



Northeastern

U N I V E R S I T Y

BOUVÉ COLLEGE OF HEALTH SCIENCES

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GUIDEBOOK
for
Graduate Students in Pharmaceutical Science
at Northeastern University

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Graduate Programs in Pharmaceutical Science

Master of Science (M.S.)

- Pharmaceutics and Drug Delivery Systems
- Pharmacology
- Toxicology
- Interdisciplinary Pharmaceutical Science

Doctor of Philosophy (Ph.D.)

- Medicinal Chemistry and Drug Discovery
- Pharmaceutics and Drug Delivery Systems
- Pharmacology
- Toxicology
- Interdisciplinary Pharmaceutical Science

This Guidebook describes the curriculum, requirements, policies and procedures for the M.S. and Ph.D. programs in Pharmaceutical Science at Northeastern University. Policies and regulations applying to all graduate programs are established by the University Graduate Council. Additionally, each graduate degree-granting unit has further discretion for establishing discipline-specific policies within the limits defined by the University Graduate Council and the Graduate School of the College in which the program resides. The policies contained in this Guidebook for the M.S. and Ph.D. programs in Pharmaceutical Science are consistent with, and extend, those stipulated by the *Northeastern University Graduate Student Handbook* and the *Bouve College of Health Sciences Graduate Policies and Regulations*. The student should consult these sources for general regulations, policies and procedures covering such matters as credit requirements, student responsibilities, code of conduct, academic and co-curricular life, faculty rights and responsibilities, personnel policies, benefits, and services. If any information contained in this booklet conflicts with the general University policy, then the University policy will prevail. The University reserves the right to change the information contained in this document.

(Revised August 2006)

The Master of Science in Pharmaceutical Science

Admissions Requirements

- A baccalaureate degree or equivalent in biology, chemistry, medical technology, pharmacy, chemical engineering, or related field.
- At least two semesters (2 semesters) undergraduate courses (or their equivalent) in each of the following: mathematics (including calculus), biology, physics, and organic chemistry.
- A minimum (undergraduate) grade-point average (GPA) of 3.000 or better.
- Test of English as a Foreign Language (TOEFL) must be taken by students whose native language is not English (suggested scores: 600 written and 250 computer).
- Official copy of score from the Graduate Record Examination (GRE). This test must have been taken in the last five years.
- Admissions are for the fall semester only.

Applicants with deficiencies in any of these areas may be admitted to the Master of Science level of study and allowed to take undergraduate courses at Northeastern University concurrently with certain graduate courses. Students admitted with deficiencies must remediate them during the first year of graduate work. Failure to do so will result in dismissal from the program. Applicants for the Master of Science Program can request full- or part-time study. However, an I-20 visa requires that a student be enrolled full-time. Full-time status means that a student must be registered for 8 SH credit each semester of the academic year or be taking a course that confers full-time status.

Curriculum Requirements

All M.S. programs in pharmaceutical science require a set of common courses taken by all students in the degree program. In addition, students in each specialization track are required to take a defined set of discipline-specific courses and a number of general electives. The number of specialization and elective courses differs slightly between tracks. The MS degree may be completed on either a full-time or part-time basis and may include a research / thesis option.

Pharmaceutical Science common courses – 5-6 SH

- PSC G100 Concepts in Pharmaceutical Science 2 SH
- PSC G210 Drug Design, Evaluation and Development 2 SH
- PSC G212 Research Skills and Ethics 1 SH OR
CHM G200 Research Skills and Ethics in Chemistry 2SH OR
BIO G381 Ethics in Biological Research 2 SH

Specialization Courses - 20-28 SH

A minimum of six semester hours is required in this category depending on specialization. Students should consult with their advisor when selecting these courses. See details below for courses required for each specialization.

General Electives - 0–9 SH

Thesis credit of four semester hours (when available) may be used to partly fulfill this requirement.

Total number of credits 33 SH

Specialization in Pharmaceutics and Drug Delivery Systems

Pharmaceutical Science Common Courses – 5-6 SH

Pharmaceutics / Drug Delivery Specialization Courses - 22 SH

- BIO G300 Graduate Biochemistry 4 SH
- BIO G301 Molecular Cell Biology 4 SH
- PSC G214 Experimental Design and Biometrics 2 SH
- PSC G216 Human Physiology and Pathophysiology 2 SH
- PSC G218 Biomedical Chemical Analysis 2 SH
- PCT G250 Advanced Physical Pharmacy 2 SH
- PCT G252 Pharmacokinetics and Drug Metabolism 3 SH
- PCT G254 Advanced Drug Delivery System 3 SH

General Electives – 5-6 SH

Advisor consultation is required when choosing electives.

Total number of credits 33 SH

Specialization in Pharmacology

Pharmaceutical Science Common Courses – 5-6 SH

Pharmacology Specialization Courses - 20 SH

- BIO G300 Graduate Biochemistry 4 SH
- BIO G301 Molecular Cell Biology 4 SH
- PSC G214 Experimental Design and Biometrics 2 SH
- PSC G216 Human Physiology and Pathophysiology 2 SH
- PSC G218 Biomedical Chemical Analysis 2 SH
- PCL G205 Pharmacology 1 2 SH
- PCL G206 Pharmacology 2 2 SH
- PCL G262 Receptor Pharmacology 2 SH

General Electives – 7-8 SH

Advisor consultation is required when choosing electives.

Total number of credits 33 SH

Specialization in Toxicology

Pharmaceutical Science Common Courses - 5 SH

Toxicology Specialization Courses - 28 SH

- BIO G300 Graduate Biochemistry 4 SH
- BIO G301 Molecular Cell Biology 4 SH
- PSC G214 Experimental Design and Biometrics 2 SH
- PSC G216 Human Physiology and Pathophysiology 2 SH
- PSC G218 Biomedical Chemical Analysis 2 SH
- TOX G270 Clinical Toxicology 2 SH
- TOX G272 Environmental Toxicology 3 SH
- TOX G274 Organ Systems Toxicology 3 SH
- TOX G276 Experimental Toxicology 3 SH
- TOX G278 Biochemical Toxicology Lab 3 SH

General Electives - optional

Advisor consultation is required when choosing electives.

