Proposing Institution: South Carolina State University

Program Title: Master of Science in Bioengineering Science
Academic Track / Industry Track

Date of Submission: September 15, 2013

Signature of Executive Officer:

Date 9/13 /2013

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2. Classification

Program Title:	Master of Science in Bioengineering Science
Options:	Academic or Industry Track, 40 hours each
Academic Unit:	Department of Biological and Physical Sciences
Level of degree:	Master of Science
Proposed implementation date:	August 2014
CIP code:	140501
Site:	South Carolina State University, Main Campus
Program qualifies for supplemental Palmetto Fellows Scholarship and LIFE Scholarship awards:	Yes _____ No:_ _X____
Delivery Mode:	Traditional, online, distance

3. Institutional Approval

The following institutional bodies have approved this proposal; their dates of approval are indicated.

Educational Policies Council (5/22/12)
Faculty Senate (5/29/12)
Vice-President of Academic Affairs (5/22/12)
President (5/30/13)
Board of Trustees (9/12/13)

4a. Purpose of the Program

South Carolina State University proposes to develop a new master's degree program in Bioengineering Science (MBES). The proposed MBES will be housed primarily in the Department of Biological and Physical Sciences. The purpose is to establish a graduate program that is interdisciplinary among Biology, Chemistry and Computer Science. It is expected that students from three undergraduate areas - Biology, Chemistry and Computer Science will enroll in this master's program. This represents a substantial pool of potential enrollees. The main goal of this program will be to provide a bridge between undergraduate studies and advanced academic or professional degree programs. There will also be an option for students who seek training for industry employment. The program will develop integrative knowledge in biological, biochemical and biomedical engineering and will focus on the biological and non-clinical biomedical sciences and technologies underlying bioengineering problems. The curriculum is concentrated on various combinations of scientific, mathematical, computational and engineering principles in the analysis and evaluation of bioengineering problems, including applied research in molecular biology, biochemistry, computer science and biomedical science. The program is in collaboration with University of South Carolina (USC) , Medical University of South Carolina (MUSC), and Clemson (CU) and will complement existing programs at those institutions.

The program will include academic (thesis) and industry (nonthesis) tracks. The academic track will prepare students for entry into advanced degree programs leading to professional careers as biologists and biomedical scientists. For students in this track, the MBES will provide opportunities to conduct research with faculty from the collaborating institutions and improve the success of their subsequent applications for advanced

degree programs. The academic track will provide a transition for SC State undergraduates who plan to enter Ph.D. programs and is intended in part to improve the opportunities and success rate of SC State graduates applying for graduate school. It will also increase SC State undergraduates' awareness of graduate school opportunities. The industry track will include training for industry careers in biotechnology, bioengineering and agriculture. Students pursuing this track will serve a one semester internship at a local industry involved with biotechnology. Two industries have agreed to support internships from students in the program – ArborGen, located in Summerville, SC, and Greenwood Genetics, located in Greenwood, SC. Letters of intent from representatives of these industries are included at the end of this application (Part 15, Articulation). This track will enhance employment opportunities in medicine, industry, and agriculture. The program is unique and fills a need at SC State, because no graduate program in the biological sciences or computer science currently exists at SC State and many of its undergraduates enter Master's degree programs at out of state institutions. It is expected that the great majority of the enrollment in this program will be members of underrepresented minority groups. Representation of these groups in scientific professions will increase as a result.

4b. Objectives of the Program

The objectives of the MBES program are:

- to provide an interdisciplinary bridge between biology, computer science, and engineering at the graduate level.
- to address the shortage of underrepresented minorities who pursue the industry employment or the Ph.D. in bioengineering and related fields.
- to increase the number of interdisciplinary and collaborative graduate programs with other research universities in the state.
- to contribute to a well-trained South Carolina workforce in bioengineering sciences.

