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## **CSLA Academic Plan Priorities - Achieving Disciplinary Cohesion**

The College of Science and Liberal Arts is committed to complementary aims: creation of sustainable excellence and identification of opportunities for development. Identification of academic priorities at the present time—to preserve excellence in mathematical sciences and to evolve the bioscience theme in the college—affords the college an opportunity to narrow its focus while working collaboratively to advance its strategic theme of open sourcing knowledge.

The College of Science and Liberal Arts (CSLA) was formed in 1982. It was then known as The Third College because it had been preceded by NJIT's Newark College of Engineering and the New Jersey School of Architecture. In 1986 the College was given its current name as a result of a more sharply defined mission and direction. Growing steadily ever since, CSLA now consists of six academic departments—Biological Sciences, Chemistry and Environmental Science, History, Humanities, Mathematical Sciences, and Physics—all of which are active in fostering the NJIT mission of education, research, economic development, and service. CSLA also hosts the Department of Aerospace Studies, the Rutgers/NJIT Theatre Arts Program, and the Interdisciplinary Program in Materials Science and Engineering (offered jointly with NCE). Devoted to research-based instruction, CSLA offers academic programs from the undergraduate to the doctoral levels, with emphasis on cross-disciplinary interactions.

The college's first strategic plan, which covered the period from September 2004 through June 2009, focused on defining a coherent identity for CSLA that included increasing enrollment and expanding research activities. During this five-year period, enrollment in the College's programs doubled to approximately 10 percent of the university's students. This gain was achieved by CSLA while simultaneously providing a foundational curriculum for all NJIT undergraduate students that delivers 40 percent of total instructional efforts at NJIT. The strategic plan's success is also reflected in the area of external funding. CSLA's contribution has increased dramatically, tripling the amount of expenditures to nearly \$15M by the end of the first strategic planning cycle. As a result, our research activities in mathematical fluid dynamics, mathematical biology, quantitative and computational neuroscience, solar and terrestrial physics, optical science, materials science, kinetics and thermochemistry, and alternative energy are nationally prominent.

CSLA is now in its second strategic planning cycle that will take the College into yet another

level of excellence in education and research by June of 2014. The current plan, available on the CSLA website with other strategic planning initiatives, calls for enhancing undergraduate and graduate education in both quality and quantity and for identifying ways to allow research groups to establish and meet their own unique goals.

The academic plan presented here was constructed with input from all CSLA departments; the initiatives identified have been chosen to complement the priorities articulated as part of College's Strategic Plan developed in 2009 and currently being implemented. Specifically, we aim to advance the creation of sustainable excellence and identification of opportunities for development with focus on two key areas:

- CSLA will preserve excellence in mathematical sciences
- CSLA will evolve the bioscience theme across all its departments

CSLA's role, responsibilities, and history of accomplishments warrant the implementation of such a plan.

### **Preserving Excellence in Mathematical Sciences**

Before 1986, the Department of Mathematical Sciences was primarily a service department with minimal research activities and only two degree programs, the BS in Actuarial Science and the MS in Mathematics. Today, the Department of Mathematical Sciences is a thriving center for education and research. At the undergraduate level, the department offers a Bachelor of Science in Mathematical Sciences including four areas of concentration: applied mathematics, applied statistics, mathematical biology, and mathematics of finance and actuarial science. A BS in Computational Sciences was also recently developed. In addition to a significant responsibility to the general education program, there are five different minors, and two double majors with physics and computer science. Five different masters' degrees are also offered in applied mathematics, applied statistics, computational biology, biostatistics, and mathematical and computational finance. Finally, a PhD in Mathematical Sciences, offered in collaboration with the Department of Mathematics and Computer Science at Rutgers University-Newark, offering applied mathematics and applied probability and statistics tracks, is in place as well.

In 2004, the Department of Mathematical Sciences was designated as one of the three programs to receive a Strategic Initiative Award for a period of three years. The objective of this investment was to enable the department to achieve national and international visibility and recognition. The specific research areas selected within the department were mathematical fluid dynamics and mathematical biology. A major undertaking of this strategic initiative has been the organization of the highly successful annual *Frontiers in Applied and Computational Mathematics conference*, an event that attracts mathematicians and scientists to the NJIT campus from all over the US and other foreign countries. The department met, and in some categories exceeded, all the goals set in the university's strategic planning document, as they continue to press towards increased prominence. It has achieved this goal by assembling one of the strongest groups of applied mathematicians in both excellent research output and high quality doctoral student production in the country. In 2007, Academic Analytics, as reported in the *Chronicle of Higher Education* (Nov. 7, 2007), ranked the Department of Mathematical Sciences as number

10 in the nation based on its faculty's scholarly productivity. In 2008, the department was also ranked by NSF as 38<sup>th</sup> in the nation in "total and federally financed R&D expenditures in the mathematical sciences at universities and colleges, FY 2005–08". In addition to the mathematical biology and fluid dynamics clusters, both being among the strongest of such groups in North America, the department has research strengths in important applied areas of mathematics including electromagnetics, waves and acoustics, applied statistics and biostatistics, all functioning under the auspices of the Center for Applied Mathematics and Statistics.

