

To: Antonio Moreira, Vice Provost for Academic Affairs
From: Elizabeth Connor, Chair of Biology, University of Massachusetts, Amherst
Laura Galloway, Chair of Biology, University of Virginia
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Date: 27 March 2017; revised 30 April 2017
Re: Review of the department of Biological Sciences

A. Background

Below we outline our understanding of the Department of Biological Sciences and its context. It is within the framework of this context that we make our observations (section B) and recommendations (sections C, D, E). Those recommendations are made with the interests in growth and excellence, of both the Department and the University, in mind.

A.1. University context. The University of Maryland Baltimore County (UMBC) is a medium-sized state university currently classified as an R2 “higher research” institution in the Carnegie classification. It is a major gateway for regional students to enter college, with a very strong record of recruiting students from underrepresented minority groups. There is a large influx of students from community colleges, which contribute up to 50% of the student body. In addition, there is a large outflux of students to other universities in the UM system; this movement is facilitated and driven, at least in part, by the distribution of available undergraduate majors among the UM campuses. A large proportion of the student body at UMBC maintains interests in science, technology, engineering and mathematics.

The College of Natural and Mathematical Sciences houses the Departments of Biological Sciences, Chemistry and Biochemistry, Marine Biotechnology, Physics, Mathematics and Statistics, and Naval Science. Within this college, the Department of Biological Sciences provides training for undergraduate students, masters students and doctoral students, and houses faculty who perform original research across a variety of disciplines. It is the primary department supporting training or research in the life sciences at UMBC.

A.2. Department context. The Department of Biological Sciences (hereafter referred to as “the Department”) is a broad-based department with research and teaching missions that span a wide range of disciplines, including ecology, evolution, cell biology, developmental biology, microbiology, genetics, genomics and computational biology. It offers BA and BS degrees in Biological Sciences, a BS degree in Biochemistry jointly offered with the Department of Chemistry and Biochemistry, a BS in Bioinformatics, a BA in Biology Education, an MS in Biological Sciences, an MS in Marine, Estuarine and Environmental Science, an MPS in Biotechnology, an MS in Applied Molecular Biology, and PhDs in Biological Sciences, Molecular and Cell Biology, Neurosciences and Cognitive Sciences, and Marine, Estuarine and Environmental Science. The current faculty composition includes 22.5 tenured/tenure-track faculty (7 Full, 12 Associate and 3 Assistant Professors, and one member with a 49% appointment in Biological Sciences) and 9 non-tenure-track faculty (5 Senior Lecturers and 4 Lecturers). The T/TT faculty participate in both the research and teaching missions of the Department, whereas NTT faculty contribute to the teaching mission. All faculty contribute service, including one-on-one advising of undergraduate majors.

The Department has seen dramatic changes over the past 15 years due to three motivating factors. First, the numbers of undergraduate majors have increased approximately three-fold over this period, from ~600 majors to ~1750 majors (not including the Biochemistry students jointly taught with the Department of Chemistry and Biochemistry). This persistent growth of students entering life sciences reflects a nation-wide trend and is comparable to changes seen at other institutions. Second, the economic crisis which began in 2009 has led to a decrease in the level of extramural funding among T/TT faculty; this decline also reflects nationwide trends whereby the number of funded researchers in departments has decreased, the budgets of funded grants are lower, and the funding rates (funded grants per submission) have decreased. Third, budgetary overruns that occurred prior to 2010, which were sanctioned by the prior Dean of the college, were actively being repaid over that last six years, constraining departmental spending.

The Department responded in several ways to the increase in undergraduate student enrollment. First, the undergraduate curriculum was revised (a) to include a BA degree, which required fewer Biological Sciences courses and thus attenuated potential class enrollments, and (b) to reduce the numbers of required courses for both BS and BA degrees. Second, course sizes were allowed to increase; currently, freshman- and sophomore-level course have risen to ~300 students per course. Lastly, since NTT faculty teach 3 to 4 times as much as T/TT faculty, NTT teaching faculty were hired to replace the loss of T/TT faculty. This hiring strategy has allowed the department to respond to its increase in majors, but has resulted in the decrease from ~29 tenured/tenure-track faculty to ~21 T/TT faculty.