5. Justification

5a. Need for the Program

The MBES program is designed primarily for students who will pursue professional, (MD degree) or advanced graduate study, (PhD degree) after graduation. It is expected that completion of the program will improve students' academic preparation and rates of acceptance into these programs. Students graduating from the MBES program will have improved their preparation for advanced graduate programs in biology, molecular biology and fields of biology that require computer skills(bioinformatics, structural biology), so a wide range of programs will be available to them. In addition, those MBES graduates who pursue professional degrees would be more competitive on admissions examinations. A greater number of minority students entering graduate and professional programs and successfully completing them will serve the overall goal of increasing minority representation in STEM disciplines. In addition to preparing students for advanced graduate study, this program will prepare students for employment in bioengineering/biomedical industries and governmental agencies related to bioengineering and biotechnology. For students who do not continue their education after completing the MBES program, one of the target employment options will be as a biomedical engineer. According to the U.S. Bureau of Labor Statistics (BLS) Occupational Outlook Handbook, 2013, (http://www.bls.gov/ooh/architecture-and-engineering/biomedical-engineers.htm) a master's degree is now recommended for employment as a biomedical engineer, and is likely to become required. The median pay in this field in 2010 was $81,540 per year. Biomedical engineering employment opportunities nationwide are expected to increase by 62% by 2020, much faster than average. A master's degree will improve the graduate's ability to compete for these positions. Compared to the rest of the nation, South Carolina does not have a high number of biomedical engineering jobs, about 110 according to the BLS. Most of these are in the Charleston and Greenville – Spartanburg areas, which have relatively high employment in these areas compared to national data. The demand in South Carolina is likely to grow as new industry is attracted. A relatively high number of biomedical engineering jobs also exists in North Carolina and Florida, areas of potential employment for graduates. Another potential area of employment is in agricultural and food science technologies, with about 150 jobs in South Carolina, according to the BLS. The BLS projects job growth in this area to be about average (10% by

2020). The outlook for employment for individuals trained in bioengineering sciences in South Carolina looks positive. A search on the website of the SC Department of Employment and Workforce conducted in June 2013 revealed 28 open jobs in the medical and diagnostics laboratory industry group and 26 in the pharmaceutical industry group, both of which would be industries of potential employment for graduates of the proposed program. The need for underrepresented minorities in science and technology fields is expected to increase employment opportunities in South Carolina and nearby states for graduates of the MBES program. Nationally, employment opportunities exist for bioengineering Master's degree holders in the defense and security industries, as well as federal agencies including the Department of Defense, the National Institute of Standards and Technology, the National Institutes of Health, the Food and Drug Administration, the U.S. Department of Agriculture, the U.S. Patent and Trademark Organization and various intelligence agencies. According the University of Maryland's website, the demand for bioengineering graduates in these federal agencies was a central factor in the development of an online Master's in Bioengineering at the University of Maryland (http://www.bioe.umd.edu/media/release.php?id=57).

5b. Centrality of the Program to the Mission

South Carolina State University's proposed MBES degree is entirely consistent with the University's mission statement. These new efforts in bioengineering science described above would merge University goals with twenty-first century technology needs. The MBES degree will advance the overall mission of outreach and economic development as is referenced in the University's mission statement, in part:

> *"SC State University prepares highly skilled, competent and socially aware graduates to enable them to work and live productively in a dynamic, global society. Through technology and traditional methods of teaching and learning, research and service, the University enhances the quality of life of citizens and contributes to the economic development of the state and nation."*

South Carolina State University is a land grant institution with the mission of providing education and service to the citizens of South Carolina. The university does this primarily through affordable quality undergraduate programs, but there are a few graduate programs already in place. The addition of the MBES will increase the graduate programs available, complement an existing Master's in Engineering and Environmental Science, and provide a bridge for graduates to highly technical industry positions or advanced graduate programs. Consistent with the mission of SC State, this will improve the quality of life for the graduates. It will also contribute to the economic development of the state by improving the quality of the workforce to biotechnology industries that relocate to South Carolina. Most of the students in the program are expected to be drawn from underrepresented minority groups. Representation of minority group members in bioengineering and biotechnology professions and degree programs, where they are currently under represented, will increase as a consequence of M.S. degree holders entering the workforce or advanced degree programs.

5c. Relationship of the Proposed Program to Related Programs within the Institution

The proposed program will complement a new M.S. in Energy and Environmental Science that will also be housed in the Department of Biological and Physical Sciences. The MBES will be the first graduate program to integrate the biological, biotechnical and computer sciences. Other master's programs at SC State neither focus on biology nor integrate the sub-disciplines that contribute to bioengineering sciences. The program will contribute to collaboration and cooperation between faculty from biology and computer science.