Total number of credits 33 SH

Interdisciplinary Specialization

Pharmaceutical Science Common Courses – 5-6 SH

Interdisciplinary Courses – 24 SH

- BIO G300 Graduate Biochemistry 4 SH
- BIO G301 Molecular Cell Biology 4 SH
- PSC G214 Experimental Design and Biometrics 2 SH
- PSC G216 Human Physiology and Pathophysiology 2 SH
- PSC G218 Biomedical Chemical Analysis 2 SH

Plus at least 10 SH from the following list of options:

- Any PSC, PCL, PCT or TOX course
- Any BIO or CHM course (with permission of the advisor)

General Electives – 3-4 SH

Advisor consultation is required when choosing electives.

Total number of credits 33 SH

Other requirements for the Master of Science:

Master of Science Paper

A scientific paper approximately 20 pages in length is written under the guidance of a faculty member in the Department of Pharmaceutical Sciences, or a faculty member in another department subject to approval by the student's M.S. program advisor. The topic of the paper is determined in consultation with the faculty advisor. For instance, if the student has been involved in research with the advisor, the paper may report the results of that research in the format of a scientific journal publication. Alternatively, the Master's paper may be a review of the published research on a particular topic. In either case, the content should include a review of the relevant scientific literature, and it should integrate and interpret the research findings in the field. The paper should be fully referenced using an accepted style for scientific literature citation. The M.S. research paper may be the topic of a 1 SH elective course taken for credit toward the M.S. degree, such as Directed Study (PSC G411). The M.S. Research Paper requirement is waived if the student elects instead to complete an M.S. thesis (below).

Master of Science Thesis Option

Students who undertake a thesis are expected to document the results of extended research and make an original contribution to their field. This work should give evidence of the candidates' ability to conduct independent investigation and to interpret the results of their research in an acceptable manner.

- *Thesis Registration*

Students may receive a maximum of four semester hours of credit for M.S. thesis research. Students should register for PSC G682, Thesis, twice for 2 SH each during the fall and spring semesters of their second full year of study, or after completing 15 credits of study. If completion of the thesis requires additional time, the student should register for PSC G699 (0 SH) Thesis Continuation.

- *Thesis Committee*

The thesis committee should be composed of at least three members: two from the sponsoring program and the third from outside the student's program. The outside member may be a Northeastern University faculty member. The Director of the graduate programs in Pharmaceutical Science appoints any additional members considered necessary to this committee. The student's major adviser serves as the committee chairperson. The student, after consulting with the chairperson, is responsible for calling all meetings.

- *Thesis Proposal*

The thesis proposal should be no more than 50 double-spaced pages (12 point font minimum and one half inch margins on all sides). This page limit excludes references but includes figures, figure legends and tables. Aside from these exceptions, the proposal should otherwise conform to the format and structure of an NIH grant proposal with four sections: Specific Aims, Background and Significance, Preliminary Studies, and Experimental Design and Methods. See the Department of Pharmaceutical Sciences Thesis Proposal document for detailed instructions on the preparation of a thesis proposal and the required form pages. The thesis proposal must be defended orally before the dissertation committee and signed by all dissertation committee members *before the student undertakes their planned research*. The signed facepage of the proposal should be submitted to the Director of the graduate program in Pharmaceutical Science and to the Bouve College graduate office.

- *Thesis Final Defense*

The final defense is taken after the student completes the thesis research and all other requirements for M.S. degree. The defense deals with the subject matter of the dissertation/ thesis, significant developments in the field, and the student's background knowledge in her/his field of specialization. The Dissertation/Thesis Committee conducts the final defense.

At least two weeks prior to the expected date of the oral defense, the written thesis must be circulated to the student's Thesis Committee. After careful examination by the committee, recommendations may be made that the student clarify or rewrite portions of the thesis *before the final defense is scheduled*. Once the thesis committee concurs that the thesis is acceptable, a date is chosen for the final oral examination. At least one week prior to the defense, the student should inform the Graduate Program so that an announcement can be posted on the Department of Pharmaceutical Science website and distributed to faculty and students. The final defense is open to anyone who wishes to attend. The final defense typically lasts at least two hours. After presentation of the work by the student and responses to audience and committee questions, the committee meets in executive session to decide whether the student successfully defended the thesis. The committee's decision is then announced to the student. If the committee's vote has been favorable, the student incorporates committee suggestions and corrects any typographical errors, and the dissertation is signed and passed on to the Director of the Pharmaceutical Science graduate program. Requests for a second defense are unusual, irregular occurrences but may be permitted in the event that the previous oral defense was judged by the Committee to be inadequate.

- *Thesis Deadline*

The thesis should be written, defended, and signed at least three weeks before the University commencement deadline. Students must deposit signed copies of the thesis in the department and the Snell Library.

General Policies Common to all M.S. Specializations

Grading policy

Students are expected to maintain a grade-point average of 3.0 (B) or better in all course work. Students whose cumulative grade-point average falls below 3.000 will receive written notification by the Graduate Committee that they have been placed on academic probation. Students on probation must meet with their academic advisor to devise a plan to clear the deficiency and return to non-probationary status. A student must clear the deficiency and return to non-probationary status within one semester, unless the course that must be retaken is not offered during the probationary semester. In such a case, the course to be retaken must be completed during the next semester that it is offered with a grade of B or better. Moreover, any new courses taken during the intervening time must also be passed with a grade of B or better. Bouve College policy stipulates that a student may repeat a course only once to achieve a passing grade, and may repeat only two required courses during his/her entire program of study. A

student may only be placed on probation twice during enrollment, and must correct the deficiencies as specified in the plan agreed upon with the advisor. Failure to remediate the deficiency and return to non-probationary status within the agreed upon time limit will result in the student's dismissal from the M.S. program.