These changes have synergized to reduce the overall research productivity of the T/TT faculty. First, their numbers have decreased. Second, their funding rates have decreased, as have rates nationally. Third, the repayment of previous budgetary overruns has been accommodated by reducing the numbers of TAships granted (from ~46 to ~31); the fewer numbers of graduate students have led to fewer numbers of undergraduates performing research as graduate students serve as primary supervisors. In addition, the increase in student enrollments has increased the number of student advisees, currently 55 to 60 students per faculty member, adding a significant constraint to available time. The overall decrease in the number of T/TT faculty has led to the lack of critical mass for several research clusters.

A.3. Department environment. The department is housed in two adjoining buildings, the Biological Sciences Building and Schwartz Hall. The former was renovated in ~2000 and has laboratory and office space suitable for modern biological sciences research. The latter has not been renovated since its construction in 1983 and is showing its age; both research and teaching laboratories are below the standards expected for a modern research institution. The vivarium would not meet AAALAC standards. Classroom space in the complex is adequate, and can be configured to accommodate modern pedagogical techniques.

B. Observations and impressions

Below we report our observations and impression of the Department, within the context provided above. These observations provide the framework and rationale for our recommendations (section C, below), opinions regarding the action items proposed by the department (section D) and responses to specific queries from the university (section E).

B.1. Atmosphere. Given the challenges posed by increasing enrollments, decreased financial support and an aging infrastructure, departmental personnel are remarkably upbeat, collegial, supportive and

interactive. This atmosphere was both evident and genuine across faculty of all ranks and disciplines, graduate and undergraduate students, and staff. Members of the faculty, graduate student and undergraduate populations have all cited this positive environment as a contributor to their choice to join the UMBC community.

B.2. Faculty. The faculty are highly collegial and focused on excellence. There is a general desire to increase the numbers of T/TT faculty, but an acknowledgement of their perceived need to sacrifice hiring of Assistant Professors to recruit NTT faculty to accommodate the teaching needs.

1. Research. Given the constraints of teaching and infrastructure, the quality and quantity of the scientific publications is high. The rate of funding is good, given the current and historical funding climates. We were impressed by the tenacity displayed by T/TT faculty of all ranks to pursue extramural funding from a variety of sources. A significant fraction of this research is performed by graduate students, who are supported primarily via TAs drawn from the departmental budget. Thus, research productivity is constrained by the availability of these funds.
2. Teaching. The commitment of the faculty to the quality of their teaching is impressive. The teaching loads for both T/TT and NTT faculty were appropriate for the institution; it is clear that the appropriate teaching load for T/TT faculty has allowed them to maintain the degree of productivity seen.
3. Service. The service load for the faculty is high. This reflects the increased demands placed on them by increased enrollments, including a high advising load. The advising load in the Department appears to be at least twice that of other departments due to the high FTE student to faculty ratio.

B.3. Graduate Program. The graduate program has notable strength in generating high-quality graduates as evidenced by (a) their overall high rate of publications and (b) their placement into post-doctoral positions at high-quality institutions. The student community appears to be collegial. However, we see notable weaknesses, including:

1. A lack of graduate-level courses. Most graduate instruction comes in the form of shared undergraduate/graduate coursework.
2. A lack of in-depth institutional training in scientific ethics. While there is brief training during orientation, a mandatory, full-length graduate course in scientific ethics is a requirement for many graduate fellowships.
3. A lack of mandatory institutional professional development workshops. Students do not receive consistent formal training in communication, writing, or grant preparation. While opportunities exist, as for ethics training above, formal training is not a requirement of the graduate program and such experiences are left to the discretion of the students and their mentors.
4. A paucity of graduate fellowships. Students do not appear to be pursuing extramural funding on their own at high frequency, and a formal course or workshop promoting the development of proposals is not in place.
5. A lack of RAs. Graduate support relies heavily on TAs, which impose a burden on student training. There is a low number of students supported on outside grants relative to the funding levels observed.

