PROGRAM POLICY STATEMENT
FOR MS IN BIOINFORMATICS AND COMPUTATIONAL BIOLOGY COMPUTATIONAL SCIENCE CONCENTRATION

I. PROGRAM HISTORY

A. RATIONALE

The completion of the human genome sequence marked the beginning of a new era of biological research. Scientists have begun to systematically tackle gene functions and other complex regulatory processes by studying organisms at the global scales. Advances in high-throughput biotechnologies and large-scale bioscience have further enabled modeling and simulation over a multitude of length, time and biological scales from biomolecules, cells, tissues and organs to organisms and population. With the enormous volume of data being produced, biology is becoming an increasingly quantitative science. Computational approaches, in combination with experimental methods, have become essential for generating novel hypotheses, deriving new scientific knowledge, and driving discovery and innovation.

Bioinformatics & Computational Biology is an emerging field where biological and computational disciplines converge. According to the National Institutes of Health, the working definitions of Bioinformatics and Computational Biology are as follows:
- Bioinformatics: Research, development, or application of computational tools and approaches for expanding the use of biological, medical, behavioral or health data, including those to acquire, store, organize, archive, analyze, or visualize such data.
- Computational Biology: The development and application of data-analytical and theoretical methods, mathematical modeling and computational simulation techniques to the study of biological, behavioral, and social systems.

Fundamental to the modern day biological studies and key to the basic understanding of complex biological systems, Bioinformatics & Computational Biology is impacting the science and technology of fields ranging from agricultural and environmental sciences to pharmaceutical and medical sciences. The research requires close collaboration among multi-disciplinary teams of researchers in quantitative sciences, life sciences, and their interfaces.

According to many accredited scientific and industry reviews, bioinformatics and computational biology may well be the single fastest-growing specialty in the life sciences. The University of Delaware currently offers a specialized graduate degree in Bioinformatics & Computational Biology, although related courses have been taught in several departments for a number of years. The Master's program in Bioinformatics & Computational Biology offers graduate education in a discipline essential for UD as a major research university. According to the International Society for Computational Biology, there are presently 180 bioinformatics related degree programs worldwide, almost 100 in the United States alone.

The Master of Science program in Bioinformatics & Computational Biology trains the next-generation of researchers and professionals who will play a key role in multi- and interdisciplinary teams, bridging life sciences and computational sciences.

Due to the interdisciplinary nature of bioinformatics and computational biology, experts in these fields within the University of Delaware are housed in many Colleges and Departments on campus and may be in one of several engineering, math or life sciences disciplines. Therefore, the Master's in Bioinformatics and Computational Biology is offered as a university-wide interdisciplinary graduate program that attracts students to many Departments across Colleges.

The Center for Bioinformatics and Computational Biology (CBCB) administers the MS program in Bioinformatics and Computational Biology and coordinates with the individual Departments involved in the program. While this interdisciplinary degree program is offered to students within various Departments, students are required to meet program specific requirements to be awarded the degree in Bioinformatics and Computational Biology.

The scientific curriculum will build upon the research and educational strength from Resources, and Earth, Ocean & Environment. The Master's program will provide a solid foundation for the future development of a PhD degree program in Bioinformatics and Computational Systems Biology. The program will be synergistic to the existing degree programs, providing a critical component to University's strategic priorities in Energy and Environment studies and Translational Medicine, and serving as a pillar of UD's Path to Prominence.

B. DATE OF PERMANENT STATUS
Permanent status approval May 2017

C. DEGREES OFFERED

The programs offer the degree Master of Science in Bioinformatics & Computational Biology (BICB-MS) with a Computational Sciences Concentration (CS).

II. ADMISSION

A. ADMISSION REQUIREMENTS

Admission to the graduate program is competitive. Those who meet stated requirements are not guaranteed admission, nor are those who fail to meet all of those requirements necessarily precluded from admission if they offer other appropriate strengths.

The following are the admission requirements to the Master of Science program in Bioinformatics & Computational Biology:
- A bachelor's degree at an accredited four-year college or university with a minimum grade average of 3.0 on a 4.0 system;
- Applicants may have undergraduate degrees from biological, computational, or other disciplines. However, applicants are expected to have scholarly competence in mathematics, computer science and/or biology;

- The following GRE scores are competitive: Quantitative: 650, Verbal + Quantitative: 1200 if taken prior to August 1, 2011 or Quantitative: 151, Verbal + Quantitative: 307 if taken after August 1, 2011. No GRE subject test is required;
- International student applicants must demonstrate a satisfactory level of proficiency in the English language if English is not the first language. The University requires an official paper-based TOEFL score of at least 550, , or at least 79 on the Internet-based TOEFL. TOEFL scores more than two years old cannot be considered official;
- Three letters of recommendation are required. At least one letter must be from professors, other letters can be from employers or others who have had a supervisory relationship with the applicant and are able to assess the applicant's potential for success in graduate studies; and
- Applications must also include a resume outlining work and academic experience, as well as an application essay consisting of the answers to the following questions:
    1. What educational background and scientific research or employment experience prepare you for this bioinformatics degree program?
    2. What are your long-term professional objectives?
    3. What specific attributes of the bioinformatics program make you feel that this degree is appropriate to help you achieve your professional objectives?

