PROPOSAL TO ESTABLISH Graduate Certificate in Biotechnology

Type of Degree: Graduate

Title of Proposed program: Graduate Certificate in Bioinformatics

Degree and Abbreviations: Graduate Certificate in Bioinformatics

Please designate a responsible department and individual for this proposal:

Seema Freer Ph.D.,
Associate Professor,
Coordinator, PSM Programs in Biology,
Department of Biology, Rm 333 C
215 204-8842
sfreer@temple.edu

FEBRUARY 1, 2018
TEMPLE UNIVERSITY
Department of Biology
Graduate Certificate in Bioinformatics

I. Overview and Rationale

Bioinformatics is the science that happens when computers are joined with the latest discoveries in genomics, biochemistry and biophysics. It is a rapidly growing field that brings together elements of biology, chemistry, computer science, physics, and statistics. Bioinformatics is an area of rapid job growth and has become an essential part of healthcare research and the biotechnology and pharmaceutical industries. Bioinformatics specialists are employed to process and analyze the high volume of genomic and proteomic data generated from large scale sequencing and related efforts that form the foundation of personalized medicine.

Since the start of this program in Fall of 2014 the Professional science Master’s (PSM) in Bioinformatics has seen a growth in numbers and graduates have found positions in the fields of genomics, bioinformatics and computational biology.

This program has also been very popular with scientists who have previously been trained in molecular biology, and seek to train in bioinformatics for their own research without having to rely on outsourcing their work. There is an awareness among the faculty of the Steering Committee that such students who are seeking advanced training, and not a career change, would prefer not to complete a 30 credit degree option, but choose just the courses which would bridge the gap in knowledge in this field. Such students, and others, who for various reasons cannot commit to a 4 - 5 semester program would benefit from a 1 - 2 semester Graduate Certificate in Bioinformatics.

II. Relationship of Proposed Program to others in the College or University

The certificate will provide advanced academic credentials for the working professional seeking training beyond the baccalaureate degree. This Certificate program will closely reflect the parent program PSM in Bioinformatics but with the focus of allowing students to complete it in 1-2 semesters and add to the training the courses that would be most relevant to their career goals. The PSM in Bioinformatics is a 4 - 5 semester program developed by the faculty of Biology, Chemistry and Computer and Information Sciences with an External Advisory Board consisting of experts in academia and industry.

Recent graduates have found positions in industry and some have gone to pursue a Ph.D. in Bioinformatics. The Certificate in Biotechnology program will provide a mechanism to obtain a certificate in the field in 1 - 2 semesters, or for the part time student, the time required to complete 12 credits of core classes, with a GPA of 3.0. The classes will be taught by the same faculty as in the PSM in Bioinformatics program, as students will be taking the same core classes as the PSM in Bioinformatics students without committing to a capstone project or a graduate degree requiring 30 credits. The Certificate in Biotech program will credential such students in the field through a curriculum chosen according to the student’s interest or gap in knowledge.
III. **Curriculum** Below is the list of core course which a student may take to complete the Graduate Certificate in Bioinformatics. Student advising will be provided to meet the specific interests for each student. Detailed course descriptions provided in Appendix I. Student will pick any of the following Core Curricular classes offered in the PSM in Biotechnology program for a total of, and no more than 12 credits. **Detailed course descriptions provided in Appendix I**

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<tr>
<th>Course Code</th>
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<td>BIOL 5509</td>
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IV. **Impact on Faculty and Students** This will not impact faculty or require new faculty.

V. **Impact on Resources** This program is a tuition generating program and will contribute to the revenue stream already generated by the parent program.

VI. **Assessment** A formal assessment will be conducted after the certificate has run for one or two years.

VII. **Summary of Peer or Aspirant Programs**
A Graduate Certificate in Bioinformatics is offered in a few universities. Appendix II has a chart showing the peer and aspirant universities selected from a list of public universities located in urban areas. These criteria were previously used for the recently conducted Biology department self-study.

VIII. **Implementation**
Pending approval, the certificate program is ready for a start date of Fall 2018.

IX. **Process for Proposal Development**
The certificate program was developed by the Steering Committee based on reflection of graduate outcomes, conversations with students and the Committee’s observations of student progress. The focus of developing this program was to provide a mechanism for students to succeed who, for various reasons whether financial, academic or work related could not continue in the program.
Appendix I

BIOL 5132 Biostatistics 3 credits
Biostatistics is an important part of the research activities related to biological and medical issues. Statistics is used to analyze phenomena with random properties and is often essential to draw the right conclusions based on a data set. The course will be designed to cover different statistical methods for data analysis mainly applied to medical and biological problems. Advanced undergraduate and graduate students with interests in medicine and biomedical research will benefit most from the course. However statistical methods that can be applied to behavioral science and ecology will also be covered.