B.4. Undergraduate Program. The Department has worked to maintain high-quality degree programs, despite a student-to-faculty ratio of 86:1, by far the highest at the university. It has invested in the hiring of NTT faculty to accommodate, to some degree, the growth of enrollments. The dedication of the

faculty to modern pedagogical techniques is clear, with large numbers of faculty embracing active learning approaches and many embracing the team-based-learning classrooms provided by the university. Faculty of all ranks participate in teaching large-enrollments classes, and the involvement of research-active faculty with beginning students was noted as a highlight by multiple undergraduates interviewed.

The combination of the increase in student enrollment, the decrease of T/TT faculty, and the decrease in numbers of graduate students to serve as mentors has led to a paucity in the availability of positions for undergraduate researchers, which is a hallmark of Carnegie R1 and R2 universities. The Department has responded by reinstating the PhageHunters course-based research experience (CRE). In addition, there are plans to add additional CREs to address this need.

B.5. Facilities. The Department is housed in two buildings; the Biology Building was renovated to good operating conditions in ~2000, whereas Schwartz Hall is showing its age. The quality of the research and teaching labs make it difficult to attract incoming faculty and do not make a positive impression on undergraduate students. A beneficial change has been the creation of core facilities (*e.g.*, the Keith R. Porter Imaging Facility) to support the research needs of faculty both within and outside of the Department.

B.6. Diversity. UMBC is notable for its commitment to diversity and that is evident throughout the Department. The undergraduate class is highly diverse, and students appear to be collegial and interactive. The graduate student population is diverse, with both domestic and international students represented in expected numbers. The faculty is also diverse, notable for its strong complement of female faculty at all ranks, and members of a number of racial and ethnic groups, which project a culture and environment of inclusion and opportunity for their students.

B.7. Responsiveness to Departmental changes. The Department has changed over the past 15 years, where enrollments have increased threefold, research grants are difficult to obtain, and funds available for graduate student support have diminished. Given the constraints on faculty hiring, the department has reacted in an understandable way to the increased teaching burden by revising its majors and hiring NTT faculty to replace outgoing T/TT faculty. The Department would benefit from further introspection of its practices and scrutiny of its procedures and protocols for aspects which, while they worked well in the past, may be in need of revision given the new landscape. We outline suggestions in this regard below.

To realize the successful adaptation of the Department to its new student enrollment burden, a reduction in the abnormally high student to faculty to student ratio, an increase in student satisfaction and improvement of university rankings, and growth of the research profile of both the Department and the university as a whole, the strategic plan for the College and University must accommodate a reevaluation of the distribution of faculty lines among departments. While the Department has responded to its new burdens, its current strategies and resources are incompatible with its vision and its expected role as a center for high-quality research. Lacking institutional support, both the College and Department will fail to meet the expectations of twenty-first century students in the Life Sciences.

C. Recommendations.

Below we provide specific recommendations based on our observations, discussions with faculty, students, staff and administrators, and review of materials provided and materials obtained from internet sources.

C.1. Faculty & Research

- Due to huge increases in undergraduate interest in the Biological Sciences, majors and course enrollments have gone up dramatically. The resulting faculty to student ratio is both dramatically out of line with other departments and insufficient to provide a high-quality educational and research environment. *Recommendation:* Increase number of tenure-track faculty.
- Faculty numbers have remained flat over time, but T/TT faculty have been replaced by NTT such that Lecturers make up a third of faculty. *Recommendation:* To maintain and enhance the research profile of the department in keeping with the department's vision and UMBC's strategic plan, the number of tenure/tenure-track, research active faculty must be increased. The numbers of NTS faculty should not be reduced as their contributions are required to manage the large student enrollments, which are not predicted to decrease nationally in the near future.
- Given the projected growth of the T/TT faculty associated with increased space and undergraduate enrollments, we recommend the Department establish a plan for growth and faculty hiring. At present, hiring seems to be driven by teaching mission more than strategic development of research strength. *Recommendation:* Faculty, in particular T/TT faculty, should develop a multiyear vision and hiring plan designed to move the Department toward increased research prominence and enhanced graduate recruiting.
- The current Department Chair inherited a budget that was chronically in the red. At the same time, changes implemented above the department level required a balanced budget. The Chair has been successful at reigning in spending and developing a balanced budget. However, the Department is still saddled with paying back their debt to the College, presently somewhat more than \$200K. This debt repayment, combined with limited overhead, is interfering with important department functions, *e.g.*, supporting service contracts on shared critical equipment, investing in additional research infrastructure. *Recommendation:* Release the Department from repayment of the remainder of its debt. They have made hard budget cuts and been conscientious about debt repayment. Rewarding these efforts by exempting them from further repayment will allow them to develop a financial model that allows for development of their research mission.
- Faculty hires in the sciences are expensive as they require substantial start-up packages. The start-up packages offered by UMBC in Biological Sciences are much smaller than institutions with comparable research expectations. Packages could be increased sizably and still be below comparable institutions. The current plan to wait for further faculty hiring until the new building comes on-line would seem to exacerbate the problem as making several hires at once would require a substantial outlay of start-up funds. *Recommendation:* Develop a hiring plan to bring in a regular flow of new faculty; at the institutional level, develop a financial plan to have a greater amount of start-up funds available at these intervals; reduce expectations for the departmental contribution to start-up funds.

