The Bioengineering Graduate program offers programs of graduate study leading to a professional Masters in Bioengineering (M.B.E.) degree, and the Doctor of Philosophy (Ph.D.) degree. A joint M.D./Ph.D. is offered between the Rice Department of bioengineering and Baylor College of Medicine. Also, a joint M.B.A/M.B.E. degree is offered between the Rice Department of Bioengineering and the Jones School of Management. Few students interested solely in a Master of Science (M.S.) degree are admitted and only under special circumstances.

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Students are advised to consult the Rice University General Announcements book for additional information or changes

Department of Bioengineering
Chair: Jennifer West, PhD
Graduate Academic Affairs Committee Chair: A.G. Mikos, PhD
Updated August 2008
I. THE Ph.D. DEGREE

I.1 Curriculum

The Ph.D. curriculum consists of three components: foundation, supporting, and advanced topics courses. Collectively, they should afford the student broad exposure to her/his chosen field of research interest. The total number of hours required is 30 and the maximum number of hours which can be transferred is twelve (12).

A. Foundation Courses — The following core courses are required for all students:

- Fundamentals of Bioengineering (BIOE 551, 1 credit hour).
- Cell Biology (BIOS 341, 3 credit hours).
- Fundamentals of Systems Physiology (BIOE 572, 3 credit hours).
- Math 381 or a 400 level or higher math course (3 credit hours).
- Design and Analysis of Experiments – Module I (BIOE 548, 1.5 credit hours)
- Design and Analysis of Experiments – Module II (BIOE 549, 1.5 credit hours)
- Training in the Responsible Conduct of Research (BIOE 594, 1 credit hour).
- Life Sciences Entrepreneurship (BIOE 633, 1.5 credit hours).

Students must take a minimum of 5 graduate level BIOE courses.

B. Supporting Courses — Five major tracks that reflect research interests within the Bioengineering department are recognized. Students must elect a specialization track and are required to take three supporting courses in that area, with the exception of the Translational Bioengineering Cancer Research (TBCR) track which requires six courses. Students who have already taken courses substantially similar to any of the required supporting courses may request to substitute an alternate course by submitting a memo to the Graduate Academic Affairs Committee. The Table below presents the five tracks and the corresponding supporting courses.

<table>
<thead>
<tr>
<th>TRACK</th>
<th>TAKE ALL SIX COURSES FROM THE LIST BELOW</th>
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</thead>
<tbody>
<tr>
<td>Translational Bioengineering Cancer Research (TBCR)</td>
<td>• Cancer Biology (MDACC - GS040063)</td>
</tr>
<tr>
<td></td>
<td>• Oncology for Bioengineers: Molecules to Organs (BIOE 661)</td>
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<tr>
<td></td>
<td>• Mechanisms In Cancer Therapeutics (MDACC - GS040213)</td>
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<tr>
<td></td>
<td>• New Technologies for Cancer Diagnostics: Nano-Micro-Macro</td>
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<tr>
<td></td>
<td>• Translational BIOE Seminar (BIOE 585)</td>
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<tr>
<td></td>
<td>• Translational Research (MDACC - GS210232)</td>
</tr>
<tr>
<td></td>
<td>All courses at MDACC except for BIOE 661</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>TRACK</th>
<th>CHOOSE THREE SUPPORTING COURSES FROM THE LIST BELOW</th>
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</thead>
<tbody>
<tr>
<td>Molecular, Cellular and Tissue Engineering (MCTE)</td>
<td>• Biochemical Engineering (BIOE 460)</td>
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<td></td>
<td>• Biosystems Transport Phenomena (BIOE 520)</td>
</tr>
<tr>
<td></td>
<td>• Gene Therapy (BIOE 522)</td>
</tr>
<tr>
<td></td>
<td>• Tissue Engineering (BIOE 620)</td>
</tr>
<tr>
<td></td>
<td>• Pharmaceutical Engineering (BIOE 625)</td>
</tr>
</tbody>
</table>
### TRACKS