B. APPLICATION

Application to the Master's program in Bioinformatics & Computational Biology is submitted using the on-line graduate admission application that includes transcripts from all previous college or university study, letters of recommendation, resume, application essay, and official GRE and TOEFL scores (if applicable). If any part of an application is missing, evaluation of the application cannot begin. The applicant will apply to the Department of Computer & Information Sciences.

B.1. APPLICATION DEADLINES
Admission decisions are made on a rolling basis as and when applications are complete.
Decisions on financial aid awards are usually made in March-May for the Fall Semester, and in November-December for the Spring Semester. The central graduate admissions office continues to process applications and transcripts throughout the year and follows the stated two (2) week processing timeline for all materials received in the office.
The application deadlines are:
- Fall Semester: July 1st (regular application); March 1st (financial aid)
- Spring Semester: December 1st (regular application); October 1st (financial aid)

B.2. CHANGE OF CLASSIFICATION
Students currently matriculated in other graduate degree programs should complete a "Change of Classification" Form to seek approval to enter the Master of Science program in Bioinformatics & Computational Biology. The Bioinformatics Graduate Committee will evaluate each Change of Classification request on a case-by-case basis and determine whether the student is required to submit a completed admission application form to the Office of Graduate and Professional Education and follow the same procedures for admission as other applicants.

C. ADMISSION STATUS

Students may be admitted into the Professional Science Master's program in Bioinformatics with regular status or provisional status.

Regular. Regular status is offered to students who meet all of the established entrance requirements, who have a record of high scholarship in their fields of specialization, and who have the ability, interest, and maturity necessary for successful study at the graduate level in a degree program.

Provisional. Provisional status is offered to students who are seeking admission to the degree program but lack one or more of the specified prerequisites. All provisional requirements must be met within the deadline given before regular status can be granted. Students admitted with provisional status are generally not eligible for assistantships or fellowships. Students who file an application during the final year of undergraduate or current graduate work and are unable to supply complete official transcripts showing the conferral of the degree will be admitted pending conferral of the degree if their records are otherwise satisfactory and complete. For students lacking appropriate preparatory course work, additional courses applicable to certain areas of study may be required prior to admission or students may be admitted with the provision that completion of certain area content courses be completed concurrent with the courses in the degree program.

III. ACADEMIC

A. DEGREE REQUIREMENTS
A.1. THESIS OPTION

The Thesis Master's degree requires 31 credits of course work and must include 15 credits of Bioinformatics and Computational Biology core courses, 3 credits of Ethics, 6 credits of Elective and 1 credit of Seminar. Up to six credits of MS Thesis must be used to meet the degree requirements. The University requirements for master's thesis shall apply to the thesis in this degree and shall be supervised by the Thesis Faculty Advisor.

THESIS OPTION

BICB-MS Computational Sciences Concentration Thesis	
31 Credit Hours Total	
Bioinformatics & Computational Biology Core – Computational Sciences	15 Credits
Ethics Core	3 Credits
Electives – Computational Sciences	6 Credits
Thesis	6 Credits
Seminar	1 Credit*

* Attendance in seminar is required for every Fall & Spring semester while enrolled as a student.

A.2. NON-THESIS OPTION

The Non-Thesis Master's degree requires 31 credit hours of course work and must include 15 credits of Bioinformatics and Computational Biology core courses, 3 credits of Ethics, 6 - 12 credits of Elective and 1 credit of Seminar. Up to six credits of Special Problems can be used to meet the degree requirements. The Special Problems credits must be related to the program objectives in bioinformatics and computational biology, and approved by the Graduate Program Committee.

NON-THESIS OPTION

BICB-MS Computational Sciences Concentration Non-Thesis	
31 Credit Hours Total	
Bioinformatics & Computational Biology Core – Computational Sciences	15 Credits
Ethics Core	3 Credits
Electives – Life Sciences	6 Credits
Non-Thesis Courses	6 Credits
Seminar*	1 Credits*

* Attendance in seminar is required for every Fall & Spring semester while enrolled as a student.