5d. Similar Programs in the State

M.S. in Biomedical Engineering, USC
M.S. Bioengineering, CU
M.S. in Biotechnology, Claflin University

5e. Similarities and Differences between the Proposed Program and Others in the State, the Region and the Nation

Elements of master's degree programs at USC and CU are similar to the proposed program, and some of their courses are included in this program as part of a statewide collaboration. USC offers a Biomedical Engineering master's degree that is narrower in scope than the proposed program because it is limited to medical application rather than including a more general academic, agricultural or industrial application. The CU Bioengineering program focuses on synthesis of biomaterials, which is not part of the proposed program. The M.S. in Bioengineering at CU is relatively limited with a focus on non-thesis degrees. As with the USC program, the proposed MBES program at SC State would be broader in scope and more general than the CU program. The proposed program is intended to complement the programs at USC and CU, and to broaden the statewide foundation for such programs. One difference between the proposed program and existing ones in the state is that graduates will be prepared to enter a wide range of advance degree programs. Another important difference is that the proposed program includes an industry track for those pursuing employment in biotech and bioengineering industries. Additionally, the HBCU status of SC State would help provide opportunities for minority students in bioengineering sciences. Claflin University in Orangeburg (another HBCU) offers a Master's degree in biotechnology. The Claflin program differs substantially from the proposed MBES program in that it focuses on forensics with a curriculum that overlaps little with that of the MBES.

An internet search for Master's programs in bioengineering returned the one at Clemson and others at Stanford University, the University of California, Berkeley, University of California Los Angeles, University of Illinois Chicago. These are all Ph.D. granting institutions, with a different overall mission than SC State. Most of these programs focus on engineering aspects of the field and/or have a strong applied biomedical component, whereas the proposed program emphasizes biological aspects of bioengineering and is intended primarily for students who intend to pursue higher academic or professional degrees. Other similar programs are strictly biomedical engineering, such as the program at USC, with a narrower focus than the proposed program and an emphasis on medical technology. Nationally, there are few online bioengineering Master's programs. A Google search of online bioengineering programs returned one at the University of Maryland (http://www.bioe.umd.edu/home).

6. Admissions Criteria Specific to the Program

To gain admission to the MBES degree, all applicants must meet the requirements for entrance into SC State's Graduate School. These requirements are detailed in the SC State Graduate Catalog, 2012-2014. In addition to general Graduate School admission requirements, the MBES Program requires the following:

1) Applicants for the MBES program must have a bachelor's degree or higher from an accredited college or university, with competence in a science field related to the chosen area of emphasis. The applicant's undergraduate transcript and GPA must reflect the ability to handle advanced science course work (usually a 3.00 or higher in science courses). Applicant review will occur by a multi-disciplinary team of faculty from the College of Science, Mathematics Engineering and Technology. All applicants must also submit scores from the general GRE; a score of 1000 or above will be preferred.

2) Coursework: one year of Calculus (M153 and 154 or equivalent), Computer Science (C150 or 151 or equivalent), Statistics or Biostatistics (M208 or ENV302 or equivalent), Bioinformatics (CS495 or equivalent), Comparative Anatomy (B201 or equivalent), Vertebrate Physiology (B202 or equivalent) and Genetics (B204 or equivalent). Courses that have not been completed in undergraduate school must be taken within the first year after admission in addition to the required graduate courses.

3) Research: All applicants must demonstrate participation in a supervised undergraduate research experience.

7. Enrollment

7a. Table A – Projected Total Enrollment

PROJECTED TOTAL ENROLLMENT						
YEAR	**FALL**		**SPRING**		**SUMMER**	
	Headcount	Credit Hours	Headcount	Credit Hours	Headcount	Credit Hours
2014 – 15	6	54	6	54	6	36
2015 – 16	12	114	12	90	12	72
2016 – 17	14	132	14	108	14	82
2018 – 19	16	152	16	120	16	96
2019 – 20	16	152	16	120	16	96

7b. Basis for the estimates:
a) This is a two-year program;
b) Six students new to the institution will enroll in the program each year in the first two years, 8 students per year thereafter;
c) New students will enter the program in the fall semester;
d) There will be little if any attrition between academic years;
e) Students will take a full load according to the curriculum below;
f) All students in the program will take summer courses.

