KU BioE Program Highlights

The mission of the Bioengineering (BioE) Graduate Program is to be a national leader in BioE research, education, and technology transfer. Students work with BioE Faculty affiliates from a wide variety of technical and clinical backgrounds to pursue interdisciplinary research that will solve challenging problems in the field of BioE and lead to the advancement of scientific knowledge. Our priority is academic excellence. The M.S. and Ph.D. degree programs in BioE were approved by the Kansas Board of Regents on March 15, 2007. The first class of nine graduate students started in the Fall 2007 and has grown to forty-one students in the Spring 2010. BioE is attracting top quality graduate students as reflected in the profile of the incoming class: mean GPA is 3.84 and the mean GRE Quantitative score is 734. Four BioE students are currently Self Fellows and two will begin Self Fellowships Fall 2010. BioE speaks directly to KU’s vision for interdisciplinary education since the program is based on the principle that fusion of knowledge from traditionally separated disciplines can lead to creative approaches for solving problems. The Bioengineering Graduate Program reflects the mission statement of KU and its commitment “to offering the highest quality undergraduate, professional, and graduate programs”. The BioE graduate program also speaks directly to the efforts of the KU School of Engineering to become a leader in fundamental discoveries and technologic developments that will solve problems, which have an impact on the health and well-being of individuals across the globe. A critical aspect of this program is the numerous opportunities that are available to the graduates. For example, the U.S. Department of Labor, Bureau of Labor Statistics predicts that while employment of engineers is expected to grow about as fast as the average for all occupations over the next decade (2008-2018), the rate of expected growth for Biomedical engineers is 72%, which is the fastest expected growth rate for any engineering discipline.
Doctor of Philosophy (PhD) in Bioengineering
Master of Science (MS) in Bioengineering

1. What do we do and why do we do it?

We consider our students to be our greatest asset, and working with them to achieve joint success under our mission is our greatest accomplishment. The Kansas Board of Regents approved the PhD and MS degree program in Bioengineering (BioE) on March 15, 2007. The BioE Program at the University of Kansas (KU) SOE provides an excellent intellectual environment for a graduate student. We are committed to educating outstanding interdisciplinary professionals, who are equipped with the background, skills and knowledge to provide twenty-first century leadership in BioE. The first class of 4 doctoral students and 7 master’s students started in Fall 2007 and has grown to 35 students in Fall 2009. Graduate student enrollment in BioE is expected to reach a steady state of 80 total graduate students over the next 5 years.

KU BioE includes six tracks of study: 1) Bioimaging, 2) Bioinformatics, 3) Biomaterials and Tissue Engineering, 4) Biomechanics and Neural Engineering, 5) Biomedical Product Design and Development, 6) Biomolecular Engineering. What is Bioengineering? The National Institutes of Health defines bioengineering as a discipline that "...integrates physical, chemical, and/or mathematical sciences and engineering principles for the study of biology, medicine, behavior, or health. It advances fundamental concepts, addresses topics from the molecular to organ systems levels, and develops innovative diagnosis, and treatment of disease, for patient rehabilitation, and for the improvement of health." Nationally, BioE and Biomedical Engineering (BME) are used interchangeably.

1A. Mission of Unit

Our mission is to be a national leader in BioE research, education, and technology transfer. Students work with BioE faculty affiliates from a wide variety of technical and clinical backgrounds to pursue interdisciplinary research that will solve challenging problems in the field of BioE and lead to the advancement of scientific knowledge.

1B. Unit Goals and Priorities

Our goal is to train the next generation of BioE leaders as researchers, educators and entrepreneurs. Our priority is academic excellence.

1C. Short Mission Statement

KU has Bioengineering to promote discovery and technological advances that will lead to solutions to seemingly intractable problems that have an impact on the health and well-being of the members of our society.

1D. Role of Unit

BioE is directly related to the efforts of the KU SOE to become a leader in fundamental discoveries and technological developments that will solve problems that have an impact on the health and well-being of the population of the USA and across the globe. BioE matches KU’s vision for interdisciplinary education, since the program is based on the principle that fusion of knowledge from traditionally separated disciplines can lead to creative approaches for solving problems.
**1E. Need and Impact Statements**

The BioE degree is a direct response to the ever-expanding biosciences community in the Kansas City and Lawrence areas, the Biosciences Initiative, and the Kansas Economic Growth Act.

