Department of Biochemistry & Molecular Biology Strategic Planning
Phase III Part II: Research and Graduate Education

Vision and Mission

The Department of Biochemistry and Molecular Biology (BMB) seeks to expand its areas of strength in research covering cellular biochemistry in humans, plants, and microbes, hire strategically to develop strengths in computational biology, and move towards more translational approaches in collaboration with the newly formed Institute of Applied Life Sciences (IALS). BMB will also play a leadership role in advancing plant sciences relative to the land grant mission of the university. BMB will continue to assume a central role in graduate training through the Molecular and Cellular Biology (MCB) and Plant Biology (PB) Interdepartmental Graduate Programs and the Chemistry-Biology Interface (CBI) program. BMB remains committed to the highest quality undergraduate education through excellent courses with enhanced learner-centered teaching, effective advising, and broad opportunities for research training.

BMB is currently at one of the most critical junctures in its almost 50 year history. The department is experiencing significant faculty turnover coming from several recent and pending faculty retirements and the loss of a senior faculty member attracted to a competitive institution. This contraction is felt even more severely given the increase in departmental majors, doubling from 280 to 560 since 2010 to the present. BMB will need to rapidly and strategically recruit multiple tenure stream faculty. This is essential to meet the research and training missions of the department, allow it to remain competitive for research funding and developing collaborations, to meet its teaching mission, and to attract high quality students and faculty.

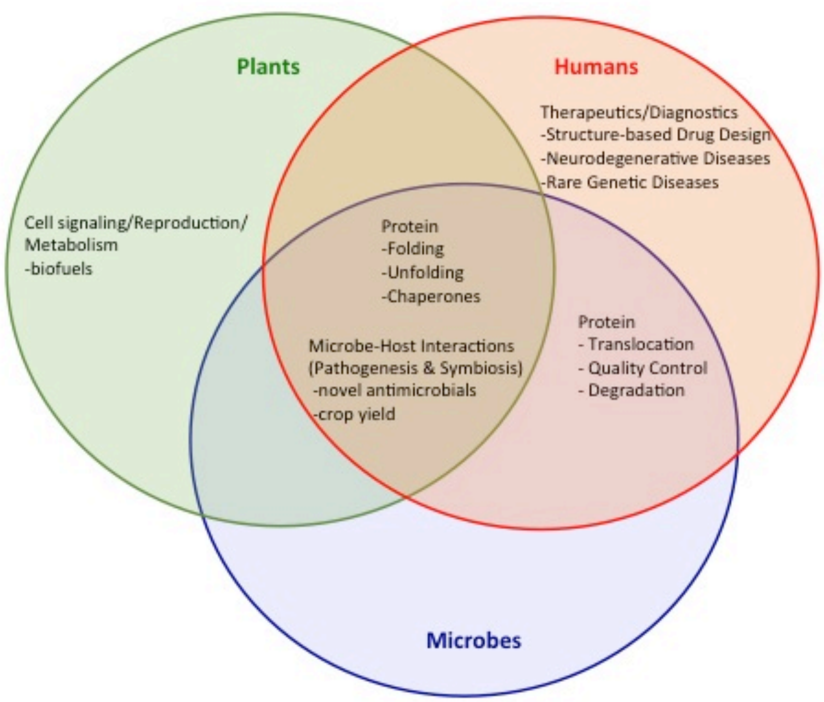

Figure 1. BMB faculty research strengths. New faculty hires with expertise in computational biology will complement and enhance existing research strengths, contribute to the mission of the IALS with respect to translation of basic research and move BMB faculty research into new areas.

Current Departmental Profile: BMB within the discipline of biochemistry, CNS and UMass

BMB faculty are a cohesive unit with the collective vision that quality basic research moves the discipline of biochemistry forward and is the foundation for translational and applied biochemistry. BMB faculty are nationally competitive, particularly in areas of cellular signaling, protein structure, folding, and degradation, as measured by success in attracting federal research funding, and they play leadership roles in campus initiatives as diverse as The Institute for Massachusetts Biofuels Research (TIMBR) and Models to Medicine (M2M) Center in IALS. We intend to hire strategically in these areas to benefit from overlapping interests and facilities within IALS, the Medical School, the Center for Agriculture and other campus initiatives as we strengthen the department. Specifically, future BMB hires will expand upon areas of excellence in protein folding and aggregation diseases, plant signaling and metabolism, and computational biology. Such efforts will also strengthen major campus initiatives such as the expansion of neuroscience and sustainability.