- The Department appears to provide effective mentoring of its pretenure faculty. The dean-supported External Mentors Program compensates for the loss of on campus critical mass in individual research areas. However, there does not appear to be formalized annual feedback to pretenure faculty on their performance. *Recommendation:* The Department Chair should review annual faculty reports and respond with feedback in a timely way to provide a paper trail of how faculty are meeting expected performance measures.

C.2. Graduate Program

- The size of the graduate program is too small for the number of research active faculty. It must be increased, though the historic size is likely unrealistic. Increases to program size will necessitate a greater diversity of support than current funding patterns (see below.)
- The 32 TA positions are loosely assigned to labs; faculty each expect two TA lines for students in their labs. Many faculty do not exceed two graduate students, and a minority of students are supported via research grants or extramural fellowships. *Recommendation:* Increase graduate student training by increasing graduate support via research grants and providing a mechanism to promote the development and submission of graduate student fellowships (see below). Reduce TA support to one line for faculty without a recent history of substantial funding; this will enable the collection of preliminary data required for grant submission while investing in research programs which require students to enable grant renewal.
- Graduate students are currently supported at a level of \$23,518 prior to candidacy and \$24,600 after. For students being supported by TAships, this funding level covers their teaching efforts in two academic semesters as well as three months of summer support at a rate of ~\$2,000/summer month. This investment of Department resources for summer graduate student stipends is a serious drain on Department funds and limits expansion of the graduate student program. *Recommendation:* Require that all submitted research grants include support to cover, at a minimum, graduate student summer salaries.
- There was no report of external support for graduate students with either fellowships or research support, *i.e.* NSF GRFP, NIH F31, NSF DDIG. *Recommendation:* Encourage applications to these programs with the goal of having this be a mechanism to increase (albeit slightly) the size of the graduate program. An annual Departmental workshop can facilitate the creation and submission of these proposals.
- Graduate TAs assist in lab classes. However, their typical time investment per week is on the order of 8-12 hours, with as many as two GTAs supporting a single 24-person lab. *Recommendation:* Use graduate TAs more efficiently in the classroom, with one TA per lab section and increase weekly hours to closer to half-time. This will allow more classes to have TA support and reduce the teaching burden on faculty of large classes. In addition, professionalize graduate TA responsibilities by allowing graduate students to fully teach lab sections; some teachers give pre-lab lectures relegating graduate students to answering questions, this limits graduate student's training.
- Graduate students report a deficit of courses with students needing to retake cross-listed upper-level undergraduate courses that they had taken as undergraduates. Graduate students need training that moves them beyond what they had as undergraduates. *Recommendation:* Establish formal graduate level courses in each discipline area that are taken by all students in those areas. This does not need to be all courses that students take, but they need to receive formal

classroom training (*i.e.*, not journal clubs). Alternatively, encourage graduate enrollment in appropriate courses offered in other UMBC departments or at neighboring institutions.

