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GRADUATE

NEW/REVISED/DELETED GRADUATE PROGRAMS COVERSHEET

(Degree Programs, Sequences, Graduate-Level Certificates)

Graduate Curriculum Committee

2006-07

Deadlines for receipt by Graduate Curriculum Committee:

Revised Degree Program, Sequence, Graduate-Level Certificates: **October 1**, 2006, for inclusion in 2007-08 catalog.
New Sequence, New Graduate-Level Certificates: **September 15**, 2006, for inclusion in 2007-08 catalog.
New Degree Program: **February 10, 2006**, for inclusion in **2008-09** catalog.

DEPARTMENT/SCHOOL Biological Sciences **DATE** Aug. '06

TITLE OF DEGREE, SEQUENCE, OR CERTIFICATE M.S. Sequence In Biomathematics

Proposed Action: (Refer to Part I, Section C of *GCC Proposal Guidelines and Procedures.*)

☒ New*: (Check one.)
- ☐ Degree Program** (goes beyond Graduate Curriculum Committee)
- ☒ Sequence (goes beyond Graduate Curriculum Committee)
- ☐ Post-Master's Graduate Certificate (goes beyond Graduate Curriculum Committee)
- ☐ Post-Baccalaureate Graduate Certificate (goes beyond Graduate Curriculum Committee)
- ☐ Graduate Certificate

☐ Change in requirements for: (Check one.)
- ☐ Degree Program ☐ Sequence ☐ Certificate

☐ Other program revisions

☐ Deletion of: (Check one.)
- ☐ Degree Program (goes beyond Graduate Curriculum Committee)
- ☐ Sequence (goes beyond Graduate Curriculum Committee)
- ☐ Post-Master's Graduate Certificate (goes beyond Graduate Curriculum Committee)
- ☐ Post-Baccalaureate Graduate Certificate (goes beyond Graduate Curriculum Committee)
- ☐ Graduate Certificate

*Attach approved *Request for New Program Approval: Reporting of Financial Implications* form (available at www.academicsenate.ilstu.edu/documents.html).

**Obtain the New Program Request (NEPR) format from the Office of the Provost.

Attachment: Summary of proposed action. For all proposals, provide current title and current catalog copy. Provide new title and new catalog copy for new programs, and for revised programs if catalog copy/title is altered. For revised programs, provide a summary of the changes. (Refer to New/Revised/Deleted Programs checklist in *GCC Guidelines and Procedures.*)

SEE ATTACHED.

Routing and action summary:

1. ______________ ______ Dept./School Curriculum Committee Chair — Date Approved
2. ______________ ______ Department Chair/School Director — Date Approved
3. ______________ ______ College Curriculum Committee Chair — Date Approved
4. ______________ ______ College Dean — Date Approved
5. ______________ ______ Teacher Education Council Chair (28 copies to Dean of College of Education) — Date Approved
6. ______________ ______ Graduate School — Date Approved

*Submit **10** copies of proposal to the Graduate Curriculum Committee. In addition, for new and deleted degree programs, sequences, and Post-Baccalaureate and Post-Master's certificates, submit an electronic version (MS Word format). These proposals are routed by GCC to the Academic Senate. The Senate requires electronic submission of all materials for posting to the Senate Web site.*

REQUEST FOR APPROVAL OF
A SEQUENCE OF A DEGREE PROGRAM

Institution: Illinois State University

Responsible Department/School or Administrative Unit: Department of Biological Sciences

Proposed Program Title: M.S. Sequence in Biomathematics

Previous Program Title (if applicable): NA

CIPS Classification (applicable to new program): 26.0101

Date of Implementation: Summer 2007

Background and Justification: Mathematics pervades biological research. Nearly all sophisticated biological research makes use of applied statistical techniques of varying degrees of complexity in designing and analyzing experiments. Application of those techniques is vital to the interpretation of biological data. Models constructed of differential equations or of difference equations (in both cases both deterministic and stochastic) are widely employed in the fields of ecology, evolutionary biology, population genetics, epidemiology, and physiology to describe biological phenomena, and to make predictions of future events or responses to experimental intervention. Game theory is widely applied in evolutionary studies of animal behavior in order to understand the fitness effects of behavioral decisions. The growing field of bioinformatics (using computer-intensive methods to extract information from enormous data bases such as sequences of nucleic acids or proteins) makes use of statistics, probability theory, computer intensive methods, and graph theory to detect patterns in large data sets and to interpret those patterns. At some level all biologists make use of the tools of mathematics, but it is increasingly obvious that there is a prominent research role for scientists working at the interface of Biology and Mathematics, having greater mathematical sophistication than the typical biologist, and greater knowledge of biology than the typical mathematician. The increasing application of mathematics to biological problems has led to us to develop a MS sequence in Biomathematics. This MS sequence will be enable biologists to pursuing careers in Biomathematics.

