

UNIVERSITY OF MAINE SYSTEM FORMAT FOR NEW PROGRAM PROPOSALS

I. Full program title: *Master of Science Degree in Bioinformatics*

II. Program objectives.

A. Narrative description of program rationale.

The Graduate School of Biomedical Sciences (GSBS) proposes to develop two new graduate programs that will be incorporated into the existing Functional Genomics track in GSBS: a Master of Science and a Professional Science Master's degree in bioinformatics. Bioinformatics is the application of mathematical, statistical, and computational approaches to understand biological processes. This burgeoning multidisciplinary field requires training and professional development, yet a Master's degree program in this area is currently not available in the State of Maine. The University of Maine (UM) is poised to be an educational leader in this field by training students for jobs that are becoming available across the state and nationally in industry, colleges, and research institutes. The MS degree in bioinformatics, which will be offered online, will be an interdisciplinary collaboration across the fields of mathematics, computer science, spatial information science and engineering, and molecular and cell biology.

GSBS is a collaboration of 7 research institutions with over 80 faculty members across the state serving as mentors, committee members, or classroom instructors. GSBS students have the resources and infrastructure of the partner institutions and the UM Graduate School available to them. The distance between the 7 institutions requires that all GSBS classes be taught through videoconferencing. For the new MS degree, an asynchronous online component would be added. Twenty-one faculty representing the UM, Jackson Laboratory (JAX), Mt. Desert Island Biological Laboratory (MDIBL), and Maine Medical Center Research Institute (MMCRI) currently participate in teaching GSBS classes in the Functional Genomics track. The courses that are offered in Functional Genomics will be incorporated into the Bioinformatics Master's degree as either required or elective classes. The GSBS MS in bioinformatics would not only provide a quality program with world renowned partners in biomedical and biotechnology fields, but would also be a cost-competitive program compared with the ~15 other online bioinformatics MS programs that are currently available.

B. General program goals (limit to 3-5 major items maximum).

The MS degree in bioinformatics will be new programs offered online and will be interdisciplinary programs spanning the fields of mathematics, computer science, spatial information science and engineering, and molecular and cell biology. GSBS currently has in place an interdisciplinary PhD program in Functional Genomics. The proposed Master's degrees will strengthen the existing program in Functional Genomics by providing new, complementary classes and also serve as a pipeline for competitive students to continue in the Functional Genomics track. No bioinformatics Master's degree program is currently available and so a need exists for new Master's degree programs in this field. The online Master's degree in bioinformatics from UMaine would be attractive to recent graduates seeking specialized training and for scientists who are already in the workplace and seeking advanced training or new job opportunities.

General program goals are to:

1. Train students in bioinformatics and make them competitive for jobs in the field. Qualified students from across the country can enroll in this program. Students need not be enrolled in UM graduate programs offered in a traditional format.
2. Provide a flexible program that is responsive to rapidly changing technologies in bioinformatics
3. Investigate and evaluate interdisciplinary team-based problem solving experiences in an on-line setting
4. Improve graduate offerings for current PhD students in the GSBS program.
5. Develop new online courses or convert traditional classroom courses that are currently offered to online classes so that students at a distance can have access to the bioinformatics curriculum

6. Provide more class offerings in bioinformatics to qualified undergraduates (by permission) across the country

- C. Specific student outcomes or behavioral objectives (limit to 5-8 items, written for public accountability)

Students in the Master's degree program will be well prepared for jobs in bioinformatics or be eligible for promotions in their current employment. Students completing the program will be able to:

- Manage, analyze, effectively interpret and communicate a range of biological data types.
- Work effectively as team members in interdisciplinary settings
- Effectively use current technologies needed to be competitive in the current job market

III. Evidence of program need.

A. Existence of educational, economic and social needs to include citations or specific authorities or studies consulted.

