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## Proposal to the Senate Educational Policy Committee

**PROPOSAL TITLE:** Proposal for a Bioengineering Concentration within the Master of Science (M.S.) in Bioinformatics

**SPONSOR:**

Michael Insana  
Head, Department of Bioengineering  
1270 DCL, MC-278  
217-333-1867  
[mfi@illinois.edu](mailto:mfi@illinois.edu)

**COLLEGE CONTACT:**

Victoria L. Coverstone  
Associate Dean, Office of Graduate and Professional Programs, College of Engineering  
306 Engineering Hall, MC-266  
217-333-0678  
[vcc@illinois.edu](mailto:vcc@illinois.edu)

**BRIEF DESCRIPTION:**

The Department of Bioengineering and the College of Engineering propose a Bioengineering concentration within the campus-wide M.S. program in Bioinformatics.

The Bioengineering concentration within the M.S. in Bioinformatics will be offered with both thesis and non-thesis options. The thesis option requires a minimum of 32 hours, and the non-thesis option requires 36 hours, each including 28 hours of coursework. The 28 hours of course work will comply with the requirements of the campus-wide Master of Science in Bioinformatics and are specified as follows:

- One course from the approved Bioinformatics list of Computer Sciences Core courses (4 hours)
- One course from the approved Bioinformatics list of Biology courses (4 hours)
- One course from the approved Bioinformatics list of Bioinformatics courses (4 hours)
- BIOE 504—Analytical Methods in Bioengineering or BIOE 505—Computational Bioengineering (4 hours)
- One course in Systems Biology from departmental list (3 hours)
- 9 hours of electives; a maximum of 2 hours of BioE seminar courses.
- Overall a minimum 12 hours at the 500-level courses and 8 of those hours within the Department of Bioengineering are required; a maximum of 2 hours of BioE seminar courses can be counted.

Course requirements are listed in Appendix B. Students must select elective courses in consultation with their departmental advisor and are strongly encouraged to select from among courses offered by the Department of Bioengineering.

For the Thesis option, students must also complete a minimum of 4 hours of thesis within Bioengineering Research (BIOE 599). Students are required to present a seminar on their thesis research during the last semester of their study program. It is highly recommended that students register for 1 hour of seminar (BIOE 500) each semester as preparation for presenting their thesis.

With the permission of their advisor, students in the Department of Bioengineering may choose to pursue a non-thesis option within the M.S. in Bioinformatics. The non-thesis option requires a minimum of 36 hours of coursework with the same course requirements specified in the thesis option above. Supplementary requirements toward satisfying the 36 hours include an additional 8 hours of elective courses. Within these 8 additional hours, the student may incorporate supervised research experiences, including internships and projects, with the approval of their advisor.

Any single course counts towards one requirement and cannot be used for multiple requirements.

#### **JUSTIFICATION:**

The discipline of Bioinformatics addresses the need to manage and interpret the data that is being massively generated by genomic, proteomic and metabolic research. This discipline represents the convergence of biology, computer and physical sciences, and encompasses analysis and interpretation of biomolecular data, modeling of biological phenomena, and development of modeling and computational approaches. With current technology, scientific discovery occurs in a global arena and data are stored and archived massively in databases, disseminated through cable or wireless conduits, and analyzed. This includes information on genomes, biomolecules, biomolecular circuitry, and biological processes at the molecular, cellular, individual and population levels. Improving human health demands better understanding of multi-dimensional data structures, including proactive control and clear understanding of chemical, biological and pathological processes. Ultimately, we expect a better life. The College of Engineering and the Department of Bioengineering have a comprehensive mission that relates to human health, and is driven mainly by applying engineering perspectives to biology and human health. This involves addressing important issues in biology. Within this framework, bioinformatics plays an important role in the management and exploitation of human and animal genomic, transcriptomic, proteomic, cell and tissue resources.

#### **Biology, Engineering and Human Health in Bioinformatics**

Researchers in the human health and animal sciences have contributed to developments in bioinformatics, mostly through advances in genetics, genomics, proteomics, systems biology and evolution. Bioengineering and biomedical engineering departments throughout the US offer courses in genomic science that have immediate applications to human health. Many bioengineering departments offer undergraduate and graduate Bioinformatics programs, including the Massachusetts Institute of Technology, University of California San Diego and Stanford University.