BIOL 5403 Genomics 3 credits
This graduate course will cover the processes of gene inheritance and gene expression as they are manifested across the entire genome. Students will learn about genome-related technologies, including genome sequencing and mapping. They will also learn about genome structure and how genomes vary across species, as well as the forces driving these evolutionary changes. A significant part of the course will cover genome-level data analyses, and students will complete a major project in genome analysis, in addition to several smaller problem-based assignments

BIOL 5411 Structural Bioinformatics I 3 credits
This graduate course will cover the processes of gene inheritance and gene expression as they are manifested across the entire genome. Students will learn about genome-related technologies, including genome sequencing and mapping. They will also learn about genome structure and how genomes vary across species, as well as the forces driving these evolutionary changes. A significant part of the course will cover genome-level data analyses, and students will complete a major project in genome analysis, in addition to several smaller problem-based assignments

CHEM 5412 Structural Informatics II 3 credits
This course is designed to provide a basic introduction to experimental and computational methods used in protein structure determination and molecular modeling. The course emphasis will be on the use of computational methods to understand protein folding, dynamics and structure based drug design. The course will provide practical training in the application of modeling techniques in drug discovery.

BIOL 5509 Computational Biology 3 credits
This is a course on the application of genome-related concepts to genome sequence data. Students will gain familiarity with both existing software and with basic programming (scripting) skills for problems in genomics. Further, students will come to understand the connections between standard computational and statistical approaches and their underpinnings in those fields increasingly dominated by
These include the fields of molecular evolution, population genetics, molecular genetics, molecular biology, and biochemistry. The course will be a hands-on computational lab course, with students working on problems and assignments in class using their laptop computers. Shell scripting and the programming language Python will be used for most of the course.
Appendix II

Undergraduate and graduate level Certificates being offered in Biology department of selected public universities located in urban areas.

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<th>List of Universities selected</th>
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PROPOSAL TO ESTABLISH Graduate Certificate in Biotechnology

Type of Degree: Graduate

Title of Proposed program: Graduate Certificate in Bioinnovation

Degree and Abbreviations: Graduate Certificate in Bioinnovation

Please designate a responsible department and individual for this proposal:

Seema Freer Ph.D.,
Associate Professor,
Coordinator, PSM Programs in Biology,
Department of Biology, Rm 333 C
215 204-8842
sfreer@temple.edu

FEBRUARY 1, 2018
TEMPLE UNIVERSITY
Department of Biology
Graduate Certificate for Bioinnovation

I. Overview and Rationale
The primary objective of the Professional Science Master's (PSM) in Bioinnovation program is to develop a portfolio of knowledge and experience that will allow individuals with background in science, business, communication, law and policy and regulation to pursue careers in fast growing fields, such as global health, pharmaceutical and biotech industry, bioinformation, technology transfer, environment and trade. The program provides (a) extensive biotechnology and biomedical background to challenge and complement traditional thinking and applications; (b) reviews translational nature of biodiscoveries through classroom instruction and direct interaction with different bioindustry professionals, including scientists, lawyers, journalists, etc.; (c) develops team and matrix work routines and effective communication skills. The program is designed to help graduates in obtaining relevant employment as well as to accelerate career advancement and/or allow career shift of currently employed professionals.

The Graduate Certificate in Bioinnovation is being designed to allow working professionals with an interest in earning academic credentials and practical training in the business of science by taking 12 credits of Core Curricular classes in Bioinnovation program.

II. Relationship of Proposed Program to others in the College or University:
The certificate will provide advanced academic credentials for the working professional seeking training beyond the baccalaureate degree. The certificate of Bioinnovation is being developed as a 12 credits course derived from the parent program, PSM in Bioinnovation. The PSM in Bioinnovation is 4 - 5 semester degree program which includes one summer semester and is a collaborative curriculum planned by the Temple University's Department of Biology and Fox School of Business. Developed with input from an external advisory board composed of leading individuals in the field, the programs curriculum provides students with the skills and knowledge necessary to manage the rapid transitions that happen as a by-product of innovation such as creating start-ups, protecting intellectual property and acquiring funding.

Since the start of the program in Fall of 2014 this program has grown and its recent graduates have developed start-ups and have found jobs in the healthcare, pharmaceutical and industries where an expertise in Life Sciences is required. The Steering Committee has recommended that a shorter transcripted certificate program be developed to help students who, due to the financial burden, their workload at their jobs or changes in their work responsibilities cannot commit to 4 - 5 semester 30 credit degree program. The Graduate Certificate in Bioinnovation will alleviate some of the issue which working professional face by being offered over 1 - 2 semesters requiring a total of 12 credits.

III. Curriculum
Below is the list of core courses which a student may take for up to and no more than 12 credits to complete the Graduate Certificate in Bioinnovation. Student advising will be
provided to meet the specific interests for each student. **Detailed course descriptions provided in Appendix I**

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<td>Innovative BioModels and Concepts</td>
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<td>BIOL 5227</td>
<td>Biomarkers and Biotargets: Research and Commercialization</td>
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<td>BIOL 5228</td>
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<td>BIOL 5229</td>
<td>Systems Biology: Principles and Applications</td>
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<td>BIOL 5505</td>
<td>Ethics, Regulation and Policy</td>
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<tr>
<td>SGM 5136</td>
<td>Principles of Management and Strategy</td>
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I. **Impact on Faculty and Students** This will not impact faculty or require new faculty.

II. **Impact on Resources** This program is a tuition generating program and will contribute to the revenue stream already generated by the parent program.

