BOARD OF HIGHER EDUCATION

REQUEST FOR COMMITTEE AND BOARD ACTION

COMMITTEE: Academic Affairs **NO**: AAC 16-15

COMMITTEE DATE: January 19, 2016

BOARD DATE: January 26, 2016

APPLICATION OF UNIVERSITY OF MASSACHUSETTS BOSTON TO AWARD THE DOCTOR OF PHILOSOPHY IN COMPUTATIONAL SCIENCES

MOVED: The Board of Higher Education hereby approves the application of **the University of Massachusetts Boston** to award the **Doctor of Philosophy in Computational Sciences**

Upon graduating the first class for this program, the University shall submit to the Board a status report addressing its success in reaching program goals as stated in the application and in the areas of enrollment, curriculum, faculty resources, and program effectiveness.

Authority: Massachusetts General Laws Chapter 15A, Section 9(b)

Contact: Winifred M. Hagan, Ed.D.,
Associate Commissioner for Academic Affairs and Student Success

BOARD OF HIGHER EDUCATION

January 2016

University of Massachusetts Boston
Doctor of Philosophy in Computational Sciences

INTENT AND MISSION

The proposed Ph.D. program in Computational Sciences (CSCI) is closely aligned with the University of Massachusetts Boston (UMB) mission and is intended to contribute to its' strength as an urban, student-centered, public research university. UMB is the most diverse university campus in the New England region and is the only public research university in the Boston metropolitan area. It is intended that the institution's demographics will ensure that the program will engage and promote a computational science avenue for traditionally underrepresented and underserved students. The program is consistent with UMB's strategic plan to enhance research, teaching, and community service. It is planned to enhance UMB's national and international reputation by building on existing robust programs with positive local, national, and international reputations.

The proposed program is intended to coordinate and promote computationally-based research, to foster computational sciences education and to provide for the expansion of computational resources and support at UMB. The program is intended to build on the strong scientific collaborations that already exist among the faculty within the College of Science and Mathematics. CSCI is intended to provide a forum for the multidisciplinary exchange of ideas among researchers, educators and students. Regularly scheduled seminars and symposia will be offered to highlight advances in computational sciences. The CSCI program will also serve to develop and facilitate new projects in computationally-based research and education, working with scientists from multiple departments and centers within UMB. The proposed program has been developed by UMB in recognition of the need for graduate-level training at the intersection of the disciplines of mathematics and computer science.

The proposed program has obtained all necessary governance approvals on campus and was approved by the University of Massachusetts Board of Trustees on December 9, 2015. The required letter of intent was circulated on June 4, 2015. No comments were received.

NEED AND DEMAND

National and State Labor Market Outlook

Computational science is an interdisciplinary field in which realistic mathematical models combined with scientific computing methods are used to study, usually through computer simulation and modeling, systems of real-world scientific or societal interest. Research scientists invent and design new approaches to problem solving and find innovative uses for new knowledge. They study and solve complex problems in computing for business, medicine, science, and other fields. Most jobs for computational research scientists require a Ph.D. Employment of computer and information research scientists is projected to grow 15 percent from 2012 to 2022, faster than the average for all occupations. These scientists are likely to

enjoy excellent job prospects, because many companies report difficulties finding these highly skilled workers[1].

The Occupational Outlook Handbook issued by the Bureau of Labor Statistics of the US Department of Labor documents the need to grow the workforce in computational sciences research at the doctoral level. "*Most computer and information research scientists require a Ph.D. in Computer Sciences or a related field, such as computer engineering."* The proposed program is expected to equip its graduates with deep knowledge for solving numerical and combinatorial problems that arise in a variety of disciplines.

According to the US Bureau of Labor Statistics, in 2012 computer and information research scientists held about 26,700 jobs. The table below presents the industries that employed the most computer and information research scientists in 2012. Most computer scientists employed by the federal government work for the Department of Defense.