BioE targets science and engineering bachelor’s degree holders who seek a career at the interface between science and engineering. Similar programs are well established around the country, with 69 programs recently ranked in the 2010 *Ranking of Graduate Programs in US News & World Report* (USNWR). KU BioE is unique at both the state and regional levels. KU is the only academic institution in the state offering a graduate degree in BioE. Wichita State University plans to offer an undergraduate BioE degree in fall 2010. Only one institution in the Big 12 (U Texas) offers the BioE degree. On average, there are 4-5 requests per month from students seeking information about the BioE program. Coupled with our strong application pool (see details in section 3), these results indicate that KU is taking advantage of substantial student demand for BioE.

National BME statistics reflect the trend of increasing interest in BioE degrees at all levels. The number of BS, MS, and PhD degrees granted in BioE rose significantly between 1999 and 2008 (Fig. 1), with the rate of increase among the very fastest-growing interdisciplinary degree programs in the US. The impressive growth of the KU BioE graduate program (Fig. 2) parallels the national growth trend (Fig. 1). USNWR reports that of the 69 top SOE, all but 8 have a BME department and all but 4 offer a BS in BME. BioE also brings diversity to the SOE. ASEE reports the percentage of BS, MS, and PhD degrees awarded to women (women are underrepresented in engineering) is 18%, 23%, 21.1% in Engineering and 38.6%, 42.8%, 34.9% in BME, respectively.

The U.S. Department of Labor, Bureau of Labor predicts that while employment of engineers is expected to grow about as fast as the average for all occupations over the next decade (2008-2018), the rate of expected growth for Biomedical engineers is 72%, which is the fastest expected growth rate for all engineering.
2. Who does it? Faculty in Profile

BioE has faculty affiliates who are appointed in other departments, rather than faculty assigned directly to BioE. Productive faculty with education and research interests in parallel to the mission of BioE are invited to be affiliates of the program. Expectations of faculty affiliates include offering courses relevant to BioE, willingness to mentor a BioE student in his/her research program, and/or willingness to serve on a BioE committee(s). Sixty faculty (20% female) are currently BioE faculty affiliates; they represent 18 departments, 4 Schools (Engineering, Medicine, Allied Health, College of Arts & Sciences), and 2 campuses.

The Program Director is the student’s default advisor. When the student declares a track of study, the track director is the primary advisor. When the student selects a mentor from the BioE faculty affiliates, the mentor is the primary advisor. Figure 6 shows the distribution of active faculty mentors by home department. The student works with the mentor to establish a research committee and Plan of Study, which must satisfy program requirements and establish the background necessary for the thesis. BioE students take courses from departments across both KU-Lawrence and KUMC campuses.

<table>
<thead>
<tr>
<th>Tracks</th>
<th>Number of Faculty</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioimaging, Track Director: Larry Cook, KUMC</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>- magnetic resonance imaging, magnetic resonance spectroscopy and image processing, photacoustic imaging and biomedical ultrasound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioinformatics, Track Director: Xuewen Chen, KU</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>- biological sequence analysis, structure and function of proteins and nucleic acids, genetic networks and gene expression, molecular evolution and hypothesis generation from large-scale data sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomaterials and Tissue Engineering, Track Director: Michael Detamore, KU</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>- drug delivery, tissue engineering, biosensors, biocompatible materials, hydrogels, microparticle fabrication, gene and protein delivery, biocatalysis and dental materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomechanics and Neural Engineering, Track Director: Carl Luhrs, KU</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>- musculoskeletal biomechanics, neural control, motor control, brain plasticity, biofluids, tissue and joint mechanics, orthopedics, spine, bio-robotics and rehabilitation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomedical Product Design and Development, Track Co-Director: Lisa Friis and Sara Wilson, KU</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>- diagnostic tools, therapeutic devices, and biomaterials with a focus on the context of clinical, business and regulatory environments and product commercialization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomolecular Engineering, Track Director: Marylee Southard, KU</td>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>- diagnostic and therapeutic substance design, tracking of interfacial phenomena, drug metabolism and targeting, design of techniques to analyze and modify cellular function</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Several faculty are involved with multiple tracks of study; total 60*†

2A. Quantitative and Qualitative Indicators

The following summary is based on responses from 33 of the 60 current BioE Faculty Affiliates for the period 1/2007 to 1/2010. 23 males and 10 females replied to the survey; among those whom replied there were 9 assistant, 9 associate, 13 full, and 2 distinguished professors. As a program, BioE cannot nominate a faculty member to the graduate faculty; therefore, BioE recognizes the graduate faculty status as established by the home department. When necessary, BioE assigns affiliate faculty to special status when thesis committee membership is desired for a non-graduate faculty affiliate. Faculty affiliates select their track(s) of affiliation, with the distribution across tracks shown on Table 1.

