

**Florida International University Ph.D. in Biomedical Engineering  
Division of Colleges and Universities Staff Analysis**

**Recommended Action: Approve Implementation  
Implementation Date: Fall 2004**

**Estimated Costs:**

	Total	% & \$ Current	% & \$ New	% & \$ C&G	Cost per FTE
Year 1	\$213,651	\$117,750 55.1%	\$7,401 3.5%	\$88,500 41.4%	\$41,717
Year 5	\$1,107,056	\$310,550 28 %	\$88,254 8%	\$708,252 64%	\$18,463

**Projected FTE and headcount are:**

	Projected Headcount	Student FTE
<b>First Year</b>	5	3.0
<b>Second Year</b>	13	7.8
<b>Third Year</b>	25	15
<b>Fourth Year</b>	32	19.2
<b>Fifth Year</b>	36	21.6

## Abstract

The Ph.D. Biomedical Engineering (BME) will prepare graduates for industrial or academic research in one (or more) of five areas of specialization: (1) biomechanics, biomaterials, and medical devices; (2) bioinstrumentation and biomedical image/signal processing; (3) drug delivery/tissue engineering; (4) medical physics/nuclear medicine; and (5) bio-nanotechnology. The first two are classic to biomedical engineering, and areas in which FIU has established strengths. The third is a future cornerstone area of biomedical engineering. The fourth and fifth areas are opportunities for a niche of expertise at FIU in areas of increasing importance in intellectual property development for application in clinical practice. Clinical and industrial practice will be integrated into the academic programs through the Biomedical Engineering Partnership Program.

This is the third biomedical engineering Ph.D. program in the State University System. The University of Florida and Florida State University/Florida A&M University offer the other two programs.

The Ph.D. program will require a total of 90 credit hours beyond the BS degree. These credits will be comprised of a minimum of 48 hours in coursework and a minimum of 24 hours of dissertation.

Dr. Thomas Skalak, Professor of Biomedical Engineering at the University of Virginia, was retained as a consultant to review the written proposal. Dr. Skalak stated that the proposal was outstanding and that the proposed program could attract large numbers of highly-qualified Ph.D. students, and this, in turn, should improve recognition of FIU in science and engineering generally, while also improving the positive impact of FIU upon the South Florida biomedical engineering business sector. In his report, he outlined several recommendations in the areas of faculty, coursework, stipends, and facilities.

**1. The proposed program is listed in the current State University System Master Plan, and the goals of the proposed program relate to the institutional mission statement as contained in the Master Plan.**

The proposed Ph.D. in Biomedical Engineering is listed in the Florida SUS 1998-2003 Master Plan. The FIU mission statement includes five key strategic themes that guide the University's development: International, Environmental, Urban, Health, and Information. A program in Biomedical Engineering supports the University's strategic plan for increasing offerings in health-related disciplines, and will also provide a foundation for further development of health-related programs at FIU.

**2. The proposed program does not duplicate other SUS offerings or, otherwise, provides an adequate rationale for doing so.**

The FIU proposal states that the programs at the University of Florida and at the Florida State / Florida A&M Colleges of Engineering are also new and, thus, have modest numbers of students; and that neither has any faculty wholly dedicated with 100% effort to biomedical engineering. The University of Miami, a private university offers a Ph.D. in Biomedical Engineering. That program has 7 faculty and approximately 30 Ph.D. students. The University of Miami and FIU are located in one of the densest regions of biomedical industry within the U.S. Miami-Dade County ranks 10<sup>th</sup> in medical devices employment and 13<sup>th</sup> in pharmaceutical employment with 3,996 and 1,583 employees, respectively.

There are two areas of program emphasis that will be unique to the FIU program – nuclear medicine and bio-nanotechnology.

**3. There is evidence that planning for the proposed program has been a collaborative process involving academic units and offices of planning and budgeting at the institutional level, as well as external consultants, representatives of the community, etc.**

The proposal contains a letter of support from the Advisory Board composed of members of the Biomedical and Clinical communities in South Florida. Faculty for this program come from various engineering programs. One professor comes from the Cardiovascular Engineering Center, and Dr. Renugopalakrishnan, the Eminent Scholars Chair in Biomedical Engineering, will devote 50% of his effort to the proposed program.

**4. The proposal provides a reasonable timetable of events leading to the implementation of the proposed program.**

The proposal indicates a timetable beginning in fall 2000 for planning of the program. Year 2002 and 2003 were used to develop and submit the proposal to the College Curriculum Committee and Graduate Council, Provost, President and Board of Trustees for approval. Date of implementation of this program will be fall 2004, pending approval by the Florida Board of Governors.

