

Professional Science Master's (PSM) in Biotechnology Program Policy

Part I. Program history

A) Statement of purpose and expectations for graduate study

The Professional Science Master's in Biotechnology seeks to provide advanced, interdisciplinary didactic coursework in the life sciences, training in business applicable to scientific industry and experiential training in an industrial setting. Graduates will be poised to enter positions in diverse biotechnology industries.

B) Date of permanent status-

Provisional status, May 2010; Pending review for Permanent Status in 2015

C) Degrees offered Professional Science Master's (PSM) in Biotechnology

Part II. Admission

A) Admission requirements

Admission to the PSM in Biotechnology requires a prior scholastic index (grade point average on a 4.0 point scale) of at least 2.8 overall and 3.0 in the sciences. Those who meet the stated minimum requirements are not guaranteed admission, nor are those who fail to meet all those requirements necessarily precluded from admission if they offer other appropriate strengths.

There is also the possibility of entering the program after the successful completion of two courses of the Biological Sciences core with a grade of B or better (not B-) as a continuing education student and the achievement of an overall GPA of 3.0 in graduate classes attempted. Students may also be admitted after successful completion of the "Certificate in Biotechnology".

Applicants who are not U.S. citizens or permanent residents must complete the Test of English as a Foreign Language (TOEFL) with a score of 550 or higher on the paper-based test or 79 or higher on the Internet-based test. Previous education, training or residence in the U.S. does not exempt foreign nationals from these requirements. Requests for a waiver of the language test requirements (for example, for students from English-speaking countries outside of the U.S., or for foreign students who have a college degree from a U.S. institution) must be approved by the University of Delaware Office of Graduate Studies. Students who need further training in English prior to attending graduate school may apply for admission through the University of Delaware English Language Institute's Conditional Admission Program http://www.udel.edu/eli/programs_grad_cap.html.

The Graduate Record Examination is required of all applicants to the PSM in Biotechnology including those who have successfully completed the "Certificate in Biotechnology".

B) Prior degree requirements

BA or BS degree, preferably in a science or engineering discipline

C. Application deadlines.

Fall admission: Full consideration deadline: January 15th with rolling admission to continue until May 1st for foreign nationals and July 1st for US citizens/permanent residents.

Spring Admission: Full consideration deadline: October 1st with rolling admission to continue until November 1st for foreign nationals, December 15th for US citizens/permanent residents.

D. Special competencies needed

Applicants are required to have completed, at the undergraduate level, the following (or the equivalent): two years of biological sciences; one year of mathematics, preferably to include calculus and/or statistics; one year of college physics; one year of general chemistry; and one course in organic chemistry.

E. Admission categories.

Provisional admission may be offered with the stipulation that any deficiency in undergraduate training be made up (without graduate credit).

Students with TOEFL scores below the minimum required for admission may be considered for conditional admission if they enter the University of Delaware English Language Institute's academic English program.

F. Other documents required

Applications must also include three letters of recommendation from persons able to judge the applicant's ability to pursue graduate study, a resume or CV outlining work and/or academic experience in the field of biotechnology as well as an application essay consisting of the answers to the following questions:

1. What scientific research/employment experience have you had? Please be specific about the field of work and job responsibilities
2. What are your long-term professional objectives?
3. What specific attributes of our Department and the PSM in Biotechnology make you feel that this degree is appropriate to help you achieve your professional objectives?

G. University statement:

Admission to the PSM in Biotechnology program is competitive. Those who meet stated requirements are not guaranteed admission, nor are those who fail to meet all of those requirements necessarily precluded from admission if they offer other appropriate strengths.

