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Economic Benefits of Proposed University of Central Florida College of Medicine

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1. Introduction:

The Milken Institute was engaged to determine the economic impact of a college of medicine on the Orlando region. During the course of our study, we were also asked to evaluate the capabilities of university life-science spin-offs and related economic benefits.

We discovered that Orlando already possesses many of the characteristics necessary to the formation of a life-science cluster, including a growing population, good quality of life, a well-established, research-based university in the area, community and private-sector support, and infrastructure that will support a large industrial base. In fact, the only factor not present — and it is a crucial one — is a research-based college of medicine that will not only attract top scientists and faculty, but also related life-science businesses from other regions.

The following pages detail the impacts of a medical school on its affiliated university research, as well as on the growth of a life-science sector that would likely arise because of the medical school, and on the greater Orlando economy, which will likely see benefits far beyond increased university employment. The findings show an economic impact of $1.4 billion and the creation of more than 6,000 additional jobs directly attributable to the presence of a college of medicine. With the growth of a related life-science industry, or cluster, the economic impact could eventually approach $6.4 billion and mean the creation of up to 25,000 jobs.

2. The Life-Science Industry

The Milken Institute has allocated tremendous resources to analyzing the major life-science economies in the United States.[1] The sector encompasses biotechnology, pharmaceuticals, medical devices and includes associated R&D activities and supporting infrastructure — such as research universities, teaching hospitals, medical laboratories and venture-capital firms — making it one of the most knowledge-intensive and research-rich segments of the U.S. economy. The life-science industry directly and indirectly supports millions of jobs and pays above-average wages. Just as important, it is an emerging powerhouse for U.S. global economic competitiveness.

The life sciences do not comprise new disciplines or industries. In the past decade, regional economies, such as Boston, San Diego and Philadelphia, have grown and prospered because they built on their existing core life-science assets. They used advances in material sciences, computing and information technologies to strengthen cooperation and facilitate the application of discoveries in the field. As life expectancy continues to increase, so does our demand for improved quality of life. As such, there is no limit to the potential for the life sciences, both in research and research applications.

Many regions of the country are competing for life-science clusters. They understand that the long-term economic potential is immense. Clusters offer the creation of valuable

production industries and jobs. Most of all, clusters promote innovation in science and technology, which invariably lead to sustained economic growth.

There is still room for life-science clusters in regions that are experiencing population growth and can boast research universities, laboratory space, medical schools, hospitals, infrastructure, developable land, private investment and a desirable quality of life.

3. A College of Medicine's Value

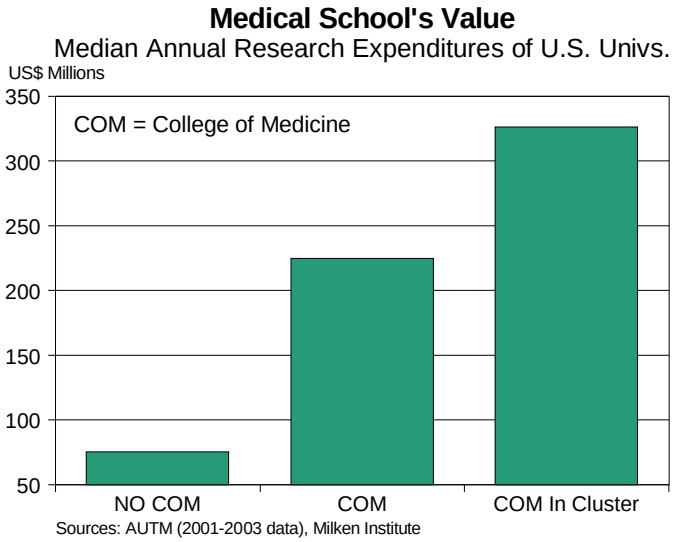
A research-based college of medicine (COM) plays a crucial role for any region that aspires to develop a life-science cluster. (Note: A COM here is defined as a stand-alone practice facility conducting research and development.) Among other things, a COM provides valuable infrastructure, such as wet-lab space and skilled technicians to assist scientists and researchers. This is an infrastructure used not just by the university-based researchers, but by private-sector researchers and entrepreneurs located in surrounding communities. All too often, wet-lab space and other core facilities are scarce without a COM. As a consequence, life-science entrepreneurs will typically locate near a COM. Regions without COMs, regardless of other desirable aspects, remain at a tremendous disadvantage.

Perhaps just as important, a research-based college of medicine brings critical human capital to the region. COM faculty members tend to perform cutting-edge research that, when successfully developed, forms the building blocks for additional research and development. Successful clusters arise when the research and researchers stay within close proximity, fully utilizing available services and expertise.

R&D assets are widely recognized to be the pipeline of technological innovation, and levels of R&D expenditures are accepted as reliable indicators of a region's ability to innovate.[2] A region with a good R&D infrastructure has a comparative advantage for the creation of new, sustainable industrial clusters, attracting tech-based firms and an educated work force.

According to data compiled from the Association of University Technology Managers (AUTM), research expenditures that stem from universities with medical schools are significantly higher than expenditures originating from universities without medical schools.[3] The median annual research expenditure by universities without medical schools was $75.3 million between 2001 and 2003. On average, universities with medical schools invested $224.8 million.[4]

Meanwhile, universities with a medical school surrounded by life-science clusters, such as those in San Diego, Raleigh-Durham, San Francisco and Philadelphia, spend even more on R&D — more than $320 million annually — compared to medical schools not associated with clusters.



Although the University of Central Florida lacks a college of medicine, its research expenditures exceed the median for universities without medical schools. Based on UCF data, the university spends $103 million a year on R&D, or about $27.7 million more than the average university without a medical school. More recently, the UCF Photonics Center of Excellence and the Institute for Simulation and Training led "the list of 26 national awards winners [for the prestigious 2006 Department of Defense Multidisciplinary University Research Initiative (MURI) grant program], receiving three of the prestigious grant awards. Thirty grants totaling 26 MURI awards were given to 20 universities for a total of $150.6 million in awards over five years. It is expected that Florida's grant contracts will be valued at approximately $15 million."[6]

Such successful R&D ventures illustrate the innovativeness of current UCF faculty.[7] The R&D expenditures also indicate that a research-based environment has been established, both within the university and the community at large.

As of early 2006, corporate partnerships have committed more than $52 million toward funding a college of medicine. This support is crucial; commitment by local industry to convert research into practical therapies, devices and other related products is a key ingredient for leveraging a college of medicine into broader efforts to create a successful and vibrant life-science industry. Community willingness to provide significant seed funding is a tangible demonstration of local commitment to enrich its knowledge-based economy.

4. The Economic Impact of a College of Medicine

The economic impact analysis of a medical school at UCF captures the total impact generated from the creation of a medical school. It also accounts for additional R&D dollars that would be awarded as a result of the school presence.