III. **Assessment** A formal assessment will be conducted after the certificate has run for one or two years.

IV. **Summary of Peer or Aspirant Programs**

V. A Graduate Certificate in Bioinnovation is not offered in any University. Appendix II has a chart showing the peer and aspirant universities selected from a list of public universities located in urban areas. These criteria were previously used for the recently conducted Biology department self-study.

VI. **Implementation**

Pending approval, the certificate program is ready for a start date of Fall 2018.

VII. **Process for Proposal Development**

The certificate program was developed by the Steering Committee based on reflection of graduate outcomes, conversations with students and the Committee’s observations of student progress. The focus in developing this program was to provide a mechanism for students to succeed who, for various reasons whether financial, academic or work related could not continue in the degree program. The committee also considered the working professional who are seeking a shorter program.

**Appendix I**

- **BIOL 5226. Innovative Biomodels and Concepts (Core: 3 credits)**
  The aim of this course is to familiarize students with current concepts, models, and cutting-edge technologies applicable in different bioindustries. The scope of topics ranges from the implementation of discoveries stemming from molecular genetics, cell biology and nanotechnology in different industries to integration of omics techniques in personalized medicine, drug discovery and pharmacovigilance.

- **BIOL 5227. Biomarkers and Biotargets: Research and Commercialization (Core: 3 credits)**
This course focuses on the evolution of biomarker and biotarget research, with emphasis on biomarker validation and biotarget druggability. The students will analyze real-life examples of biomarkers and biotargets in medicine, drug development, and environmental science. The formation of therapeutic target databases and development of multi-target agents will be critically evaluated.

- **BIOL 5228. Epigenetics, Genetics: Applications in Drug Design and Drug Response (Core: 3 credits)** This course focuses on applications of current epigenetics knowledge in health industries. Special emphasis is on epigenetic and genetic testing in clinical settings, epigenetic and genetic determinants of drug response as well as drug- and environment-induced modulation of epigenetic status. By successfully accomplishing this course, the students will learn a) how the epigenetic status may affect drug response; b) how drugs and environment may affect the epigenetic status itself; c) how pharmacoepigenetic mechanisms offer another level of explanation for inter-individual variations in drug response; and d) how pharmacoepigenomics varies within and between different populations.

- **BIOL 5229. Systems Biology: Principles and Applications (Core: 3 credits)** This course provides an overview of systems biology technologies and the scientific challenges in applicability of system biology paradigms in the analysis of biological processes. Topics covered include the use of genome-scale in silico models and dissecting transcriptional control networks. By successfully completing this course, the students will obtain background on theoretical and modeling techniques, and software platforms for systems biology.

- **BIOL 5239. Dissemination of Bio-discoveries and Virtual Reality in Medicine (3 credits)** The students will learn contemporary methods of effective dissemination of research findings and concepts to professional and lay audiences. Current real-life findings will be presented through slide and video development, press releases, and the use of social media. Furthermore, this course will provide the students with a background on Virtual Reality and its applications in medicine, laboratory research, training and education in bioindustry.

- **SGM 5136 Principles of Management and Strategy (Core: 3 credits)** This is a core and onboarding course for all students in Innovation and Entrepreneurial Institute and will be recommended for all Bioinnovation students taking their first class in business school. Since Fox does morph its courses often, given the nature of the field, there is a possibility a new on boarding course will be offered in the future.

- **BIOL 5505 Ethics in Biotechnology (Core: 3 credits)** The Ethics and Policy course is designed for students in the PSM program. This course will provide an understanding of ethical decisions, governmental regulations and policies in biotechnology. A case study approach will be used to provide a framework for discussions of policy and ethical decision making. Guest speakers will provide insights from legal and governmental perspectives on emerging and current biotechnology applications.
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FEBRUARY 1, 2018
TEMPLE UNIVERSITY
Department of Biology
Graduate Certificate in Biotechnology

I. Overview and Rationale

Biotechnology is, at its simplest, technology based on biology. It harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet. Modern Biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes. Recent advances in biotechnology are helping us prepare for and meet society's most pressing challenges.

The Professional Science Master’s (PSM) in Biotechnology was developed to train STEM majors to participate in the continued technological advances needed through a formal academic curriculum. PSM in Biotechnology program’s growth over the past 6 years has validated the premise that academic training in the field of Biotechnology will result in trained individuals who will participate in research development and advancement in the biotechnology and pharmaceutical industries. The PSM program in Biotechnology has a 95% employment record with most students entering the pharmaceutical or related industries.

The PSM in Biotechnology degree program can be completed in 4-5 semesters which includes one summer semester. Among the working professionals who are seeking advancement and career mobility, a 4-5 semester training is often not feasible, and the interest in a shorter 1-2 semester certificate program has been frequently requested. Further, a small percentage of student have dropped out of the program as they could not commit to a 4-5 semester degree program due to the financial burden, their workload at their jobs or changes in their work responsibilities.

The Steering Committee has therefore considered a shorter, transcripted certificate program, which could be completed in 1-2 semesters, serving the working professionals who need academic credentials for career advancement.

II. Relationship of Proposed Program to others in the College or University:

The certificate will provide advanced academic credentials for the working professional seeking training beyond the baccalaureate degree. The certificate will be transcripted requiring the completion of up to and no more than 12 credits from the list of core classes in the current curriculum of the PSM in Biotechnology. It will also be a means for training of students who are unable to complete the rigors of a 4 - 5 semester degree program, in 1 - 2 semesters.

