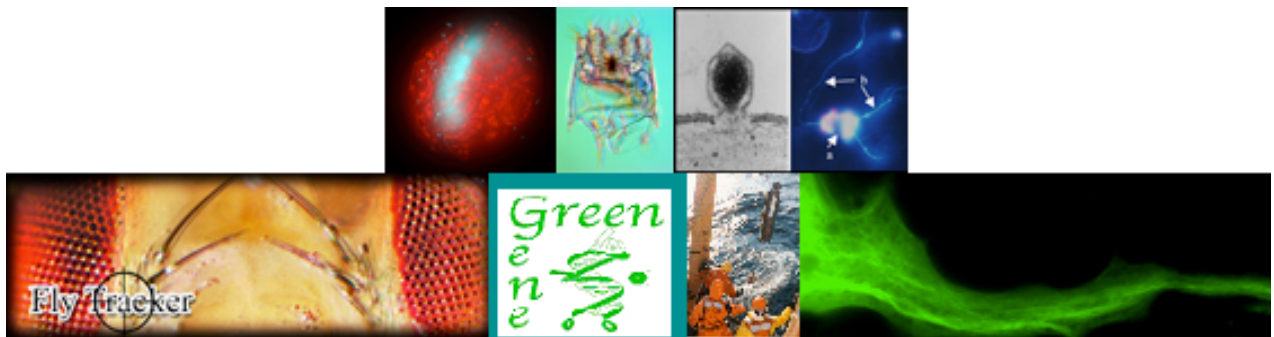


**UMass Lowell
Biology**

University of Massachusetts Lowell Department of Biological Sciences

BIOLOGY GRADUATE STUDENT MANUAL



Edition (Fall 2010/Spring 2011)

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UNIVERSITY OF MASSACHUSETTS LOWELL
GRADUATE ACADEMIC CALENDAR
FALL 2010

TBD	Graduate Walk-in Registration
September 1	First day of classes for Fall 2010
September 6	Labor Day (University Closed)
September 15	Last day for refund of tuition & fees Last day for late registration/Enrollment changes
September 16	Last day to submit Advanced Degree Clearance Forms for Summer degree
October 11	Columbus Day (University Closed)
October 12	Monday Class Schedule (Does not apply to the Graduate School of Education)
November 08	Advising/Spring registration begins iSiS system open for enrolled students
November 10	Thursday Class Schedule (Does not apply to the Graduate School of Education)
November 11	Veterans Day Observed (University Closed)
November 23	Last day for graduate students to turn in completed work to instructor for summer and spring incomplete grades
November 25-28	Thanksgiving recess
December 3	Last day to drop classes with "W" Last day to submit Graduate Degree Clearance Forms for Fall Degree
December 10	Last day of Fall Semester classes Last day for faculty to file grade change forms with Registrar's Office for incomplete grades for spring and summer courses
December 13-21	Fall Semester Exams

UNIVERSITY OF MASSACHUSETTS LOWELL
GRADUATE ACADEMIC CALENDAR
SPRING 2011

TBD	Graduate Walk-in Registration 3-7 pm location to be announced
January 24	First day of classes for Spring 2011
February 4	Last day for refund of Tuition & Fees Last day for late registration/Enrollment changes
February 21	President's Day (University closed)
March 13-20	Spring break
April 4	Fall registration begins iSiS system open for enrolled students
April 13	Last day for graduate students to turn in completed work to instructor for Fall incomplete courses Last day to submit Graduate Degree Clearance Forms for Spring Degree
April 18	Patriots Day (University closed)
April 28	Friday Class Schedule (Does not apply to Graduate School of Education)
April 29	University Day (No Classes). Offices will remain open.
May 2	Last day to drop classes with "W"
May 09	Last day of Spring Semester classes Last day for faculty to submit grade change for Fall incompletes.
May 11-19	Spring Semester Exams
May 28	University Commencement



DEPARTMENT OF BIOLOGICAL SCIENCES

The Department of Biological Sciences prepares students for a variety of careers that contribute to society's understanding and advancement of health and environmental issues. Students majoring in biological sciences go on to become researchers, doctors and educators.

After receiving their Bachelor's degree, many will be employed by academic and industrial research institutions, or involved in bio-medical research or environmental field studies. Some become science educators; others choose to continue their education in professional (medical, veterinary, dental) schools, or complete requirements for the M.S. or Ph.D. in graduate school. Integration of their science knowledge, with that derived from core courses in the humanities and social sciences, will prepare our graduates to better understand the complex scientific and ethical issues which will arise as advances continue to be made in contemporary biology.

The department is committed to educating its students about diverse topics pertaining to biology and their practical and ethical impact on the world we live in.

For more information about our programs, please contact:

Dr. Mark Hines
Chair, Department of Biological Sciences
One University Ave.
Lowell, MA 01854
978-934-2860

Dr. Jerry Hojnacki
Graduate Coordinator
978-934-2370

also see the department webpage at:

http://www.uml.edu/stage/college/arts_sciences/biology/

WHO'S WHO IN THE BIOLOGICAL SCIENCES**FACULTY**

Professor	Research Area	Office	Phone
Dr. Mark Hines (Chair)	Microbial Biogeochemistry	OS 414	x2867
Dr. Susan J. Braunhut	Tissue Regeneration, Cancer Therapy, Vascular Biology	OS 415B	x2876
Dr. Dave Eberiel (Emeritus)	Pre-Medical, Pre-Dental Pre-Vet Advisor	OS 523	x2866
Dr. Deane L. Falcone	Plant Biochemistry, Plant Stress	OS 518	x2678
Dr. Peter Gaines	Molecular & Developmental Biology	OS 515	x2894
Dr. Jessica Garb	Molecular Evolution and Systematic Biology	OS 520	x2899
Dr. Michael V. Graves	Molecular Biology, Virology	OS 415A	x2887
Dr. Garth Hall	Neurobiology Neurodegeneration	OS 519	x2893
Dr. Rick Hochberg	Invertebrate Zoology Marine Biology	OS 413A	x2885
Dr. Jerome Hojnacki	Atherosclerosis, Lipid Biochemistry, Nutrition	OS 517	x2370
Dr. Ezequiel Rivera	Cell and Plant Biology	OS 522	x2868
Dr. Juliette Rooney-Varga	Microbial Ecology	OS 524	x4715
Dr. Thomas Shea	Cellular Neurobiology Alzheimer's Disease	OS 513	x2881

