-34	Score
1	PA	5150	34	100.0
2	MA	3271	36	98.0
3	CA	9002	17	93.5
4	NY	5430	20	92.8
7	MI	3055	23	91.3
9	MN	1849	28	91.0
12	NC	2670	22	90.0
14	TX	5244	16	89.7
16	IL	3407	19	89.2
23	NJ	2263	20	87.3
42	FL	2420	12	80.4

Florida scored close to the bottom of benchmarked states in the number of graduate students in the life sciences in 2002 (14th nationwide), although its performance is a clear improvement over its ranking in the bachelor degree measure. The state had 5,905 life-science graduate students, or 28.3 per 10,000 people ages 25 through 34. The state's shortcoming is most striking when compared to Massachusetts, which had 8,393 graduate students, or 93.3 for every 10,000 people ages 25–34.

Life Sciences Graduate Students, 2002

Rank	State	Number of Students	Per 10,000 People Ages 25-34	Score
1	MA	8393	93.3	100.0
2	PA	9267	62.4	95.9
4	CA	17845	33.8	92.4
5	NY	10793	40.1	91.6
8	TX	10086	31.1	88.4
9	IL	6268	34.7	87.1
10	MI	4961	37.6	86.8
12	NC	4409	36.1	85.7
13	MN	2816	41.9	85.0
14	FL	5905	28.3	84.4
23	NJ	3023	26.6	80.2

With only 140 life sciences master's degrees awarded in 2001 (or 0.7 degree for every 10,000 people ages 25–34). Florida ranked second to last among benchmarked states. This weakness further is demonstrated in Florida's national ranking (42nd), capturing only 65 percent of California, the leading state.

Life Sciences Master's Degrees Awarded, 2001

Rank	State	Number of Degrees	Per 10,000 People Ages 25-34	Score
4	CA	1810	3.4	94.1
5	MI	707	5.3	94.0
6	MN	437	6.5	93.8
9	PA	624	4.1	90.4
12	MA	406	4.4	89.0
13	NJ	447	3.9	87.9
15	IL	554	3.1	86.3
21	NC	366	3.0	83.9
32	NY	318	1.2	72.1
42	FL	140	0.7	61.3
48	TX	18	0.1	21.2

In the number of life sciences Ph.D.s awarded Florida again ranked next to the bottom, ranking above only Minnesota among benchmarked states in 2001. Its universities granted 3,429 Ph.D.s, or 35.3 per 10,000 people ages 25–34. Massachusetts, which produced 97.5 Ph.D.s, ranked first nationally.

Life Sciences Ph.D.s Awarded, 2001

Rank	State	Number of Degrees	Per 10,000 People Ages 25-34	Score
1	MA	4122	97.5	100.0
2	PA	4592	66.1	96.1
4	CA	10610	42.3	95.8
5	NY	5931	46.9	93.6
7	TX	6173	39.1	91.8
8	MI	3119	49.9	90.7
10	IL	3724	42.7	89.9
12	NC	2717	46.4	89.1
15	NJ	2369	45.6	88.1
18	FL	3429	35.3	87.3
35	MN	1204	38.3	82.3

David Heyens, president of North American Business for Cardinal Health, moved his company's R&D division from Clearwater to New Jersey because of the lack of high-value knowledge workers. These include doctorate degree holders conducting R&D.

Florida ranked 35th nationwide and scored last when measured against its peer and leading states in awarding medical degrees in 2001. The state's composite score of 58.0 placed Florida about 40 percent behind New York, which ranked No. 1 nationally.

Medical Doctor (MD) Degrees Awarded, 2001

Rank	State	Number of Degrees	Per 10,000 People Ages 25-34	Score
1	NY	1683	6.3	100.0
2	PA	1046	7.0	99.0
5	IL	1042	5.8	94.4
7	MA	579	6.4	92.4
11	TX	1115	3.4	83.1
19	NC	419	3.4	75.4
20	MI	442	3.3	75.3
22	MN	257	3.8	74.1
27	CA	1052	2.0	70.2
31	NJ	313	2.8	68.1
35	FL	355	1.7	58.0

Similar to its standing in medical degrees awarded, Florida scored lowest among benchmarked stated in life sciences post-doctoral degrees in 2002. Florida generated 588 life sciences post-doctoral degrees (2.8 per 10,000 people ages 25–34); Massachusetts produced more than 5,080 life science post-doctoral degrees (56.5 per 10,000 people).

Life Sciences Postdoctorates, 2002

Rank	State	Number of Postdocs	Per 10,000 People Ages 25-34	Score
1	MA	5082	56.5	100.0
4	CA	5448	10.3	86.9
5	NY	3101	11.5	85.1
6	PA	1946	13.1	84.0
7	NC	1301	10.7	80.5
8	MN	862	12.8	80.1
9	TX	2154	6.6	79.1
13	MI	954	7.2	76.0
18	IL	877	4.9	72.5
22	NJ	507	4.5	69.3
30	FL	588	2.8	66.3

The number of life sciences bachelor's degrees awarded from 1991–2001 in Pennsylvania is almost double that of Florida. Moreover, when Florida's ranking of bachelor's degrees awarded is normalized per 10,000 non-farm workers, it becomes evident that the low number (33) of degrees could imperil the long-term growth prospects of Florida's life sciences industry.

Recent Bachelor's Degrees Awarded in Life Sciences

Rank	State	Number 1991-2001	Per 10,000 Non-Farm Workers 2001	Score
1	PA	53,929	94.9	100.0
2	CA	91,580	62.5	97.7
3	MA	31,032	93.2	97.3
4	NY	57,269	66.4	96.3
5	NC	27,122	69.5	93.4
6	MI	30,071	66.0	93.3
9	TX	47,713	50.1	92.3
12	IL	33,493	55.9	91.9
17	MN	17,569	65.6	90.8
26	NJ	19,688	49.3	88.1
39	FL	23,669	33.0	84.5

Between 1991 and 2001, Florida rated poorly in the number of life sciences master's degrees. With only 1,487 degrees awarded, or 2.1 per 10,000 non-farm workers, Florida ranked 38th nationally and scored second to last among benchmarked states.

Recent Master's Degrees Awarded in Life Sciences

Rank	State	Number 1991-2001	Per 10,000 Non-Farm Workers 2001	Score
1	CA	17343	11.9	100.0
3	MI	6605	14.5	98.1
7	PA	5727	10.1	95.7
8	MN	3415	12.7	95.4
9	MA	3784	11.4	95.1
12	NJ	4014	10.0	94.6
17	IL	4435	7.4	93.3
19	NC	3108	8.0	92.6
28	NY	3581	4.2	89.7
38	FL	1487	2.1	83.4
48	TX	173	0.2	64.1

In the measure of recent life sciences Ph.D.s awarded, Florida's score of 86.16 is about 14 percent behind the top-ranked state, Massachusetts. All the benchmarked states produced more Ph.D.s degrees per 10,000 non-farm workers than did Florida.

Recent Ph.D. Degrees Awarded In Life Sciences

Rank	State	Number 1991-2001	Per 10,000 Non-Farm Workers 2001	Score
1	MA	38,573	115.9	100.0
2	CA	96,181	65.9	98.0
3	PA	44,350	78.0	96.3
4	NY	57,910	67.4	95.9
6	TX	57,207	60.1	94.6
9	IL	37,530	62.6	93.1
10	MI	30,524	67.0	92.9
11	NC	26,662	68.4	92.5
20	NJ	21,060	52.7	88.6
27	FL	27,155	37.9	86.2
42	MN	11,784	44.0	84.0

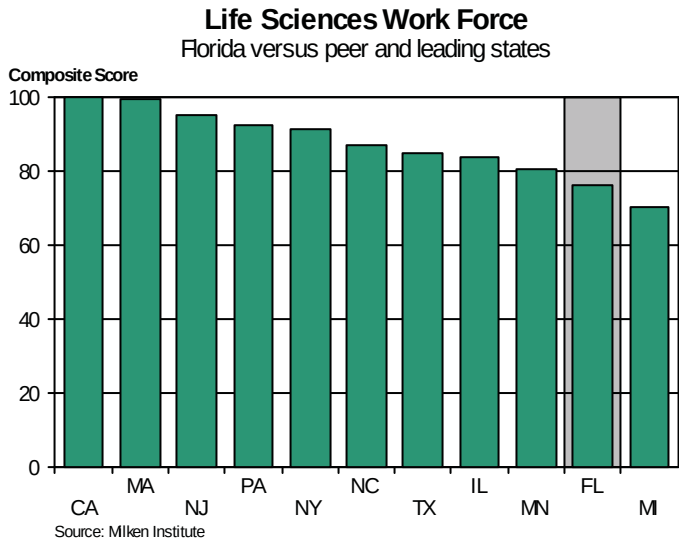
Florida ranked lowest in medical degrees awarded from 1991 to 2001. Florida's number of medical degrees awarded per 10,000 non-farm workers is also very weak, with 4.9 versus 19.6 degrees awarded in New York.

Recent Medical Doctor (MD) Degrees Awarded

Rank	State	Number 1991-2001	Per 10,000 Non-Farm Workers 2001	Score
1	NY	16,863	19.6	100.0
2	PA	10,390	18.3	97.3
3	IL	10,233	17.1	96.6
5	MA	5,729	17.2	94.1
9	TX	10,744	11.3	93.0
14	MI	5,298	11.6	90.2
15	MN	3,366	12.6	89.0
16	NC	4,265	10.9	88.7
19	CA	9,692	6.6	87.7
28	NJ	3,105	7.8	84.3
35	FL	3,484	4.9	80.5

The Work Force

The life sciences workforce measure uses thirteen components and their aggregate scores. Among these components are the intensity of biomedical engineers and the intensity of chemical engineers, for example. In this measure, Florida scores next to the bottom among benchmarked states and 16th nationally.



Florida has few life sciences job positions, relative to the other states. This rather low ranking is not surprising, given that Florida's universities do not fully address industry needs and have awarded few life sciences degrees during the past decade. A report from the state Office of Program Policy Analysis and Government Accountability recently noted, "Graduates of programs that prepare students in areas such as engineering that may advance the state's economic development goals are more likely not to find employment in the Florida work force."[48]

Peer states pursue innovation degree and training programs. The North Carolina Biotechnology Center (NCBC) offers what it describes as "training programs in community colleges, teacher-training programs for K-12, and university-level courses." [49] The North Carolina Biomanufacturing and Pharmaceutical Training Consortium was launched in 2003 with the goal of renewing and expanding the bioscience work force.[50]

In response to the need to grow California's bioscience work force, the State University Program for Education and Research in Biotechnology initiative focuses the resources of the entire California State University system on biotechnology.[51] Specific initiatives are also under way in Minnesota. The Workforce Boards of Southeast Minnesota map emerging occupations and career ladders within the life sciences, develop training packages, and create strategies to integrate immigrant workers.[52]

In response to requests from industry and graduate students to improve the academic and technical curricula for professional development, the State University of New York, Stony Brook developed a "Fundamentals of the Bioscience Industry" program. A university-industry joint venture, the program for graduate science students teaches industry fundamentals, including what it describes as "life science product development cycles, regulatory practices, financial models, managerial challenges, future trends and needs in the life sciences, and ethical issues facing the industry today."[53]

Florida outperforms all the benchmarked states in the intensity of biomedical engineers. Florida employed 350 biomedical engineers in 2003. Normalized for the relevant workers, this represents almost forty engineers per every 100,000 workers. Florida's national rank (third) is solid, but the absolute numbers are not sufficient to address state demand. The state's strengths in the medical devices industry helps explain the high score in this occupation.