Attracting research funding is but one criterion for attaining excellence. The Department of Mathematical Sciences not only has a proven record of recruiting top faculty candidates at all ranks, but the department also has in place one of the most active and organized mentoring programs for junior faculty which ensures their success as well as giving them a full appreciation of the demands placed upon them. To this end, the department has rigorous pre-tenure evaluation mechanisms based on established research metrics/productivity and potential long term contributions to the university. The departmental P&T committee has, therefore, opted in a number of cases not to renew the appointments of tenure-track faculty members on such basis. The willingness to make the difficult decision to carefully evaluate junior faculty and their contributions in line with the university's aspirations to become a premier science and technology university is an important characteristic of the Department of Mathematical Sciences that has helped build its strength and visibility. Even in cases of productive faculty members with successful grant funding and publication, the department demands an exceptional level of scholarly work consistent with its desire to achieve increased national prominence and international presence.

*Because the department has recently undergone changes in personnel due to terminations and resignations continued support will be required to ensure that strategic activities and instructional programs will not be compromised.*

### **Evolving the Bioscience Theme in the College**

The quality of the college's academic programs is enhanced by our research activities. As with their academic programs, each department has identified its own areas of interest and strength for its research programs. In addition to these specific research directions in each CSLA department, we have nurtured a thrust in the biosciences that is shared among all departments within the College. Bioscience, as an interdisciplinary field that derives knowledge from biology, chemistry, mathematics, and physics--all present as distinct disciplines within our college--is a natural domain for a CSLA-wide synergy. This common interest at first emerged independently within the departments and was then collaboratively pursued in our first strategic plan, in which we advanced a vision of a unified bioscience theme as a college-wide priority in education and research. This emphasis includes the areas of biology, biochemistry, biofluids, biophysics, biomaterials, biostatistics, mathematical biology, and pharmaceutical chemistry. Emerging complementary themes in the liberal arts—emphasis on the environment in the Department of History (Federated), health communication in the Department of Humanities, and science education in the Program in Science, Technology, and Society—allow the theme of bioscience to serve as an integrative theme across all departments and programs.

In order to augment existing faculty strengths in these areas and to foster resulting synergies, the CSLA departments are eager to maximize their coordinated efforts to build a solid bioscience research and education coalition across their academic disciplines. A comprehensive faculty recruiting strategy under this rubric would allow the college to further its nascent efforts in this growth field in a coordinated effort that will strengthen the whole of CSLA as well as its distinct parts. Moreover, this strategy will foster interaction not only between the departments of CSLA but also across the university.

### Biological Sciences: Nurturing Emerging Strengths

The 21<sup>st</sup> century is being termed the *Century of Biology*. With the sequencing of the human genome, as well as the genomes of other animals, mankind is at the threshold of significant and far-reaching discoveries in the life sciences. In addition to the vast discoveries over the past several centuries, new experimental and quantitative techniques and technologies will profoundly change how we study and view biological systems. Biology is also the unifying category for all life sciences and it continues to be the most common education path for students who seek to enter the health and medical fields, those who aim for a career in the pharmaceutical and biotechnology industries, or for the scientists who wish to focus on research in life sciences. The research activities in bio-related fields at NJIT are some of the most diverse in New Jersey, and the continued expansion of research expertise in these areas will enhance the health and safety of our society, while providing further understanding and better tools for improving treatments in medicine and health.

The Department of Biological Sciences at NJIT is federated with its counterpart at Rutgers-Newark, a strategy which allows for a powerful partnership that combines Rutgers' strength in cell biology with NJIT's strength in computational biology. As such, there is a very close cooperation between the two units on all academic and scholarly matters. The degrees offered by the department include BA-BS, MS, and PhD, all of which awarded jointly with Rutgers-Newark. Enrollment in biological sciences at NJIT has steadily grown since its inception in 2004 as a division of the Department of Mathematical Sciences, and especially since it became a full-fledged department in 2007. This trend appears to be continuing. The current undergraduate student population is about 270, with an expected entering first-year class of approximately 50 FTFT students and approximately 20 transfers. Over forty percent of these students are also matriculated in the Albert Dorman Honors College, constituting the NJIT department with the highest representation in this college. The first cohort of graduate students joined the department in 2006. Since then the PhD student body has tripled, and the MS student number has steadily risen. Until recently, the overwhelming majority of courses taken by NJIT biology students have been offered and staffed by the Rutgers side. A multi-year plan that gives NJIT additional instructional responsibilities is in progress. The department is currently staffed with five faculty members, plus one faculty affiliate with primary appointment in the Department of Mathematical Sciences. Three of the biology faculty have joint appointments in Mathematical Sciences. All six faculty members are strongly active in research. Three university lecturers were recently hired in dual teaching and administrative roles (graduate program administration, laboratory coordination, and pre-health advising).

