

University of Massachusetts
Department of Biology Self-Study Document
Academic Quality Assessment and Development
January 2, 2018

Introduction

The Department of Biology is one of the largest departments, in terms of undergraduate student enrollment, in the College of Arts and Sciences, which is the biggest academic unit in the University of Massachusetts Dartmouth. The Biology Department has a long history of providing high-quality undergraduate and graduate education in biology and marine biology.

The Biology Department aligns itself with the mission and vision statements of the University of Massachusetts Dartmouth, which are described below:

Mission Statement

The University of Massachusetts Dartmouth distinguishes itself as a vibrant public university actively engaged in personalized teaching and innovative research, and acting as an intellectual catalyst for regional and global economic, social, and cultural development.

Vision Statement

Within a climate that is inclusive, open, and diverse, UMass Dartmouth will be the university of choice for students seeking high quality liberal arts and science programs as well as professional academic programs that build a foundation for civic responsibility, individual skills and professional success.

UMass Dartmouth will distinguish itself by providing a personalized academic environment where the scholarly research and creative activities of faculty and graduate students are interwoven with the undergraduate experience.

UMass Dartmouth aspires to create additional Masters and Doctoral programs, with commensurate support, in addition to enhanced technological capabilities for the delivery of our educational and outreach programs.

The Biology Department:

- 1) engages in personalized teaching, particularly in laboratory sections and upper-level courses with relatively small class sizes, and in research projects for undergraduate students.
- 2) engages in innovative research. All of the tenured and tenure-track faculty are research-active and publishing in major journals in their field.

3) has had long-standing and successful master's degree programs in biology and marine biology, and is in the first year of a newly approved Ph.D. program in Integrative Biology.

Evidence of the Biology Department's commitment to the mission and vision of UMass Dartmouth will be developed in this self-study document.

Undergraduate Program in Biology/Marine Biology

We offer degrees in 1) Biology and 2) Biology with a Marine Biology option. During the first 2 years the curriculum for both degrees are similar (Appendix A; all appendices are on the accompanying flash drive). In the third year students desiring the Marine Biology degree option then select from a variety of upper-level courses that focus on the marine environment (Appendix B). Other students select courses based on their career interests or according to the Advising tracks (discussed below). Our upper-level courses are now at or near enrollment capacity.

The Biology curriculum provides strong grounding in basic sciences, math, and English skills during the freshman and sophomore year required courses. Beginning fall 2017 the core curriculum was revised to both modernize and enhance coverage of fundamental topics. Our 6 core courses plus 4 labs for Biology majors include Introductory Biology I & II (formerly Biology of Organisms), which encompasses biology from molecules to ecosystems, with an emphasis on evolutionary perspectives; Cell Biology (formerly Biology of Cells), an introduction to cell and molecular biology; and Biology of Populations is being restructured to become Ecology & Evolution, which provides an introduction to evolution, ecology, and population genetics. To add additional fundamental background two new courses were added to the core; Genetics (BIO 235) and Experimental Design and Analysis (BIO 215).

The new core also includes Biology laboratory experiences in all of the first 4 semesters beginning with the year-long Introductory Biology I & II. Part of the 2017 curriculum change the laboratory structure was also modified to transition content from existing laboratory courses (Biology of Cells and Biology of Populations) into laboratories that incorporate broader concepts and experiences Cells and Genetics laboratory (BIO 236) and Experiments in Ecology & Evolution laboratory (BIO 225) as part of the 2017-2018 curriculum.

The first year lecture courses are taught by a full-time lecturer B. Winslow and the second year courses by tenure-track or tenured faculty (W. Hable, J Koop, R. Drew & T. Rajaniemi). Laboratory sections associated with the core lecture courses are taught by teaching assistants, part-time lecturers, full-time lecturers, and tenure-track faculty all under the guidance of the lecture instructors. Course instructors also serve as laboratory coordinators and determine the content of the laboratory activities.

During their junior and senior years and after consultation with their faculty advisors, students select upper-level Biology courses that will help them meet their academic and career goals in various fields within the broad discipline of biology. All of our upper-level courses in biology are taught by tenured, tenure-track faculty as well as some full time lecturers. New faculty have developed courses in their research specialties that bring depth to the curriculum.