#### **Why Should a Bioinformatics Concentration Be Offered by the Department of Bioengineering?**

Bioinformatics is at the cross roads of experimental and theoretical science and includes biological fields as diverse as molecular evolution, biological modeling, integrative imaging,

quantitative physiology, statistical genomics and systems biology. Bioinformatics has immediate applications in studies related to human health. These applications include understanding the molecular basis of biological phenomena related to animal development, disease and behavior. Bioinformatics is a dynamic interdisciplinary field. Much like biotechnology and genomics, bioinformatics is moving from applied to basic science, from developing tools to developing and testing hypotheses. The proposed Bioengineering concentration within the M.S. in Bioinformatics will provide advanced training in aspects of bioinformatics that pertain to the dynamic and complex behavior of biomolecular systems in the contexts of tissues, organs. and disease. This will prepare students for employment in research laboratories in academia, government and the private sector, especially those with a biotechnology, pharmaceutical, or bioengineering focus. Our concentration will ensure that molecular biology and biotechnological principles as well as more traditional fundamentals (quantitative genetics, statistical genomics, imaging and analysis, systems approaches, etc.) are adequately covered in the M.S. degree. This comprehensive training should satisfy the specific demands of a degree based on the engineering and life sciences.

#### **BUDGETARY AND STAFF IMPLICATIONS:**

- a. *Additional staff and dollars needed* – None. Current enrollment in the existing concentrations of the Bioinformatics M.S. for 2009 are as follows: Animal Science (0), Computer Science (4), Crop Science (3), Chemical and Biomolecular Engineering (0), and Graduate Library Information Science (3). The maximum projected enrollment for the Bioengineering concentration is 10 students per year. No additional staff or budget is required to support enrollment at this level. Per Appendix B, students are allowed to select from an extensive list of courses which include BIOE rubric graduate courses and courses from other departments. BIOE graduate courses can support a section size of up to 25 students in a given semester with existing faculty. Current enrollments in BIOE graduate courses could support the additional enrollment from this program without additional resources. The majority of the other courses listed have open enrollment. Based on the number of hours that might be required from courses outside of the department and the number of courses that are capable of fulfilling these hours, the additional enrollment impact on other departments should be minimal. If course enrollment in external departments becomes restrictive, the majority of course requirements can be met with BIOE core, cross-listed, or special topic courses.
- b. *Internal reallocations* – Per the rationale in item (a), no change in class size, teaching load, or student-faculty ratio for the graduate courses utilized in this proposal is indicated by this proposed program.
- c. *Effect on course enrollment in other units and explanations of discussions with representatives of those departments* – There is minimal impact on course enrollments in other units. The majority of the course requirements can be handled by BIOE core, cross-listed, or special topic courses if necessary.
- d. *Impact on the University Library* – The projected enrollment is relatively small. No impact to the University Library is indicated by the changes outlined in this proposal.
- e. *Impact on computer use, laboratory use, equipment, etc.* – The projected enrollment is relatively small. No additional impact to computer use, laboratory use, or equipment is anticipated with the changes outlined in this proposal.

#### **SUPPLEMENTARY ADMISSIONS INFORMATION:**

Students may apply for admission to the program through the Department of Bioengineering graduate admissions process.

To ensure the success of all students pursuing this concentration within the M.S. in Bioinformatics in a timely manner, applicants to the program must have a solid background in biology, training in mathematics, and some experience in computer science. Prerequisites include:

- at least one Calculus course equivalent to University of Illinois MATH 220 or 234 or more advanced,
- at least one Statistics course equivalent to University of Illinois STAT 200 or IE 300 or more advanced,
- at least one Molecular and Cellular Biology course equivalent to University of Illinois MCB 100 or more advanced,
- at least one introductory Computer Science course equivalent to University of Illinois CS 101 or 150 or more advanced.

Students with deficiencies in these prerequisites are expected to remediate this situation even when the remediation does not result in course credit towards the Bioengineering concentration within the M.S. in Bioinformatics degree.

**DESIRED EFFECTIVE DATE:** Fall 2011

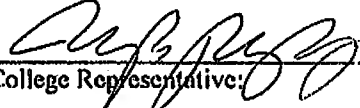
**STATEMENT FOR PROGRAMS OF STUDY CATALOG:** See Appendix A.

**CLEARANCES:**

**Signatures:**

  
\_\_\_\_\_  
Unit Representative:

3/5/13  
Date:

  
\_\_\_\_\_  
College Representative:

3/9/13  
Date:

  
\_\_\_\_\_  
Graduate College Representative:

4/29/13  
Date:

\_\_\_\_\_  
Provost Representative:

\_\_\_\_\_  
Date:

\_\_\_\_\_  
Educational Policy Committee Representative:

\_\_\_\_\_  
Date:

## Appendix A: Statement for the Programs of Study Catalog

New additional sections for the POS are shown below. No other changes requested.