Description of Proposed Program: We propose that M.S. graduate students in the Sequence in Biomathematics will take a set of core courses that will provide students with the mathematical underpinning for applications of mathematics to biology. We propose this M.S. sequence through the Department of Biological Sciences because all sequences are administered within a department. However, the sequence and training will be interdisciplinary, and will start with core courses from the Department of Mathematics to provide the students with a strong foundation. After the core courses the students can choose from two sets of electives that provide training emphasizing either *Biological Statistics and Modeling* or *Computation and Bioinformatics*. The need for additional courses will be determined by faculty advisor, student, and the student's graduate committee. The objectives of the proposed sequence include: (1) To provide a cross-disciplinary but focused learning environment for students enrolled in the Sequence in Biomathematics through participation in a cohesive curriculum designed to improve the students' skills in applications of mathematics to biological problems. (2) To demonstrate to prospective students that this is a unique training opportunity offered by collaborating ISU faculty that work at the interface of these fields. (3) To enhance the effectiveness of the graduate training sequence by creating a 'cohort' experience for new graduate students. (4) To establish a cohesive set of research, learning, and training opportunities for graduate students.

M.S. Sequence in Biomathematics. 30 h required**, including thesis (minimum of 4 credits BSC 499).

**Most students in this sequence will be required to take 33 h, 3 more than the minimum required for a MS in Biological Sciences. This added requirement reflects the interdisciplinary nature of this sequence: MS students in this sequence must know a considerable amount of biology and have a firm grounding in mathematics, including differential equations (vital for modeling) and statistical theory (vital for statistical approaches to biological research). This small increase in hours is justified because without it, students would not have sufficient training and knowledge of both mathematics and advanced biology. Therefore the core of our program requires 4 mathematics courses at the 300-level which will give a biological sciences graduate student the necessary background to pursue successfully research at the interface of biology and mathematics. Students who have a stronger undergraduate training in mathematics will likely not need to take all of the mathematics classes in the core and thus could complete their degree within 30 credit hours. The addition of 3 h (i.e., one additional course) should not delay students inordinately in the pursuit of their degree.

Sequence structure: The core courses include: thesis research in the Department of Biological Sciences, a seminar (taken twice for different topics of current research in biomathematics), and a set of Mathematics classes that are essential for providing background for biologists to conduct research in Mathematical Biology. In addition, students must take at least 14 h of coursework chosen from the electives listed below. A minimum of 13 h outside the core must be at the 400 level. At least 12 h of Biological Sciences courses outside the core must be included. Transfer credit may be granted for MAT 340, 341, 350, or 351, provided that at least 2 Mathematics courses are taken while in residence at ISU.

Prerequisites: 2 semesters of calculus, 1 semester of linear algebra.

Emphases and advisement: Each student in the sequence selects one of the following emphases: (1) Biological Statistics and Modeling, or (2) Computation & Bioinformatics. Each student's thesis committee will guide the research and choice of courses outside of the core, including any additional courses necessary for the particular student's project.

Core courses (taken by all M.S. students in the sequence): BSC 420.36 Seminar in Biomathematics (1 h, taken 2 times for total 2h, different topics are addressed each semester); BSC 499 Thesis Research (4 h); MAT 340 Differential Equations I (3 h); MAT 341 Differential Equations II (3 h); MAT 350 Applied Probability Models (4 h); MAT 351 Statistics and Data Analysis (4 h).

Emphasis in Biological Statistics and Modeling: Electives: BSC 343 Neurobiology (3 h); BSC 403 Plant Ecology (4 h); BSC 404 Population Ecology (4 h); BSC 405 Community Ecology (4 h); BSC 450.37 Advanced studies in Biostatistics (3 h); BSC 471 Evolutionary Population Genetics (3 h), BSC 486 Ethology (4 h); MAT 353 Time Series (4 h); MAT 356 Stat. Computing (4 h); MAT 362 Linear Program (2-4 h); MAT 378 Mathematical Modeling (4 h); MAT 450 Finite Sampling (3-4 h); MAT 453 Regression (3-4 h); MAT 455 Stochastic Processes (3-4 h); MAT 456 Multivariate Statistics (3-4 h); MAT 458 Design of Experiments (3-4 h).

