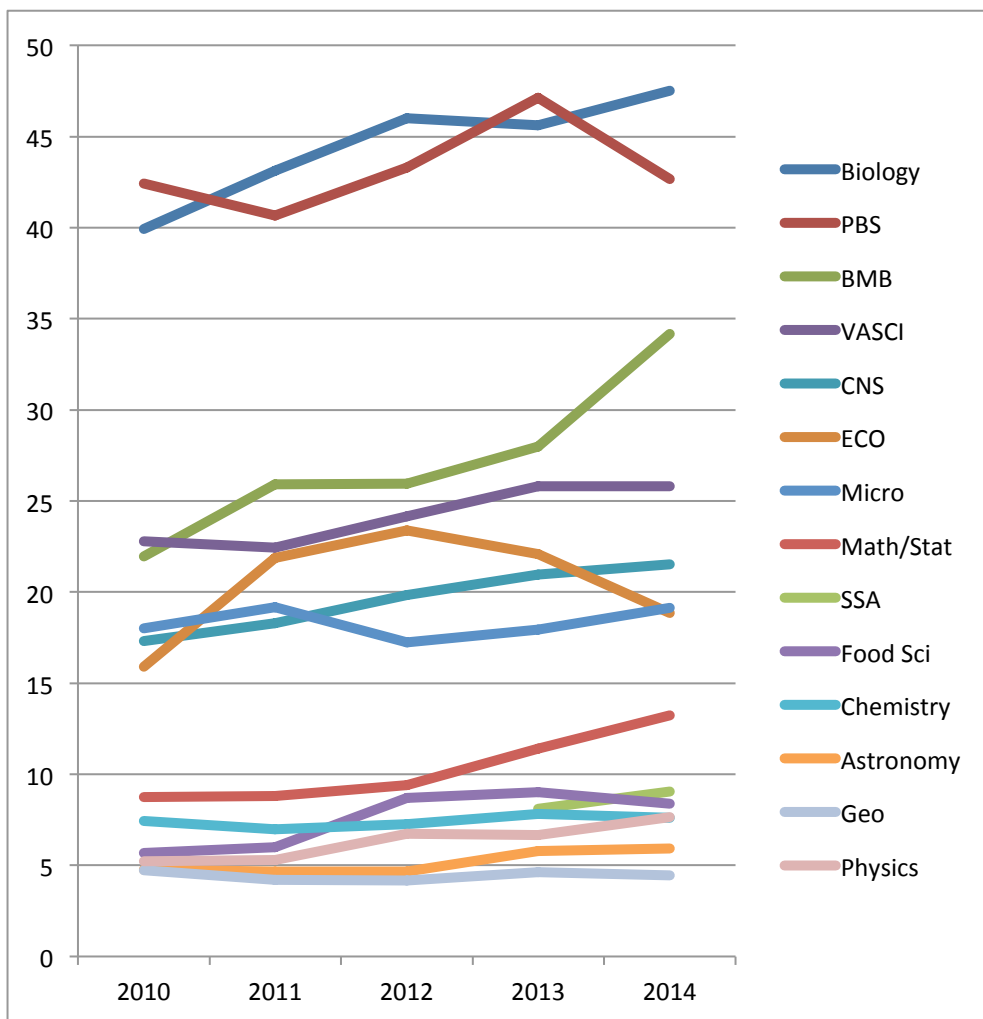


A Focus on the Undergraduate Curriculum & Student Experience: Fall 2015
Biochemistry and Molecular Biology

