

**BOARD OF HIGHER EDUCATION**  
**REQUEST FOR COMMITTEE AND BOARD ACTION**

**COMMITTEE:** Academic Affairs

**NO:** AAC 16-16

**COMMITTEE DATE:** January 19, 2016

**BOARD DATE:** January 26, 2016

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**APPLICATION OF UNIVERSITY OF MASSACHUSETTS BOSTON TO AWARD THE DOCTOR OF PHILOSOPHY IN INTEGRATIVE BIOSCIENCES**

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

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 Integrative Biosciences**

#### **INTENT AND MISSION**

The proposed Integrative Biosciences Graduate Program (IBGP) is closely aligned with the University of Massachusetts Boston's (UMB) mission to make it a student-centered, urban public research university. The proposed Integrative Biosciences Graduate program is multidisciplinary and closely aligned with UMB's strategic plan to enhance research, while continuing to promote teaching excellence and community service. The IBGP program is expected to enhance UMB's national and international reputation by building on the strengths of the existing faculty research programs across the College of Science and Mathematics (CSM) which have earned national and international recognition.

The purpose of the IBGP is to produce independent researchers able to apply interdisciplinary approaches to solving problems in the areas of Biochemistry, Biophysics, and Bioinformatics. UMB reports that these are rapidly developing fields, which require biologists to think like physicists, chemists to have a solid understanding of biology, and computational biologists to be capable of interpreting vast amounts of high-throughput data from genome- and proteome-scale experiments. UMB expects that IBGP will train researchers that are prepared to problem solve, be self-learners, create opportunities for carrying out original research that is interdisciplinary and collaborative.

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*

Employment of biochemists and biophysicists is projected to increase by 19 percent from 2012 to 2022 (US Bureau of Labor Statistics), much faster than the average for other occupations in the field. Biochemists and biophysicists held about 29,200 jobs in 2012, and this number is projected to increase by 5,400 jobs by 2022. The high concentration of universities and Research and Development efforts at the biotechnology companies in Massachusetts, are expected to position IBGP graduates in high demand both in academia and the industry. According to the Massachusetts Executive Office of Labor and Workforce Development, the growth in the state is projected to be faster than the national average. According to US Bureau of Labor Statistics, the total number of computer and information research scientists' jobs is expected to increase by 15%, or 4,100 jobs, between 2012 and 2022. Many of these jobs will be allocated to bioinformatics, an integral component of computational analysis in the life sciences.

According to Massachusetts Executive Office of Labor and Workforce Development, the growth in this area in the state is projected to be close to national average, about 14%<sup>1</sup>.

Many other areas of research and development in the life sciences are expected to provide employment growth for biochemists, biophysicists, and bio-informaticians. Greater demand for clean energy is expected to increase the need for biochemists to research and develop alternative energy sources, such as bio-fuels. A growing population and rising food prices are expected to fuel the development of genetically engineered crops that provide greater yields and require fewer resources to produce. Additionally, efforts to discover new and improved ways to clean up and preserve the environment will increase demand for biochemists and biophysicists. Finally, as the amount of biological data continues to grow and computer analytical techniques and software continue to become more sophisticated, the number of dedicated bio-informaticians is expected to continue to grow significantly. Experts project that computational biologists will be in great demand within the bio-pharma and biotechnology industry<sup>2</sup>.

### *Student Demand*

Student demand was identified by analyzing UMB enrollment growth and CSM programmatic development patterns, which indicated increasing student interest in degrees in interdisciplinary research. Anticipated student demand from UMB students is reported to be an outgrowth of CSM being the fastest growing college within the University. Biology represents the largest undergraduate major within the CSM, and many biology students working in faculty laboratories have expressed interest in continuing their training in graduate school, specifically in fields such as biochemistry, biophysics, and bioinformatics. For example, in the AY 2012-2013 UMB graduated 164 students with Bachelor's Degrees in Biology and Biochemistry, many of whom developed strong relationships with their faculty advisors and expressed interest in further study. UMB additionally expects that the dozens of colleges and universities in the greater Boston Area will provide many potential students with interest in the proposed program. UMB maintains that its' location along the MBTA Red Line innovation corridor, makes the proposed program appealing to recent graduates from local four-year institutions who would like to continue their academic careers in close proximity to one of the largest life sciences geographies in the US. UMB graduates are also expected to provide a diverse pool of potential candidates for the proposed program.