Dr. Naomi Wernick	Teaching Faculty	TBA	TBA
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TECHNICAL AND ADMINISTRATIVE STAFF

Name	Title	Office Phone Ext.	
Rizvana Bhaiwala	Professional Technician	OS 601A	x2882
Gail Skinner-Brassard	Professional Technician	OS 521	x2879
Alex Cepeda	ORS Facility Manager	OS 618	x2830
Karen (Chur) Thompson	Professional Technician	OS 516	x2865
Danielle White	Staff Assistant	OS 414	x2864

ADMINISTRATIVE STAFF

Graduate Admissions Office

For help with issues, contact:

Linda Southworth (Director of Graduate Admissions)	x2373
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Registrar's Office

Angela Claude – manages transfer courses for all students	x2379
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Leah Rigs – Answers graduate questions, graduate clearance forms	x2391
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International Student and Scholars Office

Maria Conley – International Student Advisor	x2386
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Laura Edwards – Student Exchange Visitor Information	x2383
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Academic Expectations of Graduate Students



You are in a unique position as a graduate student at UML. Undergraduate students look up to you for both knowledge and advice, and faculty members have higher expectations of you compared to undergraduate students. Therefore, graduate students are expected to exercise elevated professional and ethical conduct during their academic program. We expect graduate students to maintain integrity in learning, independent scholarship, and professional philosophy. Below, we outline specific academic expectations for graduate students enrolled in the M.S. and Ph.D. program at UML.

1. Show up on the first day of classes. Missing any classes at the beginning of a semester is unacceptable unless an emergency warrants the absence. You must notify the appropriate faculty member of any scheduled absences well ahead of time. In the event that you miss the first class meeting of the semester, you are **not** guaranteed enrollment in the class, and you may be dropped from the class at the professor's discretion.

2. Show up for class prepared and on time. You are, in a sense, a role model for the undergraduate students, and arriving unprepared and/or late for any class is unprofessional and unacceptable.

3. Graduate students must earn a grade of B (3.0) or better. No graduate degree will be awarded to a student whose cumulative average for course work is below 3.0. Remember, as a graduate student, you are held to higher expectations by the faculty. A course grade below a 3.0 reflects poorly on your academic achievements, and may be viewed as unacceptable by a future graduate program or employer.

4. All international students on F-1 or J-1 visas must register as full-time students (9 credits) each semester until their degree requirements are completed. Any variance from this policy must be approved by the Dean of the Graduate School.

5. Demonstrate professional behavior in all of your interactions with other students, (graduate and undergraduate), faculty and staff.

6. Schedule meetings with faculty members in advance. Make arrangements via phone or email. Do not show up to a faculty or staff member's office unannounced and expect them to drop their current schedule of events to accommodate your needs. Understand that faculty and staff members have the right to allocate their own

professional time and have many commitments throughout the course of their day.

7. A Leave of Absence should be scheduled ahead of time and brought to the attention of the faculty advisor and/or course professor immediately. Graduate students should inform the appropriate faculty member of the need for the leave of absence and the expected date of return.

8. Graduate students are expected to fulfill the requirements of their program in a timely manner. See your advisor on a regular basis to ensure that you are enrolled in the appropriate courses and following the recommended guidelines for your academic program.

Policies for Teaching Assistants and Research Assistants

1. No teaching/research assistantship may be awarded to a graduate student with incompletes, F's, or U's on his or her transcript.

2. No teaching/research assistantship may be awarded to a graduate student with a cumulative grade point average below 3.0 on the official transcript.

3. No university-funded teaching/research assistantship may be awarded to a master's degree candidate if he or she has completed the total number of credits required for his or her program.

4. Level 3 teaching/research assistantships may only be awarded to graduate students who have reached doctoral candidacy (i.e. completed all course work, oral/written and language examinations) and are enrolled in dissertation research.

5. Teaching assistantships are paid by the University and TAs are expected to behave in a manner appropriate for university instructors. TAs are expected to complete all assignments on time including creating lectures, quizzes and exams, and the grading of those materials. TAs are expected to show up on time for all teaching periods and to be completely prepared. TAs must post office hours and must be available at those times. In addition, TAs must respond to student phone calls and emails in a timely manner. The TA assignment is a priority over all other activities. TA graduate research and outside employment are not more important than the TA assignment. TAs will be evaluated twice per semester. If a TA performance is acceptable then only one evaluation will be submitted at the end of the semester. If performance is sub-par, then a mid semester evaluation will be submitted and will act as the beginning of a probationary period. If one or two negative evaluations are submitted, then a TA may

lose their appointment. The Department takes these positions very seriously since the education of students is at stake. Poor performance will not be tolerated.

Research Assistantships Funded by Principal Investigators

Research assistantships are available through special arrangements with individual research advisors. Individuals interested in research assistantships should contact departmental faculty members concerning the availability of this form of financial aid. It should be noted that granting of such assistantships is at the discretion of individual faculty each of whom may have their own specific requirements that students must fulfill. Not every student working in a given laboratory may have support.

Students who receive teaching or research assistantships must be matriculated and full-time (minimum of 9 credits/semester) and must maintain a minimum 3.0 GPA.

RAs will be evaluated each semester similarly to those submitted for TAs. RAs are at risk of losing their RA if their performance evaluations are poor.



General Requirements for Admission to Graduate Study

1. The applicant must show official evidence of having earned a baccalaureate degree or its U.S. equivalent from an accredited college or university. If an international transcript does not adequately demonstrate that an applicant has the equivalent of an American bachelor's or master's degree, the Graduate School will require such verification by an independent service such as the Center for Educational Documentation, Boston, MA (617-338-7171).
2. The degree must have been earned with a satisfactory scholastic average to demonstrate that the applicant has had adequate preparation for the field in which graduate studies are to be undertaken.
3. The applicant must have obtained a satisfactory score on the appropriate entrance examination required for admission by the program or department to which admission is sought. The official score report must be submitted; a photocopy of the examinee's report is unacceptable. Unless otherwise stated under a specific program description, the required examination is the Graduate Record Examination General Test.
4. The Commonwealth of Massachusetts requires that all full-time graduate students (9 or more credits) must be immunized against measles, mumps, rubella, tetanus, and diphtheria. In addition, all students in programs in the health professions, regardless of age or enrollment status, must show proof of immunization. Students will not be permitted to register for courses at the University unless proof of immunization has been sent directly to the Director of Health Services, University of Massachusetts Lowell, Lowell, MA 01854 (978-934-4991).