<table>
<thead>
<tr>
<th>TRACK</th>
<th>CHOOSE THREE SUPPORTING COURSES FROM THE LIST BELOW</th>
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</table>
| Bioimaging and Optics (BIO)          | • Advanced Biophotonics (BIOE 684)  
                                       | • Fundamentals of Medical Imaging I (BIOE 485)  
                                       | • Fundamentals of Medical Imaging II (BIOE 486)  
                                       | • Supramolecular Biophysics and Bioengineering (BIOE 542)  
                                       | • Molecular Biophysics I (BIOS 551)  
                                       | • Methods of Experimental Physics I (PHYS 537) & Methods of Experimental Physics II (PHYS 538)  
                                       | • Biomedical Engineering Instrumentation (BIOE 383)  |
| Biomaterials, Biomechanics and Tissue Engineering (BBTE) | • Biomaterials Engineering (BIOE 531)  
                                       | • Continuum Biomechanics (BIOE 472)  
                                       | • Extracellular Matrix (BIOE 464)  
                                       | • Polymer Synthesis, Soft Nanomaterial and Nanocomposites (CHEM 597)  
                                       | • Tissue Engineering (BIOE 620)  |
| Computational and Theoretical Bioengineering (CTBE) | • Computational Molecular Bioengineering/Biophysics (BIOE 589)  
                                       | • Methods of Molecular Simulation (BIOE/PHYS 610)  
                                       | • Probability in Bioinformatics and Genetics (STAT 423)  
                                       | • Statistical Mechanics (CHBE 611 or CHEM 520 or PHYS 526)  
                                       | • Systems Biology and Molecular Design (BIOE 515)  |

### C. Advanced Topics Courses —
A large array of advanced specialty courses is available to BIOE graduate students. Each student should select the courses most appropriate for her/his research work with the help of the thesis advisor and the Graduate Academic Affairs Committee.

### D. Graduate Seminar Course —
Students must register for the graduate seminar (BIOE 698 (F) and BIOE 699 (S)) every semester of their first three years of study. Students beyond their third year are not required to attend but are highly encouraged to do so. This course is given on a pass/fail basis only. Attendance at seminars is mandatory unless the absence has been excused in advance by the course administrator. Graduate students may miss up to two seminars per semester. Seminars will be given by leaders from the field of bioengineering. In general, there will be a time scheduled for graduate students to meet with the seminar speaker for an informal discussion. Attendance at these sessions is not mandatory but strongly recommended.

### I.2 Course Requirements

Ph.D. students entering Rice with a bachelor’s degree must take at least 30 semester hours of foundation, supporting and advanced topics courses and maintain a grade point average of at least 3.2. Courses in which a student receives a grade below a B- may not be used to fulfill the coursework requirement. All coursework must be at the graduate level or above. During their first semester in residence, all full-time Ph.D. students must register for at least four advanced courses, not including any taken on a pass/fail basis. Students in the MD/PhD program or students who have received credit for graduate courses taken during their M.S. studies may petition the Graduate Academic Affairs Committee to relax the requirement of registering for four advanced courses during the first semester. After the first semester, students should register for enough advanced courses so that they meet at all times the satisfactory progress requirements outlined in section I.8.
Ph.D. students entering Rice with a master’s degree or students in the MD/PhD program may petition the Graduate Academic Affairs Committee to receive credit for graduate courses taken during their M.S. studies. To do this, students should submit a memo and copies of all relevant transcripts to the Graduate Academic Affairs Committee.

Such credit will not exceed 12 semester hours, and these students must take at least 18 credit hours of advanced courses at Rice. The following restrictions also apply:

a) Each case must be individually approved by the Graduate Academic Affairs Committee based on the work done for the M.S. degree.
b) A student may not count towards the Ph.D. requirements a course which is substantially the same as one completed during M.S. work. The decision as to whether a course is “substantially the same” will be made by the Graduate Academic Affairs Committee.
c) As with all graduate students, the thesis advisor may require further course work if it is considered essential for the thesis research.

