

DEPARTMENT/PROGRAM PLANNING PROCESS FOR 2014-15

Investment of Choice — Intellectual mission and scholarly recognition.

1. At present, how would you describe your department's place in your discipline? What is its special character or niche? What are you known for by colleagues elsewhere? Understanding that departments cannot do everything, what subfields or foci have attained a critical mass?

Response: The microbiology program at UMass Amherst ranks in the top tier of microbiology research as well as undergraduate and graduate training programs in the nation. Therefore we are a destination of choice and a point of pride for UMass. The department seeks to develop and maintain exceptional scholarly research programs while training and educating undergraduate and graduate students in microbiology to promote lifelong, independent learning. Our strength lies in our holistic approach to training microbiologists in the areas of medical microbiology, genetics and physiology, environmental microbiology, and applied molecular biotechnology, where we have attained a critical mass of researchers in each subfield. The Microbiology Department provides the academic home for a highly interactive group of investigators whose research covers all of these areas. One researcher in our department, Dr. Derek Lovley, is particularly well known for his research in environmental microbiology and was named a 'highly cited researcher' by Thomson Reuters in 2014. Our researchers publish important and groundbreaking findings on a regular basis in top journals including *Nature* and *Science*, and our graduates successfully compete for positions in industry, academia, the government and top ranking medical and graduate schools.

We recently initiated a one-year, non-thesis professional Master's degree in Applied Molecular Biotechnology (AMB) that has successfully placed its graduates in various biotechnology and pharmaceutical companies. The AMB program combines state-of-the-art laboratory training with lecture-based courses to train students in the latest techniques and concepts of molecular biology and biochemistry. Students are specifically trained over the course of the year in protocols most desired by the leading biotech companies, making them highly competitive in the job market. The curriculum was designed with the biotechnology industry in mind to provide students with a broad knowledge base and the research skills to be competitive for positions in industry, but also academia. This is a highly attractive program for anyone with a BS degree in the sciences looking to do graduate work towards the MS degree with a guaranteed short turnaround. These graduates command starting salaries that are in the range of \$15K to \$20K more than they would receive with the BS degree, making this an excellent investment.

With a new hire in medical microbiology starting in January of 2015, the department now has 4 faculty members with active research in this area. For a microbiology department not directly connected to a medical school, this an important area to build in since over 65% of all undergraduate students express an interest in pathogenic microbiology. The investment in

hiring faculty with medical microbiology interest and expertise has certainly made this subfield an area of competitive focus. This area of strength is further supported and enhanced through collaborations with faculty from other departments on campus in the Models to Medicine Core and UMass Medical School.

2. What is your department's role in your college and in the University? How do you contribute to the college and campus scholarly mission? In what ways does your department engage in interdisciplinary activity?

Response: Our department contributes to scholarly missions in the areas of life sciences and Earth, environmental and sustainability sciences, the School of Nursing, as well as the School of Public Health. Specifically, we are actively engaged in research, we train undergraduate and graduate students as well as post-doctoral researchers, and we serve the needs of the Commonwealth and nation in a broad spectrum of areas. Microbes are estimated to contribute half of the planet's total biomass and play a profound role in the natural history and environmental health of the planet. They also are the primary agents of infectious disease for humans and our food supply and must be managed to improve our quality of life. Finally, microbes are used in the development of new technologies (e.g., medicine, agriculture, energy, environmental remediation). As a result, our department participates in interdisciplinary activities on campus with Biology, Biochemistry and Molecular Biology, Veterinary and Animal Sciences, Food Science, Chemistry, Physics, Geosciences, Environmental Conservation, Polymer Sciences, Civil and Environmental Engineering, and Chemical Engineering.

From an academic standpoint, the percentage of undergraduate non-majors enrolled in our classes remain among the highest in the College of Natural Sciences and currently stands at 81% for the 2012 - 2013 school year. The increasing enrollment in the Microbiology major and the growing demand for microbiology courses by students from a number of other departments as well as a significant increase in the number of Microbiology minors, has demanded that the department enact major changes to accommodate our student body. One of the most significant changes has been the development of a new lab course for non-microbiology majors (Microbio 390B). This new course more closely matches the needs of pre-health sciences students from other departments. This change resulted in the creation of more room in the original Microbio 312 lab course for microbiology majors. Therefore we now have two sections of Microbio 312 and six sections of Microbio 390B. In addition, the Microbio 255 laboratory course that serves nursing majors was expanded from two to three sections because of increased enrollments.