The Biology program has a series of advising tracks for our students to help them plan their course of study and reach their career and personal goals. The advising tracks include: General Biology, Cell and Molecular Biology, Marine Biology, Ecology and Evolution, and Pre-healthcare Professions (Appendix C). In 2016 the Pre-health advising track was enhanced to include specialized advising for students who show an interest and have the potential for gaining admission to medical programs (MD Vet & Dental). A Pre-Health committee made up of Biology faculty review rising sophomores and students who have achieved a competitive GPA in post-graduate pre-requisite courses are given a secondary advisor to assist with planning for medical school applications.

There are several opportunities for additional learning experiences for students. Many faculty serve as mentors for undergraduate students in research projects. Students receive credit (BIO 440 and 441) although faculty receive no teaching credit or funds for supplies. Students completing internships on or off campus can receive Experiential Learning credit (BIO 298). In addition, the department has a Teaching Experience course (BIO 270) where high-achieving junior and senior biology majors can serve as teaching assistants in laboratory courses.

Our undergraduate majors come from throughout the Commonwealth, with a preponderance of students from southeastern Massachusetts. Many students are the first in their families to attend college, which is true for the university as a whole. The Biology department is very attractive to incoming freshmen and we consistently have a large first year class (Table 1).

Table 1. Fall admissions data		
Year	Freshmen	Transfers
2011	130	11
2012	79	35
2013	88	26
2014	70	35
2015	67	37
2016	62	25
2017	125*	
* Preliminary data: freshman & transfer students combined.		

From 2005 to 2010 an informal survey of incoming freshman was taken at orientation to understand student interests and career plans. Consistently, about 25% of freshmen plan to major in marine biology and 50-60% intend to apply for post-graduate study in the health professions. The remaining students have a wide array of interests outside of health and marine biology. This survey was again administered to this year's incoming students (fall 2017) and the trends were similar: 34% marine, 50% medical, and 14 % of the incoming class having other goals involving biology.

In addition, twice each year the university accepts students into the Biology program who transfer from other colleges and universities (Table 1). Moreover, many students studying at the university in other majors, or with an undeclared major, express a desire to change their major to biology, and we accept approximately 20 of these internal transfers each year (Table 2).

Table 2. Students within UMD changing majors. Data are based on change-of-major forms signed by department chair.		
Year	Entering Biology	Leaving Biology
2010-2011	41	10
2011-2012	39	24
2012-2013	34	27
2013-2014	48	33
2014-2015	36	28
2015-2016	33	19

We also serve the needs of many non-majors students for courses in biology within the university, either to satisfy University Studies requirements in science, or to meet the needs of students in the College of Nursing. We offer courses in General Biology (BIO 101 and 102) and courses that focus on various topics in biology (BIO 103 & 108) or oceanography (BIO 112). Courses for nursing students (which are often also taken by biology majors desiring careers in the health professions) include Human Anatomy & Physiology I and II with lab (BIO 221, 222, 223, 224) and Medical Microbiology and lab (BIO 251 and 261).

Overall course registrations are very high (Table 3). The courses for non-majors are taught by a mix of tenured/tenure-track faculty, full-time lecturers (FTLs) and part-time lecturers (PTLs), who play a valuable role in our instructional commitments. We are very fortunate that we have little turnover of PTLs and FTLs and our current lecturers have served us well for several years.

Table 3. Fall Semester Course Registrations		
Year	Undergraduate	Graduate
2010-2011	2010	33
2011-2012	1854	24
2012-2013	1931	38
2013-2014	1987	48
2014-2015	2060	46
2015-2016	1858	49

We continue working to make our curriculum more reflective of trends in biology, in particular the previously mentioned core curriculum overhaul and also by continuing to add new courses. Each new faculty hire has resulted in new approaches to established courses. In the last three years Evolutionary Biology, Biology of Populations, and Biostatistics were taken over by new faculty members. New courses have been developed by both new and senior faculty; most recently; Conservation Biology, Dynamic Biological Systems, Coral Reef Biology, Ecological Immunology, and Medical Anatomy & Physiology (BIO 322). Most new courses are originally established as part of the department's Proseminar topics course (BIO 411) that serves as a means to allow faculty to experiment with new course material before establishing a formal course.