These impacts specifically reflect the construction and operating phases of the medical school. The construction phase accounts for the first two planning years; the operating phase includes the next 10 years. During this latter period, we assume that the presence of the medical school will generate a great deal of research and development, particularly with National Institutes of Health (NIH) and other types of R&D funding. The total impacts under COM scenario are summarized in the table below.

Economic Impact of College of Medicine

Impacts on Orlando Economy: End of Yr. 10

	Baseline	COM
Government Cost*	N/A	+ $194.3 million
Number of Jobs	1.4 million	+6,470
Average Wage for Additional Jobs	$62,570	$79,895
Total Wages	$86 billion	+ $517 million
Tax Revenue*	N/A	+ $81.4 million
Total Economic Impact	$239 billion	+ $1.4 billion

Sources: Milken Institute, Arduin, Laffer & Moore Econometrics*

The "baseline" column projects Orlando's economy at the end of the operational phase — in other words, what is expected to occur, independent of the existence of a medical school. Even without a college of medicine, Orlando's employment base is projected to reach 1.4 million by the end of 2017. Similarly, the total wage and salary disbursements are expected to reach $86 billion, producing a total economic impact of $239 billion.

A college of medicine alone could be responsible for:

- 6,470 additional jobs;
- $517 million in increased wages;
- $81.4 million in additional tax revenue;
- $1.4 billion in increased economic impact.

By the end of 2017 (the end of the 10th year of the operational phase), the presence of a medical school would generate direct employment within the university and produce economic benefits for Orlando. The additional jobs would be primarily in the educational services and construction industries. The bulk of jobs generated in education services, however, would consist of more than medical school faculty — namely scientists, lab technicians and contract specialists, as well as general support and administrative positions. More important, these jobs would be created as a result of incremental funding from the NIH and other private sources. The following table provides an industry breakdown of the estimated employment gains by the end of 2017.

Additional Jobs Created in COM Scenario

Industry Breakdown

Industry	Total Impact
Agriculture, forestry, fishing, and hunting	18
Mining	0
Utilities	10
Construction	1026
Manufacturing	63
Wholesale trade	69
Retail trade	258
Transportation and warehousing	91
Information	82
Finance and insurance	92
Real estate and rental and leasing	222
Professional, scientific, and technical services	142
Management of companies and enterprises	25
Administrative and waste management services	228
Educational services	3396
Health care and social assistance	240
Arts, entertainment, and recreation	60
Accommodation and food services	273
Other services	173
Total Additional Jobs	**6468**

With the COM overall wage per employee and income per capita would reach $62,651 and $56,737, respectively, by the end of 2017. As previously indicated, the additional jobs would yield an average wage-per-employee total of $79,895. The proposed college of medicine would generate total economic activities valued at $1.4 billion in the Orlando metropolitan area.

The estimated economic impact includes:

- wages and salaries provided to employees at the proposed medical school;
- additional goods and services provided to the region because of new economic activity added to the local economy;
- intra-regional purchases that will elevate Orlando's economic production.

Under COM Scenario

At the End of Year 10, Operational Phase

	Baseline	COM
Overall Wage Per Employee	$62,570	$62,651
Overall Income Per Capita	$56,399	$56,737

Source: Milken Institute

5. Florida's Current Position in the Life-Science Industry

The life-science industry comprises biotechnology and pharmaceutical manufacturing, medical-devices manufacturing and R&D related to the life sciences.

Defining Life Sciences

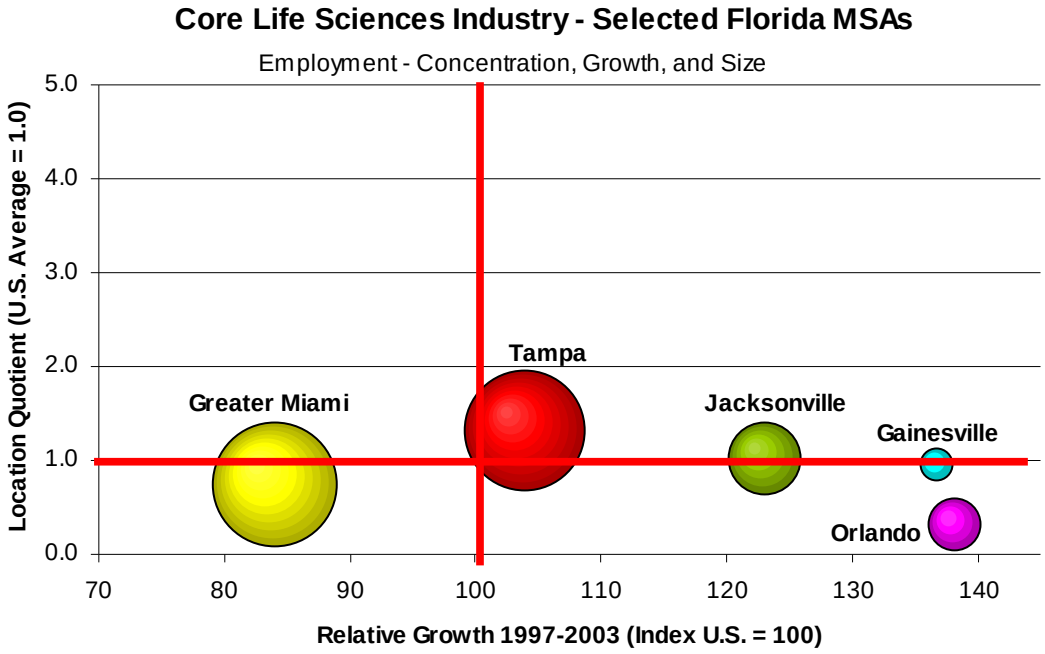
NAICS	Life Science Industry Group
325411	Medicinal and Botanical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325413	In-vitro Diagnostic Substance Manufacturing
325414	Other Biological Product Manufacturing
334510	Electromedical Apparatus Manufacturing
334517	Irradiation Apparatus Manufacturing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

Source: Milken Institute

With regard to life-science employment, most of Florida's key metros are growing relatively faster than the national average. According to the Bureau of Labor Statistics and other government sources, the greater Miami region, for example, currently employs more than 10,500 people in life sciences, making it the largest metro in the state, in terms of life-science employment.[8] However, the Orlando metropolitan area ranks as the fastest-growing area, in terms of life-science employment, and currently outpaces the national average by 38 percent.

The following bubble chart illustrates how Florida's metropolitan areas (MSAs) fare with respect to the life-science industry, relative to the national average. Such bubble charts are powerful visual tools for comparing the strengths and weaknesses in life-science employment across different metropolitan areas. Each chart illustrates three aspects of the life-science industry for the metropolitan area examined.