Part III. Academic

A. Degree Requirements

1. List course requirements

The PSM in Biotechnology requires 42 credits of graduate level course work consisting of:

- 1) 12 credits of graduate level course work in the biological sciences comprised of at least one course in each of three of the five following areas: Molecular Biology, Genetics, Cell Biology, Physiology and Microbiology (see list below)
- 2) 9 credits of graduate level courses in fields related to biotechnology including bioinformatics, engineering, chemistry, agriculture, food safety, health sciences and statistics (see approved list below). One class must be from the category "statistics" unless the student has prior coursework in statistics. This determination is made by the program director.
- 3) 15 credits of ~~"Plus"~~ business/management courses, one from each of the following five categories: ~~ethics;~~ intellectual property/legal regulatory affairs; ~~S~~ Survey of business or public administration; ~~introductory accounting;~~ Leadership and organizations; ~~and~~ Project management/decision making (see below).

4) 6 credits of BISC 872, internship. The experiential portion of this class will in most cases be completed during a 7 month long, full time internship at a biotechnology company and be supervised jointly by a representative of the host company and a University of Delaware faculty member. Students pursuing the PSM degree who have significant prior bench experience will be encouraged to focus their capstone on improving a company's business/management plan or moving a newly developed product to market. Such projects could include; an analysis of how to bring a product to market, how to improve team interactions between company groups or how to scale up a research project to commercial scale. Students pursuing the PSM degree without prior experience working at the bench will be encouraged to focus their capstone on a specific scientific research question. Such projects could include: testing methods to increase production of recombinant proteins, testing the specificity of antibodies being developed or direct research product development. The capstone is assessed by the quality of the work performed at the internship and two written reports. The first is due within one month of the start of the internship and includes 1) a comprehensive description of the work environment including corporate history, corporate organizational structure including a description of the corporate focus, and a detailed description of the organization of the internship environment emphasizing its value to the company as a whole. This document should also include a plan of work outlining the background of the project, the learning objectives for the internship and goals to be accomplished developed in consultation with and approved by both the faculty and internship mentors. and 2) The second, a scholarly paper is due at the completion of the internship and should outline the objectives of internship, the value of these objectives to the company, what was accomplished on each objective, and recommendations for future work. This document should also discuss what skills the student learned/refined during the internship, what aspects of the PSM curricula were helpful for success in the internship and what additional knowledge would have been useful. Internships may be full-time or part-time depending on the schedule/needs of the student and employer. Internships may be paid or unpaid with the final grade based on the written reports and mentor evaluation. Students who are employed in the field of biotechnology are encouraged to develop their capstone projects at their place of employment as part of a professional development plan, however the expectation is that the "capstone" will be different than the student's normal job responsibilities.

The program will make every effort to assist students with identifying internship opportunities and negotiating internship plans. However, students bear significant responsibility in this process as well and failure to either identify an internship and/or formulate an acceptable internship plan by the end of the student's third semester of full time study (or completion of 33 credits of course work) is considered failure to make satisfactory progress towards degree.

Biological Sciences Core (at least 12 credits, four classes; must include classes from at least three of the five following categories)

Cell Biology	Credits
BISC 612- Advanced Cell Biology	3
BISC 625- Cancer Biology	3
BISC 671- Cellular and Molecular Immunology	4
PLSC635- Plant Developmental Biology	3
ANFS 671 Paradigms in Cell Signaling	<u>4</u>