Bioinformatics graduates are needed to serve pharmaceutical companies, research laboratories and biotechnology companies. In the 1990's, as the up-and-coming microarray and genome sequencing technologies were being integrated into the biotechnology field, there were few scientists with sufficient training to bridge the gap between biology and computation and informatics. Students are now expected to have training in bioinformatics to be competitive. In 2000, the US market research company, *Oscar Gruss*, estimated that the value of the Bioinformatics Industry would reach \$2 billion and is estimated to be growing at a rate of 50% a year. The International Society for Computational Biology (ISCB), a society founded to bring together the computational biology community, has over 2000 members in more than 50 countries. ISCB had approximately 525 jobs for bioinformatics majors in 2010.

The biotechnology/biomedical sector is growing in Maine. According to the Maine International Trade center, "the biotechnology and medical products industries are among the strongest and best performing Maine industries in terms of export growth." (p.19 of 2009 Annual Report Maine International Trade Center.) "This diversification of Maine's economy has taken place over the past several years, with electronics, vehicles, and biotech products now ranking high on the list." (p.15) Maine is experiencing a growth in biotechnology and biomedical sectors with 176 biotechnology/biomedical companies across the state. As shown in Figure 1, there were approximately 130 advertisements for computer and information scientists and biological scientists in Maine from September 2009 to September 2010 (provided by John Dorrer, Center for Workforce Research and Information, Maine Department of Labor). This double coding is necessary because the job code for bioinformatics/biocomputing currently does not exist. These data support the position that there is a need for a Maine workforce with bioinformatics skills. In addition, the letters of support from Maine research institutions (The Jackson Laboratory, Mt. Desert Island Biological Laboratory) and biotech/biomed companies summarize the need and desire for a bioinformatics workforce in Maine.

Figure 1.

Computer and Information Scientists, Research; Biological Scientists

HWOL Sources

excluding Third Party Postings; Bulk Employers

Methodology:

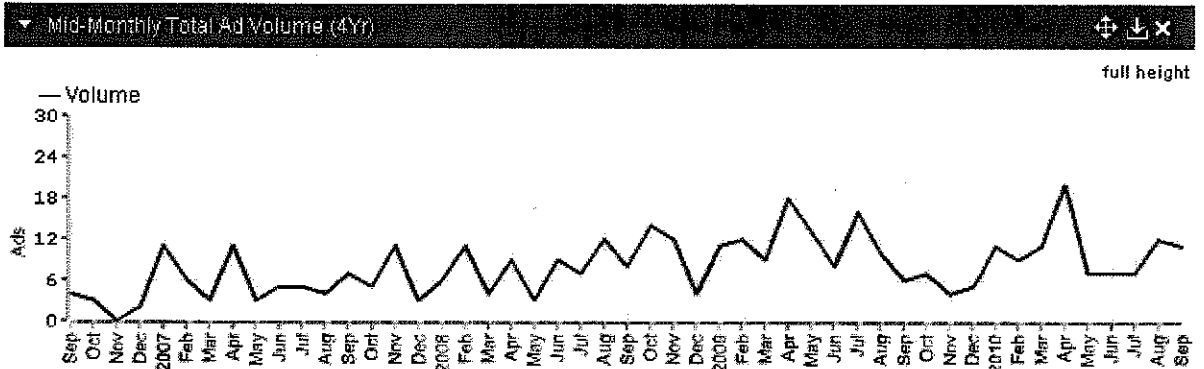
[summary](#) [listing](#)

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Time Series Charts

[collapse all](#) | [add chart](#)

Chart data is updated as of the close of the most recent time period.



B. For 2-year programs, indicate potential employers who have requested the program and their specific employment projections. (Support data to be attached.)

As indicated in Table 1, the predicted Fastest-Growing Occupations nationally? include network systems and data communications analysts (#2) with a 53% increase in jobs by 2018, medical scientists (#4) with a 40% increase, biochemists and biophysicists (#6) with a 37% increase, and computer software engineers, systems software (#11) with a 30% increase. Bioinformatics, computation biology, and biostatisticians were not included in this analysis because these fields are so new that the job codes in the databases currently do not exist for these occupations. However, in conjunction with the data in Figure 1, showing job opportunities in the computer and information/biological sciences, there is strong evidence that the interdisciplinary field of bioinformatics is a growth sector with many available jobs.