Type of Employer	**%**
Federal government	26
Computer systems design and related services	18
Colleges, universities, and professional schools; state, local, and private	13
Research and development in the physical, engineering, and life sciences	11
Software publishers	8

Source: www.bls.gov/ooh/computer-and-information-technology/computer-and-information-research-scientists.htm#tab-3

The US Bureau of Labor Statistics also projects that computational scientists who can design the "brain system" of a robot or create new programming languages will be in high demand in the next ten years as well. It is also expected that an extensive growth in data collection by various businesses would lead to an increased need for data mining and analysis services. Computational scientists will be in high demand to generate advanced algorithms to help businesses collect, sort, and manage enormous amounts of data. A growing emphasis on cyber-security is creating additional demand for computational scientists, who will drive innovation efforts aimed at preventing cyber-attacks and tracking hackers. Advancements in robotics and software development are also driving job growth.

There are currently 287 positions for computational scientists available in eastern Massachusetts with salaries ranging advertised between $100K and $150K[2].

Student Demand

UMB reports that CSM is the fastest growing college within the University, and the computational sciences area is experiencing the fastest growth, within the college. Student demand was evident by analyzing enrollment growth and CSM programmatic development patterns, which indicated increasing interest in degrees in computational sciences that bridge the disciplinary boundaries. CSCI program discussions with UMB STEM students, particularly in the College of Science and Mathematics provided further positive indication of students interest

[1] *http://www.bls.gov/ooh/computer-and-information-technology/computer-and-information-research-scientists.htm Retrieved 12/15/2015*

[2] *https://www.wantedanalytics.com/wa/jobs?country=US&jloc=state-22&jocc=15111100 Retrieved 12/15/2015*

in the interdisciplinary computational sciences program area. In addition, UMB reports that it is becoming increasingly popular among international STEM students who would like to study in the United States. The proposed CSCI program is expected to attract a significant number of aspiring Ph.D. applicants from countries such as India and China, where demand for doctoral degrees in bioinformatics, data analytics, and computational physics is growing exponentially. UMB expects a large pool of talented domestic and international recruits to apply to the proposed interdisciplinary CSCI program.

OVERVIEW OF PROPOSED PROGRAM

Duplication

The University of Massachusetts Dartmouth offers a Computational Science and Engineering option within the Ph.D. in Engineering and Applied Science program and the Massachusetts Institute of Technology offers a Ph.D. in Computational Science and Engineering. Each of these programs is quite different in emphasis with a strong focus on the engineering discipline. The proposed program is characterized by interdisciplinary computation applied in fundamental sciences such as biology, chemistry and physics.

UMB provided the table shown below, which summarizes the graduate offerings from its' sister "Urban 21" institutions. The majority of IHE's are offering interdepartmental programs making use of the strengths of departments and faculty.

Graduate programs offering in "Urban 21" institutions and their interdepartmental status

UNIVERSITY	Bio	Chem	BioCh	MolBio	Geol	Env	Math	CompS	Phys	Int.Dep
Alabama Birmingham	PhD	PhD	Y	Y			PhD	PhD	PhD	YES
Cincinnati	MS	PhD	BS		PhD		PhD	BS	PhD	YES
Cleveland State	MS	MS	YES	YES		PhD	MS	MS	MS	YES
Florida Ag. & Mech	MS	MS	NO	NO				MS	PhD	NO
Georgia State	PhD	PhD			MS		PhD	PhD	PhD	YES
Houston	PhD	PhD	PhD		PhD		PhD	PhD	PhD	NO
Indiana U	PhD	PhD	PhD	PhD	MS	BS	PhD	PhD	PhD	YES
Illinois at Chicago	PhD	PhD	PhD	PhD	PhD	PhD	PhD	PhD	PhD	YES
Maryland Baltimore	YES	YES	PhD	YES		PhD	YES	YES	YES	YES
Memphis	PhD	PhD			MS	PhD	PhD	PhD	MS	NO
Missouri-St. Louis	PhD	PhD	MS				PhD	MS	PhD	NO
Missouri-Kansas City	PhD	PhD	PhD	PhD	PhD	MS	PhD	PhD	PhD	YES
New Orleans	PhD	PhD				PhD	PhD	PhD	PhD	YES
CUNY	PhD	PhD	PhD		PhD		PhD	MS	PhD	YES
Pittsburgh	PhD	PhD	YES	YES	PhD	PhD	PhD	PhD	PhD	YES
Portland State	PhD	PhD	NO		MS	PhD	PhD	PhD	PhD	NO
Temple	PhD	PhD		PhD	PhD		PhD	PhD	PhD	YES
Toledo	PhD	PhD	YES	YES	PhD	PhD	PhD		PhD	YES
Virginia Common	MS	PhD	PhD	PhD		MS	MS	MS	MS	YES
Wayne State	PhD	PhD		PhD	PhD		PhD		PhD	UNDET
Wisconsin–Milwaukee	PhD	PhD	BS	YES	PhD	PhD	PhD	MS	PhD	NO