Six new students are expected to enroll in the first year. This estimate is based on the pool of biology, chemistry and mathematics graduates who intend to go on to professional or graduate school and would benefit from further preparation. Biology and chemistry majors often indicate an interest in a Master's degree – they would like to 1) have more time or background before making career decisions, 2) increase their preparation for professional or advanced degree programs or 3) improve their employment options with further training. Many enroll in Master's programs in other schools for those purposes, even though they would prefer to stay at SC State. It is anticipated that these students would enroll in the MBES program. Six additional students are expected in the second year. In subsequent years a total of eight new students per year are expected to enroll. Attrition is expected to be low because this is a graduate program and most students will initially be SC State University biology graduates with known background and qualifications. Enrollment is expected to stabilize at around 16.

7b. Source of Students

It is anticipated that all enrollment will be new enrollment. It is not expected that graduate students in the MBES program will move from existing programs and there is no intention to recruit students from existing programs. Initially students will come from SC State University undergraduate programs, but others could come from Claflin or other universities.

8. Curriculum

8a. Outline of Curriculum – 40 Credits

Semester 1		**Semester 2**	
Course	**credit**	**Course**	**credit**
BES 510 – Integrated Bioengineering	2	BES 550 – Bioanalytical Instrumentation	2
BES 520 – Histology	3	BES 540 – Human Anatomy	3
BES 530 – Molecular, Cell & Developmental Biology I	3	BES 531 – Molecular, Cell & Developmental Biology II	3
BES 555 – Seminar I	1	BES 555 – Seminar II	1
Total	**9**	**Total**	**9**

Summer:
BES Elective 1 (distance, online), **3 credits**
BES 670 Bioengineering Field Experiences I, **3 credits**

Semester 3		**Semester 4**	
Course	**credit**	**Course**	**credit**
BES 655 – Capstone - Seminar	1	BES 671 (6 credits) – Bioengineering Field Exp. II (Industry track only)	6
BES 545 – Engineered Physiology	3	or BES 672 (6 credits) – Thesis	
BES Elective 2	3		
BES Elective 3	3		
Total	**10**	**Total**	**6**

Elective Courses and Institutions

Elective Course (choose any 3)	**Credit**	**Institution**
BES 600 -- Computational Structural Biology	3	USC via distance classroom
BES 610 -- Information Flow in Biological Systems	3	SCSU
BES 620 -- Evolutionary Computation and Genetic Algorithms	3	SCSU
BES 630 – Biomedical Basis for Engineered Replacements	3	(SCSU)
BES 660 -- Tissue Engineering	3	CU via distance classroom
BES 640 -- Stem Cell Biology	3	SCSU
BES 650 -- Methods in Bionanotechnology	3	SCSU

8b. New Courses
All of the courses below that are offered at SC State University are new courses that have been developed for the MBES program. The two courses cross listed with USC and CU (BES 520 Histology (USC BIOL J530) and BES 660 Tissue Engineering (CU BIO E 801)) are existing courses that will be integrated into the curriculum.

Course Descriptions (all courses are 3 credits except BES 671 and BES 672, which are 6 credits each, BES 510, which is 2 credits, and BES 555 and BES 655, which are 1 credit each, as shown in the curriculum above)

BES 510 Integrated Bioengineering Science Communication – Topics for this course will include career development, ethics in biotechnology, understanding integrated bioengineering disciplines, science/technical communication, and preparation of manuscripts, grant proposals and scientific presentations.

BES 520 Histology (USC BIOL J530) – Basic human microscopic anatomy of tissues, organs and organ systems.

BES 530/531 Molecular, Cell & Developmental Biology I & II – The study of cell biology. Topics include how and where intracellular and intercellular molecules control cellular functions such as gene expression, secretion, motility, signaling, cell cycle control and differentiation.

BES 540 Human Anatomy/Physiology – The study of the anatomy and physiology of the 11 organ systems in humans. Studies include food processing and nutrient allocation, circulation and respiration, excretion, communication via hormones and nervous transmission, reproduction, behavior, locomotion and support.