Progression requirement

Bouve College policy expects that students register for coursework or continuation credit each semester of the academic year (fall and spring semesters) once they are matriculated as full- or part-time students. Moreover, international students are required to maintain full-time student status during the fall and spring semesters. Non-international students who are not able to register for courses during a particular semester must inform the Graduate Program Director in writing and state when they plan to resume their curriculum. Approval of this petition retains the student's status in the M.S. program. M.S. students are expected to complete all degree requirements within two to three years if enrolled on a full-time basis, or within three to five years on a part-time basis. If progress toward the degree is slowed or interrupted for personal reasons, the student must petition the Pharmaceutical Sciences Graduate Committee for an extension of the expected time to completion. If an extension is approved, the student will be directed to meet with his/her academic advisor to devise a plan to achieve completion of the degree. Course credits earned in the Bouvé College of Health Sciences Graduate School, or accepted for transfer from another institution, are valid for a maximum of seven years between the time taken and the completion of degree requirements, unless the Graduate Committee grants an extension.

Academic honesty and research integrity

The Department of Pharmaceutical Sciences has a zero tolerance policy regarding academic dishonesty and violations of research integrity. It is the student's responsibility to understand and uphold these policies. Definitions of plagiarism, cheating, fabrication, falsification, unauthorized collaboration, and actions that facilitate academic or research dishonesty are provided in *The Northeastern University Graduate Student Handbook* (<http://www.neu.edu/handbook/studenthandbook.pdf>) and the *Bouve College of Health Sciences Graduate Policies and Regulations*. The lack of knowledge of these definitions does not void the student's responsibility for upholding them. Offenses of academic honesty and research integrity are egregious violations of ethical standards and may result in the student's immediate dismissal from the graduate program.

Financial Information

Tuition rates, all fees, rules and regulations, courses and course content are subject to revision by the President and the Board of Trustees at any time. A listing of fees can be obtained from the Customer Service Center, 254 Richards Hall, 617.373.2270, www.customerservice.neu.edu. M.S. students are generally not eligible for stipended graduate assistantships (SGA's) but may be considered for part-time research support provided by faculty research grants or part-time administrative support provided by the Dean's Office.

Student Status and Registration

Applicants may be accepted as regular, provisional, or conditional students, and must confirm acceptance within the period designated in the acceptance letter. Students will be assigned an advisor from their program, and must confer with the advisor regarding an approved program of studies and course selection prior to registration. Registration is required for all courses, and entry is granted on a first-come, first-served basis.

The Doctor of Philosophy in Pharmaceutical Science

Admissions Requirements

- A baccalaureate degree or equivalent in biology, chemistry, medical technology, pharmacy, chemical engineering, or related field.
- At least two semesters (2 semesters) undergraduate courses (or their equivalent) in each of the following: mathematics (including calculus), biology, physics, and organic chemistry.
- A minimum (undergraduate) grade-point average (GPA) of 3.000 or better.
- Test of English as a Foreign Language (TOEFL) must be taken by students whose native language is not English (suggested scores: 600 written and 250 computer).
- Official copy of scores from the Graduate Record Examination (GRE) general portion. This test must have been taken in the last five years. Applicants who have received an M.S. degree from an accredited U.S. institution may waive the GRE requirement.
- Applicants for the Doctor of Philosophy must apply for full-time study only.
- Admissions are for the fall semester only.

Curriculum Requirements

The Doctor of Philosophy (Ph.D.) program is a full-time program of study requiring successful completion of coursework, a qualifying examination, and a research thesis. All specializations within Pharmaceutical Science require a common core curriculum. The remaining coursework may differ slightly as specialization and general elective requirements differ between the concentrations. All Ph.D. students must be enrolled full-time, requiring that students must register for 8 SH each semester (excluding summers) or else register for a course that confers full-time status.

Pharmaceutical Science common courses – 5-6 SH

- PSC G100 Concepts in Pharmaceutical Science 2 SH
- PSC G210 Drug Design, Evaluation and Development 2 SH
- PSC G212 Research Skills and Ethics 1 SH OR
CHM G200 Research Skills and Ethics in Chemistry 2SH OR
BIO G381 Ethics in Biological Research 2 SH

Specialization Courses – 12-28 SH

A minimum of twelve semester hours is required in this category depending on specialization. Students should consult their advisor when selecting these courses. **NOTE:** The specialty portion of the Ph.D. Qualifying Examination is based on these courses. See details below for courses required for each specialization.

General Electives - 2-17 SH

Ph.D. Courses - 10 SH minimum

- PSC G300 Pharmaceutical Science Seminar 1 SH (may be taken more than once)
- PSC G681 Thesis Proposal 1 SH
- PSC G800 Qualifying Exam Preparation 0 SH
- PSC G810 Pharmaceutical Science Colloquium 1 SH
- PSC G892 Dissertation 2 SH (must be taken at least twice)

Total number of credits 45 SH

Specialization in Pharmaceutics and Drug Delivery Systems

Pharmaceutical Science Common Courses – 5-6 SH

Pharmaceutics / Drug Delivery Specialization Courses - 22 SH

- BIO G300 Graduate Biochemistry 4 SH
- BIO G301 Molecular Cell Biology 4 SH
- PSC G214 Experimental Design and Biometrics 2 SH
- PSC G216 Human Physiology and Pathophysiology 2 SH
- PSC G218 Biomedical Chemical Analysis 2 SH
- PCT G250 Advanced Physical Pharmacy 2 SH
- PCT G252 Pharmacokinetics and Drug Metabolism 3 SH
- PCT G254 Advanced Drug Delivery Systems 3 SH

General Electives – 7-8 SH

Advisor consultation is required when choosing electives.

Ph.D. Core - 10 SH

Total number of credits 45 SH

Specialization-specific non-course requirements:

- Participation in the weekly Pharmaceutics Seminar / Journal Club

Specialization in Pharmacology

Pharmaceutical Science Common Courses – 5-6 SH

Pharmacology Specialization Courses - 18 SH

- BIO G300 Graduate Biochemistry 4 SH
- BIO G301 Molecular Cell Biology 4 SH
- PSC G214 Experimental Design and Biometrics 2 SH
- PSC G216 Human Physiology and Pathophysiology 2 SH
- PCL G205 Pharmacology 1 2 SH
- PCL G206 Pharmacology 2 2 SH
- PCL G262 Receptor Pharmacology 2 SH

General Electives – 11-12 SH

Advisor consultation is required when choosing electives.