**Major:** Bioinformatics

**Degrees Offered:** M.S.

**Graduate Concentration:** Bioengineering

### Graduate Degree Programs

The Bioengineering Concentration in Bioinformatics is focused upon development of methods that are capable of efficiently analyzing the tremendous amount of high-throughput and high-dimensional data generated by next-generation genomics and proteomics technologies, in order to facilitate discoveries in biology and medicine. The program trains computational biologists with a broad interdisciplinary skill set to address “Big Data” challenges. Special emphasis is placed upon the interface between computational biology and other areas related to bioengineering, including medical imaging, synthetic biology, systems biology, genomics, cellular engineering, and nanotechnology. Research topics include the development of novel computational methods in biological network construction, complex systems modeling, high-throughput DNA sequence comparisons, and statistical machine learning techniques for imaging analysis. Each focus area is aimed at developing a more complete fundamental understanding of cardiovascular disease, mental disorder, infectious disease, or cancer with regard to bioinformatics.

### Admission

Applicants to the Bioinformatics program must have a solid background in biology, training in mathematics, and some experience in computer science. A minimum grade point average of 3.00 (A = 4.00) for the last two years of undergraduate study is required. Applicants should show evidence of strong quantitative skills and of serious interest in the life sciences.

Other prerequisites include:

- at least one Calculus course equivalent to University of Illinois MATH 220 or 234 or more advanced,
- at least one Statistics course equivalent to University of Illinois STAT 200 or IE 300 or more advanced,
- at least one Molecular and Cellular Biology course equivalent to University of Illinois MCB 100 or more advanced,
- at least one introductory Computer Science course equivalent to University of Illinois CS 101 or 150 or more advanced.

Students with deficiencies in these prerequisites are expected to remediate this situation even when the remediation does not result in course credit towards the Bioengineering concentration within the M.S. in Bioinformatics degree.

### Degree Requirements

\*For additional details and requirements for all degrees, please refer to the department's [Graduate Studies Web site](#) and the [Graduate College Handbook](#).

## Master of Science – Bioinformatics, Concentration in Bioengineering

Requirements	Thesis Option	Non-thesis Option
<b>Credit Hours</b>	<b>Hours</b>	<b>Hours</b>
<b>Total Credit for the Degree</b>	<b>32</b>	<b>36</b>
Thesis Research – BIOE 599 (min-max applied toward degree):	Min 4	n/a
Course Work	28	36
One course from the approved Bioinformatics list of Computer Sciences core courses (4 hours)	4	4
One course from the approved Bioinformatics list of Biology core courses (4 hours)	4	4
One course from the approved Bioinformatics list of Bioinformatics core courses (4 hours)	4	4
One course in systems biology from departmental list	3	3
BIOE 504 or BIOE 505	4	4
Elective Courses	9	17
<b>Other Requirements and Conditions:*</b>		
A minimum of 12 500-level credit hours overall applied toward the degree, with 8 hours being Bioengineering courses; a maximum of 2 hours of seminar courses can be counted to towards these 12 hours.		
A concentration is required.		
The non-thesis option is only available with permission of the advisor. Requirements include an additional 8 hours of elective courses which, with the approval of an advisor, may include supervised research experiences including internships and projects.		
The minimum program GPA is 3.0		

No changes follow...

## Appendix B: Course Requirements

1. One course from the approved Bioinformatics list of Computer Sciences core courses (4 hours)
2. Select one course from: BIOE 504 – Analytical Methods in Bioengineering or BIOE 505 – Computational Bioengineering
3. One course from the approved Bioinformatics list of Bioinformatics core courses (4 hours)
4. One course from the approved Bioinformatics list of Biology core courses (4 hours)
5. *Systems Biology* (3 hours)
  - BIOE 598SZ—Special Topics\* – *qualifies when taken for at least 3 credit hours and the topic is Gene Regulatory Networks or another advisor-approved topic.*
  - BIOE 498—Special Topics\* – *qualifies when taken for at least 3 credit hours and the topic is Gene Regulatory Networks or another advisor-approved topic.*
  - CS 498 – Special Topics\* – *qualifies when taken for at least 3 credit hours and the topic is Algorithms in bioinformatics or another advisor-approved topic*
  - MCB – 419 Brain, Behavior & Info Process

\* It is expected that special topics sections will abide by the limitation on the number of repetitions set by Senate Rule and if, after initial pilot offerings, permanency is desired, proposals to convert them to permanent courses will be submitted through the usual channels. Upon approval, the courses will be considered for addition to the list.