The Professional Science Master’s in Biotechnology (PSM Biotech) is a two-year degree program hosted at the Department of Biology with courses taught by diverse faculty from Temple University, industry, and government. The Graduate Certificate in Biotechnology program will provide a mechanism to obtain a certificate in 1 - 2 semesters, or, for the part time student, in the time required to complete 12 credits of core classes, with a GPA of 3.0. The classes will be taught by the same faculty as in the PSM in Biotechnology program, as students will be taking the same core classes as the PSM in Biotechnology students without committing to a capstone project or a graduate degree requiring 30 credits. The Certificate in Biotech program will credential future leaders in the field through a curriculum chosen according to the student’s interest.
III. **Curriculum:**
Below is the list of core courses which a student may take to complete the certificate in Biotechnology. Student advising will be provided to meet the specific interests for each student.

Student will pick any Core Curricular classes offered in the PSM in Biotechnology program for a total of, and no more than 12 credits. Note BIOL 5501 and 5521 are 1.5 credits each. **Detailed course descriptions provided in Appendix I**

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<tr>
<td>BIOL 5501</td>
<td>Analytical Biotechnology</td>
</tr>
<tr>
<td>BIOL 5521</td>
<td>Nucleic Acid Technologies</td>
</tr>
<tr>
<td>BIOL 5503</td>
<td>Biotechnology Lab I</td>
</tr>
<tr>
<td>BIOL 5505</td>
<td>Ethics, Policy and Regulation</td>
</tr>
<tr>
<td>BIOL 5502</td>
<td>Microbial Biotechnology</td>
</tr>
<tr>
<td>CEE 5793</td>
<td>Environmental Biotechnology</td>
</tr>
<tr>
<td>BIOL 5504</td>
<td>Biotechnology lab II</td>
</tr>
<tr>
<td>BIOL 5479</td>
<td>Current Topics in Biotechnology</td>
</tr>
</tbody>
</table>

IV. **Impact on Faculty and Students** This will not impact faculty or require new faculty.

V. **Impact on Resources** This program is a tuition generating program and will contribute to the revenue stream already generated by the parent program.

VI. **Assessment** A formal assessment will be conducted after the certificate has run for two years.

VII. **Summary of Peer or Aspirant Programs** A Graduate Certificate in Biotechnology is offered in a few universities. Appendix II has a chart showing the peer and aspirant universities selected from a list of public universities located in urban areas. These criteria were previously used for the recently conducted Biology department self-study.

VIII. **Implementation**
Pending approval, the certificate program is ready for a start date of Fall 2018.

IX. **Process for Proposal Development**
The certificate program was developed by the Steering Committee based on reflection of graduate outcomes, conversations with students and the Committee’s observations of student behaviors.
progress. The focus of developing this program was to provide a mechanism for students to succeed who, for various reasons whether financial, academic or work related could not continue in the program. It is also designed for students who want to enhance their knowledge of biotechnology but do not wish to enroll in the full length PSM program.

Appendix I

BIOL 5501 Analytical Biotechnology 1.5 credits This course provides a comprehensive introduction to current approaches to the analysis of biomolecules, with a special focus on proteins and nucleic acids giving the students a background on the basic principles of key analytic biotechnologies, and how these technologies allow sensitive and accurate detection, purification, and characterization of biomolecules.

BIOL 5521 Nucleic Acid Technologies 1.5 credits New technologies that detect, purify, synthesize and sequence DNA and RNA are providing new insight on the structure, function, and evolution of genes and genomes. The accelerating 'big bang' of nucleic acid sequence data reflects major recent advances in nucleic acid sequencing and sequence analysis. Nucleic Acid Technologies is designed to provide information on the technologies by which RNA and DNA can be isolated, analyzed and manipulated to gain insight on gene function and to enable new biotechnological applications.

BIOL 5503 Biotechnology Lab I 3 Credits This course is designed to provide practical, hands-on experience with human cell culture techniques, in vitro manipulation of genes and proteins, and data analysis that are fundamental to many areas of biotechnology.

BIOL 5504 Biotechnology Lab II 3 Credits
This course is designed to introduce students to some of the major areas of microbial biotechnology including wine production, utilization of microbial fuel cells (MFCs) and wastewater treatment.

BIOL 5505 Ethics and Policy in Biotechnology 3 Credits
The rapid growth of biotechnological applications and commercialization of these products has resulted in seemingly retroactive regulations and policies to govern the safe use of these technologies. This course will provide awareness and an ethical framework to the future leaders of the Biotech sector who are in the Professional Science Master's program.

BIOL 5502 Microbial Biotechnology 3 Credits
Microbial Biotechnology is a graduate student level course that provides an overview of how microbes are manipulated to solve practical problems through biotechnology. Topics include microbial ecology, cloning, protein engineering, industrial microbiology, pathway engineering, bacteria and plants, phage, the gut microbiome, metagenomics and the biorefinery.