BES 545 Engineered Physiology - The course covers engineering aspects of medical physiology, building cells, tissues, organs, and organisms. Methods such as genetic engineering, tissue implantation, organ printing, robotized prosthetics, among others are also covered. Biomedical aspects of engineering a physiological system are emphasized

BES 550 Bio-Analytical Instrumentation – Lecture course covers the fundamentals of instrumental characterization of biological materials and systems including: confocal microscopy, scanning and transmission electron microscopy, quantitative polymerase chain reaction (PCR), electron and x-ray spectroscopy, gas and liquid chromatography, and mass spectrometry.

BES 555 Seminar – A course designed to orient and acquaint a student with current issues and developments in the fields of biomedical sciences and technologies.

BES 600 Computational Biology – Principles of computational modeling of complex biological systems.

BES 610 Information Flow in Biological Systems – This course will convey the basic principles of modern genetics and the relationship between genetic information flow and tissue engineering. Specific components will include the historical development of genetics, gene regulation, and genetic control of development, molecular genetics and genomics.

BES 620 Evolutionary Computation and Genetic Algorithms – Course will address the study of evolutionary computation techniques including genetic algorithms, genetic programming, evolutionary strategies, and evolutionary programming. Topics include representation of individuals (genomes), fitness function, population and evolutionary operations. Different classes of genetic algorithms are covered. The basic

tools for genetic programming are illustrated. The application of genetic algorithms within the sectors of machine learning, classifier systems, electrical engineering, and molecular biology are discussed.

BES 630 Biomedical Basis for Engineered Replacements – This course focuses on forms and functions of major human organs and systems, providing examples of engineering repair and replacement methods, presented in the light of pathologic or traumatic organ dysfunction.

BES 640 Stem Cell Biology – This course will introduce the study of human stem cells, their production and application. Specifically the course will cover topics such as cell cycle regulation, differentiation and activation, the blastocyst and inner mass cells. Different types of stem cells, stem cell therapies, and related ethical issues will also be discussed.

BES 650 Methods in Bionanotechnology - This course introduces concepts in nanomaterials and their use with biocomponents to synthesize and address larger systems. Technological impact of nanoscale systems, synthesis, and characterizations of nanoscale materials are discussed.

BES 655 Capstone - Seminar – A course designed to orient and acquaint a student with current issues and developments in the fields of biomedical sciences and technologies.

BES 660 Tissue Engineering (CU BIO E 801) – Structure and properties of the main classes of materials used in artificial organs and surgical implants; metals, ceramics, polymers, composites, and materials of biological origin; mechanical properties, corrosion, and design.

BES 670 Bioengineering Field Experiences I – In this course student will spend an eight week summer period as a research assistant in an established research laboratory conducting research designed in agreement with the research laboratory director or they will spend eight weeks in a cooperative internship position with a biotechnology or bioengineering industry.

BES 671 Bioengineering Field Experiences II – Limited to students pursuing the industry track only. Students will spend one semester in a cooperative position with a biotechnology or bioengineering industry. The student will be evaluated by the industry supervisor at the end of the semester. Graduation from the program will be contingent on a satisfactory evaluation.

BES 672 MS Thesis – Students write and orally defend a research-based thesis under the direction of an approved research mentor. The thesis and its defense serve as the MS comprehensive examination.

9. Assessment

The following student learning outcomes have been developed for the program:

1) Demonstrate effective communication skills. The students must be able to develop, evaluate and review communication tools such as research proposals, scientific publications and general methodologies on a specific topic.
2) Design, execute and analyze the results of experiments on bioengineering problems.
3) Compose a report or presentation describing original research.
4) Write and defend a thesis (for thesis track students).
5) Demonstrate competency with bio-analytical instrumentation.
6) Evaluate and assess ethical issues in bioengineering sciences.

The assessment of the above student learning outcomes will be measured using a multiple instruments including:

- Projects (individual and group), tests, exams, and/or reports. Details of each of these will be outlined in the course syllabi.
- For students in the thesis track, a thesis which includes the collection of data, observation of data, analysis of data, and conclusion from analysis.
- For students in the industry track, a satisfactory performance report from the industry supervisor of their internship

The program will be assessed through the following metrics:

- Graduation rate (it is expected that at least 50% of a cohort group will graduate annually after the second year).
- Rate of student publication and/or conference presentations (it is expected that there will be at least one publication or conference presentation for each student during the program).
- Employment data for graduates (it is expected that at least 50% of the graduates will obtain employment in industry or acceptance into professional or doctoral programs).
- Employer and alumni survey (a survey will be conducted annually to ascertain the perception among employers and graduates of the extent they believe the program has prepared students for their careers).