- The time to PhD is a mean of 6.3 years; funding is guaranteed for six years with a seventh year of support routinely provided. These numbers are all a bit higher than many comparable programs. With each graduate student staying for a long time, it is difficult accept many new students into the program in any given year, and students lack motivation to finish in times comparable to peer institutions. *Recommendations:* (1) Reduce guaranteed funding to 5 years, with explicit justification required for a sixth year. (2) Move the Qualifying exam to Spring of the second year instead of Fall of the third year; this will move students to degree faster as the summer will not be spent in exam preparation. (3) Consider making the third rotation optional, only for undecided students. (4) Institute a formal annual review of the progress of each graduate student by an impartial and objective committee of graduate faculty with benchmarks for performance and explicit evaluation of short-term and long-term goals set in the previous meeting.
- Extensive formal, required, institutional training of graduate students is absent; most training is optional and/or delivered by individual faculty, which is both more heterogeneous and less rigorous. *Recommendation:* Establish a first-year course sequence that emphasizes graduate student professional development, including grant writing, oral presentations, poster presentations, time allocation skills, and scientific ethics. If these experiences are delivered by existing courses (*e.g.*, BIOL700), the depth and breadth of content of this course is not clear, nor is it clear this is mandatory for all students.
- All career paths for biology doctorates require effective communication. Currently, one presentation is required in year 5, which seems a bit late in students' careers to provide useful feedback for their research. *Recommendation:* Develop of a greater culture of student research presentations with a seminar series where graduate students to present yearly after their first year.

C.3. Undergraduate Program

- There is broad enthusiasm for the undergraduate mission and modern pedagogy across faculty in the department. The sheer number of majors, and student to faculty ratios that outstrip all other departments, create complexity in delivering on this mission. *Recommendation (Also noted above):* Increase the number of faculty to bring student-to-faculty ratios in line with other departments. This will result in an enhanced undergraduate experience with more course offerings, smaller size courses and increased availability of undergraduate research opportunities.
- Teaching labs have outdated equipment which constrains students learning. A goal of UMBC is to produce a work force trained in the life sciences and biotechnology for the local community. Updated laboratory equipment in the teaching labs is an important part of this. *Recommendation:* Increase student lab fees for recurring expenses and maintenance, repair, and replacement of equipment. In addition, have a one-time institutional investment to update lab equipment (consider approaching local corporations for matching funds).
- The undergraduate advising load is substantial including, but not limited to, three weeks in the fall and the spring where multiple hours per day are devoted to advising. Faculty take advising responsibilities seriously, but 55-60 advisees per research active faculty is too much.

Recommendation: Hire professional advisors to substantially reduce the advising burden, these may be staff or non-tenure-track faculty with partial teaching loads. In addition, consider alternative modes of advising to increase efficiency, *i.e.*, group or peer advising with a focus on specific areas of biology, careers, or undergraduate stages.

- A BA program was introduced in 2010 with a goal of serving students with interests in health professions; this program of training has fewer requirements in Biological Science and Chemistry. Since the majority of students who aspire to careers in medicine and dentistry do not succeed in being admitted to these very competitive programs, assessment of the career success and career paths of students graduating with a BA may be timely. *Recommendation:* Track career outcomes of a cohort of BA graduates versus BS graduates and assess if the different curricular paths have the desired outcomes in terms of student success and career satisfaction.

C.4. Facilities and Infrastructure

- There is great excitement and apprehension about the new ILSB building. The apprehension reflects a lack of clarity on how the building will be used. It will house a state-of-the-art vivarium, and people who work with vivarium-housed animals will relocate their research programs. The fate of the remainder of the research space (perhaps up to 15-20 labs) is unclear but includes the perception that lab groups will move in and out based on research interactions. *Recommendation:* Formally program the use of the building. The “hoteling” model (groups moving in and out) will result in a waste of space as return space in a faculty member’s home building will be preserved. Departments need to be able to plan hiring and the new high quality space will be very attractive to faculty candidates. A formal plan for its use is needed.
- Research and teaching space is limited and some is fairly poorly maintained. In particular, the laboratories in Schwartz Hall were scored as either inadequate or very inadequate in the Assessment of Physical Facilities and Support Facilities report (Table 12 of Self Study). There is the perception that the administration is supportive of educational enhancements but not of enhancements to research facilities. *Recommendation:* Make renovation or replacement of Schwartz Hall an institutional priority. Given the numbers of undergraduate majors and the importance of adequate, modern research space for acquiring extramural funds, developing a plan and resources for this is of paramount importance.
- Relatively recent changes have moved staff from the Department to the college level. These changes are positive in terms of efficiently carrying out the research mission. However, it is clear that post-award management of sponsored projects is an area that requires further change. *Recommendation:* Ensure post-award staff are sufficient in number and adequately trained. Strong fiscal staff are important for the stated goal of enhancing the research mission.