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<u>BISC639 Developmental Neurobiology</u>	<u>3</u>	
<u>BISC690 Fundamentals of Pharmacology</u>	<u>3</u>	
<u>BMEG605 Princ of BME I: Molec and cell systems</u>	<u>3</u>	
Genetics	Credits	
BISC 654- Biochemical Genetics	3	
BISC 656- Evolutionary Genetics	3	
BISC 693- Human Genetics	3	
PLSC 636- Advanced Plant Genetics <u>Plant Genes and Genomes</u>	<u>3</u>	3
PLSC 605- Plant breeding	<u>3</u>	
Microbiology	Credits	
ANFS 635- Animal Virology	3	
ANFS 639- Food Microbiology	3	
BISC 641- Microbial ecology	<u>3</u>	
BISC 682- Bacterial Pathogens; molecular mechanisms	3	
BISC 645- Bacterial Evolution	<u>3</u>	
BISC 679- Virology	3	
PLSC 619- Soil Microbiology	4	
PLSC 629- Introduction to Fungi	4	
MAST 618- Marine microbial ecology	3	
<u>MAST625 Microbial Physiology and Diversity</u>	<u>3</u>	
Molecular Biology	Credits	
ANFS 670- Principles of Molecular Genetics	3	
BISC 602- Molecular Biology of Animal Cells	3	
BISC 665- Advanced Molecular Biology and Genetics	<u>3</u>	
CHEM642- Biochemistry II	3	
Physiology	Credits	
BISC 605- Advanced Mammalian Physiology	3 <u>4</u>	
BISC 615- Vertebrate Developmental Biology	3	
BISC 675- Cardiovascular Physiology	3	
KAAPHESC 651-Neurophysiological Basis of Human Movement 3		
HESC 654- Survey of Medical Physiology	<u>3</u>	
<u>BISC 606 Advanced Mammalian Physiology II</u>	<u>4</u>	
<u>BISC627 Advanced Neurophysiology</u>	<u>3</u>	
<u>BMEG606 Princ of BME II: Tissue and organ systems</u>	<u>3</u>	

Biotechnology-related science courses (three courses from the following list adding up to at least 9 credits, one must be from the category “statistics” unless the student has documented prior exposure to statistical analysis of data)

Agriculture/food science:	Credits
ANFS 628- Food Chemistry	4
ANFS 629- Food Analysis	4
ANFS 633- Poultry pathology	3
ANFS 636- Immunology of domestic animals	3
ANFS 637- Avian immunology	3
ANFS 643- Food engineering technology	3
ANFS 649- Food biotechnology	4
ANFS 654- Advanced ruminant nutrition	3
BREG 603/PLSC 603- Soil physics	3
ENWC 611- Insect pest management	3
ENWC 610- Medical, Veterinary, and forensic entomology	3
ENWC 619- Biological control	3
ENWC 805- Insect-plant chemical ecology	3

Bioinformatics:	Credits
ANFS-BINF 644- Bioinformatics	3
CISC 636- Introduction to bioinformatics	3
CISC 637- Database Systems	3
CISC 681- Artificial Intelligence	3
CISC 683- Introduction to data mining	3
CISC 841- Bioinformatics	3
MAST 697- Bioinformatics programming for Biologists	3
MAST 698- Environmental and systems bioinformatics	3
BINF650 Protein Modifications	3
BINF694 Systems Biology I	3
BINF695 Computational System Biology	3
BINF815 Ethics, Business & Communication	3
BINF816 Systems Biology of Cells in Engineered Environments	3

Chemistry/Biochemistry	Credits
CHEM 641- Biochemistry	3
CHEM 645- Proteins, Structure and Function	3
CHEM 646- DNA-Protein Interactions	3
CHEM 649/686- Molecular Biophysics <u>Biophysical Chemistry</u>	3 3
CHEM 653- Bioinorganic Chemistry	3
CHEM 681- Green Chemistry	3
CHEM643 Intermediary Metabolism	3
CHEM684 Biochemistry of Nucleic Acids	3
MAST683 Environmental Chemistry	3

PLSC608/CHEM608 Environmental Soil Chemistry 3

Engineering:

CHEG 617 Colloid science and engineering 3

CHEG 620 Biochemical Engineering 3

CHEG 621- Metabolic engineering 3

CHEG 625- Green Engineering 3

CHEG 649 Molecular Biophysics 3

CHEG 650- Biomedical Engineering 3

CHEG 805 Multidisciplinary biotechnology 3

CPEG 630 Neurons and networks 3

ELEG 643 Biomedical Nanotechnology 3

ELEG 670- Biophysics of excitable membranes 3

ELEG 671- Introduction to biomedical engineering 3

ELEG 675- Image processing with biomedical applications 3

ELEG 678- Introduction to nano and biophotonics 3

ELEG 679- Introduction to medical imaging systems 3

MEEG 612- Biomechanics of human movement 3

MEEG 682- Clinical biomechanics 3

MEEG 683- Orthopedic Biomechanics 3

MEEG 684- Biomaterials and tissue engineering 3

MEEG 685- Control of human movement 3

MEEG 686- Cell and tissue transport 3

BMEG679 Introduction to Medical Imaging Systems 3

CHEG624 Bio-Based Materials 3

ELEG801 Advanced Topics in Biomedical Engineering 3

Health Sciences

BISC 600- Biotechnology and molecular medicine 3

HESC 601 Research Methods 3

NURSHESC687- Nursing Sciences Research 3

NURS 621- Advanced pathophysiology 3

NURS 622- Advanced pharmacology 3

NURS 638 Health sciences evaluation 3

PHYT 809 Psychosocial Aspects of Health and Disease 3

PHYT 606 Research 3

PHYT 623- Clinical Neuroscience 3

Advanced Laboratory Techniques

BISC 601- Immunochemistry 4

BISC 604- Nucleic Acids Laboratory 4

BISC 619 Gene Expression Laboratory 4

CHEM679 Biomolecular NMR Spectroscopy 3

3

Statistics/data analysis:

BISC 643- Biological Data Analysis	3
CHEG 604- Probability and statistics for engineering	3
STAT 608- Statistical Research Methods	3
STAT 609- Regression and Experimental Design	3
STAT 611- Regression Analysis	3
STAT 615- Design and Analysis of Experiments`	3
STAT 616- Advanced Design of Experiments	3
STAT 617- Multivariate Analysis	3
STAT 619- Time Series Analysis	3
STAT 620- Nonparametric Statistics	3
STAT 621- Survival Analysis	3
STAT 656- Biostatistics	3
STAT 674- Applied Data Base Management	3
STAT 675- Logistic Regression	3

PSM ~~Plus~~ Business/management component (15 credits):

~~Whereas students in Professional Science Master's Programs may have professional goals that would lead them into business and industry, or to government or non-profit employment, the University of Delaware offers two tracks for the PSM PLUS component.~~

PSM students will take at least 15 credits of PLUS-business/management coursework in addition to their science core distributed among the categories listed below as below. ~~The University recommends the student follow one of the tracks below, however students may cross over tracks to fit their interest.~~

Business/industry track	Government/non-profit track
Survey of Business (3 credits)	Survey of Public Administration (3 credits)
BUAD 7500 - Survey of Business* <u>(preferred)</u>	UAPP 803- Seminar in Public Administration
ACCT800 Financial Reporting and Analysis	
Leadership and Organizations (3 credits)	Leadership and Organizations (select 1, 3 credits)
BUAD 870- Leadership and Organizational Behavior	UAPP 835- Organizations and Management
BUAD872 Organizational Development and Change	UAPP 604- Leadership in Organizations
UAPP761 Conflict Resolution Collab Prob Solving	
Project Management, Operations or Entrepreneurship (select 1, 3	Managerial Decision Making or Financial Management (select 1, 3

credits)	credits)
BUAD 835 Managing New Product Development Projects	UAPP 819 Management Decision Making in Public & Nonprofit
BUAD811 Globalization and Business	
BUAD 831- Operations Management and Management Science	UAPP 833 Financial Management in Public and Nonprofit Sectors
BUAD 871- Managing for Creativity and Innovation	UAPP 827 Program and Project Analysis
ENTR 860- High Tech Entrepreneurship	UAPP 829 Taxation and Fiscal Policy
MISY 840 -Project Management and Costing	
UAPP 827- Program and Project Analysis	
UAPP698 Management Decision Making in Public & NP Sectors	
UAPP697 Leading Organizations in Public & NP Sectors	
Intellectual Property (3 credits)	Legal and Regulatory Affairs (3 credits)
CHEG 595- Intellectual Property for Engineers and Scientists	UAPP 646 Administrative Law and Policy
Ethics (3 credits):	
BISC 631 Practice of Science	UAPP 648- Environmental Ethics
BUAD 840- Ethical Issues in Global Business Environments	UAPP 650 Values Ethics and Leadership
BINF815 – Ethics, Business & Communication—3	BUAD861 Ethical Leadership Development