10. Faculty

10a. Table B – Faculty List

List Staff by Rank (e.g. Professor #1, Professor #2, Associate Professor #1, etc)	Highest Degree Earned	Field of Study	Teaching in Field (Yes/No)
Professor #1	Ph. D.	Biology	Yes
Professor #2	Ph. D.	Biology	Yes
Professor #3	Ph. D.	Chemistry	Yes
Associate Professor #1	Ph. D.	Chemistry	Yes
Associate Professor #2	Ph. D.	Biology	Yes
Associate Professor #3	Ph. D.	Computer Science	Yes
Assistant Professor #1	Ph.D.	Biochemistry	Yes
Assistant Professor #2	Ph.D.	Biology	Yes
Assistant Professor #3	Ph.D.	Biology	Yes

10b. Any faculty added in support of the proposed program will be required to have a Ph.D. from an accredited program in Biological, Mathematical, Chemical or Bioengineering Sciences as required by the position. In addition they will be required to have postdoctoral experience, presented at a professional meeting and published in a refereed professional journal.

10c. Faculty and administrators in the program will initially be drawn from existing faculty. Faculty in the proposed program will be released from one existing undergraduate course to teach one graduate course. The undergraduate course from which they will be released will be taught by existing adjunct faculty.

10d. As is currently applicable to faculty in all existing programs at SC State University, the MBES faculty will be required to attend annual conferences, topical meetings, and participate in research, consulting, and in curriculum development. Release time is not provided by SC State University, but is paid from research grants. Travel funds for faculty attendance at conferences will be obtained from research grants. Academic Program Coordinators or Department Chairs have a 25%-50% release time respectively in their administrative capacities.

10e. The institutional definition of the full-time equivalent (FTE) for a faculty member per semester in the undergraduate level is as follows:

4 – Course -load = 1 FTE	2 – Course -load = 0.50 FTE
3 – Course -load = 0.75 FTE	1 – Course -load = 0.25 FTE

For the graduate level, the full-time equivalent (FTE) is:

3 – Course-load = 1 FTE	2 - Course-load = 0.67 FTE
1 - Course-load = 0.33 FTE	

10f. Table C: Number and full-time equivalent of administrators, faculty and staff in the M.S. degree in Bioengineering Science program.

UNIT ADMINISTRATORS, FACULTY AND STAFF SUPPORT						
YEAR	**NEW**		**EXISTING**		**TOTAL**	
	Headcount	FTE	Headcount	FTE	Headcount	FTE
ADMINISTRATION						
2014-15	0	0	1	0.25	1	0.25
2015-16	0	0	1	0.25	1	0.25
2016-17	0	0	1	0.25	1	0.25
2017-18	0	0	1	0.25	1	0.25
2018-19	0	0	1	0.25	1	0.25
FACULTY						
2014-15	0	0	6	2.0	6	2.0
2015-16	0	0	7	3.0	7	3.0
2016-17	0	0	7	3.0	7	3.0
2017-18	0	0	7	3.0	7	3.0
2018-19	0	0	7	3.0	7	3.0
STAFF						
2014-15	0	0	1	0.25	1	0.25
2015-16	0	0	1	0.25	1	0.25
2016-17	0	0	1	0.25	1	0.25
2017-18	0	0	1	0.25	1	0.25
2018-19	0	0	1	0.25	1	0.25

During the first year, 6 faculty will teach one course at 0.33 FTE. During subsequent years, 2 faculty will teach two courses at .66 each and 5 faculty will continue to teach one course

11. Physical Plant

No modifications are required to the existing building or facilities as a result of the new MBES program. The MBES program will be housed in the department of Biological & Physical Sciences.

The Biological & Physical Sciences Department is located in Hodge Hall. This includes a new Hodge Hall Annex, the Leroy Davis Annex. The new annex facilities include offices, smart classrooms, an auditorium, teaching laboratories with prep rooms, and research laboratories and totals over 57,000 square feet. Computer science facilities, which will be used in the program, are located in a new 85,000 square foot Engineering building.

