MATHEMATICS PROPOSAL TO THE
MADISON INITIATIVE FOR UNDERGRADUATES

ABSTRACT. This proposal aims to redesign our main Calculus sequence and to restore the Mathematics department to a position where it can fulfill its service role and administer a quality major program. We propose the creation of an innovative sequence of 2 Calculus courses for students in the biological and biophysical sciences that will include an application oriented computational lab, integrative sections and a modular format for the second course. The modular format is designed to streamline the delivery of mathematical knowledge and to adapt the content to the wide variety of targeted majors. The computer lab will accommodate variations in student’s learning preferences, and enhance their ability to learn independently. The development of these courses will involve a campus-wide group of faculty and consultation with students. The success of this reform will provide momentum to address similarly our other calculus sequences targeted to engineering, social sciences, business and the physical sciences.

The Mathematics department has reached a situation where it cannot administer its service and major courses adequately because of lack of faculty. The department has repeatedly lifted enrollment caps to accommodate students, with classes that are seriously overcrowded. A second portion of the proposal describes its precarious situation and the resources needed to avert further damage.

Introduction

Mathematics is a key subject in the career of a large majority of students on campus. Originally linked to the physical sciences and engineering, in recent years mathematics has become a cornerstone for advanced work in many business, life sciences and social sciences majors. This development is coupled with the increasing use of mathematical modeling, analysis and computations in these disciplines’ research: all top-ranked universities are invariably coupled with top-ranked mathematics departments, reflecting this fundamental role.

The nature of mathematics has not changed, but with the years our student population has. We teach both graduate and undergraduate students with different backgrounds, different majors and different needs. Within a large lecture we apply the “one size fits all” philosophy, covering minimally the needs of all these students even as the reality of our student population demands a change from our traditional teaching. Fortunately we now have a golden opportunity to bring about such a change: our faculty is very young (37% of our faculty is under 40, while only 13% is over 60) and they are not only willing but quite familiar with different ways of teaching. This proposal is a step forward towards channeling that energy and knowledge into meeting the emerging educational needs of our students. Unfortunately, under serious reduction of its faculty, the Department is now at a breaking point: classes are being capped for lack of classroom space; the sizes of some classes are double, even triple the recommended size; we are unable to offer needed classes for the math major; the quality of our program is being seriously undermined. A second goal of this proposal is to ensure that the Department can serve its majors and continue to fill its service role at the university under very severe strain of its resources.

Rethinking large service courses: Calculus

The teaching of Calculus represents the main obligation of the Mathematics Department in its service role. Indeed, every year we teach Calculus to more than 5000 students in several courses with different levels. More than 50 majors on campus require one or more semesters of Calculus
(that is 31% of all majors) and each one of these has needs for different subtopics. Going beyond the uniform model of lecturing to tailor content to individual needs is a formidable challenge. With the support of the provost office, we have tried some innovations in the last 4-5 years: we have run dorm sections modeled after the WES program where students, supervised by trained TAs, got 2 extra hours a week collaboratively working on problems beyond those in the homework; we have piloted some changes to lectures – pre-lecture quizzes to encourage students to read material before class, changes in the pedagogy of TA sessions with the use of more collaborative learning techniques, group work in large study rooms staffed with TAs providing support to the groups; we have taught a number of Calculus bio-FIGS. All these initiatives were deemed to be not far-reaching or non-scalable: they worked well only in small groups or perhaps in a small number of lectures, but they would need a considerable investment to make them work universally and properly.

Here we propose the development of a new type of Calculus class. Because of the sheer size of the project we will initially focus on the relatively smaller group of students in the life sciences, who are indeed a priority of the MIU program. If this first phase is successful, our intention is to investigate its application to Engineering students (our main Calculus client). Once this second phase is carried out, the teaching of Calculus can be readily adapted to suit the needs of different departments. The changes are not minimal or aesthetic: we are not merely suggesting the addition of components to the traditional lecture (more TA help, enrichment sections, etc). The proposal reflects a significant innovation of our current model, with the aim of making Calculus more individually relevant to our students.