The following year summary is based on responses from 33 of the 60 current BioE Faculty Affiliates for the period 1/2007 to 1/2010. 23 males and 10 females replied to the survey; among those whom replied there were 9 assistant, 9 associate, 13 full, and 2 distinguished professors. As a program, BioE cannot nominate a faculty member to the graduate faculty; therefore, BioE recognizes the graduate faculty status as established by the home department. When necessary, BioE assigns affiliate faculty to special status when thesis committee membership is desired for a non-graduate faculty affiliate. Faculty affiliates select their track(s) of affiliation, with the distribution across tracks shown on Table 1.

During the first three years of the program, the 33 respondents published a total of 395 peer-reviewed manuscripts, with an average of 4 publications per year. Over $7 million in grants and contracts, with a yearly average of $212K/faculty member, were brought into KU from the following sources: NIH, NSF,
KU-GRF, Royal National Institute for Deaf People, Industry, American Heart Association-Heartland, Oral and Maxillofacial Surgery Foundation, K-INBRE, Arthritis Foundation, State of Kansas, KBA, IAM, ONR, NASA, KCALSI, and DOD. Twenty-two patents were achieved during this time period.

Representative awards and honors for the BioE faculty affiliates: AAAS Fellow, AIMBE Fellow, ASHA Fellow Award for distinguished research & service, Editor’s and publisher (Elsevier) award, featured in Science Careers, Outstanding reviewer for national journal, KU Louise Byrd Graduate Educators Award, Teaching Achievement Award, Bellows Scholar, NSF CAREER Award, Outstanding Educator Award, KU SOE Miller Award for Distinguished Research, KU SOE Miller Award for Distinguished Service, Kemper Fellowship for Teaching Excellence, KTEC Scholar, Gould Award for Distinguished Service in Undergraduate Engineering, Outstanding Woman Educator, KTEC Pipeline Award, Department Undergraduate Teacher of the Year, Miller Scholar, and Chancellor’s Club Research Award.

BioE faculty affiliates are frequently appointed to Editorial Boards: 36% of the respondents serve on editorial boards; these respondents serve on the editorial board for 36 different journals. The affiliates provided 130 invited presentations, 39% were grant reviewers for NIH, 24% were grant reviewers for NSF, and 39% were session chairs at 49 different national/international conferences.

2B. Succession Plan

The BioE faculties come from diverse teaching backgrounds in multiple engineering departments and beyond. Affiliated faculty who work with BIOE students completing graduate degrees include the following areas: including Aerospace Engineering, Chemistry, Chemical & Petroleum Engineering, Civil, Environmental, and Architectural Engineering, Electrical Engineering and Computer Science, Hoglund Brain Imaging Center, KU Cancer Center, Mechanical Engineering, Molecular and Integrative Physiology, Molecular Biosciences, Neurological Surgery, Neurology, Otolaryngology, Orthopedic Surgery, Pathology and Laboratory Medicine, Pharmaceutical Chemistry, Physical Therapy and Rehabilitation Services, Physics and Astronomy, Radiology, Speech-Language-Hearing Sciences and Disorders, and the School of Business. All departments and programs establish their own faculty recruitment strategies in light of successional factors.

3. How well do we do it, and who thinks so?

Table 2 summarizes the student application, admissions, and enrollment statistics for each of the three years. The totals are plotted in Fig. 3, which demonstrates that while the number of applicants is increasing, the number of students admitted is decreasing, and the number of students enrolling remains about 15/year. These data suggest that interest in the program continues to increase, but that the program is becoming more selective and competitive. Mean test scores (GRE, GPA) for the applicants, admits, and enrolls are plotted in Fig. 4, which demonstrates high, and in most cases, increasing GRE and GPA scores.
3A. Test Scores and Entrance Requirements

The background of a sample of the admitted students over the last three years is provided in Table 3. The students primarily come from an engineering background, from universities in the Midwest, with very high scores on the GRE, high GPAs, and a diverse interest in the areas of strength within KU BioE.