Intensity of Biomedical Engineers, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	CA	1,760	95.0	100.0
2	PA	290	92.2	87.7
3	FL	350	39.8	82.8
5	MA	580	18.5	80.6
6	NJ	410	16.7	77.6
9	IL	350	13.3	74.9
10	TX	210	13.7	71.6
11	NY	200	14.1	71.5
13	NC	100	21.0	69.8
15	MN	250	5.8	66.6
25	MI	80	0.9	45.1

Florida falls behind all benchmarked states except New Jersey in the intensity of medical and health services managers. Despite the state's strong life sciences health-care services industry, Florida ranked only 20th in the nation by that measure in 2003. Florida was home to 8,480 medical and health services managers versus the top-scoring state, New York, which was home to 22,100 of these specialists. Normalized by every 100,000 workers, New York's normalized population of medical and health services managers is 2.3 times (44 percent) greater than Florida's.

Intensity of Medical and Health Services Managers, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	NY	22,100	268.3	100.0
2	TX	16,720	180.8	95.1
3	PA	11,630	211.7	94.7
6	MA	7,420	237.0	93.4
8	CA	16,500	114.1	91.0
11	IL	8,560	149.7	90.0
12	MI	7,130	165.4	90.0
14	NC	6,340	171.3	89.7
17	MN	4,590	177.1	88.4
20	FL	8,480	117.5	87.9
26	NJ	5,200	134.1	86.5

Florida compares poorly to peer and leading states in the measure intensity of chemical engineers, ranking 36th in the nation with a score of 59.4. The statistical differences between Florida and the

benchmarked states are not marginal: Florida's score and that of its closest peer state, Minnesota, are separated by more than 10 percent.

Intensity of Chemical Engineers, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	TX	5,030	54.4	100.0
4	NJ	1,590	41.0	89.4
5	CA	2,900	20.1	85.0
11	MA	830	26.5	80.3
15	NC	830	22.4	78.4
18	IL	920	16.1	75.2
20	NY	1,130	13.7	74.7
21	MI	730	16.9	74.3
24	PA	790	14.4	73.0
28	MN	420	16.2	70.3
36	FL	440	6.1	59.4

A measure of the intensity of material engineers also reveals a less optimistic situation, with Florida failing to outperform any of benchmarked states. Florida ranked 33rd in the nation in 2003, with 460 material engineers, or 6.4 material engineers per 100,000 workers employed.

Intensity of Material Engineers, 2003

Rank	State	Number	Per 100,000 Workers	Score
4	CA	2,290	15.8	90.3
5	MA	800	25.6	89.5
6	PA	1,160	21.1	89.5
7	MI	960	22.3	88.9
10	TX	1,470	15.9	87.3
11	IL	1,020	17.8	86.4
13	NY	1,090	13.2	82.8
24	MN	340	13.1	74.7
27	NC	350	9.5	70.5
29	NJ	340	8.8	69.3
33	FL	460	6.4	67.0

Among the benchmarked states, Florida fared well in the intensity of electro-mechanical technicians. At 1,750 electro-mechanical technicians, or 24.2 technicians per 100,000 workers, in 2003 Florida ranked fourth nationally.

Intensity of Electro-Mechanical Technicians, 2003

Rank	State	Number	Per 100,000 Workers	Score
2	MA	2,010	64.2	95.1
3	CA	3,700	25.6	89.2
4	FL	1,750	24.2	83.7
7	TX	1,370	14.8	76.7
9	PA	860	15.7	74.2
10	IL	850	14.9	73.6
14	MI	680	15.8	72.8
15	NJ	620	16.0	72.3
17	MN	440	17.0	70.7
18	NC	540	14.6	70.4
20	NY	760	9.2	67.7

All the benchmarked states except Michigan and Texas scored ahead of Florida in the intensity of biochemists and biophysicists. In 2003, Florida had about 180 biochemists and biophysicists, or 2.5 scientists for every 100,000 workers.

Intensity of Biochemists and Biophysicists, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	CA	3,970	27.5	100.0
2	NJ	1,410	36.4	97.6
4	MA	830	26.5	89.7
5	NY	1,440	17.5	87.1
6	NC	570	15.4	79.4
8	PA	590	10.7	74.4
14	MN	200	7.7	62.9
19	IL	270	4.7	57.6
22	FL	180	2.5	45.8
35	MI	0	0.0	0.0
46	TX	0	0.0	0.0

Florida also ranked in the bottom tier for intensity of microbiologists. Its score of 51.3 is well below Illinois, the highest-ranking peer state. Florida's poor performance in this measure is stark when measured against New Jersey. Florida had 210 microbiologists, or 2.9 scientists per 100,000 workers, while New Jersey counted 880 microbiologists, or equivalent to 22.7 scientists.

Intensity of Microbiologists, 2003

Rank	State	Number	Per 100,000 Workers	Score
3	NJ	880	22.7	88.8
5	MA	650	20.8	85.5
6	CA	1,680	11.6	84.3
8	NY	1,050	12.7	82.2
12	IL	620	10.8	76.4
19	MN	230	8.9	66.9
21	TX	480	5.2	64.8
22	PA	320	5.8	63.5
34	NC	170	4.6	56.0
37	FL	210	2.9	51.3
48	MI	0	0.0	0.0

In the intensity of medical scientists other than epidemiologists, Florida counted 1,760, or 24.4 scientists per 100,000 workers. The state ranked 16th in the nation in 2003 and, when compared to benchmarked states, fared slightly better than Illinois and Michigan, and just behind Texas.

Intensity of Medical Scientists, Other than Epidemiologists, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	MA	6,310	201.6	100.0
2	PA	6,460	117.6	94.9
3	CA	11,530	79.7	94.3
4	NY	7,350	89.2	92.9
7	NJ	3,150	81.2	87.3
8	NC	2,960	80.0	86.8
13	MN	1,330	51.3	78.1
15	TX	2,740	29.6	76.7
16	FL	1,760	24.4	72.4
21	IL	860	15.0	63.7
23	MI	570	13.2	60.2

Florida also did not score well in its intensity of chemists, lagging behind all peer and leading states. The state's ranking in the lower half (29th in the nation) reflected 25.4 chemists per 100,000 workers, whereas Minnesota, Florida's closest competitor in this measure, had more than double the concentration. Michigan, the next highest peer state in absolute numbers, had more than 900 more chemists.

Intensity of Chemists, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	NJ	6,130	158.1	100.0
3	NY	6,770	82.2	94.4
4	CA	9,470	65.5	94.2
6	NC	4,060	109.7	94.1
7	MA	3,530	112.8	93.5
8	PA	4,040	73.5	90.2
10	IL	3,460	60.5	87.5
12	MI	2,760	64.0	86.7
16	TX	3,880	42.0	84.6
18	MN	1,540	59.4	82.5
29	FL	1,830	25.4	75.4

Florida's score is disappointing in the intensity of materials scientists. Its absolute and normalized levels of material scientists' positions do not measure up to the benchmarked states. Florida ranked 25th in the nation in 2003.

Intensity of Materials Scientists, 2003

Rank	State	Number	Per 100,000 Workers	Score
2	MA	450	14.4	98.7
5	PA	460	8.4	88.3
6	CA	860	5.9	86.5
7	NJ	330	8.5	86.1
8	TX	590	6.4	85.0
10	NY	400	4.9	76.7
11	IL	280	4.9	74.1
13	MI	200	4.6	70.5
14	NC	150	4.1	65.6
19	MN	80	3.1	55.5
25	FL	90	1.2	38.8

In intensity of biological technicians, Florida outperformed Texas, Michigan, and Illinois, earning a score of 78.3 and ranking 18th in the nation.

Intensity of Biological Technicians, 2003

Rank	State	Number	Per 100,000 Workers	Score
4	CA	6,460	44.7	90.6
5	NC	2,740	74.0	90.4
7	MA	2,380	76.0	89.8
9	NJ	2,310	59.6	87.2
12	PA	2,310	42.0	83.8
13	NY	2,770	33.6	82.7
17	MN	1,090	42.1	79.2
18	FL	1,940	26.9	78.3
19	TX	2,240	24.2	78.2
25	MI	980	22.7	72.5
38	IL	620	10.8	62.5

Chemical technicians held about 1,350 jobs in Florida in 2003; when normalized by worker size, however, only 18.7 chemical technicians per every 100,000 workers were employed in 2003. The top-scoring state, New Jersey, employed about seven times as many chemical technicians per 100,000 workers. All the peer and leading states scored higher than Florida, which ranked 31st nationally.

Intensity of Chemical Technicians, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	NJ	4,940	127.4	100.0
3	TX	6,240	67.5	94.7
4	PA	3,560	64.8	91.0
8	MA	2,190	70.0	89.0
9	NC	2,420	65.4	88.9
10	CA	4,950	34.2	86.3
11	NY	3,250	39.5	85.3
13	MI	1,910	44.3	83.5
15	IL	2,220	38.8	82.9
28	MN	800	30.9	74.6
31	FL	1,350	18.7	72.4

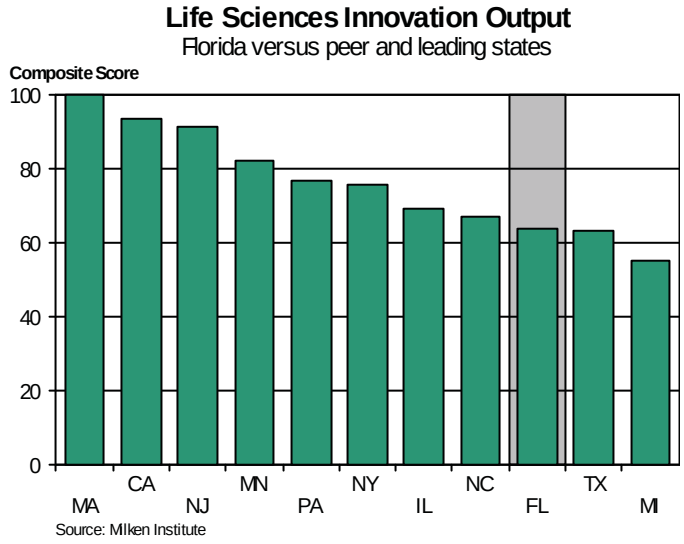
An encouraging sign is the intensity of sales representatives for wholesale and manufacturing, technical and scientific products. Florida compares favorably to most of the benchmarked states in this measure. Only California, Massachusetts, North Carolina, and Texas scored higher than Florida.

Intensity of Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products, 2003

Rank	State	Number	Per 100,000 Workers	Score
1	CA	46,440	321.1	100.0
3	MA	16,150	515.9	98.6
4	NC	16,720	451.6	97.7
6	TX	25,640	277.2	95.9
7	FL	21,460	297.3	95.5
8	IL	18,330	320.5	95.4
11	NJ	13,460	347.1	94.5
12	PA	15,530	282.6	93.5
19	MI	10,980	254.7	91.0
21	MN	7,740	298.6	90.5
30	NY	12,720	154.4	87.7

Innovation Output

The Life Sciences Innovation Output measure assesses the capabilities of a region to innovate, and the impact of such innovations on a region's future performance. The index comprises thirteen measures (five are based on FDA approval statistics; the remainder on patent data) and aggregate scores. By the majority of these measures, Florida compares poorly to its peer and leading states, averaging 24th in the nation.