## **OVERVIEW OF PROPOSED PROGRAM**

The motivation for developing the Integrative Biosciences Graduate Program (IBGP) was driven by the changing landscape of biomedical research, which is increasingly a multidisciplinary venture requiring increasing numbers of scientists with training that crosses traditional disciplinary lines in the life and physical sciences. Prospective students seek a more multidisciplinary training to be competitive for careers in the modern biological sciences, industry and academic labs seek to recruit such scientists, and many faculty members at UMB conducting research at the cusp of biology, physics, mathematics, chemistry, and computer

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<sup>1</sup>[http://lmi2.detma.org/lmi/Occupation\\_Projection\\_jobsSTEM.asp](http://lmi2.detma.org/lmi/Occupation_Projection_jobsSTEM.asp)

<sup>2</sup>[http://sciencecareers.sciencemag.org/career\\_magazine/previous\\_issues/articles/2012\\_04\\_13/career.a1200041](http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2012_04_13/career.a1200041)

science, need new mechanisms to recruit talented graduate students with these interests. An increase in multidisciplinary biosciences research is also expected to catalyze new research funding opportunities and increase the competitiveness of UMB faculty in a time of diminishing government funds. These efforts at UMB are anticipated to be further accelerated by the opening of the new Integrated Sciences Complex and the Center for Personalized Cancer Therapy, which will serve to further enhance cross-disciplinary interactions between researchers. In order to maintain sustainable, externally funded research programs in these areas, UMB sees that it is critical to establish new mechanisms to enable recruitment of graduate students who share a common interdisciplinary focus. Conversely, as hard disciplinary lines diminish to address pressing challenges in biomedical research, there is also a need to develop new programs for training the next generation of researchers who will need to master increasingly diverse interdisciplinary scientific skill sets. The IBGP directly addresses both of these needs.

### *Duplication*

The University of Massachusetts Medical School, Boston University, and Harvard University offer interdisciplinary programs in similar fields. The table below provides an overview of the four programs offered by these schools.

<b>University</b>	<b>Program</b>	<b>Areas of Focus</b>	<b>Financial Aid</b>
UMass Worcester Medical Center	Interdisciplinary Graduate Program (IGP) in Biomedical Research	Classical and molecular genetics; proteomics and genomics; X-ray crystallography and nuclear magnetic resonance; and digital imaging and laser confocal microscopy of single cells and tissues. Specialized core facilities in gene chip analysis; mass spectroscopy, transgenics, DNA sequencing, analytical ultracentrifugation and biomedical imaging enhance the research capabilities of individual labs.	Stipend - \$30,000 Adjustable to account for inflation; waiver of tuition and fees, and health, dental and disability coverage
Boston University	Molecular Biology, Cell Biology & Biochemistry Program (offers Ph.D. and Masters)	Major areas of focus: Molecular Biology, Cell Biology & Biochemistry. Faculty represent following departments: Biology, Chemistry, Biomedical Engineering, Physics, and Health Sciences.	Stipend ~\$33,000 and health insurance available for 5 years; additional: deans and first-year teaching fellowships, research assistantship; works-study aid, training grants
Harvard University	Ph.D. Program in Biological and Biomedical Sciences	Research topics range from organismal to cellular to atomic resolution. Faculty members represent following disciplines: Biological Chemistry and Molecular Pharmacology (BCMP), Cell Biology, Stem Cell and Regenerative Biology, Genetics, Microbiology and Immunobiology, Neurobiology and Systems Biology	Stipend - \$34,608 Adjustable to account for inflation; all students receive full tuition and stipend support while enrolled

Harvard University	Bioinformatics and Integrative Genomics Ph.D. Program	Preparing for original research in the development of novel approaches and new technologies to address fundamental biological questions	Stipend - \$34,608 Adjustable to account for inflation; all students receive full tuition and stipend support while enrolled
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## ACADEMIC AND RELATED MATTERS