*BUAD~~7500~~ meets prerequisites for ~~BUAD835~~, BUAD831 and BUAD871

2. Advisement All students will develop a plan of study in consultation with their advisor upon matriculation into the program.

3. Give procedure for petitions for variance in degree requirements (e.g., course substitution policies, completion deadlines, etc.)

All petitions for course substitutions and variances in the completion deadlines must be made to the Graduate Affairs Committee, Department of Biological Sciences.

4. Define any grade minimums in courses that are different from University policy.

Only graduate courses completed with a grade of B or higher fulfill the biological sciences core and the biotechnology-related course requirements including the internship for the PSM in Biotechnology. Students receiving a B- or lower in a required core course are subject to dismissal from the program. However, they may file an appeal to the Department of Biological Sciences Graduate Affairs Committee for approval to retake the course and remain in the program. If the appeal is not approved, the Graduate Affairs Committee will recommend to the

Office of Graduate Studies that the student be dismissed from the program.

Students must also earn a minimum index of 3.0 in all “plus” component courses attempted to earn the PSM in Biotechnology, and no course with a grade below a C- may be counted toward the degree.

5. Identify any courses, which may not be used towards the degree.

Only courses listed in the curriculum may count towards the degree unless a variance is granted by the Graduate Affairs Committee, Department of Biological Sciences.

6. Identify expectations of facility of expression in English (oral and written) as part of the degree requirement.

Aside from the TOFEL admission requirement for foreign applicants, there are no specific requirements. However, successful completion of the degree will require fluency in both written and spoken English.

B. Committees for exams, thesis, or dissertations

This degree has no thesis or dissertation requirements. The director of the program will compile a list of University of Delaware faculty members who are willing serve as academic advisors for PSM Biotechnology students. Students will select advisors from this list who have expertise most appropriate for their career interests within the first two weeks after matriculation. The academic advisor in consultation with the program director will provide guidance on course selection and the academic advisor will also be responsible helping the student formulate the expectations for their internship experience and for evaluating the student’s capstone internship report.

It is highly encouraged that part-time students working in biotechnology-related fields work with both their UD academic advisor and employer prior to matriculation to develop a comprehensive professional development plan that coordinates PSM Biotechnology degree requirements with work responsibilities.

C. Timetable and definition of satisfactory progress towards the degree

1. Academic load

Full-time students will enroll in at least 9 credits of classes per semester (fall and spring), however, in order to complete the degree in two years, the student will need to enroll in 12 credits of classes at least two semesters. Part-time students are expected to enroll in at least one class per regular academic semester to remain matriculated in the program and are expected to complete their degree within five years.

Time line for degree:

Semester 1- enroll in 9 credits of coursework

Semester 2- enroll in 12 credits of coursework

Semester 3- enroll in 12 credits of coursework

Winter after semester 3- begin internship

Semester 4- enroll in BISC 872 internship and single remaining didactic course (Plus course taken during evening hours, 9 credits)

Summer after semester 3- sustaining status, complete internship and final report, graduate

Normal progress towards degree is reviewed for all students in the program at the end of every academic semester and is assessed based on grades, participation in program activities and performance in the internship.