**5. The proposal provides evidence that there is a need for more people to be educated in this program at this level.**

According to the U.S. Department of Labor, the number of biomedical engineering jobs will increase by 31.4% through 2010. The rise is in part attributed to the aging population and also to a demand for improved medical devices and systems. FIU resides in one of the densest regions

of biomedical industry within the US. Miami-Dade County ranks 10<sup>th</sup> in the medical devices employment and 13<sup>th</sup> in pharmaceutical employment with 3,996 and 1,583 employees, respectively. South Florida is also the home of the leading manufacturer of generic drugs (IVAX), and contains major divisions of four of the world's largest medical devices companies - Cordis (a Johnson & Johnson Co.), Baxter, Boston Scientific, and Beckman Coulter. Former employees of the businesses as well as founders of small companies that are now divisions of the large corporations also provide a selection of local entrepreneurs. The Beacon Council, the economic development arm of Miami-Dade County, is leading the effort to sustain and grow the local biomedical industry.

Many of the Ph.D. recipients will find opportunities for employment in academic research. Biomedical programs have steadily increased over the last 30 years. There are 70 undergraduate programs and over 100 graduate programs in the U.S. as of spring 2003.

During the last two years, there have been over 50 inquires from Floridians, out-of-state, and international students about the availability of a Ph.D. To assess the demand of current students a questionnaire was sent to students in the Biomedical Engineering BS (major and minor) and MS programs. Out of 110 questionnaires, 61 responded. Of those 45 stated they planned to continue on toward a Ph.D. degree after completion of the Masters.

**6. The proposal contains reasonable estimates of headcount and FTE students who will major in the proposed program. The proposal also provides a signed EEO statement that indicates steps to be taken to achieve a diverse student body.**

The EEO Statement provides information on the enrollment and graduation rates for the past three years, by race/ethnicity and gender of students enrolled in the academic unit that will house the proposed new degree program. The new program is expected to increase the numbers of doctoral degrees awarded to minority and female students in Biomedical Engineering for Florida.

**7. The proposal provides an appropriate, sequenced, and described course of study.**

The Ph.D. program will require a total of 90 credit hours. The credits will be comprised of 48 hours of coursework and a minimum of 24 hours of dissertation. The proposal provides a program of study and descriptions of the courses.

Dr. Skalak, the consultant retained to review the proposal, felt that the curriculum was excellent, with a requirement for learning core knowledge in life sciences and engineering at levels appropriate to the Ph.D. in BME. He stated that the 48 credit requirement might be somewhat excessive for classroom instruction. Many Ph.D. programs nationally have reduced formal course credit requirements to the range of 36-42. He suggested that FIU may wish to examine whether a reduction in course credits will enable higher quality research experiences for the Ph.D. students. Dr. Skalak stated that this might become a practical need, as Ph.D. students are the "engines" of the research grants that this program expects to drive the program forward. As a result, many research-intensive faculty may wish to involve the Ph.D. students earlier and more often in research, thus lessening the material that must be conveyed through traditional classroom instruction. He stated that: (1) thematic areas of instruction in five sub-specialties were excellent; (2) the first four areas had excellent rationales and were in established and important areas of BME; (3) the application areas of cardiovascular, neural, and cancer medicine

are outstanding; and (5) the fifth one in bio-nanotechnology was very good. He felt that specific courses in the areas 1-4 were excellent in terms of breadth and depth, but that areas 5 – bio-nanotechnology could reduce the number of offerings (i.e. 2-3 courses instead of 4). Also, “other new courses” in mathematical modeling could be reduced to about 2. In both cases, he felt the listed courses appeared to be well-conceived.

**8. The proposed program relates to specific institutional strengths such as programs of emphasis, other academic programs and/or institutes and centers.**

FIU received a \$1 million grant from The Whitaker Foundation to formally initiate the biomedical engineering education programs. The BMEI (Biomedical Engineering Institute) was established and the MS in biomedical engineering was implemented. An undergraduate minor in biomedical engineering was initiated for the students enrolled in the combined BS/MS programs. A coalition of local clinical and industry partners have been developed over the past 5 years that has provided ad hoc advice and guidance to the programs as well as clinical rotations and industry internships. In 2001 this coalition was formalized into the Biomedical Engineering Partnership Program. Members of the Partnership Program provide a nominal membership grant (\$5k for large and \$1k for small companies) and receive a seat on the Advisory Board. This program now provides the structural support to the clinical rotations and industry internships for the current combined BS/MS programs. The program also provides opportunities for applied research to graduate students through a program funded by the Coulter endowment called the Research Initiation Program (RIP). This program brings together BMEI faculty and personnel from one of the Partner organizations and provides funding for joint projects that present the potential for discovery, innovation, invention, and future commercialization or other external funding. A proposal has been submitted for a second \$1 million grant from the Whitaker Foundation to help offset program expenses during the start-up years.