### *Admission*

Applicants to IBGP will be required to demonstrate adequate preparation at the undergraduate level in the form of relevant coursework and research experience. It is planned that admission decisions will be made by the Program Committee on a case-by-case basis. UMB expects that applicants will be undergraduates with Bachelor or Master of Science degrees in biology, chemistry, physics, mathematics, environmental or computer science. In addition to official transcripts showing successful completion of undergraduate and/or graduate curriculum, applicants will be required to take a general GRE test, and, for foreign applicants, a TOEFL test. Applicants will also provide a personal statement describing their research experience, career goals and interests. UMB also plans that three letters of recommendation will be required as part of the application. Applicants for transfer to IBGP will be eligible to receive transfer credit if course equivalency can be established and at the discretion of the program leadership. Transfer students will be required to pass written and oral qualifying exams and fulfill all other candidacy requirements.

## PROGRAM ENROLLMENT

Number of Students	Year 1	Year 2	Year 3	Year 4
New Full Time	4	4	4	4
Continuing Full Time	NA	4	8	12
<b>Total</b>	<b>4</b>	<b>8</b>	<b>12</b>	<b>16</b>

### *Curriculum (Attachment A)*

The proposed IBGP is designed to train students in a broad range of disciplines that cross the boundaries of biology, chemistry, and physics, without losing focus on a single interdisciplinary area. UMB proposes three tracks, Biochemistry, Biophysics, and Bioinformatics, that will offer a multi-disciplinary educational and research experience while training experts in one of these recognized areas. The proposed program is planned to capitalize on CSM faculty's expertise to extend and develop student knowledge through a formalized graduate training environment. The tracks will offer three sets of core courses that will ensure that students develop expertise in one area. As IBGP strives to provide an

interdisciplinary view of the biosciences, the program will include elements that emphasize the interdisciplinary and collaborative nature of modern research.

## **RESOURCES AND BUDGET**

### *Fiscal (Attachment B)*

The program has been designed to function within the available faculty and facility resources. UMB proposes to admit 4 new students, supported by the program as RAs during their first year. It is planned that support for graduate research assistantships will be commensurate with those in Molecular, Cellular and Organismal Biology at a rate of \$20,000 per year. Beginning in the second year of study, it is expected that students will be shifted to research assistantships supported by faculty grants, extramural training grants, and department teaching assistantships. UMB plans to require each student to teach at least two lab sections, one per semester to provide an opportunity to develop mentoring and teaching skills.

### *Faculty and Administration (Attachment C)*

UMB holds that the strength of CSM is its current faculty experience as researchers, publishing for national and international audiences in peer-reviewed scientific journals and regularly presenting papers at conferences and symposia. Faculty participating in IBGP will be drawn from various participating departments, including Biology, Chemistry, Computer Science, Mathematics, Physics, and the School for the Environment. Faculty who wish to become involved will demonstrate an active research program as established through regular peer-reviewed publications and will actively seek extramural research support in the areas encompassed by the scope of this program. New faculty will continue to be recruited through the core participating members. It is expected that by establishing IBGP, a new avenue for the recruitment of talented graduate students will increase scholarly research of participating faculty and provide an administrative framework to engage students in interdisciplinary research efforts. Graduate students interacting with faculty from different disciplines is expected to actively promote interdisciplinary research among faculty and stimulate new paths of research and funding. Participating faculty will perform vital functions for the program (admissions, curriculum, etc.) for limited and rotating periods of time. Support for half-time administrative assistant will be needed to help with program administration.

### *Facilities, Library and Information Technologies*

UMB anticipates that existing library services (subscriptions to print and electronic journals; library instruction; and reference services) will be sufficient to support the program. The major library resource required by IBGP is comprehensive e-journal access. The e-journal collection should be strengthened in areas relating to computational science, biochemistry, biophysics, and bioinformatics. Journal articles, books and other materials that are not currently available from the e-journal collection can be obtained through the library's existing Interlibrary Loan system.