Table 1.

Top 50 Fastest-Growing Occupations

Displaying Records 1 - 25 of 50

[Next 25 >](#)

[Show All Records](#)

#	Occupation	Employment		Percent Change *	Earnings	Training Needed
		2008	2018			
1	Biomedical engineers	16,100	27,600	72%	☺☺☺☺	Bachelor's degree
2	Network systems and data communications analysts	292,000	447,800	53%	☺☺☺☺	Bachelor's degree
3	Financial examiners	27,000	38,100	41%	☺☺☺☺	Bachelor's degree
4	Medical scientists, except epidemiologists	109,400	153,600	40%	☺☺☺☺	Doctoral degree
5	Physician assistants	74,800	103,900	39%	☺☺☺☺	Master's degree
6	Biochemists and biophysicists	23,200	31,900	37%	☺☺☺☺	Doctoral degree
7	Athletic trainers	16,400	22,400	37%	☺☺☺	Bachelor's degree
8	Computer software engineers, applications	514,800	669,900	34%	☺☺☺☺	Bachelor's degree
9	Veterinarians	59,700	79,400	33%	☺☺☺☺	First professional degree
10	Environmental engineers	54,300	70,900	31%	☺☺☺☺	Bachelor's degree
11	Computer software engineers, systems software	394,800	515,000	30%	☺☺☺☺	Bachelor's degree
12	Survey researchers	23,400	30,500	30%	☺☺☺	Bachelor's degree

The job category that best encompasses bioinformatics is the science, technology, engineering, and mathematics (STEM). Table 2 shows STEM occupations ranked #4 with an expected 2,262,000 jobs available by 2018 for students with a Master's degree or better. Again, these data emphasize the strong job forecast for the STEM sectors and a strong demand for MS degrees or above.

Table 2.

The number of jobs by educational demand in 2018. (in thousands)

Source: Center on Education and the Workforce forecast of educational demand through 2018

OCCUPATIONS:	Total employment		High school dropouts		High school graduates		Some college, no degree		Associate's degree		Bachelor's degree		Master's degree or better	
	#	Rank	#	Rank	#	Rank	#	Rank	#	Rank	#	Rank	#	Rank
Sales and Office Support	43,543	1	2,326	3	12,838	2	10,909	1	5,902	1	10,070	1	1,499	5
Blue Collar	34,641	2	7,123	1	15,323	1	5,805	2	3,665	2	2,388	8	338	8
Food and Personal Services	27,996	3	5,312	2	10,376	3	5,176	3	2,954	3	3,706	4	472	7
Managerial and Professional Office	17,684	4	254	5	2,033	4	2,340	4	1,767	5	7,519	2	3,772	2
Education	10,234	5	60	6	654	7	826	7	675	8	3,906	3	4,113	1
Healthcare Professional and Technical	8,813	6	0	9	450	8	611	8	2,161	4	2,924	6	2,667	3
STEM	8,553	7	28	8	729	6	866	6	1,054	6	3,615	5	2,262	4
Community and Arts	5,209	8	41	7	411	9	584	9	526	7	2,521	7	1,126	6
Healthcare Support	4,826	9	316	4	1,650	5	1,316	5	1,015	7	433	9	95	9

The Project 7 24/7 committee assembled a survey of UMaine alumni that explored topic and delivery preferences for distance education graduate programs offered through the University of Maine. Out of 1723 responses, only 63 individuals had strong or some interest in bioinformatics. Although we were disappointed with the low interest, it was not surprising. Bioinformatics is a highly specialized field and many of the alumni may not have a familiarity with the subject. Given the lack of familiarity with bioinformatics, substantial marketing will be required for this new program.