The biology model

The biological and biophysical sciences have undergone a radical change during the last three decades. There has been an explosion of quantitative data across all scales from the ecological down to the molecular level and related experimental advances that permit the verification of complex models. One consequence of this revolution is the increased demand for quantitative skills in students within traditional Biology majors, as well as more interdisciplinary majors such as Biochemistry.

The calculus-level skill set needed by students in the biological and biophysical fields can differ considerably between majors. The original design of calculus courses was mostly targeted to the typical student in the traditional physical sciences and Engineering. In addition to identifying the content that will best fulfill the curricular and professional needs of the students, there are several factors that make the development of these courses challenging, since they must satisfy several, often apparently contradictory, requirements:

- The courses must be relevant to the students and better prepare them for later courses in the biophysical sciences. The students must see this relevance during the course itself.
- The mathematical tools required by biologists and biochemists are often advanced: for example, data mining and signal or image analysis require mathematics traditionally not covered at this level.
- The applicability of fundamental mathematical methods and skills taught should be made clear and demonstrated computationally and in hands-on sessions.
- The majority of these students will not be the developers of mathematical theories or computational software, but will require enough knowledge, facility and maturity to comprehend their basic workings.
Many students will take only two semesters of calculus-level mathematics, and yet the courses must be designed to also feed into more advanced mathematical science courses and fulfill pre-med requirements.

Mathematics courses currently offered at the calculus level do not fulfill these criteria for students in the biological and biophysical sciences. We propose to

*Develop new courses, innovative in content and pedagogy that effectively teach the knowledge and tools of calculus to students in the biological and biophysical sciences. This innovative two-course sequence will (i) incorporate, in a modular format, topics such as probability, linear algebra, data analysis and differential equations, (ii) include computational skills within interactive, small-group exploration of realistic applications.*

**Course content**

In meetings and consultations with campus representatives from a variety of departments and programs involved in Biology and Biochemistry education, henceforth denoted the *campus partners*¹, a framework for the content and pedagogy of the courses has been developed. To meet this challenge we propose two courses, Mathematics 231 and 232:

**Math 231 - Introductory Calculus for Biological and Biophysical Sciences**

The first semester course, Math 231, will be primarily a first course in Calculus with emphasis on applications to the biological sciences. It will present differential and integral calculus, without which most further mathematical development is impossible. It will innovate by including an introduction to probability and continuous random variables, by including hands-on computational sessions in small groups (see below) and by always focussing on applications appropriate to the biological and biochemical sciences.

**Math 232 - Intermediate Calculus and Mathematics for Biological and Biophysical Sciences**

While the subject material in the first course has a strong internal coherence, the diversity of needs and departments do not support a “one size fits all” course for 232. The needs of a student in a traditional Biology major may be quite different from those required by a student in a major, such as Biochemistry, where needs lean towards those of Chemistry and Physics. The solution we propose is to present the material in a combinations of a seven-week core followed by a sequence of two four-week modules. We have identified the following core material and module topics for initial implementation, but we envisage the possibility of including further modules which will give the students a wider choice of topics according to their curricular needs.

**Core Material.** Core material is intended to provide material relevant to the students’ future non-mathematics courses, to prepare the students for the sequence of modules, and to fulfill 234 prerequisites. The syllabus includes: (i) integration by parts and other integration techniques, (ii) Taylor series and approximations, (iii) three dimensional geometry.

**Module: Linear Algebra.** This module will give an introduction to matrix algebra, its application and computations. It will cover the solutions of large systems of equations, eigenvalues and eigenvectors and singular value decomposition. The application to Principal Component Analysis, an important concept in multivariate data analysis and data mining will be emphasized.

**Module: Dynamics.** This module will introduce systems of differential and difference equations. Fundamental applications will be covered: the dynamics arising in reaction kinetics (mass-action

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¹Faculty and staff members of this group are named in the Development Group section.
laws, Michaelis-Menten kinetics) of complex biochemical networks, and the significance and modelling of ecological webs with difference equations. This module will be a good preparation for courses such as Physical Chemistry.