MD/PhD students in the Medical Scientist Training Program may waive the following courses: Biochemistry (BIOS 301), Cell biology (BIOS 341), Molecular Biology and Genetics (BIOS 344), Neurobiology (BIOS 421), Endocrinology (BIOS 422), Immunobiology (BIOS 423), Fundamental Systems Physiology (BIOS 572), Integrative Neuroscience Core I (NEUR 511), Integrative Neuroscience Core II (NEUR 512), and Abnormal Behavior (PSYC 332).

Students with prior credit in statistics may petition the Graduate Academic Affairs Committee to waive BIOE 548 and BIOE 549. This petition must be approved by the instructor of BIOE 548 prior to submitting it to the Graduate Academic Affairs Committee for consideration. Each case must be individually approved by the Committee.

Students with an M.S. degree in bioengineering from Rice granted within three years prior to their entry into the Ph.D. program will have all courses taken during their M.S. work at Rice counted toward the 30 hour requirement.

The university minimum requirement for the doctorate degree is 90 semester hours beyond the bachelor’s degree (60 hours beyond the master’s degree). Ph.D. students must earn the additional credits they need for graduation by registering for the thesis research course BIOE 500 (up to 12 credit hours per term) during the terms they are engaged in research.

Departmental policy requires that full-time students be registered for at least 12 credit hours each semester.

I.3 Teaching Requirement

Teaching is a graduate degree requirement. Each teaching assignment is given a value of 0.5 to 1.0 based on the responsibilities (i.e., some classes may only equal one half of a full TA assignment). After their first semester in residence, students may be asked to spend the equivalent of six to ten hours per week on teaching assignments for a total of 3.0 teaching assignments. Teaching assignments usually involve tutoring, leading recitation sections, grading papers or supervising work in the undergraduate laboratory. Note: (a) Students will not have any teaching responsibilities during their first semester in residence. (b) Teaching responsibilities may be assigned for a maximum of classes equaling a total of 3.0 teaching assignments. Students planning to pursue an academic career are encouraged to request more involved teaching assignments.

At the beginning of a teaching assignment, students should meet with their course faculty and discuss expectations and deadlines for the teaching assignment. At the end of the semester, there will be an evaluation of students’ performance in their teaching assignment. If a student receives an unsatisfactory rating, that semester will not count towards the maximum three semester assignment.

I.4 Selection of Principal Advisor and Thesis Topic

The faculty members of the bioengineering department will present their research topics to the first-year graduate students during orientation week to allow time for shadowing during the early portion of the fall semester. Soon after these presentations, students will submit a list of the labs they wish to shadow. PhD students must shadow a minimum of two labs. Towards the end of the Advisor Selection Process (early November), all graduate students
must submit to the GAAC a list with their three top choices of research projects. These three choices must include topics offered by at least two faculty members.

The selection process is coordinated by the department chair and the graduate studies committee in an effort to match the wishes and needs of the students to those of the faculty and to the available funded research projects.

I.5 Ph.D. Qualifying Examination

There is no Ph.D. qualifying examination.

I.6 Progress Report

All graduate students are required to submit a semiannual progress report. The report will be submitted to the bioengineering department office and the members of their thesis committee (see Thesis Proposal section). It should state the student’s progress with completed coursework and research, list any publications or conference presentations by the student, and describe the work planned for the next 6-month period. The due dates are January 31 and July 31.

All graduate students will have a yearly evaluation meeting with their Thesis Committee beginning the year their proposal is approved. Written progress reports will continue to be required at the six month intervals.

I.7 Thesis Proposal

Before the beginning of their fifth semester in residence (excluding summers), Ph.D. students must have completed the following:
 a) Selected a thesis committee,  
b) Prepared a thesis proposal, and  
c) Defended this proposal during a meeting of their thesis committee.

