

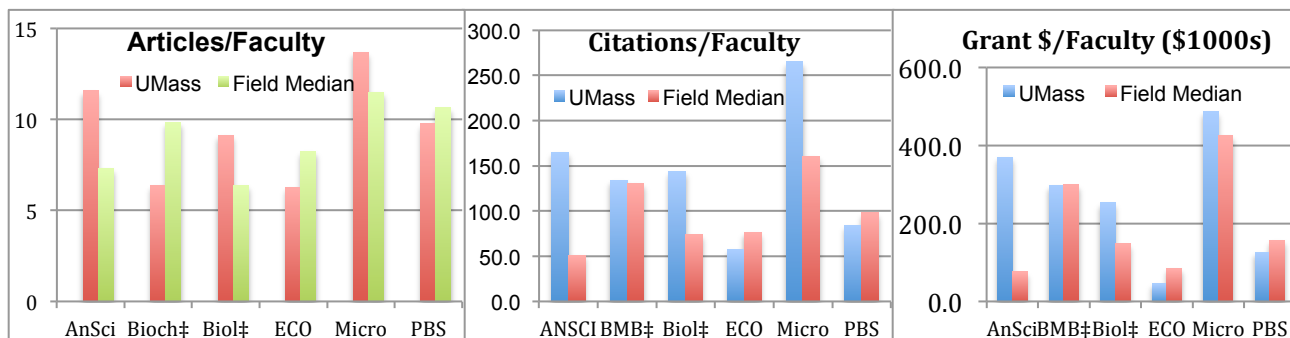
Biology Department Strategic Plan: Research Recommendations

I) Process

In September of 2014 the Biology Department Chair appointed a Research Strategic Planning Task Force (RTF) with representation from across research themes in the Department: Sam Hazen (chair), Peter Alpert, Magdalena Bezanilla, Jeff Blanchard, Gerry Downes, Tom Maresca, Jeff Podos. This task force discussed the Biology research mission and facilitated faculty discussions in two Faculty Meetings that took place in March of 2015. This document reflects the Department discussion and presents a set of recommendations designed to increase the research success of the Biology Department.

II) Department Research Overview

As befits a broad Biology Department, our faculty's research spans all levels of biological complexity, from the molecular to the ecological. The Department inactivated its graduate program in favor of an Interdepartmental Graduate Research Programs (IDGP) model, and Departmental research largely maps to the four life science IDGPs (MCB, NSB OEB, PB). The Biology Department has achieved major recognition for our scholarly output, sponsored research, technology transfer, and badges of distinction, as described in our recent environmental scan. The Academic Analytics 2013 Database provided for this strategic planning exercise compares the UMass Biology Department to 205 "similar programs" and reveals that we excel by every measure when compared to the mean for the group (grant awards per faculty = 0.3 vs. 0.1; faculty with grants = 68% vs. 50%; grants per Faculty = 1.6 vs. 1.0; grant \$ per faculty = \$254K vs. \$148K; articles per faculty = 9.2 vs. 6.4; % of faculty with articles = 91% vs. 88%; and citations per faculty = 143.7 vs. 74.3). In fact, the US News and World Report ranked "Biological Science" at UMass Amherst as 55th in the nation, tied with the University of Utah, the University of Oregon, the University of Iowa, and the University of Florida, among others. While this ranking most likely includes the contributions of life scientists from across the College of Natural Sciences (CNS), a comparison of these parameters across the 5 main CNS life science departments shows Biology to be a major contributor to our national ratings (see graphs below). Given the research talent in Biology, the complementary and overlapping strengths of other life science departments in CNS, and the increased support for the life sciences on campus (e.g. the Massachusetts Life Science Center (MLSC) and the Institute for Applied Life Sciences (IALS)), we anticipate that this national ranking can be improved dramatically in the near future.



Graphs displaying the academic analytics 2013 data for Research Articles/Faculty (left), Citations/Faculty (middle) and Grant Awards/Faculty (right) for five life science departments in CNS. In each graph, values for UMass units are compared to the mean for the field (comparable departments as determined by Academic Analytics).