Module: Probability. A basic introduction to probability theory, covering discrete and continuous random variables, their mean and variance, correlation and independence of random variables, multivariate distributions, a description of Markov processes and Monte Carlo simulations. Applications to genetics.

Module: Basic multi-variable calculus. This module introduces functions of several variables, partial derivatives and multiple integrals and their geometric meaning. Applications include numerical computations of these quantities and minimizing energy landscapes.

All modules will be developed in consultation with the client departments, to ensure that their curricular needs are met. Further modules under discussion include:


Module: Optimization. An introduction to search methods for finding minima of functions and with applications, for example, to energy landscapes and molecular configurations.

Teaching and Pedagogy

In deliberations within the committee\(^2\) and in discussions with campus partners, several broad guidelines emerged for the teaching and organization of these courses:

Class Size should be appropriate for faculty-student interaction. As we describe in more detail below, we believe an appropriate balance to be classes of approximately 90-100 students.

Hands-on Student Learning will include interactive learning through computation and group interaction, especially with regards to applications to realistic datasets. The courses should include at least one-hour per week of computer lab.

The first two courses in the current standard calculus sequence, Math 221 and 222 are both 5-credit courses which meet in a standard lecture-discussion format for 3 hours weekly in a large lecture (200 or more students) and for 2 hours weekly in a teaching assistant-led, small discussion section (less than 25 students). Each teaching assistant leads 2 groups of students, i.e., is in charge of approximately 45-50 students.

The considerations we have listed lead us to propose a different contact structure for these courses, while retaining the same number of contact hours. We propose lecture sizes of approximately 90-100 students and each lecture will have 2 dedicated TAs. In order to integrate fully the lectures, discussions and the computational laboratory component, the students will attend the faculty led lectures two hours per week and the teaching assistant led discussions sections two hours per week. The fifth contact hour, an integrative session will be led by both the faculty and the teaching assistant in groups of 2 TA sections of approximately 45-50 students. We believe the slight increase in faculty time (4 hours instead of 3) and TA time (5 hours instead of 4) required for the course will both enhance the coherence of the instruction and the learning outcomes, while increasing access to the Professor.

\(^2\)These are members of the Department of Mathematics with research and teaching interests at the interface of Mathematics, Biology, Chemistry, Biochemistry, Physics and Computer Science, as well as members of the Math department-MIU committee. The composition of this committee is given in the Development Group section.
In the first course (Math 231) the integrative session will be spent in group work around computational projects, either in a classroom setting or in a computational laboratory. We will develop several computational projects during the semester, which will both enhance the learning of the material and introduce the necessary computational tools for Math 232. There have been preliminary discussions on the type of computational software that will be used. The modern suite Matlab™ seems most appropriate since it combines acclaimed computational tools and flexibility to understand the underlying mathematics. It is the state of the art software in the application of mathematics and has a growing acceptance in the biological sciences in addition to the biophysical sciences, where it has long been used.

The format of the second semester course will be targeted to emphasize the biological applications, integrating computation and theory. In order to do this, the computational laboratory will become more central. In the format proposed, the integrative session, as well as at least one of the teaching assistant led hours will be held in the laboratory. For each module we will develop realistic computational projects.

The teaching assistants will receive special training, both in the applications areas and in the new pedagogical approach. Part of the TA training will be similar to that of the TAs participating in the WES program, with an emphasis on inclusion, diversity and on effective ways to manage and structure groups to maximize learning. This training will be done in collaboration with either the WES program or the Delta program (or both). TAs will also be trained in the computational aspects of the courses by either the faculty or other experienced TAs. Preferentially TAs will be chosen amongst students working in biomathematics.

The ideas and descriptions in this section should be readily applicable to Calculus classes for other majors, including Engineering, Business and majors in the physical and social sciences. One will need to change content and modularization accordingly. Indeed, if successful this format could be appealing also outside Calculus, they could serve as a test bed for a broader rethinking of service instruction of other Math courses at this level.