The thesis committee is composed of at least three members. Two, including the committee chair, must be members of the Department of Bioengineering faculty; one member must have his or her primary appointment in another department within the university.

The thesis proposal is a written summary of research progress up to that point and future research plans. This document should contain (as a minimum) the following sections:
 a) Abstract (not to exceed 250 words),  
b) Background with extensive literature survey,  
c) Problem statement,  
d) Research plans and methodology,  
e) Any results obtained up to that point, and  
f) Proposed time-line for completion of thesis research.

Portions of manuscripts or reports to sponsors (if available) could be incorporated in the thesis proposal. The thesis proposal must be distributed to the members of the thesis committee at least one week before the scheduled meeting. This meeting should be viewed as an opportunity to assess the student’s progress and knowledge of the research field, to assure that the student has developed a coherent research plan, and to provide the student with input from the members of the committee in time to incorporate useful suggestions in the thesis research. After the meeting, the thesis advisor should inform the graduate studies committee of the thesis committee’s evaluation of the student’s progress and of any recommended action.

I.8 Internship Opportunity

In addition to course work, students are encouraged to participate in a three- to six-month internship experience. Well received by bioengineering graduate students, the internship program provides an opportunity to gain real-world exposure and/or learn new techniques and tools to apply to their research or gain substantial teaching experience. Students may choose to intern in industry, clinical labs, government national labs, international labs, or
teaching institutions. The internship training program for each student is managed through collaborative interaction between the adviser, the hosting company or lab, and the bioengineering program.

I.9 Satisfactory Progress

Ph.D. students are expected to make continuous and satisfactory progress towards fulfilling their degree requirements. Satisfactory progress is defined as follows:

- By the end of the 1st semester in residence, Ph.D. students must have at least 12 semester hours of graduate courses (excluding courses taken on a pass/fail basis);
- They must maintain a GPA of 3.2 or better;
- After their 1st semester in residence, students must work on their thesis research on a full-time basis;
- They must submit their progress reports by the deadlines;
- They must submit and successfully defend their thesis proposal before the beginning of their fifth semester in residence; and
- Satisfactory evaluation of all TA assignments (maximum of three).

Students who fail to meet any of the above requirements will receive letters of warning. GPA falls below 3.2 for two consecutive semesters excluding the summer semester the student’s stipend will be suspended and the student will become responsible for tuition cost until the student’s cumulative GPA gets above 3.2. At that point, the advisor will have the prerogative to dismiss the student. In cases of egregious failure to maintain satisfactory progress a student’s fellowship may be terminated. Decisions to reduce or terminate student stipends will be made on a case-by-case basis. The graduate studies committee, the thesis advisor and the department chair will consider all the factors that may have affected a student’s performance before reaching such a decision.

I.10 Approval of Candidacy and Final Oral Examination

All Ph.D. students must submit a petition for approval of candidacy through the department chair to the Office of Graduate Studies. Since this petition must reach the Office of Graduate Studies before November 1 of the academic year in which graduation is expected, the students must fill the necessary departmental forms at least one week before that deadline. Final approval will come from the Associate Provost and is valid for four years. After a student's candidacy has been approved and upon completion of his/her research project the student must schedule, in coordination with his/her research advisor, a public oral examination for the defense of his/her thesis.

I.11 Acceptance of the Thesis

The completed thesis must be submitted in either final or advanced draft form to the members of the thesis committee at least two weeks before the oral examination. In the course of this examination, the thesis committee members may recommend revisions or additions, which must be incorporated in the final thesis, which is then signed by all committee members. Within one calendar year of passing the oral examination, the student must submit two copies of the signed, final thesis to the Office of Graduate Studies. Final approval of the thesis is by the Associate Provost.