Massachusetts' strong measure is explained largely by its strong leadership by research institutions, such as the Massachusetts Institute of Technology, which focuses heavily on entrepreneurial and commercialization.[54]

Illinois' long-term strategy for life sciences industry growth is the establishment of SBIR "factories" where scientists who cannot attract sufficient seed money sell or license their technology to other corporations.[55]

The Maryland Industrial Partnerships (MIPS) program facilitates the commercialization of technology by providing matching funds ($1.35 million annually) for collaborative R&D projects between companies and University Maryland faculty.[56]

The Austin Technology Incubator program at the University of Texas, Austin, accelerates university commercialization and provides access to advice from leaders in Austin's high-tech community.[57] In addition, it provides consulting, financing referrals, marketing, and promotional assistance.

At SUNY's Center for Biotechnology, a Graduate Internship in Biotechnology and Patent Law program designed for third- and fourth-year graduate students and postdoctoral fellows exposes them to career paths such as scientific advisers and patent attorneys. Law firms, for one, benefit from the students' expertise in the science behind the patentable technology or product.[58]

Florida's FDA drug approval is 16th in the nation. With the exception of Minnesota, Florida placed behind all benchmarked states. In the 2002–2004 period, the FDA approved six new drugs from Florida, or 0.3 new drug approvals per million inhabitants.

FDA New Drug Approval

Rank	State	Total 2002-2004	Per Million People, 2004	Score
1	NJ	67	7.7	100.0
4	MA	12	1.9	63.2
5	CA	27	0.8	62.6
6	NC	13	1.5	61.8
7	NY	19	1.0	61.5
8	IL	14	1.1	59.0
9	PA	12	1.0	55.7
12	TX	11	0.5	46.9
14	MI	5	0.5	37.5
16	FL	6	0.3	35.6
26	MN	1	0.2	7.7

A slightly better situation is denoted by Florida's score for FDA approval of medical devices. The state ranks 10th nationally, and among the benchmarked states, it outscored Pennsylvania, Illinois, Texas, Michigan, and North Carolina. Given its strength in this field, the ranking should improve.

FDA New Medical Devices Premarket Approval

Rank	State	Total 2002-2004	Per Million People, 2004	Score
1	CA	32	0.9	100.0
2	MN	8	1.6	89.1
3	MA	8	1.2	84.5
4	NJ	6	0.7	67.9
5	NY	8	0.4	62.3
10	FL	5	0.3	47.2
11	PA	4	0.3	46.0
13	IL	3	0.2	35.0
15	TX	3	0.1	23.5
31	MI	0	0.0	0.0
34	NC	0	0.0	0.0

Florida compares poorly to its peer and leading states in the measure of Phase I clinical trials. Florida's score of 58.9 ranked the state 16th in the nation. In 2004, Florida had seventy-three products in Phase I trials. Normalized for population, this corresponds to 0.4 product for every 100,000 people. Given Florida's resources, the state should focus on improvement in this measure.

Clinical Trials (Phase I)

Rank	State	Currently Recruiting	Per 100,000 People, 2004	Score
2	MA	94	1.5	78.1
3	NY	170	0.9	76.7
4	PA	129	1.0	76.4
5	TX	176	0.8	75.4
8	CA	174	0.5	68.8
9	NC	71	0.8	67.8
10	MN	52	1.0	67.7
12	IL	83	0.7	66.0
16	FL	73	0.4	58.9
19	MI	49	0.5	57.1
30	NJ	33	0.4	50.2

In the measure of Phase II clinical trials, Florida scored 36th nationally. All the benchmarked states, except for New Jersey and California, scored above Florida. In absolute numbers, Florida had more products in Phase II testing than did Massachusetts, North Carolina, Minnesota, Michigan, and New Jersey. But when normalized for every 100,000 people, Florida scored in the bottom tier.

Clinical Trials (Phase II)

Rank	State	Currently Recruiting	Per 100000 People, 2004	Score
7	MA	310	4.8	82.4
9	NC	353	4.1	80.1
16	PA	405	3.3	76.1
18	IL	402	3.2	75.4
20	MN	207	4.1	75.2
24	NY	502	2.6	73.1
28	MI	300	3.0	71.5
32	TX	490	2.2	69.0
36	FL	377	2.2	66.6
40	NJ	212	2.4	64.4
48	CA	548	1.5	62.2

In the measure for Phase III clinical trials, Florida scored near the bottom among benchmarked states, ranking 45th in the nation. In 2004, Florida had 433 potential new drugs in Phase III trials, or 2.5 products for every 100,000 people. In contrast, the state's closest competitor peer state, Michigan, had slightly more than three products per 100,000 people at the Phase III stage. Florida scores fairly well in absolute numbers, but the ranking suggests the state should make significant strides as a center for clinical trials and research.

Clinical Trials (Phase III)

Rank	State	Currently Recruiting	Per 100000 People, 2004	Score
16	MA	332	5.2	86.5
17	NC	397	4.6	86.0
21	MN	268	5.3	84.8
33	PA	436	3.5	81.2
40	IL	398	3.1	78.0
41	NJ	301	3.5	77.5
42	MI	318	3.1	76.0
44	NY	467	2.4	74.4
45	FL	433	2.5	74.2
48	TX	427	1.9	68.5
49	CA	504	1.4	64.0

In the measure of life sciences patents issued, Florida filed 2,172 patents during the 2000–2004 period, ranking 48th in the nation. This number is equivalent to 1.7 patents per 100,000 people.

Life Sciences Patents Issued

Rank	State	Number of Patents 2000-2004	Per 100,000 People, 2004	Score
15	MN	315	6.2	81.5
18	MA	347	5.4	80.2
34	NJ	327	3.8	73.7
40	NC	283	3.3	70.3
43	PA	323	2.6	67.6
44	MI	278	2.7	67.1
46	IL	300	2.4	65.3
47	NY	332	1.7	61.1
48	FL	297	1.7	59.9
49	TX	308	1.4	56.6
50	CA	400	1.1	55.6

Looking at the benchmarked states, Minnesota had the highest number of patents (6.2) issued for every 100,000 people in 2004.

The measure of weighted life sciences patent growth depicts growth from one period to another. Patent growth is an indicator of established competitive advantage through increased protection of intellectual property. Among the benchmarked states, Florida compares well to Pennsylvania, Texas, Michigan, New Jersey, Illinois, and New York. Its score of 56.0 ranked Florida 27th in the nation for the period 2002–2004. The growth rate must increase, however. to reach that of the leading states.

Weighted Life Sciences Patent Growth

Rank	State	Score 2000-2004
3	MN	91.9
5	CA	81.4
18	NC	64.0
25	MA	56.7
27	FL	56.0
28	PA	54.9
34	TX	43.3
36	MI	42.2
39	NJ	37.1
41	IL	34.6
48	NY	13.0

The number of patents in life sciences divided by the total number of patents for a region is illustrated in the weighted percentage of life sciences patents in the region. This measure mirrors the concentration of life sciences inventiveness and intellectual capital protection among all industries in a region. With the exception of Illinois, Michigan, and Texas, Florida falls behind the benchmarked states, ranking 28th in the nation.

Weighted Percentage of Life Sciences Patents

Rank	State	Score 2000-2004
2	MA	93.8
5	PA	87.8
7	NJ	85.4
11	CA	82.5
15	NC	81.1
20	MN	76.8
24	NY	74.8
28	FL	73.3
29	IL	73.1
39	MI	62.3
40	TX	61.8

The current impact index (CII) is the number of times a company's previous five years of patents are cited in the current year, relative to all patents in the U.S. patent system. This measure reflects the relative "current impact" of a region's patents. By this measure, Florida earned a score of 85.8 and ranked 37th in the nation for the period 2002–2004. Florida trails all peer and leading states, although not significantly.

Weighted Life Sciences Current Impact Index

Rank	State	Score, 2000-2004
2	CA	97.2
3	MN	96.9
7	MA	93.9
15	NC	91.4
17	NY	91.3
19	TX	91.0
23	NJ	90.2
30	IL	88.8
32	PA	88.0
35	MI	87.4
37	FL	85.8

The weighted life sciences technology strength measures the number of patents multiplied by the current impact index. This indicator reflects the patent portfolio size inflated or deflated by patent quality. Florida scored at the bottom in this measure, and ranked 17th in the nation.

Weighted Life Sciences Technology Strength

Rank	State	Score, 2000-2004
1	CA	100.0
2	MA	86.0
3	NJ	81.0
4	NY	80.9
5	PA	79.8
7	MN	73.5
8	TX	73.2
10	IL	71.5
13	NC	69.8
16	MI	65.9
17	FL	65.8

The weighted life sciences technology cycle time signals how fast the technology is "turning over" by assessing the median age in years of "prior art" patents cited in the patents issued within a region. Regions that exhibit shorter cycle times are gaining a competitive edge, as they are advancing more quickly from previous technology to current technology. With a respectable score of 97.8, Florida leads its peer and leading states and ranks eighth in the nation.

Weighted Life Sciences Technology Cycle Time

Rank	State	Score, 2000-2004
6	IL	98.3
8	FL	97.8
12	MN	97.4
14	PA	97.3
15	NC	97.3
17	MI	97.0
21	NJ	96.7
22	MA	96.4
25	TX	96.3
27	NY	96.2
37	CA	95.2

The weighted life sciences science linkage measures the average number of science references cited on the front page of a company's patents. This indicator is based on counts of patent references to scientific papers. In this category, Massachusetts is the top scorer, with 100 index points. Florida scored 86.0 and placed next to last among benchmarked states (35th in the nation).

Weighted Life Sciences Science Linkage

Rank	State	Score 2000-2004
1	MA	100.0
2	TX	99.2
8	CA	97.6
13	NC	95.5
14	MN	94.8
15	NY	94.5
16	IL	93.8
22	PA	91.4
25	MI	90.6
35	FL	86.1
38	NJ	84.4

The weighted life sciences strength measure is the product of the number of patents multiplied by science linkage and reflects the total number of science links in the region's patent portfolio. This measure helps identify how regions balance their quantity and quality of life science patents. Similar to Florida's trailing performance in the science linkage component, the state registered the lowest score among benchmarked states and ranked 18th in the nation.

Weighted Life Sciences Science Strength

Rank	State	Score, 2000-2004
1	CA	100.0
2	MA	89.9
3	NY	83.8
4	PA	82.2
6	TX	80.8
7	NJ	79.1
9	IL	76.2
10	MN	75.4
12	NC	74.3
16	MI	70.5
18	FL	69.3

With a few clear exceptions Florida has ranked consistently within the top twenty states in the strengths and weaknesses of its innovation pipeline. Florida has a significant capacity for innovation and development, thanks to several prominent research institutions and the University of Florida. But it is not enough for Florida to rank in the top twenty. In order to surpass its peer states and achieve parity with the leading states in the life sciences, Florida must improve its levels of human capital, venture capital, and research capital.

Florida's Life Sciences Industry Profile

Industry Concentration

This section gives practical advice for decision makers by analyzing Florida's successes and challenges in a national context. We continue to compare Florida statistics with those of five peer states and five leading states. Peer states are similar to Florida in geography, demography, and economic structure.

Pear and Leading States

Peer States	Leading States
Illinois	California
North Carolina	Massachusetts
Michigan	New Jersey
Minnesota	New York
Texas	Pennsylvania

Texas, New York, Florida, Illinois, and Pennsylvania share similar demographics, and Florida and Minnesota share strengths in medical devices. The remaining states lead the nation in life sciences development.