BIOL 5479 Current Topics in Biotechnology 3 Credits
This course is designed to survey current issues in technologies including therapeutics and diagnostics, and to examine consequences of developments in this
area. The course is designed in a Problem Based Learning format, where students research critical areas and provide oral and written reports for other members in the class. The course is organized by topics including Concepts in Genetics, Cloning and Ethics, Gene Therapy, Prenatal Diagnosis, Gene Therapy for Cancer, Cell Replacement Therapy, Genomics and Proteomics, Vaccines, Forensics, Plant Biotechnology, and Instrumentation. At the end of the course, each student makes a formal presentation on a specific advance in biotechnology.

**CEE 5793 Environmental Biotechnology 3 Credits**

Biotechnology plays a central role in environmental science and engineering, including wastewater treatment, pathogen control, and biodegradation. The objective of the course is to provide environmental engineers and scientists with advanced concepts and quantitative tools that are necessary for understanding environmental processes and designing environmental protection systems.
# Appendix II

Undergraduate and graduate level Certificates being offered in Biology department of selected public universities located in urban areas.

<table>
<thead>
<tr>
<th>List of Universities selected</th>
<th>Department</th>
<th>Certificate in Genome Medicine (Undergraduate)</th>
<th>Certificate in Biology Teacher preparation</th>
<th>Certificate in Learning beyond the classroom</th>
<th>Certificate in Biotechnology</th>
<th>Certificate in Life Sciences Research (Undergraduate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEMPLE UNIVERSITY</td>
<td>Biology</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>University of Washington</td>
<td>Biology</td>
<td></td>
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<tr>
<td>University of Utah</td>
<td>Biology</td>
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<tr>
<td>Purdue University</td>
<td>Biological Sciences</td>
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<tr>
<td>University of Pittsburgh</td>
<td>Biological Sciences</td>
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<tr>
<td>North Carolina State U</td>
<td>Biological Sciences</td>
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<tr>
<td>University of Iowa</td>
<td>Biological Sciences</td>
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<tr>
<td>Indiana University</td>
<td>Biology</td>
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<tr>
<td>ASPIRANT (ABOVE)</td>
<td></td>
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<tr>
<td>PEER (Below)</td>
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<tr>
<td>TEMPLE UNIVERSITY</td>
<td>Biology</td>
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</tr>
<tr>
<td>University at Buffalo</td>
<td>Biological Sciences</td>
<td></td>
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</tr>
<tr>
<td>University of Virginia</td>
<td>Biology</td>
<td></td>
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<tr>
<td>University of Delaware</td>
<td>Biological Sciences</td>
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<tr>
<td>SUNY Albany</td>
<td>Biological Sciences</td>
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<tr>
<td>University of Cincinnati</td>
<td>Biological Sciences</td>
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</tbody>
</table>
Establish the Master of Arts Program in Biology

College of Science and Technology

Summary

The department currently offers a PhD in Biology, MS in Biology, PSM in Biotechnology, PSM in Biotechnology, PSM in Bioinnovations and a PSM in Scientific Writing. Inquiries from prospective students suggest that our current programs are not meeting the needs of all those seeking an education in Biology at the master’s level at Temple University. The MA will provide an important niche for those whose interests are not met by the MS and PSM programs. If the program is approved, the department will seek to establish an accelerated +1 Masters program.

1. Program Rationale

About 13 years ago, shortly after formation of the College of Science and Technology the department converted an MA program to an MS program to more accurately reflect the college’s and department’s emphasis on research. The MS requires that all students complete a research-based thesis. In this document the term, research-based thesis describes a thesis based on original experimental research whether it be conducted in a laboratory, in the field or in a computational setting. It should be distinguished from a thesis based on a review of the literature, which will be referred to as a non-research literature thesis.

Nationally, graduate enrollment has grown considerably in most Science and Engineering fields, particularly in Biology (https://www.nsf.gov/statistics/seind14/index.cfm/chapter-2/c2s3.htm). Within this population there is a segment that does not wish to engage in experimental research, whether they are recent graduates seeking further education or more mature individuals seeking to redefine their careers. This is reflected in the considerable growth that the Biology department has seen in the Professional Science Masters programs established within the last few years. PSMs are typically focused on a sub-specialty of a particular field and there is a limit to the number that the department can offer. An MA program will provide a broader umbrella for those students seeking a master’s degree without engaging in experimental research. The large number of graduate courses available in our current doctoral and masters’ programs, many of which are offered in the evening, make the department particularly competitive compared to neighboring institutions. Students will also be able to take advantage of courses designed for the PSMs to advance professional development.

Comparison to other MA and MS programs

Many peer and aspirant biology departments have separate MA and MS programs (e.g. University of Virginia, SUNY Buffalo). MA programs typically require a thesis based primarily on independent research but not necessarily experimental research, for example a non-research literature thesis. This may be referred to as a non-laboratory research thesis option, or simply a “non-thesis option”. Other models exist, local examples include:
Villanova’s MA has no thesis requirement but has others: a comprehensive exam and a core requirement of 4 graduate courses with a laboratory component.

St Joseph’s University’s MA has no thesis requirement but every elective has a laboratory component.

Some MS biology programs offer a non-laboratory research thesis option or replace the thesis requirement altogether, for example:

**West Chester University of Pennsylvania** offers a MS with a “non-thesis option” consisting of, “a comprehensive literature search and/or development of specialized techniques” to be presented in an “open seminar”. It also requires a written comprehensive examination and 3 research techniques courses.