Ph.D. Core - 10 SH

Total number of credits 45 SH

Specialization-specific non-course requirements:

- Participation in the weekly Pharmacology/Toxicology Journal Club

Specialization in Medicinal Chemistry and Drug Discovery

Pharmaceutical Science Common Courses – 5-6 SH

Medicinal Chemistry / Drug Discovery Specialization Courses – 10 SH

- PSC G222 Chemistry and Biology of Drugs of Abuse 3 SH
- PSC G224 Behavioral Pharmacology and Drug Discovery 2 SH
- PSC G226 Imaging in Medicine and Drug Discovery 2 SH
- CHM G376 Bioorganic Chemistry 3 SH

General Electives – 18-20 SH

Advisor consultation is required when choosing electives.

Ph.D. Core - 10 SH

Total number of credits 45 SH

Specialization-specific non-course requirements:

- Participation in Medicinal Chemistry and Drug Discovery Journal Club

Interdisciplinary Specialization

The interdisciplinary Ph.D. specialization is intended to meet the needs of students interested in combining courses and skills from different areas of specialization. At least one of the specialization areas must come from within the Department of Pharmaceutical Sciences. The second area may come from a department in another College at Northeastern University, such as biology, chemistry, or engineering, or from a different institution. The areas of academic concentration are reflected in the coursework, qualifying examinations, and dissertation work undertaken by the student. The thesis advisor must be a tenured or tenure-track member of the Department of Pharmaceutical Sciences.

The Pharmaceutical Science Common courses are required. Specialization and General Elective courses are selected and approved by the student in conjunction with the advisor. Students electing the interdisciplinary option must fulfill the same requirements as all other PhD candidates.

Pharmaceutical Science Common Courses – 5-6 SH

Interdisciplinary Courses – 24 SH

- BIO G300 Graduate Biochemistry 4 SH
- BIO G301 Molecular Cell Biology 4 SH
- PSC G214 Experimental Design and Biometrics 2 SH
- PSC G216 Human Physiology and Pathophysiology 2 SH
- PSC G218 Biomedical Chemical Analysis 2 SH

Plus at least 10 SH from the following list of options:

- Any PSC, PCL, PCT or TOX course
- Any BIO or CHM course (with permission of the advisor)

General Electives – 5-6 SH

Advisor consultation is required when choosing electives.

Ph.D. Core - 10 SH

Total number of credits 45 SH

Specialization-specific non-course requirements:

- Weekly participation in one of the Department's Journal Clubs, e.g. the Pharmacology/Toxicology Journal Club, Pharmaceutics Journal Club, or the Medicinal Chemistry and Drug Discovery Journal Club

General Policies Common to all Ph.D. Specializations

Grading policy

Students are expected to maintain a grade-point average of 3.0 (B) or better in all course work. Students who receive an F grade in required courses will be dismissed from the PhD program and may petition the Graduate Committee for admittance to the master's level of study. Students whose cumulative grade-point average falls below 3.000, or who receive a grade of C in a core course, will receive written notification by the Graduate Committee that they have been placed on academic probation. Students on probation must meet with their academic advisor to devise a plan to clear the deficiency and return to non-probationary status. A student must clear the deficiency and return to non-probationary status within one semester, unless the course that must be retaken is not offered during the probationary semester. In such a case, the course to be retaken must be completed during the next semester that it is offered with a grade of B or better. Moreover, any new courses taken during the intervening time must also be passed with a grade of B or better. Bouve College policy stipulates that a student may repeat a course only once to achieve a passing grade, and may repeat only two required courses during his/her entire program of study. A student may only be placed on probation twice during enrollment, and must correct the deficiencies as specified in the plan agreed upon with the advisor. Failure to remediate the deficiency and return to non-probationary status within the agreed upon time will result in the student's dismissal from the Ph.D. program.

Colloquium attendance

All Ph.D. students are required to attend the weekly Pharmaceutical Science Colloquium series. Announcements of times and locations of these seminars are listed on the Department web site, distributed weekly to students mailboxes and by e-mail to their University e-mail addresses. Attendance is monitored by sign-up sheet at each Colloquium. One excused absence is permitted per semester. Failure to regularly attend Colloquia may result in sanctions such as probation or dismissal from the Ph.D. program.

Journal Club participation

Each field of specialization sponsors a weekly Journal Club at which students present and evaluate the current scientific literature of their field. Students in Pharmaceutics and Drug Delivery are required to attend the weekly Pharmaceutics Journal Club, whereas student in the Pharmacology and Toxicology specialization are required to attend the Pharmacology/Toxicology Journal Club. Students in the Medicinal Chemistry and Drug Discovery specialization are required to attend Journal Club in the Center for Drug Discovery. Students in the Interdisciplinary Ph.D. program must also attend one of these. Attendance at one of these Journal Clubs is required each academic semester. Further, each student is required to participate in Journal Club for course credit (PSC G300 Pharmaceutical Science Seminar) at least twice during their course of study. Failure to regularly attend Journal Club may result in sanctions such as probation or dismissal from the Ph.D. program.

Doctor of Philosophy Qualifying Examination

Students are expected to take the Ph.D. qualifying examination after completion of their second year in the program. The qualifying examination tests students' knowledge and skills in both required courses and specific content areas. This examination is composed of two parts: a series of written examinations in the student's field of specialization, and a general oral examination. The dates of the written examinations will be announced at the beginning of the spring semester and all students qualified to sit for the examinations will be expected to take the exam at the times announced. The oral examination for each student will be scheduled within approximately two weeks after successful completion of the written part.