This significant increase in lab sections has resulted in the addition of over 250 more students being served in microbiology labs over the last 3 years. At the same time we have also added new lecture sections to Microbio 160 to accommodate the growing demand for this general education course and is now home to the large Plaques course (Microbio 140P) being taught by Dr. Rich. The department has been accommodating a growing number of majors as well as an increasing number of service course requests, especially by students wanting to go into pre-Health professions. At the same time we have seen a 41% drop in TA allocation over the last

seven years. We also lost one essential staff member in teaching services and have had no increase in the budget for supplies for the teaching labs.

It is now clear that commercial and industrial interests in biotechnology comprise ever-increasing employment opportunities in the Commonwealth of Massachusetts and around the world. Students from all majors in our college have come to realize this important fact. The department of Microbiology now offers a Biotechnology Certificate program, designed to prepare interested students to meet the needs of this growing industrial base through training in diverse areas of biological science that make up the basis of biotechnology. This certificate program requires that in conjunction with their major program of study in the home department, students take a minimum of 15 credits of approved courses covering topics in the area of biotechnology from other science departments. This certificate program offers undergraduate students recognition for the interdisciplinary training they have received in biotechnology, propelling them into biotechnology jobs across the country.

Our faculty also contribute significantly to the interdepartmental programs where Dr. Kevin Griffith has been teaching in the core MCB course and our department head, Dr. John Lopes, has been teaching Advanced Genetics. These important departmental accommodations by both our faculty and graduate TAs have contributed significantly to the overall mission of the CNS and the university at large.

Destination of Choice – Doctoral education

1. There are many excellent choices of colleges/universities in the country for someone seeking an MA or a PhD in your field. At present, what attracts graduate students to your department? What do you promise to provide them that makes the experience distinctive?

Response: The microbiology department maintains a vibrant and growing microbiology curriculum for graduate students and takes pride in maintaining very high standards for hiring faculty and accepting graduate student applicants. First, our department consists of top-caliber researchers who are working and publishing in cutting-edge areas of microbial research. Second, our graduate students are trained in a wide range of fundamental microbial, proteomics, cell biology, genetics, environmental, and immunology techniques. These techniques are utilized along with cutting edge technologies in the field of microbiology that better prepares them for a diverse and ever-changing work force. As the microbiologist Louis Pasteur once said, “Chance favors the prepared mind.” Third, our department is very collegial and collectively works to help all of our graduate students succeed at all levels of training. Graduate students are attracted to the accessibility of faculty and the family atmosphere that exists in our department. From the regular TGIF social gatherings organized by the graduate students to holiday dinners and retreats, the department seeks opportunities to maintain a cohesive and collaborative atmosphere within which to work and study.

One specific and attractive curriculum change for the Ph.D. program is that it now includes mandatory laboratory rotations for the first two semesters with a third optional rotation available.

The rotation program allows students to explore various areas of microbiology research and experience different research environments before committing to a single lab to conduct their dissertation research. This also gives faculty an opportunity to assess student aptitude and interest. An inherent benefit of the program is that it also enables high caliber students to develop broad-based training in research, and a distinctive feature is that students now have the freedom to select a research advisor in an informed manner after having spent at least 4 months in that specific lab. There is also the added benefit of not feeling obligated to remain in the lab of an investigator even when things are not working out as expected because they “accepted” you in to the Ph.D. program. The current system comes with the understanding that there are multiple factors which are taken into account when a student makes the decision to join a lab. The investigator also has a better set of parameters to gauge the success of a student in his/her lab after supervising them through the rotation process. Students now understand that they are accepted into the Microbiology department and not into any individual lab. This is a very attractive feature and the best graduate programs in the country have a robust rotation program.

We promise our graduate students constant and consistent access to faculty mentors, departmental resources to ensure that they are able to travel to at least one professional meeting each year, a productive and caring environment in which they will thrive, clear and consistent guidelines about the requirements for completion of the program of study and a professional atmosphere where they will be nurtured to become effective, successful scientists, ready for the work world either in industry or academia. These fundamental features combined with the opportunity for collaboration across departments make our department a destination of choice for those looking for a strong, rigorous, yet supportive academic research environment.