Through our strategic planning process, Biology faculty have explored strategies for improving our Departmental research mission while remaining open to new organizational structures for the life science units in CNS, including the possible creation of a School of Life Sciences. The strategic plan that emerged focuses on defining and addressing some of the challenges the Biology Department has encountered as a broadly defined "Biology" department that does not have its own graduate program. The issues of research cohesion and the fostering of a forward-looking research vision in a broad department emerged as central themes. Biology faculty are united in recognizing and greatly

appreciating the significant strengths of the Department, and our strategic recommendations are designed to maintain and build on these strengths while finding ways to strengthen our research mission and identify strategic areas for future research growth.

Breadth as a Departmental Strength: As described in our “environmental scan”, the breadth of the Biology Department remains a major research strength, helping foster collaborations across research areas that span multiple levels of biological organization. Over the last decade the Department has tried to further integrate our diverse research mission by focusing several new faculty hires in areas that bridge IDGP-based research foci. Recent searches in Biophysics, Evolutionary/Developmental Biology, Computational Genomics, and Ecological Physiology have resulted in the hiring of outstanding new faculty members who are strengthening links between OEB-, PB-, MCB-, and NSB-associated Biology Department researchers. Our diversity of experimental questions and systems has also enabled use to help form and build new, interdisciplinary research clusters across the college and campus, such as Biofuels, Microbiomes, and other areas that align with evolving campus strategic plans. Our researchers play a major role in these and numerous other cross-campus research initiatives, and our mix of basic and applied research will be an increasingly important contributor to IALS. Approximately 2/3rds of our tenure stream faculty have joined the Models to Medicine (M2M) and Center for Bioactive Delivery (CBD) centers in IALS, and these ties need to be expanded and deepened. Harnessing our deep expertise in high-end light microscopy, Biology faculty have been central to the establishment of the IALS Light Microscopy Center of Excellence and to equipping this facility with several million dollars of state-of-the-art equipment that includes super-resolution microscopy. Recent Biology hiring in the area of computational genomics has helped establish extensive expertise in this area on campus, a key to future research success across life science disciplines.

Breadth as a challenge to the Departmental research mission: While research breadth is clearly desirable for fostering research cross-fertilization and increasing our ability to contribute to new campus-wide research themes, it has also created challenges in our ability to establish and maintain a departmentally-oriented research identity and to create a cohesive long-term vision of our research enterprise. Since Biology faculty members only recruit and train graduate students through the four IDGPs, faculty members tend to identify their research programs primarily with IDGPs rather than with their academic home. Our breadth also presents a challenge to strengthening existing clusters through hiring in cluster-specific areas. Establishing departmental hiring priorities has been a process of balancing between areas that “bridge” clusters versus those more focused on strengthening clusters in innovative ways. While these are not necessarily mutually exclusive, to date the Department has not agreed upon a longer range hiring road map.

Another clear challenge to our research mission is the size and growth of our undergraduate major, particularly when viewed in relation to our tenure stream/research faculty numbers. Our student to faculty ratio is over 40:1, making it the highest in the college. As described in the fall planning document, Biology has grown to be the second largest major in the University. To cope with this growth, we have hired additional teaching faculty at the expense of growing our research faculty core. In combination with a growing teaching load for all faculty members, this has clearly impacted both the growth and visibility of our research mission and affected our ability to build in specific research areas. Furthermore, our expanding undergraduate teaching mission has reduced our ability to contribute to the graduate curriculum. This, combined with the historical decision to embrace the IDGPs rather than focus energy on our Departmental Graduate Program, has detracted from the formation of a departmental research identity and community.

III) Recommendations: Establish three research clusters that help build research vision, success, and visibility

As a mechanism to build on existing strengths and facilitate a broader research visioning, the Department plans to form three new formal research clusters, each with a cluster leader and the mission to enhance the research success and visibility of the cluster. Each cluster will develop a common strategic research vision that builds towards vibrant and resource-rich areas of science. The new cluster structure will help direct new faculty hiring in new and innovative research directions. We will continue to give weight to hiring in areas that simultaneously strengthen and bridge multiple clusters. We feel this cluster organization will also help improve mentoring of junior faculty members and help foster and clarify a departmentally based research culture. Overall, increased cluster congruity will improve our ability to pool resources, recruit and retain top faculty, increase collaboration, improve our research productivity and funding success, and increase our success and visibility as a research powerhouse. This cluster organization could also provide the seed for broader reorganization of life science research in the college.