Part One. Analysis of Current Curriculum

Ratios of Undergrad Major:Tenure System Faculty in CNS



1a. Coherence and accessibility of essential curricular features

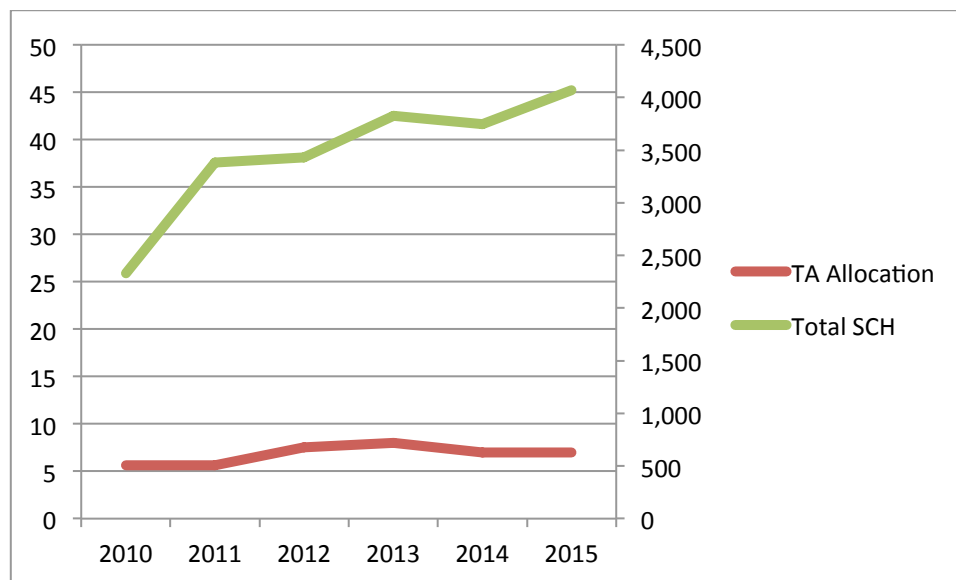
- required courses including key General Education courses your students should take:* BMB has no control over access of BMB majors to GenEd courses (which are by default, not BIOCHEM courses); however, BMB majors are generally able to access required courses offered within CNS (e.g. Intro Bio, Gen Chem through Organic, Physics, etc.) in a timely fashion.
- preferred course sequencing (e.g., a clear order to courses and the ability for students to take them in that sequence in a timely manner):* The BMB curriculum is highly structured in years one through three, with clear sequencing. So much so that students who enter the BMB major as first year students or even second year students transferring from Biology or Microbiology can complete the BMB degree requirements in 3.5 years. Many BMB majors take advantage of this one semester “cushion” and add another major or a minor. Junior transfer students can usually finish in two years; however, there are some issues with junior transfer students who haven’t taken all of the courses that are required of 1st

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and second year BMB majors. They cannot actually finish in two years, but this is not communicated to them at the time of admission.

Figure 2. BMB Total SCH (fall semester) compared to TA Allocation 2010-2015



- *availability/access to the courses students need:* The steady increase in BMB majors over the past decade (610 majors as of fall 2015, a four year doubling rate—up from a five year doubling rate last year) is resulting in larger class sizes throughout the major. Total SCH taught by BMB (fall semester only) have nearly doubled in the past five years, although our instructional support allocation (for TAs) has not only not kept up, but has actually decreased in 2014 and 2015. The two required biochemistry lab courses that are designed for sophomores and juniors are constrained to 48 students per section based on available teaching lab space. The BMB Junior Year Writing course (max 25 students per section) has also been impacted by increasing numbers of majors. These courses have become bottlenecks that push out the timing of our course sequencing by at least 1 semester. We are offering as many sections as our instructional support resources allow (1 graduate TA for a 24 student section of a 10 contact hour lab, with 4 hours of weekly prep time and grading), but we are running out of time slots (4-8 hours per week) for the lab courses. The accessibility of independent study research and honors thesis research has long been hallmarks of the BMB curriculum. The curriculum is designed to leave the senior year schedule flexible enough to allow a substantial commitment of time to research. Recent senior exit surveys indicate that over 70% have engaged in independent study research (campus average is 32%). The bottlenecks in the two required BMB lab courses are eroding this flexibility as more students (especially students who joined the major after their first year) are taking these courses in their junior and senior years instead of in their sophomore and junior years. Significantly, the increasing ratio of BMB majors to tenure system (research active) faculty (see figure 1 above) is the third highest in CNS and is rendering independent study research less accessible. As of January 2016, with the loss of two more tenure system faculty (a retirement and a departure), the ratio will increase to 48 (same as Biology). Similarly, approximately 36% of BMB majors are in CHC, and since BMB departmental honors requires a senior thesis there are not enough faculty mentors to go around.
- *identification of tracks or pathways for students, etc.:* The BMB major does not have tracks or pathways. Students are required to take 8 credits of advanced electives. Here the curriculum is very flexible, and the bridging nature of biochemistry becomes readily apparent. This array of choices within the major comes at the point at which BMB majors have the knowledge base in chemistry, biology and the