B. COURSE CURRICULUM

The tables below list the course curriculum for the major components of the Master of Science program in Bioinformatics & Computational Biology.

B.1. BIOINFORMATICS SCIENCE CORE – COMPUTATIONAL SCIENCES

Bioinformatics & Computational Biology Core – Computational Sciences (15)	
Bioinformatics (3)	BINF 644 Bioinformatics
Introduction to Discipline (3)	BISC 609 Molecular Biology of the Cell (3)
	BISC 654 Biochemical Genetics (3)
	PLSC 636 Plant Genes and Genomes (3)
Systems Biology (3) [select one]	BINF 694 Systems Biology I
	BINF 695 Computational Systems Biology (3)
Database (3) [select one]	CISC 637 Database Systems (3)
	BINF 640 Databases for Bioinformatics (3)
Biostatistics (3) [select one]	HLPR 632 Health Science Data Analysis
	STAT 656 Biostatistics (3)

B.2. ETHICS CORE

Ethics Core (3)

Ethics (3) [select one]	PHIL 648 Environmental Ethics (3)
	UAPP 650 Values Ethics and Leadership (3)
	BUAD 840 Ethical Issues in Global Business Environments (3)

B.3. BIOINFORMATICS & COMPUTATIONAL BIOLOGY SEMINAR

Seminar (1)	
Seminar	BINF 865 Seminar (0-1*)

* Attendance in seminar is required for every Fall & Spring semester while enrolled as a student.

B.4. BIOINFORMATICS & COMPUTATIONAL BIOLOGY THESIS/NON-THESIS

FOR THESIS OPTION

Thesis (6)	
Thesis (6)	BINF 869 Master's Thesis (1-6)

FOR NON-THESIS OPTION

Non-Thesis (6)	
Non-Thesis	Additional Electives (1-6)
[Select two]	BINF 666 Special Problems (1-6)

B.5. ELECTIVES – COMPUTATIONAL SCIENCES

Electives – Computational Sciences (6) [select two]
BINF 650 Protein Modifications
BINF 689 Topics
BINF 666 Special Problems
BINF 816 Systems Biology of Cells in Engineered Environments
CISC 621 Algorithm Design and Analysis
CISC 640 Computer Graphics (3)
CISC 681 Artificial Intelligence (3)
CISC 683 Introduction to Data mining (3)
CISC 841Algorithms in Bioinformatics (3)
CISC 844 Computational Biomedicine (3)
CISC 849 Advanced Topics in Computer Applications (3)
CISC 879 High Performance Computing and Data Analytics (3)
CISC 882 Natural Language Processing (3)
CISC 886 Multi-Agent Systems (3)
CISC 887 Internet Information Gathering (3)
CISC 888 Machine Learning (3)
CISC 889 Advanced Topics in Artificial Intelligence (3)
CHEG 620 Biochemical Engineering (3)
CHEG 621Metabolic Engineering (3)
ELEG 633 Image Processing (3)
ELEG 652 Principles of Parallel Computer Architectures (3)
ELEG 655 High-Performance Computing with Commodity Hardware (3)
ELEG 657 Search & Data Mining
ELEG 671 Mathematical Physiology (3)

ELEG 675 Image Processing with Biomedical Applications
ELEG 679 Introduction to Medical Imaging Systems (3)
ELEG 680 Immunology for Engineers (3)
ELEG 815 Analytics I: Statistical Learning
ELEG 817 Large Scale Machine Learning
MATH 607 Survey of Scientific Computing (3)
MATH 611 Introduction to Numerical Analysis and Scientific Computing (3)
STAT 608 Statistical Research Methods (3)
STAT 615 Design and Analysis of Experiments (3)
STAT 619 Time Series Analysis (3)
STAT 621 Survival analysis (3)
STAT 670 Introduction to Statistical Analysis I (3)
STAT 671 Introduction to Statistical Analysis II (3)
STAT 674 Applied Data Base Management (3)

C. COMMITTEES AND DIRECTOR

The development, administration and progress assessment of the Master of Science program in Bioinformatics & Computational Biology will be guided by the Director and the Bioinformatics Steering Committee and the Bioinformatics Graduate Committee, as outlined below.

C.1. BIOINFORMATICS STEERING COMMITTEE

The Steering Committee will advise the development and progress assessment of the Master of Science program in Bioinformatics & Computational Biology. The committee consists of faculty members from all ten Departments across four Colleges participating in this degree program.