The X (horizontal) axis measures the average growth in life-science employment for each metropolitan area, compared to the national average. A score of 100 indicates that total employment in the life-science industry between 1997 and 2003 grew at the national average. Life-science employment in Greater Miami grew about 15 percent slower than the national average. Orlando, on the other hand, has been growing 38 percent faster than the national average over this same period. This accelerated growth represents the opportunity that a college of medicine could exploit.

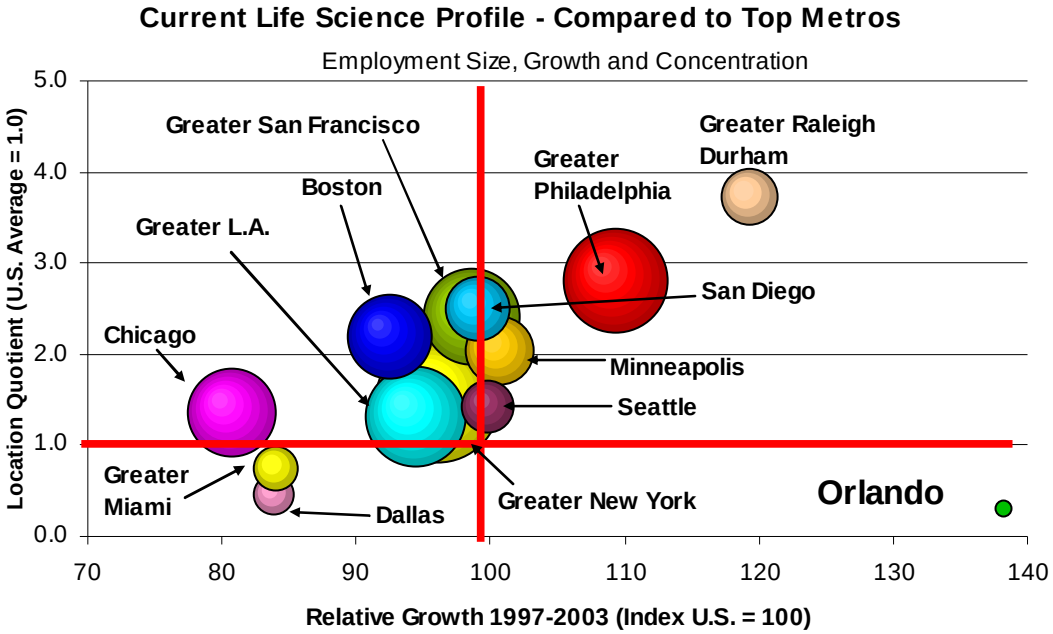


The size of the bubble represents the total number of life-science jobs in the metropolitan area. The Greater Miami region has the largest bubble; the 10,500 people who work in the life-science industry there total more than the number of people working in the industry in any other Florida MSA. Orlando's bubble is small, indicating that few people work in the life-science industry overall.

The Y (vertical) axis corresponds to the concentration of life-science industry employment in the MSA, or what we term the "location quotient" (LQ). The location quotient measures the share of life-science employment in the MSA, relative to the share of life-science employment in the nation as a whole. A metropolitan area with a strong life-science employment base will have its bubble above the 1.0 horizontal line, indicating that its percentage of total industry jobs is higher than that for the United States as a whole. If the metropolitan area has a percentage of total industry jobs equal to the national average share, the location quotient will equal 1.0.

Generally speaking, the LQ quantifies the importance of an industry, in this case life sciences, to a region's economy. In terms of employment concentration, the Tampa area boasts the highest LQ in the state (1.32), or roughly 32 percent above the national average. Life-science employment in the Orlando region stands below the national average.

The second bubble chart compares the Greater Miami and Orlando regions to several of the nation's top life-science clusters. Of these, Greater Raleigh-Durham, Greater Philadelphia and San Diego exhibit the optimal positions.



If a metro has a LQ above 1.0 and an index growth greater than 100 (see, for example, Greater Raleigh-Durham and Greater Philadelphia), then its 2003 concentration of employment is not only higher than that for the United States on average, but its employment has also grown relatively faster than the nation's between 1997 and 2003. The life-science clusters in these metropolitan areas are experiencing strong growth, represented by their positioning in the upper-right quadrant of the chart.

Among Florida's rapidly growing MSAs, Greater Miami is well equipped for developing a life-science cluster and, with the addition of Scripps, will be in an even better position to capitalize on its resources. Scripps will provide an engine of growth toward life sciences there by attracting top-notch scientists and researchers. In addition, its presence will yield a positive spillover effect that should benefit the southern part of the state and, to some extent, the entire state. As evidenced by San Diego, the presence of Scripps stimulates interaction among local universities and businesses. "A regional science center backed by resident research-oriented institutions, such as the University of California, San Diego, and other bio-science and molecular research centers, can extend the benefits of external economies of scale."[9] This creates an opportunity for life-science startups to evolve directly from the university or research center and, in doing so, allows for various specialists, scientists and post-doctorates to join local companies.

The Scripps impact will complement medical schools, research centers and hospitals throughout Florida, and attract a pool of talent to the region. Life-sciences firm will find it advantageous to locate around industry-related R&D network.

Compared to the nation's top clusters, Orlando is experiencing the fastest rate of growth. While the high growth rate can be explained in part because Orlando's life-science sector is young and small, the growth also represents strong momentum. Some components of

the life-science industry, such as medical devices and biotechnology, are taking hold in the region. The rapid accumulation of these assets — attracted by UCF, the regional infrastructure and amenities, and ample availability of land — is forming a stronger life-science base. This equips Orlando for developing a life-science cluster, as well. To the extent that a research-based college of medicine is capable of capturing this momentum, there is potential for the formation of a vibrant life-science cluster.

6. The Outlook for Orlando's Life-Science Industry

The prospects are promising for a life-science industry to form in Orlando. Currently, the industry does not have a large local presence, but it is growing significantly faster than the national average, as noted above. Most important**,** Orlando possesses several of the attributes essential for the formation of a successful life-science industry. These include:

- a dynamic and fast-growing metropolitan area with a desirable climate and high quality of life;
- a university with a proven history of obtaining research grants and creating relevant technologies, especially in the related areas of photonics and optics;
- a university that ranks as one of the top universities in the world in research stemming from optics and acoustics;
- two renowned hospital systems with nine separate hospitals;
- the ability to convert core research into viable companies (the University of Central Florida technology incubator was ranked No. 1 in the nation in 2004 in accomplishing this task, according to the National Business Incubation Association);
- infrastructure to support a large and growing industrial base, including a world-class airport and 100-acre research and technology park, with another 700 acres at Lake Nona that can be developed as high-level research areas (including wet labs);
- complementary industries, including the developing I-4 Hi-tech Corridor (90,000 acres available for development);
- and significant private-sector and community support for a college of medicine at UCF.