IMPORTANT: *The rules, regulations, and policies delineated by the Graduate School constitute only the minimum requirements for admission, retention, and graduation. Each department may have additional requirements mandated by the unique nature of its programs. It is the responsibility of the graduate student to be aware of the minimum requirements of the Graduate School and, in addition, to fulfill the special requirements of the particular program in which he or she is enrolled.*

Application Procedure for Graduate School at UML

Application procedures, deadlines and materials for admission may be found on the web at the following address:

http://www.uml.edu/catalog/graduate/admissions/Application_Procedure.htm

Department of Biological Sciences: Admission Requirements

All graduate students must have achieved grades of B or Better in the following core undergraduate courses*:

- a. Principles of Biology
- b. Genetics
- c. Biochemistry
- d. One upper level biology course.

*These courses must be taken prior to admission if they were not a requirement of the former undergraduate degree (e.g., Engineering).

International Students

International students must have graduated overall in either the “First Class with Distinction” or “First Class” (the equivalent of our 4 and 3 point GPA).

Graduate Record Examination (GRE)

All students should have a combined GRE of 1100 minimum. A higher quantitative score can compensate for a lower verbal score. Each part needs to be ~500 or higher. No acceptances of 400 or below on any part. Most of our students have 600+ on the quantitative. Test scores are criteria for admission. Achieving a minimum score does not guarantee admission.

TOEFL

We have been accepting the paper TOEFL (TOEFL CBT). The last administration of TOEFL CBT was on September 30, 2006. The TOEFL program is phasing in the Internet-based version of the TOEFL test - the TOEFL® iBT. In areas where the TOEFL iBT is not yet available, the paper-based version of the TOEFL test will be available on a limited basis to supplement the TOEFL iBT test center network. An acceptable TOEFL score depends entirely on the requirements of each institution. There is no specific passing or failing score.

BS/MS PROGRAM (Plus 1 MS)

An accelerated five-year course of study leading to the BS and MS degrees in Biological Sciences is available to full-time students who have a grade-point average of 3.0 or above at the end of their junior year. Interested students, after evaluation and acceptance by the Department's graduate selection committee, meet with the graduate coordinator to design a plan for completion of requirements for both degrees within a five-year time frame. Up to 6 credits of graduate courses (500 level or higher) may be used by a student in the BS/MS program for both graduate and undergraduate degrees. **Graduate Record Exam scores are not required.**

The objective of these programs is to foster critical thinking and to develop skills needed for independent laboratory study. This is accomplished, in part, by offering advanced lecture, seminar and laboratory courses. While it is possible to complete MS requirements without the thesis or project option it is this latter activity that most distinguishes graduate from undergraduate students. All full-time M.S. degree students are, therefore, strongly urged to elect thesis or project options. The Department of Biological Sciences also collaborates with the Department of Chemistry in offering the Ph.D. Option in Biochemistry. Laboratory thesis research is a required component of this program.

Eligibility

1. Only students who have earned a minimum of **75 credits** in the undergraduate Biology program at UML are eligible to apply for the BS/MS program. Credits from other institutions (i.e., transfer credits) do not count towards the 75 credit total.
2. Up to 6 credits of graduate coursework (at the 500 level and above) with grades of B or better can be used toward the BS/MS degree (i.e., an undergraduate student who has taken a 500 level class and received a B or better can use this credit toward both their BS/MS degree).
3. Students from other departments at UML may be accepted into the BS/MS Program if they have completed acceptable baccalaureate Biology or comparable course work.
 - a. At minimum, a student from another department must take the following courses at UML to be eligible for the BS/MS degree: Principles of Biology I,II; Genetics; Biochemistry; and Organic Chemistry I, II.
 - b. These students may also choose to apply graduate credits towards their BS/MS degree (see criterion 2 above).
 - c. Any deficiencies in the student's academic record will be noted by the Admissions committee. A student may still be accepted into the program, i.e., "Accepted with conditions." Additional coursework may be required.

GRADUATE PROGRAMS IN BIOLOGICAL SCIENCES

Master of Science

The objective of this program is to foster critical thinking and to develop skills needed for independent laboratory study. This is accomplished, in part, by offering advanced lecture, seminar, and laboratory courses. There are two options available for the M.S. degree: **M.S. in Biology** and **M.S. in Biology-Biotechnology** (described on following page).

While it is possible to complete M.S. requirements without the thesis or project option, it is the latter activities that most distinguish graduate from undergraduate students. All full-time M.S. degree students are, therefore, *strongly urged* to elect thesis or project options.

If you have specific questions about our Master's Program, contact Dr. Jerome Hojnacki, our Graduate Coordinator (x2885, Jerome_Hojnacki@uml.edu)

General Requirements for the Master's Degree

To be recommended for a master's degree, a candidate must satisfy all requirements of the Graduate School and the specific requirements of the department in which he or she is enrolled. The requirements of the Graduate School are listed below.

A candidate for the master's degree must complete the following within five years of matriculation in order to receive the degree:

1. A course of study designed by the department in which he or she is enrolled must be completed and approved by the Graduate School. The course of study must have a minimum of 30 credit hours of graduate work including, where applicable, a thesis or project in the student's chosen field.
2. A student must successfully pass an oral or written examination on his or her complete master's program if required by the department.
3. Satisfactory grades in all subjects offered for the degree must be earned.
4. All financial obligations, including tuition, fees, and expenses, must be satisfied as evidenced by completion and submission of a signed Graduate Degree Clearance form to the Graduate School Office.