**Target audience and development group**

The target audience for 231-232 are students who need at least one semester of calculus-level mathematics (which includes all pre-med students and many majors). In addition the Biochemistry, Biology, Chemistry and Molecular Biology majors require more than one semester of calculus-level mathematics. Majors in Biological Systems Engineering (joint Engineering/CALS major), Biomedical Engineering and Chemical and Biological Engineering may benefit more from the 231-232-234 sequence of calculus courses instead of the traditional 221-222-234. Academically, 231-232 would be offered at the same level as 221-222: we intend 231 to serve as a prerequisite for 222 and 232 to serve as a prerequisite for 234.

Given that Biochemistry alone graduates approximately 100 majors per year, we estimate that we will need to run two lectures of 231 in fall and one in spring, and also one 232 lecture in both fall and spring. Each lecture will be 1\frac{1}{3} of a regular teaching assignment, and thus we expect we will need 2 FTE on a permanent basis to run the courses. During the developmental stages the faculty will be developing textbooks, modules and computational projects. **These will be free to students who will not need to purchase a course textbook or other material. We estimate this will save students around $20,000 per year.**

The development of these courses has broad based support in the Mathematics department. We list below a group of 11 faculty that have committed to participate in the development of these
courses and teach them. Two of the faculty members hold joint appointments with Biochemistry departments. Three other members have research interests in the biosciences. The course development will occur in constant consultation with a variety of stakeholders, including students and faculty in bionscience departments. In particular, we intend to regularly consult juniors and seniors in the biological and biophysical sciences majors about their experience in learning and application of mathematics. Preliminary consultation meetings, resulting in the broad outline of this proposal, were held with the UW faculty and staff members listed below.

**Mathematics Faculty** David Anderson, Sigurd Angenent, Gheorghe Craciun, Alexander Kiselev, Gloria Mari-Beffa, Laurentiu Maxim, Paul Milewski, Julie Mitchell, James Rossmanith, Jean-Luc Thiffeault, Benedek Valko.

**Campus Partners** Professor Allan Attie Department of Biochemistry. Professor Teri Balser Department of Soil Science & Director ICBE. Professor Jeff Hardin Department of Zoology & Director of BioCore. Professor Tony Ives Department of Zoology & BioCore instructor. Professor Bret Larget Department of Botany and Statistics. Professor Nicole Perna Department of Genetics. Professor Tom Record Departments of Chemistry and Biochemistry. Professor Gary Roberts Department of Bacteriology. Dr. Lillian Tong ICBE. Professor Jennifer Reed Department of Chemical and Biological Engineering. Professor Phillip Barak Curriculum Chair in the Department of Soil Science and Interim IT Director in CALS.

**Assessment**

The problem our proposal aims to address is the inadequate First Year Calculus instruction of students, and in particular that of students in the biological and biophysical sciences. Our objectives in that respect are:

A. To provide instruction that is relevant to the different majors.

B. To provide a better understanding of key calculus-level concepts in mathematics and a more hands-on experience via the Computational Lab.

C. To provide a sufficient understanding of more advanced topics (depending on the modules chosen in Math 232), to the extent needed by the major.

D. To ensure that students who take these courses can successfully advance to the third course in the calculus sequence (Math 234) and higher (Math 320, 340).

In order to assess these objectives we will take the following steps:

1. To assess how well we have accomplished objectives A and B, we will analyze the performance of students in those courses in the major that make heavy use of mathematical concepts. We will compare their performance to that of students who have taken the regular calculus sequence Math 221-222 and will look for improvement. We will also ask students in Math 221-222 and in Math 231-232 to fill out surveys about their satisfaction with the applicability of the mathematics they learned in those sequences. These surveys will be given to students in their junior and senior year.

2. To assess C we will identify courses in the students’ majors where they make use of higher level, more complex mathematical concepts, such as physical chemistry, and we will work with the instructors and students to measure to what extent students have enough understanding of the concepts to be able to use them effectively. These measurements can be

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3Math 320: Linear Algebra and Differential Equations; Math 340: Matrix and Linear Algebra
done with embedded questions in some of the tests/assignments, or by simply identifying activities that show the mastery needed and collecting data on performance.