The cornerstones of the Department of Biological Sciences in education and research are in neuroscience and in ecology and evolution. Both areas, but especially the neuroscience group, are further complemented by members of the NJIT Department of Mathematical Sciences. A similar collaboration is developing with the small biophysics group located in the Department of Physics. The strengths of the NJIT biology group is in quantitative and computational biology, with emphasis on membrane and cellular biophysics, computational neuroscience, computational molecular biology and computational ecology. The department is committed to an interdisciplinary model of research and teaching and acts as a catalyst for excellence in life sciences education and research within CSLA. Thus, there are clearly opportunities for cross-fertilization in academic units such as Biological Sciences, Biomedical Engineering, Chemical, Biological and Pharmaceutical Engineering, Chemistry and Environmental Science, Mathematical Sciences, Physics, Computer Science, Information Systems, as well as areas within history, humanities, and STS.

*Collaboration among NJIT departments and other benchmarked national and international institutions is of natural importance for the continued development and growth of biological sciences on our campus. If such gains are to continue, a sustainable basis of support must be allocated.*

#### Physics: Advancing Existing Strengths

Just as the Department of Mathematical Sciences has achieved national prominence, the Department of Physics has significantly contributed to NJIT's standing in national rankings. The department is a major force in research and education at NJIT. Its faculty, university lecturers, research professors—as well as postdoctoral fellows, graduate students, and, in some cases, undergraduate students—form a strong and accomplished community of scholars. The key historical moment that determined this present success was the formulation of several strategic directions for the department in the 1990s. Among them was the decision to focus on five important areas of physics: solar and terrestrial physics; optics and photonics; condensed matter physics; and materials and device physics. Of prominence is the solar physics group, formed in 1997, which has expanded to cover a comprehensive range of topics in both solar and terrestrial physics. A key reason for the present success of the department is its deliberate and successful efforts in attracting outstanding faculty, dedicated to excellence and achievement, with expertise primarily in these five research areas. More recently, a new area of emphasis—biophysics—has become an important disciplinary interest within the department.

The academic programs in physics, with a balance between fundamental science and application, are aimed at educating students so they may participate in the research and development of novel technologies. The department offers applied physics degrees at the BS, MS, and PhD levels. It also houses the NJIT interdisciplinary Program in Materials Science and Engineering, offered jointly with NCE, awarding degrees at both the MS and PhD levels. In addition to its own degree programs, the department runs a significant introductory physics program for the NJIT community at large, as well as courses at the upper division and graduate levels that are taken by students enrolling in other science and engineering majors. In support of these disciplinary and multidisciplinary areas, it is important to recognize the department's exemplary level of external funding. The Department of Physics alone accounts for roughly sixteen percent of all research

expenditures within NJIT. Last year, NSF funding alone for the department was \$4.3M of the total \$26.95M for NJIT. Based on rankings established by the National Science Foundation, external research funding for the department places it 49<sup>th</sup> among the nation's physics departments at this country's research universities. The success in attracting significant research funds is a testimonial to the constructive spirit that currently exists in the department. Furthermore, by putting in place a mentoring program, the physics Committee on Promotion and Tenure has been able to guide its junior faculty successfully through the process of mentoring early-career researchers. This has resulted in a very healthy environment in the department.

In that biotechnology is an area that produces a growing number of jobs, particularly in New Jersey, the department has developed biophysics specializations at all levels of education. Now, because of student interest, a full undergraduate degree program in biophysics is under development for implementation in spring 2011. Plans to develop double majors in biophysics and biology, as well as in biophysics, biochemistry, and mathematics are also underway. In the area of biophysics, we are presently exerting a strategy that includes these directions: recruiting new faculty; enhancing our collaboration with other departments at NJIT, Rutgers-Newark, and the University of Medicine and Dentistry of New Jersey; and creating an infrastructure for biophysics research, an expansion that is necessary for competitive funding. Additionally, the Department of Physics is already participating in several grant opportunities in biomaterials and biosensors in cooperation with other departments and colleges at the university.