Recently FIU was awarded \$600,000 from the National Science Foundation Partnerships for Innovation Programs to fund the following activities associated with the Biomedical Engineering Partnership Program. (1) A Technology Entrepreneurship Competition; (2) a Collaborative Technology Innovation Program and (3) a Technology Entrepreneurship and Innovation Center (a resource for technology transfer activities specifically for biomedical engineering).

The expansion of the biomedical engineering programs will have significant impact on the development of a Medical Physics program in collaboration with the Physics Department; an application for a Research Center at a Minority Institution from the National Institute of Health to establish base infrastructure for biomedical research at FIU; the development of a bioinformatics program in cooperation with the School of Computer Science and the Biological Sciences Department; and, technology entrepreneurship program as a joint enterprise with the College of Business Administration. The College is also embarking on other partnerships with institutions, one being the agreement between FIU and the National Autonomous University of Mexico (UNAM) (300,000 student population). The agreement stipulates research and teaching collaborations between the biomedical engineering program at FIU and the Biomedical Sciences Ph.D. program at UNAM.

**9. If there have been program reviews or accreditation activities in the discipline pertinent to the proposed program, or in related disciplines, the proposal provides evidence that**

**progress has been made in implementing the recommendations from those reviews.**

There have been no formal reviews of the program. The Biomedical Engineering Advisory Board does review the biomedical engineering programs regularly.

**10. The proposal provides evidence that the institution has analyzed the feasibility of providing all or a portion of the proposed program through distance learning technologies via its own technological capabilities as well as through collaboration with other universities.**

Presently, the majority of the program coursework will be provided by standard delivery at the University Park Campus. It is expected that some courses may be offered to remote sites (e.g., other universities, industries, etc.) through either FEEDS or Internet. All courses are expected to utilize the Internet to support teaching activities.

**11. The proposal provides evidence that there is a critical mass of faculty available to initiate the program based on estimated enrollments.**

The proposal states that no additional faculty will be needed to initiate the program, and that the Biomedical Engineering doctoral program already has an adequate number of faculty members in the University to provide a curriculum that has been developed around their strengths. Two additional faculty members may be added, one each in the third and fourth years in order to maintain a high degree of excellence in the biomedical engineering programs. By the fifth year, the Biomedical Engineering faculty will spend an average of 25% of their workload effort on such activities as teaching, research supervision, advising, and committee participation. The affiliated faculty members will spend 5% of their workload on research supervision and teaching.

In the Consultant's report, Dr Skalak stated that the number of faculty (11) was only minimally enough to cover the 5 major areas of Ph.D. education (about 1-2 people per area). He emphasized that new faculty hiring indicated in the proposal would be critical to maintaining a vigorous program in all five areas. Connected with this, expansion into an additional area "bioinformatics" might overload the program. On the other hand, he felt the expansion into the technology entrepreneurship effort with the business school would be an excellent move, considering the strengths of the BME industry-partners program.

**12. For doctoral programs, the proposal provides evidence that the faculty in aggregate have the necessary experience and research activity to sustain the program.**

The faculty has a total of 708 publications (journal papers, conference papers and book chapters). The faculty have served as the major professor on 16 dissertations and been on 34 dissertation committees; served as major professors for 97 thesis/projects and participated on 107 thesis/projects committees. The consultant felt that the faculty was very good and had the expertise needed to provide high-quality instruction and research mentoring in all five areas. He indicated that the faculty had done a great job of creating industrial linkages and that the publication records of most of the faculty were developing and should continue with the new program. Dr. Skalak stated that the replacement for Dr. James Moore, a key faculty member who is no longer at the university, should be a high-quality person.

**13. The proposal provides evidence that, if appropriate, there is a commitment to hire additional faculty in later years, based on estimated enrollments.**

The University is committed to add faculty as the program grows.

**14. The proposal provides evidence that library volumes and serials are sufficient to**

**initiate the program.**

The proposal states that the library currently has sufficient books and serials to launch the proposed program. The total number of volumes related to biomedical engineering currently available in the FIU library is 479. There are also 21 serials related to biomedical engineering currently available in the FIU library that covers a majority of the major journals in the area of biomedical engineering. The proposal also states that in addition to the printed volumes, the FIU library subscribes to 270 online databases, including a number of titles related to the proposed doctoral program. FIU has access to approximately 600 journals in Engineering and related disciplines. The consultant reported that the library resources were excellent.