3. In order to assess objective D we will collect data for comparison on performance in Math 234 and Math 320, or 340, both for students coming from Math 221-222 and from Math 231-232. We will also provide surveys to students to identify which subjects in Math 234 they felt less prepared for after taking Math 231-232. In this way we will be able to modify the structure of required modules to be sure students are fully prepared for further work.

Assessment will be done in collaboration with the ICBE.

Timeline for Development of Math 231-232

If awarded the funds and faculty lines, we intend to adopt the following timeline:

Academic Year 2011-12. Development of 231-232 materials, including class notes, modules, computer lab activities. For this stage we request three courses teaching release for each one of two faculty members in addition to two TAs at 50% to help with programming and web-design for the courses.

Academic Year 2012-13. Run the first pilots, one of 231 in fall, and 232 during spring. These pilots will be assessed. Experience gained from the pilots will be incorporated during summer 2012. Ideally, two new FTE would be in place during this year.

Steady State. We shall offer two sections of Math 231 and one of Math 232 each fall, followed by one section of 231 and one of 232 each spring. This corresponds to 2500 credit hours/year. We expect the demand to increase with implementation and add additional sections as needed.

Critical needs in service courses and the mathematics major

During the last 10 years the Math Department has lost 10 faculty positions, with 9 FTE losses taking place within the last 5 years. As a result we had to close the equivalent of 27 undergraduate
classes in the last 5 years. To add to this unfortunate situation, in the last five years enrollments in most\(^4\) of our classes have remained steady or have steadily increased, as shown in figure 1\(^5\).

The result has been devastating not only to our service classes, but more drastically so to our mathematics major program. Table 1 lists our initial fall enrollment numbers in a variety of classes, together with the maximum class sizes from only 6 years ago.

<table>
<thead>
<tr>
<th>Course</th>
<th>previous cap</th>
<th>early Fall numbers</th>
<th>Course</th>
<th>previous cap</th>
<th>early Fall numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>114 5 cr</td>
<td>200</td>
<td>287</td>
<td>421 W</td>
<td>25</td>
<td>41</td>
</tr>
<tr>
<td>221 5 cr</td>
<td>200</td>
<td>6 lect. from 209 to 289</td>
<td>475</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>234</td>
<td>100</td>
<td>260, 319 and 238</td>
<td>514</td>
<td>30</td>
<td>38</td>
</tr>
<tr>
<td>275 H 5 cr</td>
<td>25</td>
<td>42</td>
<td>521</td>
<td>30</td>
<td>31, 34 and 38</td>
</tr>
<tr>
<td>321</td>
<td>30</td>
<td>70</td>
<td>541</td>
<td>30</td>
<td>33 and 39</td>
</tr>
<tr>
<td>341 H W</td>
<td>25</td>
<td>38</td>
<td>632</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>375 H 3cr</td>
<td>25</td>
<td>46 and 21</td>
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<td></td>
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</tbody>
</table>

Table 1. Initial enrollments in fall 2010. Critical enrollments in bold; "H" indicates an honors class; "W" a writing intensive class.

**Overcrowding of classes**

After discussion in the department, the faculty opposed the strict capping of classes, concerned by the possible inability of students to graduate without our required service courses. Instead, the department has lifted the enrollment caps repeatedly in order to meet the increasing demand. We are now at a point where student enrollment is only limited by the size of the available classrooms: we can no longer find classrooms large enough to accommodate everyone. Classes such as Math 234, 421, 475, 521 and 632 were full in early Fall and had students waiting for others to drop or for us to find a larger classroom so they could enroll. There is unanimous agreement among the faculty that teaching quality is seriously suffering: we have been forced to hire outside lecturers to teach several classes, including, for the first time, gateway classes in the major (for example 421). Also for the first time, we have had to ask first year postdoctoral fellows to teach large introductory lectures primarily attended by first year students. If we add to this the fact that we needed to hire 29 TAs outside mathematics this fall, and the fact that eight of our basic spring courses remain unstaffed, one gets a clear picture of how dire our situation is.