Course Requirements for the M.S. in Biology

1. Required Courses:

- A. Biochemistry (81.519)
- B. Professional Communication in Science and Technology (81.604)

2. Project/Thesis Credits

- A. Master's Project Option: 6 credits project
- B. Master's Thesis Option: 12 credits thesis

3. Course Electives:

- A. Master's Project Option: 18 credits of 81.5XX
- B. Master's Thesis Option: 12 credits of 81.5XX

Nine credits of approved transfer credits or nine credits of relevant graduate course work (500 level) from other departments within the University can apply. A 3.0 GPA is required at completion of all course work.

Course Requirements for the M.S. in Biology-Biotechnology Option

1. Required Courses (24 credits):

- A. Biochemistry plus Biochemistry Techniques (81.519/521)
- B. Professional Communication in Science and Technology (81.604)
- C. Immunology plus Laboratory (81.593/595)
- D. Cell Culture (81.576)
- E. Cell Biology (81.452) or Stem Cell Biology (81.560)
- F. Molecular Biology plus Laboratory (81.567/569).

2. Project/Thesis Credits:

- A. Master's Project Option: 6 credits project
- B. Master's Thesis Option: 6-12 credits thesis

3. Course Electives (if no project or thesis is completed):

- A. 6 credits of 81.5XX

Nine credits of approved transfer credits or nine credits of relevant graduate course work (500 level) from other departments within the University can apply. A 3.0 GPA is required at completion of all course work.

Research Options for the Master's Degree

A student can opt to complete a master's **Thesis** or a **Project**. A proposal must be approved by the department in which the student is enrolled and the final project or thesis must be of graduate level quality. The following pages detail these two options.



Masters Thesis Option

The Masters Thesis Option is a research-intensive program in which the student develops, plans, conducts, analyzes, and presents an independent, original project, under the supervision of a Principal Investigator (PI). This option is meant for self-motivated students who wish to excel in science and gain experience in all aspects of the scientific process, from becoming an expert in the scientific literature in their research area to analyzing and presenting their own work. Students gain valuable first-hand experience that will provide them with a solid foundation in the scientific research process and that is qualitatively different from coursework. Their training differs from students in the non-thesis options and, ideally, results in the publication of at least one manuscript in a peer-reviewed scientific journal. Because their program is research-intensive, they have a distinct advantage when moving on to doctoral programs or employment in scientific research-based fields. However, in order to succeed in their Masters thesis program, students must be self-motivated and committed to their project. Thesis students are given priority if funds for student support (TA or RA) are available, but do not necessarily receive funding. Students are strongly discouraged from choosing the Thesis Option solely for financial reasons, as the two are not necessarily linked.

Applying to conduct Thesis research

Acceptance to the Biological Sciences Masters Program does not ensure acceptance into a program of directed Thesis research. Because of the rigorous nature of the Thesis program, students hoping to pursue a Masters Thesis are encouraged to submit a transcript, their GREs, and a letter of intent to their prospective thesis advisor explaining why they want to pursue a thesis project. Students are also encouraged to enroll in Special Problems in Biology, or a similar course, and in order to get credit for writing a thesis proposal. This course provides a forum for the student to get credit for exploring the possibility of a thesis project prior to committing fully to the project. If the student receives a B or below in this course, the Thesis option may not be appropriate for them.

Expectations/Milestones for Thesis students

I. Coursework

- Students are encouraged to focus their coursework (electives) on areas related to their research and professional goals. As much coursework as possible should be completed in their first two

semesters, so that more time is available to focus on their Thesis research in their final semesters.

- Because of the time required for conducting independent research, students are encouraged to enroll for the maximum number of Thesis Research credits (12 credits). If they make satisfactory progress on their Thesis while, students will receive a PR for “Progress” (but not credits), which is automatically converted to an S for “Satisfactory” when their completed thesis is submitted to the University. The student does not obtain these credits until the Thesis is submitted and these credits **cannot** be converted into any other type of credits (e.g., Project or Practicum) in the event that a thesis is not completed.

II. Thesis Proposal

During the first semester that a student has chosen to conduct a Thesis, students should meet with their Thesis advisor to develop an outline for their research project. They should spend a significant amount of time becoming familiar with the current scientific literature in their research area (for example, reading 5-10 papers per week) and writing a Research Proposal. The Research Proposal should be 10-15 pages (double-spaced, 12 point Times font, 1” margins, not including the Project Summary and Literature Cited Sections). The following format should be used:

- Project Summary (< 1 page; 1-3 paragraphs)
- Introduction and Background (~5-7 pages)
- Review of the current scientific literature and rationale for the proposed project
- Objectives and Hypotheses (<1 page)
- Experimental Approach (~4-6 pages)
- Expected Benefits (<1 page)
- Literature Cited
 - Students are expected to rely on at least 25 primary literature sources for their Thesis proposal.

The proposal should be submitted to the Thesis Advisor for comments and corrections, and returned to the student within 2 weeks. Once the suggestions have been incorporated (or successfully argued against) and the Thesis advisor has approved of the Proposal, the student should submit their proposal to their Committee and allow them at least two weeks to review it, prior to their first Committee meeting.

Students are strongly encouraged to submit their proposal to external or internal grant programs. In addition to the possibility of obtaining a stipend or other financial award, learning how to submit a proposal is an excellent

experience for students and may lead to prestigious recognition of the student's work.

III. Selection of a Thesis Committee

The Thesis Committee consists of three faculty members: the Thesis Advisor and two faculty members with expertise in areas related to the students' project or professional interests. The student may have one Committee member from another department or institution. The Committee serves several purposes:

- To provide advice and expertise to the student in order to aid them in the pursuit of their Thesis Research project.
- To provide balance to and review of the Thesis research, including the somewhat subjective decision of when the student has completed enough work to fairly constitute a complete Thesis.

IV. Proposal Presentation to the Committee

At least two weeks after submitting their Proposal to their Committee members, the student should present their proposed work to their Committee. This presentation can be open to the public. It should be noted that given the busy schedules of faculty members and students, students should schedule their meeting (i.e., contact Committee members and find a time and room that is available for the meeting) as soon as their proposal is approved by their advisor. The student should put together a PowerPoint presentation of their proposed research and schedule a 'dry run' with their Thesis advisor before presenting it to their Committee. Students are strongly encouraged to practice their presentation several times in front of friends/fellow students before meeting with their Advisor.