Cluster Research Themes

Neurobiology and Animal Physiology (NAP)

Faculty in the Neurobiology and Animal Physiology (NAP) cluster focus on the biology of the nervous system and functional aspects of animal cells and organs. Major themes within this group include neuroendocrinology, neural degeneration and regeneration, muscle physiology, and sensory systems biology. This research cluster constitutes a key segment of the Neuroscience community on campus. Investment and building on the strengths of this cluster would be an effective approach to establishing neuroscience initiatives on campus, including the formation of a new Neuroscience Institute, and several Biology Faculty members are part of the CNS Neuroscience Task Force. The faculty in this group have already helped create the “Neural Disease and Degeneration” M2M cluster in IALS, and the NAP cluster will form a strong nucleus for researchers across the College whose research investigates nervous system development and function at the cellular through tissue levels.

Genomics, Evolution, and Biodiversity (GEB)

Faculty in the Genomics, Evolution, and Biodiversity (GEB) cluster explore a broad array of biological systems and major themes in biology that include ecology, adaptation, diversification, and phenotypic evolution. Genomic perspectives allow increasingly precise and comprehensive insights into evolutionary processes and the origins of biodiversity. Field-based ecological studies draw connections between biodiversity and evolutionary processes such as speciation, co-evolution, and adaptive radiation. The research mission of the GEB Cluster is enhanced by our recent investments in genomics, and also by our department’s extensive natural history collections.

Cellular, Developmental, and Genetic Mechanisms (CDGM)

The Cellular, Developmental and Genetic Mechanisms (CDGM) cluster comprises faculty whose research focus is to understand the molecular mechanisms that underlie cellular and developmental patterning and physiology. Faculty work on wide-ranging systems across the eukaryotic tree of life, and this diversity is viewed as a strength that should be harnessed in collaborative efforts to decipher the molecular mechanisms that drive signaling from within cells to whole organisms. Building to the strength in this group, particularly harnessing the IALS multi-million dollar imaging facility, will be a major goal for CDGM. With carefully selected hires, this Cluster will provide depth in quantitative cell and developmental questions ranging from defining the molecular and cellular mechanisms underlying critical processes in embryonic development (e.g. cell division, migration, signaling, polarity, differentiation, tissue patterning and growth) to understanding the evolution and functional interactions of essential structures (e.g., mitotic spindle, centrosomes, and membrane trafficking systems). The quantitative aspects of the new era of cellular imaging will also provide bridges to physics and chemistry, as well as to IALS.

Cluster Roles

1) Optimize and expand the resources needed to support cluster members' research

a) Implement programs to increase grant success and foster multi-investigator collaborative grant submission. In this era of reduced funding rates in nearly all arenas, it is more critical than ever to refine grant applications so they are as competitive as possible. The Biology Department has a mixed record on intra-departmental grant review prior to submission, and a major role of clusters will be to work to improve grant success by providing timely feedback from peers within the department. Clusters will also facilitate the pursuit of multi-investigator research and training grant opportunities. Each cluster will institute a formal process for supporting grant writing and improving funding success that may include incentives for grant reviewers and grant writers. As an example, investigators could hold a lunch where Specific Aims are vetted, followed by timely and extensive internal review of complete proposals by a subset of cluster members. The process should be designed to reduce barriers to requesting assistance. Increased internal peer review of proposals will also serve to increase familiarity of the research performed in the cluster, critical to identifying synergies that could form the basis of additional collaborative grant proposals. To encourage faculty to take advantage of this cluster resource, faculty that comply with Specific Aim and full proposal deadlines, but whose vetted proposals do not receive external support, will receive financial contributions to their RTF accounts that would help support their ongoing efforts to secure funding. Additionally, clusters would support teaching releases to allow a principal investigator to develop a large multi-investigator proposal.

b) Expand development efforts and industry relations: Biology Department faculty have had remarkable and largely unrecognized success in securing funds from industry to promote their research, spectacularly illustrated by the recent award of \$200 million dollars to fund the development of a new bacteriocin-based drug platform - a collaboration between Dr. Riley and her Chinese colleagues - and the work of Dr. Irschick to develop applied uses for "GeckSkinTM" that have led to a recently approved proposal to form a new Center for Evolutionary Materials. Biology research clusters will be charged with taking advantage of the expertise in each group and in the Department to explore and foster increased research funding from private sources and industry. This promises to be a key component of sustained research success in an era of reduced government grant funding. Finally, given the large Biology Alumni network, new development efforts geared toward research infrastructure and faculty research development will also be explored.

