March 28, 2008

MEMORANDUM

TO: Herbert Rabin
Interim Dean, A. James Clark School of Engineering

FROM: Phyllis Peres
Associate Provost for Academic Planning and Programs

SUBJECT: Proposal to establish a dual M.S. in Bioengineering – M.D. degree program with the University of Maryland, Baltimore (PCC log no. 07036)

On March 7, the Senate Committee on Programs, Curricula and Courses approved your proposal to establish a dual M.S. in Bioengineering – M.D. degree program with the University of Maryland, Baltimore. A copy of the approved proposal is attached.

The approval is effective Fall 2008. The College should ensure that the degree program is fully described in the Graduate Catalog and in all relevant descriptive materials, and that all advisors are informed.

CWR/

Enclosures

cc: Carmen Balthrop, Chair, Senate PCC Committee
Sarah Bauder, Office of Student Financial Aid
Mary Giles, University Senate
Barbara Hope, Data Administration
Denise Nadasen, Institutional Research & Planning
Anne Turkos, Archives
Linda Yokoi, Office of the Registrar
Mary Ann Ottinger, Graduate School
Gary Pertmer, A. James Clark School of Engineering
William Bentley, Chair, Fischell Department of Bioengineering
THE UNIVERSITY OF MARYLAND, COLLEGE PARK
PROGRAM/CURRICULUM PROPOSAL

DIRECTIONS:
- Provide one form with original approval signatures in lines 1 - 4 for each proposed action. Keep this form to one page in length.
- Early consultation with the Office of the Associate Provost for Academic Planning & Programs is strongly recommended if there are questions or concerns, particularly with new programs.
- Please submit the signed form to Claudia Rector, Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus.
- Please email the rest of the proposal as an MSWord attachment to pcc-submissions@umd.edu.

DATE SUBMITTED 1/16/08

COLLEGE/SCHOOL ENGR

DEPARTMENT/PROGRAM BIOE

PROPOSED ACTION (A separate form for each) ADD ___ DELETE ___ CHANGE X

DESCRIPTION (Provide a succinct account of the proposed action. Details should be provided in an attachment. Provide old and new sample programs for curriculum changes.)

We are proposing to package our existing MS degree in Bioengineering so that it “fits” (i.e. scheduling) with the MD degree offered at UMB. There is no change in our requirements, no impact on resources, and no impact on faculty load or library services. Just a request to accept two life sciences courses offered at UMB as part of the MD curriculum to count for two life sciences electives in our MS degree.

JUSTIFICATION/REASONS/RESOURCES (Briefly explain the reason for the proposed action. Identify the source of new resources that may be required. Details should be provided in an attachment.)

APPROVAL SIGNATURES - Please print name, sign, and date

1. Department Committee Chair PETER KOFIGAS 11/2/07
2. Department Chair WILLIAM E. BENTLEY 11/1/07
3. College/School PCC Chair MELVIN W. WILSON 12/16/07
4. Dean ROBERT OHLIN 11/12/07
5. Dean of the Graduate School (if required) CARMEN BalThrop 3/16/05
6. Chair, Senate PCC MELVIN W. WILSON 3/12/05
7. Chair of Senate PHILIP D. LEROY 3/28/08
8. Vice President for Academic Affairs & Provost PHYLLIS PEROS 3/28/08

VPAAP 8-05
Doctor of Medicine  
School of Medicine  
University of Maryland, Baltimore  

*as a dual degree program with*  

Master of Science in Bioengineering  
Fischell Department of Bioengineering  
University of Maryland, College Park  

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Dr. William E. Bentley  
Fischell Distinguished Professor and Chair  
Fischell Department of Bioengineering  
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301 405 4321  

Dr. Jordan E. Warnick  
Assistant Dean for Student Education & Research  
Professor of Pharmacology & Experimental Therapeutics  
University of Maryland, School of Medicine  
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410 706-3026
MD/MS BIOE Program Overview

This document describes a 5 year, combined degree program consisting of a Doctor of Medicine (MD) degree and a Master of Science (MS) degree in Bioengineering (BIOE). The MD/MS BIOE program is administered jointly by the School of Medicine (SoM) at the University of Maryland, Baltimore and the Fischell Department of Bioengineering (FDB) at the University of Maryland, College Park. The objective of this program is to broaden the educational and research scope of medical doctors in significant fields of bioengineering. Thus, the program should be attractive to those clinicians interested in areas including clinical research, biomaterials, biomedical imaging, medical device innovation, medical device development, and drug development. Graduates of the combined program will receive a Doctor of Medicine degree from the University of Maryland School of Medicine as well as a Master of Science degree from the A. James Clark School of Engineering at the University of Maryland, College Park.