V. Active Research

Students are likely to begin their research before their Committee meeting and to be actively engaged in their project by the time their meeting has been held. Research is exciting and interesting, but can also be difficult and discouraging because success usually comes only after many failures. This facet of research is to be expected and, therefore, students should plan to spend **more time than they expect** in the lab conducting research. While time spent in the lab does not ensure successful experiments, it makes them possible. When not engaged in coursework, students should plan to spend **at least** 40-hours/week conducting lab research. With coursework, writing, and data analysis, a schedule of 45-55 hours/week to include all of these activities is realistic. If financial considerations require students to be employed (outside of the lab) during their research project, they should realize that it is entirely likely that they will not complete their Masters degree within two years. In addition, students should expect to continue their research activities

at times when the university is not in session (*i.e.* winter, spring, and summer breaks). Research does not follow an academic calendar and it is unrealistic to expect success if one is going to put their project on hold for several weeks two or three times a year. Furthermore, it is at these times, when classes are not in session, that a student will have more free time to focus on their research activities without the added distraction of course work. Although the general outline of a 30 credit Masters degree program consists of four semesters of study over two academic years, a student should be aware that inclusion of a thesis **may increase** the time needed to complete the degree.

Important: *Students should plan to meet about once per week (or more) with their Thesis advisor during active research in order to consult with them, seek advice on research problems, etc.*

VI. Data analysis

Like experimental work, data analysis typically takes more time than students (or PIs!) expect. Ideally, data analysis is done as results are generated. A useful goal is to generate publishable figures from experimental data as soon as the results are available. Data analysis and making figures is more efficient and easier if it is done when the results are fresh and having the figures available for interpretation can enlighten subsequent experimental work. The student should work closely with their Thesis advisor during data analysis.

VII. Presentation of project

Students are expected to present their results at the *University Annual Student Research Symposium*. In addition, they are encouraged to present at regional or national meetings. Abstracts and presentations submitted to such meetings must be approved by the Thesis advisor.

VIII. Writing the Thesis

The ultimate goal of research is publication and dissemination of results. For a Thesis project, the goal is that at least one manuscript be submitted to a peer-reviewed scientific journal. In order to further this goal, the following format for writing a Thesis is encouraged:

- Abstract (< 1 page; essentially the same as the abstract for the manuscript to be submitted)
- Literature review chapter, which is an expansion of background section of Proposal; should be 12-20 pages and synthesize the current research related to the student's work. The student should rely on at least 30 primary literature sources for their review.
- Chapter(s) describing their project in the format of a scientific paper, to be submitted to a journal without major changes.

- The student should allow sufficient time for their advisor to edit their Thesis (up to 2 weeks for each draft or portion) and, once a draft has been approved by their advisor, for their Committee to review the Thesis prior to their defense (two to three weeks).
- Review the UML guidelines for writing and submitting Theses.

IX. Thesis Presentation and Defense

The Thesis Defense is the culmination of a student's Thesis program. *The Thesis Presentation is a public event and must be announced to the University community.* The Defense typically follows the presentation and offers an opportunity for Thesis Committee members to address any questions or concerns about the Thesis and for the student to demonstrate their expertise in their chosen area of research.

Masters Project Option

This option is for students who wish to gain *some* hands-on research experience during their graduate program, but *do not want* to complete a Thesis. Students choosing this option should meet with their advisor and outline clear and defined expectations of their work on a semester-by-semester basis. It should be emphasized that project research credit should be treated as elective course work for which the student is paying tuition for the credits. Since such projects do not require the commitment necessary to complete a thesis, students *should not expect to receive* TA/RA support for such work.

Procedure for students accepted into a Master's program who decide to continue on for the doctorate (Ph. D) but want to first complete their master's degree.

1. The student must complete all required courses, compile a 3.0 grade point average, and successfully defend his/her thesis, if required.
2. The student must complete the Graduate School clearance process for the master's degree.
3. A student is prohibited from enrolling in doctoral research until he or she has completed the clearance process for the master's degree.
4. The student must then apply to the doctoral program by completing the standard application process.
5. Official admission into a doctoral program and receipt of a letter of acceptance are contingent upon completion of the clearance process for the master's degree.

Professional Science Masters Degree

The Department of Biological Sciences offers four Professional Science Master's (PSM) Degree options: **Applied Biotechnology, Biosafety, Environmental Biotechnology, and Project Management for Life Sciences**. PSM's maintain a strong science core while incorporating professional communication (oral, written) skills, multidisciplinary training, management courses, and a professional internship into the curriculum. Applicants to PSM's include individuals with baccalaureate degrees currently employed at science companies, as well as new bachelor's degree recipients from the United States and abroad who desire to combine in-depth science training with workplace skills important for their career advancement

General Requirements for the PSM Degree

The curriculum requires students to complete: 2 core courses (Biochemistry I and Professional Communication in Science and Technology) common to all options; 1-2 core courses specific to the option that allow for specialization; additional electives within and outside the Biology Department that permit flexibility in meeting the students' employment needs and interests; 2 advanced courses specific to the option; and a 1 credit Professional Internship that can be completed during a summer session or either academic semesters. The total minimum credit requirement for each option is 37.