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mechanistic underpinnings of biological processes, along with critical thinking skills, so are ready to explore biochemistry in a larger context according to their interests. BMB majors are able to take advanced electives in all of the life science programs as well as, chemistry, physics, math, computer science, public health, kinesiology, etc. Many of our majors (over 100 in AY 14-15) earn advanced elective credit through independent study research in these same areas.

1b. Clarity of your communication to students about

- goals, expectations:* BMB submitted an application for accreditation from the Association of Biochemistry and Molecular Biology (ASBMB) in October of 2015. Development of this application was a departmental effort and provided an opportunity for an evaluation of the BMB curriculum. Our curricular goals and expectations align well with those of the ASBMB (see table below); however, we know that these could be better communicated to our students. We have resolved to articulate the learning objectives for all BMB courses in the course syllabi. ASBMB offers an accreditation exam, and two of our faculty serve as graders. We expect that the performance of our majors on this exam will be a useful gauge of our effectiveness in clearly communicating the expectations embedded in our curriculum.

Table 1 below organizes the required BMB courses by learning objectives. Courses that include experimental design, use of literature/databases, teamwork and laboratory safety are inquiry-based.

Learning objectives	Intr. Biol. BIOL 151, 152, 153*	Gen Chem CHEM 111*/ 112*	Gen Phys PHYSICS 131*/133*	Calculus MATH 127/128	Statistics STATS 240	Mol. Bio. BIOCHEM 275	Research Seminar BIOCHEM 291H	Intro. Biochem Lab BIOCHEM 276
knowledge base	✓	✓	✓	✓	✓	✓		✓
reasoning				✓	✓	✓		✓
quantitative skills		✓	✓	✓	✓	✓		✓
experimental design						✓		✓
use of literature/databases						✓		
communication						✓	✓	✓
ethics						✓	✓	✓
teamwork						✓	✓	✓
lab safety								✓
Learning objectives	Organic CHEM 261/262*	Genetics/ Genomics/ BIOCHEM 390/H	Core BIOCHEM 523/524	Core BIOCHEM Lab 526*	Phys Chem BIOCHEM 471	Writing BIOCHEM 491H	Integrative Experience: Biochem in the Real World BIOCHEM 394RI	Independent research, (optional Honors Thesis Research) BIOCHEM 196, 296, 396, 496, (499Y, 499T)
knowledge base	✓	✓	✓	✓	✓		✓	✓
reasoning		✓	✓	✓	✓	✓		✓
quantitative skills		✓		✓	✓			✓
experimental design				✓				✓
Use of literature/databases		✓		✓		✓	✓	✓
communication		✓		✓		✓	✓	✓
ethics				✓		✓	✓	✓
teamwork		✓	✓	✓	✓	✓	✓	
lab safety				✓				✓