Application to the MD/MS BIOE Program

As the program involves two degrees, applicants must broadly satisfy application requirements in both programs. There are multiple paths to acceptance into the program: 1) Students applying to the MD program, and who have an engineering degree from an accredited college or university, may apply directly to the MD/MS BIOE program; 2) Current MD students with engineering degrees may apply directly to FDB for entrance into the MD/MS BIOE program; 3) Applicants to the MD program or current students with degrees in chemistry, biology, physics, or mathematics are also encouraged to apply, and their application will be reviewed on a case-by-case basis. All applicants will be reviewed by admissions office/committees at both the SoM and FDB. The MD/MS BIOE application is first reviewed by the SoM with FDB faculty participating in the interview process. Subsequent to the SoM evaluation, selected applications are forwarded to the FDB admissions committee for the MS program evaluation. We estimate that about 10 students a year would seek admission into the dual degree MD/MS program.

MD/MS BIOE Program Schedule

Students enrolled in the MD/MS BIOE program would begin studies with the first two years of the MD curriculum as defined by the SoM. The typical MD curriculum includes courses covering Structure & Development, Cell & Molecular Biology, Functional Systems, Neuroscience, Host Defenses & Infectious Diseases, Pathophysiology & Therapeutics, and Physical Diagnosis. After the conclusion of the second year as well as subsequent examinations (approximately July 5), students would shift to the MS BIOE curriculum. The bioengineering curriculum would then last approximately 12 months, with 8 months of combined coursework and research efforts as well as 4 months devoted entirely to research endeavors. At the end of the bioengineering studies, students would return to the MD curriculum and proceed in the typical fashion.

MS BIOE Curriculum

The requirements for a MS degree in bioengineering within the MD/MS BIOE program include (1) four bioengineering core courses, (2) two engineering elective courses, and (3) 6 credit hours of thesis research as part of a research project. The MS BIOE degree normally also requires two life sciences electives, which would be satisfied by courses in the MD component of the curriculum. The bioengineering core courses consist of:

- Biomolecular and Cellular Rate Processes (BIOE 601)
- Cellular and Tissue Biomechanics (BIOE 602)
- Electrophysiology of the Cell (BIOE 603)
- Cellular and Physiological Transport Phenomena (BIOE 604).

Participating MD/MS BIOE students may or may not choose to complete a research based thesis as part of the MS BIOE program, as described below.
Thesis Option – A thesis MS degree is the preferred option as it provides participating students direct exposure to state of the art bioengineering research. Furthermore, a thesis project provides the student the opportunity to formulate and complete a bioengineering research project under the supervision of participating graduate program faculty. In order to complete the MD/MS BIOE program with a thesis, students must complete a research project. This project would be defined in the summer months before coursework begins and completed throughout the year. A MS thesis must then be defended before a thesis committee prior to graduation.

Non-Thesis Option – A non-thesis MS degree is an option, however this track is somewhat discouraged. Students who select a non-thesis program would not be required to complete a research project, but would be required to complete additional coursework (Please see Non-Thesis track).

Three program tracks for the MS degree in bioengineering, including the Molecular and Cellular Bioengineering (MCB) track, the Biomaterials in Bioengineering (BB) track, and the Non-Thesis (NT) track, have been defined and are described on subsequent pages.

Financing the MD/MS BIOE Program
The financial cost of the 5 year MD/MS BIOE program is essentially the cost of the 4 year MD program at the SoM plus the cost of 1 year (summer, fall, and spring terms) at the FDB. The financial arrangements for the 4 year MD program would remain unchanged by participation in the MD/MS BIOE program. The financial cost associated with the MS BIOE program is primarily the cost of tuition for the year. The current rate for in-state graduate tuition is $427 per credit hour. However, those students selecting the thesis option may receive tuition, salary, and benefits support from their research advisor for the duration of their MS study. This support would be considered and developed on a case-by-case basis between the participating student and research advisor. Please note that current FDB policies do not require a research advisor to financially support a MS student.

Molecular and Cellular Bioengineering (MCB) Track
The Molecular and Cellular Bioengineering track is designed for students with interests in engineering concepts applied to fundamental molecular and cellular processes as well as engineering devices that are based upon cellular mechanisms. A total of six courses are required, four of which must be the bioengineering core courses (See Table 1). Two additional courses focusing on molecular and cellular bioengineering topics must be completed. MCB Electives are presented in Table 2. Please note, however, that alternative courses may be completed after consultation with the program director.