C.5. Diversity

- As with most programs in the Biological Sciences, diversity is strongest at the undergraduate level. However, the gender ratios among both faculty and graduate students are quite strong. Faculty and graduate student diversity is comparable to national averages. Department hiring will take advantage of a Research Professor to tenure-track faculty program for underrepresented minorities. *Recommendation:* Maintain and enhance efforts to recruit diverse faculty and graduate students. A diverse set of mentors is important for diversity at the undergraduate level to work its way up the pipeline.

D. Response to Department Proposed Future Directions

D.1. Expanding Discovery-Based Laboratory Courses

- CRE-style courses, like those proposed, provide students with valuable research skills comparable to those attained in independent research experiences. However, these research-intensive lab courses are very costly in terms of personnel time and lab expenses. Before developing and implementing this suite of new CRE courses, we suggest that a careful resource analysis be performed to determine the feasibility of this plan. Are sufficient faculty available to develop and teach these courses. What is the projected enrollment and how many students will be served? Are there sufficient lab support personnel, TAs, and instructors to launch and sustain these courses? Are there sufficient funds generated from revised lab fees to provide supplies and equipment for these courses, especially as the current lab fees do not cover current costs?

D.2. Formalization of undergraduate and graduate TA training.

- This proposal is to develop two new one-credit courses that will be required of undergraduates and graduate students who serve as TAs. The goals of this training are laudable and may result in better TA training, replacing the current training method. A senior graduate student will teach the courses with guest lectures by Department faculty. Before investing time and resources into these courses, the Department might consider the following questions. Must this course be offered every semester? Will the participating faculty be NTT and/or T/TT? Do undergraduates have to take this course prior to becoming a TA or concurrent with their teaching duties? Who will train and mentor the senior graduate student in pedagogical concepts and methods? Will these courses be replicating programs currently offered by the Faculty Development Center or the UMBC Department of Education?

D.3. Expanding the Training Program for undergraduate TAs and Establishing a Center for Training in Biology Education

- Establishing this center will unify the Department expertise in pedagogy and evidence-based teaching. The role or need of such a center in coordinating TA training is unclear. Before implementation, the Department should be clear as to what goals will be met by this center that are currently unachievable.

D.4. Establishing Research Centers Focusing on Biology Research

- We strongly support the forming of research centers that help to build research excellence and increase the visibility of a research group. It is important that the centers bring faculty together with a shared research vision and enthusiasm for collaboration, communication and development of synergistic activities. We endorse centers that are focused in mission and well aligned with the strategic objectives of the College and University.

D.5. Improving Graduate Training.

- We support the goal of having graduate students develop individual development plans (IDP) and encourage the Department to build on the work and planning already in place in the UMBC Graduate School. Further, we support opportunities to inform graduate students of alternative career paths. UMBC alumni may be a valuable resource.
- We are less enthusiastic about the proposed first year techniques mini-courses. The breadth and diversity of the Biological Sciences graduate program make only a subset of techniques applicable to every graduate student. Further, a one-time, hands-on and one-size-fits-all

experience will not provide the type of training a student using the technique requires. Instead we encourage an 'open-lab' environment where students who need to learn a new technique are welcomed in labs with that expertise. This lab will then be a resource for advice and consultation as the student proceeds with their research. It may be useful for each lab to list techniques where they have expertise and are willing to train and advise a graduate student in developing that skill set.

E. Response to Institutional Queries

Below we provide responses to the specific queries posed by UMBC that are not covered in the above report.