2. Grade requirements (general and specific).

Only graduate courses completed with a grade of B or higher fulfill the biological sciences core and the biotechnology-related course requirements for the PSM in Biotechnology. Students must also complete BISC872, internship with a grade of at least B. Students receiving a B- or lower in a required core course are subject to dismissal from the program. However, they may file an appeal to the Department of Biological Sciences Graduate Affairs Committee for approval to retake the course and remain in the program. If the appeal is not approved, the Graduate Affairs Committee will recommend to the Chair of the Department of Biological Sciences that the student be dismissed from the program.

Students must also earn a minimum index of 3.0 in all “plus” component courses attempted to earn the PSM in Biotechnology.

All graduate courses successfully completed with a B or higher that were applied towards earned graduate certificates, but not graduate degrees, at the University of Delaware will be directly applicable to the PSM in Biotechnology.

3. Thesis/dissertation progress timetable guidelines.

N/A

4. Thesis/dissertation defense guidelines.

N/A

5. Forms required.

The application for advanced degree must be filed with the Office of Graduate studies prior to the beginning of the last semester in the program

6. Identify consequence for failure to make satisfactory progress.

Students failing to make satisfactory progress towards degree will be identified by the Graduate Affairs Committee, Department of Biological Sciences, in consultation with the student’s academic advisor/program director. Recommendations for dismissal are made by the Department Chair of Biological Sciences to the University of Delaware Office of Graduate studies.

Students who feel that they have been graded inappropriately or receive what they perceive as an unfair evaluation by a faculty member may file [grievances](#) in accordance with University of Delaware policies. Students are encouraged to contact the Department's Graduate Program Director prior to filing a formal grievance in an effort to resolve the situation informally.

Part IV. Assessment Plan

Consistent with the Mission Statement presented earlier in this document, five student learning goals are defined. Students will:

1. Have advanced knowledge of the discipline of biotechnology
2. Have experience working with interdisciplinary teams on biotechnology
3. Achieve competence in scientific communication
4. Be knowledgeable in scientific business ethics
5. Understand the application of business/management theory to science

The specific goals stated above are mapped to various science and PLUS courses in the program Assessment Plan which guides program evaluation and is filed with the Center for Educational Effectiveness.

These goals are assessed through multiple indicators including:

- Faculty evaluation of student progress in course work
- Survey of internship mentors

- Surveys of students and program alumni
- Faculty and internship mentor evaluation of the internship work and written products
- Employer surveys

Both short term and long term impacts are assessed.

Part V. Financial aid-

Students enrolled in this program are responsible for their tuition and living expenses. Both the Department of Biological Sciences and University of Delaware Office of Financial Aid will provide assistance in identifying suitable fellowships, grants and loans to help finance their education.

Part VI. Departmental Operations

A. General student responsibilities

Access to Student Records

Students wishing to review their Departmental file must submit a written request to the Graduate Program Director at least 24 hours in advance. Students must review the file in the presence of departmental staff or faculty and are not permitted to remove a file from Wolf Hall but may photocopy documents from their folder. All access to student records is in accordance with the Family Educational Rights and Privacy Act.

Standards of Student Conduct

A) Academic honesty

All graduate students are subject to University of Delaware regulations regarding [academic honesty](#).

B) Laboratory Safety and Research Regulations

Graduate students performing laboratory research are subject to all University regulations regarding safety, use of human subjects and animals, and hazardous/radioactive material use and disposal. These guidelines may be found in the University of Delaware Policies and Procedures Manual. Students participating in off campus internship experiences are expected to fully comply with all safety regulations of the workplace.

C) Contact information

It is the responsibility of all students to ensure that their contact information on file with the university is current (mailing address, phone number, email address). It is also the student's responsibility to regularly monitor their email, phone and mail for important notices regarding their enrollment.

D). Departmental facilities

Occasionally student's graduate assistantship or other assignments may require the use of departmental laboratories or other facilities. Keys to laboratories, etc., are maintained in the Department office and will be issued based on faculty and Department Chair approval. Any assignments that require the expenditure of departmental funds (e.g. data collection activities) require departmental approval in advance and are processed through the department in which the work is to be done.