2. How well do we prepare students at both the MA and PhD levels to compete for the positions they aspire to? Is the structure of our requirements tailored to what the institutions/employers they hope to impress are looking for?

Response: While we do not maintain formal statistics on where our graduate students work after receiving their degrees in our department, we do have information over the past five to ten years assessing where they are. The positions they currently hold are a great indication of their success in competing at the very highest level. Our past graduate students hold tenure-track faculty positions at top schools such as UConn, Dartmouth College, Hofstra University, NC State, to name a few. They also hold prominent positions in industry including principal scientist at the Institute for Systems Biology, Exxon Mobil, KnipBio Inc., Philips Healthcare, Astrazeneca, Cubist, GENEWIZ Inc., OPKO Diagnostics, Earth Research Institute, Genzyme and Cell Signalling Technologies. Many have post-doctoral positions at UMass Medical School, Harvard Medical School, MIT, Massachusetts General Hospital, Boston University, St. Jude’s Children’s Research Hospital, NC State, Emory University, Pfizer Inc., and the CDC in Atlanta.

The department of microbiology continues to maintain high standards in our program in terms of degree requirements, and overall expectations of our graduate students. We require students to pass a rigorous comprehensive preliminary exam before advancing to candidacy. The

department also requires candidates to have at least one first-author publication in a reputable journal before they can defend their dissertation work. As a result of these high standards, many of our graduate students publish several articles in leading journals before their defense date making them attractive for both academic and industrial postdoctoral positions across the US and abroad. The diversity of world-class academic and industry research facilities in which our graduates currently hold positions is a testament to the quality of the mentorship and training that is provided at UMass Amherst.

3. What is the attrition rate in your department? What factors lead to non-completion? At present, is your department making any special efforts to ensure timely completion of the doctorate?

Response: At the end of the 2013 school year the Department of Microbiology had 47 (22 MS and 25 doctoral) graduate students. The number of graduate degrees awarded each year has been very consistent, hovering between 11 and 15. There were 15 awarded for the 2013 to 2014 school year. Of the Master's degree candidates who enrolled in the department between 2006 and 2010, only 2 left without a degree and 95% completed the degree within 2 years. In fact between 2007 and 2009 we had a 100% completion within 2 years. For the doctoral program we had an 87% admittance to candidacy rate between 2006 and 2013, with 60% completing the doctoral degree within 5 years. Between 2000 and 2010, 77% of all students advanced to candidacy and completed a doctorate degree in Microbiology. The data indicate that the attrition rate in the microbiology major is very low.

What leads to non-completion: For students who left the department without a doctoral degree, most did not advance to candidacy because they did not pass the preliminary comprehensive exam. Most of these students completed the Master's degree before leaving the department. There was also a small percentage that left because of personal or family related problems.

Efforts to ensure timely completion: Our department has established and enforces a timeline for the completion of the Ph.D. in 5-6 years (nearly all of our Ph.D. students enroll with only a B.S.). Primary Ph.D. coursework is completed in four semesters with immediate administration of the preliminary comprehensive examination where they advance to candidacy. Students then form their Ph.D. dissertation committees and execute their Prospectus within the next 1-1.5 years. Completion of the Ph.D. then takes an additional 1.5-3 years. Our non-thesis, professional M.S. degree is on a set 12-month schedule for completion, and our traditional M.S. program is completed in 1-2 years. The graduate program director regularly communicates with students and their PI to ensure that they are on target with all the timelines. Since a requirement for dissertation defense is publication of at least one article in a reputable related journal, candidates and PIs also work to ensure that timely publication of research data takes place. These important waymarks throughout the graduate career help to ensure timely completion of the doctoral degree.

Source: All data are from the Doctoral Completions and Time to Degree by Entering Cohort, Academic Years 1995-96 through 2013-14 - OAPA

Destination of Choice: Undergraduate education

1. Program Attractiveness and Competitiveness.

To what extent and in what ways does your department contribute to the “destination” goal, and to the campus’s overall attractiveness vis-à-vis competitor institutions?