ACADEMIC AND RELATED MATTERS

Admission

Applicants to CSCI will be required to demonstrate adequate preparation at the undergraduate level in the form of relevant coursework and research experience. Admission decisions will be made by the program committee on a case-by-case basis. Given the multi-disciplinary nature of the CSCI, UMB expects that applicants will be undergraduates with Bachelor of Science degrees in computer science, mathematics, biology, chemistry, physics, or graduate students with Master's degrees in these areas. In addition to official transcripts showing successful completion of undergraduate (and graduate, when applicable) coursework, applicants will be required to take a general GRE test, and, for foreign applicants, a TOEFL test. Applicants will also be expected to provide a personal statement describing their research experience, career goals and interests. The program will require three letters of recommendation to be submitted with the application.

Students who transfer to the CSCI program will receive transfer credit or advanced standing for their previous work when they demonstrate course equivalency. Credits for previous work will be given at the discretion of the program committee. Transfer students will still be required to pass written and oral qualifying exams and fulfill all other candidacy requirements.

PROGRAM ENROLLMENT

	# of Students Year 1	# of Students Year 2	# of Students Year 3	# of Students Year 4*
New Full-Time	4	4	4	4
Continuing Full-Time	0	4	8	12
New Part-Time	0	0	0	0
Continuing Part-Time	0	0	0	0
Total	4	8	12	16

Curriculum (Attachment A)

The proposed program is planned to consist of three tracks: *Data Analytics, Bioinformatics*, and *Computational Physics*, which will require 36 credits of course work, 4 credits of program seminar, and 20 credits of dissertation research. The core courses are planned for one year-long sequences: Numerical Analysis and Advanced Probability & Computer Simulation. In addition, students will be expected to complete a year of coursework in a focused application area, and a year of coursework in Computer Science (Parallel Computing and Analysis of Algorithms).

The choices of electives outside these core sequences is broad, allowing the needed flexibility in a program of this scope, while the core sequences ensure a sound intellectual basis for the program and a commonality among the students. A qualifying examination requiring each student to demonstrate a graduate-level proficiency in mathematics, computer science, and one of the specialty areas (data analytics, computational physics, or bioinformatics) is anticipated. Dissertations will be expected to be interdisciplinary and to reflect components in mathematics, computer science, and a specialized area. Dissertation committees will have representatives

from all three areas, as will the committee that manages the overall program. All Computational Sciences courses will be cross-listed with several of the participating departments.

Internships or Field Studies

There are no internships or field studies included in the proposed program. Research opportunities and assistantships are detailed in the section below and are the more appropriate learning experience for emerging research scientists.

RESOURCES AND BUDGET

Fiscal (Attachment B)

UMB plans that the CSCI program will operate based on existing resources. As a part of the natural growth of the Mathematics Department UMB expects there will be the need to add additional lines to support courses offered in the CSCI program,

Additional support will be required for graduate students during the first three years of the CSCI program. New students will be supported in the first year through research assistantships allocated by the University to allow them to initiate their research efforts. After the first year they will be supported through a mix of grant funding provided by their advisors and through department-based teaching assistantships. Each student will be expected to participate in teaching three sections one per semester during their graduate career in order to develop their mentoring and teaching skills. During those semesters, the students will be teaching assistants for the program and it is planned that they will be available for teaching courses in the participating departments. In most cases, UMB anticipates that the student will teach in the home department of their primary faculty advisor.

An increase in the graduate student population in the College of Science and Mathematics (CSM) will create an additional administrative burden. Given that the CSCI will not be affiliated with a single department but rather will be a part of CSM, the proposal calls for half-time support for an administrative assistant supported by the CSM budget.

Faculty and Administration (Attachment C)

Faculty members in the CSM have a tradition of inter-departmental collaboration and work to produce a continuous stream of quality research. It is planned that faculty members for the CSCI PhD program will be drawn from several participating departments. Faculty members who wish to become involved will be required to demonstrate an active research program, established through regular peer-reviewed publications and by actively seeking research support in the areas encompassed by the scope of the proposed program. New faculty will continue to be recruited by the core participating members.