6. Electives – Choose 8 hours (thesis option) or 16 hours (non-thesis option) from the following list or other graduate level course in consultation with advisor. Bioengineering courses are highly recommended.

ANSC 444 – Applied Animal Genetics  
ANSC 445 – Statistical Methods  
ANSC 446 – Population Genetics

ANSC 542 – Applied Bioinformatics  
ANSC 545 – Statistical Genomics

ANTH 441 – Human Genetics

BIOE 598 – Special Topics: Computational Cancer Biology  
BIOE 504 – Analytical Methods in Bioengineering  
BIOE 505 – Computational Bioengineering

BIOP 420 – Molecular Biophysics

CHEM 470 – Computational Chemical Biology  
CHEM 574 – Genomics, Proteomics, Bioinfo

CHBE 571 – Bioinformatics

CPSC 440 – Applied Statistical Methods I  
CPSC 542 – Applied Statistical Methods II  
CPSC 567 – Bioinformatics & Systems Biol

CS 413 – Intro to Combinatorics  
CS 418 – Interactive Computer Graphics  
CS 420 – Parallel Progrmg: Sci & Engrg  
CS 446 – Machine Learning  
CS 450 – Numerical Analysis  
CS 512 – Data Mining Principles  
CS 519 – Scientific Visualization  
CS 578 – Information Theory

ECE 486 – Control Systems

IB 402 – Molecular Evolution  
IB 405 – Ecological Genetics  
IB 504 – Genomic Analysis of Insects

LIS 451 – Intro to Network Systems  
LIS 501 – Info Org and Access

MCB 410 Developmental Biology  
MCB 432 – Computing in Molecular Biology

Continued electives from previous page

STAT 420 Methods of Applied Statistics  
STAT 424 Analysis of Variance  
STAT 425 Applied Regression and Design  
STAT 428 Statistical Computing  
STAT 429 Time Series Analysis  
STAT 525 Computational Statistics  
STAT 571 Multivariate Analysis

UNIVERSITY OF ILLINOIS  
AT URBANA-CHAMPAIGN

University Library

Office of Dean of Libraries  
and University Librarian  
230 Main Library, MC-522  
1408 West Gregory Drive  
Urbana, IL 61801



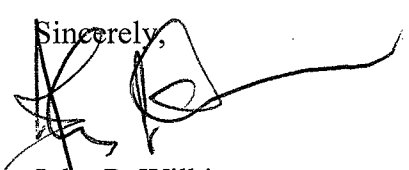
August 21, 2013

Michael Insana  
Head, Department of Bioengineering  
1270 DCL, MC-278

Dear Professor Insana:

Thank you for affording the University Library the opportunity to review the College of Engineering's proposal to the Senate Committee on Educational Policy to create a Bioengineering Concentration within the Master of Science in Bioinformatics. Librarians in the Grainger Engineering Library and our subject specialists for Chemistry, Biology and the Biomedical Sciences all read this proposal and discussed it amongst themselves, agreeing that the proposed program would have little impact on the library's operations or material needs.

Sincerely,



John P. Wilkin  
Juanita J. and Robert E. Simpson  
Dean of Libraries and University Librarian

c: Peg Burnette  
William Mischo  
Mary Schlembach  
Elizabeth Stovall, Graduate Programs Director, CoE  
Thomas Teper  
Kelli Trei



Name of existing Illinois (UIUC) degree: \_\_\_\_\_

Name of non-Illinois partnering institution: \_\_\_\_\_

Location of non-Illinois partnering institution:

State of Illinois     US State: \_\_\_\_\_     Foreign country: \_\_\_\_\_

- B.  Proposal to create a new academic unit (college, school, department, program or other academic unit):

Name of proposed new unit: \_\_\_\_\_

- C.  Proposal to rename an existing academic unit (college, school, department, or other academic unit):

Current name of unit: \_\_\_\_\_

Proposed new name of unit: \_\_\_\_\_

- D.  Proposal to reorganize existing units (colleges, schools, departments, or program):

1.  Proposal to change the status of an existing and approved unit (e.g. change from a program to department)

Name of current unit including status: \_\_\_\_\_

2.  Proposal to transfer an existing unit:

Current unit's name and home: \_\_\_\_\_

Proposed new home for the unit: \_\_\_\_\_

3.  Proposal to merge two or more existing units (e.g., merge department A with department B):

Name and college of unit one to be merged: \_\_\_\_\_

Name and college of unit two to be merged: \_\_\_\_\_

Proposed name and college of new (merged) unit: \_\_\_\_\_

4.  Proposal to terminate an existing unit:

Current unit's name and status: \_\_\_\_\_

- E.  Other educational policy proposals (e.g., academic calendar, grading policies, etc.)