**Fairleigh Dickinson University** offers an MS in which a research thesis may be substituted with “two additional biology courses”

**Rutgers University** offers a MS with a “non-thesis option” consisting of “an essay on some problem (critical analysis of a topic) in biology of current research interest” and a written and/or oral comprehensive examination.

**Lehigh University** has a Distance Education MS in Molecular Biology with 3 non-research thesis options.

**Summary statement on MA versus MS**

The department does not wish to modify the current MS by providing a non-laboratory research thesis option. It is the Biology department's position that there should be a clear distinction between a master's program that requires an experimental research thesis and one that does not. Students who wish to complete a Masters without doing experimental research would be directed to the MA program described in this proposal.

2. **RELATIONSHIP OF PROPOSED PROGRAM TO OTHER PROGRAMS IN THE DEPARTMENT, COLLEGE AND UNIVERSITY**

**PSM programs.** The MA will provide an important niche for those whose interests are not met by the highly focused PSM programs (potential applicant pool is described below). Students enrolled in the MA program will be permitted to petition to transfer to the PSM programs if their goals change but realistically this should be considered towards the end of the first semester.

**MS program.** Students wishing to complete an experimental research thesis must enroll in, or petition to transfer to the MS program. It will not be an option in the MA program.

**Post baccalaureate program.** Students with a BA/BS seeking to strengthen an application to medical school will be informed of the Post-Baccalaureate Pre-Health Program offered by CST.

**The Lewis Katz School of Medicine** offers a MS with either a 30 credits research-based thesis or a 36 credit non-thesis option.
3. CURRICULUM FOR MA

<table>
<thead>
<tr>
<th>PROPOSED MA</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>8003 Introduction to Biological Research</td>
<td>3</td>
</tr>
<tr>
<td>Electives (5 total)</td>
<td>15</td>
</tr>
<tr>
<td>Seminars (2 total)</td>
<td>6</td>
</tr>
<tr>
<td>9996 Non-research thesis</td>
<td>6</td>
</tr>
<tr>
<td>Total (minimum)</td>
<td>30</td>
</tr>
</tbody>
</table>

**Required Courses**

1. BIOL 8003 Introduction to Biological Research

2. Non-research literature thesis  BIOL 9996 (6 credits - two semesters).

   BIOL 9996, requires an advisor who must be graduate faculty. Advising may be provided, under the guidance of biology graduate faculty, by NTT research faculty, or a postdoc with appropriate credentials, or graduate faculty in other Temple departments. The thesis will be evaluated by the student’s advisor and one other graduate faculty member.

**Electives** can be selected from any biology graduate level course. Courses of a more general nature that may be taken for credit include:

- BIOL 5505 Ethics, Policy and Regulation (PSM) (3 s.h.)
- BIOL 5506 Professional Development Seminar (PSM) ) (1 s.h.)
- BIOL 5511 Ethics in Bioinformatics. (2 s.h.)
- BIOL 8985 Teaching in Higher Education: Life Sciences. (3 s.h.)

**Seminars.** Two 3 credit seminar courses (BIOL 825x) are required.

The MA will be more attractive if students are permitted to take courses from other colleges such as the College of Education. Nevertheless, at least 21 credits should be biology courses. Non-biology graduate elective courses must be from a biology related field such as Psychology, Education, Chemistry, Neuroscience, Computer Science, etc. Such electives must be approved by the graduate chair and the student’s advisor.

4. IMPACT ON FACULTY AND STUDENTS

**Admission Requirements (based on MS program)**

Applicants should have a solid background in Biology and should have taken at least eight undergraduate Biology courses and one year each of Chemistry, Physics, and Calculus. The Biology Department Graduate Committee may allow exceptions to these course requirements after review.

A baccalaureate degree in a science field is required.

**Potential Student Pool**
Informed in part by inquiries about our current master’s programs, we expect our pool of students to be diverse and to include:

- Students with STEM undergraduate degrees
- Applicants preparing for specific careers such as patent law.
- Professionals such as teachers seeking advanced degrees without participating in lab research
- Domestic and foreign applicants

In the last few years we have received about 15-20 applications per year to the MS program from students who meet the standards for admission but have too little research experience to be accepted provisionally by a research advisor. About a third of these are international students. It is reasonable to believe that some would be interested in an MA program.

Recruitment will be aided by the increasing visibility and strength of various graduate programs in the department.

**Impact on Faculty**
Admission to the MS program requires that a faculty member agree to act as a prospective advisor to ensure that the student can complete the research thesis component of the MS. This policy would be relaxed for the MA. Nevertheless, every student in the MA program will need an official advisor to oversee the non-research literature thesis. While an MA student will require less supervision than a MS student, enrollment in the MA will depend on the number of faculty who can commit to advising MA students while mentoring graduate students more deeply engaged in their laboratory’s research projects.

Advising could be provided, under the guidance of biology graduate faculty, by NTT research faculty, or a postdoc with appropriate credentials, or graduate faculty in other Temple departments.

### 5. Program Resources, Estimated Costs and Revenue Stream

**Faculty**
Since all courses will be selected from pre-existing graduate programs no further faculty are required. No staffing expansion is anticipated.