Response: The Department offers a core curriculum for undergraduates for the purpose of awarding a Bachelor of Science degree to Microbiology majors. The program features an array of lecture and laboratory classes designed to give our graduates a competitive edge in the job market and a graduate school career. In addition to courses taught by research active faculty who are at the very top of their respective fields, students get an opportunity to participate in cutting edge research and many become authors on important publications from the specific labs they worked in on independent study projects.

These laboratory independent study projects are usually the culminating experience of a successful undergraduate training and result in vastly increased competitiveness for jobs and graduate school. We encourage and support our students in finding meaningful practical experience in a research lab and often take independent study students from other departments across the college into our labs. Our departmental web site includes a special page on “Getting Research Experience in Microbiology” that helps guide students to available opportunities. Many of our Microbiology undergraduate students take advantage of these attractive internship opportunities, including independent study projects, teaching assistantships, summer fellowship programs at UMass and at other institutes (e.g. Rockefeller, MIT, Stanford University, etc.) and internships/summer jobs in biotech companies, hospitals and nature centers, depending on their interests. The recent senior survey data suggest that almost 85% of our microbiology undergraduate students participate in independent study research.

Points of Pride/Destination of Choice: In addition, the Microbiology Program offers students in *Commonwealth Honors College* an opportunity to pursue departmental honors with the culminating experience based on independent research with a faculty member. Students write an honors thesis on their work as well as present their work at an annual poster session hosted by the department. It is therefore little surprise that **three Microbiology students (Tara Mahendrarajah, Benjamin Waldman and Alyson Warr) have won the prestigious Barry Goldwater Scholarship since 2011, with another being an Honorable mention (John Manteiga). We also had an emerging scholar this year (John Sissay-Beckford).**

This type of unique experience and scholarly achievement is readily recognized by prospective students and their parents as well as undeclared students looking for a strong undergraduate life sciences major that will guarantee them future success in vast array of career choices. We believe these positive trends cement the department of Microbiology as a destination of choice for any serious scholar.

2. Overall Program Effectiveness. *How well is your department meeting the overall needs and expectations of your majors for a high-quality educational experience?*

Response: Since UMass Amherst is an environment where innovative scholarly activity is valued and encouraged, our top students expect to participate in undergraduate research activities. In the department of Microbiology, we know that providing our students with the opportunity to participate in undergraduate research engages their intellectual curiosity, satisfies their thirst for discovery, and gives them a much needed creative outlet. According to the latest senior survey, 82% of our graduating seniors were involved in research projects with a faculty member. A major advantage of participation in undergraduate research is that students get an opportunity to establish a relationship with a faculty mentor. This type of working relationship has been shown to increase retention and graduation rates. Students benefit from the wisdom, knowledge and experience of a mentor, while faculty members benefit from the questions students ask, the discoveries they make and the energy they bring to the projects being investigated in the lab. Scholarly activities also help make the resumes of undergraduates more attractive to graduate schools and prospective employers, and give faculty mentors the ability to write more detailed and meaningful letters of recommendation.

Microbiology students therefore see this type of research experience as an important component in the delivery of a high-quality undergraduate education. Research invariably leads to a better understanding of and a deeper appreciation for the discipline under investigation. As a bonus, our student's career goals are usually better clarified after they participate in research. This type of experience not only help our students prepare for graduate school and the workforce but also provide them with a sense of community and belonging in the department, thus enhancing their overall experience at the departmental level and influencing their view at the college and university level.

Students also cite the high quality of academic instruction and access to faculty in Microbiology. Over 94% of our graduating seniors report that they were satisfied with the access they had to faculty, the quality of the instruction they received and access to the classes they took in our department. These positive responses are a direct result of the caring scholarly environment that the microbiology department has cultivated over the years. Faculty members make themselves available to meet with students and accommodate special arrangements when warranted. Our emphasis on ensuring that our students are skilled in critical thinking and decision making, as supported by the appropriate use of analytical and quantitative techniques, while becoming effective communicators who can prepare and deliver oral and written presentations using appropriate technologies go a long way in their preparation and overall satisfaction.