State-of-the-art technology is critical to modern biochemistry and molecular biology, and the resources available at UMass Amherst have been greatly enhanced through the establishment of IALS. However, availability of adequate high quality laboratory space for new faculty hires remains a significant challenge facing BMB. Furthermore, faculty productivity hinges on financial and personnel resources to support research, including 1) PhD level staffing of core instrumentation facilities, 2) support of graduate student training in the face of diminishing federal funds for research, and 3) staff support for the administration of externally funded research. The ability to provide graduate education that prepares students for careers in the high technology sectors of biomedicine and a bio-based economy dictates that the university must continue to invest in the faculty, facilities and personnel support required to build this critical workforce for the Commonwealth and the nation. Two of the most important components of faculty productivity, and by far the most cost effective investments in faculty and, therefore, research and student success, are staff support for the administration of externally funded research and technical staff support for the multi-user, high cost equipment needed to perform state-of-the art biochemical research, both of which often involve multi-PI, cross-departmental or multi-institutional projects. Technical staff support is essential to maintain and upgrade high technology equipment, to train faculty and students in its applications, and offer fee-for-services to industry.

Currently, BMB has a total of 23 faculty members, of which 14 are tenure system (TT), including 2 Distinguished Professors, 7 Professors (5 of whom are elected Fellows of disciplinary societies), 2 Associate Professors, and 3 Assistant Professors who were reappointed through their Tenure Decision Year in AY 13/14. The Department will welcome one new TT Assistant Professor with the start of AY15/16. Of these 15 TT faculty members, 47% are women and 33% are minority (four are Asian and one is Hispanic). BMB has three Research Professors and six non-TT faculty members comprised of one Clinical Professor and Director of the IALS, one senior lecturer, two lecturers, and two Extension Associate Professors; one of whom is the director of the Core Mass Spectrometry Facility and the other is an IALS-related hire with expertise in designing, optimizing and executing high throughput screens of small molecules for drug discovery. BMB has six full time staff (with one Academic Advisor search underway) to support faculty and over sixty grant-funded graduate students, postdocs, research fellows, along with almost 600 undergraduate majors.

Our Fall 2014 "look in the mirror" reflected a highly productive faculty unit. Data from Academic Analytics (2013 and 2012 releases, Tables I and II, respectively, appended to this document) placed BMB above the median for most of the quantitative measures of research productivity within a field of over 160 departments in 2013 and a field of over 200 departments in 2012. We consider biochemistry units at the UC Berkeley, UC San Francisco, University of Washington, University of Colorado and the Plant Biology program at Michigan State University to be aspirational by reputation. Because BMB does not have a departmental PhD program, Academic Analytics data for direct comparisons of BMB faculty productivity to peer institutions were not available during the campus doctoral program review. Additionally, data reflecting faculty numbers, productivity and institutional support have not been readily available for aspirational peer institutions.

Current and potential research strengths

One core group of faculty in BMB (Figure 1) has a strong biophysical focus, with a number of faculty trained formally as physicists or chemists and then moving into biochemistry as a discipline. The focus of this group is on proteins that are challenging to characterize (e.g., membrane proteins, glycosylated proteins), their homeostasis from early processing to localization and degradation, and how defects in these cellular processes lead to disease. This group is highly visible externally, with a reputation that attracts new faculty applicants. Another contingent are molecular biologists who trained in model systems and use them and their associated tools to delve into the mechanisms of a variety of cellular processes in plant systems, from signal transduction to metabolism and metabolic engineering and plant interactions with microbes. BMB faculty who use plant experimental systems have a high degree of national and international visibility, so much so that we are targets for other universities looking to advance their plant biology programs.