Population Estimates, July 1, 2005

State	Population
California	36,132,147
Texas	22,859,968
New York	19,254,630
Florida	17,789,864
Illinois	12,763,371
Pennsylvania	12,429,616
Michigan	10,120,860
New Jersey	8,717,925
North Carolina	8,683,242
Massachusetts	6,398,743
Minnesota	5,132,799

Source: www.census.gov

Location Quotients (LQs) identify specializations in the local economy. This measure compares the local economy (Florida's) to the national economy by calculating the ratio of an industry's employment share of the local economy to the industry's employment share of the national economy. It is important to know that LQs are based on work force, not population.

Florida's **life sciences knowledge-intensive sectors**—termed *therapeutics and devices* for purposes of this study—have outpaced the national average by only one measure: the concentration of employment in medical devices. Florida trails both the peer and leading states in employment concentration in biotech manufacturing and in pharmaceuticals. Florida also experiences shortcomings in its R&D life sciences employment concentration.

Florida must re-examine its resources and diversify its life sciences industry; like the leading states, North Carolina continues to gain momentum in almost all sectors. Florida's lack of diversity shows in its rankings. Out of fifty states, Florida ranks 17th overall. Although solid, this ranking places Florida in the second tier of states in life sciences development, and clearly below its potential.

Life Sciences Therapeutics and Devices Industry
Florida versus Peer and Leading States, 2004

Rank	State	Medical Devices		Biotech Manufacturing		R&D		Total Therapeutics and Devices		Overall Score
		Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	
1	CA	61,664	1.46	10,511	1.40	38,532	1.85	140,699	1.47	100.00
2	NJ	14,916	1.34	7,776	3.98	11,197	2.08	65,796	2.65	94.40
4	MA	16,721	1.90	1,922	1.22	17,541	4.02	51,241	2.05	68.80
5	MN	18,881	3.47	1,114	0.85	5,732	1.58	33,588	2.01	64.30
6	PA	7,907	1.22	4,517	1.63	12,162	1.59	54,350	1.54	62.30
9	NC	19,873	0.74	4,064	2.14	6,826	1.30	35,379	1.46	51.70
10	NY	12,409	0.85	1,864	0.45	14,027	1.22	55,530	1.05	50.80
12	IL	9,294	0.77	1,579	0.55	4,020	0.51	37,026	1.01	41.60
16	MI	22,864	0.77	665	0.31	3,385	0.57	22,736	0.82	30.40
17	FL	14,864	1.09	365	0.10	3,307	0.32	30,331	0.63	29.30
21	TX	14,648	0.56	1,553	0.33	5,014	0.39	28,900	0.48	25.00
	US	363,982	1.00	65,066	1.00	179,923	1.00	829,322	1.00	–

The next table illustrates how Florida's successes are tied to its health-care services sector, a reflection of the state's reputation as a retirement mecca and its rapidly growing population. Florida has a large pool of health-care workers (almost 635,000). The largest segment falls under general/medical and surgical hospitals. HMO medical centers, in particular, are surpassing the national average in employment concentration but still underperform leading states, such as California and Massachusetts. Florida's physician offices and medical laboratories also demonstrated employment concentration above the national average in 2004. Florida ranked well above most of its peer states, as well as many of the leading states, scoring 83.8 in overall life sciences health-care services.

Life Sciences Health-Care Services Industry
Florida versus Peer and Leading States, 2004

Rank	State	Offices of Physicians		HMO Medical Centers		Medical Laboratories		Home Health Care Services		General Medical and Surgical		Nursing Care Facilities		Total Therapeutics and Devices		Overall Score
		Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	
1	NY	129,924	1.0	1,894	0.7	7,648	0.9	75351.00	1.5	313219.00	1.2	130478.00	1.3	798,891	1.2	100.0
2	CA	208,732	0.9	10,846	2.3	17,760	1.1	43929.00	0.5	354955.00	0.8	101134.00	0.6	978,724	0.8	94.6
3	TX	148,022	1.0	1,182	0.4	7,196	0.7	162134.00	2.9	240634.00	0.8	92693.00	0.8	790,159	1.0	93.2
4	PA	89,920	1.1	123	0.1	7,923	1.4	24206.00	0.8	232157.00	1.4	81883.00	1.2	575,143	1.3	90.5
6	FL	142,186	1.2	9,131	1.3	9,576	1.2	16099.00	1.0	219807.00	1.0	81396.00	0.9	634,958	1.0	83.8
7	MA	45,952	0.9	2,684	2.7	3,010	0.9	17181.00	1.0	137793.00	1.4	56715.00	1.5	337,463	1.3	77.6
8	IL	76,996	0.9	351	0.2	4,237	0.7	21371.00	0.6	245590.00	1.2	73330.00	1.1	478,985	1.0	73.5
9	MI	61,157	0.9	1,730	1.3	2,423	0.5	24259.00	0.9	176273.00	1.3	40991.00	0.8	381,599	1.1	70.2
10	NJ	61,994	1.0	691	0.6	7,701	1.9	26155.00	1.1	130420.00	1.1	44055.00	1.9	342,731	1.1	67.7
15	MN	57,968	1.4	0	0.0	1,464	0.5	11071.00	0.7	80017.00	1.0	45117.00	1.4	229,376	1.1	60.6
24	NC	59,257	1.0	99	0.1	3,819	1.0	35434.00	1.6	86824.00	0.7	42623.00	0.9	276,195	0.9	55.5
	US	2,008,665	1.0	41,252	1.0	133,526	1.0	770759.00	1.0	3986282.00	1.0	1571090.00	1.0	10,652,475	1.0	–

The following table measures total life sciences scores. We calculate them by assigning weights to the two components—*therapeutics and devices*, and *health-care services*. We take the sum of the weighted scores of the life sciences therapeutic and devices, and life sciences health-care services, and benchmark it to the top state score.

Our findings show that (with the exception of Michigan) Florida has not caught up to its peer states. Florida's life sciences health-care services jobs are important, but most are not the knowledge-based positions that will keep the state competitive globally.

Total Score for Life Sciences Industry
Florida versus Peer and Leading States, ranked by Employment and LQ, 2004

Rank	State	Therapeutics and Devices	Heath Care Services	Total Life Sciences
1	CA	100.00	94.60	100.00
2	NJ	94.43	67.67	86.70
3	PA	62.35	90.50	73.60
4	MA	68.79	77.57	73.25
5	NY	50.85	100.00	69.36
7	MN	64.35	60.63	64.26
10	NC	51.70	55.54	54.06
11	IL	41.56	73.74	53.84
12	TX	24.97	93.23	49.80
13	FL	29.27	83.84	49.30
15	MI	30.43	70.22	45.21

The availability of medical specialties has kept pace with the growth of the elderly population in the Tampa–St. Petersburg–Clearwater region, and the metro area has the highest overall score in therapeutics and devices among all Florida metro areas. The sector's outstanding performance is represented by an employment LQ of 2.23. Among Florida's metropolitan areas, no metro are reached employment LQs above the national average in industry sectors.

A large number of employees in Florida metro areas are involved in the life sciences health-care services industry (see the following two tables). The Punta Gorda metropolitan area ranks among the most popular retirement destinations in Florida, as reflected in its high LQs of 2.4 (offices of physicians) and 2.6 (nursing-care facilities). Eighteen of twenty Florida metro areas show employment LQs greater than 1.0 in the physician offices sector, indicating its importance. The Deltona–Daytona Beach–Ormond Beach metro area employment LQ of 17.7 in the HMO sector is the largest in Florida, followed closely by Tallahassee.

The Miami–Fort Lauderdale–Miami Beach metro area ranks first in the total life sciences score (see the following two tables), based on strengths in its health-care services and medical devices sectors. The geographic dispersion of life sciences therapeutics and devices indicates that most of the current employment is concentrated in Tampa–St. Petersburg–Clearwater; Miami–Fort Lauderdale–Miami Beach; and Jacksonville. These three locations have some success in the life sciences, although the potential is present in other locations as well.

Characterizing the dynamics of the Jacksonville life sciences industry, Bob Blankemeyer, president of Medtronic ENT & Neurological Technologies notes that while the northeast region is growing in both population and service industry infiltration, it lacks the university and medical teaching infrastructure to support the same growth rate for the pharmaceutical and medical device sectors. "The supporting life science services that would augment product development and new therapy opportunities are limited," he said. "Compared with California, Minnesota, Illinois, and the northeastern U.S., Jacksonville is far behind." Still, the presence of University of Florida affiliate Shands Jacksonville and Mayo Clinic's plans to develop a fully operational research hospital offer potential for Jacksonville to expand its role as a hub of clinical testing.

Life Sciences Therapeutics and Devices Employment and LQ, 2004

Rank	MSAs	Med. Dev.		Pharma.		R&D		Thera. And Dev.		Score		
		Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Overall
1	Tampa-St. Petersburg-Clearwater	7,320	2.23	962	0.48	1,542	0.95	9,833	1.32	93.20	100.00	100.00
2	Miami-Fort Lauderdale-Miami Beach	6,565	1.06	2,638	0.71	1,045	0.34	10,550	0.75	100.00	56.92	81.22
3	Jacksonville	3,520	2.29	0	0.00	20	0.03	3,577	1.02	33.90	77.66	57.75
4	Gainesville	459	1.29	7	0.03	292	1.66	775	0.96	7.30	82.55	41.36
5	Deltona-Daytona Beach-Ormond Beach	797	1.83	0	0.00	10	0.05	807	0.81	7.70	61.84	35.97
6	Sarasota-Bradenton-Venice	1,081	1.40	13	0.03	31	0.08	1,125	0.64	10.70	48.62	30.68
7	Orlando-Kissimmee	1,725	0.67	83	0.05	23	0.02	1,831	0.31	17.40	23.65	21.22
8	Ocala	129	0.50	0	0.00	117	0.92	246	0.42	2.30	32.00	17.77
9	Pensacola	234	0.54	69	0.26	0	0.00	303	0.31	2.90	23.35	13.57
10	Palm Bay-Melbourne-Titusville	191	0.35	0	0.00	134	0.49	325	0.26	3.40	19.68	11.78
11	Port St. Lucie-Fort Pierce	132	0.40	0	0.00	24	0.15	156	0.21	1.50	15.93	9.01
12	Naples-Marco Island	128	0.38	13	0.06	0	0.00	142	0.18	1.30	13.85	7.86
13	Lakeland	203	0.38	0	0.00	7	0.03	210	0.17	2.00	13.04	7.78
14	Cape Coral	192	0.35	0	0.00	0	0.00	192	0.15	1.80	11.54	6.91
15	Purta Gorda	18	0.17	0	0.00	22	0.42	40	0.16	0.50	12.47	6.65
16	Tallahassee	49	0.10	0	0.00	39	0.17	88	0.08	0.80	6.22	3.65
17	Fort Walton Beach-Crestview Destin	32	0.14	0	0.00	0	0.00	32	0.06	0.30	4.73	2.61
18	Panama City-Lynn Haven	9	0.05	0	0.00	0	0.00	9	0.03	0.10	1.65	0.90
19	Counties not part of MSAs	79	0.00	9	0.00	0	0.00	88	0.00	0.80	0.14	0.50
20	Vero Beach	0	0.00	0	0.00	0	0.00	0	0.00	0.00	0.00	0.00