In short, there is strong reason to believe that a life-science cluster could thrive in the Orlando region. However, one key element is missing: Every major life-science cluster in the nation has a research-based college of medicine that serves as an incubator for developing ideas, technologies and life-science firms.

Based on our research, Orlando's ability to reach its potential as a thriving life-science cluster is handicapped without a research-based college of medicine. With a properly designed college of medicine, Orlando will possess all the major attributes necessary for the creation of a vibrant life-science cluster.

Orlando is home to one of the largest health-care systems in the state. Florida Hospital, Orlando Regional Healthcare and other medical facilities are situated within the metropolitan region. Given the area's current resources, infrastructure, existing research

base and rapid economic growth, the metro would serve as an ideal candidate for a medical school.

Orlando's current life-science sector is comprised mainly of medical-device manufacturing firms. According to the Harris InfoSource (a D&B-owned Company), 17 out of the top 20 life-science firms are engaged primarily in life-science manufacturing.[10] UCF is directly responsible for 320 jobs in R&D testing laboratories.

Top Life Science Firms in Orlando Metro

Ranked by Employment

Rank	Company Name	Employment Count	Sales Amount	Primary NAICS Code
1	University of Central Florida	320	NA	541710
2	Invacare Florida Corp	300	$22.8	339113
3	Invacare Corp	250	$18.9	339112
4	Omnicare Clinical Research Inc	175	NA	541710
5	Atlantic Coastal Electronics	172	$17.0	339112
6	Alcon Laboratories Inc	170	$35.7	334510
7	Nephron Pharmaceuticals Corp	150	$43.7	325412
8	Invivo Research Inc	132	$12.2	334510
9	Magnatone Hearing Aid Corp	125	$8.1	334510
10	Ocean Optics Inc	100	$18.8	334516
11	Orthomerica Products Inc	90	$16.2	339113
12	Audina Hearing Instruments Inc	85	$6.6	334510
13	Electone Inc	85	$11.0	334510
14	Agri-Starts Inc	65	$3.0	541710
15	Lasersight Inc	56	$6.2	334510
16	All American Amputee	40	$3.0	339113
17	Eastern Isotopes Inc	40	$23.4	325412
18	Medline Industries Inc	40	$6.9	339112
19	Telstar Electronics Inc	37	$1.0	334510
20	Hill Labs Inc	35	$3.3	325412

Source: Harris Infosoure

UCF is building the Burnett Biomedical Science Research Center, which could complement the proposed college of medicine. The university already offers a nursing program and has well-established partnerships with nearby hospitals, should a medical school be built.

Most universities offer a niche that distinguishes them from other schools, whether it's an outstanding biotechnology research faculty or the best scientists in a particular field. A niche attracts faculties and researchers. It also leads to companies investing in the facility or locating around a specialty. At UCF, that specialty is in the field of optics, photonics and simulation.

UCF Optics Program

UCF is home to one of the best Optics and Photonics programs in the nation. According to the Center for Science and Technology Studies (CEST), the university ranks as one of the top universities in the world when it comes to measuring the quality of research stemming from Optics and Acoustics. UCF accounts for 4.04 percent of the world share of publications in this subfield, just behind Caltech (5th).

Optics & Acoustics

Universities and Colleges, Ranked by Number of Publications in this Subfield, 1998-2002

Universities and Colleges	Country	Number of Publications	Rank	Impact	Rank	Activity	World Share of Publications
Massachusetts Institute of Technology (MIT), Cambridge	USA	244	(1)	152	(5)	180	7.45%
University of Rochester	USA	207	(2)	125	(36)	189	6.33%
Pennsylvania State University, University Park	USA	150	(3)	131	(30)	154	4.59%
University of Southampton	UK	147	(4)	152	(6)	187	4.50%
California Institute of Technology (Caltech), Pasadena	USA	133	(5)	154	(3)	175	4.05%
University of Central Florida, Orlando	USA	132	(6)	125	(35)	199	4.04%
University of Tokyo	Japan	131	(7)	124	(41)	47	4.01%
Osaka University	Japan	130	(8)	132	(29)	94	3.96%
Stanford University	USA	122	(9)	162	(1)	109	3.73%
Royal Institute of Technology (KTH), Stockholm	Sweden	109	(10)	128	(31)	191	3.33%

Source: CEST

CEST defines impact and activity as follows:

Impact: Quality indicator, that reflects the number of citations of a university in a specific subfield as a percent share of the number of total publications of the university in that field divided by the total citations of the world in the specific field as a share of the world's total publications in that field.

Activity: Quantity indicator measured by the number of publications in qualified subfields as % of total publications of a specific university and divided by the world's publications in that specific field as a share of the world's total publications.

College of Optics and Photonics faculty were awarded $15 million from federal, state and private sources, the third largest award behind the College of Engineering and Computer Science ($17.5 Million) and College of Education ($17.3 Million).

The College of Optics and Photonics is recognized as one of the top three independent optics academic departments in the nation and offers interdisciplinary graduate programs leading to master's and Ph.D. degrees in optics. The Center for Research and Education in Optics and Lasers (CREOL) and the Florida Photonics Center of Excellence (FPCE) are research centers within the college. Various methodologies, primarily related to novel optical imaging techniques, are revolutionizing the way we visualize various objects, particularly biological tissues. For example, many biological tissues are remarkably transparent to near-infrared wavelengths but strongly scatter this light. Advances in the understanding of multiple scattering allows us to determine the size, shape and depth of various materials buried centimeters below the tissue surface without actually producing images.

Research in multiphoton confocal imaging allows 3D imaging of the position of specific molecular species in cells. By frequency tuning of the laser illumination source, different molecular species can be overlaid in 3D. Augmented reality programs being developed at CREOL allow images of virtual objects to be overlaid on real objects and will be useful for medical training. Near-field scanning microscopy allows objects with features smaller than the wavelength of light to be imaged.

The theme of biomedical research at UCF is the genomic and molecular basis of diseases and therapeutics. The Burnett College at UCF is building basic research programs in four areas: cancer, cardiovascular diseases, neurodegenerative diseases and infectious diseases. Core biomedical science technologies under development by the Burnett College include bio-imaging, adult stem cell and tissue engineering, and 3D computer simulation of gene expression profiles in the brain.

The presence of a medical school could enhance these programs' capacities to attract scientists and entrepreneurs looking to do business within Central Florida's high-tech corridor. UCF's research and commercialization program serves as a liaison among faculty, industry leaders and government, and is essential to the economic viability of Central Florida's high-tech corridor. In addition, the university's tech transfer office and technology incubator program play vital roles in the development of startups and local business looking to partner with the university. Additionally, UCF is home to a wide range of life sciences-related programs already in existence.