- a. Please comment on the appropriateness of general goals and specific objectives of the program. How are they being met? *This information has been provided in the above report.*
- b. What is the students' perception of the quality of the program and their evaluations of the faculty's teaching and mentoring? *The committee met with both undergraduate and graduate students.*

Undergraduate students. *Student satisfaction among this select group was quite high. They cited the generous financial aid packages as a significant factor in their decision to attend UMBC as well as the collaborative atmosphere of the campus and the department and the campus' reputation for excellence in STEM disciplines and training. Students praised the Supplemental Instructor program as well as the peer tutoring services provided by the Biology Learning Center and the use of undergraduate teaching assistants in most of their courses. The opportunity to participate in research was highly valued as was the quality of the upper-level Biological Sciences electives and the connections these courses made to research.*

Graduate Students. *This information has been provided in the above report.*

- c. Are the proposed directions of growth of the program consistent with the nature, mission and overall plans and priorities of the College and the University? Please comment on the overall quality of the program relative to its aspirational peers. *This information has been provided in the above report.*
- d. What is the quality of the curriculum? Do teaching materials and pedagogical methods reflect state of the art within particular areas? *This information has been provided in the above report.*
- e. Considering the program's assessment of student learning outcomes, discuss ways the faculty might most effectively "close the loop" by enhancing its use of the outcomes of assessment to improve teaching and learning. *The Biological Sciences instructional team is thoughtful and extensive in their assessment and review of the effectiveness of their teaching and student learning. They are clearly meeting the assessment goals of "closing the loop."*
- f. Is the level of scholarly work by faculty members in the program suitable for this program? Does the program as operating or planned provide sufficient opportunities for continued growth in quality of scholarship, creativity of faculty, and research opportunities for students? *The Biological Sciences faculty are appropriately productive by most measures of scholarly output, especially given the limited support of shared research facilities and infrastructure. There are not sufficient opportunities for expansion of the research effort and productivity of individual faculty or the department as a whole. The T/TT faculty in Biological Sciences is undersized and this limits the Department's ability to construct robust research foci. Expansion of the research T/TT faculty and development of strong research themes will increase the visibility of the Department and UMBC,*

increase the ability to compete for individual and collaborative grants, increase the recruitment of graduate students, and increase the capacity for undergraduate independent research opportunities.

- g. Given your review, do you think the program resources are being used effectively? Are there other ways you can suggest for them to be used? Are there additional ways the program might generate revenue? *The Department's resources are largely being used effectively. One increase in efficiency can be realized by shortening the time to degree for graduate students and limiting the support of graduate student to 5 rather than 6 years. The Department might also consider how they deploy graduate TAs in their courses; it is likely that they can enhance the instructional impact of their current TAs. It is clear that the current lab fee structure is insufficient to support the CRE lab courses; the lab fees should be raised in order to support these research experiences. The development or expansion of revenue generating programs in the Department is simply not possible at this time given the teaching and advising load of faculty and contraction of the T/TT faculty pool. The Department is struggling to sustain its current research and teaching missions and in its current form has no capacity to invest faculty and staff time and resources to develop revenue-generating programs.*
- h. To what extent does or should the program collaborate with other units of the University? *In teaching, the Department collaborates with the Chemistry Department in offering the Biochemistry major. The Department is collaborating with other units to form collaborative research centers: the Interdisciplinary Consortium for Applied Research in Ecology and Evolution and the Center for Biomolecular Innovation, Technology, and Entrepreneurship. The Department is interested in developing productive collaborations that will positively impact their research and teaching missions.*
- i. With regard to any resources identified as needed in the self-study or the external evaluation, which one is most urgent and/or most likely to benefit the program and how? *Expansion of the tenure track faculty is viewed as critical for the continued and future success of the Department. To meet this hiring goal, it will also be necessary to provide up-to-date research facilities for these new faculty, such as in the Interdisciplinary Life Science Building.*

The benefits to increasing the Biological Sciences tenured/tenure-track faculty are numerous and wide spread and include:

- *enhanced ability to reach critical mass and develop strength in a research area*
- *increased ability to compete for individual and collaborative grants*
- *increased research funding to the Department and university*
- *more competitive recruitment of graduate students and expansion of graduate training*
- *enhanced course offerings in the undergraduate and graduate curricula*
- *increased capacity for undergraduate independent research opportunities*
- *reduced service burdens on individual faculty (e.g., advising) that currently jeopardize their research competitiveness*
- *improved student to faculty ratio in Biological Sciences that will impact the University ranking*
- *increased visibility of the Department and UMBC.*