**15. The proposal provides evidence that classroom, teaching laboratory, research laboratory, office, and any other type of space, which is necessary for the proposed program, is sufficient to initiate the program.**

The proposal indicates that classrooms for lecture courses are provided by the University from general classroom space. The Center for Engineering and Applied Sciences is a 245,000 square foot facility of which the Biomedical Engineering currently occupies 12,133 sq. ft. of office space (3,923 sq. ft.) and laboratory space (8,210 sq. ft.). In addition, the College provides three computer labs for instructional purposes and one walk-in computer lab for students. The College also has three classrooms equipped with recording facilities for the delivery of distance learning courses. There is no additional teaching lab proposed for the program because course offerings do not involve labs. All research work will be carried out in the existing research labs.

The consultant felt that the current 8,000 square feet of laboratory space is barely adequate for initiation of Ph.D. programs for the 11 faculty. He stated that there should be enlargement to about 11,000 square feet that would yield 1,000 square feet per faculty member at a minimum and about 1,500 would be more desirable.

**16. The proposal provides evidence that necessary and sufficient equipment to initiate the program is available.**

Information on current equipment availability is contained in the proposal. As the research level increases, more equipment grants and research grants with provision for new equipment are anticipated to purchase additional equipment. The consultant felt that the equipment was sufficient to initiate the program.

**17. The proposal provides evidence that, if appropriate, fellowships, scholarships, and graduate assistantships are sufficient to initiate the program.**

The proposal provides information with respect to the number of students supported by teaching and research assistantships and also the number of students supported by in-state tuition waivers and out-of-state tuition waivers for 2002/03 and the expected level of support for the 2003/04 year. The proposal indicates that more research assistantships will be available with the research grants.

**18. The proposal provides evidence that, if appropriate, clinical and internship sites have been arranged.**

Internships will not be required. There are sufficient clinical sites for the program. To date, there are over 20 clinical and industry partners active in this program.

**19. The proposal provides evidence that, in the event that resources within the institution are redirected to support the new program, such a redirection will not have a negative**

**impact on undergraduate education.**

The University argues that the proposed program will enhance offerings in several departments by providing additional electives to graduate majors in other engineering disciplines. Students may, in addition, take courses currently being offered by other engineering disciplines.

**20. The proposal provides a complete budget for the program, which reflects the text of the proposal. Costs for the program reflect costs associated with similar programs at other SUS institutions.**

Because the courses and faculty are drawn from the existing programs, minimal additional resources will be needed for initiation. The College of Engineering has already committed to the allocation of assistantships from its Other Personnel Services (OPS) budget and to augment the number of faculty lines through future allocations. The College of Engineering will allocate additional resources from its Education and General (E&G) budget, which will increase as a result of enrollment growth in the program. A large percentage of the E&G funds used to support graduate students in biomedical engineering will go towards the Ph.D. students, and MS students will be supported through external funds. Ph.D. students will only be supported on E&G funds in one year of their studies and otherwise will be funded by Contract and Grant (C&G) funds. A large portion of the remaining costs is only a redirection of effort of existing faculty and staff. Also, a gradual shift in faculty FTE to C&G is included in the costs budget. In the FIU budget there is a \$15,000 stipend and \$10,000 waiver for each student per year, assuming 75% of the total student headcount are full-time, fully supported students. The proposal's tables show a .50 Full-time Equivalent (FTE) new support line for clerical assistance and .50 FTE new line for technical support for the new program. As research grows, the technical support is increased gradually to 1.0 FTE. Contracts and Grants money increases each year from \$88,500 the first year to \$708,252 in the fifth year (64% of the \$1,107,056 cost of year 5).

The consultant felt that the cost for the program was in line with other recently initiated programs. As stated in the proposal, much of the Ph.D. program load will be absorbed by external grants. In his report Dr. Skalak stated that the student stipends of \$15,000 per year were too low by about \$3-5,000 compared to competitive institutions nationally. He felt that stipends at this level would attract local applicants, but not the most competitive students.

**21. The proposal contains evidence that, if appropriate, the institution anticipates seeking accreditation for the proposed program.**

ABET does not accredit Ph.D. programs.

**22. The proposal provides evidence that the academic unit(s) associated with this new degree have been productive in teaching, research, and service.**

The faculty has a total of 708 publications (journal papers, conference papers and book chapters). The faculty have served as the major professor on 16 dissertations and been on 34 dissertation committees; served as major professors for 97 thesis/projects and participated on 107 thesis/projects committees. Faculty vitae provided in the proposal indicate that FIU's College of Engineering is highly productive in teaching and research.