Nature of the proposal: \_\_\_\_\_

Revised 10/2012

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AT URBANA-CHAMPAIGN

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APR 29 2013

OFFICE of the PROVOST

Graduate College

204 Coble Hall  
801 South Wright Street  
Champaign, IL 61820-6210



Executive Committee

April 25, 2013

2012-2013 Members

Debasish Dutta, *Chair*

Kristi Kuntz  
Office of the Provost  
207 Swanlund MC-304

Members

Barry Ackerson

Dear Kristi,

David Ceperley

Enclosed please find a proposal for a "Bioengineering Concentration within the Master of Science (M.S.) in Bioinformatics."

Lin-Feng Chen

Kent Choquette

The Graduate College Executive Committee has approved this proposal. I send it to you now for further review.

Jennifer Cole

Brooke Elliott

Susan Gamsey

Sincerely,

David Hays

Christine Jenkins

Ashleigh Jones

Tina Mattila

Andrea Golato  
Associate Dean, Graduate College

Ramona Oswald

Yoon Pak

Joseph Rosenblatt

Alex Winter-Nelson

Assata Zerni

c: V. Coverstone  
M. Insana  
A. Kopera  
M. Lowry  
S. Rodriguez Zas  
E. Stovall



**I L L I N O I S**  
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Mary Lowry

Director, Academic Programs and Policy

University of Illinois at Urbana-Champaign

Dear Mary

The campus-wide M. Sc. in Bioinformatics steering committee reviewed the proposal for a M. Sc. in Bioinformatics, Bioengineering concentration, put forward by the Department of Bioengineering. The proposal was first presented to our committee by Professors Insana and Zhong in 2012.

The steering committee agreed that the thesis and non-thesis options of the program offered by Bioengineering are aligned with the overarching goals of the campus-wide initiative. The committee supports the proposed graduate program of studies.

The proposed concentration will further strengthen the campus-wide initiative. Likewise, the infrastructure and resources developed by the units already offering M. SC. in Bioinformatics (Crop Sciences, Computer Sciences, Library and Information Sciences, Chemical and Biomolecular Engineering and Animal Sciences) and by the Illinois Informatics Institute (I3) will facilitate the establishment of the new concentration.

Do not hesitate to contact me if I can offer additional information

Sincerely

Sandra Rodriguez Zas

Campus-wide M. Sc. in Bioinformatics Committee Chair

University of Illinois at Urbana-Champaign

rodrzszs@illinois.edu

UNIVERSITY OF ILLINOIS  
AT URBANA-CHAMPAIGN

EP.14.03

Office of the Provost and Vice Chancellor  
for Academic Affairs

Swanlund Administration Building  
601 East John Street  
Champaign, IL 61820



July 30, 2013

Gay Miller, Chair  
Senate Committee on Educational Policy  
Office of the Senate  
228 English Building, MC-461

Dear Professor Miller:

Enclosed is a copy of a proposal from the College of Engineering and the Graduate College to establish a Bioengineering concentration in the Master of Science in Bioinformatics.

The proposal has been reviewed and approved by the College of Engineering Executive Committee as well as the Graduate College Executive Committee. It now requires Senate review.

Sincerely,

A handwritten signature in black ink that reads "Kristi A. Kuntz".

Kristi A. Kuntz  
Assistant Provost

Enclosures

c: V. Coverstone  
R. Dennis  
M. Insana  
A. Kopera  
M. Lowry  
S. Rodriguez Zas  
E. Stovall



UNIVERSITY OF ILLINOIS  
AT URBANA-CHAMPAIGN

College of Engineering  
306 Engineering Hall, MC 266  
1308 West Green Street  
Urbana, IL 61801



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MAR 14 2013

GRADUATE COLLEGE

March 8, 2013

Andrea Golato  
Associate Dean  
Graduate College  
204 Coble Hall  
MC-322

Via: Michael B. Bragg, Engineering College

Dear Dean Golato:

The College of Engineering Executive Committee has reviewed and approved the following proposals:

**Proposal for a Bioengineering Concentration within the Master of Science (M.S.) in Bioinformatics**

Attached is a copy of the requests.

Sincerely yours,

John Hart, Secretary  
Executive Committee

Approval Recommended:

Michael B. Bragg, Interim Dean  
College of Engineering

3/19/13  
Date

JBF/rd

Enclosure

c: Victoria Coverstone  
Jonathan Freund  
Elizabeth Stovall  
Robin Dennis