Course Requirements for each PSM Option

I. Applied Biotechnology Option

1. Core Biology Requirements

66.635 Project Management (College of Management)
 81.519 Biochemistry
 81.521 Biochemical Techniques
 81.542 Cell Biology or
 81.560 Stem Cell Biology
 81.576 Cell Culture
 81.567/569 Molecular Biology/Laboratory
 81.593/595 Immunology/Laboratory
 81.604 Professional Communication in Science and Technology

2. Additional Biology Courses (3 credits minimum)

81.541 Topics in Cell Biology
 81.540 Advances in Plant Biology
 81.582 Cancer Biology
 81.542 Cell Biology
 81.580 Developmental Biology
 81.504 Environmental Microbiology
 81.590 Human Neurobiology

81.560 Stem Cell Biology
81.572 Virology

3. Advanced Biotechnology/Interdisciplinary Courses (6 credits minimum)

92.586 Applied Statistics or
19.575 Introduction to Biostatistics and Epidemiology
10.586 Biotechnology Processing Project Laboratory
10.555 Biopharmaceutical GMP and Licensing
10.535 Cell and Microbe Cultivation
10.545 Isolation and Purification of Biotechnology Products

4. Professional Internship (1 credit)

II. Biosafety Option

1. Core Requirements

19.525 Recognition of Work Environment Hazards: Introduction to Occupational and Hygiene Ergonomics
19.573 Bioaerosols in Health and Biodefense
81.519 Biochemistry
81.604 Professional Communication in Science and Technology

2. Additional Biology Courses (18 credits, any Biology Graduate courses, 81.XXX)

3. Advanced Interdisciplinary Courses (choose 6 credits)

19.509 Hazardous Waste Worker Health
19.503 Toxicology and Health
95.504 Introduction to Radiological Sciences
19.515 Principles and Practices of Biological Safety
19.516 Laboratory Environmental Health and Safety

4. Professional Internship (1 credit)

III. Environmental Biotechnology Option

1. Core Requirements

92.586 Applied Statistics or
19.575 Introduction to Biostatistics and Epidemiology
81.504 Environmental Microbiology
81.519 Biochemistry
81.521 Biochemistry Techniques
81.567/569 Molecular Biology/Lab
81.604 Professional Communication in Science and Technology
66.635 Project Management (College of Management)

2. Advanced Interdisciplinary Courses (choose 14 credits)

14.567 Environmental Aquatic Chemistry
14.568 Environmental Fate and Transport
14.578 Biological Wastewater Treatment
14.595 Hazardous Waste Site Remediation
81.505/507 Bioinformatics Lecture/Lab
81.523 Biology of Global Change
81.540 Advances in Plant Biology
81.542 Cell Biology
81.557/559 Advanced Invertebrate Zoology Lecture/Lab
81.560 Stem Cell Biology
19.573 Bioaerosols in Health and Biodefense
81.576 Cell Culture

3. Professional Internship (1 credit)

IV. Project Management for Life Sciences Option

1. Core Requirements Project Management for Life Sciences Option

66.635 Project Management (College of Management)
81.519 Biochemistry
81.604 Professional Communication in Science and Technology

2. Additional Biology Courses (choose 21 credits) (any Graduate, 81.XXX)

3. Advanced Management Courses (choose 6 credits)

26.590 Survey of Intellectual Property
61.640 Financing Innovation and Technology Ventures
62.630 Market Research for Entrepreneurs
64.650 Innovation and Emerging Technologies
64.655 Corporate Entrepreneurship
64.681 New Venture Implementation
66.630 New Product Development
66.640 Building and Managing Entrepreneurial Teams
64.680 New Venture Planning

4. Professional Internship (1 credit)

Doctoral Research (Ph.D.) in the Biological Sciences



Ph.D. in Biomedical Engineering and Biotechnology

Overview. The Ph.D. Program in Biomedical Engineering and Biotechnology brings together expertise in related fields from the entire UMass system. The program emphasizes a multidisciplinary, team approach in course/seminar presentations across the campuses, laboratory rotations, and joint research projects prior to dissertation specialization.

The program is open to a wide range of baccalaureate degree recipients with strong quantitative skills and engineering/physical science, life/clinical science and related backgrounds. Applicants who have earned degrees in the following fields will be strong candidates for the program: biology, chemical engineering, chemistry, clinical laboratory science, computer science, electrical engineering, mathematics, mechanical engineering, physics, plastics engineering and polymer science. Applicants will be admitted directly into the Ph.D. Program. A Master's of Science degree will be awarded along the way to the doctorate after successful completion of 31 credits including a capstone project/directed study. Although individuals will apply to and conduct their dissertation research on one of the four UMass campuses, intercampus faculty mentoring of dissertations, enrollment in any of the nearly 300 relevant graduate courses across the campuses (on campus or online) and resource sharing/library access will be available and encouraged. The over 600 biotechnology, medical devices, pharmaceutical, and related companies in eastern Massachusetts create a resource that will be approached for research opportunities as well as career placement and graduate internship development.

To Apply

Interested students may apply for the Ph.D. program in Biomedical Engineering and Biotechnology to any ONE of the four participating UMass campuses, depending upon their research interests. Please review the database of faculty research to identify potential dissertation topics. Upon degree completion, all campuses will be listed on the student's diploma.

Admission Criteria

Students holding bachelor's degrees (or a U.S. equivalent from a foreign institution) and master's degree recipients with strong quantitative skills in the majors listed above may apply. Applicants should have an overall undergraduate grade point average of 3.0 or higher. Applicants must also have completed courses in calculus. Successful applicants will normally have had undergraduate coursework in statistics/experimental design and in life science/biomedical science.

The application package must include the following:

1. Official test score from the Graduate Record General Examination.
2. Official test score of the Test of English as a Foreign Language (TOEFL) (for international applicants and native speakers of languages other than English).
3. Official undergraduate and graduate transcripts.
4. Three letters of recommendation.
5. A personal statement indicating why the individual is applying to the program, and his or her research interests and career plans.
6. Early applications are encouraged and an interest in the need for financial aid (Teaching/Research Assistantships) should be indicated.

Early applications are encouraged and an interest in the need for financial aid (Teaching/Research Assistantships) should be indicated.

Faculty Advising by Campus

The following faculty members/program directors are available to answer any additional questions:

UMass Boston Dr. Manickam Sugumaran
617-2876698 manickam.sugumaran@umb.edu

UMass Dartmouth Dr. Alex Fowler 508-999-8542 afowler@umassd.edu; Dr.Sankha Bhowmick 508-999-8619 sbhowmick@umassd.edu; Dr.David Goodson508-999-8420 dgoodson@umassd.edu

UMass Lowell Dr. Bryan Buchholz 978-934-3241 Bryan_Buchholz@uml.edu

UMass Medical School Michael Cole, Director of Recruitment and Admission (508) 856-4779 Michael.Cole@umassmed.edu



Ph.D. in Biochemistry

Overview. The Department of Biological Sciences collaborates with the Department of Chemistry in offering the **Ph.D. Option in Biochemistry**. Laboratory thesis research is a required component of this program. If you have specific questions about our Doctoral Biochemistry Program, contact Dr. Thomas Shea (x2881, thomas_shea@uml.edu), our Biochemistry Doctoral Program Coordinator.