UCF is currently among the largest producers of medical preparatory degrees in the state. In 2005, faculty research awards reached $103.6 million, of which $43.7 million and $25.6 million came from federal and state sources, respectively, while $34.3 million stemmed from private sources. The addition of a medical school would help boost federal funding, namely through National Institutes of Health. The added funding would enhance the R&D base of the university and provide more leverage to attract top faculty and associate scientists.

7. Current State Profile and Upcoming Challenges

Florida's economy is flourishing. The state leads the nation in new job creation and boasts the lowest unemployment rate among the 10 most populous states. Overall economic growth exceeds the national average, and the unemployment rate is the third-lowest in the nation. State fiscal policies are paying dividends, as well. According to Laffer Associates, Florida ranks 12th on overall competitiveness, compared to the other 50 states. In 2005, the Small Business and Entrepreneurship Council ranked Florida the sixth friendliest state, in terms of policy environment and entrepreneurship. Strong economic growth, sound fiscal policy and a desirable climate and quality of life have encouraged above-average population growth throughout the state.

Nevertheless, problems exist. The average income for state residents ranks near the bottom in the country. While Florida has posted robust increases in overall job growth,

the quality of jobs in Florida still lags behind the national average. Particularly, jobs in industries that require highly skilled labor and generate high production value represent a smaller proportion of jobs in Florida, compared to the rest of the nation (i.e., manufacturing only accounted for 6.4 percent of all jobs in the state, compared to a 13.7 percent share in the nation).

Upgrading Florida's Job Quality

2004

	Florida	U.S.
Higher Paying Industries Comprise Lower Share of Total Jobs in FL		
Manufacturing	6.4%	13.7%
Information	3.1%	3.5%
Finance and Insurance	7.0%	7.6%
Life Sciences	0.4%	0.6%
Lower Paying Industries Comprise Higher Share of Total Jobs in FL		
Retail Trade	8.4%	6.8%
Accommodation & Food Services	4.1%	3.0%
Other Services	3.3%	2.9%

Source: BEA, NIPA Accounts

Similarly, Florida lags the nation in technology, information and life-science jobs. The "high-paying jobs deficiency" exposes a weakness in Florida's position in an otherwise healthy economy and may dampen the state's long-term growth prospects. Jobs in the sciences are rapidly growing on a national level. This sector is proven to create high-paying, high-value-added jobs in major U.S. metropolitan areas. The sector's contribution goes beyond simply improving the state's job quality, however. Its reliance on R&D, an educated work force and high capital investment can transform the state's technology base and aid long-term economic development. Breakthrough developments stemming from this sector translate into treatments and cures that are capable of reaching out to a global platform.

8. Potential Additional Economic Impacts of a UCF Medical School

The governor of Florida wants to improve the quality of the state's work force and diversify its economy. His plan focuses on luring more high-tech firms to the state, specifically in the area of life sciences.

> *"The bioscience industry is key to solidifying Florida's future as a global hub for innovation and groundbreaking research and development. We must continue to foster an environment that attracts the field's best and brightest."*[11]
> *— Governor Jeb Bush*

With respect to the governor's proposed agenda, the Milken Institute has examined the importance of a medical school to the Orlando metropolitan economy. A college of

medicine would provide an academic dimension to an already existing health-care network, raising the quality and access of medical care and technology in Central Florida. Working with existing assets, such as the Burnett College of Biomedical Science and Central Florida's high-tech corridor, a college of medicine would enhance the breadth and depth of research. Once established, a college of medicine could then serve as the platform that promotes research and encourages entrepreneurial activity. With the right policy mix and R&D base, a college of medicine could help create startups and attract life-science firms to the region.

With the governor having set aside $630 million in his proposed budget to bolster the state's high-tech and bioscience industries, a medical school at the University of Central Florida could act as a catalyst to attract high-end life-science activity in the state.

The Prospect for Further Life-Science Development: The addition of a medical school and increased R&D would contribute toward building a knowledge base that could be leveraged by entrepreneurs (many of whom are faculty members or doctoral students themselves) in developing new life-sciences spin-offs and startups. Eventually, these companies will grow and expand, creating incentives for other companies to locate nearby.

Should the presence of a medical school trigger life-science activity in the metro region, the economic benefits would be even greater. Thus, this scenario would attempt to capture the additional economic benefits if related businesses cluster and in turn create jobs at a rate similar to that experienced in other U.S. clusters. The life-science cluster scenario attempts to capture the additional benefits of economic growth driven by life-science firms. The underlying assumption for this scenario is based on an examination of top life-science clusters (e.g., San Diego, Raleigh-Durham, Seattle) that have grown on average by 1.4 percent per quarter in the 15 years.

After comparing Orlando's relative strengths and weaknesses, and in consideration of its smaller life-science research base, the Milken Institute has calculated a lower and more conservative growth rate of 0.9 percent per quarter. The table below summarizes the results of Orlando's life-science cluster scenario, having already incorporated the impacts of a college of medicine.

Economic Impact of Life Science Cluster

Impacts on Orlando Economy: End of Yr. 10

	Baseline	COM	COM+Cluster
Government Cost*	N/A	+ $194.3 million	+ $194.3 million
Number of Jobs	1.4 million	+6,470	+25,730
Average Wage for Additional Jobs	$62,570	$79,895	$90,152
Total Wages	$86 billion	+ $517 million	+ $2.3 billion
Tax Revenue*	N/A	+ $81.4 million	+ $365.2 million
Total Economic Impact	$239 billion	+ $1.4 billion	+ $6.4 billion

Sources: Milken Institute, Arduin, Laffer & Moore Econometrics*

If life-science businesses in Orlando form and create jobs in a similar pattern as experienced in other leading clusters (but at a more conservative rate for Orlando), the clustering impacts could create:

- up to 25,730 jobs,
- increased wages by up to $2.3 billion,
- up to $362.5 million in tax revenue,
- an additional $6.4 billion in economic impact,

by the end of 2017 (end of 10th year of the operational phase).

Of the additional 25,730 jobs created, roughly 8,600 would stem directly from life sciences. The other 17,130 jobs would be created in other sectors as a result of the economic "ripple effect" from the life-science industry (based on Orlando's life-science multiplier, derived from the Bureau of Economic Analysis). In other words, for every job created in Orlando's life-science sector, two more jobs would be created in other sectors of the metro. The additional jobs created in the life-science scenario would generate an average wage per employee of $90,152. This depicts the most important factor in the cluster scenario: that the jobs being created would be high-paying, value-added jobs that would enhance Florida's knowledge-based economy.