It is expected that, the proposed CSCI Ph.D. will serve as a new avenue for the recruitment of talented graduate students and enhance the productivity of scholarly research with participating faculty. It is also expected to provide a framework to engage students in interdisciplinary research efforts. Graduate students interacting with faculty from different disciplines will actively promote interdisciplinary research among the participating faculty and stimulate new paths of

research and research funding. Participating faculty will perform vital functions for the program (admissions, curriculum development, research mentoring, etc.). This service to the program will be for limited periods of time through membership on the program committee on a rotating basis. A half-time administrative assistant (shared with the Integrative Bioscience Ph.D. Program) will be needed to help with the administration of the program. Four research assistantships are planned to support first-year graduate students. Stipends are expected to be at the $20,000 level to ensure that the program is competitive with other doctoral programs in the area. These will be provided by UMB. After the first year, it is expected that students will be supported through a combination of eight department-based teaching assistantships and eight grant-funded research assistantships.

Facilities, Library and Information Technologies

UMB reports that new library resources are not necessary to support the proposed program. The literature base of computational sciences is primarily online. As a consequence, the Healey Library's existing online resources and hard copy holdings will only be needed to provide a reference base. There will be an increase in the use of interlibrary loan for references needed for dissertation writing.

The field of computational sciences is information technology-intensive. The core computational facility for the Computational Sciences program will be the high-performance computing cluster at UMB. The existing clusters of CSM, as well as the resources of the Massachusetts Green Computing Consortium will provide the major facilities that will be utilized. The program will draw on the established IT infrastructure for instruction (e.g., Blackboard Learn) and email communication already in place at the university. The new program will be conducive to proposal writing for shared equipment and training grants from the major federal funding agencies. As the program grows and develops, additional high performance computational resources will be acquired.

The General Academic Building (GAB) has opened this fall, and will provide students and researchers access to the Technology Enhanced Active Learning (TEAL) Classroom. This 63-seat classroom is expected to be leveraged by the CSCI program to facilitate teamwork and class-wide collaboration. It will have extensive technological adaptations, ideal for teaching in the computational sciences; students will have computer monitors, computer workstations, and connections for laptops. All computers will be capable of projection onto a large screen under the control of a central console for the instructor. Support will also be available for instructors through the TEAL Classroom Fellows program. It will offer fellows a stipend of $800 and guaranteed scheduling in the TEAL Classroom.

Affiliations and Partnerships

UMB plans that the proposed CSCI Program will form an Industrial Advisory Board to inform updates and adjustments to all aspects of our curriculum in order that graduates will be desirable to local industry.UMB expects to use the input from this advisory board for continuous improvement to all aspects of our program.

The US Department of Energy (DOE)'s Computational Sciences Graduate Fellowship[3] and the EPA's Science to Achieve Results (STAR) fellowships[4] are examples of funding opportunities that will be sought to support and encourage cross-disciplinary training. UMB also anticipates that several foundations, including the Burroughs Welcome Fund[5], will be approached to provide graduate fellowships that emphasize the importance of interdisciplinary training, once the program has earned approval. Students will be mentored in how to seek out these sources of funding.

PROGRAM EFFECTIVENESS

Goal	Objective	Strategy	Timetable
Increasing faculty research productivity	Increasing the number of publications produced by participating faculty	Show increase with the implementation of the program starting at year Y+1	Year Y[6] and onwards
	Increasing the number of grants submitted by the participating faculty.	Show increase with the implementation of the program starting at year Y+1	Implementation year Y and onwards
Refine and update curriculum	Keeping curriculum current and relevant	Analyze curriculum at faculty meetings and in the biannual board meetings	Year Y+1 and onwards
Make our graduates attractive for future employers.	Preparing students to graduate with a significant research portfolio	Analyze publication records of graduate students in dedicated faculty meetings	Year Y+1 and onwards
Timely completion of the program	Ensure that graduate students make timely progress towards the completion of degree	Students and their advisors will file an annual report on students' progress in the program.	Year Y+1 and onwards
Improve attractiveness and competitiveness of the program	Increase the visibility of the program	Monitor the employment records of graduates and use them in our marketing	Year Y+4 and onwards