To see how these circumstances affect our classes, consider the example of Math 234 (third semester Calculus). This class is a 3 cr. class where the professor is assisted by one TA for every 80+ students. While TAs for math courses at the 200 level normally have 40 students whom they meet twice weekly, Math 234 TAs have four sections with only one weekly contact hour. Accordingly, they have less per-student time for personal interaction and feedback. Even though we have added graders, the grader is disconnected from the class in many ways and the feedback is not as effective. Math 234 was designed to have around 100 students, much the same way Math 340 and 320 are designed, to allow additional contact with the professor. Some of the sections now have over three times that size and contact between student and professor is almost nonexistent.

The damage done by overcrowding to high impact courses such as honors courses, writing intensive courses and courses in the major is very serious. As an illustration, the recommended

\(^4\)With the exception of Math 210, which has shrunk greatly since it is no longer required by the School of Business.

\(^5\)A temporary drop in the 2005 freshman class caused a drop in enrollment of 2nd and 3rd year students in 2006-07.
size of an Honors class is around 25 students. Our Calculus Honors sequences are year long courses and, when they are run with the recommended class size, professor and students usually know each other very well by the end of the sequence. As someone who knows them well, the professor is often one of the main and best sources of recommendation letters as the proportion of students that go to graduate or professional schools, mostly outside mathematics, is very high. The students usually form social/academic groups creating many life-long friendships⁶. Often the professor remains in contact after graduation. In the last five years most of these classes have had to run with an initial enrollment of 50-60 students in only one section. The students’ experience is completely different: larger more impersonal classes, less personal attention, and some of the benefits of the Honors class are no longer there. To the students these classes are closer to a large lecture than to an Honors class. Often many students drop the class, reducing enrollment from 50-60 to around 40. Nonetheless the large-lecture atmosphere has been established and the damage is already done. Students have analogous problems in our writing intensive classes where personal feedback from the professor is highly necessary. Since our writing intensive classes are gateway courses to the math major, the damage reaches far beyond them. Even though overcrowding hurts many of our classes, a more personal attention is indispensable if students in high impact classes are to reap the benefits that the special character of the courses claims to provide.

We currently have overcrowding problems across the spectrum, including some of the large lectures, Honors classes, writing intensive classes, gateway courses in the major, courses for seniors in the major, and graduate classes.

**Reduction of the number of math classes offered to the major**

Another consequence of the reduction of our undergraduate offering is the lower number of courses in the major that we currently run. We now offer the basic classes all majors must take, some (Math 521 and 541) above recommended capacity. But almost all courses that are meant to enrich the major and make it more competitive have been taken away from the timetable. For example, Math 519 is an upper level class in differential equations. It is recommended for math majors with an applied option who require knowledge of mathematical modeling, and also for students applying to graduate school. The class has run twice in the last six years. Math 552, Math 635 and Math 627 have a similar situation. We have been forced to offer Math 435 (Cryptography) once every other year, even though it runs at double capacity whenever we can run the course.

For lack of options the reduction in undergraduate math courses also forces our best undergraduate students into graduate classes, often prematurely, as they run out of undergraduate classes to take. Contrary to what one might think, this is not beneficial in the least. The pedagogy of graduate courses presumes a level of maturity and independence which most of our undergraduates, even the good ones, often lack. Where an advanced undergraduate course on, say Fourier analysis, would be an excellent preparation for graduate school, the corresponding higher level, faster paced, graduate course will merely provide the undergraduate with a weak foundation. Now that the number of these students have increased, it is not uncommon to have professors worrying openly about the undergraduates in their graduate classes and discussing what to do about them.

Finally, the difficulty in staffing undergraduate classes has forced the mathematics department to ask interdisciplinary faculty who were hired in Chancellor Ward’s Cluster Hiring Initiative to teach mainstream math classes instead of the interdisciplinary classes which they were hired to design.