The department is in the process of searching for two new faculty members to support the increasing emphasis on "Integrative Biology". These new hires will begin in the fall of 2018 and should add several new courses to the department offerings over the next few years.

To further enhance the breadth and depth of study and to emphasize laboratory-based education, which we feel is essential in the training of biologists, three graduation requirements have been instituted. First, the number of upper-division biology electives has been increased to 21 credits. Second, we require that, of the 21 course credits, a minimum of two courses must include a laboratory component. Finally, the university's required Capstone course was developed (BIO 499) in the Biology department as a multi-section (5 topic choices per year) with topics covering areas of faculty expertise. Students select one of these low enrollment sections (12 students) where they have an opportunity to research and discuss in detail a topic of interest at an advanced level. This course includes a research (poster) presentation by all students to the entire department.

The Biology curriculum is very challenging for many students and, as is true at most colleges and universities, there is attrition from the program, especially during the freshman year (Table. 4).

Table 4. First Year Retention Rate for Biology Majors			
Cohort	Within Department	Within College	Within University
Fall 2010	60.3%	73.0%	73.8%
Fall 2011	58.8%	71.8%	74.1%
Fall 2012	64.1%	70.5%	79.5%
Fall 2013	56.6%	69.9%	74.7%
Fall 2014	69.6%	82.6%	84.1%
Fall 2015	62.1%	69.7%	69.7%

Nonetheless, for the last 7 years we have consistently graduated >50 students each year with B.S. degrees in Biology or Marine Biology from a total enrollment of ~300 majors (Table 5).

Table 5. Number of Undergraduate Students Majoring in Biology/Marine Biology and Degrees Conferred			
Calendar Year	Fall	Spring	Degrees conferred
2010-2011	270	274	55
2011-2012	283	264	54
2012-2013	301	263	56
2013-2014	313	286	65
2014-2015	317	278	53
2015-2016	297	279	79
2016-2017	312	273	65

Assessment of Academic Programs

Undergraduate program

In the spring of 2012, the department completed a program-level assessment plan for the undergraduate program. The department has established learning objectives in three areas:

1) Content knowledge, 2) Proficiency in analytical and technical skills, and 3) Fluency in the scientific literature.

Area 1: Content knowledge.

Learning objectives:

- Upon completion of the two-year core, Biology majors will be able to identify, explain, differentiate, and utilize fundamental concepts related to Cellular and Molecular Biology, Organismal Biology, Ecology, and Evolutionary Biology.
- Upon graduation, Biology majors will have more in-depth understanding of concepts in one or more sub-disciplines.

Assessment plan:

Content knowledge at the time of graduation is assessed with the Major Field Test, which is administered in the Capstone course (BIO 499). A total of 42 students took the test in AY 2015-16 and 55 in 2016-17. Results include the total test score, subscores for general content areas (Cell Biology; Genetics and Molecular Biology; Organismal Biology; Population Biology, Ecology, Evolution, and Analytical Skills), and scores for assessment indicators for some more specific content areas.

Results:

Rather than focus on absolute scores, we are considering which areas have higher or lower scores, and are using those data to examine whether our course offerings are consistent with the department's goals for student learning. For instance, the lowest scores are in the area of Organismal Biology of plants, which is addressed by only one upper-level elective course in this category. The highest scores are in the area of Population Genetics and Evolution, which has been stressed in core courses and is addressed in multiple upper-level electives.

The undergraduate curriculum was revised (beginning with Fall 2017 freshmen) to provide a broader content base in the core classes. The Biology Department Curriculum Committee is currently reviewing the content of our upper-level course offerings.

Area 2: Proficiency in analytical and technical skills.

Learning objectives:

At all levels of the major, and with increasing sophistication over time, Biology majors will be able to:

- articulate biological questions and formulate hypotheses
- design an experiment to test a hypothesis
- collect and analyze data using appropriate biological research tools and computer software
- express results in writing, verbally, and graphically
- explain the importance of the results in the context of the original hypothesis

Assessment plan:

A rubric has been developed for scoring each of these learning objectives from student lab reports (Appendix D). Scores have been compiled for students in Biology of Organisms I (BIO 131, end of first semester of biology core, baseline) and Biology of Populations (BIO 211, end of fourth and final semester of biology core). The assessment plan calls for assessment of analytical and technical skills for graduating students based on capstone projects, but those projects have not fit well with the established rubric and we are investigating alternatives.