Students are required to pass three of a maximum of five written examinations on different content areas within their specialization. No fewer than three faculty will contribute questions for the written examinations for each student, and no faculty will write more than the equivalent of one entire exam. The topic areas for the written examinations, and the dates when each is to be administered, will be announced at least 2 months in advance. The format for the written examinations may vary between specializations, e.g. faculty in some disciplines may ask a series of comprehensive essay questions, whereas others may provide a research paper from the biomedical literature and ask questions based upon its content. The written examinations are scheduled within two weeks of each other and graded by the providers of the question(s). A score of 70 or above is a passing grade for each written exam. A student who fails to pass 3 written exams will be required to withdraw from the PhD program. Students must pass the written portion of the exam prior to taking the oral examination.

The oral examining committee consists of at least four faculty: the dissertation advisor; at least two other members of the Pharmaceutical Sciences faculty; and at least one member from outside the Department. Members are selected by the advisor and/or Program Director, in consultation with the student. The oral exam is graded on a pass/fail basis. Students who fail the oral examination on the first attempt may retake the exam within a time period designated by the oral examining committee, but not to exceed 6 months. Those who fail twice will be dismissed from the program. The two parts of the qualifying examination must be completed before the thesis proposal is defended.

Doctoral Candidacy

Doctoral students who have completed a minimum of 33 hours of graduate credit beyond the bachelor's degree and who have passed the written and oral qualifying examinations are admitted to candidacy for the doctoral degree.

Doctoral Dissertation

Doctoral students must complete a dissertation that embodies the results of extended research and makes an original contribution to their field. This work should give evidence of candidates' ability to conduct independent investigation and interpret the results of their research in an acceptable manner. The doctoral dissertation advisor serves as chairperson of the Dissertation Committee, which consists of no fewer than five members. Selection of an advisor is by mutual consent of the student and a member of the faculty, with approval by the Director of the Pharmaceutical Science graduate program. At least two members of the committee must be Pharmaceutical Sciences faculty members. At least one member is to be selected from outside the Department. Individuals are chosen for their expertise in the student's area of research. Doctoral students should select a dissertation advisor in the second year of the program and are expected to begin research and demonstrate satisfactory proficiency in the laboratory before taking the Ph.D. qualifying examination.

- *Dissertation Proposal Defense*

Within a year after completion of the qualifying examination, but not later than the beginning of the fall semester of the fourth year, students should prepare and defend a written proposal detailing their planned thesis project. Failure to do so will be regarded as failure to progress in the Ph.D. program and will result in a warning from the Graduate Director. Students who do not correct the deficiency within one semester will be placed on probation. The student on probation must complete the thesis proposal defense and return to non-probationary status within one semester or will be dismissed from the Ph.D. Program.

The thesis proposal should be no more than 50 double-spaced pages (12 point font minimum and one half inch margins on all sides). This page limit excludes references but includes figures, figure legends and tables. Aside from these exceptions, the proposal should otherwise conform to the format and structure of an NIH grant proposal with four sections: Specific Aims, Background and Significance, Preliminary Studies, and Experimental Design and Methods. See the Department of Pharmaceutical Sciences *Thesis Proposal* document for detailed instructions on the preparation of a thesis proposal and the required form pages. The thesis proposal must be defended orally before the dissertation committee and signed by all dissertation committee members *before the student undertakes their planned research*. A copy of the signed facepage of the proposal should be submitted to the Director of the graduate program in Pharmaceutical Science and to the Bouve College graduate office.

- *Progress Reports*

The dissertation committee meets at 6 month intervals, but not less than once a year, to evaluate the student's research progress and to be presented with written and oral progress reports on the direction and status of the research. The progress report should be written in a brief format, identical to that described for the formal thesis (see *Instructions for Preparation of the Thesis*). Low productivity or unsatisfactory work provides the basis for a warning by the dissertation committee and/or the Graduate Education Committee. Two such warnings will result in a student's dismissal from the program.

- *Registration for Dissertation*

Advisor consent and completion of all course work (with the exception of the Colloquium course) must be documented before students register for the first dissertation course. Students must register for PSC G892, "Dissertation," for at least two semesters and up to a maximum of three semesters, and then for PSC G899, "Dissertation Continuation," each semester thereafter until the thesis has been successfully defended. Students are given a maximum of five years after establishing degree candidacy to complete the degree requirements.

- *Ph.D Thesis Preparation*

Detailed guidelines for the format and content of the written dissertation are given in *Instructions for Preparation of the Thesis*. The completed thesis document should be reviewed first by the thesis advisor. Feedback from the advisor should be incorporated into the thesis before distribution of the document to the dissertation committee. The completed thesis should be delivered to dissertation committee members not less than two weeks before the scheduled oral defense.

- *Oral Defense*

The final oral examination is taken after the student completes the Ph.D. thesis research and all other requirements for Ph.D. degree. The defense deals with the subject matter of the dissertation/ thesis, significant developments in the field, and the student's background knowledge in her/his field of specialization. The Dissertation/Thesis Committee conducts the final defense. The committee may recommend that the student clarify or rewrite portions of the thesis *before the final defense is scheduled*. Once the committee concurs that that thesis is acceptable, a date is chosen for the final oral examination. At least one week prior to the defense, the student should inform the Graduate Program Director so that an announcement can be posted on the Department of Pharmaceutical Science website and distributed to faculty and students. The final defense is open to anyone who wishes to attend. The final defense typically lasts at least two hours. After presentation of the work by the student and responses to audience and committee questions, the committee meets in executive session to decide whether the student successfully defended the thesis. The committee's decision is then announced to the student. If the committee's vote has been favorable, the student incorporates committee suggestions and corrects any typographical errors, and the dissertation is signed and passed on to the Director of the Pharmaceutical Science graduate program. Requests for a second defense are unusual, irregular occurrences but may be permitted in the event that the previous oral defense was judged by the Committee to be inadequate.

- *Deadline*

The final thesis should be written, defended, and signed at least two weeks before the University commencement deadline. Students must deposit signed copies of their thesis in the department and Snell Library.