It is planned that the core computational facility for IBGP 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 facility that will be utilized by IBGP. The program will draw on the established IT infrastructure for instruction and email communication. UMB anticipates a new program will create a framework conducive to application for shared instrumentation and training grants from the major federal funding agencies. NSF has a Major Research Instrumentation Program<sup>3</sup> and NIH has a similar Shared Instrumentation Grant (SIG) Program<sup>4</sup>. UMB is actively developing core facilities, such as those supported by the Center for Personalized Cancer Therapy and the Biology Imaging Center, and expects to apply for instrumentation grants to fund those initiatives. IBGP will also be competitive for federal training grants, such as the NSF-funded Graduate Assistance in Areas of National as well as the National Science Foundation Research Traineeship Program (NRT). UMB faculty members have successfully competed for multiple past grants, and have a current NRT grant. The anticipated growth of life science research at UMB, IBGP scientists are expected to be able to compete for NIH graduate training grants, such as the Ruth L. Kirschstein Institutional National Research Service Award. Multiple examples of funding opportunities that encourage cross-disciplinary training were included in the proposal for the program. Several foundations, including the Burroughs Wellcome Fund<sup>5</sup>, also provide graduate fellowships that emphasize the importance of interdisciplinary training. UMB further anticipates that as IBGP grows and develops, additional high performance computational resources will be acquired. In partnership with Boston University, Harvard University, the Massachusetts Institute of Technology, and Northeastern University, UMB has access to the Massachusetts Green High Performance Computing Center (MGHPCC), which provides state of the art infrastructure for computationally intensive research that is vital to the increasingly sensor and data-rich environments of modern science and engineering. Computers at the MGHPCC run millions of virtual experiments every month, supporting thousands of researchers in Massachusetts and around the world. Previously UMB was limited by the bandwidth of its connection to the MGHPCC, however recently this bandwidth was dramatically increased and attributed to hardware improvements introduced after this proposal was submitted. In addition, UMB has its own High Performance Computing Center, which is expected to be made available to IBGP.

UMB reported that no new facilities are necessary to support the proposed program. The research projects of IBGP students will be carried out in participating faculty's laboratories that are already fully outfitted with the necessary research equipment. The program capitalizes on the proximity of research spaces of the many participating departments in the new Integrated Sciences Complex (ISC), which opened in January 2015. Physical proximity of laboratories and faculty offices are conducive to carrying out interdisciplinary research projects. In addition to new research spaces, the ISC includes seminar rooms that can be used for scheduling graduate courses. Though no new regular courses are proposed for the program, the existing

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<sup>3</sup> (MRI) (<http://www.nsf.gov/pubs/2015/nsf15504/nsf15504.htm>),

<sup>4</sup> (S10) (<http://grants.nih.gov/grants/guide/pa-files/PAR-16-054.html>).

<sup>5</sup> 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>).

courses offered by the participating departments are expected to have higher enrollments due to participation of IBGP students and will thus benefit from the additional seminar room spaces.

### *Affiliations and Partnerships*

The Office of Graduate Studies at UMB has mechanisms in place to support graduate student travel to scientific conferences. The Biology Department has a fellowship that also supports student travel. In addition to these mechanisms, CSM has established several partnerships with local businesses that provide support for graduate students, such as the Sanofi Genzyme Doctoral Fellowships, which provide matching funds for one year to support PhD students who have passed their qualifying exams. In addition, UMB has been involved in a multi-year collaboration with the Dana Farber/Harvard Cancer Center. This collaboration has been supported by a U56/U54 Minority Institution/Cancer Center Partnership Grant from NIH. Student training is a significant part of this partnership, and IBGP students are expected to benefit from this resource. As well, UMB students have internships at local biotechnology companies such as Merck, and this is expected to continue to expand connections between the industry and UMB.

### **PROGRAM EFFECTIVENESS**

<b>Goal</b>	<b>Measurable Objective</b>	<b>Strategy for Achievement</b>	<b>Timetable</b>
Faculty productivity	Number of papers produced by IBGP faculty	Show increase with success of IBGP after 3 years	Start tracking in year 1
Faculty productivity	Grants submitted	Show increase with success of IBGP after 3 years	Start tracking in year 1
Begin offering qualifying exams	Approved by governance	Develop appropriate examination procedures for the three tracks; acquire timely university governance approval	End of year 1
First students advanced to candidacy	4 students having fulfilled all candidacy requirements	Mentorship by faculty advisor	End of year 3
Graduate first cohort	4 students obtain	Mentorship by faculty advisor	End of year 5
Start tracking post-graduation success	Graduates placed in appropriate postdocs and first jobs	Develop annual online graduate survey to track student outcomes	End of year 5
Program continuous improvement	Evaluate program success	Program Advisory Board Evaluation	Annually