Life Sciences Health-Care Services Industry, Selected Industries, 2004

Rank	MSAs	Offices of Physicians (except Mental Health Specialists)		HMO Medical Centers		Medical Laboratories		Home Health-Care Specialists		General Medical and Surgical Hospitals		Nursing Care Facilities		Total Health-Care Services		Score		
		Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Emp.	LQ	Overall
1	Miani-Fort Lauderdale-Miami Beach	43,159	1.30	1,416	2.00	3,289	1.50	18,779	1.40	70,634	1.00	21,098	0.80	203,273	1.10	100.00	58.40	100.00
2	Punta Gorda	1,430	2.40	0	0.00	0	0.00	403	1.80	2,535	2.10	1,201	2.60	6,082	1.90	3.00	100.00	65.00
3	Tampa-St. Petersburg-Clearwater	22,058	1.20	0	0.00	2,208	1.80	7,376	1.10	30,788	0.90	13,653	1.00	99,460	1.00	48.90	53.90	64.90
4	Gainesville	2,351	1.20	0	0.00	198	1.50	365	0.50	9,457	2.40	998	0.60	15,675	1.50	7.70	78.10	54.19
5	Deltona-Daytona Beach-Ormond Beach	2,814	1.20	873	17.70	332	2.10	1,134	1.20	7,066	1.50	2,788	1.50	18,522	1.50	9.10	75.60	53.47
6	Jacksonville	12,071	1.40	0	0.00	180	0.30	1,881	0.60	17,656	1.00	5,941	0.90	49,067	1.10	24.10	56.80	51.06
7	Orlando-Kissimmee	14,847	1.00	0	0.00	1,012	1.10	4,097	0.70	25,712	0.90	10,013	0.90	67,635	0.90	33.30	46.50	50.39
8	Pensacola-Ferry Pass-Brent	3,654	1.50	0	0.00	56	0.40	1,111	1.20	6,754	1.40	1,955	1.00	16,284	1.30	8.00	66.80	47.23
9	Sarasota-Bradenton-Venice	6,349	1.50	0	0.00	561	2.00	2,162	1.30	8,312	1.00	3,305	1.00	25,771	1.10	12.70	59.40	45.46
10	Palm Bay-Melbourne-Titusville	4,589	1.50	0	0.00	820	4.10	608	0.50	6,564	1.10	3,249	1.40	19,233	0.12	9.50	62.10	45.16
11	Port St. Lucie-Fort Pierce	3,096	1.70	0	0.00	40	0.30	1,362	2.00	2,677	0.70	1,900	1.30	11,813	1.20	5.80	64.10	44.14
12	Vero Beach	1,517	2.20	0	0.00	0	0.00	321	1.20	1,321	0.90	487	0.90	4,460	1.20	2.20	62.30	40.72
13	Cape Coral-Fort Myers	4,888	1.60	0	0.00	438	2.20	1,142	1.00	5,861	1.00	1,853	0.80	17,422	1.10	8.60	55.80	40.61
14	Lakeland	4,610	1.60	0	0.00	53	0.30	630	0.60	6,386	1.10	2,176	0.90	16,569	1.10	8.20	54.90	39.78
15	Ocala	2,664	1.90	0	0.00	27	0.30	493	0.90	1,886	0.70	1,854	1.70	8,369	1.10	4.10	58.00	39.19
16	Panama City-Lunn Haven	1,411	1.30	0	0.00	0	0.00	197	0.50	2,343	1.10	688	0.80	6,099	1.10	3.00	56.90	37.81
17	Fort Walton Beach-Crestview-Destin	1,396	1.10	0	0.00	9	0.10	126	0.30	1,894	0.80	925	1.00	5,288	0.80	2.60	51.80	28.04
18	Tallahasee	2,210	0.90	873	16.40	0	0.00	713	0.70	1,886	0.40	1,043	0.50	10,120	0.70	5.00	38.30	27.30
19	Not included in MSAs	4,978	0.50	30	0.10	352	0.50	2,869	0.80	8,188	0.40	5,200	0.70	26,867	0.50	13.20	27.00	25.39
20	Naples-Marco Island	2,094	1.10	0	0.00	0	0.00	330	0.50	1,886	0.50	1,069	0.70	6,950	0.70	3.40	36.20	24.99

Florida MSAs: Total Score for Life Sciences
Ranked by Employment and LQ, 2004

		Score		
Rank	MSAs	Therapeutics and Devices	Heath-Care Services	Total Life Sciences
1	Miani-Fort Lauderdale-Miami Beach	81.20	100.00	100.00
2	Tampa-St. Petersburg-Clearwater	100.00	64.90	99.90
3	Jacksonville	57.70	51.10	63.10
4	Gainesville	41.40	54.20	52.20
5	Deltona-Daytona Beach-Ormond Beach	36.00	53.50	47.90
6	Sarasota-Bradenton-Venice	30.70	45.50	40.80
7	Orlando-Kissimmee	21.20	50.40	35.80
8	Punta Gorda	6.70	65.00	30.80
9	Pensacola-Ferry Pass-Brent	13.60	47.20	28.90
10	Ocala	17.80	39.20	28.80
11	Palm Bay-Melbourne-Titusville	11.80	45.20	26.70
12	Port St. Lucie-Fort Pierce	9.00	44.10	24.30
13	Lakeland	7.80	39.80	21.60
14	Cape Coral-Fort Myers	6.90	40.60	21.30
15	Vero Beach	0.00	40.70	16.20
16	Naples-Marco Island	7.90	25.00	15.80
17	Panama City-Lynn Haven	0.90	37.80	15.70
18	Tallahasee	3.70	27.30	13.60
19	Fort Walton Beach-Crestview-Destin	2.60	28.00	13.10
20	Not Included in MSAs	0.50	25.40	10.50

The analysis of Florida's life sciences employment shows that medical devices and health-care services are the industry's sector anchors. Florida has not developed a competitive position in several other key life sciences sectors; none of the metro areas has been able to develop concentrations of biotech manufacturing or pharmaceuticals at or above the national average.

The number of life science firms and the amount of industry wages disbursed show the size of industry operations and value of life sciences work. Location quotients based on the number of establishments in 2004 are taken to the national average. From the computations, Florida shows its strength in several sectors, especially in its health care industries. These strengths are concentrated in several counties—Broward, Hillsborough, Miami–Dade, Palm Beach, and Pinellas. Of note, the Memorial Healthcare System in Broward had 10,000 employees and annual revenues of more than $471 million in 2004. In Miami–Dade, Jackson Memorial Hospital, affiliated with the University of Miami, has 8,000 employees and annual revenues of more than $960 million. In contrast, counties including Dixie, Franklin, Holmes, Jefferson, and Lafayette show very low concentrations of health-care industries. Although general health care is not a significant growth resource, it can serve as a foundation for clinical trials and medical tourism, which can add significant value to the state's life sciences sector.

Statewide, Florida is weak in biotech manufacturing, nursing-care facilities, drugs and pharmaceuticals, general medical and surgical hospitals, dentist offices, ambulatory health-care services, and R&D.

Sector Location Quotients of Annual Average Establishments
2004

Sectors	CA	FL	IL	MA	MI	MN	NC	NJ	NY	PA	TX
Biotech Manufacturing	1.43	0.47	1.13	1.10	0.58	1.26	0.79	1.87	0.49	0.94	0.95
Nursing Care Facilities	0.54	0.72	1.21	1.34	0.86	1.22	1.19	0.74	0.63	1.38	1.26
Drugs and Pharmaceuticals	1.08	0.65	1.19	1.58	0.82	0.72	1.21	3.35	1.20	1.30	0.91
General Medical and Surgical Hospitals	0.85	0.72	1.06	0.87	1.13	0.95	0.57	0.84	0.62	1.41	1.28
Home Health-Care Services	0.62	1.18	0.68	0.91	1.25	0.59	1.61	0.69	0.62	1.39	2.26
Medical and Diagnostic Labs	0.88	1.59	0.92	0.88	0.75	0.27	0.79	1.39	1.10	1.23	1.27
Medical Devices and Equipment	1.09	1.15	1.21	1.05	1.13	1.43	0.93	1.11	0.90	1.05	0.83
Offices of Dentists	1.06	0.87	1.16	1.01	1.21	0.85	0.79	1.18	1.12	1.13	0.98
Offices of Other Health Practitioners	0.80	1.11	1.08	0.87	1.12	1.06	0.87	1.07	1.01	1.17	1.00
Offices of Physicians	0.93	1.31	0.98	0.79	0.99	0.36	0.82	1.26	1.23	1.08	1.35
Other Ambulatory Health-Care Services	0.45	0.94	1.19	0.87	0.73	1.31	0.72	0.95	0.78	2.36	1.29
Outpatient Care Centers	0.76	1.09	0.61	1.16	1.36	0.73	0.84	0.87	0.81	1.79	0.96
Psychiatric and Substance Abuse Hospital	1.10	1.39	0.83	1.59	0.64	0.32	0.31	0.77	0.44	1.56	1.38
R&D in Life Sciences*	1.49	0.67	0.77	2.57	0.55	1.05	1.27	1.45	0.86	1.01	0.71
Specialty (Except Psychiatric and Substance Abuse)	0.57	2.21	0.42	1.28	0.80	0.23	0.80	3.14	0.28	1.63	2.13

Sources: Milken Institute, Bureau of Labor Statistics
*Data from 2002. Latest Available

Florida's weakness in R&D deserves special attention. The base for R&D is an important measure of the knowledge assets of the state. Michigan, Illinois, and Texas score comparably to Florida in this measure. All four states have low location quotients in life science R&D, employment, and firms. Illinois fared better than Florida in terms of firms, and all three states fared better in terms of employment.

Florida's biotech manufacturing sector shows a similar weakness in firm location quotients, scoring 0.47. This is aggravated by Florida's biotech manufacturing employment location quotient of 0.10. Florida lacks sufficient medium and large-sized firms to support a biotech manufacturing work force, which constitutes an important element of the life science mix.

It is interesting to note that while Florida excels in the health-care sectors, there are comparatively few firms to support its large employment base. This applies especially to nursing-care facilities. The large labor force is concentrated within a relatively small number of firms.

Within Florida, general medical and surgical hospitals play a leading role in life sciences employment; almost 80 percent of the state's anchor firms (firms with more than 500 employees) are in this sector. Although the number of major hospitals is not disproportionate to that of the other nine states, the hospitals constitute a substantial proportion of Florida's health-care services.

As shown in the following table, Florida has a high number of small health-care firms. There are 1,875 small firms in the physician offices sector, nearly 50 percent of the state's total number of small firms.

In comparison, in the biotech manufacturing, pharmaceuticals, and medical devices and equipment sectors, we see far fewer firms at all sizes, suggesting that although Florida shows strength in its medical devices and equipment sector, its pharmaceutical and biotech sectors are still quite young.

Size of Life Science Firms in Florida
2004

Sectors	<100	100-199	200-299	300-399	400-499	>=500	Total
Biotech Manufacturing	12	–	–	–	–	1	13
Nursing Care Facilities	221	344	50	13	8	4	640
Drugs and Pharmaceuticals	56	6	2	1	1	3	69
General Medical and Surgical Hospitals	76	17	17	22	11	132	275
Home Health-Care Services	362	75	31	9	2	5	484
Medical and Diagnostic Labs	128	14	3	4	–	2	151
Medical Devices and Equip	35	6	2	–	–	1	44
Offices of Dentists	158	2	–	–	–	–	160
Offices of Other Health Practitioners	182	8	4		1	–	195
Offices of Physicians	1,875	53	11	6	1	4	1,950
Other Ambulatory Health-Care Services	152	16	7	2	2	4	183
Outpatient Care Centers	376	33	6	4	4	3	426
Psychiatric and Substance Abuse Hospital	29	21	4	6	–	1	61
Specialty (Except Psychiatric and Substance Abuse)	20	7	6	7	1	7	48
Total	3,682	602	143	74	31	167	4,699

Sources: Milken Institute, Selectoryonline.com

Most of Florida's anchor firm medical and surgical hospitals are located in Miami, Tampa, Orlando, and the Jacksonville metropolitan statistical area, which account for ninety-two of 162 of anchor firms in the state. Florida Hospital Orlando in Orange County, employed 14,000 people in 2004.