C. Detailed survey of similar programs that are offered within the University System, other higher education institutions or other agencies within the State.

There are no bioinformatics programs currently available in Maine. The ISCB's website is a useful resource for finding programs and jobs worldwide (<http://www.iscb.org>). There are 198 programs registered at ISCB in bioinformatics, computational biology and biotechnology. In the United States there are 5 diploma/certificate programs, 12 BS, BSc, BA, B.Eng programs, 32 MS, MSc, MA, M.Eng, and 39 Ph.D/DSc programs. More information about each program can be found at <http://www.iscb.org/iscb-degree-certificate-programs>. There are more than 15 Master's degree programs online, including ones through Stanford, Johns Hopkins and University of Maryland College Park. Graduate degree programs in bioinformatics currently available in New England include:

- Boston University: has a relatively comprehensive program offering an MS degree in clinical bioinformatics and a Ph.D. degree in bioinformatics, with 50 faculty members from 5 BU campuses. For their bioinformatics programs BU has partnered with the National Institutes of Health, through their NCBI division, to offer enhanced training and research opportunities. No online courses are available. The approximate cost is \$45,000
- Brandeis University: started a partial online Master's degree program in 2009 with 25 prospective students and 15 accepted students. The approximate cost is \$44,000
- Northeastern University: offers a Professional Science Masters degree in bioinformatics, but no online courses are available. The approximate cost is \$39,000
- Harvard-MIT Health Sciences and Technology program: offers an MS degree in biomedical informatics granted from MIT, but no online courses are available. The approximate cost is \$40,000
- Johns Hopkins University: offers an MS degree in Bioinformatics, jointly offered with the Zanvyl Krieger School of Arts and Sciences and the Whiting School of Engineering. The degree is offered online. The approximate cost is \$42,000

The estimated cost for the UMaine Bioinformatics Master's degrees is \$12,800 for in-state students and \$34,500 for out-of-state students, making UMaine a more economical choice, especially for students residing in Maine.

D. Enrollment projections for five years. (Support data shall be attached.)

We anticipate that our enrollments will be:

First year – 0 students; will work with CED to convert traditional classes to an online format and develop new online courses

Second year – 5-10 students

Third year – 10-15 students

Fourth year – 10-20 students

We also anticipate that there will be students who will be interested in taking individual classes based on their interest in bioinformatics, but will not be enrolled in a degree program. We can accommodate a maximum of 20 students without incurring threshold costs.

IV. Program content. The opening paragraph will indicate the holistic nature of the program design in narrative form with attention to such items as listed below but not limited to these:

Students entering the program are expected to come from a cell and molecular biology background and require more intensive training in math, computer and information science, or from the mathematics, computer or information sciences disciplines and need training in cell and molecular biology. The curriculum includes 12 credits in either of these core areas to meet foundations requirements for the different backgrounds. Students will then take a 12 credit bioinformatics core in common along with 6 thesis credits. The bioinformatics curriculum will make use of several existing courses in addition to some new courses. Several of the existing courses are already offered completely on-line.

A. outline of required and/or elective courses (not syllabi);

Courses that exist and are available online:

SIE 507 Information Systems Software engineering

SIE 550 Engineering Databases

INT601 Responsible Conduct of Research

Courses that exist but are not online:

BMB 525 Functional Genomics

BMB 400 Molecular Genetics

BMB – GSBS graduate modules in cell and molecular biology

MAT 437 Statistical Methods in Research

MAT 500 Computational Genomics

Courses to be developed:

Biomodules would be project based and student driven

Biomodule – database development (need some programming) – Bult and Nittel

Biomodule – Statistics (need basic stats) – Halteman, Richardson

Biomodule – Ontologies (could take early without programming classes) – Blake, Beard

SIE Data Mining (3 cr) – Beard (prereq for Data Mining Biomodule)