As result of the high-quality nature of jobs created by the life-science sector, overall average wage per employee and income per capita would rise to $63,076 and $57,917, respectively, by the end of 2017. Income per capita would rise by $1,500[12] more than it would otherwise in the absence of a college of medicine and the life-science cluster.

The total economic impact, valued at $6.4 billion, captures additional wage and salary income, and other business and proprietary revenues, because of structural changes in the regional economy that would take place due to the presence of higher-skilled labor and higher-paying jobs. Mostly, the total impact figure reflects a higher rate of entrepreneurial activities and the formation of technology-oriented firms in the region. Cluster formation would enable the Orlando region to capture a high percentage of value of production (reducing leakage or out-of-region purchase of goods and services) and help build up economic wealth in the Orlando area.

Under COM + Cluster Scenario

At the End of Year 10, Operational Phase

	Baseline	COM+Cluster
Overall Wage Per Employee	$62,570	$63,076
Overall Income Per Capita	$56,399	$57,917

Source: Milken Institute

9. Critical Elements Leading to Life-Science Cluster Development

All the nation's top life-science centers share common attributes that are key to the performance of their clusters. Among them: the presence of a highly skilled work force; extensive research facilities, ranging from medical schools to research centers and parks;

star scientists; and a high concentration of life-science firms. A metropolitan area must have these attributes to establish an economically viable life-science cluster. As discussed earlier, Orlando has many of these attributes.

In their earlier stages, prior to emerging into top life-science centers, universities within these metros played a significant role in luring in R&D dollars and attracting well-balanced mix of faculty. In addition to serving as incubators for business startups, universities act as foundations for research and development and are important factors for attracting firms and industries into a region.

The presence of an R&D-based medical school in conjunction with surrounding biomedical facilities, research parks and life-science firms is among the necessary ingredients to nurture the success and growth of a cluster.

Each metro among the top life-science centers exhibits some area of specialization that acts as the driver for that cluster. For example, San Diego's specialization lies in data imaging, biotech and R&D, while Greater Philadelphia relies heavily on pharmaceuticals. Similarly, Minneapolis' medical-devices industry is responsible for driving its life-science sector.

R&D assets are vital for the life sciences — more so than for many other industrial sectors — primarily because the sector is intensely dependent on basic research, especially in its early stages. The research often takes place at academic research institutions and medical research facilities by biotechnological scientists with substantial public funding. Academic research universities and institutions draw biological scientists, medical engineers, multidisciplinary scientists, research funding and new ideas into biological and medical inventions and products. Hence, a medical school with an R&D program often is a necessary asset in building a life-science cluster.

In a knowledge-based economy, the linkages among firms often consist of talent, human capital, ideas and innovation. The external economies of agglomeration (i.e., firms and groups of talented people congregating in a research center, such as a school of medicine) are critical building blocks in the formation of regional competitiveness. Individual firms or talent will share the burden of costs, as well as the production efficiency at lower costs across the entire industry, benefiting the region and enhancing industry's competitiveness.

Case Study No. 1: The Importance of R&D in San Diego

NIH funding to San Diego's biotech research institutes confirms its dominant position in this critical area. San Diego research institutes were granted $316 million in NIH funding in 2002, or 17 percent of NIH's total funding to research institutes that year. San Diego's major NIH-funded biotech research institutes include the Scripps Research Institute, the Salk Institute for Biological Studies, the Burnham Institute and the UCSD medical school. The life-sciences heavyweight, Scripps Research Institute, alone received $191 million in 2002, the highest NIH-funded biotech institute nationally.[13]

A regional science center such as the Scripps Institute, backed by research-oriented institutions like UCSD and other bio-science and molecular research centers can extend the benefit of external economies of scale. Thus, it is not surprising to see the number of biotech startups affiliated with UCSD, and the many Ph.D.s who have joined local companies. Some have estimated that 95 percent of Ph.D.s from UCSD and San Diego State University enters into private industry in the San Diego area, whereas about 85 percent of Ph.D.s nationwide enters academia.[14] It is clear that the region, both in industry and academic institutions, has formed a new culture, placing a high value on human capital at work, combined with an entrepreneurial spirit.

The San Diego model works almost perfectly from a regional industry-building and economic development perspective, attracting talent from other areas to reinforce and compensate for the shortcomings of the local infrastructure (e.g., the limited number of universities in a small geographical boundary). Through this "enrichment process," San Diego has heightened its capacity to bring in not only talent and a "denser" human capital pool, but along with them, millions of dollars in research funding. This concentration of talent aided the area in attracting bioscience and biotech talent from other regions, including neighboring Los Angeles and Orange counties.

Case Study No. 2: Medical School's Importance to Philadelphia's Life-Science Cluster

Research shows that almost all creative centers are places with a high concentration of educated people and the ability to retain skilled workers.[15] Successful life-science clusters are highly dependent on the quality of medical and technological research, as well as the availability of specially trained research scientists and technicians. The universities therefore form the basic intellectual infrastructure that supports the continued success of the local scientific clusters.[16] Much of the research generated in the Greater Philadelphia area is performed at medical schools and other medical research institutions with substantial federal government R&D support, especially NIH funding. A university's ability to build intellectual capacity by recruiting and retaining world-class scientists lies at the core of this success. Such universities have been the hotbed of technological innovation and entrepreneurship. Most life-science firms trace their intellectual roots and human capital back to these institutions.

The University of Pennsylvania Medical School is one of the oldest and most prestigious in the country. Its network of leading hospitals, exceptional graduate medical programs and highly regarded dental and nursing schools serve as the principal focal point for medical training and research in the Greater Philadelphia area. Penn is the largest recipient of research and development funding in the state, with the largest portion of its research spending directed to medicine and life sciences.[17] The University of Pennsylvania hospital is nationally ranked in 15 categories, including cancer; digestive disorders; ear, nose and throat; geriatrics; gynecology; cardiology and heart surgery; hormonal disorders; kidney disease; neurology; neurosurgery;, ophthalmology; and psychiatry.

Along with other university-affiliated hospitals, such as those associated with the University of Pennsylvania, Temple University and Drexel University, Jefferson Hospital has continued to keep Philadelphia a leading center of research and advanced medical techniques. Drexel University's College of Medicine, in partnership with Tenet Healthcare, manages three of the leading hospitals in Greater Philadelphia. Drexel's College of Medicine is one of the top 100 universities in the country in federal research expenditures.[18] The partnership with Tenet Healthcare allows the university to pool its resources with Tenet's teaching hospitals and attract research funding through managed health-care sources in addition to the pharmaceutical funding most prevalent in the Greater Philadelphia area. A point worth noting is that Drexel was a university without a college of medicine until a decade ago. Its academic reputation largely resided on engineering and biotechnology. The university's decision to acquire and build a medical college, despite the overcrowding of medical schools in the city, validates the assumption that the advancement of life- and bio-science depends on a solid research-based medical school.