Based on the year's figures, this hospital has the largest employment among life science establishments in Florida. But it is important to note that the general medical and surgical hospitals sector is present in many areas of the state.

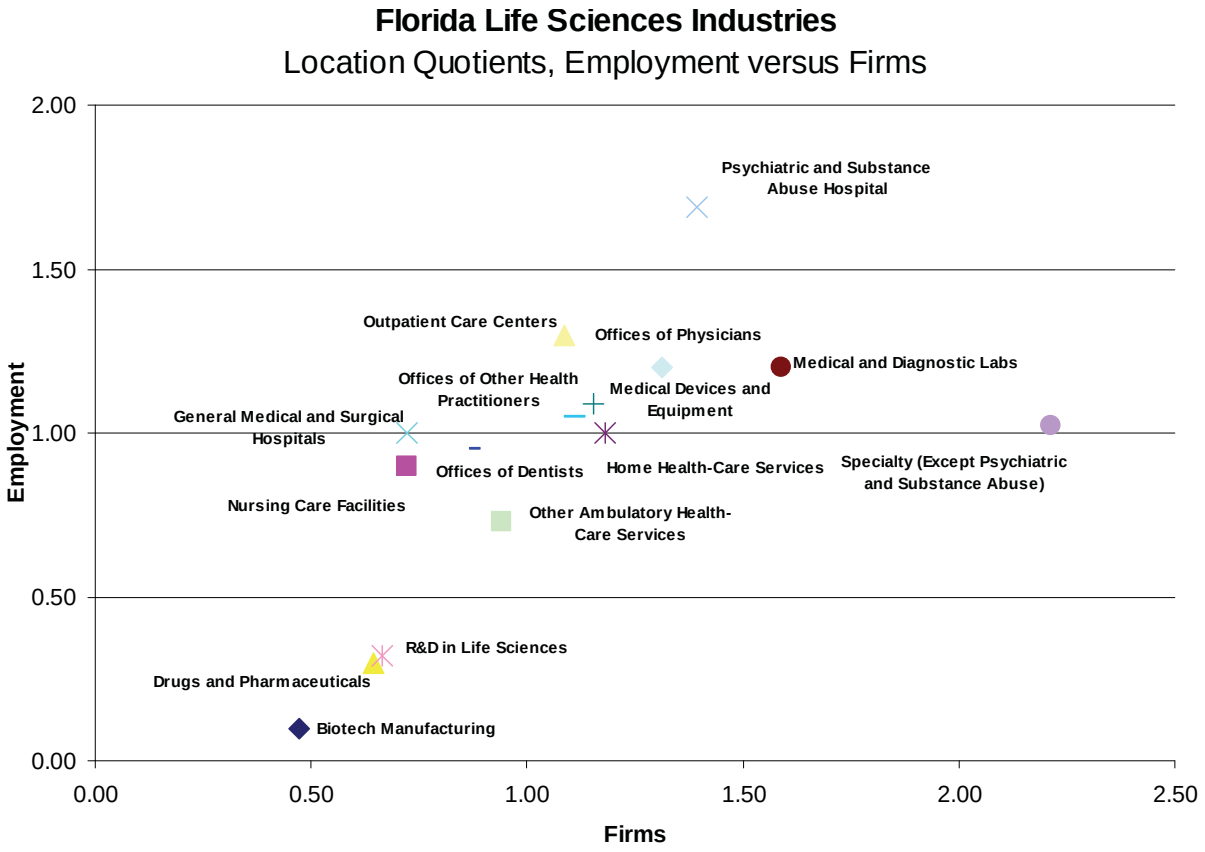
Anchor Firms in Florida, 2004

MSA	Nursing Care Facilities	General Medical and Surgical Hospitals	Home Healthcare Services	Medical and Diagnostic Labs	Offices of Physicians	Other Ambulatory Healthcare Services	Outpatient Care Centers	Psychiatric and Substance Abuse Hospital	Specialty (Except Psychiatric and Substance Abuse)	Grand Total
Deltona-Daytona Beach-Ormond Beach	–	4	–	–	–	–	1	–	–	5
Fort Walton Beach-Crestview-Destin	–	2	–	–	–	–	–	–	–	2
Gainesville	–	3	–	–	–	–	–	–	–	3
Jacksonville	1	12	–	–	–	–	–	–	1	14
Lakeland	–	4	–	–	–	–	–	–	–	4
Miami-Fort Lauderdale-Miami Beach	1	46	4	1	–	2	–	–	3	57
Naples-Marco Island	–	1	–	–	–	–	–	–	–	1
Not Included in MSAs	–	4	–	–	–	–	–	–	–	4
Ocala	–	2	–	–	–	–	–	–	–	2
Orlando-Kissimmee	1	13	1	–	–	–	1	–	–	16
Palm Bay-Melbourne-Titusville	–	4	–	–	2	–	–	1	–	7
Panama City-Lynn Haven	–	2	–	–	–	–	–	–	–	2
Pensacola-Ferry Pass-Brent	1	5	–	–	1	–	–	–	–	7
Port St. Lucie-Fort Pierce	–	1	–	–	–	–	–	–	1	2
Punta Gorda	–	2	–	–	–	–	–	–	–	2
Sarasota-Bradenton-Venice	–	4	–	–	–	–	–	–	–	4
Tallahassee	–	1	–	–	–	1	–	–	–	2
Tampa-St. Petersburg-Clearwater	–	21	–	1	1	1	1	–	2	27
Vero Beach	–	1	–	–	–	–	–	–	–	1
Grand Total	4	132	5	2	4	4	3	1	7	162

Source: Milken Institute, Selectoryonline.com

Most of the health-care sectors have a reasonably strong presence relative to the national average. Among the best-performing sub-sectors are psychiatric and substance abuse; specialty (except psychiatric and substance abuse); and medical and diagnostic laboratories. These have employment and firm location quotients of more than 1.50.

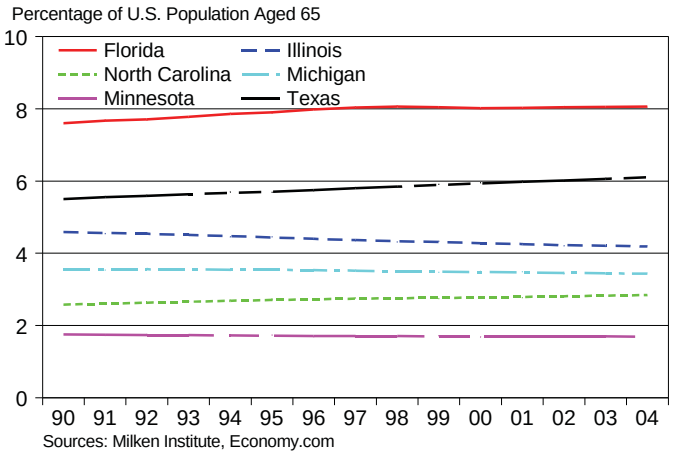
Drugs and pharmaceuticals, biotech manufacturing, and life sciences R&D have less presence in Florida, both in terms of employment and number of firms. The following scattergram shows that most sectors' presence is comparable to the national average. The weaknesses in the knowledge-intensive sectors, however, warrant special attention for policy making and economic strategizing.



The average annual wage per worker shows the value of industry output and how much it costs to employ a worker in a particular sector. Overall, Florida's life science wages per worker are low, suggesting the low value of the state's life sciences work and labor costs. Compared to the U.S. average, Florida's life sciences workers are paid consistently low across all sectors, with the exception of nursing-care facilities and other ambulatory health-care services, and home health-care services. The average wages for these two sectors were roughly equal to the national average in 2004, and wages for the latter surpassed the U.S. average.

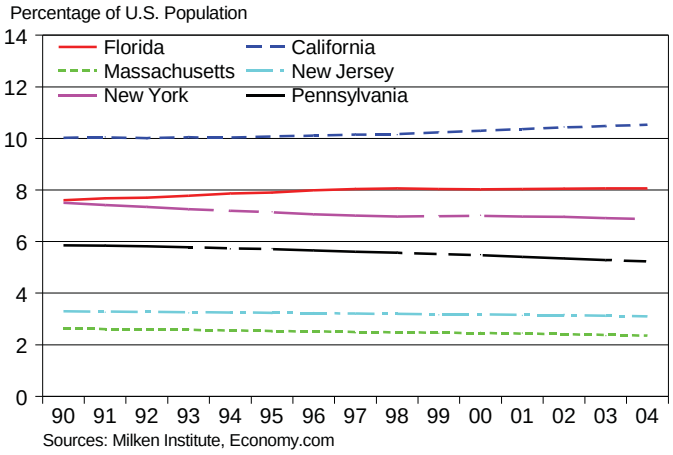
Florida is home to a large number of retirees. We use resident populations age 65 and older as an estimate for the retirement population. From 1990 to 2004, the state had a high percentage of residents 65 and older—8 percent—and led its peer states by about 2 percent. Compared to the leading states, Florida again shows a higher percentage. New York came close to Florida in 1990, but its retirement population has declined since then.

Percentage of U.S. Population Ages 65 and Above
Florida versus Peer States, 1990-2004



Sources: Milken Institute, Economy.com

Percentage of U.S. Population Ages 65 and Above
Florida versus Leading States, 1990-2004



Sources: Milken Institute, Economy.com

The higher number of older residents increases the demand for health-care services and contributes to a well-established sector. But again, these health-care resources by themselves do not create high-value work. They can create a foundation upon which to build strategies for luring and developing more value-added industries, through clinical trials, therapeutic research, and medical tourism. The relatively low presence of knowledge-driven life science sectors, such as biotech manufacturing, pharmaceuticals, and R&D, can be seen to have a direct effect on the wages paid to workers employed in those sectors.

The following table shows the wages per life sciences worker in Florida. Indeed, while a worker earns on average less than what he or she will earn in the other states, the annual wages are not substantially lower. But the annual wages for workers in the higher-value sectors are substantially lower than the national average, as well as for all the benchmarked states. This suggests that the

value of knowledge-intensive life sciences work in Florida is lower than in the other states; otherwise, sectors that would have grown or become more competitive would have driven up the demand for skilled workers and higher wages.