12. Equipment

No new equipment will be purchased for the program. Hodge Hall and Davis Hall contain sufficient equipment to support the program. There are four established research laboratories with biomedical, biochemistry, molecular biology equipment available to the program. In addition, a recently established common user biomedical laboratory houses state of the art items of equipment for molecular biology. The new equipment includes a real-time PCR machine, an autoclave / sterilizer, a -80°C freezer, a water purification system for ultra-pure water, a gel scanner and imager, 2 micro balances, a fluorescence microscope, an ice machine, a fluorospectrometer, a UV-VIS spectrophotometer, a sonic dismembrator and a dry ice maker. Equipment in the faculty research laboratories of Drs. David Scott, Waltena Simpson, Rahina Mahtab, Sakuntala Warshamana – Green and Dr. Mahtabbuddin Ahmed, will also be available for use in the program. The major equipment in these laboratories includes an additional real-time PCR machine, 2 -80^{0}C freezers, two table top microcentrifuges, 2 centrifuges, a gel-doc gel photography system, an ultra-pure water filter, a fluorescence microscope, a universal microplate reader and CO_2 incubator for cell culture.

13. Library Resources

The library provides subscriptions and bibliographic electronic databases for current and retrospective information in biology and bioengineering. These databases include millions of peer-reviewed journals and other reference sources for research and study. The databases include:

- Omni File, ACM Digital Library, Academic Search Premier, Dialog, Academic Library, Complete E-Book Collection, JSTOR, ProQuest, and ACM Digital Library.

The databases:

a) supplement the existing print materials for currency;
b) enhance the acquisition of new materials;
c) provide on-site and Internet access; and
d) improve the overall quality areas of the bioengineering collection.

The library uses the following resources and services to support access to quality biology and bioengineering collections:

- Statewide library borrowing available to students and faculty allows individual check-out privileges at more than 55 public, private, and technical college and university libraries in South Carolina.

- PASCAL Delivers allows users to request rapid book delivery using interlibrary loan services from any member library within the state of South Carolina by submitting an electronic request for delivery of a book to their home institution, and receive the books within a 48 hour period.

- Interlibrary loan services are available from more than 58,000 libraries of all types in 115 countries and more than 88 million bibliographic records when materials are not owned by the library. Many interlibrary loan requests for scientific articles can be filled in one day by electronic PDF.

- Community Higher Education Council (CHEC) agreement with Claflin University and Orangeburg-Calhoun Technical College provides interlibrary loan services among the three Orangeburg institutions.

14. Accreditation, Approval, Licensure, or Certification

The MBES is not subject to any specialized or professional accreditation or approved by any state agency other than the Commission on Higher Education (CHE). Also, the graduates of the program are not subject to licensure or certification by any public or private agency.

15. Articulation

Some of the courses included in the curriculum of this program are also taught in similar master's programs at USC and CU. The instructors for the courses from USC and CU will also teach the SC State University courses as distance courses. One course will be team taught with MUSC faculty at MUSC. The distance courses will be taught as a part of an NSF-funded cooperative agreement between SC State, USC and CU (see section 16, Estimate Costs, below), referenced in USC sub-award no. 13-2360, section E2. In addition to collaboration with USC, CU, SC State University has entered into agreements with two local biotech industries (Greenwood Genetics, Greenwood SC and ArborGen, Summerville SC) to accept students in the program as interns to complete a nonthesis track. Letters of support have been obtained from each industry partner. Draft MOUs have been developed with USC and CU for mentoring graduate students and offering online courses. These will be executed upon approval of the program.

16. Estimated Costs and Sources of Financing

The program will be initially funded by an existing Cooperative Agreement with the National Science Foundation ("Research Infrastructure Improvement at SCSU" (NSF/EPSCOR Award EPS-0903795). The initial grant provides stipends for 6 students for the first year. These stipends will be granted to South Carolina residents. Once the grant expires the program is expected to become self-sustaining through tuition and research grants. Initially most students will in state. The tuition rate is $4,629 per semester, for a total yearly rate of $9,258 per student. Out-of-state tuition would generate more revenue. Tuition from the anticipated eventual enrollment of 16 students will support all program costs beyond existing SC State professor salaries, which will be obtained through reallocation from other university accounts. Every effort will be made to maintain affordability to students. Students in the program are likely to eligible for federal financial aid. Some students may be funded through federal grants. One likely source of funding is the National Science Foundation's Bridge to the Doctorate program, available to the state of South Carolina through SC State University as an SC Alliance for Minority Participation (SCAMP) institution.
No "unique cost" or special state appropriations will be requested.