Advances in technology are enhancing all aspects of how BMB faculty approach their experimental systems. We are particularly fortunate to have access to state-of-the-art instrumentation through IALS; indeed, BMB faculty have been founding members of the M2M Center and have provided leadership on the establishment of several new instrumentation cores that will benefit not only BMB research, but that of life scientists across campus. The Mass Green High Performance Computing Center (MGHPCC) is an important asset for the campus life science research community, and BMB has again provided leadership in developing the MGHPCC user model. We have one *bona fide* computational biologist currently, with other faculty moving into computer modeling of cellular processes, and we are eager to build strength in cellular and molecular computational biology. Faculty candidates for position(s) in computational biology may bring expertise in the study of large genomic datasets, simulation of pathways and molecular properties, and/or integration of complex experimental data, for example from structural biology and systems-based analysis of dynamic molecular complexes. Additional leverage will derive from computational biology hires who provide expertise in quantitative cell biology based on advanced imaging technology and in modeling protein-protein or protein-small molecule interactions, which will facilitate design of potential lead compounds for drug design in M2M Center strategic goals.

Overall, BMB has never been in a better position to recruit new talent to campus, and we are excited about the directions that we along with future hires can explore. We see new opportunities in the study of several areas of biochemistry, namely, central metabolism, enzymology and protein structure function relationships. Specifically, new technology will allow us to explore the problems of central metabolism and their connection to disease from the standpoint of a metabolic system. Similarly, enzymology can now be approached as a network of allostery, communication and signaling pathways. Advances in structural biology tools enable reconstructive biochemistry.

The intellectual cohesiveness of BMB is rooted in part in our common origins in basic research. At the same time, we relish the opportunity to see our discoveries deployed for the betterment of the human condition, whether through the treatment of disease, increased food security or in developing sustainable sources of fuel. Our research using plant systems is particularly amenable to the translation of ideas from the bench to useful applications, and our leadership in the recent acquisition of a large plant cell culture collection positions us to interface much more directly with industry than even three years ago. Translational science presents new opportunities for BMB faculty, and we are committed to the success of IALS through strategic hiring in partnership with IALS.

Challenges and Opportunities for BMB Hiring

As discussed above, BMB is at a critical juncture in realizing our vision for the future through faculty hiring, and research space is the most significant obstacle. One highly visible senior faculty member from the plant biochemistry cohort has been recruited by an aspirational peer institution as of January 2016 and will vacate space in the Plant-Microbial Genomics Cluster in LSL-1. Two senior faculty retired in 2014. Neither had active research programs nor laboratory space at the time of their retirement. All but three of the current TT faculty members in BMB are actively engaged in research. These three (senior) faculty members, currently not occupying research lab space, are slated to retire within approximately three years. The recent move of a significant fraction of the Department to the LSL leaves BMB with sufficient laboratory space for our new faculty hire—Meg Stratton, *thus all faculty hires going forward require new space to be* identified. Renovating two floors in the A-wing of LGRT (9 and 10) would cost approximately $6M and would enable BMB to recruit five to six new faculty. High quality research space in LGRT is important to maintain departmental cohesiveness, and our commitment to undergraduate education is best served by an identifiable "home" in LGRT for our ~600 undergraduate majors to seek out advising and community.

The criteria for space assignments in LSL (both 1 and 2) going forward from the original cluster model are still a work in progress, and it is clear that there isn't enough space in LSL-1 or LSL-2 to accommodate all of the life science research on campus. BMB has a large contingent of faculty in LSL space (half of our TT faculty and five BMB non-TT faculty). As LSL clusters evolve, there needs to be an awareness that if LSL space is intended to be transitory (five to ten years) there must be research space available to TT faculty for the duration of their time as active researchers regardless of their research program's relevance to LSL clusters or IALS. Thus, renovation of space in LGRT is the single most important next investment in BMB. Note that vacant space in LGRT is available now for renovation—in space most recently vacated by BMB faculty moving to LSL, so departmental cohesiveness would be fostered without further disruption to current faculty.