Results:

We compared scores for the 2012 cohort between their first semester (Orgs 131) and their fourth semester (Pops 211) in the program. As expected, scores improved in all categories. Median scores increased from 1 to 3 for the three of the objectives (articulate questions and formulate hypotheses, express results, and explain results).

Area 3: Fluency in the scientific literature.

Learning objectives:

Upon graduation, Biology majors will be able to

- read, with critical understanding, current journal articles in at least one field of biology
- communicate, verbally and in writing, the findings of current articles
- evaluate the literature relevant to a biological questions

Assessment plan:

Rubrics have been developed for the scoring of these learning objectives from students' written assignments (Appendix E). A survey of upper-level courses has been conducted to identify courses with written assignments that address these objectives. Collection and scoring of assignments is planned to begin in Spring 2018.

Graduate program

The department has established learning objectives in three areas: 1) Content knowledge, 2) Critical thinking and analytical and technical skills, and 3) Written and verbal communication skills.

Learning objectives:

Area 1: Content knowledge.

- Students will develop an advanced theoretical and conceptual framework in a subdiscipline of biology.

Area 2: Critical thinking and analytical and technical skills.

Students will apply the methods of scientific inquiry in an independent research project. Each student will be able to

- evaluate the published research on a particular research topic
- plan an independent research project, including designing experiments to test specific hypotheses
- complete all data collection for the project
- analyze and interpret data collected

Area 3: Written and verbal communication skills.

Students will communicate the results of an independent research project.

- Each student will describe the project's purpose, methods, results, and their interpretation in a written thesis.
- Each student will present and defend verbally the research project's results in a public setting.

Assessment plan:

Content knowledge is assessed based on completion of coursework. Each student completes a minimum of 15 credits of graduate-level coursework. The curriculum plan is designed by the student and major advisor, with input and approval by all members of the student's thesis committee. Each semester, the thesis advisor reviews the progress of the student. According to University's policy, graduate students must earn a grade of C or better for the course to satisfy degree requirements, and the student must have a GPA of at least 3.0 to graduate.

A rubric is being developed that can be used to assess objectives in all three areas at the time of the thesis proposal and at the time of the thesis defense (Appendix F).

Graduate Programs in Biology, Marine Biology and Integrative Biology

The Department of Biology has long-standing graduate programs leading to a M.S. in either Biology or Marine Biology. Both programs consist of a combination of coursework and rigorous research and culminate in a research thesis. Some faculty have doctoral candidates in intercampus Ph.D. programs including Biomedical Engineering & Biotechnology and the School for Marine Science.

This fall (2017) we launched a new Ph.D. program in Integrative Biology. The program is based on the complex fundamental research problems of ecological, behavioral, and organismal biology. Students in this program will be offered training in the techniques and approaches of molecular and developmental biology, ecology, and quantitative genetics. This doctoral program within integrative biology will leverage the department's expertise, bringing a unified and coherent research focus leading to an increased recruitment of high-quality students at the graduate and undergraduate levels.

Regardless of graduate program, we strongly encourage all graduate students and their advisors to disseminate their findings via student-authored publications, and recommend students attend national and international scientific conferences. Travel grants to support student conference presentations are available on a competitive basis.

During the past 6 years the diversity of research areas has increased with the addition of new faculty that work on diverse and integrative questions.

Our graduate programs are relatively small but have remained constant with 21-28 MS candidates and 13-15 PhD candidates in intercampus Ph.D. programs in Biomedical Engineering/Biotechnology and the School for Marine Science (Table 6). With the new PhD program in Integrative Biology (Appendix G), we anticipate an increase in PhD students in the near future. Currently 9 students are self-funded, 2 are supported by fellowships, 6 are supported by grants, and 14 are supported by teaching assistantships.

Institutional support for the graduate program has been modest. In 2010 the department agreed to increase undergraduate enrollment and was compensated with an increase in institutional support to \$180,000. That number has remained fixed, but we have recently increased the teaching assistantship salary, which includes tuition credits, from \$15,000 to \$18,500. Teaching assistants must serve as the instructor of record for one lab section and assist in a second lab section.