## EXTERNAL REVIEW AND INSTITUTIONAL RESPONSE

The proposed program was reviewed by Dr. Stanislav Schvartsman, Ph.D., Professor and Director of Graduate Studies in the Department of Chemical and Biological Engineering, and associated faculty in the Lewis-Sigler Institute for Integrative Genomics and Department of Molecular Biology at Princeton University, and by Dr. Meena Subramanyam, Ph.D., Vice President of Translational Sciences & Technology at Biogen Idec Inc., in Cambridge, MA. A site visit was conducted on August 27, 2015, in addition to a paper review. The reviewers provide an enthusiastic endorsement of IBGP, noting it is an innovative program that does not duplicate existing educational offerings in the UMass system. The reviewers also noted that all required infrastructure and resources are already in place, which increases the program's feasibility. The reviewer team did not identify any deficiencies in the proposed curriculum, admission and degree requirements, faculty research and teaching credentials, or employability of program graduates. The team found that the proposed budget amount of \$20,000 for graduate fellowships to be insufficient and not competitive enough to recruit and retain strong candidates. They suggested an increase to \$27,000, citing federal fellowships as precedent. The reviewers also suggested funding for participation and travel to scientific conferences, and to provide an allocation for an annual retreat.

UMB responded with updates to the IBGP proposal to include the reviewer's recommendations. Travel support for PhD students is available through other mechanisms, such as the Lipke Endowment that has been used in the Biology department to support graduate student travel to scientific meetings, or travel fellowships available through the Office of Graduate Studies. In response to the proposed allocation of funds for an annual retreat, the dean's office of the CSM committed to support an annual graduate student scientific symposium. UMB plans to make the symposium accessible to all CSM graduate students. UMB expects this venue to add a valuable innovative dimension to their graduate education environment.

## 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 Integrative Biosciences**.

## ATTACHMENT A: CURRICULUM

<b>Required (Core) Courses for all three tracks (Total # of courses required = 2)</b>		
<i>Course Number</i>	<i>Course Title</i>	<i>Credit Hours</i>
BIOL 697	Program Seminar	2
BIOL 650	Scientific Communication	3
	SubTotal # Core Credits Required	5
<b>Biochemistry Track Required (Core) Courses (Total # of courses required = 5: 3 from this track+1 from each of the other two tracks)</b>		
<i>Course Number</i>	<i>Course Title</i>	<i>Credit Hours</i>
BIOL 612	Advanced Cell Biology	3
BIOL 676	Advanced Molecular Biology	3
BIOL 678	Protein Chemistry and Enzymology	3
BIOL 680L/CHEM 680L	Physical Biochemistry	3
CHEM 681	Medical Biochemistry	3
	SubTotal # Track Core Credits Required	16
<b>Biophysics Track Required (Core) Courses (Total # of courses required = 5: 3 from this track+1 from each of the other two tracks)</b>		
<i>Course Number</i>	<i>Course Title</i>	<i>Credit Hours</i>
PHYSIC 645	Cancer Biophysics	4
PHYSIC 610	Topics in Medical Imaging	4
PHYSIC 640	Scientific Computation and Visualization	4
PHYSIC 614	Thermodynamics and Statistical Mechanics	4
PHYSIC 650	Introduction to Stochastic Processes	4
	SubTotal # Track Core Credits Required	18
<b>Bioinformatics Track Required (Core) Courses (Total # of courses required = 5: 3 from this track+1 from each of the other two tracks)</b>		
<i>Course Number</i>	<i>Course Title</i>	<i>Credit Hours</i>
BIOL 625	Genomics and Biotechnology	3
BIOL 664	Bioinformatics for Molecular Biologists	3
CS 612	Algorithms in Bioinformatics	3
MATH 480	Statistical Learning	3
PHYSIC 640	Scientific Computation and Visualization	3
	SubTotal # Track Core Credits Required	16