**Entrance Requirements.** Admissions to the KU BioE Graduate Program is granted to students who have a superior record of achievement in their previous studies and demonstrate a strong potential for success in advanced level studies.

**Admissions Standards.** The applicant must have a MS degree from an accredited college or university with a minimum GPA of 3.5 (4.0 scale) for the MS program. The highly qualified applicant (GPA>3.75) may apply for admission directly into the PhD program after completing the BS degree. Admissions standards include GRE: V > 500, Q > 700, and A > 4.0. Applicants normally have a BS or MS degree in an engineering discipline, physical sciences, life sciences, or a closely related field. A strong applicant will have outstanding academic credentials, research experience, research interests that fit one of our tracks of study, strong letters of recommendation and a strong potential for advanced study.

**Required Academic Preparation.** Students may enter BioE prior to meeting all the prerequisites if approved by the Admissions Committee. These students must plan to complete the prerequisites during
their enrollment in the program in addition to the requirements for the PhD degree in BioE. Course credits from prerequisites are not applied toward the graduate degree.

Switching from MS to PhD. A BioE MS candidate may request that the Graduate Studies Committee change his/her status to a PhD aspirant. The committee’s decision is based on the student’s letter of intent, academic performance, and the advisor’s support letter.

<table>
<thead>
<tr>
<th>DEG</th>
<th>INSTITUTION</th>
<th>MAJOR</th>
<th>GRE Q</th>
<th>GRE V</th>
<th>GRE A</th>
<th>GPA</th>
<th>TRACKS OF INTEREST</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS</td>
<td>Washington U</td>
<td>BME</td>
<td>800</td>
<td>600</td>
<td>5.0</td>
<td>3.76</td>
<td>Bioproduc, Biomechanics &amp; Neural</td>
</tr>
<tr>
<td>MS</td>
<td>Wright State U</td>
<td>BME</td>
<td>710</td>
<td>500</td>
<td>4.0</td>
<td>3.00</td>
<td>Bioimaging</td>
</tr>
<tr>
<td>BS</td>
<td>Lehigh U</td>
<td>BME</td>
<td>720</td>
<td>610</td>
<td>5.0</td>
<td>4.00</td>
<td>Biomaterials &amp; Tissue</td>
</tr>
<tr>
<td>BS</td>
<td>Wichita State U</td>
<td>Comp Engr</td>
<td>740</td>
<td>450</td>
<td>2.5</td>
<td>3.80</td>
<td>Biomaterials &amp; Tissue</td>
</tr>
<tr>
<td>BS</td>
<td>U Missouri</td>
<td>BioE</td>
<td>690</td>
<td>490</td>
<td>4.0</td>
<td>3.60</td>
<td>Biomaterials &amp; Tissue, Bioproducts</td>
</tr>
<tr>
<td>BS</td>
<td>KU</td>
<td>Envir/Chem Engr</td>
<td>690</td>
<td>650</td>
<td>4.5</td>
<td>3.84</td>
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</tr>
<tr>
<td>BS</td>
<td>U Pittsburgh</td>
<td>BioE</td>
<td>720</td>
<td>430</td>
<td>6.0</td>
<td>3.45</td>
<td>Biomechanics &amp; Neural</td>
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<tr>
<td>BS</td>
<td>CO School of Mines</td>
<td>Biochem Engr</td>
<td>800</td>
<td>620</td>
<td>4.5</td>
<td>3.64</td>
<td>Biomolecular, Biomaterials &amp; Tissue</td>
</tr>
<tr>
<td>BSBE</td>
<td>U Memphis</td>
<td>BME</td>
<td>760</td>
<td>600</td>
<td>4.5</td>
<td>3.9</td>
<td>Biomedical Product Design &amp; Dev.</td>
</tr>
<tr>
<td>BS</td>
<td>Iowa State U</td>
<td>ME</td>
<td>750</td>
<td>560</td>
<td>4.5</td>
<td>3.74</td>
<td>Biomechanics &amp; Neural</td>
</tr>
<tr>
<td>BS</td>
<td>Olivet Nazarene U</td>
<td>Engr</td>
<td>800</td>
<td>580</td>
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<td>3.94</td>
<td>Biomechanics &amp; Neural</td>
</tr>
<tr>
<td>BS</td>
<td>KU</td>
<td>Chem Engr</td>
<td>680</td>
<td>470</td>
<td>3.5</td>
<td>3.88</td>
<td>Biomaterials &amp; Tissue, Biomolecular</td>
</tr>
<tr>
<td>BS</td>
<td>KU</td>
<td>ME</td>
<td>690</td>
<td>510</td>
<td>4.5</td>
<td>3.93</td>
<td>Biomechanics &amp; Neural</td>
</tr>
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<td>3.90</td>
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<tr>
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<td>AE/EPHSX</td>
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<td>630</td>
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<td>Bioproducts</td>
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<td>BME</td>
<td>670</td>
<td>490</td>
<td>5.0</td>
<td>3.77</td>
<td>Biomaterials &amp; Tissue</td>
</tr>
</tbody>
</table>