Table 1: Required Bioengineering Core Courses (must complete all four)
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOE 601</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 602</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 603</td>
<td>3</td>
</tr>
<tr>
<td>BIOE 604</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 2: MCB Elective Courses (must complete two)*
<table>
<thead>
<tr>
<th>Course Number</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOE 689</td>
<td>3</td>
</tr>
</tbody>
</table>
In addition to the coursework described above, an MS thesis must be completed. Research efforts will be directed by a faculty advisor, who should be identified at the time of application to the program. The research project should be well defined prior to the July 5 start date in the MS phase of the MD/MS BIOE program (see Program Schedule) in order to facilitate completion in the 12 month MS program. A MS thesis must be defended before a thesis committee prior to graduation.

**Biomaterials in Bioengineering (BB) Track**

The Biomaterials in Bioengineering track is designed for students with interests in biomaterial fabrication, characterization, and applications in biomedical engineering. A total of six courses are required, four of which must be the bioengineering core courses (See Table 1). Two additional courses should be selected from the BB Electives (See Table 3). Please note, however, that alternative courses may be completed after consultation with the program director.

**Table 3: BB Elective Courses (must complete two)**

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Biomaterials</td>
<td>BIOE 689 / ENMA 698 3</td>
</tr>
<tr>
<td>Polymers, Bio-Polymers and their Applications in Nano- and Bio-Technology</td>
<td>BIOE 689 3</td>
</tr>
<tr>
<td>Tissue Engineering</td>
<td>BIOE 689T / ENCH 648T 3</td>
</tr>
<tr>
<td>Polymer Physics</td>
<td>ENMA 620 3</td>
</tr>
</tbody>
</table>

*Please note that the courses listed here are only a sampling and alternative courses may be chosen after consultation with the program director.

In addition to the coursework described above, an MS thesis must be completed. Research efforts will be directed by a faculty advisor, who should be identified at the time of application to the program. The research project should be well defined prior to the July 5 start date in the MS phase of the MD/MS BIOE program (see Program Schedule) in order to facilitate completion in the 12 month MS program. A MS thesis must be defended before a thesis committee prior to graduation.

**Non-Thesis (NT) Track**

The Non-Thesis track is designed for students who wish to focus on coursework, rather than an additional research program. For the NT track, a total of eight courses are required, four of which must be the bioengineering core courses (See Table 1). Four additional courses should be selected from the NT Electives (See Table 5). Please note, however, that alternative courses may be completed after consultation with the program director.
director.

Table 5: NT Elective Courses *(must complete four)*

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Imaging and Imaging Analysis</td>
<td>BIOE 689 / ENEE 739</td>
</tr>
<tr>
<td>Introduction to Biomaterials</td>
<td>BIOE 689 / ENMA 698</td>
</tr>
<tr>
<td>Polymers, Bio-Polymers and their Applications in Nano- and Bio-Technology</td>
<td>BIOE 689</td>
</tr>
<tr>
<td>Evolutionary Computation and Artificial Life</td>
<td>BIOE 689</td>
</tr>
<tr>
<td>Chemical and Biological Detection</td>
<td>BIOE 689 / ENPM 808B</td>
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<tr>
<td>Cell Motility</td>
<td>BIOE 689</td>
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<tr>
<td>Bionanotechnology: Physical Principles</td>
<td>BIOE 689</td>
</tr>
<tr>
<td>Quantitative Cell Physiology</td>
<td>BIOE 689Q</td>
</tr>
<tr>
<td>Tissue Engineering</td>
<td>BIOE 689T / ENCH 648T</td>
</tr>
<tr>
<td>Advanced Topics in Information Processing: Exploiting Biological Resources</td>
<td>CMSC 828U</td>
</tr>
<tr>
<td>Methods of Engineering Analysis</td>
<td>ENCH 620</td>
</tr>
<tr>
<td>Advanced Biochemical Engineering</td>
<td>ENCH 648</td>
</tr>
<tr>
<td>Polymer Physics</td>
<td>ENMA 620</td>
</tr>
<tr>
<td>Digital Imaging Processing</td>
<td>ENEE 631</td>
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<tr>
<td>Advanced Topics in Microelectronics: Mixed Signal VLSI Circuit Design</td>
<td>ENEE 719</td>
</tr>
</tbody>
</table>

*Please note that the courses listed here are only a sampling and alternative courses may be chosen after consultation with the program director.