Emphasis in Computation & Bioinformatics: Electives: BSC 350 Molecular Biology (3 h); BSC 353 Biotechnology Laboratory I: DNA (3 h); BSC 355 Genomics & Bioinformatics (3 h); BSC 415 Advanced Cell Biology (3 h); BSC 419 Molecular Biology of the Gene (4 h); BSC 467 Microbial Genetics (4 h); BSC 470 Evolution (3 h); BSC 417 Evolutionary Population Genetics (3h); MAT 356 Statistical Computing (4 h); MAT 361 Discrete Math (2- 4 h); MAT 363 Graph Theory (4 h); MAT 461 Advanced Topics in Discrete Math (3–4 h).

Core Courses			
Course		**Hours**	**Status**
Seminar in Biomathematics	BSC 420.36	2 total (1 h - taken twice)	Offered
Research in Dept of Biological Sciences	BSC 499	4	Offered
Differential Equations I	MAT 340	3	Offered
Differential Equations II	MAT 341	3	Offered
Applied Probability Models	MAT 350	4	Offered
Statistics and Data Analysis	MAT 351	4	Offered
Electives – Choice of Classes in One of Two Emphases to Fulfill Focused Training in Biology and Additional Electives for Further Training			
Emphasis in Biological Statistics and Modeling (12 credits required)			
Neurobiology	BSC 343	3	Offered
Plant Ecology	BSC 403	4	Offered
Population Ecology	BSC 404	4	Offered
Community Ecology	BSC 405	4	Offered
Advanced Studied in Biostatistics	BSC 450.37	3	Offered
Evolutionary Population Genetics	BSC 471	3	Offered
Ethology	BSC 486	4	Offered
Additional Electives for Emphasis in Biological Statistics and Modeling			
Time Series	MAT 353	4	Offered
Statistical Computing	MAT 365	4	Offered
Linear Program	MAT 362	2-4	Offered
Mathematical Modeling	MAT 378	4	Offered
Finite Sampling	MAT 450	3-4	Offered
Regression	MAT 453	3-4	Offered
Stochastic Processes	MAT 455	3-4	Offered

Multivariate Statistics	MAT 456	3-4	Offered
Design of Experiments	MAT 458	3-4	Offered
Emphasis in Computation and Bioinformatics (12 credits required)			
Molecular Biology	BSC 350	3	Offered
Biology Technology Lab. I: DNA	BSC 353	3	Offered
Genomics and Bioinformatics	BSC 355	3	Offered
Advanced Cell Biology	BSC 425	3	Offered
Molecular Biology of the Gene	BSC 419	4	Offered
Microbial Genetics	BSC 467	4	Offered
Evolution	BSC 470	3	Offered
Evolutionary Population Genetics	BSC 471	3	Offered
Additional Electives for Emphasis in Computation and Bioinformatics			
Statistical Computing	MAT 356	4	Offered
Discreet Math	MAT 361	2-4	Offered
Graph Theory	MAT 363	4	Offered
Advanced Topics in Discreet Math	MAT 461	3-4	Offered

Credit Totals – BSC 19h MAT 14h.

Catalogue Copy:

Master's in Biological Sciences

. . . sequence within the M. S. program in (1) Behavior, Ecology, Evolution, and Systematics (BEES), (2) Biomathematics, (3) Biotechnology, or (4) Conservation Biology, each of which...

Biomathematics: Students in the Department of Biological Sciences may elect to pursue a sequence in Biomathematics, a course of study that provides students with a unique and strong cross-disciplinary training in biology and mathematics. The sequence is designed first to give students a solid foundation in mathematics (core courses), then training in one of two biological areas that use specific types of mathematical applications to address biological questions (emphases). Before entering the sequence, students should have 2 semesters of calculus and 1 semester of linear algebra. This is a 30 hour program including 2 hours of BSC 420.36 and 4 hours of thesis BSC 499. All students are required to take the sequence core courses of 20 hours (BSC 420.36, BSC 499, MAT 340, MAT 341, MAT 350 and MAT 351). Transfer credit can be offered for the core math classes provided that students take at least 2 courses from the Mathematics department while at ISU. In addition students will choose 14 hours of electives from two areas of emphasis, with a minimum of 12 hours from the Department of Biological Sciences. A minimum of 13 hours outside of the core courses must be at the 400 level. The areas of emphasis and their courses are: *Emphasis in Biological Statistics and Modeling* with a choice of courses from BSC 343, BSC 403, BSC 404, BSC 405, BSC 450.37, BSC 471, BSC 486, MAT 353, MAT 356, MAT 362, MAT 378, MAT 450, MAT 453, MAT 455, MAT 456, MAT 458; or *Emphasis in Computation & Bioinformatics:* with a choice of courses from BSC 350,