**Costs and Budget**
No program specific courses will be established. Current graduate courses should be able to assimilate the number of expected participants. As a consequence the program will be financially self-sufficient if enrollment is low in any one year. The only initial cost will be development of a webpage. We anticipate combining the MA and MS webpage and taking the opportunity to upgrade the MS webpage.

**Initial (start-up) Costs:**

- Web page development $2,000
Estimated total initial cost: $2,000

Recurring Costs
Periodic upgrades of the webpage are anticipated and should be less than $2,000 every three years.

Program Revenue
The program is anticipated to be financially self-sufficient with minimal enrollment.

Tuition represents the main revenue stream. Assuming that the program will be completed in two years, students will take 15 credits/year. Since recurring costs will be minimal, all gross revenue will effectively be net revenue. Some revenue will be shared with other colleges such as the College of Education if students take courses outside of CST.

Estimated revenue is as follows: Tuition is assumed to be entirely at the in-state rate: $1,019/credit (out-of-state rate is $1,343/credit).

Year 1 tuition revenue (3 students): $45,855
Year 2 tuition revenue (6 students): $91,710
Year 3 tuition revenue (6 students): $91,710

6. PROGRAM OUTCOMES

Successful graduates will demonstrate:
- Advanced knowledge in one or more fields of biology
- Proficiency in searching, analyzing and interpreting primary scientific literature
- The ability to write critical, authoritative, in-depth scientific reviews
- Effective communication at a professional level using oral, written, or electronic media

7. IMPLEMENTATION

Fall 2018
1. Rational
The CIS department proposes to change the existing Graduate Masters Certificate in Information Science and Technology. The Board approved Certificate is comprised of 12 graduate credits selected from one required core course and three elective courses. This proposal raises the overall coursework to 15 credits and eliminates the required course, thus allowing students more flexibility in customizing their learning. Our rationale for changing the Graduate Certificate in IS&T is to reflect the new M.S. in IS&T program requirements.

The certificate is designed to meet professional needs for individuals in the workforce who seek advanced training and advanced competencies in information science and technology, but who may be unable to complete the 30-credit, 2-year M.S. in IS&T program. Due to the overlapping coursework, the revised Graduate Certificate can also serve as a pathway to the existing M.S. in IS&T program.

2. Relationship to other programs
No related programs

3. Curriculum
The Graduate Masters Certificate in IS&T requires a total of 15 credits. Any 5 courses which are approved for the M.S. in IS&T degree can be taken, excluding CIS 9XXX courses (independent study and MS project courses), for a minimum of 15 credits. Any 5000-level CIS course approved for the M.S. in IS&T program will count for this certificate. See Appendix for a list of available courses.

4. Impact on faculty and students
No impact as all the courses for the Masters Certificate in IS&T are already being offered as part of the M.S. in IS&T degree program.

5. Impact on resources
No impact as all the courses for the Masters Certificate in IS&T are already being offered as part of the M.S. in IS&T degree program.

6. Assessment (goals and learning outcomes)
The goal of the certificate program is to provide applicants who are unable or unwilling to complete the entire 2 year M.S. in IS&T program a means of obtaining additional training. The learning outcomes for the certificate are that the student be able to have an understanding of operating systems and system architectures, including networks and distributed systems, as well as common computer applications, including databases, mobile, and web technologies; and be able to communicate using oral, written or electronic media, and have teamwork and leadership skills needed to identify, analyze and solve informational system issues.

7. Summary of peer programs
NA.

8. Implementation
The proposed change will take effect in Fall 2018. Because the certificate program is a subset of the MS/IST program, we anticipate the majority of the students already interested in our MS/IST program, but are unable to commit to the full degree.

9. Process
The concept of the original Masters Certificate in IS&T was established in Spring 2014. This updated Master Certificate in IS&T was developed and approved by the CIS graduate committee with the approval of the Chair of CIS (Slobodan Vucetic) and the CST Associate Dean for Science Education (Sue Jansen-Varnum).

10. Appendix

**General Program Requirements:** *Number of Credits Required Beyond the Baccalaureate: 15*

<table>
<thead>
<tr>
<th>Select from the following CIS courses*</th>
<th>15 credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code</strong></td>
<td><strong>Title</strong></td>
</tr>
<tr>
<td>CIS 5105</td>
<td>IT Process Management</td>
</tr>
<tr>
<td>CIS 5106</td>
<td>System Development Processes</td>
</tr>
<tr>
<td>CIS 5107</td>
<td>Comp Systems Security&amp;Privacy</td>
</tr>
<tr>
<td>CIS 5108</td>
<td>Emerging Technologies</td>
</tr>
<tr>
<td>CIS 5208</td>
<td>Knowledge Management</td>
</tr>
<tr>
<td>CIS 5210</td>
<td>Seminar in Information Science and Technology</td>
</tr>
<tr>
<td>CIS 5274</td>
<td>Software Quality Assurance and Testing</td>
</tr>
<tr>
<td>CIS 5275</td>
<td>Software Project Management</td>
</tr>
<tr>
<td>CIS 5301</td>
<td>Advanced Database Management Systems</td>
</tr>
<tr>
<td>CIS 5303</td>
<td>Usability Engineering</td>
</tr>
<tr>
<td>CIS 5304</td>
<td>Network Technologies</td>
</tr>
<tr>
<td>CIS 5306</td>
<td>Software Engineering</td>
</tr>
<tr>
<td>CIS 5410</td>
<td>Advanced Seminar in Information Science and Technology</td>
</tr>
</tbody>
</table>

* Note that this is not an exhaustive list. Any 5000-level CIS course approved for the M.S. in IS&T program will count for this certificate.
Proposal to Change the Master’s Degree in Chemistry to an M.S.