Doctoral Dissertation Research

In addition to the other requirements of the Graduate School, a candidate for a doctoral degree must complete an acceptable dissertation. The dissertation must satisfy the following criteria: 1) it should demonstrate the candidate's intellectual competence and maturity in the field of concentration; 2) it should make an original and valid contribution to knowledge; and 3) it should be an individual achievement and the product of independent research. Although doctoral dissertations may result from a project involving collaboration of several scholars, the individual contribution of each doctoral candidate must be substantial, clearly identifiable, and presented separately. The Committee will judge the completed dissertation in terms of the candidate's ability to review and make critical use of the literature; to formulate a problem, develop appropriate methodology, and work systematically toward a solution; and to summarize the material or data and draw conclusions from them. The writing should be of publishable quality.

Dissertation Committee

After a student has chosen an area of research and a research supervisor, a Dissertation Committee is selected by the student and his or her research advisor in accordance with the policy of the department. The Dissertation Committee shall consist of at least three members, one of whom is the research supervisor and at least two of whom shall be from the student's major department. An outside expert from industry or another university may be a member of the committee, but that individual must possess academic credentials which would qualify him or her to serve as a member of the University of Massachusetts Lowell faculty. The responsibilities of the Dissertation Committee shall be to:

1. Approve the research topic;
2. Supervise the progress of the dissertation;
3. Read, evaluate, and approve or disapprove of the written dissertation;
4. Hear, evaluate and approve or disapprove of the oral defense of the dissertation;
5. Report the completion of all dissertation requirements to the department and the Graduate School.

Dissertation Credits

If the graduate student requires the use of University resources to continue his or her dissertation but has completed the required number of credits for doctoral research, he or she may sign up for 3, 6, or 9 credits of Continuing Graduate Research (see General Regulations). (**Note: International students on F-1 or J-1 visas must be registered for a minimum of nine credits each semester**). Graduate students who have completed all the requirements except the writing and defense of the dissertation and who do not need to use university resources must register for Continued Matriculation (CM.601.201) and pay a fee each semester until they graduate.

Dissertation Preparation

Every graduate student who completes a dissertation is required to bear the cost of microfilming and of binding two copies of the manuscript for the University's files. Copywriting is optional and available for an additional fee.

Dissertation Defense

One week prior to the dissertation defense, announcements of the defense, listing the graduate student's name, dissertation title, and place and time of the defense, must be submitted to the chairperson of the department, the college dean, and the Graduate School dean for posting and distribution. The defense is open to the public.

Doctoral Degree Requirements

The doctoral degree is conferred upon graduate students who have met the requirements below.

1. The student must successfully complete the graduate courses in the major field and the number of course and dissertation credits required by the particular program.
2. If indicated, the language requirement specified by the major department must be satisfactorily completed.
3. A qualifying examination, oral and/or written, conducted by the major department, must be passed before any work is begun on the dissertation. If the student fails the qualifying examination he or she may, at the discretion of the department, be permitted a second and final opportunity. At this point, having completed steps 1 through 3, the student is admitted to candidacy for the doctorate.
4. A dissertation based upon the results of original research, and which is satisfactory to the Dissertation Committee of the major department, must be completed.
5. A final oral dissertation defense conducted by the Dissertation Committee, based primarily upon, but not necessarily limited to, the contents of the candidate's dissertation must be passed. The examination cannot be scheduled until all members of the Dissertation Committee have had seven working days in which

to read the dissertation. The oral examination is to be conducted by the Dissertation Committee, whose membership may be augmented by the non-voting faculty and representatives of the Graduate School. In order to pass the defense, the candidate may not receive more than one dissenting vote from the members of the Dissertation Committee.

6. All financial obligations (tuition, fees, and expenses) must be satisfied as evidenced by the completion and submission of a Graduate Degree Clearance form to the Graduate School Office.

Procedure for students accepted into a doctoral program who elect to instead obtain the master's degree and leave the university.

1. The student must file an Academic Petition requesting to be changed from the doctorate to the master's degree program.
2. The student's research advisor must submit to the Records Office, grade change forms withdrawing the student from doctoral dissertation and adding master's thesis for the appropriate number of credits.
3. The student must complete all required courses for the master's degree, compile a minimum 3.0 grade point average, successfully defend his/her thesis, and complete the clearance process at the Graduate School.
4. All graduate courses (and undergraduate course work used for graduate credit), whether taken for the original doctoral program or for the master's degree, will be included in the grade point average and listed under the master's degree program.

Graduate Certificates

Most graduate certificates are comprised of four courses (12 graduate credits) designed to provide specific knowledge and expertise vital to today's changing and complex needs in the work place. In most cases courses may be applied toward a degree program.

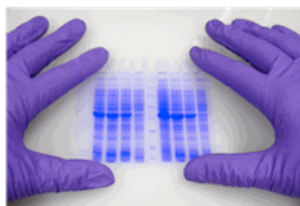


Requirements to Complete a Graduate Certificate

The four courses must be completed within a five year period with a minimum 3.0 grade point average, and with no more than 6 credits below B. Courses completed for one certificate may not be used for another certificate.

Certificate Application Process

Graduate certificate programs are designed for students holding a baccalaureate degree in a field related to the certificate program. The application fee is \$30 (In-State) and \$40 (Out-of-State) and no graduate record exam (GRE) is required.



1. Biotechnology and Bioprocessing

Biological Sciences and Chemical & Nuclear Engineering
Departments (Interdisciplinary)

Contact: Dr. Carl Lawton 978-934-3158, carl_lawton@uml.edu

The certificate is intended for students who hold a baccalaureate degree in science, engineering, health, or related disciplines. The courses emphasize biological and engineering principles, process concepts and the application of these to process design and improvement. Courses deliberately cross disciplinary boundaries and emphasize teamwork in a multidisciplinary environment as well as a result-oriented, document-driven approach to efficient project completion.