*including a lab component or a lab course

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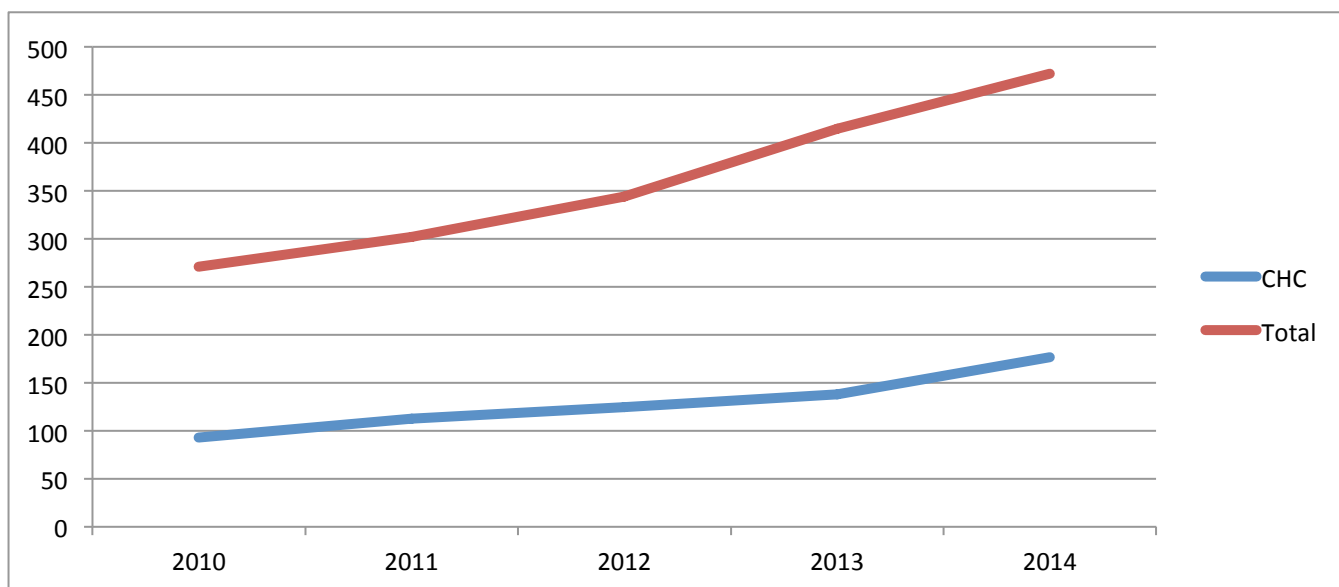
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- *opportunities available to them through the curriculum being offered:* We communicate the opportunities available to our majors through the BMB curriculum in multiple ways: our IE course has a career component in which BMB alumni drawn from many career paths are guest speakers, we provide substantial support to the Biochemistry Club, an RSO and undergraduate chapter of ASBMB, to network with BMB alums and leaders in the biotech/pharma industry. The Biochemistry Club sponsors multiple events throughout the academic year that extend this networking to life science majors, by organizing career panels similar to those in the IE course, running workshops on how to find a research position on campus, organizing panels on research internships and organizing field trips to biotech companies. BMB also offers an optional seminar (Biochem 291H) in which BMB faculty give 30 minute research seminars that showcase research done by undergraduates in their labs.
- *Is this information clearly defined and accessible to the students through websites, advising communications, etc.:* The BMB website was revamped in 2013 to provide clear and accurate information about the requirements for the major, advising resources (students can make an advising appointment online) and opportunities for BMB majors. Current and former students are featured on the website in short profiles and news items. We will need to update our web page to be mobile accessible and are awaiting a cost estimate.

1c. Effective use of faculty time in enhancing the student experience

From 2010-2014, on average, 36% of BMB Majors were also in CHC (see Figure 3 below). BMB Departmental Honors requires a research thesis, which has become increasingly challenging as the ratio of BMB majors to research active faculty has soared in the past five years (Table 1).