While many departments struggle with finding a good advising mechanism, over 97% of Microbiology seniors said that they were satisfied with the undergraduate advising that they

received (85.8% of these were very satisfied). This is a direct result of the hard work of our dedicated undergraduate student advisor, Shelley Thibodo, whose personal touch to student advising has long been recognized as a major asset to the department. Students often talk about the fact that Shelley is caring, patient and understanding in her everyday deliberations with students, whether in a class setting or in her office. She knows each microbiology student and is willing to work with them to accomplish their career and personal goals. This goes a long way in meeting the expectations of our students.

Ongoing Challenges and Recommendation: One of the major challenges facing the Microbiology Department for the past two decades has been our outdated teaching lab and pre-room facilities and equipment. This remains a major area of frustration for students, faculty and teaching service staff. Our laboratory facilities are outranked by those in every community college in the surrounding area and remain a source of ongoing embarrassment as we try to recruit top students interested in the Microbiology major. Students who have transferred from STCC and HCC voice their utter surprise at our failing infrastructure, outdated microscopes, spectrophotometers and centrifuges and the complete lack of resources they have come to expect at an institution of higher learning.

If we are to continue attracting excellent students in our department and raise our profile as a destination of choice for a major with ever increasing interest to undergraduate and graduate students, UMass will have to invest in the renovation and updating of its teaching labs. This will significantly increase the number of students we can accommodate in each lab room, increase safety for both students and instructors and equip our students to better compete upon graduation. **It is our recommendation that the teaching labs be renovated immediately and that the outdated equipment be replaced as recommended by the last AQAD review team and the team prior to that, in order to accommodate the effective delivery of high quality undergraduate education that students, parents and employers have come to expect from us. Since teaching lab space is at a premium across campus, this will not only benefit the microbiology department, but these labs would also be available for other departments within CNS to utilize. We believe that this would be a timely investment as we seek to increase enrollment in our department and continue to compete with similar schools in the northeast for the best science students.**

3. **Student Engagement. *The campus plan emphasizes active and engaged learning, and strong advising and teaching relationships demonstrated to promote student success. How well is your department incorporating these goals across its undergraduate experience?***

Response: The microbiology department continues its history of delivering cutting edge and relevant content to our students in innovative ways. These include cutting edge pedagogical advances like team-based learning, the utilization of required laboratory courses where students can directly observe and participate in the principles they have learned in a lecture setting. Classroom instructions are dynamic including innovative lectures supplemented with videos and

animations, student led and driven discussions, presentations by students following substantial research and careful organization of materials, invited experts in the field including UMass alumni as well as a strong emphasis on the reading and understanding of research articles relevant to the field. This combination has resulted in the preparation of graduates who are at the very top of their fields in practical experience and understanding of the biomedical sciences.

4. Teaching Contributions and Effectiveness. *How well are you organizing and delivering undergraduate instruction?*

Response: The microbiology curriculum for undergraduate students in our department is well aligned with the American Society for Microbiology Curriculum Guidelines and has been refined over the years to best prepare our students. The courses offered challenge our students to learn scientific and critical thinking skills. The course content and departmental teaching culture converge to help students develop transferable skills that are important for their future contributions to the biomedical and basic research science fields. These include an emphasis on written and oral communication of key scientific concepts and quantitative reasoning through meaningful class discussions, the reading of scientific papers and the integration of ongoing research findings in the labs of various faculty members into lecture and lab courses.

Through a diversity of laboratory courses and our newly introduced Integrative Experience courses, students also have an opportunity to apply microbiology course content in solving real-world problems. Faculty members have favored an evidence-based instructional approach that has been demonstrated to be most effective in student learning for long-lasting and deep understanding of complex scientific principles. This has resulted in some pedagogical changes including team-based learning structures, case studies and industry-leaning analyses. These innovations in the delivery of undergraduate instruction have collectively promoted a deep understanding of the concepts and skills that are deemed to be of lasting importance, well beyond the classroom and the laboratory into real-world problem-solving. With growing enrollment and demand for our courses, the microbiology teaching services in collaboration with the respective instructors, have designed and executed additional laboratory sections to accommodate the current need.