*As is the case with the Department of Mathematical Sciences, however, it must be noted, that the Department of Physics has lost a number of faculty and lecturers due to retirement. In both cases, there is a pressing need for investment if such excellence is to continue.*

#### Chemistry and Environmental Science: Restoring a University Priority

The Department of Chemistry and Environmental Science was formed in 2001 by separating the Chemistry Division from what was then the Department of Chemical Engineering, Chemistry, and Environmental Science. With its NCE base in the original department, the Chemistry Division provided service functions primarily in teaching the freshman chemistry course sequence and additional chemistry courses for chemical engineering majors and other disciplines having such requirements in their curricula. The division also offered undergraduate and graduate degrees in applied chemistry, but did not have a doctoral program until 2000. Formed during a period of economic constraint, the new department suffered and lacked the appropriate resources for an effective launch including the availability of an appropriate main office, operating budget, and support staff. Even meeting their instructional responsibilities seemed unmanageable with fewer faculty and a much smaller teaching assistant allocation; indeed, some chemistry faculty desired to keep a primary affiliation in chemical engineering because of the uncertainties facing the new department. In 2004, three social science faculty with significant interest in environmental issues were integrated into the Department of Chemistry and Environmental Science. Their affiliation at the time was the prior Department of Humanities and Social Science. This small but research-active group now oversees undergraduate courses in environmental policy and also runs the MS program in Environmental Policy Studies and the new Graduate Certificate in Sustainability Policy and Environmental Management. With such

responsibilities, and the desire to give them more flexibility in managing these programs, the department is considering the creation of a separate division for the environmental policy group.

Over the last five years the Department of Chemistry and Environmental Science has developed a clear vision for their growth in education and research that has led to reorienting its academic offerings. As a result, the total enrollment of majors in the department has increased significantly in the last four years. A new MS program in Pharmaceutical Chemistry is flourishing, and if the success of our biology programs is any indicator, the newly developed BS program in Biochemistry will do very well. The department has also recently reorganized their laboratory and instructional functions by increasing oversight, introducing on-line homework in the first-year chemistry program, modernizing the learning center, and adding tutorial support.

The department has always had a solid track record in research. Although the size of the chemistry and environmental science faculty now stands at half the size it once was, they remain remarkably productive in grant-funded activities and PhD mentoring. Future growth areas are expected to be biological research, material science, and nanotechnology. Currently the department has an annual funding on the order of \$2-3M from agencies such as NSF, DOD, US EPA, and NIH. Faculty members have also received prestigious awards such as the Marie Curie and Fulbright Fellowships. Typically, the thirteen departmental faculty publish 30-40 peer-reviewed journal papers and present 50-60 papers per year at conferences and professional meetings. The doctoral student output has ranged between three to five graduates per year. A stronger Department of Chemistry and Environmental Science will be beneficial not only to other CSLA units but also to NCE. The department would like to rebuild a partnership with the Otto H. York Department of Chemical, Biological, and Pharmaceutical Engineering, as well as the Department of Civil and Environmental Engineering to revive environmental research at NJIT, once the largest program in the university. Similar partnerships with the Department of Biomedical Engineering, the bioinformatics group in the Department of Computer Science, and the computational biology group in the Department of Mathematical Sciences are natural.

*The centrality of chemistry to the sciences is a given. And, with the education and research activities in environmental science and engineering, historically areas of strength at NJIT, poised for a revival, an investment that restores the long-term health and strength of the department seems sensible at this point.*

### The Liberal Arts and the Social Sciences: Achieving Cohesion

*Medical humanities*—a term encompassing intricate societal concerns of environmental and health-related matters—offers a cohesive force for the liberal arts within CSLA. Indeed, medical humanities has evolved over the last few decades as advances in medicine, such as the application of stem cell research and nanotechnology, engendered attention to medical ethics from philosophers, theologians, cultural theorists, and social scientists. In the Department of History, emphasis on the history of science, technology, environment, and medicine/health—as well as a new degree emphasis on legal studies—affords a unique opportunity to attract researchers in medical humanities and the history of science in conjunctions with the science departments in the college. Such opportunities are also apparent in the Department of Humanities within the MS in Professional and Technical Communication in the area of health

communication; and the same is also evident in the Program in Science, Technology, and Society in areas such as science education and environmental studies. Evolution of the bioscience theme within CSLA will thus allow each department and program to benefit from planned prioritization of the academic plan.

In conclusion, on June 30, 2010, we presented a prelude document to our academic plan priorities—*Toward an NJIT Academic Plan 2010 - CSLA Component (goal relationships)*—as a way to enhance our college’s strategic plan. As we then wrote, “we remain firmly dedicated to conducting the highest caliber of scholarly research, to providing all undergraduates with the fundamentals needed for lifelong learning through our general education courses, and to preparing the next generation of leaders through a broad array of undergraduate and graduate programs and professional education opportunities.” Preserving excellence in mathematical sciences and evolving the bioscience theme across all CSLA departments will allow further focus of our strategic plan. The faculty and administration in CSLA look forward to working with colleagues across the NJIT campus to identify common areas of advancement through the strategic/academic planning process.