BMB Majors and BMB CHC Scholars



- *(e.g., offering small upper-division courses):* With the exception of two lab courses and the Junior Year Writing course, required BMB courses have enrollments over 100. This year, Biochem 275 has 230 and 90, fall and spring, respectively; Biochem 523 (newly converted to TBL format) has two sections of 99, and we have just added a spring section (capacity of 81 in a TBL room); Biochem 524 has 180, Biochem 471 (flipped/TBL format) has 126; and Biochem 390G, a new course in genetics and genomics (TBL format) will start with 81 students. Tenure system faculty teach these courses (except 390G) and teach two of three core graduate courses (MCB 642 and BMB 623). All of the BMB undergraduate courses

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(except 524) employ pedagogical practices that result in experiential learning and a small class size experience; either through hands-on laboratory work in teams of four, apprentice-based research experiences in independent study or thesis research, or team based learning (either combined with TBL technology, or TBL pedagogy in a conventional lecture venue). As the number of BMB majors increases, we are finding it challenging to access TBL classrooms at times that don't conflict with other major's requirements, and the lack of instructional support for large enrollment courses impacts faculty research time. BMB faculty are highly research active, with research expenditures per faculty within the top quartile of CNS. The time that faculty spend mentoring undergraduate students, graduate students and postdocs in their labs is not reflected in organized classroom sections or SCH, but it is highly valuable to the research and teaching missions of the campus.

- *mentoring and advising, etc.:* With a student to faculty ratio of 48 (as of Jan 2016) it is not a good use of faculty time to serve as primary academic advisor and there aren't enough faculty to serve as research mentors to undergraduate majors.

Part Two. Goals for Student Learning and the Student Experience

RESPONSE 2. Student Learning Goals/Objectives: Updated from 2013 (appended at the end of this document)

Consider your department's goals for student learning and for the student experience: Senior exit surveys have been very consistent over the past five years. BMB alumni are pursuing graduate training in numbers at least one standard deviation above the campus mean and most of the rest are employed. Recent data on medical school admissions revealed that 38% of BMB majors who applied for medical school were accepted, which is higher than the campus average of 30%.

Consider how these objectives align with Strategic Planning Priorities, including:

- *Diversity emphasis within department and college-level curriculum and in the student experience:* As of 2014 (the most recent data available to us), BMB had the third highest number of URM students (87/522) in CNS, and the third highest percentage of URM students (16%) in a CNS major (after pre-med and pre-dental). The STEM education literature, including BMB faculty research (D. Gross et al., Increased Preclass Preparation Underlies Student Outcome Improvement in the Flipped Classroom doi: 10.1187/cbe.15-02-0040CBE Life Sci Educ vol. 14 no. 4ar36) supports team-based pedagogy as an effective approach to fostering the success of students from diverse backgrounds. Seven out of the nine major's BIOCHEM courses now employ team-based pedagogy; however, BMB majors don't start taking these courses until their sophomore year. Recent data collected on student performance in required courses for first year life science students and sophomore BMB majors reveals a significant achievement gap for underrepresented minority students. In response, BMB Academic Advising staff are partnering with BMB faculty instructors and the CNS Director of Student Success and Diversity to identify at risk students early in the semester and engage in intensive advising. BMB faculty are participating in preparation of a CNS-lead grant proposal to the Howard Hughes Medical Institute "Inclusive Excellence" program and are on the CNS Faculty Advisory Committee for Diversity and Student Success, both of which are dedicated to improving outcomes for domestic students of color, pell grant eligible, transfer, and first-generation college students in CNS. These proposals have several types of activities; outreach and recruitment to regional school systems (Springfield, Holyoke, Chicopee, currently not the source of diversity in the UMass Amherst student population), summer bridge programs for admitted students from diverse backgrounds, cohort building among these students, and faculty

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development activities that foster curriculum changes to incorporate more authentic research experiences into introductory courses.

- Global perspectives on scientific research in biochemistry are not explicitly addressed in the BMB curriculum. A primary focus of the BMB major is for students to gain hands on experience with biochemistry research. BMB majors are encouraged to seek research experiences outside of UMass (e.g. summer internships) including international study abroad. The BMB curriculum is flexible enough to accommodate a semester abroad and allow for completion of an honors thesis and timely graduation.