[3] The DOE characterizes their fellowship as "Multidisciplinary" with stated goals of strengthening collaborations to "build [a] national community of scientists." http://www.krellinst.org/csgf/about-doe-csgf

[4] http://www.epa.gov/ncer/fellow/

[5] Burroughs Wellcome Fund provides fellowship opportunities through their Career Awards at the Scientific Interface. They state, "In recognition of the vital role such cross-trained scientists will play in furthering biomedical science, the Burroughs Wellcome Fund has made a major investment in young investigators with backgrounds in the physical, chemical, or computational sciences whose work addresses biological questions and who are dedicated to pursuing a career in academic research" (http://www.bwfund.org/page.php?mode=privateview&pageID=76).

[6] Y denotes the year of implementation of the program

EXTERNAL REVIEW AND INSTITUTIONAL RESPONSE

The external review team was comprised of Dr. Christoph Börgers, Ph.D., Professor and Chair of the Mathematics Department at Tufts University in Medford MA, and Dr. Loredana Lanzani, Ph.D., Professor of Mathematics at Syracuse University in Syracuse NY. The team conducted a site visit and paper review of the proposed program. In general the reviewers were enthusiastic about the proposal, and believe that the program will be of great benefit for the students at UMB, for the Boston area, and for Massachusetts. They expressed concern regarding the small number of new faculty positions in the participating departments and suggested that with more faculty, course requirements could be expanded and students in the program could benefit. At the same time the team underscored that the program can unquestionably be mounted with the faculty currently present at UMB.

Emphasizing that most important for a Ph.D. student is developing their area of research, and recognizing that UMB has many outstanding research projects in computational science, often in collaboration with other universities, institutes, or industry companies, the review team noted that the proposed program will undoubtedly create more such projects providing students with a competitive advantage in the job market. At the same time, the reviewers were concerned with the fairly heavy teaching load for students in years 2 through 5, in particular the requirement to teach at least three sections. The reviewers do not agree that this is a good general requirement. The team also expressed encouragement for the Venture Development Center (VDC) at UMB to be actively supportive of the CSCI program and help create new internship opportunities for the students. They noted that the center currently hosts over 70 companies, all operating in areas that require computational scientists. They suggested provisions for internships could satisfy the Center's increased demand for graduate students. The reviewers emphasized that this is a growth industry and predicted that graduates will be much sought-after because computation and 'Big Data' are growing rapidly.

UMB agreed with the suggestions regarding additional faculty, noting that the program has received assurances from the administration that as it grows new faculty positions will be added to the departments. Regarding teaching, program leaders maintain that valuable collaboration and communication skills are developed through teaching, which are transferable to academic and industrial careers. UMB expects student learning to be strengthened by teaching and to provide students with important interactive experiences in a diverse settings. Program leaders are working in collaboration with the VDC leaders to increase integration between VDC and the proposed academic program. UMB emphasized the strong and productive relationship between CSM and VDC and the success in helping students find internship opportunities with the VDC-based start-ups. CSM and VDC are currently designing a joint programmatic Vertical Community initiative, which would enable CSCI students from different cohorts to acquire meaningful experience with corporate partners.

STAFF ANALYSIS AND RECOMMENDATION

Staff thoroughly reviewed all documentation submitted by the **University of Massachusetts Boston** and external reviewers. Staff recommendation is for approval of the proposed **Doctor of Philosophy in Computational Sciences**.

ATTACHMENT A: CURRICULUM

Major Required (Core) Courses (Total courses required** = 6**)		
Course Number	Course Title	Credit Hours
MATH 624	Numerical Analysis I	3
MATH 625	Numerical Analysis II	3
MATH 642	Probabilistic Simulation	3
MATH 647	Probability Models	3
CSCI 601	Program Research Seminar	2
CSCI 602	Program Research Seminar	2
	SubTotal # Core Credits Required	16
Concentration Core Courses (Total courses required = 2)		
	Data Analytics Track	
CS671	Machine Learning	3
CS738	Data Mining	3
	Bioinformatics Track	
CS615	Bioinformatics	3
BIOL664	Bioinformatics for Molecular Biologists	3
	Computational Physics Track	
PHYS 616	Mathematical Physics	3
PHYS 637	Stochastic Processes	3
	SubTotal # Concentration Credits Required	6
Other/Elective Course Choices (Total courses required =6)		
CS612	Bioinformatics	3
CS624	Analysis of Algorithms	3
CS630	Databases management Systems	3
CS636	Database Application Development	3
CS670	Artificial Intelligence	3
CS671	Machine Learning	3
CS672	Neural Networks	3
CS680	Object-Oriented Design and Programming	3
CS681	Object-Oriented Software Development	3
CS682	Software Development Laboratory I	3
CS683	Software Development Laboratory II	3