Pharmaceutical Science Colloquium

Each Ph.D. candidate nearing completion of their research is required to present their thesis findings at a Pharmaceutical Sciences Colloquium. This presentation should be scheduled at least 6 months before the anticipated completion of the thesis. The student must register for PSC G892 Pharmaceutical Sciences Colloquium during the semester that the colloquium presentation is to be given.

Time for Completion of Program

The time required for a student to complete the Ph.D. varies, depending on the individual, specialization and advisor. Students are expected to complete their degrees in four to six years, depending on their motivation and the progress of their research. If progress toward the degree is slowed or interrupted for personal reasons, the student must petition the Pharmaceutical Sciences Graduate Committee for an extension of the expected time to completion. If an extension is approved, the student will be directed to meet with his/her academic advisor to plan an alternate plan for completion of the degree. Course credits earned in the Bouvé College of Health Sciences Graduate School, or accepted for transfer from another institution, are valid for a maximum of seven years between the time taken and the completion of degree requirements, unless the Graduate Committee grants an extension.

Academic honesty and research integrity

The Department of Pharmaceutical Sciences has a zero tolerance policy regarding academic dishonesty and violations of research integrity. It is the student's responsibility to understand and uphold these policies. Definitions of plagiarism, cheating, fabrication, falsification, unauthorized collaboration, and actions that facilitate academic or research dishonesty are provided in *The Northeastern University Graduate Student Handbook* (<http://www.neu.edu/handbook/studenthandbook.pdf>) and the *Bouve College of Health Sciences Graduate Policies and Regulations*. The lack of knowledge of these definitions does not void the student's responsibility for upholding them. Academic dishonesty and misconduct in research are regarded as egregious violations of ethical standards and may result in the student's immediate dismissal from the graduate program.

Assistantships

Northeastern University offers a variety of forms of financial assistance to help graduate students defray the costs of their education.

- *Stipended Graduate Assistantship (SGA)*

Stipended Graduate Assistantships are a category of financial aid provided to Ph.D. students at Northeastern University. SGAs provide non-taxable tuition remission and a taxable cash stipend. Awards do not cover University fees other than tuition; all non-tuition fees must be paid by award recipients. Each recipient receives a contract letter detailing the terms of their specific assignment. Only full-time graduate students are eligible to receive SGA awards. To be eligible for an SGA, a student must request SGA support, accept the conditions of the award, and be in good academic standing. Acceptance of an SGA requires a work commitment of 20 hours per week. The balance of the student's full-time effort is expected to be devoted to pursuit of degree requirements, e.g. coursework and thesis research.

The SGAs awarded to students in Pharmaceutical Sciences may be either teaching assistantships (TA's) or research assistantships (RA's), depending on the source of the funds and the work to be performed by the student. Students who are supported by Teaching Assistantships and Research Assistantships are employees of Northeastern University during the term of their award, and they work under the direction of the faculty member who is designated as their supervisor.

Teaching Assistants provide help to a faculty member in teaching undergraduate courses. The assignment of TA's to specific courses or faculty is made by the Director of the Graduate Program upon consultation with the Graduate Education Committee. TA's may be asked to grade examinations, supervise student laboratory exercises, prepare for laboratory exercises, proctor examinations, tutor students or offer review sessions. Supervisors report the performance of TA's to the Graduate Committee. Students who fail to meet their obligations as TA's will receive a warning from the Graduate Committee. The Graduate Director retains the authority to withdraw the stipend for a TA whose performance is unreliable, inadequate or unsatisfactory.

Research Assistants are supported on a research grant provided by a faculty member and are offered by the faculty member holding the grant. The term of support, amount of the stipend, and specific duties are stipulated by the research plan and the budget allocated in the grant, and are at the discretion of the faculty member. The duties involve meeting the goals of the grant-funded research project and may or may not overlap the student's thesis research. The supervisor retains the right to discontinue support if the student fails to meet obligations, or performs in an unsatisfactory manner in conducting the research.

- *Tuition Assistantship (NUTA)*

Northeastern University Tuition Assistantships require a work commitment of 10 hours per week and offers taxable tuition remission only. Students are required to enroll in a minimum number of semester hours of classes during each semester of the assignment.

- *Tuition Scholarship (NUTS)*

Northeastern University Tuition Scholarships require no work commitment. This award consists of a specified amount of non-taxable tuition waiver. The amount of the award is determined by the Graduate Program Director.

- *Minority Tuition Scholarships*

Minority Tuition Scholarships require no work commitment. This award consists of a specified amount of non-taxable tuition waiver. Students must be U.S. citizens or permanent residents to be eligible for this award.

Financial Information

Tuition rates, all fees, rules and regulations, courses and course content are subject to revision by the President and the Board of Trustees at any time. A listing of fees can be obtained from the Customer Service Center, 254 Richards Hall, 617.373.2270, www.customerservice.neu.edu. Ph.D. students are exempted from tuition, and unless requested otherwise by the student, a stipend for living expenses.

Student Status and Registration

Applicants may be accepted as regular, provisional, or conditional students, and must confirm acceptance within the period designated in the acceptance letter. Students will be assigned an advisor from their program, and must confer with the advisor regarding an approved program of studies and course selection prior to registration. Registration is required for all courses, and entry is granted on a first-come, first-served basis.

Course Descriptions

Pharmaceutical Science

PSC G100

Concepts in Pharmaceutical Science 2 SH

This course will introduce new students in the Pharmaceutical Science Graduate Program to important concepts in medicinal and combinatorial chemistry as they relate to drug discovery, and a brief overview of pharmacology, drug metabolism, pharmacokinetics, and toxicology. In addition, the students will be introduced to the major drug receptor families and their signaling pathways.

PSC G210

Drug Design, Evaluation and Development 2 SH

This course will teach students the concepts of using immunological, genomic, and proteomic techniques to find novel drug targets. In addition, the students will be introduced to the concepts of drug targeting and dosage forms, *in vivo/in vitro* drug screening, and the importance of pharmacogenetics to explain variability in drug reactions.

Prereq. PSC G100.