3B. Financial Support and other Recruitment

Financial support offers (scholarships, fellowships, GTAs, GRAs) are critical for the successful recruitment of high quality graduate students (Table 4). BioE is competing with institutions which typically guarantee five years of PhD support (via fellowships, GTA, and/or GRA). With the exception of the Self Fellowships, KU BioE is unable to make offers comparable to other institutions. BioE has 10 GTA slots which are used to attract new students, although the students typically move into GRA positions within the first three semesters. BioE students have also competed very successfully for Self and IAMI fellowships and for School of Engineering scholarships and fellowships.
Program Awareness. We have adopted a multi-faceted approach to improve program awareness: 1) an up-to-date, informative and engaging program website, 2) Graduate Studies brochure, 3) Email to Science, Technology, Engineering, and Math (STEM) students who have performed well on the GRE, 4) Facebook to connect admitted prospective students to our current students, 5) recruitment booth at the annual BMES conference for direct interaction with prospective students and to meet with leaders in BME, and 6) a yearly multi-day visitation for all admitted domestic students (1 day each at KUMC and KU-L).

3C. Demographics (mean age, number of majors)

The program offers the Doctor of Philosophy (PhD) degree in BioE. During the first semester, the student selects a track of study, an advisor and an advisory committee. The advisory committee guides the student’s development through the Plan of Study within the chosen track and helps the student select and develop a research topic.

The student, in consultation with his/her advisor and advisory committee, develops a Plan of Study and a research program to satisfy the degree requirements, which includes Core, Depth, Breadth and Research credit hours. The student selects from six interdisciplinary tracks of study. Track topic details are provided in Table 1.

Degree and gender statistics are shown in Fig. 5. The total enrollment for the MS program has increased significantly. Enrollment of male students is decreasing, while enrollment of female students is increasing. As the program has become more competitive, it is clear that it is attracting a very talented group of female graduate students. As shown in Table 4, these students come from a variety of strong universities and have earned an array of BS/MS Degrees.

<table>
<thead>
<tr>
<th>Term</th>
<th>Bioe GTA</th>
<th>Dept GTA</th>
<th>GRA</th>
<th>Self Fellows</th>
<th>IAM Fellows</th>
<th>SOE S</th>
</tr>
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<tbody>
<tr>
<td>FA 07</td>
<td>9</td>
<td></td>
<td></td>
<td>1</td>
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<td>$13,153</td>
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<td>1</td>
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<td>3</td>
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<td>1</td>
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</tr>
<tr>
<td>FA 10</td>
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<td>NA</td>
<td>5</td>
<td>3</td>
<td></td>
<td>$21,500</td>
</tr>
</tbody>
</table>

These numbers represent the totals during the specified term, not new offers.

Table 4. Summary of Student Financial Offers

![Figure 5. MS and PhD Enrollment.](image-url)
**3D. Program Productivity**

Upon entering the program, the student is required to declare a track of study and to identify a mentor. The 41 students currently in the program are distributed across the six tracks as demonstrated in Table 1. The distribution of current faculty mentor home departments is shown in Fig. 6 (3 students undeclared).