CS724	Topics in Algorithm Theory and Design	3
CS738	Data Mining	3
CS752	Parallel Programming	3
MATH620	Combinatorial Analysis	3
MATH640	Computational Algebraic Topology	3
MATH648	Statistical Learning	3
MATH673	Structure and Dynamics of Complex Networks I	3
MATH674	Structure and Dynamics of Complex Networks II	3
MATH677	Symbolic Computation	3
MATH680	Introduction to Computational Algebraic Geometry	3
CHEM601	Thermodynamics and Kinetics	3
CHEM TBA	Molecular Simulations	3
PHYS610	Topics in Medical Imaging	3
PHYS611	Classical Mechanics	3
PHYS616	Mathematical Physics	3
PHYS637	Introduction to Stochastic Processes	3
PHYS638	Quantum Measurement and Control	3
PHYS640	Scientific Computation and Visualization	3
BIOL625	Genomics and Biotechnology	3
BIOL664	Bioinformatics for Molecular Biologists	3
BIOL615	Immunology	3
BIOL626	Molecular Genetics of Bacteria	3
BIOL641	Quantitative Population Modeling	3
BIOL674	Cell Signaling	3
BIOL677	Advanced Eukariotic Genetics	3
BIOL681	Network Biology	3
	SubTotal # Elective Credits Required	18
	Required Dissertation Research for all three tracks	
	Dissertation Research	20 credits minimum

Curriculum Summary	
Total number of courses required for the degree	14
Dissertation Research	20 credits minimum

Total credit hours required for degree	60
Prerequisite or Other Additional Requirements: 20 credits of dissertation research 4 credits of research seminar	

ATTACHMENT B: BUDGET

REVENUE ESTIMATES

	Year 1 2016	Year 2 2017	Year 3 2018	Year 4 2019	Year 5 2020
Full-Time Tuition Rate: In-State	1944	1944	1944	1944	1944
Full-Time Tuition Rate: Out-State	7326	7326	7326	7326	7326
Mandatory Fees per Student (In-state)	13680	14090	14513	14949	15397
Mandatory Fees per Student (out-state)	15288	15747	16219	16706	17207
FTE # of New Students: In-State	0	0	0	0	0
FTE # of New Students: Out-State	0	0	0	0	0
# of In-State FTE Students transferring in from the institution's existing programs					
# of Out-State FTE Students transferring in from the institution's existing programs					

Tuition and Fees	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs	Newly Generated Revenue	Revenue from existing programs
First Year Students										
Tuition										
In-State	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Out-of-State	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Mandatory Fees	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Second Year Students										
Tuition										
In-State			$0	$0	$0	$0	$0	$0	$0	$0
Out-of-State			$0	$0	$0	$0	$0	$0	$0	$0
Mandatory Fees			$0	$0	$0	$0	$0	$0	$0	$0
Third Year Students										
Tuition										
In-State					$0	$0	$0	$0	$0	$0
Out-of-State					$0	$0	$0	$0	$0	$0
Mandatory Fees					$0	$0	$0	$0	$0	$0
Fourth Year Students										
Tuition										
In-State							$0	$0	$0	$0
Out-of-State							$0	$0	$0	$0
Mandatory Fees							$0	$0	$0	$0

Fifth Year Students										
Tuition										
In-State									$0	$0
Out-of-State									$0	$0
Mandatory Fees									$0	$0
Gross Tuition and Fees	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Grants	$0	$0	$82,400	$0	$169,744	$0	$262,254	$0	$360,163	$0
Contracts	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Campus budget allocation	$118,450	$0	$121,775	$0	$125,199	$0	$128,726	$0	$132,359	$0
Other Revenues (specify in cell 54)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total	$118,450	$0	$204,175	$0	$294,943	$0	$390,981	$0	$492,522	$0