C.2. BIOINFORMATICS GRADUATE COMMITTEE

The Graduate Committee will be responsible for admission, advising, and progress assessment of the students in the Master of Science program in Bioinformatics & Computational Biology, working closely with the students' Faculty Advisors. The committee consists of at least two representative faculty members from each participating College in this degree program.

C.3. DIRECTOR

The Director of the Professional Science Master's program in Bioinformatics will be responsible for the overall implementation, quality and progress of the degree program, advised by the Steering Committee and the Industry Advisory Board. The Director will also be the Chair of the Bioinformatics Graduate Committee. We propose that the Director of the Professional Science Master's program in Bioinformatics be a rotating position. Because of a significant amount of time and effort spent in starting up the program, we propose that the Director be located in Computer & Information Sciences for the first two years to get things started. Then, the position will rotate for a three-year term. The Director may appoint a Coordinator to provide day-to-day program management and assist with student recruitment, admission, advising, progress assessment, and career planning.

D. SATISFACTORY PROGRESS

D.1. FACULTY ADVISOR

Students are required to choose an appropriate Faculty Advisor from a list of faculty members participating in the degree program or have an appropriate Faculty Advisor appointed by the Director of the Master of Science program in Bioinformatics & Computational Biology. The participating faculty members are faculty approved by the Bioinformatics Steering Committee to advise students and/or serve as research mentors or co-mentors. The list of participating faculty, along with their departments and research interests, are available from the Bioinformatics program web site (http://bioinformatics.udel.edu/Education).

The Faculty Advisor will be the primary contact of the student for questions and advice. The student will develop a plan of study for the program with the Faculty Advisor before the beginning of the second semester. The Director of the Master of Science program in
Bioinformatics & Computational Biology will verify that the student has completed the requirements for the program and will approve the application for the degree upon successful completion of the requirements.

D.2. ACADEMIC LOAD

Full-time student is expected to complete the BICB-MS program (31 credits) in two years. The program may be completed over a longer time frame for part-time students.
Students enrolled in at least 9 credit hours or in sustaining credit are considered full-time students. Those enrolled for fewer than 9 credit hours are considered part-time students, although students holding assistantships are considered full-time with six credits. Generally, a maximum load is 12 graduate credit hours; however, additional credit hours may be taken with the approval of the student's adviser and the Office of Graduate and Professional Education. A maximum course load in either summer or winter session is 7 credit hours. Permission must be obtained from the Office of Graduate and Professional Education to carry an overload in any session

D.3. TRANSFERABILITY

Prior to admission to the Master of Science program in Bioinformatics & Computational Biology, a prospective student from another institution can be approved by the Bioinformatics Graduate Committee to take up to 9 graduate credits that, if/when admitted to the degree program, would be applied to that degree. Once the student has successfully completed 9 approved graduate UD credits and been admitted to the degree program, then a maximum of 9 graduate credits, but not the grades or quality points, can be transferred into the Master's program from another institution with the approval of the Graduate Committee.

Students who complete graduate credits with the classification of CEND (Continuing Education Non-degree) at the University of Delaware may use a maximum of 9 graduate credits earned with this classification toward their graduate degree.

All requests for transfer credit should be directed to the academic home department, Department of Computer & Information Sciences, using a "Request for Transfer of Graduate Credit" Form. Transfer credits will be accepted provided that such credits: (i) were earned with a grade of no less than B-, (ii) are approved by the Bioinformatics Graduate Committee, (iii) are in accord with the Program Policy Statement of the Master's program in Bioinformatics & Computational Biology, (iv) are not older than five years, (v) are graduate level courses, and (vi) were completed at an accredited college or university. Graduate courses counted toward a degree received elsewhere may not be transferred into a degree at UD. Credits from institutions outside of the United States are generally not transferable to UD.

D.4. MASTER'S THESIS

The Master's thesis of the BICB-MS program will be in most cases completed at the University of Delaware supervised by the Thesis Faculty Advisor. Unless special permission is granted, students need to complete 12 credit hours prior to the start of their thesis. Each student working on a master's thesis, with the advice of the Thesis Faculty Advisor, needs to establish a Thesis Committee. The Committee should consist of 3 at least three faculty members, the composition of which should be approved by the Bioinformatics Graduate Committee. The Committee Chair should be the Thesis Faculty Advisor and a participating faculty member in the degree program. At least one other member should be a participating faculty member in the program.

Students, with the assistance of their Thesis Faculty Advisor, will prepare and present a research proposal to their Thesis Committee for review and approval of the proposed research project. Following completion of the research outlined in the proposal, the MS degree candidate will prepare a written thesis according to the guidelines set forth by the Office of Graduate and Professional Education. Upon completion of the master's thesis, a final oral examination must be passed, consisting of a seminar and a defense of the master's thesis. The final oral examination will be directed and evaluated by the student's Thesis Committee.