10. Clustering and Regional Prosperity

The key element to competitiveness in a global economy is a region's ability to support and enhance the growth of the interrelated industries in which that particular region can specialize. This concentration of interrelated industries is often referred to as a cluster.

"A cluster is a geographic concentration of competing, complementary or interdependent firms with a common need for talent, technology, infrastructure etc. Cluster relationships are dynamic and evolve in reaction to market and other forces."[19] Clusters are a complex network of suppliers, services, support institutions and producers, including governmental and nongovernmental entities, such as universities, patent attorneys and venture capitalists, located in a particular region that drive innovation and the creation of new products, new companies and higher-skilled/higher-wage jobs.[20] These agglomerations of interrelated industries foster wealth creation in a region, principally through the export of goods and services beyond its borders.[21] In essence, forming the concentration of industries or cluster aims to capture higher economic value of ideas, creativity and eventually productions. The fuller and bigger the cluster or industries group, the high economic value a region can capture and quicken building the economic wealth.

Each industry cluster is unique due to differences in industry sector, number and sizes of establishments, purchase-sale linkages, inter-firm cooperation and collaboration, and the strength of its research and development base. "A common misperception of clusters is that they are based upon a single industry. One industry might be at the core of a cluster, but without its partners, it may not endure for long."[22]

The knowledge-intensive life-science industry is driven by the creation, accumulation and exploitation of knowledge. The life-science industry will increase our understanding of diseases, and subsequent development of new, effective drugs and vaccines, thereby

providing careers in cutting-edge R&D, high-tech manufacturing and medical services. As economic activity is increasingly based more on intangible assets, those regions that experience rapid growth of life-science clusters will be those with more innovations, less of which will escape to other regions, or at least will do so at a slower rate.

While clusters do not form overnight, it is imperative to have the right ingredients for industry clustering and technology-based economic development. Without an anchor such as a research-based medical school, the opportunity for building a fully functioning cluster is highly unlikely, as evidenced by the development of leading life-science clusters around the nation.

11. Conclusion: Building a Medical School That Serves Community Needs

Orlando is one of the fastest-growing metropolitan areas in its size class in the country. Additionally, Orlando is one of a few large metropolitan areas that have no research-based college of medicine of their own. Despite this short-coming, Orlando and UCF have fostered a growing technology research-and-development base. Currently, UCF's optic and laser program ranks among the best in the world, competing against programs at MIT, Penn State and Stanford. The program has strong applications in tissue and other medical research and production. It is unlikely that this achievement is by accident. Rather, it is indicative of UCF's ability and capacity to foster, retain and attract world-class researchers. A medical school in the region would be able to cross-pollinate medicine, research from Burnett Biotech Centers and the region's existing life-science firms.

The intrinsic value of building a college of medicine in Orlando is apparent. It serves the needs of the fast-growing metropolitan area where there are nine hospitals. A medical college at the minimum would serve the health-care system as its R&D base and help train physicians, technicians and other medical specialists. Economically, the impact is large, as well. By its 10^{th} year of operation, the estimated contribution of the proposed medical school will create more than 6,000 jobs and generate total economic wealth valued at $1.4 billion. The state and local government will receive tax revenue valued at $81.4 million.

Currently, the Orlando metropolitan area already has many of the necessary attributes for building a vibrant technology-based cluster, including a life-sciences cluster. All that is missing is a research-focused college of medicine. In addition to enriching Orlando's current research base, a college of medicine could act as an anchor for loosely connected research outfits and industry productions. Doing so directly addresses one of the most pressing economic issues Florida faces and is consistent with the goals of state leaders, including Governor Bush.

Building stronger and bigger industry clusters is a self-serving economic development strategy in a race to out-compete other regions. Beyond the bragging right of who dominates in an industry production space, the economic consequences are immense.

Those regions that dominate will be able to extract and exploit the highest value of production, from R&D to production of new products and services. Most critically, talent and human capital tend to migrate to regions that prosper and dominate. Regions that fall behind will lose their human capital base. It is the reality of economic development in United States and around the world.

There is a small yet fast-growing life-science industry in Orlando. The University of Central Florida has fostered numerous small technology firms and outfits, many of them in the life sciences. At this point, the base is weak, compared to such titans as Boston, Philadelphia, San Francisco and San Diego. The region and UCF have a choice to make about building a research-based college of medicine that would complement the growing number of technology firms through its renowned incubating practice, and making a serious attempt to build up industry concentration to host these firms. In doing so, the region can build its technology base, offering many in Orlando the opportunity to participate in higher-paying jobs. The economic outcome of not doing so is even more apparent: other regions may harvest these smaller firms' research products and potentially even lure these firms away.

12. Appendix: Methodology Behind the Economic Impact Analysis

COM Scenario

The starting point for this analysis was the estimated expenditures and budget information provided by UCF. These expenditures were broken down into two categories: the planning and construction period, and recurring operational expense per year, which were examined for the first 10 years of the college of medicine's operation.

During the planning years, $99 million in capital expenditures were assumed to be spent. This amount would go directly toward the building of the college of medicine and the Burnett Biomedical Sciences research facility. Additionally, it would create a significant number of construction jobs, of which only a portion would remain during the recurring years.

In addition to the capital expenditures, it was assumed that the gross funds for the medical school required from the state would total $18.6 million in the first two planning years. In year three, medical school classes are assumed to begin. This starts the period of recurring costs, of which the Milken Institute examined the costs through the first 10 years. The gross costs during this 10-year period were assumed to be $328.8 million ($20.3 million in the first year, up to $37.3 million in Year 10).

		Gross Medical School Funds Required
Planning	Year 1	$6.4
	Year 2	$12.2
Recurring	Year 1	$20.3
	Year 2	$26.3
	Year 3	$28.7
	Year 4	$30.0
	Year 5	$33.7
	Year 6	$37.8
	Year 7	$39.0
	Year 8	$38.2
	Year 9	$37.5
	Year 10	$37.3

Source: UCF

A portion of the gross medical school funds required in any given year after year one is dedicated to sustaining the employment base in the previous year. By applying this methodology, we force our model to capture the net number of additional jobs created given the incremental gross medical school funds required between each period. It also ensures the prevention of double counting.

Starting at the onset of the recurring period, classes were assumed to begin. In the first year, 40 students are assumed to attend the new UCF medical school. This number increases through the period so that by Year 8, the school is assumed to be at capacity,

with 480 students entering each year. Based on UCF's plans, the Milken Institute also assumed that UCF would begin hiring faculty and staff immediately, although this would take the first several years to complete.