PSC G212

Research Skills and Ethics 1 SH

This course will teach students the basics of laboratory safety, safekeeping laboratory data, and the process of writing a grant proposal.

In addition, case studies will explore the concepts of data distortion or fabrication, conflicts of interest, confidentiality, ethical aspects of peer review, and the attribution of credit in science.

PSC G214

Experimental Design and Biometrics 2 SH

Discusses fundamental principles of experimental design and statistical analysis, with particular emphasis on clinical research. Topics include descriptive statistics, hypothesis testing, analysis of variance, correlation, regression, chi square test, and non-parametric methods.

PSC G216

Human Physiology and Pathophysiology 2 SH

Introduces major topics in human physiology, emphasizing knowledge essential to health-related laboratory research. Topics include neurophysiology, immunology, cardiovascular, respiratory, renal and gastrointestinal physiology, and endocrinology.

PSC G218

Biomedical Chemical Analysis 2 SH

Presents the modern reagents, techniques, and instrumentation used to analyze biological samples and purify their components (e.g. drugs, metabolites, hormones, macro-molecules, organelles, and cells) in health and disease. Emphasizes basic concepts and mechanisms at the molecular level, and applications to human samples.

Prereq. BIO G300 and BIO G301.

PSC G222

The Chemistry and Biology of Drugs of Abuse 3 SH

This course provides an interdisciplinary introduction to substance abuse including the medicinal chemistry and neurobiology of drugs that act through the opioid, dopamine, acetylcholine, and cannabinoid systems. Neurochemical mechanisms that are common to many addictive agents, and those that are specific to individual drug classes, are compared and contrasted. The involvement of the brain dopamine system is highlighted, and differences and similarities between the pharmacology of abused and therapeutic drugs are discussed, together with the development of medications for treating drug dependence. The course includes lectures by experts on particular topics on their own recent research. Students are introduced to key aspects of biological and chemical research as they pertain to drug abuse and its treatment.

Prereq. BIO G300 or CHM G376 or PSY140

PSC G224**Behavioral Pharmacology and Drug Discovery 2 SH**

This course prepares students to understand the advantages, shortcomings and pitfalls of the use of live, behaving animals in drug discovery. The material covered includes an in-depth analysis of ethical issues in animal research. Other general topics include: aspects of animal behavioral models; behavior and brain biochemistry, and methods of behavioral analysis. Specific topics include: psychopharmacology; fear and anxiety; pain and stress; depression and reward; general arousal, and tolerance, drug abuse and habitual behaviors. The ways in which animal behaviors can be described in a quantitative manner and the effects of medications and abused drugs quantified and related to human diseases and drug responses, are an important component of the course.

Prereq. PSC G100 and CHM G200 or PSC G212

PSC G226**Imaging in Medicine and Drug Discovery 2 SH**

This course prepares students to understand modern non-invasive medical imaging modalities, principally positron emission tomography (PET) and magnetic resonance imaging (MRI), used in metabolic and functional studies. The course reviews the basic science of magnetic resonance and radioactivity and radiation measurement, as well as tracer kinetics, but concentrates on applications. Topics covered include a survey of clinical radiological studies; clinical and preclinical human drug discovery and development research involving imaging, and the development and uses of radiopharmaceuticals and other contrast agents for imaging modalities including x-rays and ultrasound as well as PET and MRI.

PSC G280**Immunobiotechnology 2 SH**

Presents the basic elements of immunopathology, reviewing the components and function of the immune system. Covers the disorders of the complement system, the biologic mechanisms of immunologically-induced tissue injury (hypersensitivity reactions), autoimmunity, and immunodeficiency. Considers the immunological features of cancer and transplant rejection.

Prereq. BIO G283 or permission of instructor.

PSC G290**Molecular Modeling and Drug Design 2 SH**

Covers computer graphics-assisted modeling of drugs and their macromolecular targets. Includes hands-on experience with several modeling programs, as well as theoretical concepts related to the drug design process.

Prereq. PSC G100.

PSC G300**Pharmaceutical Science Seminar 1 SH**

A Journal Club format teaches the students to critically evaluate the scientific literature. Several sections may be offered each semester to accommodate different specializations or interest groups.

Students normally register twice in their 3rd year.

PSC G314**Special Topics of Pharmaceutical Science 2 SH**

Course content depends on the instructor.

Prereq. PSC G100 or permission of instructor.

PSC G401**Pharmaceutical Science Internship 1 SH**

An experiential component of the graduate curriculum that fosters professional development through summer internship in drug discovery, development, and/or regulatory affairs in pharmaceutical or biotechnology companies. Students will engage in pharmaceutical science research or work in an environment outside the university but under the supervision of a faculty instructor.

Prereq. Permission of program director.

PCL G260**Pharmacology 1 2 SH**

Surveys the chemical and pharmacological basis of the major classes of drugs and their use in the treatment of disease. Characteristics of drugs studied include indications, adverse reactions, contraindications, structure-activity relationships, metabolism, mechanism of action, and clinically significant interactions.

Prereq. PSC G100 and PSC G216 or permission of instructor.

PCL G261**Pharmacology 2 2 SH**

Continues Pharmacology 1, although in a format that is not contingent that Pharmacology 1 precedes this course.

Prereq. PSC G100 and PSC G216 or permission of instructor.

PCL G262**Receptor Pharmacology 2 SH**

Reviews receptors for drug substances and for endogenous ligands in a format that combines lecture presentations and discussion. Focuses on the evaluation of current literature. Covers techniques available to study receptors, various models for receptor-ligand interactions, stereochemical aspects of receptor interactions, receptor mediated coupling mechanisms, and evaluation of several specific receptor systems.

Prereq. PSC G100 or permission of instructor.

PCT G250**Advanced Physical Pharmacy 2 SH**

This course covers the physical and chemical principles in drug formulation design with emphasis on topics such as solutions of non-electrolytes and electrolytes, ionic equilibria, drug complexation, reaction kinetics, mass transport, and interfacial phenomena.

Prereq. Permission of instructor.