16a. Table D - Costs to the Institution and Sources of Financing.

ESTIMATED COSTS BY YEAR						
CATEGORY	**1st**	**2nd**	**3rd**	**4th**	**5th**	**TOTALS**
Program Administration	18,000	18,000	18,000	18,000	18,000	**90,000**
Faculty Salaries	115,460	200,860	200,860	200,860	200,860	**918,900**
Graduate Assistants	0	0	0	0	0	**0**
Clerical/Support Personnel	8,000	8,000	8, 000	8,000	8,000	**40,000**
Supplies and Materials	5,000	5,000	5,000	5,000	5,000	**25,000**
Library Resources	3,000	3,000	3,000	3,000	3,000	**15,000**
Equipment	0	0	0	0	0	**0**
Facilities	0	0	0	0	0	**0**
Other (identify)	0	0	0	0	0	**0**
TOTALS	**149,460**	**234,860**	**234,860**	**234,860**	**234,860**	**1,088,900**
SOURCES OF FINANCING BY YEAR						
Tuition Funding	55,548	111,096	129,612	148,128	148,128	**592,512**
Program-Specific Fees	0	0	0	0	0	**0**
State Funding	0	0	0	0	0	**0**
Federal Funding	220,000	0	0	0	0	**220,000**
Reallocation of Existing Funds	102,960	164,960	164,960	164,960	164,960	**762,800**
Other Funding (Specify)	0	0	0	0	0	**0**
TOTALS	**378,508**	**276,056**	**294,572**	**313,088**	**313,088**	**1,575,312**

The following calculations were made to estimate costs in the above table.

Faculty salaries are assumed to be the normal salaries for 9 month positions in the Department of Biological and Physical Sciences: assistant professor $58,000, associate professor $62,000, full professor $72,000. An

existing full professor will be assigned the job of Academic Program Coordinator (APC) for the program. The APC will be given 25% release time. If the APC earns about $72,000 in nine months, then 25% of $72,000 is $18,000.

In the first semester, 2 assistant professors will teach at 0.33 FTE each. The assistant professors earn $58,000 per year for a total cost of $38,280. The histology course will be taught at no cost to SC State University as a part of the NSF cooperative agreement with USC described above. In the second semester one course each will be taught by 1 full professor (0.33 X $72,000 annual salary) and 2 associate professors (0.33 X $62,000 annual salary X 2), for a total of $64,680. In the first year adjuncts will be hired to teach the 5 courses taught by professors assigned to the graduate program at $2,500 per course or $12,500 total. The total faculty cost for the first year will be $38,280 + $64,680 + $12,500 = 115,460.

Clerical support, supplies and materials and new library resources (subscriptions to online refereed journals) will bring the total to $149,460.

In the second year, the equivalent of 3 associate professors teaching in Semester 3 at 0.33 FTE each will cost an additional $62,000 over year one. Elective courses from USC and CU (BES 600 -- Computational Structural Biology and BES 660 -- Tissue Engineering) will be offered as a part of the cooperative agreement. After the first year, the cost of these courses will be supported by tuition. Semester 4 is for research or industry internships and no courses will be taught. In year two there will be 3 additional adjunct positions for a total of 8, costing an additional $7,500. In the second year, after the cooperative agreement has expired, histology will be taught on a contract basis for $7,500. It is expected that two students will do research in laboratories at USC or CU and the research advisors at those schools will be compensated at 25% of their summer salary which is typically 2/9 of the 9 month salary. Assuming a salary of $75,000 the cost for this will be (0.25 X 0.222 X $75,000) = $4,200 each or 8,400 total. The total faculty costs for year two and subsequent years will be year 1 (115,460) + $62,000 + 7,500 + 7,500 + $8,400 = $200,860.

Clerical support, supplies and library needs will remain the same.