1. Detailed description and rationale
The Department of Chemistry will replace the currently offered M.A. (Master of Arts) degree with the M.S. (Master of Science) degree. The program will remain unchanged.

The M.S. is the appropriate degree for a chemistry master’s degree. Our M.A. designation is a vestige of a bygone era; Chemistry is the last department in the College of Science and Technology to offer only the M.A. degree. Our current program is consistent with others awarding M.S. degrees, including those at other Pennsylvania state-related institutions (Penn State, Pitt) and at other peer institutions. Penn State and Pitt do not offer direct admission to master’s programs but instead offer the M.S. to students who do not qualify for Ph.D. candidacy. But local peers Drexel and Rutgers do offer direct admission to master’s programs and grant M.S. degrees to students doing either a coursework-based or a thesis-based master’s. UPenn offers direct admission to a Master’s of Chemical Science (M.C.S.) program. Perhaps most importantly, the American Chemical Society, in its nationwide accounting of graduate degrees in chemistry and related fields, does not even offer an option to report M.A. degrees in chemistry but implicitly assumes that all master’s degrees in chemistry are M.S. degrees.

2. Curriculum
These changes will not affect the credits required or time to graduation.
   a. Please see Appendix A for the portion of our Graduate Handbook relevant to master’s degrees in the Department of Chemistry.
   b. Courses are mostly scheduled in the evenings to allow students, especially those with full time jobs, to progress efficiently toward their degree. Students pursuing a thesis-based master’s can do their research when it is convenient for them, within the constraints of lab safety.
   c. The program is held on Main Campus.

3. Impact on Faculty and Students
   a. This change should have no effect on faculty, who are already teaching the necessary courses.
   b. This change should have no significant effect on students, except they will henceforth receive the more appropriate M.S. degree.
4. **Impact on Resources**
   a. There will be no changes in special tuition or fees. Students who apply to the master’s programs are typically self-funded.
   b. The program is held on Main Campus.
   c. We do not anticipate either short- or long-term effects on any other University programs.
   d. We do not anticipate any impact on space resources.

5. **Assessment**
   The program goals and assessment remain unchanged and can be found at: https://cst.temple.edu/academics/graduate-programs/chemistry

6. **Implementation**
   The proposed change will take effect beginning with the December 2018 graduation. There will be no impact on enrolled students.

7. **Process for Development of Proposal**
   a. This proposal was developed by the Graduate Committee of the Department of Chemistry (Rod Andrade, Frank Spano, and Ann Valentine) with the approval of the Chair of the Department of Chemistry (Dan Strongin) and the CST Associate Dean for Science Education (Sue Jansen-Varnum).
   b. The visiting team recommendations from the most recent periodic program review (2017) do not mention the master’s degree designation. It is not known whether they noticed that our master’s degree is currently an M.A. rather than an M.S.
   c. There are no implications for accreditation.
<table>
<thead>
<tr>
<th>DEGREE</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
</table>
| M.A. with Thesis (Option One) | Six formal lecture courses (18 course credits)  
One literature seminar CHEM 9990 (2 credits)  
Research - CHEM 9996 (6 credits)  
Any additional combination of an approved graduate course or research (CHEM 9996) for a total of 4 credits  
Thesis defense (all the requirements stated above for this degree must be satisfied before the defense) |
| M.A. based on Coursework (Option Two) | Ten (10) formal lecture courses (3 credits each)  
Master’s Exam |
| M.A. “5th year” (Option Three) | Same requirements as option one  
Must have begun research no later than undergraduate senior year |
| M.A. “Along-The-Way” (Option Four) | Same as Option 1  
One (1) semester of teaching (minimum)  
Significant research productivity |

- **Option One** designed for students that are not full-time. The student cannot be receiving financial support from the Chemistry Department when completing this option. Any student wanting to pursue this option must receive prior approval from the Graduate Committee.
- **Option Two** designed for those students who already have extensive experience in the laboratory and is exercised by students currently employed in local chemical industry. Students must get permission from the Graduate Committee to pursue this program.
- **Option Three** designed for current Temple undergraduates who wish to spend an additional year to obtain the M.A. degree. (Depending on the progress of the research, it may take longer to obtain the degree.) These students generally begin their undergraduate research during their junior year. At the time of entry into the program, the student’s transcript must show a grade point average (GPA) of at least a 3.0.
- **Option Four** is reserved for students in the Ph.D. program who wish to obtain a M.A. degree.

**Note:** The Master’s exam in Option Two is given in the student’s area of interest. It is written by a group of faculty and/or the research advisor (if applicable). All preliminary requirements (i.e., courses, seminar etc.) must be satisfied before scheduling the exam.