The microbiology department also offers a number of service courses designed to satisfy the BS general education requirement. The Biology of Cancer and AIDS course currently meet in two sections each semester, serving between 700 and 800 students each semester. We also offer laboratory courses to satisfy lab requirements for students in the nursing and nutrition program. The percentage of undergraduate non-majors enrolled in our classes remains among the highest in the College of Natural Sciences and currently stands at 81% for the 2012 - 2013 school year.

5. Student Outcomes

What is their overall assessment of their learning across your courses?

Response: Based on the Microbiology Class Enrollments and Grade Distributions for AY2013-2014, the average GPA for all students in all courses taught was 3.4. This is exceptional for a department with very challenging courses like microbiology. Approximately 53% of the 38 classes/class sections taught had no student receiving a letter grade of D or F or withdrawing while failing. The vast majority of our courses had less than 3.5% of students with a DFW. These data are a strong indication of positive learning outcomes since they span classes at all levels. In the 2011 - 2013 student satisfaction survey, the microbiology department ranked above average in virtually all categories.

What is their assessment of the extent to which UMass contributed to important skills and habits of mind?

Response: According to the 2011 - 2013 senior survey, the overwhelming majority of microbiology majors expressed satisfaction with the overall UMass experience (3.65/4.00). Approximately 90% of our seniors report that they had a positive overall experience in the microbiology department. Over 80% of microbiology majors report receiving career preparation and guidance from teaching faculty, laboratory supervisors or through undergraduate advising. Although the number of students in our department continues to increase, the senior survey reveals that over 90% of our students report that faculty are accessible. Students were most satisfied with the quality of academic advising, rating Microbiology more than 2 standard deviations above the average for all departments in this category.

6. Effective Use of Resources. Promoting quality and effectiveness across all the domains identified above relies on the effective deployment of resources. Given the many competing demands on resources, and especially on faculty time and talent, how effectively do you use your instructional resources?

Response: The department of microbiology provides quality instruction to microbiology majors as well as a substantial number of non-majors in our service courses. 78.5% of the students we currently instruct are non-majors. In an effort to increase the diversity of perspectives from which students receive instructional material, increase the depth and breadth of knowledge in any given course, while increasing the amount of time research faculty have during the semester to focus on research and still fulfill their teaching obligations, the department moved to a co-teaching model for all of our undergraduate courses in 2011. This has worked really well overall although individual instructors are still refining each course to ensure the most seamless transition for students. This model gives our students an opportunity to have meaningful encounters with more faculty members in any given semester, expanding their knowledge base while efficiently utilizing faculty time and strengths.

In an effort to continue this type of high level instruction while accommodating all of our students, we have created multiple sections to various courses, including labs and lectures. The concepts taught in a microbiology lab require hands on assistance and guidance from individuals with the expertise to do so. For laboratory courses, we have relied heavily on the expertise of our graduate teaching assistants with knowledge of a diversity of microbiological

training, including novel advancements in the field. Students who have never seen microorganisms under a microscope find it difficult to identify what is being described in a text without direct assistance on the bench. One faculty member would not be able to attend to a class of 30 to 60 students in two lab rooms at each sitting to accomplish these important teaching goals. Moreover, since we work in less than ideal instructional space and with often failing equipment, the need for close guidance becomes even more important. Even with these major infrastructural and lab equipment challenges, our students remain competitive as they apply to graduate and medical schools as well as on the job market.

7. Diversity, inclusion and access. *How well does your department do in attracting the interest of students in under-represented groups and sustaining it all the way to graduation?*

Response: The microbiology department has not made any deliberate efforts in a formal way to recruit underrepresented minority undergraduate students in the recent past. Our department gets only approximately 25 to 30 students declaring microbiology as a major from the incoming freshman class. This is due mainly to the fact that most high school students considering a major in the life sciences are not familiar with the area of microbiology as an option. Therefore, the majority of the students in our major transfer from programs like Biology and Biochemistry into Microbiology, sometime around their sophomore year. We therefore have a representative minority population that reflects very closely that of CNS, although our department has a higher URM population. The College of Natural Sciences has a 12% URM student population and the department of Microbiology has a 15.2% URM population.