<b>Elective Course Choices (Total courses required = 2-3) (attach list of choices if needed)</b>		
BIOL 697	Introduction to Computational Data Analysis for Biology	3
BIOL 615	Immunology	3
BIOL 626	Molecular Genetics of Bacteria	3
BIOL 627	Bacterial Physiology and Genomics	3
BIOL 642	Biogeography	3
BIOL 691	Developmental Biology	3
BIOL 666	Mammalian Toxicology	3
BIOL 674	Cell Signaling	3
BIOL 677	Advanced Eukaryotic Genetics	3
BIOL 681	Network Biology	3
CHEM 658	Medicinal Chemistry	3
CS 672	Neural Networks	3
MATH 303	Introduction to Mathematical Biology	3
PHYSIC 602	Laser Optics	3
PHYSIC 603	Advanced Laser Optics	3
PHYSIC 635	Physics on the Back of an Envelope (Estimation in Physics)	3
EEOS 611	Applied Statistics	3
	SubTotal # Elective Credits Required	5 or 7
	<b>Required Dissertation Research for all three tracks</b>	
	Dissertation Research	32 credits minimum
<b>Curriculum Summary</b>		
Total number of courses required for the degree		9-10
Dissertation Research		32 credits minimum
Minimum credit hours required for degree		60
<b>Prerequisite, Concentration or Other Requirements:</b>		
All students take Program Seminar and Scientific Communication (5 credits total). Students take 3 core courses from their own track plus one course from a list of core courses for each of the other two tracks (16 or 18 credits total). Also, students take two or three more electives from either the track core lists or from a common electives list, for a total of 28 course credits. The remaining 32 credits for a total of 60 program credits come from original research credits.		

ATTACHMENT B: BUDGET

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

	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
<b>Tuition and Fees</b>										
<b>First Year Students</b>										
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
<b>Second Year Students</b>										
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
<b>Third Year Students</b>										
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
<b>Fourth Year Students</b>										
Tuition										
In-State							\$0	\$0	\$0	\$0
Out-of-State							\$0	\$0	\$0	\$0
Mandatory Fees							\$0	\$0	\$0	\$0
<b>Fifth Year Students</b>										
Tuition										
In-State									\$0	\$0
Out-of-State									\$0	\$0
Mandatory Fees									\$0	\$0
<b>Gross Tuition and Fees</b>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0

<b>Grants</b>	\$0	\$0	\$82,400	\$0	\$169,744	\$0	\$262,254	\$0	\$360,163	\$0
<b>Contracts</b>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<b>Campus budget allocation</b>	\$118,450	\$0	\$121,775	\$0	\$125,199	\$0	\$128,726	\$0	\$132,359	\$0
<b>Other Revenues</b>	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<b>Total</b>	\$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
<b>Personnel Services</b>										
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
<b>Total Personnel</b>	<b>\$30,820</b>	<b>\$70,350</b>	<b>\$31,745</b>	<b>\$72,461</b>	<b>\$32,697</b>	<b>\$74,634</b>	<b>\$33,678</b>	<b>\$76,873</b>	<b>\$34,688</b>	<b>\$79,180</b>
<b>Operating Expenses</b>										
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 Overhead	\$630	\$0	\$630	\$0	\$630	\$0	\$630	\$0	\$630	\$0
Other (colloquia, symposia, etc.)	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
<b>Total Operating Expenses</b>	<b>\$7,630</b>	<b>\$0</b>	<b>\$7,630</b>	<b>\$0</b>	<b>\$7,630</b>	<b>\$0</b>	<b>\$7,630</b>	<b>\$0</b>	<b>\$7,630</b>	<b>\$0</b>

<b>Net Student Assistance</b>										
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
<b>Total Student Assistance</b>	<b>\$80,000</b>	<b>\$0</b>	<b>\$164,800</b>	<b>\$0</b>	<b>\$254,616</b>	<b>\$0</b>	<b>\$349,673</b>	<b>\$0</b>	<b>\$450,204</b>	<b>\$0</b>
<b>Capital</b>										
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
<b>Total Capital</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>	<b>\$0</b>
<b>Total Expenditures</b>	<b>\$118,450</b>	<b>\$70,350</b>	<b>\$204,175</b>	<b>\$72,461</b>	<b>\$294,943</b>	<b>\$74,634</b>	<b>\$390,980</b>	<b>\$76,873</b>	<b>\$492,522</b>	<b>\$79,180</b>