⁶One such group called itself “group 490” because they were students taking Math 375 and Chem 115—they added the numbers, and essentially formed a spontaneous FIG.
and then teach. E.g. the math courses in Structural Biology, Systems Biology and Bio-Statistics designed by cluster faculty have hardly run, if at all, because the cluster faculty is being diverted into the teaching of our service classes.

**Peer comparison**

Despite our precarious situation, the Math Department has managed to maintain an excellent research program. Nationwide, the mathematics department has been consistently ranked in the top 15 for as long as we can remember (at least for the last 40 years). In last NRC ranking we ranked in 9th position\(^7\). The top 20 mathematics departments in public research universities on average teach 600 students per faculty. We teach 50% more, or 900 students per faculty. The list below shows NRC ranking and Spring 09 FTE numbers in the top 20 math departments in public research institutions.

<table>
<thead>
<tr>
<th>U. and ranking</th>
<th>Student #</th>
<th>faculty #</th>
</tr>
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<tbody>
<tr>
<td>Berkeley (1)</td>
<td>35,409</td>
<td>67*</td>
</tr>
<tr>
<td>Michigan (7)</td>
<td>41,041</td>
<td>62</td>
</tr>
<tr>
<td>UCLA (12)</td>
<td>39,352</td>
<td>60*</td>
</tr>
<tr>
<td>Texas-Austin (14)</td>
<td>50,000</td>
<td>51 (+25* lect.)</td>
</tr>
<tr>
<td>Penn State U (9)</td>
<td>44,832</td>
<td>57</td>
</tr>
<tr>
<td>UIUC (17)</td>
<td>41,495</td>
<td>67</td>
</tr>
<tr>
<td>UC San Diego (13)</td>
<td>27,500</td>
<td>55</td>
</tr>
<tr>
<td>Wisconsin (9)</td>
<td>42,030</td>
<td>46.5</td>
</tr>
</tbody>
</table>

*Numbers with asterisk were obtained from their web site.

We are 5 FTEs below the smallest sized department among all top 20 math departments in public research universities, and 14 FTEs below the average size, including universities with smaller student bodies. If the Mathematics Department is to continue a quality undergraduate program for its own majors as well as those of other departments, it desperately needs additional faculty.

**Budget request**

To cover the minimal teaching needs (i.e. splitting overcrowded writing intensive and Honors classes, splitting some of the major classes, splitting critically large lectures - Math 234 - and offering needed major classes) we will need a minimum of 4 FTEs. It would be beneficial if some FTEs could be open rank to compensate for the expected loss of some highly reputed senior faculty.

We will need the following funds to develop and implement the Biology Calculus sequence, plus two faculty FTEs, ideally during year 2012-13.

That is, we are requesting a total of 6 faculty lines, plus the following funds:

**Development phase 2011/2012**

Six course buyouts for faculty to develop free course materials ......... $141,000
2 TAs at 50% to develop computational lessons ........................... $16,264

**Deployment phase 2012-∞**

2 TA FTE at 50% .............................................. $16,264
TA training hours (6 TAs, 10 hours each) ................................. $2,712
Assessment .......................... $35,000

None of the payroll costs include fringe benefits (health insurance, social security, etc). None of the graduate TA costs include tuition remission.

Prepared by Prof. Sigurd Angenent, Prof. Gloria Marí Beffa (contact, maribeфф@math.wisc.edu), Prof. Paul Milewski, Prof. Julie Mitchell.

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\(^7\)The data for that ranking was collected in 2005, exactly at the beginning of our dramatic shrinking. The shrinking has affected our standing as we were ranked No. 16 by latest US News ranking, the all time low in recent memory.
October 25, 2010

Dear Chancellor, Deans and UW students,

This is a letter enthusiastically endorsing the MIU proposal entitled "Mathematics for Biological and Biophysical Sciences" that has been put forward by the Department of Mathematics.

The proposal addresses the problem of proper training in Mathematics for students in the Biological and Biophysical Sciences. For several years there have been discussions on having Calculus level courses redesigned for our students, whose needs are varied and often different from those in the traditional Physical Sciences and Engineering. We feel that the new modular design addresses the diverse needs of our students while preserving core foundations in Calculus.