Average Wage per Worker in the Life Sciences Industry, 2004

Sectors	CA	FL	IL	MA	MI	MN	NC	NJ	NY	PA	TX	US
Biotech Manufacturing	$61,678	$44,577	$59,430	$96,195	–	–	$68,635	–	$53,490	–	$47,199	$71,557
Nursing Care Facilities	$26,273	$25,933	$21,828	$30,463	$24,107	$22,471	$22,054	$30,409	$31,569	$26,395	$21,163	$24,382
Drugs and Pharmaceuticals	$113,408	$50,210	$82,757	$102,544	$81,247	$70,712	$73,775	$99,813	$70,490	$87,766	$73,350	$84,848
General Medical and Surgical Hospitals	$54,019	$39,650	$41,169	$48,761	$39,905	$42,010	$40,138	$47,240	$46,590	$40,955	$42,063	$42,368
Home Health-Care Services	$29,933	$29,841	$24,475	$29,516	$25,570	$20,312	$16,917	$24,430	$25,769	$27,588	$13,193	$22,406
Medical and Diagnostic Labs	$50,263	$44,989	$47,828	$51,233	$50,507	$56,078	$49,135	$68,131	$48,869	$50,701	$47,011	$49,527
Medical Devices and Equipment	$69,183	$50,394	$57,960	$60,896	–	–	–	$56,749	$52,161	$48,384	$47,402	$55,671
Offices of Dentists	$37,666	$41,323	$38,379	$43,695	$39,848	$48,842	$46,203	$41,483	$36,980	$35,680	$40,258	$39,374
Offices of Other Health Practitioners	$31,456	$34,048	$34,758	$33,666	$33,255	$36,156	$34,229	$35,436	$30,000	$30,623	$35,462	$31,993
Offices of Physicians	$59,037	$52,991	$63,412	$63,154	$59,153	$62,060	$53,185	$66,311	$59,364	$54,611	$60,437	$57,238
Other Ambulatory Health-Care Services	$40,938	$35,075	$35,117	$46,025	$36,998	$39,120	$28,213	$43,768	$38,563	$30,858	$34,169	$35,453
Outpatient Care Centers	$43,244	$37,390	$40,417	$47,783	$45,010	–	$37,988	$42,796	$41,489	$52,743	$44,953	$41,871
Psychiatric and Substance Abuse Hospital	$36,449	$29,383	$37,173	$41,429	$29,724	–	$38,116	$33,781	$39,645	$33,672	$34,115	$33,826
R&D in Life Sciences*	$81,664	$46,459	$76,696	$79,018	$73,576	$55,741	$72,683	$75,739	$48,146	$79,934	$53,794	$71,173
Specialty (Except Psychiatric and Substance Abuse)	$44,451	$37,990	$40,979	$44,844	$34,757	–	$38,163	$45,825	$65,072	$44,389	$41,171	$42,914

Sources: Milken Institute, Bureau of Labor Statistics

*Data from 2002. Latest Available

Conclusion

Florida's assets can be leveraged to build life sciences clusters. Of note, the UCF School of Medicine serves Orlando, a fast-growing metropolitan area with nine hospitals. The medical school is beneficial both as an addition to the region's health-care system and its R&D base. The college of medicine at Florida State University can plot similar progress along Florida's life sciences road map.

The Mayo Clinic, which opened in 2003, boasts the $22 million Griffin Center Research Building in Jacksonville and is adding a new hospital. The clinic is a major employer of physicians and health-care practitioners.

The Moffitt Research Center at the University of South Florida performs cancer R&D and is a major player in the medical world. In addition to its R&D facilities and activities, the center could serve as an impetus for medical science initiatives. Scripps Florida employs 160 scientific staff in a $12 million, 40,000-square-foot temporary facility at Florida Atlantic University. Scripps represents one answer to Florida's call to develop a knowledge-based economy.

Despite these assets, the state's life sciences industry profile is skewed toward health-care services, not higher-value sectors (with the exception of medical devices), a reality attributable to the high number of older residents.

The state has a relatively diffuse firm base to support its strong health-care work force in hospitals and specialty clinics. Despite the demand for general health-care services, this sector has a relatively small number of sector firms. The high employment quotient comes from large general hospitals, not firm location.

Florida's life sciences industry has not fulfilled its potential as a full contributor to the state's economic prosperity. Its knowledge-intensive sectors lag behind peer and leading states. In particular, its life science R&D sector must show improvement in the employment and firm base to match even the national average. With greater public and private support, however, and the development of sustainable regional clusters, we believe the industry's value-added sectors can propel the state into the role of a formidable industry player, able to compete in national and global markets.

Appendix:

Defining the Life Sciences Industry

We use data based on the 2002 North American Classification System (NAICS) for the life sciences therapeutics and devices and the health-care services sectors. The following codes apply to our industry definitions:

Definition of Life Sciences Therapeutics and Devices

NAICS	Life Sciences Industry Group
325411	Medicinal and Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325413	In-Vitro Diagnostic Substance Manufacturing
325414	Other Biological Product Manufacturing
339111	Laboratory Apparatus and Furniture Manufacturing
339112	Surgical and Medical Instrument Manufacturing
339113	Surgical Applicance and Supplies Manufacturing
339114	Dental Equipment and Supplies Manufacturing
339115	Ophthalmic Goods Manufacturing
339116	Dental Laboratories
334510	Electromedical Apparatus Manufacturing
334517	Irradiation Apparatus Manufacturing
5417102	R&D in Life Sciences

Definition of Life Sciences Health-Care Services

NAICS	Life Sciences Industry Group
621111	Offices of Physicians (except Mental Health Specialists)
621112	Offices of Physicians, Mental Health Specialists
621210	Offices of Dentists
621310	Offices of Chiropractors
621320	Offices of Optometrists
621330	Offices of Mental Health Practitioners (except Physicians)
621340	Offices of Physical, Occupational and Speech Therapists, and Audiologists
621391	Offices of Podiatrists
621399	Offices of All Other Miscellaneous Health Practitioners
621410	Family Planning Centers
621420	Outpatient Mental Health and Substance Abuse Centers
621491	HMO Medical Centers
621492	Kidney Dialysis Centers
621493	Freestanding Ambulatory Surgical and Emergency Centers
621498	All Other Outpatient Care Centers
621511	Medical Laboratories
621512	Diagnostic Imaging Centers
621610	Home Health Care Services
621910	Ambulance Services
621991	Blood and Organ Banks
621999	All Other Miscellaneous Ambulatory Health Care Services
622110	General Medical and Surgical Hospitals
622210	Psychiatric and Substance Abuse Hospitals
622310	Specialty (except Psychiatric and Substance Abuse) Hospitals
623110	Nursing Care Facilities

Notes

[1] Devol, Ross, et al. 2005. *The Greater Philadelphia Life Sciences Cluster*. Milken Institute Research Report, June, 2005, p. 67.

[2] Richard J. Cebula (1975). "Migration, Economic Opportunity, and the Quality of Life: AnAnalysis for the United States According to Race, Sex, and Age. *The Annals of Regional Science*. Volume 9, Number 1 / March, 1975. 127–133 . Abstract. www.springerlink.com/index/N5225U1312118145.pdf. Accessed 12 Oct, 2006.

[3] Including Cleveland Clinic, Florida Hospital, H. Lee Moffitt Cancer Center & Research Institute, Mayo Clinic, M.D. Anderson Cancer Center Orlando, Shands HealthCare, Jackson Memorial Hospital, etc. 2006.

[4] But hospital supplies, certain cardiac equipment, and MRI equipment markets are mature or saturated.

[5] Including the areas of minimally invasive surgery, disposable devices and supplies, orthopedic and cardiac implants, diagnostic imaging, and sterilization equipment.

[6] Major medical device manufacturers include Baxter Healthcare Corp., Beckman Coulter Inc., Boston Scientific, Linvatec Corp., Medtronics Xomed, Walter Lorenz Surgical Inc.

[7] They are Florida Agricultural and Mechanical University, Florida Atlantic University, Florida International University, Florida Gulf Coast University, Florida State University, Nova Southeastern University, University of Central Florida, University of Florida, University of Miami, University of North Florida, University of South Florida, and University of West Florida.

[8] Florida has no state personal income tax. The corporate income tax rate is 5.5 percent.

[9] DeVol, R., et al. *America's High-Tech Economy*. Milken Institute, 1999.

[10] DeVol, R., Bedroussian, A., Koepp, R., Wong, P. *Manufacturing Matters: California Performance and Prospect*. Milken Institute, 2002.

[11] DeVol, Ross, Wong, Perry, Junghoon Ki, Bedroussian, Armen, Koepp, Rob. 2004. *America's Biotech and Life Science Clusters. San Diego's Position and Economic Contributions*. Milken Institute. June 2004.

[12] DeVol, Ross, Wong, Perry, Junghoon Ki, Bedroussian, Armen, Koepp, Rob. 2004. *America's Biotech and Life Science Clusters. San Diego's Position and Economic Contributions*. Milken Institute. June 2004.

[13] Wong, Perry, Bedroussian, Armen. 2006. *Economic Benefits of Proposed University of Central Florida College of Medicine*. Milken Institute. March 2006.

[14] Cortright, J. and Mayer, H. "Signs of Life: The Growth of Biotechnology Centers in the U.S.," Washington, D.C.: The Brookings Institution, 2002.

[15] Wu, Weiping. 2005. "Dynamic Cities and Creative Clusters," World Bank Policy Research Working Paper 3509, February.

[16] Kotkin, Joel and Ross C. DeVol, *Knowledge-Values Cities in the Digital Age*. Milken Institute. February, 2001, pp. 10–15.

[17] DeVol, Ross, Rob Koepp, and Junghoon, Ki. 2004. *State Technology and Science Index: Enduring Lessons for the Intangible Economy*. Milken Institute. March, 2004.

[18] "What Are Industry Clusters?" http://www.sandag.cog.ca.us/rta/transfer/industrial_clusters.pdf Accessed: November 22, 2006.

[19] DeVol, Ross, Wong, Perry, Junghoon Ki, Bedroussian, Armen, Koepp, Rob. 2004. *America's Biotech and Life Science Clusters. San Diego's Position and Economic Contributions*. Milken Institute. June 2004.

[20] Devol, Ross., Koepp, R., and Fogelbach, F. (2002). *State Technology and Science Index: Comparing and Contrasting California*. Santa Monica: Milken Institute.

[21] Richard J. Cebula (1975). "Migration, Economic Opportunity, and the Quality of Life: An Analysis for the United States According to Race, Sex, and Age." *The Annals of Regional Science*. Volume 9, Number 1 / March, 1975. 127-133. Abstract. www.springerlink.com/index/N5225U1312118145.pdf . Accessed 12 Oct, 2006.

[22] Justin M. Nolan and Mary Jo Schneider. "Miracles in the Mountains: Medical Tourism in Rural Arkansas' Ozark and Ouachita Mountains." University of Arkansas.

[23] "The Best Money Can Buy: Medical Tourism in the U.S.A." *New America Media*, News Feature/Analysis, Hilary Abramson, Feb 2, 2006. See: http://news.newamericamedia.org/ news/view_article.html?article_id=5b7c206e74b96be675410f6f369b5113.

[24] "Torrey Pines Solidifies St. Lucie Plans." 2006. *South Florida Business Journal*. http://southflorida.bizjournals.com/southflorida/stories/2006/09/25/daily21.html?surround=lfn. Accessed October 13, 2006.