EXPENDITURE ESTIMATES										
	Year 1 2016		Year 2 2017		Year 3 2018		Year 4 2019		Year 5 2020	
	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources	New Expenditures required for Program	Expenditures from current resources
Personnel Services										
Faculty	$0	$52,500	$0	$54,075	$0	$55,697	$0	$57,368	$0	$59,089
Administrators	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Support Staff	$23,000	$0	$23,690	$0	$24,401	$0	$25,133	$0	$25,887	$0
Others	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Fringe Benefits 34%	$7,820	$17,850	$8,055	$18,386	$8,296	$18,937	$8,545	$19,505	$8,801	$20,090
Total Personnel	**$30,820**	**$70,350**	**$31,745**	**$72,461**	**$32,697**	**$74,634**	**$33,678**	**$76,873**	**$34,688**	**$79,180**
Operating Expenses										
Supplies	$4,000	$0	$4,000	$0	$4,000	$0	$4,000	$0	$4,000	$0
Library Resources	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Marketing/Promotional Expenses	$3,000	$0	$3,000	$0	$3,000	$0	$3,000	$0	$3,000	$0
Laboratory Expenses	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
General Administrative	$630	$0	$630	$0	$630	$0	$630	$0	$630	$0

Overhead										
Other (specify)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Operating Expenses	**$7,630**	**$0**	**$7,630**	**$0**	**$7,630**	**$0**	**$7,630**	**$0**	**$7,630**	**$0**
-										
Net Student Assistance										
Assistantships	$80,000	$0	$164,800	$0	$254,616	$0	$349,673	$0	$450,204	$0
Fellowships	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Stipends/Scholarships	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Student Assistance	**$80,000**	**$0**	**$164,800**	**$0**	**$254,616**	**$0**	**$349,673**	**$0**	**$450,204**	**$0**
Capital										
Facilities / Campus recharges	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Equipment	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Other	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Capital	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Expenditures	**$118,450**	**$70,350**	**$204,175**	**$72,461**	**$294,943**	**$74,634**	**$390,980**	**$76,873**	**$492,522**	**$79,180**

BUDGET SUMMARY OF NEW PROGRAM ONLY					
	Year 1 2016	Year 2 2017	Year 3 2018	Year 4 2019	Year 5 2020
Total of newly generated revenue	$118,450	$204,175	$294,943	$390,981	$492,522
Total of additional resources required for program	$118,450	$204,175	$294,943	$390,980	$492,522
Excess/ (Deficiency)	$0	$0	$0	$0	($0)

ATTACHMENT C: FACULTY

Name of faculty member (Name, Degree and Field, Title)	Ten-ured Y/N	Courses Taught Put (C) to indicate core course. Put (OL) next to any course currently taught online.	# of sections	Division or College of Employment	Full- or Part- time in Program	Full- or part-time in other department or program (Please specify)	Sites where individual will teach program courses
Gonzales, Eduardo, PhD in Mathematics, Associate Professor	☒	• MATH 680 Introduction to Computational Algebraic Geometry	(1)	College of Science and Mathematics	Full-time	Mathematics	• Main Campus
Jackson, Steven, PhD Mathematics, Associate Professor	☒	• MATH 640 Computational Algebraic Topology	(1)	College of Science and Mathematics	Full-time	Mathematics	• Main Campus
Killingback, Timothy, PhD in Mathematical Physics, Assoc. Professor	☒	• MATH 673: Structure and Dynamics of Complex Networks I • MATH 674: Structure and Dynamics of Complex Networks II	(1)	College of Science and Mathematics	Full-time	Mathematics	• Main Campus
Noel Alfred, PhD in Mathematics, Professor	☒	• MATH 624 Numerical Analysis I (C) • MATH 625 Numerical Analysis II (C)	(1) (1)	College of Science and Mathematics	Full-time	Mathematics	• Main Campus
Vuletic Mirjana, PhD in Mathematics, Assist. Professor	☐	• MATH 677 Symbolic Computation • MATH 647 Probability Models (C) • MATH 642 Probabilistic Simulation (C)	(1)	College of Science and Mathematics	Full-time	Mathematics	• Main Campus
Zara Catalin, PhD in Mathematics, Assoc. Professor	☒	• MATH 620 Combinatorial Analysis	(1)	College of Science and Mathematics	Full-time	Mathematics	• Main Campus
Zarringahalam, Kourosh, PhD in Mathematics, Assist. Professor	☐	• MATH 648 Introduction to Statistical Learning	(1)	College of Science and Mathematics	Full-time	Mathematics	• Main Campus
Ding Wei, PhD in Computer Science, Assoc. Professor	☒	• CS738 Data Mining • CS670 Artificial Intelligence	(1) (1)	College of Science and Mathematics	Full-time	Computer Science	• Main Campus
Haspel, Nurit, PhD in Computer Science, Assist. Professor	☐	• CS612 Bioinformatics • CS624 Analysis of Algorithms	(1)	College of Science and Mathematics	Full-time	Computer Science	• Main Campus