![Mentor Distribution](image)

**Figure 6. Mentor Distribution.**

BioE students have reported a total of 25 peer-reviewed manuscripts, 33 local/national/international conference presentations, and 1 patent. Four BioE students are currently Self Fellows and two will begin Self Fellowships Fall 2010. Two BioE students are Institute for Advancing Medical Innovation (IAMI) Fellows. Four BioE PhD students have been chosen to receive one year KUMC institutional GRA appointments. Four students have been awarded the Graduate Studies Summer Research Fellowships. One BioE student was selected as 1 of 5 first-ever trainees in the Kauffman Singapore Entrepreneurship Program. One BioE student won the “Best Graduate Student Presentation Award” at the annual meeting of the Society of Physical Regulation in Biology and Medicine. One student was a finalist and received Honorable Mention in the “Master Student Paper” competition at the Summer ASME Conference. Prospective BioE students have been offered, on average, a total of $92K/year from the SOE in addition to the GTA and GRA positions. BioE students have been provided numerous SOE and Graduate Studies travel awards.

### 2. Program Quality Outcomes

#### 4A. Learner Outcomes

Student awards reflect quality. All current BioE graduate students are supported through research assistantship (GRA), teaching assistantship (GTA), or fellowships. The majority of incoming BioE students receive financial support, usually in the form of GRAs, GTAs, and/or fellowships. Students with outstanding undergraduate records may be eligible for a number of special awards, including the Self Fellowship, and BioE Program and SOE scholarships/fellowships. The Self Fellowship provides stipend and tuition with leadership training to outstanding students for four years of graduate study. 12 students received Self awards through fall 2009. Each year, we nominate our students for competitive SOE scholarships and fellowships, with approximately $92K offered each year to attract our best candidates to KU. Our students also apply for funds to attend professional conferences (Graduate Studies at the University and School levels), and apply for a number of external fellowships, including National Science Foundation (NSF), National Institutes of Health (NIH), and American Heart Association (AHA).
fellowships. The foundation of funding for BioE students is the GRA, which is paid for by the affiliate faculty research grants and covers both salary and tuition.

**4B. Satisfaction Surveys**

Why do students choose KU BioE for graduate studies? We recently asked our students to provide a list of the ten reasons they chose KU for BioE. Responses included: 1) KU has many great program tracks and BioE combines them into one, 2) Students can take a wide variety of courses within each track, 3) There are many funding opportunities available, 4) Prestigious faculty, 5) Great laboratories with interesting projects, 6) Great recruiting program, 7) KU BioE accepts many different educational backgrounds including engineering, biology, chemistry, and more, 8) Kansas has a large and growing biotechnology industry, 9) Easy transition from an undergraduate program, and 10) Has a Masters degree program (many BioE programs do not).

KU Research and Graduate Studies also completed a graduate student survey. Based on preliminary analysis of the survey results, BioE was rated at or above the University mean for all questions. Based on the survey, our student's clearly value KU BioE attributes such as the quality of the BioE faculty affiliates and research opportunities, the collaborative environment, the educational flexibility offered by the program, and the administrative support. Detailed suggestions included: easier application materials for funding, more office space, more mixers and optional research laboratory rotations. Advice included: to work closely with the program director, carefully choose an advisor but as soon as possible, take deficiency course(s) prior to entering the program, and explore services offered to graduate students. Positive program attributes included advisor relationship, research projects, support from the director for nontraditional students, friendly faculty, flexibility in course selection, collegiality of the faculty, and mentorship. Negative program attributes included difficulty in finding funding, lack of dedicated office space for BioE, the need for clear expectations for 50% GRA/GTAs, difficulty in scheduling graduate and undergraduate deficiency courses, and the presence of arrogant faculty members. Recommended changes included developing a list of potential employers, more access to desks and funding, more discussion on peer-reviewed literature, requirement of an entrance exam to the program, a more formal process for deciding on a lab and mentor (e.g. lab rotations).

**4C. Placement Rates, Employer Assessments**

The KU BioE program is too new (2.5 yrs) for an analysis of employment statistics.

3. **Overall Quality**

**5A. External Indicators of Quality**

The program is too young to be included in national endeavors to be ranked, but it has the potential to be a top 25 Bioengineering program. BioE enjoys the strong support and wisdom offered by its external advisory committee. This committee did the onsite review and assessment of the BioE graduate program proposal. The committee has expressed delight regarding all metrics of the program development, and disillusionment regarding the limited resources being provided to the program.

5B. **Reflecting on Short Mission Statement**

The BioE program is well positioned to meet its mission goals.

**5C. Overall Assessment of Quality of Academic Programming**

Based upon the collective performance of the faculty and students in the BioE program, we rate the quality of the academic programming as exceptional.