Biomodule – Data Mining (need some programming) – King, Khalil, Hutchison

Bioinformatics Seminar

Fall First Year (6/7 cr)

SIE 507 Information Systems Software engineering

BMB 400 Molecular Genetics

MAT 500 Computational Genomics

Spring First Year (6 cr)

BMB 525 Functional Genomics

INT601 Responsible Conduct of Research

GSBS modules, 2

Fall Second Year (7 cr)

SIE 550 Engineering Databases

MAT 437 Statistical Methods in Research

Biomodule – database development (need some programming) – Bult and Nittel

Spring Second Year (6 cr)

SIE Data Mining (3 cr) – Beard (prerequisite for Data Mining Biomodule)

Biomodule – Statistics (need basic statistics) – Halteman, Richardson

Biomodule – Data Mining (need some programming) – King, Khalil, Hutchison

Biomodule – Ontologies (could take early without programming classes) – Blake, Beard

Bioinformatics Seminar

B. Development of new courses and/or what they may displace

One new 3 credit course will be developed in Data Mining. No such course is currently offered at University of Maine. Additionally four, 1 credit biomodule courses will be developed. These courses will demonstrate the application of computational, statistical and information science methodologies to specific biological data. These courses will not displace any current courses. No such courses are currently offered at the University of Maine.

C. Type of research activity, if any, in program design

MS students in Bioinformatics will be required to complete a thesis and 6 thesis credits. All students in the program will be required to complete a course in responsible conduct of research as part of the part of the established curriculum.

D. Nature of independent study, clinical experience, and/or field practicums employed in curriculum design - NA

E. Impact of program on existing programs on the campus

This program will formalize informal collaborations among mathematics, computer science, information science and cell and molecular biology. The impact will be positive in that formal course offering will now be in place through this program. The participating faculty in the named units support this proposal.

V. Program resources

A. Personnel.

1. Vita of faculty who will assume major role for program to be include in appendix.

Carol Kim, Professor, Molecular & Biomedical Science, University of Maine

Kate Beard, Professor, Spatial & Information Sciences, University of Maine

Carol Bult, Professor, Jackson Laboratory

Ben King, Scientist, Mt. Desert Island Biological Laboratory

2. Specific effect on existing programs of faculty assignments to new program. List necessary faculty adjustments.

If a required course becomes a teaching overload for a faculty member, CED will support the overload pay from their budget.

B. Current library acquisitions available for new programs. - NA

C. New equipment necessary for new program and plan for its acquisition and implementation

We will purchase the equipment and licensure for Adobe ConnectNow for four rooms (two at UMaine, one at the Jackson Laboratory, one at Mt. Desert Island Biological Laboratory). The cost per room is approximately \$10,000 for a total of \$40,000. Funds to cover the equipment costs will be covered by a Project 7 24/7 grant for the bioinformatics program.

D. Additional space requirements, if any, including renovations. – NA

E. Extent of cooperation with other programs, both on the initiating campus and other -campuses. –

GSBS is a collaboration of seven research institutions with over 80 faculty members, including faculty from UMaine and University of Southern Maine. Faculty members serve as mentors, committee members, or classroom instructors.

VI. Total financial consideration.

A. Estimate of anticipated cost and anticipated income of the program for five years

The estimated income for the UMaine Bioinformatics Master's degrees is \$12,800 for in-state students and \$34,500 for out-of-state students, making UMaine a more economical choice (Johns Hopkins University online MS degree program, \$42,000), especially for students residing in Maine.

To develop the courses or convert existing courses to online offerings, a small stipend will be provided to faculty. The first year \$20,000 and the second year \$27,500 will be used for faculty stipends. These costs are one time monies and will primarily be funded through Project 7 24/7. In addition, GSBS would like to upgrade the distance learning capabilities for two rooms at UMaine, one room at the Jackson Laboratory, and one room at the Maine Medical Center Research Institute (MMCRI). The Engineering College has invested the Adobe ConnectNow web conferencing package and has been very satisfied. We will also invest in Adobe ConnectNow and in equipment to support Adobe ConnectNow. The required equipment for a cost of \$10,000/room and total cost of \$40,000.