## BUDGET SUMMARY OF NEW PROGRAM ONLY

	Year 1 2015	Year 2 2016	Year 3 2017	Year 4 2018	Year 5 2019
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)	Check if tenured	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
Beck, Gregory PhD in Cellular and Molecular Pathology Associate Professor	<input checked="" type="checkbox"/>	• Immunology	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Byrnes, Jarrett PhD in Population Biology Assistant Professor	<input type="checkbox"/>	• Introduction to Computational Data Analysis for Biology	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Cai, Changmeng PhD in Biology Assistant Professor	<input type="checkbox"/>	• Advanced Molecular Biology	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Campbell, Kenneth PhD in Biological Chemistry Professor	<input checked="" type="checkbox"/>	• Mammalian Toxicology • Program Seminar	(1) (1)	College of Science and Mathematics	Full-time	No	• Main Campus
Celli, Jonathan PhD in Biophysics Assistant Professor	<input type="checkbox"/>	• Cancer Biophysics	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Gallagher, Eugene PhD in Oceanography Associate Professor	<input checked="" type="checkbox"/>	• Applied Statistics	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Haspel, Nurit PhD in Computer Science Assistant Professor	<input type="checkbox"/>	• Algorithms in Bioinformatics	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Huang, Linda PhD in Biology Associate Professor	<input checked="" type="checkbox"/>	• Advanced Cell Biology • Genomics and Biotechnology	(1) (1)	College of Science and Mathematics	Full-time	No	• Main Campus
Kesseli, Richard PhD in Genetics Professor	<input checked="" type="checkbox"/>	• Advanced Eukaryotic Genetics	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Killingback, Timothy PhD in Mathematical Physics Associate Professor	<input checked="" type="checkbox"/>	• Introduction to Mathematical Biology	(1)	College of Science and Mathematics	Full-time	No	• Main Campus
Kulkarni, Rahul PhD in Physics Associate Professor	<input checked="" type="checkbox"/>	• Thermodynamics and Statistical Mechanics • Introduction to Stochastic Processes	(1) (1)	College of Science and Mathematics	Full-time	No	• Main Campus
Olchanyi, Maxim PhD in Physics Associate Professor	<input checked="" type="checkbox"/>	• Physics on the back of an envelope (estimation in Physics)	(1)	College of Science and Mathematics	Full-time	No	• Main Campus

Pomplun, Marc PhD in Computer Science Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Neural Networks</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Rao, D.V.G.L.N. PhD in Physics Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Laser Optics</li> <li>• Advanced Laser Optics</li> </ul>	(1) (1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Rex, Michael PhD in Biology Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Biogeography</li> <li>• Scientific Communication</li> </ul>	(1) (1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Riley, Todd PhD in Computational Biology Assistant Professor	<input type="checkbox"/>	<ul style="list-style-type: none"> <li>• Bioinformatics for Molecular Biologists</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Siegfried-Harris, Kellee PhD in Developmental Biology Assistant Professor	<input type="checkbox"/>	<ul style="list-style-type: none"> <li>• Developmental Biology</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Shiaris, Michael PhD in Microbiology Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Scientific Communication</li> <li>• Bacterial Physiology and Genomics</li> </ul>	(1) (1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Skvirsky, Rachel PhD in Microbiology Associate Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Molecular Genetics of Bacteria</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Sugumaran, Manickam PhD in Biochemistry Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Protein Chemistry and Enzymology</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Sundaram, Bala PhD in Physics Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Scientific Computation and Visualization</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Torok, Bela PhD in Chemistry Associate Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Medicinal Chemistry</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Torok, Marianna PhD in Biological Sciences (Biochemistry) Associate Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Physical Biochemistry</li> <li>• Medical Biochemistry</li> </ul>	(1) (1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Veraksa, Alexey PhD in Biology Associate Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Cell Signaling</li> <li>• Network Biology</li> </ul>	(1) (1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Yelleswarapu, Chandra PhD in Physics/Optics Assistant Professor	<input checked="" type="checkbox"/>	<ul style="list-style-type: none"> <li>• Topics in Medical Imaging</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>
Zarringalam, Kourosh PhD in Mathematics Assistant Professor	<input type="checkbox"/>	<ul style="list-style-type: none"> <li>• Statistical Learning</li> </ul>	(1)	College of Science and Mathematics	Full-time	No	<ul style="list-style-type: none"> <li>• Main Campus</li> </ul>