4. **Plans for Advancement in the Program**

The program has grown rapidly and has been very successful at recruiting high caliber students. The focus on academic success will continue while also aggressively pursuing additional resources to
support the program. The individuals leading the BioE must assume responsibility for being effective spokespersons for initiatives that will grow the program.

6A. Targets for Change

Solving the Two Campus Problem. The physical separation of the two campuses (KUMC and KU-L) poses a special challenge to growing a top-ranked interdisciplinary and multidisciplinary program in BioE. Rival institutions have medical and engineering campuses that are physically integrated. Because BioE research is by nature so multidisciplinary, steps should be taken to minimize the transit time for those interested in BioE whenever possible. This can be done through: a) The provision of regular intercampus buses, preferably with in-vehicle wireless internet capability and 110 VAC power outlets for laptop computers. The cost of this transportation could be shared between campuses; b) Official encouragement for the regular use of multimedia/distance learning facilities on each campus so that BioE students and faculty can learn/collaborate without the need to commute whenever possible. This will also require more buildings to be outfitted with multimedia/distance learning facilities. For example, Lawrence students and faculty should be able to listen and participate in KUMC meetings, seminars, symposia and even Grand Rounds lectures without the need to physically travel to KUMC, and vice versa (a goal could be to allow faculty and students to achieve this from their own computers via Microsoft Net Meeting or similar software) c) Block scheduling of classes in order to minimize the number of times students and faculty on both campuses must commute each week. The Intercampus Program in Communicative Disorders is a good model for this with scheduled lectures T/TH on the Lawrence campus and M/W/F on the KUMC campus.

The need for new fundraising initiatives on both campuses. There is a need for targeted fundraising to raise money for pilot research grant funds for new initiatives in BioE and funds to support BioE graduate student research assistants. The partnerships that have been forged as part of the Bioscience Initiatives provide an opportunity to markedly increase biomedical research productivity throughout the I-70 corridor.

The strategies to boost local research include recruiting established scientists, attracting top graduate students, enhancing local university curriculum and graduate programs, and promoting university and hospital partnerships. The bioengineering graduate program is attracting top graduate students, but the individuals leading this program require additional support from both intramural and extramural initiatives to continue their efforts. The leaders of the BioE graduate program are committed to working with the administration in support of the strategies to promote biomedical research productivity. Successful deployment of these strategies is integral to the continued growth and success of the BioE graduate program.

Healthcare and the life sciences are recognized, across the nation, as leading areas for the development of new technologies. Technology transfer in these areas is seen as a revenue stream for the University. Students and faculty members in the BioE program are essential to translating life science and healthcare technologies from the lab to real-world products that benefit society. External advisory board members have indicated that at their institutions BioE leads all programs in technology transfer. The continued growth and success of the BioE graduate program is integral to our ability to stimulate entrepreneurial activities in BioE and biomedical sciences. The program is integral to our ability to attract high-profile grants such as grants from the Coulter foundation, Mann foundation and others. The leaders of the BioE graduate program are committed to working with the administration on both campuses to identify and secure resources to support interdisciplinary and collaborative research that can lead to the creation of globally competitive products and services.

Leadership Team Expansion. Because of the significant growth in the BioE graduate program, plans are being made to expand the leadership team by adding an Associate Director and a Graduate Studies Chair. This will allow the significant administrative load to be shared across additional faculty, allowing those faculty members to maintain active research programs.

5. Evaluation of Future Progress and Successes
The outcomes assessment plan is based upon the stated goals and objectives of the program and is intended to provide the type of data needed to assess the degree to which we meet our goals and objectives. The assessment plan is based upon information provided by the students, executive committee, internal review board, external review board and the Deans of the respective Schools involved in the program.