c) Optimize and expand research assistantships (RAs): This year the Biology Department received non-working Graduate Research Fellowship funds from the Graduate School and CNS in the amount of \$19,000 (two \$9500 semester-long RAs). This year's funds are being administered through a competitive application process conducted by the Research Task Force. Given the large number of active research programs in Biology, as well as a new three-cluster structure that is similar to the Division structure adopted by some other departments, the Department will work to secure at least one additional, semester-long, non-working Graduate Fellowship to allow each cluster a one-semester RA to be used to further its goals and increase the quality and success of graduate students in Biology labs.

d) Optimize and better target teaching assistantships (TAs): TA support for undergraduate teaching is also a key research resource that can be used to help junior faculty build their research programs and can help more established researchers develop new research directions and collaborations. Clusters will be charged with exploring how better to use TA support to advance the research programs of junior faculty and the overall research success of the cluster.

2) Guide strategic planning

New faculty hiring will ultimately shape the future of the Departmental Research Mission. The new clusters will define the emerging frontiers in their fields and advocate to the department for hiring in those areas. The Department as a whole will continue to make hiring decisions with the help of a Hiring Priorities Committee that will have equal representation from each research cluster. By focusing on our departmental strengths, the clusters will be able to explore collaborative multi-investigator research and grants, and enhance graduate training by developing course curriculums and training grant proposals.

3) *Mentor junior faculty*

Cluster Leaders will help the Department chair to identify appropriate mentors in both teaching and research for junior faculty, and to monitor the mentoring relationship so that any needed adjustments or changes can be made as the junior faculty member's career progresses. Cluster Leaders and junior faculty mentors will meet at least biannually with their junior faculty to ensure that junior faculty members take advantage of all young investigator funding opportunities and awards. The Department will also investigate the possibility of providing junior faculty with a one-semester teaching release prior to their tenure year in order to enhance their research portfolio.

Suggested Cluster Structure

Faculty will self-identify with one or more clusters. Members will elect a leader for a three-year term. Cluster leaders will also serve as members of the Biology Department Executive Committee. Clusters will not assume personnel action functions, leaving the Departmental Personnel Committee (DPC) unchanged, but each cluster will be well represented on the DPC. Clusters will also be appropriately represented on the Departmental Hiring Priorities Committee.

Refining Cluster Vision and Assessing Cluster Success: Futures Seminars

A process of careful assessment including external feedback will be critical to the success of this experiment and will be an important tool in the strategic shaping of cluster-based research into the future. Borrowing from the Provost's "Futures Seminars" idea, each cluster will be charged with organizing and hosting a research symposium that is focused on the cluster's research theme and vision for the future. These symposia will be open to the department and campus community. A small panel of outside experts will be asked to attend the symposia as active participants to help guide the discussions. These external contributors can be drawn from the local Life Science community and include the IALS director, members of related life science departments on campus, and from the UMass Medical School. An assessment process, perhaps based on periodic Futures Seminars, will be implemented to help refine cluster organization help ensure that cluster themes remain at the cutting edge of Biology research.

IV) Biology and IALS

The Department strongly supports the IALS mission and will work to strengthen ties and mutual benefits of both units. Biology has additional, untapped potential to strengthen and augment IALS research and contribute to the success of the new Institute overall. We recently proposed three new IALS-associated faculty positions that could have a home in Biology including: 1) a senior researcher (Associate or Full Professor level) who uses human-induced, pluripotent stem cells to model human disease, 2) a senior researcher (Associate or Full Professor level) who uses computational approaches to study development or disease who also could serve as the director of the Institute for Computational Biology, Biostatistics, and Bioinformatics (ICB3), and 3) a junior faculty hire (Biology Faculty replacement) in the area of Quantitative Developmental Cell Biology. Given the fact that IALS will be hiring more faculty than can be housed in the LSL complex, and given that Morrill 4 South is one of the closest buildings to IALS in which to house life science researchers, we propose that the 4th Floor of Morrill 4 South could be renovated to become a Biology-IALS satellite facility (see infrastructure section

below). The Biology department will continue to explore avenues for aligning faculty hiring and research with the IALS mission.