Required Courses:

10.535 Principles of Cell and Microbe Cultivation
10.545 Isolation and Purification of Biotech Products
10.555 Biopharmaceutical Regulatory Compliance
Plus One Approved Elective



2. Environmental Biotechnology

Biological Sciences, Chemistry, Civil & Environmental Engineering Departments (Interdisciplinary)

Contact: Dr. Juliette Rooney-Varga, 978-934-4715, juliette_ronneyvarga@uml.edu

Environmental biotechnology refers to the application of biological technologies to monitor, understand, and remediate environmental problems. This certificate combines courses that explore the ecological impact of anthropogenic environmental change with courses that provide training in current biological technologies that can be brought to bear on environmental problems. Recent advances in biotechnology are providing new avenues for investigating biologically mediated environmental processes, many of which were inaccessible using traditional approaches. New biological technologies are being developed to mitigate environmental problems. These include the biological remediation of pollutants, biological treatment of wastewater and drinking water, source tracking of microbial pathogens, and mitigation of toxic algal blooms. As environmental resources are increasingly strained and new biological technologies with the potential to improve our environment become available, the demand for professionals with training in environmental biotechnology will continue to increase.

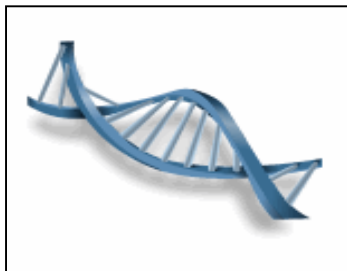
Required Courses (choose two):

81.504 Environmental Microbiology, 81.523 Biology of Global Change, 14.578 Biological Wastewater Treatment

Elective courses (choose six to eight credits):

84.580 Advanced Analytical Biochemistry, 84.514 Advanced Analytical Chemistry, 81.505/507 Bioinformatics (4 credits), 84.526 Chromatography, 14.567 Environmental Aquatic Chemistry, 14.568 Environmental Fate and Transport, 14.595 Hazardous Waste Site Remediation, 81.567 Molecular Biology, 81.569 Molecular Biology Laboratory (2 credits)

Total: 12-14 credits



3. Molecular & Cellular Biotechnology

Biological Sciences, Chemical Engineering Departments
(Interdisciplinary)

Contact: Dr. Michael Graves, 978-934-2887,
michael_graves@uml.edu

The certificate in Molecular and Cellular Biotechnology provides students with training in this growing field. Over the years, an ever increasing demand for manipulation of DNA and analysis in cultured cells in most aspects of funded research has created a growing need in the job market for trained professionals.

Required Courses:

81.567 & 81.569 Molecular Biology [Lecture/Lab], 81.576 Cell Culture

Elective courses (choose two):

81.519 Biochemistry, 81.542 Cell Biology, 81.545 Isolation & Purification of Biotech Products, 84.535 Cell & Microbe Cultivation, 81.541 Advanced Cell Biology

Thesis & Dissertation Related Questions

- 1. What is required for a student to change from a thesis to non-thesis option during his/her Masters degree program?** Any student (US or international) who wants to change his/her Masters program of study from thesis to non-thesis option must file an academic petition. If the student has taken thesis courses in previous semesters and earned a grade of "PR" (In Progress) those grades will be changed to "Ws" (Withdrawn) EXCEPT for international students.
- 2. What appears on the transcript of an international student who changes from a thesis to a non-thesis option? Can a grade of "NC" (No Credit) be granted for international students in these circumstances?** In the past, if a student earned a grade of "PR" for thesis work, the "PR" was changed to "U" (Unsatisfactory) on the student's transcript. In this circumstance, the "PR" is now changed to a "NC" (No Credit) on the student's transcript. The United States Bureau of Citizenship and Immigration Services (USCIS) requires that international graduate students be registered for a minimum of 9 credits per semester. When a student withdraws from classes s/he does not earn any credits, so the students cannot receive a "W." For an international student, this would mean that s/he is out of status and jeopardizes the student visa.
- 3. Why can't an international student be give an "S" (Satisfactory) for these courses?** A grade of "S" signifies that the student has satisfactorily completed the work. To grant a grade of "S" would raise legal issues as official records would indicate the completion of work that was never completed.
- 4. If a Masters or Doctoral student receives a "PR" for thesis or dissertation research, when and how is the the grade changed to an "S?"** When the signed Thesis/ Dissertation is turned into the library for binding.
- 5. What is needed to record the change in dissertation advisor?** To change advisors, the student must submit an academic petition with all required signatures of the coordinator and new dissertation advisor. The petition should clearly state that the previous thesis or dissertation project work is satisfactory and will carry over.
- 6. If a student changes his/her thesis or dissertation advisor and s/he received a "U" in previous thesis/dissertation research courses(s), does that carry over?** Yes, the previous research will carry over. The Graduate Coordinator determines whether previous work will or will not be counted towards the degree and notes this on the petition. The grade of "U" remains unless GPAC approves the grade change.

7. **What if the previous work does not carry over; does the “U” still appear on the transcript?** Yes.
8. **How does the Registrar’s office know who the advisor is?** Theses and dissertation advisors are recorded in ISIS. An academic petition is required to change advisors to ensure that records are accurate.
9. **What happens if there is no advisor listed for a student who is registered for thesis or dissertation research?** The Registrar’s office sends a list of students who have no advisor designated to the respective Graduate Coordinators. It is the Coordinator’s responsibility to return this information to the Registrar’s office. If an advisor is not assigned by the date listed on the letter sent out by the Registrar’s office, the Coordinator will be listed as the student’s advisor.



Graduation Information – Questions

What does a student need to do to apply for graduation? Applying for graduation is a multi-step process. Students first need to submit a “Request for Clearance Form.” Forms are available on the Registrar’s website at:

<http://www.uml.edu/admin/registrar/forms.html>. The Registrar checks the student’s records. If all is in order, the graduate degree clearance forms are sent with a letter indicating that the Clearance Forms must be received by a specific date (see Page 3) for Spring Graduation or Fall Graduation. If additional action is required (i.e., there is a problem with the number of credits towards the degree or the student’s GPA), the student receives a letter specifying what actions is required to graduate. The specified actions and the Graduate Degree Clearance Form must be received by the above-specified dates to graduate on time.