The massive infusion of capital funds to the campus for life science research puts us in an enviable position with regard to having the quality of core facilities that foster success of faculty research programs and make us attractive in the faculty hiring process. However, Ph.D.-level staff support for the IALS core instrumentation facilities is absolutely essential to their effectiveness and sustainability over the long term. In addition to the need for staff support for the new cores: Biophysical Characterization and Biological Production, there are existing cores that are being enhanced; NMR, Microscopy, Mass Spectrometry, Flow Cytometry, Genomics. These facilities have not previously been a target of investment by the university and are mostly inadequately staffed currently. The addition of new instruments will heighten the need to invest in the long-term future of these facilities so that they foster research productivity across the life sciences. The availability of the MGHPCC is a huge advantage with respect to attracting computational life scientists; however, in order for this facility to grow and be sustained, current faculty need staff support to facilitate its use in their research programs. Additionally, BMB Departmental staff are stretched thin in their (excellent) support of faculty, research personnel and students. Staff contribute enormously to student success and to faculty development and retention, and the ability to recruit and retain talented and dedicated staff members is an essential component of a successful strategic plan.

BMB and Graduate Training

As co-founders (with the Department of Biology) of the interdisciplinary Molecular and Cellular Biology (MCB) graduate training program, BMB has not had an independent PhD program for well over 20 years. The MCB program was designed to bridge the two disciplines of molecular and cellular biology, but over time these disciplines have become so intertwined that the program is more accurately described as interdepartmental rather than interdisciplinary. The MCB program has expanded to include faculty from CNS, COE, School of Public Health, and is considerably larger than the median for similar programs (Table I). In addition to recruiting and training graduate students from MCB, BMB faculty draw graduate students from the Plant Biology (PB) program and to a much lesser extent, graduate programs in Chemistry and the two other interdepartmental life science programs, Neuroscience and Behavior (NSB) and Organismal and Evolutionary Biology (OEB). BMB faculty partnered with Chemistry faculty in the establishment and continued funding of the only NIH-funded graduate training grant currently on campus, the Chemistry Biology Interface (CBI) program, now in its 20th year. BMB faculty have been co-PIs on an NSF-funded Cellular Engineering IGERT training grant, which has evolved into the recently awarded NIH Biotechnology T-32 training grant. With resources combined between NIH and campus, these training grants provide two years of support to approximately 6 students per year, so graduate students in BMB labs from any of these programs are largely supported on research assistantships (RAs) from individual faculty research grants.

The recent doctoral program review conducted by the graduate school came on the heels of the updated National Research Council "ranges", and in both cases, the life science interdepartmental graduate programs fared less well than many existing life science departmental graduate programs on campus, which is ironic given the move towards cross disciplinary research and graduate training at federal funding agencies. One contributing factor in these outcomes was the difficulty of evaluating programs that are quite diffuse and misleadingly inclusive. In addition, there are numerous structural problems with the interdepartmental graduate programs that have been identified in the past two AQAD reviews, not least of which has been a lack of administrative stature on campus. These programs have no input into hiring or faculty teaching, so have not been in a position to be strategic about developing areas of strength to attract top students. Graduate student support is also not competitive with peer or aspirational institutions. First year graduate students are supported by TAs that are provided by the only two departments without independent PhD program (BMB and Biology) thus limiting the size of the first year class. Table III shows how low the enrollments have been since 2005, despite a large number of faculty participants in the MCB and PB programs. This is problematic for new faculty who need to be able to recruit graduate students in order to establish their independent graduate programs.

The graduate curriculum fee is another factor that hinders the ability to recruit top students. Graduate students supported on TAs or state-funded RAs do not incur the graduate curriculum fee—only grant funded RAs are charged curriculum fees. Since the actual training of graduate students on TAs or RAs (grant-funded or not) is the same, the graduate curriculum fee is a tax on research grants that has no relationship to actual graduate student training. This fee increases 5% annually, but grant awards do not, so graduate student stipends become less competitive and grant budgets are stressed.

The interdepartmental graduate programs have been under review this academic year by a committee of stakeholders including BMB faculty. This committee is proposing substantive changes to address these challenges as well as to partner with the Graduate School to facilitate a wide range of career options from academia to industry to alternative careers such as law, journalism, policy, government, etc.

Independent of these structural problems, BMB will need to work on its visibility and web presence in order to attract qualified students. Based on BMB strengths, it should attract students seeking training in biophysics and plant biology. BMB looks forward to working with our colleagues in the new College of Computer Science to bridge biochemistry and computer science in order to attract the next generation of big data, computational biochemists. We are encouraged also by an emerging interest in the area of biological mathematics within the Department of Mathematics and Statistics. With success in these endeavors in the future, BMB seeks to draw students in computational biology as well.