Part Three. Curricular Revision Action Plan

RESPONSE 3a.

Preferred course sequencing and access to required courses: In the absence of additional instructional support or additional faculty we propose the following changes:

- 1) Re-organize the BMB IE course from a 3-credit stand alone course that currently uses one full time lecturer and one graduate student TA in the fall and 1/3 time of two TT faculty in the spring to modules that can be distributed more broadly throughout the BMB curriculum. In particular, we interpret senior exit surveys as a call to incorporate career prep (currently in the IE course) earlier into our curriculum. The IE requirement is an unfunded mandate that drains limited departmental resources (Figure 2) and adds to the already very high demand for limited classroom space. Furthermore, the rationale for this requirement is not supported by rigorous assessment or evidence as to it's value in the undergraduate curriculum. There are elements of the BMB IE course that we value and that are well-received, but that could be re-tooled as components of other required major's courses, thereby freeing up one lecturer and one graduate student in the fall and two tenure system faculty in the spring.
- 2) Work with transfer admissions staff to identify and re-direct junior transfer students who do not meet BMB requirements for junior status within the major. Junior transfer students who have not taken all of the pre-reqs for junior level courses routinely have to stay an extra semester, which is costly and frustrating for them.
- 3) Develop course-based research so that more of our majors who want to participate in research have the opportunity to do so. We will need to work with CHC on the requirements for Departmental Honors since it currently requires a research thesis project.

RESPONSE 3b. *If there is a gap you have identified in meeting these goals that can only be addressed with additional resources, describe what you would like to do and what resources would be needed?*

Consider your learning goals for students, the experiences you see as essential for helping students meet your goals for them, the gaps in the curriculum you have identified, and possibilities for moving closer to the aspirational goals for class size as illustrated above. What is an appropriate timeline for making the changes you identify?

BMB has seen the departure or retirement of four senior TT faculty and one lecturer within the past two and a half years. Combined with a four year doubling rate of BMB majors, a 6 year doubling in SCH and a decrease in

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our instructional support allocation, the department is experiencing significant enrollment stress. The balance between TT faculty research activity and classroom teaching is precarious. More tenure system faculty (from the current 13) would stabilize this balance by bringing the student to faculty ratio down, thereby allowing BMB faculty to preserve their research time as well as to offer small(ish) advanced electives (BMB currently does not offer *any* advanced electives for undergraduates) and to continue serving as research and career mentors to BMB majors.

The instructional support allocations for BMB have not changed in 4 years, although the number of BMB majors has doubled in that time. Normalization of TA workloads within CNS is long overdue. (Staff support for the teaching mission within departments is similar to instructional support allocations in that it is mostly an historical artifact. Normalization of staff support within departments is also overdue.) BMB is facing the prospect of lowering expectations for timely graduation in the case of students changing to the BMB major as sophomores and juniors. The CNS Life Sciences Curriculum Task Force is currently looking at required courses in the first two years of several life science majors with common early requirements. In particular, we are hopeful that the Intro Biology (and chemistry and physics for non-majors) laboratories will be revamped to be more inquiry driven and upgraded to provide exposure to state-of-the-art research instrumentation. We anticipate that lab fees can be deployed towards this goal, which would allow BMB to rethink our two required lab courses. We could conceivably move content from the junior lab into the sophomore lab and convert the junior lab to a course-based research format in which teams of students engage in authentic research projects in the teaching lab space. In this sort of scenario, we could move away from specific lab sections (for the junior lab course) of 24 students with one graduate TA per 10-hr per week lab section. Instead, we would achieve better outcomes if the "open" project lab was staffed by a professional technician who would train students in proper use of the equipment, prepare reagents and ensure the safety of the students, much as a TA does, but at lower cost overall. We expect that BMB majors will continue to pursue independent study research in high numbers, and this combined with a required section of authentic research will ensure that every BMB major engages in the most impactful experiential learning possible. Time frame: approximately 1 year to convert both laboratory courses.