Table 6. Graduate Student Data							
	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Total MS students	22	25	21	21	21	28	28
Total PhD students	13	14	16	14	13	15	13
Starting MS students	10	6	4	8	6	8	8
Starting PhD students	2	1	3	1	2	1	3
MS graduates	3	8	6	7	0	7	NA
PhD graduates	0	1	2	1	0	4	NA
*Graduate Publications	NA***	NA	7	9	7	6	NA
**Graduate Conference presentations	NA	NA	12	8	13	21	NA
* Peer reviewed publication ** Presentation at regional, national or international meeting. *** Data for 2011 - 2013 could not be separated by year but is included in Faculty CVs							

Faculty

Since a high of 17 tenured/tenure-track faculty in the late 90's the Biology Department has been held consistent at 14 tenure line faculty (Table 7).

The number of Full time Lecturers has increased to 5 (Table 7) to primarily meet the needs of large introductory Biology courses (BIO: 121/122 & BIO 131/132) and service courses (Human Anatomy & Physiology: BIO 221 & 222, General Biology I &II: BIO 101&102, and Medical

Microbiology BIO 251 & 261). Since 2010 (last AQAD review) faculty turnover has been limited with one faculty member leaving for another department and one not being awarded tenure. Current ranks of tenured/tenure-track biology faculty include 6 Professors, 6 Associate Professors, and 2 Assistant Professors (Appendix H: List & interests of faculty). Beginning in 2018 Full-time Lectures are eligible for promotion to Senior Lecturer (after 10 years of service to the university).

Table 7. Number of Faculty			
Year	Tenured/tenure-track	FT Lecturer	PT Lecturer
2010-2011	14	3	4
2011-2012	13	3	4
2013-2013	13	4	2
2013-2014	14	4	1
2014-2015	13	5	1
2015-2016	14	5	2
2016-2017	14*	5	2
*2016-2017 search for two new faculty hires underway			

Much of our recent and future hiring has focused on Integrative Biology with our most recent hires in Computational Biology (Vanni Bucci) and Evolutionary Ecology (Jen Koop). As currently constituted the Biology Department has faculty whose research and teaching interests span a fair amount (as much as possible) of the extensive field of Biology with some depth in both marine and several non-marine specializations. The breadth and depth of faculty research and teaching is evident in the faculty CVs (Appendix I). It has always been a goal in all faculty searches to obtain faculty with outstanding research records who can translate their interests and expertise to the classroom.

New faculty receive start-up packages to set up their research laboratories. Prior to 2010 start-up packages were quite modest, but since that time faculty have negotiated \$200,000-300,000 in research funds, provided primarily by the Dean of the College of Arts and Sciences. The Dean has also provided funds for renovation of research labs, most of which are fairly small in size.

The standard teaching load is 9 contact hours per semester. A 3-hour lecture course is 3 contact hours, as is a 3-hour laboratory. Faculty can receive a course release each semester if they advise graduate students. Full-time Lecturers teach a 12 contact hrs per semester.

Upon hire, each new faculty member is given a copy of the "Expectations for Tenure and Promotion to Associate Professor in the Biology Department" (Appendix J), which outlines expectations of accomplishments required to attain tenure. In 2017 these expectations were revised by the Biology faculty and approved by the CAS Dean and Provost. Each new faculty member receives one course release each semester for the first year to attend the New Faculty Institute organized by the Office of Faculty Development. New Biology faculty are not assigned undergraduate student advisees until their second year. The department does not have a formal mentoring program for new faculty, although the chair strives to make himself available for discussions with new faculty about teaching and departmental and university policies and practices.

All of the current tenured/tenure-track faculty are productive scholars. Almost half have grant support for their research and nearly all publish peer-reviewed journal articles each year. Summary information can be found in the attached Annual Biology Department Reports (Appendix K) and faculty curriculum vitae (Appendix I) of all faculty.

In addition, all faculty participate in departmental and/or university service activities and several are involved in public service activities, such as supporting K-12 education, presenting public lectures, or otherwise sharing their scientific expertise with the community.

Resources

The operating budget, allocated from the Dean's office and supported by fees paid by undergraduate majors, is \$80,000 per year, and has remained at that level for several years (at least prior to the last AQAD review). Approximately \$55,000 is used for teaching lab supplies and equipment service contracts. The remainder is used to support general operating expenses (e.g., telephone and fax, printing and photocopying, postage, office supplies, etc.). In addition the Dean's office provided end of the year supplemental funds in 2015, 2016, & 2017 totaling almost \$130,000 to maintain and replace equipment essential to the teaching laboratories.