V) Research infrastructure and lab renovations for new faculty hires

Current lab infrastructure and recent lab renovations: Biology faculty are now located in three separate buildings with widely varying capacities to support modern life science research. Three faculty members recently moved to outstanding new labs in the Life Science Laboratory Building, while two faculty members are in functional but antiquated lab space in Fernald Hall. The majority of Biology faculty members are located in the Morrill complex which varies widely in the quality of space. Over the last decade we have systematically renovated a great deal of substandard Morrill space into state-of-the-art research laboratories, while simultaneously clustering research groups whenever possible. In 2009 we applied for an NSF ARI-R2 ARRA grant to renovate the entire 3rd floor of Morrill 4 South as a plant biology research facility. While this application missed funding by a hair, support from the University and College has helped bring this ambitious project to fruition. If all goes as planned, six Biology researchers (including our 3 most recent faculty hires) will move into spectacular new labs by January 2016. A large, open-design lab will house four highly successful plant cell biology researchers (green shading in diagram on right), while our new neurobiologist (light blue shading) and computational genomicist (blue shading) will move to more autonomous labs. Extensive shared equipment and support areas (tan and brown shading) have allowed the highly efficient use of space, with six faculty accommodated in an area that would have previously housed four or so research programs. The floor above is already home to three of our cell biologists, and this physical clustering of similar research programs is in perfect alignment with our current strategic plan and will facilitate cluster interactions.



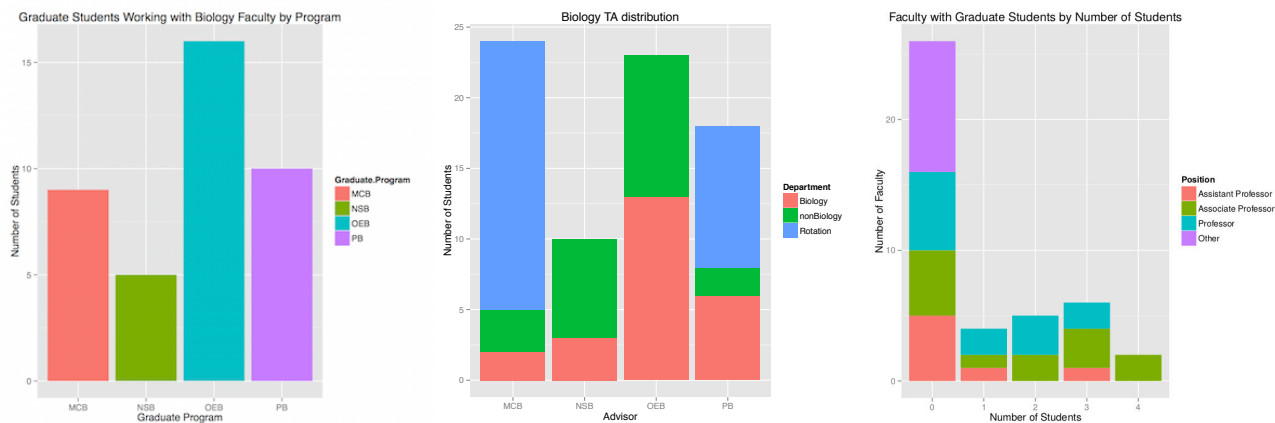
Strategies for housing future Biology faculty hires. We fully recognize the huge expense associated with providing research labs for new faculty in the life sciences, particularly in an aging building. Our next requested Biology hire, a Quantitative Developmental Cell Biologist, could be housed with minimal expense in already renovated lab space that will be available as a result of the Morrill 3rd floor renovation project described above. Depending on external administrative policy, LSL1 and LSL2 could play an important role in the future of the Biology Department. We will continue to lobby for the hiring of new Biology/IALS faculty who could be located in LSL, and we are actively exploring the idea of relocating a small number of current Biology faculty members to the LSL complex.