7A. Unit Metrics

The assessment plan is based upon the following sources:

a) **Graduate Student Evaluations** - All BioE graduate students are asked to provide their perceptions of the strengths and weaknesses of the curriculum. Students are asked to provide a written critique of the program, with special emphasis on issues that were problematic or difficult for the student. This is followed by an unstructured “exit interview” to identify additional issues and to further discuss the topics identified in the critique with the academic program director and associate director.

b) **Student Perceptions** - All BioE graduate students are asked to provide ongoing feedback regarding the program and their progress through the program.

c) **Faculty Evaluation of Students** – The program director, associate director, graduate studies chair, track directors, and the director of the Bioengineering Research Center will meet twice per semester to discuss the accomplishments and progress of the students. The minutes of these meetings will be distributed to all of the faculty participants. A primary goal of these meetings is to identify any problems that either the mentors or the students have experienced and to address these problems before they undermine the student’s success in the program.

d) **Alumni Survey** – All alumni will be surveyed twice: once at 2 years and again at 5 years after graduation. The survey will include present employment, percentage of time spent in research, publications obtained since training, participation in research projects, number of applications sent to funding agencies as co-investigator or PI, and number of applications funded as co-investigator or PI. The program will also request the curriculum vitae of each student as part of this survey.

e) **Faculty Retreats** - In preparation for and following the meetings of the External Advisory Board, faculty will hold brief “retreats” to discuss current progress of the program and to develop plans to enhance student recruitment, training, and performance.

Internal Advisory Board, External Advisory Board, and Deans’ Assessment. The major role of the Internal Advisory Board (IAB) and External Advisory Board (EAB) will be to provide the Program Director (PD), Associate Director (AD), graduate studies chair, track directors and mentors annual outcome assessments of the program. The Deans of the respective Schools involved in this program will provide an assessment of the impact of this program on their respective educational components.

The Internal Advisory Board (IAB) will review the program, recommend changes as needed, and in general, serve as on-site advisors to the PD, AD, graduate studies chair, track directors, and mentors. Under ordinary circumstances, the PD, AD and graduate studies chair will meet with the IAB on three occasions: at the beginning of the fall semester, at mid-year, and at the end of the spring semester. Minutes of each meeting will be recorded and circulated to all track directors and mentors.

The second level of Program Outcome Assessment will be carried out by the External Advisory Board (EAB). The PD, AD, and graduate studies chair will meet with the EAB in a “virtual environment” twice each year. During the fourth year of the program, the members of the EAB will complete an on-site review and evaluation of the program. The Board will prepare a written report of their assessment of the program as well as suggestions for improvement, modifications and deletions. The Board’s report will address those aspects of the program that must be enhanced in order to support the continued growth and success of the program.

The third level of Outcome Assessment will be provided by the respective Deans of the School of Engineering and School of Medicine. In their capacity as Deans at the respective Schools involved in this Program, each will provide an assessment of the impact of the Program on their respective educational components.
Executive Summary

The mission of the Bioengineering (BioE) Graduate Program is to be a national leader in BioE research, education, and technology transfer. Students work with BioE faculty affiliates from a wide variety of technical and clinical backgrounds to pursue interdisciplinary research that will solve challenging problems in the field, and lead to the advancement of scientific knowledge. Our priority is academic excellence. The National Institutes of Health defines bioengineering as a discipline that "...integrates physical, chemical, and/or mathematical sciences and engineering principles for the study of biology, medicine, behavior, or health. It advances fundamental concepts, addresses topics from the molecular to organ systems levels, and develops innovative diagnosis, and treatment of disease, for patient rehabilitation, and for the improvement of health." Nationally, BioE and Biomedical Engineering (BME) are used interchangeably.

The M.S. and Ph.D. degree programs in BioE were approved by the KBOR on March 15, 2007. The first class of 9 graduate students started in the Fall 2007 and has grown to 41 students as of Spring 2010. BioE is attracting top quality graduate students as reflected in the profile of the incoming class: mean GPA is 3.84 and the mean GRE Quantitative score is 734. Four BioE students are currently Self Fellows and two will begin Self Fellowships in Fall 2010. BioE is directly related to KU’s vision for interdisciplinary education because the program is based on the principle that fusion of knowledge from traditionally separate disciplines can lead to creative approaches for solving problems.

The Bioengineering Graduate Program reflects the mission statement of KU and its commitment “to offering the highest quality undergraduate, professional, and graduate programs”. The BioE graduate program also is directly related to the efforts of the KU School of Engineering (SOE) to become a leader in fundamental discoveries and technologic developments that will solve problems, and have an impact on the health and well-being of individuals across the globe. A critical aspect of this program is the numerous opportunities that are available to the graduates. For example, the U.S. Department of Labor, Bureau of Labor Statistics predicts that while employment of engineers is expected to grow about as fast as the average for all occupations over the next decade (2008-2018), the rate of expected growth for Biomedical engineers is 72%, which is the fastest expected growth rate for any engineering discipline.