The department also has an indirect cost account, which is funded by 10% of the indirect cost awarded on faculty grants. The indirect cost funds are used for research-oriented purchases, including start-up funds for new faculty. In addition, \$6,000 is dedicated yearly for competitive grants for research supplies for graduate students and travel awards for undergraduate and graduate students to present their research at conferences.

The department has no funds available for faculty research supplies or unanticipated needs such as any repairs of major equipment. Funds for equipment maintenance and repair must be sought from the Dean on an as-needed basis. No funds are budgeted for equipment upgrades. The end of the year input of funds from the dean's office (\$130 K over three years) were greatly appreciated and needed but these windfall inputs do not allow for long term planning.

The College Temporary Instruction Account is supported by curriculum support fees paid by students. Part-time lecturers and teaching assistants are funded by the temporary instruction account, currently \$210,500 per year.

The department has 6 teaching laboratory classrooms, one of which are solely used for Anatomy & Physiology lab and another for the Introductory Biology courses. Although one lab has been updated with modern equipment (> 10 year ago) for Cell and Molecular Biology labs, the other 5 labs are in dire need of renovation and equipment upgrades.

Each tenured/tenure-track faculty member is assigned research space. The dean has provided funding for renovation of several labs for recent hires. Faculty offices and research labs are located in 3 different buildings, which makes collaboration and sharing of equipment difficult. In addition, many faculty lack the space to enlarge their research programs to accommodate additional undergraduate, graduate students, and post-doctoral research associates. Most labs cannot accommodate desk space for students or research associates and many share small common computer room with a carousel of computers.

Finally the Department is very fortunate to have one administrative assistant and one professional technician, both of whom are highly skilled and provide outstanding support of departmental activities. However, the complexity and diversity of the tasks required by both positions has increased dramatically recently, especially in the areas of purchasing, record-keeping and reporting, and support of teaching labs. The department needs a second administrative assistant for reception and clerical duties and a second technician to assist with lab preparations and provide information technology support for technology-enhanced labs.

Summary

The Biology Department has made great strides since our last AQAD review in 2010. We have hired two excellent new faculty and are currently searching for two more. We have improved our undergraduate curriculum by revising and adding key foundational courses to our core curriculum. We have greatly increased our extramural funding and publication record, we have expanded our graduate program, and are in the first year of a new PhD Program in Integrative Biology. However, we also have identified several areas needing improvement:

- 1) The Biology Major remains in high demand for incoming students and enrollment is consistently limited by space and faculty. This demand and the need to add new graduate level courses will make it difficult to continue to provide the personalized, student-centered educational experiences in our courses, which is part of the university's mission. These new hires will aid in this situation. However, as the graduate program grows new faculty hires will become more of a necessity. We need to be able to offer more courses in support of graduate education. Offering mostly dual-enrollment courses (for biology undergraduate and graduate students concurrently) does a disservice to our graduate students.
- 2) We are in great need of more research space both for existing faculty and for new faculty. Biology has cannibalized a great deal of teaching lab prep space to accommodate faculty offices and research labs. We have reached a point that without additional space any further growth to meet current and future needs will be impossible.
- 3) Most of our teaching labs require renovation and updated equipment. Only one Biology laboratory is equipped with smart classroom technology (projector and document camera

capabilities) limiting the type of teaching presentations that can be given. We have made strides in replacing outdated equipment in the teaching labs but this needs to be a constant process to remain up to date and provide the most relevant content to our students.

Appendices

All on Flash Drive:

- A: Biology curriculum
- B: Upper-level biology courses
- C: Advising tracks and degree requirement checklist
- D Assessment: Rubric for undergraduate Area 2
- E: Assessment: Rubric for undergraduate Area 3
- F: Assessment: Draft rubric for graduate learning
- G: Accepted proposal of the Ph.D. program in Integrative Biology
- H List and interests of faculty
- I: Curriculum vitae of faculty
- J: Expectations for tenure and promotion
- K: Annual department reports (2011-2016)
- L: Biology course syllabi