PCT G252**Pharmacokinetics and Drug Metabolism 3 SH**

This course will focus on concepts of one- and two-compartment linear and non-linear pharmacokinetics and compartmental modeling with plasma and/or urinary data. Principles and methods of metabolic biotransformation and disposition of xenobiotics in biological system will be discussed.

Prereq. Permission of the instructor.

PCT G254**Advanced Drug Delivery System 3 SH**

This course will examine in depth the role of sustained, controlled, and site-specific delivery systems for drugs and genetic materials using polymeric systems, colloidal drug delivery systems, and vectors for gene therapy.

Prereq. Permission of the instructor.

PCT G256**Advanced Pharmacokinetics 2 SH**

Topics include derivation of general equations for linear and nonlinear mammillary models by using Laplace transform, input-disposition functions and general partial fraction theorem. Explores development of compartmental, physiological, and stochastic models.

TOX G270**Clinical Toxicology 2 SH**

Examines the potential toxicity of drugs, commercial products, and environmental agents. Focuses on clinical manifestations, mechanisms of toxicity, principles of treatment, and prevention of acute and chronic poisonings.

Prereq. PSC G100 Permission of instructor.

TOX G272**Environmental Toxicology 3 SH**

Discusses the distribution, interaction, and effects of toxic agents on the biosphere. Applies the results of toxicology investigation to understanding the environment's chemical pollution.

Cross-Listed: TOX U572.

TOX G274**Organ Systems Toxicology 3 SH**

Presents the principles of toxicology from an organ-systems perspective. Focuses on the concepts used to evaluate toxicity, the mode of injury at the organ and cellular level, and the basic sub-cellular mechanisms through which toxic agents produce damaging effects.
Prereq. Concepts in Pharmaceutical Science or permission of instructor.

TOX G276**Experimental Toxicology 3 SH**

Emphasizes the interpretation of toxicological literature. Employs structure activity and biochemical methods of assessment to evaluate mechanisms of toxicity of major classes of chemical compounds. Develops the ability to analyze and interpret data in the literature.
Prereq. TOX G274.

TOX G278**Biochemical Toxicology Lab 3 SH**

Introduces investigative methods for assessing toxicity. Develops the ability to analyze and interpret data generated in the lab and in the literature, and sharpens technical report-writing skills.

PSC G411**Directed Study 1 SH****PSC G412****Directed Study 2 SH****PSC G413****Directed Study 3 SH****PSC G414****Directed Study 4 SH**

Course content depends on instructor. *Prereq. PSC G100 or permission of instructor.*

PSC G660**Pharmaceutical Science Research 1 2 SH**

Students will engage in laboratory research under the guidance of an adviser.

PSC G661**Pharmaceutical Science Research 2 2 SH**

Continues Pharmaceutical Science Research 1.

PSC G669**Master's Full-time Research 0 SH**

Student is expected to conduct full-time research in an adviser's laboratory. Confers full-time status

PSC G681**Thesis Proposal 1 SH**

Intended to show full-time status during the preparation of PhD or MS thesis proposal and proposal defense before thesis committee.

Confers full-time status

Prereq. PSC G800 and completion of Qualifying Examination.

PSC G682**Thesis 2 SH**

Research/experimental work for Master's thesis. Students may register twice.

Prereq. Permission from program director.

PSC G699**Thesis Continuation 0 SH**

Continued registration while student completes Master's thesis or other research project to meet the research requirement in Pharmaceutical Science. Confers full-time status.

PSC G760**Doctoral Pharmaceutical Science Research 1 2 SH****PSC G761****Doctoral Pharmaceutical Science Research 2 2 SH**

PSC G800**Qualifying Exam Preparation 0 SH**

Intended to show full-time status during the semester of the PhD qualifying exam. Students are expected to carry a full load of research and/or teaching responsibilities in addition to this course. Confers full-time status

PSC G810**Pharmaceutical Science Colloquium 1 SH**

Intended to show full-time status during the semester students present one formal seminar on their research. This presentation will be open to all those interested. Confers full-time status
Prereq. Permission of program director and completion of PSC G892 at least twice.

PSC G869**Doctoral Full-time Research 0 SH**

Student is expected to conduct full-time research in an adviser's laboratory. Confers full-time status

PSC G892**Dissertation 2 SH**

Research/experimental work for PhD thesis. Students may register three times. Confers full-time status
Prereq. PSC G681, permission of program director.

PSC G899**Dissertation Continuation 0 SH**

Continuation of PhD dissertation research. Confers full-time status
Prereq. Permission of program director and completion of PSC G892 three times.

Other Information

The following numbers are listed for your convenience so that you may contact these offices for further information:

Office of Graduate Financial Aid 617.373.5899

Department of Residential Life 617.373.2814

Bouvé College of Health Sciences Graduate Programs Office 617.373.2708, or check our Website at www.bouve.neu.edu.

The Disability Resource Center provides a variety of disability-related services and accommodations to Northeastern University's students and employees with disabilities. Northeastern University's compliance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990 are coordinated by the dean and director of the Disability Resource Center. Persons requiring information regarding the Disability Resource Center should contact Dean G. Ruth Bork at 617.373.2675 (voice) or 617.373.2730 (TTY).

Northeastern University assumes no liability for delay or failure to provide educational or other services or facilities due to causes beyond its reasonable control. Causes include, without limitation, power failure, fire, strikes by University employees or others, damage by natural elements, and acts of public authorities. The University will, however, exert reasonable efforts, when it judges them to be appropriate, to provide comparable services, facilities, or performance; but its inability or failure to do so shall not subject the University to liability.

Northeastern University is an equal opportunity/affirmative action educational institution and employer.

Northeastern University is committed to assisting all members of the University community in providing for their own safety and security. Information regarding campus security and personal safety, including topics such as crime prevention, University Police law-enforcement authority, crime reporting policies, crime statistics for the most recent three-year period, and disciplinary procedures, is available upon request from the Northeastern University Director of Public Safety, 360 Huntington Avenue, Boston, MA 02115 or by calling 617.373.2696.