[25] Devol, Ross, and Bedroussian, Armen. 2006. *Mind-to-Market: A Global Analysis of University Biotechnology Transfer and Commercialization*. Santa Monica: Milken Institute.
[26] Curtis, Austin. (2006). "Workforce Florida Launches First Employ Florida Center." August 23, 2006. http://www.workforceflorida.com/wages/wfi/news/news_releases/Employ_Florida_Banner_Center_Aviation_Aerospace_Press.pdf. Accessed Oct 13, 2006.
[27] "USF and Byrd Alzheimer's Institute Announce NIH/NIA-Funded and First-Ever Adrc Accreditation in Florida." April 27, 2005. http://www.tampachamber.com/ci_viewnews.asp?id=695 Accessed on October 13, 2006.
[28] University of South Florida. "USF Technology Incubator." Available: http://www.incubator.usf.edu/ Accessed: January 4, 2007.
[29] *U.S. News & World Report*, 2006. http://www.usnews.com/usnews/edu/grad/rankings/ med/brief/mdrrank_brief.php. Accessed April 17, 2006.
[30] Fossum, Donna et al. "Vital Assets: Federal Investment in Research and Development at the Nation's Universities and Colleges." RAND Science and Technology. http://www.rand.org/pubs/ monograph_reports/MR1824/MR1824.sum.pdf.
[31] "MassBiotech 2010: Achieving Global Leadership in the Life-Sciences Economy." The Boston Consulting Group, Massachusetts Biotechnology Council, 2002.
http://www.massbiotech2010.org/pdf/massbiotech2010_report.pdf.
[32] http://currents.ucsc.edu/04-05/06-27/brief-biotech.asp.
[33] Barkley, David L., Deborah M. Markley, Julia Sass Rubin. 1999. "Public Involvement in Venture Capital Funds: Lessons from Three Program Alternatives." *Rural Policy Brief*. Rural Policy Research Institute.
http://www.rupri.org/publications/archive/pbriefs/PB99-2/.
[34] Robert Trigaux. 2005. "It Was a Busy Week in Fla. Business." *St. Petersburg Times*. July 29, 2005.
http://www.sptimes.com/2005/07/29/Columns/It_was_a_busy_week_in.shtml.
[35] Council for Economic Development. See: http://www.cednc.org/about/.
[36] "MassBiotech 2010: Achieving Global Leadership in the Life-Sciences Economy." The Boston Consulting Group, Massachusetts Biotechnology Council, 2002.
http://www.massbiotech2010.org/pdf/massbiotech2010_report.pdf.
[37] Gollub, James, Ted Egan, ICF Consulting. 2004. "Building the Life Sciences Cluster in British Columbia."
[38] "Ready for the Next Leap Forward: A Competitive Assessment and Strategic Plan to Develop Michigan's Life Sciences Industry." *Battelle Report on Michigan Life Sciences*, p. 52. See: http://www.csuchico.edu/ csuperb/OECD_Mich.pdf.
[39] http://www.innovationworks.org/.
[40] http://www.innovationworks.org/About/PressReleases_details.jsp?restrictids=nu_repeatitemid&& restrictvalues=0690200091781157569346848&&pageId=0690200091781155844873894.
[41] http://www.csuchico.edu/csuperb/.
[42] The "21st Century Life Science Roadmap: Creating a World-Class Life Science Industry in Texas." Texas Healthcare and Bioscience Institute. http://www.thbi.org/about/roadmap.pdf.
[43] "Networks of Innovation: Regions Collaborating to Compete in the Global Market." National Gathering of Biotech/Life Science Innovation Regions. BIO 2000 Conference, 2000. See: http://biotech.about.com/ library/bioreport.pdf.
[44] Gollub, James, Ted Egan, ICF Consulting. 2004. "Building the Life Sciences Cluster in British Columbia."
[45] CED's 2004 Entrepreneurial Satisfaction Survey Report. See: http://www.cednc.org/publications/ entrepreneurial_satisfaction_survey/?link=navInternal.
[46] http://www.gsm.uci.edu/FacultyAndCenters/CEI/CEIStudent2Startup.aspx.
[47] "New York: Laboratories of Innovation: State Bioscience Initiatives 2004." Prepared by Battelle Technology Partnership Practice and SSTI. June 2004. http://www.bio.org/local/battelle2004.
[48] Office of Program Policy Analysis & Government Accountability. Report No. 05-59, December 2005. http://www.oppaga.state.fl.us/reports/pdf/0559rpt.pdf.
[49] "MassBiotech 2010: Achieving Global Leadership in the Life-Sciences Economy." The Boston Consulting Group, Massachusetts Biotechnology Council, 2002.
http://www.massbiotech2010.org/MassBioTech2010Report.pdf.
[50] "North Carolina: Laboratories of Innovation: State Bioscience Initiatives 2004." Prepared by Battelle Technology Partnership Practice and SSTI. June 2004. http://www.bio.org/local/battelle2004.

[51] "California: Laboratories of Innovation: State Bioscience Initiatives 2004." Prepared by Battelle Technology Partnership Practice and SSTI. June 2004. http://www.bio.org/local/battelle2004.
[52] "Southeast Minnesota: Preparing to Compete in the Age of Innovation." Prepared by Corporation for a Skilled Workforce and Published by the Workforce Boards of Southeast Minnesota.
[53] http://www.biotech.sunysb.edu/educWork/index.html#newgrad.
[54] "Networks of Innovation: Regions Collaborating to Compete in the Global Market." National Gathering of Biotech/ Life Science Innovation Regions. BIO 2000 Conference, 2000.
[55] Ibid.
[56] Gollub, James, Ted Egan, ICF Consulting. 2004. "Building the Life Sciences Cluster in British Columbia."
[57] "The 21st Century Life Science Roadmap. Creating a World-Class Life Science Industry in Texas." Texas Healthcare and Bioscience Institute. http://www.thbi.org/about/roadmap.pdf.
[58] http://www.biotech.sunysb.edu/educWork/index.html#newgrad. Script 6/19/2007.

About the Authors

Ross DeVol is Director of Regional Economics and the Center for Health Economics at the Milken Institute. He oversees the Institute's research on the dynamics of comparative regional growth performance, and technology and its impact on regional and national economies. He is an expert on the intangible economy and how regions can prepare themselves to compete in it. DeVol authored the ground-breaking study *America's High-Tech Economy: Growth, Development, and Risks for Metropolitan Areas*, an examination of how clusters of high-tech industries across the country affect economic growth in those regions. He also created the *Best Performing Cities Index*, an annual ranking of U.S. metropolitan areas that shows where jobs are being created and economies are growing. His most recent work involves the study of biotechnology and other life science clusters, and the impact these industries have on regional economies. He was the lead author of *Mind-to-Market: A Global Analysis of University Biotechnology Transfer and Commercialization*, released in September 2006. This study looked at the transfer and commercialization of university-developed intellectual property on a global basis, with particular focus on the field of biotechnology. Prior to joining the Institute, DeVol was senior vice president of Global Insight Inc. (formerly Wharton Econometric Forecasting), where he supervised their Regional Economic Services group. He was the firm's chief spokesman on international trade. He also served as the head of Global Insight's U.S. Long-Term Macro Service and authored numerous special reports on behalf of the U.S. Macro Group. He is ranked among the "Super Stars" of Think Tank Scholars by International Economy magazine.

Perry Wong is a Senior Managing Economist in Regional Economics at the Milken Institute. An expert on regional economics, development, and econometric forecasting, he specializes in analyzing the structure, industry mix, and development of regional economies. He designs, manages, and performs research on labor and workforce issues; the relationships between technology and economic development; and trade and industry, with a focus on policy development and implementation in leading and disadvantaged regions. Wong is involved in regional economic development in southern China, Taiwan, and other parts of Asia. Prior to joining the Institute, he was a senior economist and director of regional forecasting at Global Insight Inc. (formerly Wharton Econometric Forecasting), where he managed regional, state, and metropolitan-area forecasts, and provided consultation. Wong was born in China's Yunan Province, raised in Guang Zhou, and lived in Hong Kong. He earned a master's degree in economics at Temple University in 1990 and has completed course requirements for his Ph.D.

Kevin Klowden is a Managing Economist in Regional Economics at the Milken Institute, specializing in the study of demographic and spatial factors (the distribution of resources, business locations, land use, and movement of labor) and how these are influenced by public policy and affect regional economies. He has an interest in the role of transportation infrastructure, as it relates to the movement of goods and people in the development of regional competitiveness. Most recently, he coordinated the Institute's two-year *Los Angeles Economy Project*, seeking public

policy and private-sector solutions to challenges the region faces amid a growing unskilled labor pool. He has organized, moderated, and participated in numerous panels on the state and local economy, and has been interviewed by both print and broadcast media regarding the state's commercial and residential real estate markets. He served on the editorial board of *Millennium*, the international affairs journal of the London School of Economics, where he earned a master's degree in the politics of world economy. Klowden earned a bachelor's degree in historical geography, as well as a master's in economic geography, from the University of Chicago.

Armen Bedroussian is a Research Economist with the Milken Institute. Bedroussian has graduate training in econometrics, statistical methods, and other modeling techniques. Before joining the Institute, he was an economics teaching assistant at the University of California at Riverside, where he taught intermediate micro- and macroeconomics. At the Institute, he has co-authored numerous studies, including *The Impact of 9/11 on U.S. Metropolitan Economies; Manufacturing Matters: California's Performance and Prospects; America's Biotech and Life Science Clusters*, *Biopharmaceutical Industry Contributions to U.S. and State Economies; The Greater Philadelphia Life Sciences Cluster;* and *Economic Benefits of Proposed University of Central Florida College of Medicine*. In addition to co-authoring the annual Best Performing Cities Index, Bedroussian is responsible for compiling the Milken Institute's Cost of Doing Business Index. He earned a B.S. in applied mathematics and a master's in economics from UC Riverside.

Anna Babayan joined the Milken Institute as a Research Analyst. Her interests are in the development of regional and industrial economics, and behavioral finance. Babayan previously worked in investment banking and taught mathematics. *The Greater Philadelphia Life Sciences Cluster* and the *Los Angeles Economy Project* are among studies to which she has contributed. Babayan is fluent in Armenian and Russian, and has a working knowledge of Italian. She earned a master's degree in economics at Bocconi Universita in Milan and a B.A. in economics from the University of Southern California.

A recent graduate from the University of San Diego, **Meggy Frye** joined the Institute as a Research Assistant in Regional Economics. At the University of San Diego, Frye earned a B.A. in economics with honors (minoring in mathematics) and presented a forecast for the San Diego housing market at the USD Burnham-Moores Center for Real Estate's annual conference. Her thesis focused on coffee demand in the United States.

Before joining the institute as a Senior Research Analyst in Regional Economics, **Daniela Murphy** worked for Bank of America, where she researched market development and the economic conditions shaping California's real estate market. Her research interests center on regional economic development, information technology, and the impact of technology on regional and national economies. Murphy's doctoral dissertation emphasized the tasks and organization of the former East German Secret Service and its influence on the German economy. She worked for the German government on the Enquete Commission, performing research on international security,

political stability, and economic growth in Eastern Europe. Murphy earned an MBA and Ph.D. at the University of Lueneburg.

Benjamin Yeo is a Research Analyst in Regional Economics at the Milken Institute. His doctoral dissertation is aimed at developing a theory of sustainability for the knowledge economy. His expertise comprises information technology (IT), planning, and knowledge management for e-business and economic development; information systems/process management; and national information policy studies. Yeo received his bachelor's and master's degrees from the School of Communication and Information at Nanyang Technological University in Singapore and his Ph.D. from the College of Information Sciences and Technology at the Pennsylvania State University. His recent projects include the Keystone Workforce Cluster project in Pennsylvania, where he assisted in the execution of an in-depth analysis of the statewide IT work force; a study of Pittsburgh's technology strategy; and Florida life sciences projects.

Photo credits:

Cover: Top photo: University of Florida Medical Plaza. Photo by Kristin Bartlett-Grace. UF News Bureau. Center photo: H. Lee Moffitt Cancer Center & Research Institute. Photo by Richard Riley. Bottom left: Photo by Ray Carson, UF News Bureau. Bottom right: Photo by USF Photography.

Back cover: Tampa skyline. Photo courtesy of University of South Florida Photography.

MILKEN INSTITUTE

1250 Fourth Street • Santa Monica, CA 90401
Phone: 310.570.4600 • Fax: 310.570.4601 • E-mail: info@milkeninstitute.org
www.milkeninstitute.org

MILKEN INSTITUTE

1250 Fourth Street • Santa Monica, CA 90401
Phone: 310.570.4600 • Fax: 310.570.4601 • E-mail: info@milkeninstitute.org
www.milkeninstitute.org