II. THE MASTER OF BIOENGINEERING (M.B.E.) DEGREE

The M.B.E. is a non-thesis degree that provides students with greater depth in their bioengineering training to advance their career objectives. Curriculum must be approved by the Graduate Academic Affairs Committee and the Bioengineering Department. This is done on a case-by-case basis and includes:

- Complete 30 semester hours of Foundation, Supporting and Advanced Topics courses with 15 credit hours from:
  - Intro to Partial Differential Equations (MATH 381) or a 400-level or higher MATH, STAT, or CAAM course
  - Fundamentals of Systems Physiology (BIOE 572), Design & Analysis of Experiments – Module I (BIOE 548), Design & Analysis of Experiments – Module II (BIOE 549), Cell Biology (BIOS
341) (Students with prior courses in statistics may petition the Graduate Academic Affairs Committee to waive BIOE 548. This petition must be approved by the instructor of BIOE 548 prior to submitting it to the Graduate Academic Affairs Committee for consideration. Each case must be individually approved the Committee.)

- One additional engineering course, and
- Two additional courses approved by the Graduate Academic Affairs Committee.

- Maintain an average GPA of 3.0 or higher.

III. THE JOINT MASTER OF BUSINESS ADMINISTRATION/MASTER OF BIOENGINEERING (M.B.A./M.B.E.) DEGREE

The Jesse H. Jones Graduate School of Management and the Department of Bioengineering offer an M.B.A./M.B.E. degree program. Curriculum must be approved by the Graduate Academic Affairs Committee and the Department of Bioengineering. This is done on a case-by-case basis and includes:

- Complete a total of 63 credit hours (39 toward the MBA; 24 toward the MBE). At least 15 of the 24 credit hours of the MBE portion must be taken from Foundation, Supporting, and Advanced Topics courses.
  - Intro to Partial Differential Equations (MATH 381) or a 400-level or higher MATH, STAT, or CAAM course;
  - Fundamentals of Systems Physiology (BIOE 572), Design & Analysis of Experiments –Module I, (BIOE 548), Design & Analysis of Experiments – Module II (BIOE 549), Cell Biology (BIOS 341); and Students with prior credit in statistics may petition the Graduate Academic Affairs Committee to waive BIOE 548. This petition must be approved by the instructor of BIOE 548 prior to submitting it to the Graduate Academic Affairs Committee for consideration. Each case must be individually approved the Committee.
  - One additional engineering course approved by the Graduate Academic Affairs Committee.

- Maintain an average GPA of 3.0 or higher.

IV. THE M.S. DEGREE

Few students interested solely in the M.S. degree are admitted and only under special circumstances. M.S. students must satisfy the departmental and university course requirements, fulfill the teaching requirement, complete a research project, write a thesis and successfully defend their work in a public oral examination.

IV.1 Course Requirements

M.S. students must take at least 18 semester hours of foundation, supporting and advanced courses as outlined in section I.1 above. A grade point average of 3.0 must be maintained at all times.

The university minimum credit requirement for the M.S. degree is 30 semester hours. M.S. students must earn the additional credits they need for graduation by registering for the master’s research courses BIOE 600 during the terms they are engaged in research. Departmental policy requires that full-time students be registered for at least 12 credit hours each semester.

IV.2 Teaching Requirement

All M.S. students must fulfill the teaching requirement as described in Section I.3 for Ph.D. candidates unless the student receives no departmental support during the M.S. study. If the student receives no departmental support the student does not need to fulfill a teaching requirement.

IV.3 Thesis Requirements

M.S. students should select a thesis advisor and research topic according to the same procedure outlined in Section I.4 for Ph.D. candidates. Each student must complete a research project, write a thesis and successfully defend his/her work in a public oral examination.
All students seeking the M.S. degree must submit a petition for approval of candidacy through the departmental chair to the Office of Graduate Studies. Since this petition must reach the Office of Graduate Studies before March 1 of the academic year in which graduation is expected, the students must fill the necessary departmental forms at least one week before that deadline. Final approval will come from the Associate Provost and is valid for two years. The final oral examination in defense of the M.S. thesis can be given only after the candidacy has been approved.