D.5. GRADE REQUIREMENTS

Only graduate courses completed with a grade of B or higher count towards the requirements of Bioinformatics Master's program. Students receiving a B- or lower in a required core course are subject to dismissal from the program. However, they may file an appeal to the Bioinformatics Graduate Committee for approval to retake the course and remain in the program if the appeal is approved. Students must obtain at least a 3.0 cumulative grade point average in the courses in the curriculum to receive the degree.

D.6. CONSEQUENCES OF UNSATISFACTORY ACADEMIC PROGRESS

The Bioinformatics Graduate Committee will meet at least once each semester to evaluate each student's progress. If a student is failing to make satisfactory progress towards a degree, the committee will recommend suitable action to the Director of the Master's program in Bioinformatics & Computational Biology. Possible actions include (but are not limited to): (i) requirement for additional courses, (ii) suspension of financial support, and (iii) recommendation

for dismissal.

D.7. STANDARDS OF STUDENT CONDUCT

All graduate students are subject to University of Delaware regulations regarding academic honesty. Violations of the UD regulations regarding academic honesty or other forms of gross misconduct may result in immediate dismissal from the Program.

D.8. DISMISSAL

The procedures for dismissal as detailed in the University Catalog will be followed. Briefly, the Graduate Committee will report its recommendation and reason for dismissal to the Director of the Bioinformatics Master's program. The Director will make a recommendation to the Office of Graduate Studies, who will decide whether to dismiss the student. The student may appeal this decision to the Office of Graduate Studies, following the procedure given in the University Catalog.

D.9. GRADUATE STUDENT GRIEVANCE PROCEDURES

Students who feel that they have been graded inappropriately or receive what they perceive as an unfair evaluation by a faculty member may file grievances in accordance with University of Delaware policies. Students are encouraged to contact the Director of the Bioinformatics Master's program prior to filing a formal grievance in an effort to resolve the situation informally.

D.10. ATTENDANCE AT CONFERENCES AND PROFESSIONAL MEETINGS

The Bioinformatics Master's program encourages students to attend conferences and professional meetings. They provide opportunities to meet future employers and colleagues, and can offer specialized training beyond course work.

IV. FINANCIAL AID

A. FINANCIAL AWARDS

Admission to the Master of Science program in Bioinformatics & Computational Biology does not automatically entitle an applicant to financial aid. Students may seek financial aid opportunities, such as fellowships or scholarships from sources within the University and from private and federal agencies. Interested students should check the Office of Graduate Studies for the most current opportunities. All master's degree students receiving research assistantships, at any point in their program, must take the MS Thesis option.

Financial aid is awarded on a competitive basis from the pool of admitted applicants. The University of Delaware's policies apply to all forms of financial aid. Please refer to the University Policies for Graduate Student Assistantships and Fellowships.
Students in the BICB-MS program may apply for the Graduate Assistantships:
- Research Assistantships (RAs) are generally funded by research grants and contracts

provided by external funding agencies. Students may be supported as an RA through their Faculty Advisor's research funds after their first year. A research assistantship provides full tuition and a stipend. The RA's advisor is responsible for defining the student's responsibilities and for evaluating the student's performance. The amount of service or research may vary from week to week but the average is usually expected to be 20 hours per week.

- Teaching Assistantships (TAs) are offered for graduate students to perform teaching and other instructional activities. The amount of service may vary from week to week but the average is usually expected to be 20 hours per week. A teaching assistantship provides full tuition and a stipend. In accordance with University of Delaware regulations, foreign students must achieve a TOEFL score of at least 600 (paper-based), 250 (computer-based), or 100 (Internet-based) in order to qualify for teaching assistantships.

B. CONTINUATION OF FINANCIAL AID

Students who are awarded financial aid must maintain satisfactory academic progress with satisfactory performance of assistantship duties (when applicable). Satisfactory academic progress includes registering for a minimum of 9 graduate-level credits each Fall and Spring semester, and maintaining a minimum 3.0 GPA.

The RA's responsibilities and performance standards will be established by the Faculty Advisor. In the event of an unsatisfactory performance by an RA, the advisor will notify the student and the Graduate Committee at least four weeks prior to terminating the assistantship.

The TA's responsibilities and performance standards will be established by the Director of the course in which the student teaches. In the event of an unsatisfactory performance by a TA, the Course Director will notify the student and the Graduate Committee of the academic department offering the course. The Committee may recommend termination of the assistantship to the Department Chair.

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