Pomplun Marc, PhD in Computer Science, Professor	☒	• CS672 Neural Networks	(1)	College of Science and Mathematics	Full-time	Computer Science	• Main Campus
Ouyang Ming, PhD in Computer Science, Assist. Professor	☐	• CS752 Parallel Programming	(1) (1)	College of Science and Mathematics	Full-time	Computer Science	• Main Campus
Simovici Dan, PhD in Mathematics, Professor	☒	• CS671 Machine Learning • CS630 Databases • CS636 Database Application Development	(1)	College of Science and Mathematics	Full-time	Computer Science	• Main Campus
Suzuki, Junichi, PhD in Computer Science, Assoc. Professor	☒	• CS680 Object Oriented Design and Programming • CS682 Object Oriented Software Development • CS681 Software Development Lab I • CS682 Software Development Lab 2	(1)	College of Science and Mathematics	Full-time	Computer Science	• Main Campus
Tran Duc, PhD in Computer Science, Assoc. Professor	☒	• CS646 Computer Communication Networks	(1) (1)	College of Science and Mathematics	Full-time	Computer Science	• Main Campus
Jacobs, Kurt, PhD in Physics, Assoc. Professor	☒	• PHYS 637 Introduction to Stochastic Processes	(1) (1)	College of Science and Mathematics	Full-time	Physics	• Main Campus
Kulkarni, Rahul, PhD in Physics, Assoc. Professor	☒	• PHYS 638 Quantum Measurement and Control	(1)	College of Science and Mathematics	Full-time	Physics	• Main Campus
Olchanyi, Maxim, PhD in Physics, Professor	☒	• PHYS 616 Mathematical Methods in Physics	(1)	College of Science and Mathematics	Full-time	Physics	• Main Campus
Sundaram, Bala, PhD in Physics, Professor	☒	• PHYS 640 Scientific Computation and Visualization • PHYS 611 Classical Mechanics	(1) (1)	College of Science and Mathematics	Full-time	Physics	• Main Campus
Yelleswarapu, Chandra, PhD in Physics, Assist. Professor	☒	• PHYS 610 Topics in Medical Imaging	(1)	College of Science and Mathematics	Full-time	Physics	• Main Campus
Veraksa, Aleksey, PhD in Biology, Assoc. Professor	☒	• BIOL 674 Cell Signaling • BIOl 661 Network Biology	(1)	College of Science and Mathematics	Full-time	Biology	• Main Campus
Huang, Linda, PhD in Biology, Assoc. Professor	☒	• BIOL 612 Advanced Cell Biology • BIOL 625 Genomics and Biotechnology	(1)	College of Science and Mathematics	Full-time	Biology	• Main Campus
Riley, Todd, PhD Computational Biology, Assist. Professor	☐	• BIOL664 Bioinformatics for Molecular	(1)	College of Science and Mathematics	Full-time	Biology	• Main Campus

		Biologists					
Green, Jason PhD in Chemistry, Assist. Professor	☐	• Molecular Simulation (CHEM TBA) • CHEM 658: Medicinal Chemistry	(1) (1)	College of Science and Mathematics	Full-time	Chemistry	• Main Campus
Rochford, Jonathan, PhD in Inorganic Chemistry, Assist Professor	☐	• CHEM 601 Thermodynamics, Statistical Mechanics and Kinetics • CHEM 602 Quantum Mechanics and Spectroscopy	(1) (1)	College of Science and Mathematics	Full-time	Chemistry	• Main Campus