A committee for the oral examination, known as the thesis committee, is selected at the time the candidacy is approved. The thesis committee is composed of at least three members. Two, including the committee chair, must be members of the Department of Bioengineering faculty. The thesis must be given to the committee members one week before the thesis defense.

III. FINANCIAL SUPPORT

Students who receive a stipend in support of their graduate work are expected to devote full-time to their studies and are not to take outside employment. Full-time for first-year students during their first semester of study is considered to consist of four or more advanced courses. During the first semester of study graduate students observe the same holiday schedule as other students engaged in course work. Subsequently, students engaged in research receive two weeks paid vacation annually, in addition to designated staff holidays.

III.1 Support Limitation Rule - Progress Report

The normal limit of financial support for graduate students is ten semesters (excluding summers). Students who anticipate taking longer than 10 semesters for completion of the Ph.D. degree, must submit an additional progress report. This report need not be lengthy but should (a) summarize work accomplished since the presentation of the thesis proposal, (b) provide specific information on research work remaining to be done and (c) indicate the estimated time for completion. Again, manuscripts, reports and even chapters of the thesis already written could be included.

The complete progress report should be submitted to the thesis committee no later than one month before the end of the tenth semester in residence. The thesis committee shall consider the report, the recommendation of the thesis advisor, and take into consideration the availability of funds and then convey to the Graduate Academic Affairs Committee its evaluation of the student’s progress. This evaluation should contain a recommendation on whether the student’s support should be terminated after ten semesters or whether exceptional circumstances exist which justify continued funding. In the latter case, a specific period for continued support, not to exceed one year in duration, shall be included in the recommendation.

The graduate studies committee will review the thesis committee’s recommendation and, in conjunction with the thesis advisor and the department chair, make a decision.

IV. OTHER REGULATIONS

All graduate students are expected to maintain continuous enrollment, unless official leave of absence has been granted. Failure to register for any period without a leave of absence granted by the Associate Provost constitutes de facto withdrawal. If a student later wishes to resume study, reapplication is required. Readmission is given only on the recommendation of the department and the approval of the Associate Provost.

Leave of absence is granted only by the Graduate Office upon the recommendation of the department, and is granted only to students in good standing with the University. Leave must be approved in advance of the academic semester in question; it will not be granted after the student has registered for courses or after the registration period has passed. Normally, leave of absence is granted for no more than two consecutive semesters. No work toward a degree may be done at Rice or involve Rice faculty (or facilities) during a student's leave of absence.
Suggested Timeline for Ph.D. Students

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<thead>
<tr>
<th></th>
<th>First year, Fall Semester</th>
<th>Second year, Fall Semester - Summer</th>
<th>Third Year</th>
<th>Fourth - Fifth year</th>
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<tbody>
<tr>
<td></td>
<td>Register for at least four graduate courses and the following:</td>
<td>Select Thesis committee for thesis proposal exam</td>
<td>Teaching Assistantships completed</td>
<td>Prepare Thesis</td>
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<tr>
<td></td>
<td>Register for Special first-year student seminar course (BIOE 551),</td>
<td>Thesis Proposal – Must be completed by the beginning of the 5th semester</td>
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<td>Defend/present Ph.D. thesis to committee (members of the thesis committee must receive the dissertation two weeks in advance of defense.)</td>
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<td>Register for The Graduate Seminar course (BIOE 698),</td>
<td>Begin Teaching Assistantships at beginning of second semester.</td>
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<td>Register for Ethics in Research Course (BIOE 594).</td>
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<td>November 2008 – Deadline for submission of thesis (top three choices ranked)</td>
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<tr>
<th>Year 1</th>
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<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
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<tr>
<td>Fall</td>
<td>Spring</td>
<td>Summer</td>
<td>Fall</td>
<td>Spring</td>
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Advisor Selection Process By end of May 1

Thesis Proposal

Teaching
Must complete three teaching assistantships

Thesis Defense
Usually between 4th and 5th year