In summary, BMB is in an excellent position to grow in visibility and stature within our discipline. With institutional investment, we will be well-positioned to play a central role in graduate training programs that produce highly successful scientists who are competitive for a broader range of workforce opportunities and who are at the leading edge of the translation of basic scientific research into applications that benefit the public.

Table I. Research Faculty Size and Productivity (2013 Academic Analytics Data)

Doctoral Program	Total Programs	Number of Faculty		Awards per Faculty		Faculty with Grants (%)		Grants per Faculty		Grant $ per Faculty (1000's)		Articles per Faculty		Faculty with Articles (%)		Citations per Faculty	
	Count	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median
BMB‡	163	20	21	0.4	0.2	80%	61%	1.6	1.3	298.5	300.0	6.4	9.9	80%	94%	133.7	130.9
MCB	155	89	28	0.4	0.2	74%	74%	1.9	1.5	372.4	366.8	12.6	10.3	96%	96%	216.9	153.5
PB	33	33	22	0.6	0.4	55%	67%	1.4	1.7	242.4	328.4	11.2	10.2	97%	95%	180.8	191.3

BMB; Biochemistry & Molecular Biology does not have a PhD program and faculty participate in two interdisciplinary graduate programs: Molecular and Cellular Biology (MCB), Plant Biology (PB)

Note A: Cells marked with a dash indicate productivity measures that are not used for the field.

Source: Academic Analytics 2013 Database (Release date 3/02/2015).

Table II. Research Faculty Size and Productivity (2012 Academic Analytics Data)

Doctoral Program	Total Programs	Number of Faculty		Awards per Faculty		Faculty with Grants (%)		Grants per Faculty		Grant $ per Faculty (1000's)		Articles per Faculty		Faculty with Articles (%)		Citations per Faculty	
	Count	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median	UMA	Median
BMB	206	19	24	0.4	0.1	84%	50%	1.6	0.9	294.1	131.2	5.7	5.9	74%	88%	120.3	72.7
MCB	158	29	28	0.3	0.1	75%	70%	1.8	1.5	373.7	362.4	12.7	9.7	96%	95%	235.6	153.6
PB	35	34	20	0.5	0.3	56%	65%	1.5	1.8	255.4	246.7	12.5	9.3	97%	95%	220.6	171.1

Note B: Peer group includes 25 public, very high research institutions. Most do not have a medical school, with the exception of University of Connecticut, Pennsylvania State and Stony Brook University. Please see attached for complete list.

Note C: Books, articles, grants, etc. per faculty are calculated using the total number of books, articles, grants, etc. for all program faculty and dividing by the total number of faculty members in the program.

Note D: Peer median is the median of comparable doctoral programs offered by peer institutions. Field median is the median of comparable doctoral programs offered by all American universities.

Source: Academic Analytics 2012 Database (Release date 04/21/2014).

Academic Analytics data coverage: Faculty (AY 2012-13), Books (2003-2012), Awards (varies), Grant Dollars (2008-2012), Articles (2009-2012), AA Citations (2008-2012), Conference Proceedings (2009-2012).

Table III. Applications and Enrollment of Entering Doctoral Students, Fall 2005 to 2014

	Fall 2005		Fall 2006		Fall 2007		Fall 2008		Fall 2009		Fall 2010		Fall 2011		Fall 2012		Fall 2013		Fall 2014	
	Applied	Yield	Applied	Yield	Applied	Yield	Applied	Yield	Applied	Yield	Applied	Yield	Applied	Yield	Applied	Yield	Applied	Yield	Applied	Yield
MCB	216	11	244	14	260	14	285	14	129	11	159	13	130	18	166	8	150	11	142	15
PB	31	6	36	3	33	2	39	1	29	3	20	3	17	3	27	8	49	2	45	8

Note A: Data are based on the current organizational structure of academic units and departments. Therefore, school or college totals may not be directly comparable to previous years due to the consolidation, reassignment, or suspension of selected academic programs.

Note B: Information is reported according to the applied major.

Note C: Only doctoral students entering state-supported programs are included (i.e. Students entering Continuing and Professional Education programs are excluded).

Note D: Acceptance rate is the the percent of applicants who were accepted.

Note E: Yield is the percent of accepted students who enrolled.

Source: OIR admissions census files, September.