The Milken Institute calculated the economic benefit from the school at UCF in three stages. The first stage runs a baseline scenario from which the economic benefits from the college of medicine are benchmarked against an economic forecast of Orlando metropolitan area without a school of medicine. The institute's econometric model was based on Global Insight's (GI) baseline forecast, which runs from 2005 4th quarter through 2017 4th quarter for the Orlando-Kissimmee metropolitan area (comprised of Lake, Orange, Osceola and Seminole counties, as defined by Bureau of Economic Analysis). The baseline scenario projects the future growth in income, wages, population and employment, based on Global Insight's embedded dynamic model framework. GI's baseline forecast is based on historical growth at both state and metro levels.

The second stage estimated the total economic benefits to the Orlando region and the State of Florida from the college of medicine alone, explicitly assuming that the college of medicine did not generate a life-science cluster. These impacts are based on the direct capital expenditures (including the construction of the college of medicine building), salary expenditures for faculty and staff, and expenditures by students who would attend the school.

Because UCF plans on fostering the research aspects of the medical school, it intends to hire faculty with a track record of obtaining federal and private research funding for their projects. The Milken Institute consequently included expected research and development funding as a part of the college of medicine expenditures. As an example, the presence of a college of medicine would attract additional NIH funding, in addition to other types of federal, public and private R&D funding. Historical NIH funding to medical schools in the United States was used to determine the additional NIH funding that would be generated (source: www.NIH.gov).

The college of medicine expenditures and R&D funding generate jobs and incomes that will work their way through the Florida economy, creating positive economic benefits. These benefits are included as the college of medicine's direct economic impact. These direct expenditures are then fed through an economic multiplier model (based on RIMS industry specific multipliers from the BEA) that accounts for all of the indirect benefits generated from the direct college of medicine expenditures.

As an example, when students come to Orlando to attend medical school, they must find apartments, as well as buy food, supplies and other necessities (or luxuries to the extent medical students can afford them). These expenditures become income to local businesspeople, generating higher incomes. The same relationship holds for the new UCF medical school faculty and staff. Additionally, the medical school itself needs supplies and resources that will benefit the state and local economy.

Life-Science Cluster Scenario

Life-science clusters, where they develop, generate strong overall economic growth for the region. Based on the Milken Institute's examination of the top life-science clusters across the country (e.g., Raleigh-Durham, San Diego, Seattle, Austin), it is estimated that a developed life-science cluster's employment has grown at 1.4 percent per quarter in the past 15 years. In attempting to capture a more realistic scenario, which accounts for Orlando's smaller and newer life-science R&D and production base, the Milken Institute assumes a lower life-science growth rate projection for the metro.

It is fair to say that early innovators who were originally involved in the development of the life-science industry exhibited exponential growth. These regions were and still are the locations of star scientists and pioneers, especially in biotechnology. South San Francisco, for example, is referred to as "the birthplace of biotech," thanks to companies like Genentech. To the extent that the sector has begun to mature, newer entrants may not be able to exhibit the same kind of growth. For this reason, the Milken Institute conservatively estimates that a successfully established life-science cluster in the Orlando region could grow 0.9 percent per quarter. The industries that make up the life-science cluster include biotechnology, pharmaceuticals, medical devices, and R&D in the life sciences.

Endnotes

[1] See, for instance: DeVol, Ross C., Wong,P., Ki, J., Bedroussian, A., and Koepp, R., *America's Biotech and Life Science Clusters – San Diego's Position and Economic Contributions*, Milken Institute, June 2004; DeVol, Ross C., Koepp, R., Ki, J., and Fogelbach, F., *California's Position in Technology and Science – A Comparative Benchmarking Assessment*, Milken Institute, March 2004.

[2] DeVol, Ross C., Koepp, R., Ki, J., and Fogelbach, F., *California's Position in Technology and Science –A Comparative Benchmarking Assessment*, Milken Institute, March 2004, pp.13.

[3] Total research expenditures, as defined by AUTM, include expenditures made by the institution in the fiscal year in support of its research activities that are funded by all sources, including the federal government, local government, industry, foundations, voluntary health organizations and other nonprofit organizations.

[4] NIH funding to universities with medical schools accounts for much of this gap.

[5] NIH funding to universities with medical schools accounts for much of this gap.

[6] University of Central Florida

[7] Orlando's successful R&D ventures also include the latest university spin-offs, such as VaxDesign, Forterra and Virtual Reality Medical Center.

[8] Greater Miami as defined by the federal Office of Management and Budget consists of three metropolitan divisions – Fort Lauderdale-Pompano Beach-Deerfield, Miami-Miami Beach-Kendal and West Palm Beach-Boca Raton- Boynton Beach.

[9] DeVol, Ross C., Wong, P., Ki, J., Bedroussian, A., and Koepp, R., *America's Biotech and Life Science Clusters – San Diego's Position and Economic Contributions*, Milken Institute, June 2004, pp. 43.

[10] Note: Data from Harris will vary considerably compared to data from government sources such as the Bureau of Labor Statistics. BLS comprises of establishment employment capturing industry specific employment within the firm rather than capturing the entire firm's employment.

[11] Skoloff, Brian, *Bush: Biotech Key to Economy*, The Miami Herald, Associated Press, Feb. 2006.

[12] Incidentally, the current gap in income per capita between the Orlando and the national average is $1,500.

[13] DeVol, Ross C., Wong, P., Ki, J., Bedroussian, A., and Koepp, R., "America's Biotech and Life Science Clusters – San Diego's Position and Economic Contributions," Milken Institute, June 2004.

[14] Gail Naughton, Dean of San Diego State University's Business School.

[15] Wu, 2005 points out that research shows that increasing the average level of education in a metropolitan area by one grade increases the total factor productivity by 2.8 percent (see: Appleseed Inc., 2003).

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

[17] Federal Reserve Bank of Philadelphia. 2002. *The Industrial Evolution: Two Decades of Change in the Philadelphia Metro Area's Economy*, Philadelphia: Federal Reserve Bank of Philadelphia, p. 13.
[18] http://www.drexel.edu/med/campus/history.asp
[19] Southern Minnesota Initiative Foundation. 2004. Cluster Study. Southern Minnesota Industry Inventory and Cluster Analysis Project. http://www.smifoundation.org/clustergeneralexecsumm04.pdf.
[20] Porter, Michael E. 1998. "On Competition," *Harvard Business Review Book Series, pp. 218-221.*
[21] Kotkin, Joel and Ross C. DeVol. 2001. *Knowledge-Values Cities in the Digital Age*, Milken Institute Research Report, pp. 10-15.
[22] DeVol, Ross C. 2000. *Blueprint for a High Tech Cluster, The Case of the Microsystems Industry in the Southwest,* Milken Institute Policy Brief, pp. 1-6.