With that said, once minority students declare microbiology as their major, they are fully supported in meaningful ways and overwhelming graduate from our program with 4 years. Individual faculty members ensure that minority students are aware of the resources available to support them and assist them in obtaining these resources by making phone calls to the appropriate campus entities, writing letters of recommendations and providing opportunities for these students to work in our research labs. We work with programs like the Louis Stokes Alliances for Minority Participation (LSAMP) Program, aimed at increasing the quality and quantity of students successfully completing science, technology, engineering and mathematics (STEM) baccalaureate degree programs, and increasing the number of students interested in, academically qualified for and matriculated into programs of graduate study.

8. International experience *is growing increasingly important in the lives of undergraduates. Does your department build into its program, an emphasis on opportunities for international exposure, study abroad, and interchange with students from other countries on our campus?*

Response: Students are encouraged to study abroad, and the spring of their junior year is purposely open so that students can participate in an international experience that appeals to them. Approximately 9% of our students participate in study-abroad programs each year.

9. Co-curricular engagement is often key to undergraduate student success. Does your department encourage students to connect to non-profit organization, community groups, etc.

Response: We do not have a formal program organized through the department, although individual students have donated their time and expertise to such causes in the local community. Approximately 62% of our graduating seniors report that they perform some type of Community service or volunteer work (2013 UMass-Amherst Graduating Senior Survey Departmental Results). This ranks significantly above the UMass departmental average of 55%.

Improving Undergraduate Retention and Graduation Rates

At the end of 2013 school year the department of microbiology had 160 unduplicated undergrad majors. The total number of undergraduate degrees awarded in Microbiology have increased from 29 in 2006 to 44 in 2014.

Our undergraduate population is made up of mostly students who transfer from other majors into microbiology. This is the case because microbiology is not a major that is well known or highlighted while students are in high school. Most students who are interested in the life sciences or pre-med will declare Biology as their major until they arrive on our campus and realize their set of options through taking classes, interacting with faculty and talking with peers. Between 2006 and 2013 we have averaged only 15 incoming undergraduate freshman students who declare microbiology as a major. In 2013 we had 19 incoming microbiology freshman students. However, once these students transfer into microbiology, mainly in their sophomore year, the retention rate is approximately 96 to 98%. This high retention rate is due mainly to the keen interest in student success that has become a part of the fabric of the microbiology program as evidenced through an emphasis on high quality instruction, consistent advising, access to teaching faculty and the opportunity for independent research.

Over 94% of our graduating seniors report that they are satisfied with the access they have to faculty, the quality of the instruction they receive and access to the classes they want to take. Over 97% said that they were satisfied with the undergraduate advising that they received (85.8% of these were very satisfied). The high retention and satisfaction rates are partially due to the fact that over 82% of our graduating seniors report that they participated in a research project with faculty outside of course requirements. A major advantage of participation in undergraduate research is that students get an opportunity to establish a relationship with a faculty mentor. This type of working relationship has been shown to increase retention and graduation rates. Students benefit from the wisdom, knowledge and experience of a mentor, while faculty members benefit from the questions students ask, the discoveries they make and the energy they bring to the projects being investigated in the lab. This type of experience not only helps our students prepare for graduate school and the workforce but also provide them with a sense of community and belonging in the department. As a bonus, our student's career goals are usually better clarified after they participate in research.

The major weakness we have is the inability to accommodate all the students who desire to have laboratory experience. With increasing enrollment each year this will probably be an ongoing challenge. Microbiology has also not actively recruited students over the past 10 years.

This is due mainly to class size constraints even as the department adds multiple sections to lab and even lecture classes to accommodate the growing demand for the courses we teach. In addition, students in pre-health fields such as physician's assistant, are increasingly seeking opportunities to take courses in microbiology to meet the requirements at leading schools. This has resulted in a strain on resources and a rush on classes. It is clear that we will have to continue to evaluate strategies to better deal with these issues in the near future.

Another area of weakness is the lack of modern teaching laboratories, equipment and supplies for students to use. While the teaching lab staff and faculty have worked miracles in maintaining the aging equipment and making do with the cramped space and outdated infrastructure, it is clear that neither faculty nor students are able to operate at their best potential. An investment in the renovation of the microbiology teaching labs and acquisition of even a subset of the much needed equipment will go a long way in helping our department become the main destination of choice for students wanting to study microbiology, as well as for those taking service courses to fulfill the requirements for related life science majors.