These courses are very much needed: the Biological and Biophysical Sciences are very different today than they were two decades ago, and the quantitative knowledge needed by our majors will continue to increase. The question of proper mathematical training in fields relevant to Biotechnology, a crucial area for the University and the modern economy, is currently at the forefront at many universities. Our students continue to require core knowledge in differential and integral calculus, while skills in linear algebra and statistics are increasingly needed when working with high-throughput genomic and biochemical data. The proposed modular system will expand the amount of relevant mathematical training our students obtain without increasing the credit requirements for our majors. We feel that the proposed courses significantly address these needs in an innovative way, and we are very excited about this development.

Sincerely,

[Signatures]

Jeffrey D. Hardin
Professor and Chair
Department of Zoology
Chair, Biocore Curriculum

Richard L. Gourse
Professor and Chair
Department of Bacteriology

William (Bill) Bland
Professor and Chair
Department of Soil Science
Nelson Institute for Environmental Studies

James C. Weisshaar
Professor and Chair
Department of Chemistry

Michael R. Culbertson
Professor and Chair
Department of Genetics
October 25, 2010

Dear Chancellor, Deans and UW students,

This letter signifies our enthusiasm for serving as Campus Partners within the "Mathematics for Biological and Biophysical Sciences" initiative that has been put forward by the Department of Mathematics.

Most of our Biochemistry majors are currently required to take two semester of calculus (221, 222), which is intended to provide them with the math background needed for their Physics and Chemistry classes. As currently designed and taught, these courses include topics in pure mathematics and engineering mathematics that are not essential for their later studies. At the same time, the courses are lacking foundations in other subjects that are more relevant to our Biochemistry majors, including linear algebra, multi-variable calculus, probability and statistics, and differential equations.

In addition to many of our Biochemistry colleagues, we are strongly in favor of the new courses being proposed. We are grateful to have a Mathematics Department willing to work closely with us on curriculum that better serves our students. While a formal approval of this course as a Biochemistry major requirement must involve our entire faculty once a formal course proposal is available, we feel confident that our colleagues will embrace these courses once this is presented to them.

The Mathematics Department has worked with us to ensure that topics of relevance to both the biological science and physical science aspects of Biochemistry will be adequately addressed, and we feel confident that together we can make real progress in strengthening quantitative skills within our major.

Sincerely,

Alan Attie
Professor
Department of Biochemistry

Tom Record
Professor
Departments of Biochemistry and Chemistry
MEMORANDUM

To: Provost Paul DeLuca
From: Gary Sandefur, Dean
Re: MIU Round 3 proposals

December 1, 2010

We are pleased to submit proposals from the College of Letters and Science for MIU Round 3. We solicited two page pre-proposals and received over 40. We reviewed these pre-proposals in the Academic Planning Council and in Senior Staff. Based on these reviews, we invited 15 submissions of full proposals. These proposals were reviewed by Senior Staff and we decided to forward these 15 to you for consideration. All are worthy of funding and would help meet critical needs in the University.

The proposals are grouped into three tiers in order of their importance in meeting the goals of the MIU, with tier 1 being the most important. Importance is based somewhat on the quality of the proposals but primarily on undergraduate educational needs. We also took into account losses in faculty numbers prior to the MIU and the success or lack thereof of departments in previous rounds of the competition.

**Tier 1:** Communication Arts, English, French and Italian, School of Journalism and Mass Communications, Philosophy, Political Science

**Tier 2:** Anthropology, Chemistry, Math, Sociology, Statistics

**Tier 3:** Communicative Disorders, Religious Studies, Service Learning, Undergraduate Research Scholars

We did not carefully assess the budgets of the proposals since we assumed that this would be done by the office of the Vice Chancellor for Administration and Finance.

xc: Associate Vice Chancellor Aaron Brower
    Associate Dean Nancy Westphal-Johnson
    Academic Associate Deans
    Associate Dean Anne Gunther
    Sheila Voss, Office of the Provost