BSC 353, BSC 355, BSC 415, BSC 419, BSC 467, BSC 470, BSC 471, MAT 356, MAT 361, MAT 363, MAT 461. For further information, see the Department's Web site at www.bio.ilstu.edu.

Rationale for Proposal: The proposed MS sequence is the central feature of the College of Arts and Sciences Program of Excellence in Biomathematics. MS students in this program will benefit by receiving training in a rapidly growing field at the intersection of biology and mathematics. Because the program has two distinct tracks with different emphases, a broad range of students can benefit from the program. Students with interests in Biomathematics cannot readily pursue a graduate degree at ISU at this time. Though the current graduate training in Biological Sciences is strong, there is no coordinated way of meeting the needs of students with interests in Biomathematics. Because we envision a diversification of research questions pursued by faculty participating in the Program of Excellence in Biomathematics, opportunities for mathematically oriented MS research in Biological Sciences will benefit graduate students beyond this sequence.

Expected Impact of Proposal on Existing Campus Programs: The proposed Biomathematics M.S. Sequence will not negatively affect other existing campus programs. We anticipate that the creation of the Sequence will help to attract a modest number (2-4 per year) of high quality M.S. students to the Department of Biological Sciences graduate programs. The program has the capacity to accept these additional students

Curricular Changes Including New Courses: There will be one new course BSC 420.36 (1 h), which is a seminar course focused on readings in current research in Biomathematics; it has already been approved. Graduate seminar is a feature of all graduate programs in biology. They serve the purpose of engaging graduate students in critical thinking and discussion on advanced research topics. ISU's existing graduate seminars in Biological Sciences (BSC 420.xx) focus on topics in Biology, and do not provide students with interdisciplinary discussion in Mathematics and Biology. This seminar provides that interdisciplinary focus and is thus the cornerstone of the developing Program of Excellence in Biomathematics. This course will be required of all students in the MS sequence in Biomathematics.

Anticipated Staffing Arrangements: Except for the new seminar course, BSC 420.36, which has recently been approved, all courses required in the Sequence are already being taught, hence are already integrated into regular course schedules and teaching assignments.

Anticipated Funding Needs and Source of Funds: Establishment of the Sequence requires no new funds. However, we will be using funds awarded by Dean Olson as part of the Program of Excellence to assist in recruitment of high-caliber research-oriented M.S. students via summer research fellowships.

Example Plans of Study

For a student with an *Emphasis in Biological Statistics and Modeling*

core – BSC 499 (4 h), MAT 340 (3 h), MAT 341 (3 h), MAT 350 (4 h) and MAT 351 (4 h), with 2 semesters of BSC 420.36 (1 h taken twice for total of 2 h).

electives for the emphasis and Biology requirement – BSC 404 (4 h), BSC 450.37 (3 h), BSC 486 (4 h), BSC 471 (3 h).

For a student with an *Emphasis in Computation & Bioinformatics*

core – BSC 499 (4 h), MAT 340 (3 h), MAT 341 (3 h), MAT 350 (4 h) and MAT 351 (4 h), with 2 semesters of BSC 420.36 (1 h taken twice for total of 2 h).

electives for the emphasis and Biology requirement – BSC 415 (3 h), BSC 419 (4 h), BSC 470 (3 h), BSC 471 (3 h).

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September 25, 2006

Steven Juliano
Diane Byers
Department of Biological Sciences
Illinois State University
Normal, IL 61790-4120

Steven and Diane,

We strongly support the proposal from Biological Sciences for a Sequence in Biomathematics. We also understand that the MS students pursuing the proposed Sequence in Biomathematics will be taking the Mathematics courses that are part of the core of that sequence (MAT 340, 341, 350, 351). Our department can assure you that those students with sufficient preparation will be able to enroll in these courses, as well as any of the elective courses that count toward meeting the sequence requirements.

The Mathematics Department is in the process of developing a parallel Sequence in Biomathematics for our own MS program.

Please let me know if you need more information from our department.

Sincerely,

George Seelinger
Chair, Mathematics Department