Summary of proposed stipend costs for each class

FIRST YEAR (\$20,000)

BMB 400 Molecular Genetics; Conversion of online course (\$5,000)

MAT 500 Computational Genomics; Conversion of online course (\$5,000)

BMB 525 Functional Genomics; Conversion of online course (\$5,000)

MAT 437 Statistical Methods in Research; Conversion of online course (\$5,000)

SECOND YEAR (\$27,500)

Biomodule (3 cr) – New Course; database development (need some programming) – Bult and Nittel (\$10,000)

SIE Data Mining (3 cr) – New Course; Beard (prereq for Data Mining Biomodule) (\$10,000)

Biomodule (1 cr) – Statistics (need basic stats) – Halteman, Richardson (\$2,500)

Biomodule (1 cr) – Data Mining (need some programming) – King, Mattingly (\$2,500)

Biomodule (1 cr) – Ontologies (could take early without programming classes) – Blake, Beard (\$2,500)

We anticipate that our enrollments will be:

First year – 0 students; will work with CED to convert traditional classes to an online format and develop new online courses

Second year – 5-10 students

Third year – 10-15 students

Fourth year – 10-20 students

We also anticipate that there will be students who will be interested in taking individual classes based on their interest in bioinformatics, but will not be enrolled in a degree program.

Total Expenditures:

Adobe ConnectNow package and equipment	\$40,000
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Faculty stipends	\$47,500
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<i>Total</i>	<i>\$87,500</i>
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This cost will be covered by the Project 7 24/7 budget designated for the bioinformatics degree (\$80,000) and the remaining \$7,500 will be covered by the GSBS.

B. Detailed information on first-year costs, including:

1. New personnel requirements (include employee benefits) – NONE

2. First-year revenue and identity of source

In the first year, courses will be developed and equipment will be purchased. Conservatively, we estimate that starting in the second year, 5 out-of-state students enrolling ($\$34,500 \times 5 \text{ students} = \$172,500$) and 5 in-state students ($\$12,800 \times 5 = \$64,000$) for a total of $\$236,500$.

3. How operational costs are to be absorbed into current campus operating budget over a 5-year period

The infrastructure is provided by GSBS. Any additional future costs will be covered by CED and tuition return from new students.

4. What additional funding is required to support the program (identify the source)

If new courses are required in the future, the GSBS will fund small stipends ($\$5,000 - \$10,000/3$ credit course) for faculty to develop these courses.

5. Lifetime of outside or independent funding and plan for how and when becomes part of E & G budget.

The Project 7 24/7 will initially fund the new degree. Any additional future costs will be covered by CED and tuition return from new students.

VII. Program evaluation.

(1) Identify formative evaluation strategies to measure both course and program development and implementation activities.

We will form a Committee of Evaluators to formatively evaluate the program in terms of both course and program development. We will seek external academic and industry evaluators along with a representative from the Center for Research and Evaluation.

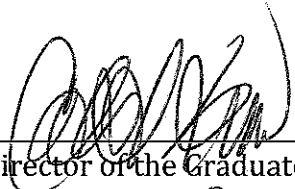
(2) Identify summative evaluation strategies to determine program effectiveness in terms of measurement of program goals.

We will conduct surveys to measure student success in terms of jobs obtained or promotions awarded and overall satisfaction with the degree programs. The surveys will be formulated with the help and approval of the Committee of Evaluators.


A. A post audit of an approved new program must be made after two years.

B. The results of the audit must be reported to the Vice Chancellor for Academic Affairs.

Approval page for Master of Science (MS) in:
Bioinformatics



Director of the Graduate School of Biomedical Sciences 5.31.12
Date



Dean and Associate 5.31.12
Date
Provost for Graduate Studies

Provost Date

President Date