IALS will be hiring substantially more new faculty than can be physically housed in the LSL complex. Given its proximity to LSL, we believe that the 4th floor of Morrill 4 South is an optimal location for 3-4 new IALS-associated Biology Department faculty members. The east and west ends of this floor were recently renovated, leaving 4000 sq. ft. of antiquated research space that could be renovated en bloc to accommodate 3 to 4 new researchers. Major infrastructure improvements associated with recent and current renovation projects would make this renovation cost effective. This renovation would complete the remarkable transition of two full floors in Morrill 4 South into a state-of-the-art research facility. We envision a two-floor IALS-Biology satellite facility holding up to 12 researchers in efficiently designed modern labs that are in close proximity to the LSL complex.

VI) Graduate Education

Graduate Teaching: As described above, Biology does not have an active graduate program, and faculty participate in one or more of the four IDGPs. The rapidly expanding Biology undergraduate mission has eroded our ability to assign faculty to teach graduate courses through the IDGPs, and our faculty involvement in graduate education is at risk. Currently four Biology faculty members contribute to portions of IDGP graduate courses as part of their Biology teaching assignments, with all other contributions being on a volunteer basis as a teaching overload. This is increasingly posing a challenge to the IDGPs, is at odds with faculty expectations in the department, and does a disservice to our junior faculty who are missing out on exposure to 1st year graduate students, potentially affecting their ability to build their research programs in the critical pre-tenure years. Without long-sought changes in the student/faculty ratio in Biology (e.g. through enrollment management or massive faculty hiring) this situation will not improve and will only get worse with continued growth of the major. The Biology Department Teaching Strategic Plan that was submitted last fall contains concrete recommendations for addressing some of these issues. These teaching recommendations align well with the research recommendations presented in this document, and their implementation would have major positive impacts on our research mission. We hope these recommendations can lead to broad improvements to both our teaching and research missions.

Graduate Training and TA resources: There are currently 39 Ph.D. students who are pursuing Ph.D. training in Biology Department labs, distributed across the four IDGPs (left graph below), along with 15 postdoctoral researchers. A number of factors (especially the increased cost of supporting graduate students and declining funding) have affected graduate training across the life sciences. This has made it more important than ever to maximize the impact of TA resources on the Departmental research mission. In AY 14-15, 75 one-semester TA appointments were used to deliver the undergraduate Biology curriculum. Biology is an outlier among CNS departments with regard to the distribution of TA resources, with a majority of the TA funds that support Biology courses used to support graduate students who work in the labs of faculty in other departments. In AY 2014-15, only 31% of the TA resources being generated by Biology undergraduate teaching were used to support graduate research in the labs of the Biology faculty members who delivered this curriculum (middle graph below). Of the remaining TA resources, 30% supported 2nd-6th year graduate students working in other departments, and 39% supported MCB and PB first-year student rotations.



Graphs showing the numbers of Ph.D. students being trained in Biology faculty labs (left), the distribution of the Biology-course generated TA-ships by IDGP, including the distribution between Biology (salmon) and other department (green) research labs (middle), and the distribution of Ph.D. students in Biology by faculty rank (right).

Junior faculty members rely heavily on graduate students to build their research programs in their early years at UMass, and TA support is an important tool to help junior faculty members get their labs going. Currently, TA resources contribute to the research programs of only two of Biology's 6 pre-tenure faculty (right graph above). It is our hope that the upcoming report from the Committee to Review the

IDGPs will provide a mechanism to address major inequities in faculty support from TA funds while facilitating TA assignments that are appropriate and equitable for the students. One department-based mechanism for addressing these issues would be for Biology to retain a portion of the TA allotment to Biology courses, to directly support graduate students working in laboratories of Biology faculty, with priority given to junior faculty. This last approach would seem to align well with new resource allocation models being developed at UMass.

Departmental Graduate Program. As part of the strategic planning exercise, Biology faculty discussed the merits of reactivating a departmental graduate program, either at the Ph.D. or M.S. levels. Faculty widely embraced the IDGP model for Ph.D. education and largely did not support reactivating a departmental Ph.D. program. However, there was much broader interest in exploring the possibility of activating a M.S. level graduate program, modeled after the IDGPs' 5th year Masters programs. These 5th year Masters programs are open to recent UMass graduates who have completed independent research, usually including an honors thesis. This has proven to be a cost-effective and mutually beneficial way to efficiently leverage undergraduate training into a masters thesis and research publications. While no consensus was reached, Biology will explore the development of a sustainable and supportable model by which a subset of advanced and accomplished undergraduate researchers could earn a 5th year M.S. in the Biology Department.