

CATALOG 2011 – 2012

Programs of Study, Courses and Requirements

Graduate Program

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Tufts University is an equal opportunity educator and employer.

BIOCHEMISTRY

The goal of the [Graduate Program in Biochemistry](#) is for students to acquire advanced knowledge of the biochemical principles that underlie how cells function in both the normal and diseased states. Because these principles form the basis for research into all cellular processes, the knowledge gained by our students through coursework and thesis research prepares them to enter careers such as biomedical research, teaching, professional schools and government labs, biotechnology industry research, and management.

View a list of [Biochemistry Program Faculty](#).

CURRICULUM OVERVIEW

During the first year, students interested in the Biochemistry Program participate in the Integrated Studies Program (ISP), a single portal of entry and common first-year curriculum for Sackler programs in Biochemistry; Cell, Molecular and Developmental Biology; Cellular and Molecular Physiology; and Neuroscience. In the first year, students complete required ISP didactic courses (BCHM 223 and 230, CNP 209 and 210, ISP 220 and SK 275). They also participate in weekly ISP journal clubs and seminars, and complete four laboratory rotations. A complete description of the Integrated Studies Program can be found [here](#).

Students electing to pursue a PhD in Biochemistry declare this intention when they select a thesis adviser at the end of May in the first year of graduate school. During the second and subsequent years, students complete an additional required didactic course (BCHM 231) and two elective credits. Students also participate in Biochemistry journal clubs and seminars and must pass a qualifying examination. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Students must pass a qualifying examination by May of their first year in the Biochemistry Program. The exam requires the preparation and defense of an original research proposal that is not related to future dissertation work or to prior research experiences. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Admission to candidacy is based on achievements in didactic courses and lab rotations, participation in seminars, and satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students begin preliminary research when they enter the Biochemistry Program and their dissertation laboratory. The student and mentor, in consultation with the student adviser and program director, select a thesis advisory committee of at least three Biochemistry Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body once a year. When the thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

TEACHING

In the third year, graduate students assist in conference and tutorial group teaching of medical students as part of their training.

PUBLICATION

Students are expected to publish their research in scientific journals appropriate to their topic. Typically, students publish one or more papers.

COURSES

BCHM000: QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. Summer. S/U. *Program Director*

BCHM 223: GRADUATE BIOCHEMISTRY (2 CR)

This course provides a graduate-level discussion of the structure and function of biologically important molecules. Problems of protein and nucleic acid biochemistry are emphasized. Fall. A-F. *Schaffhausen*

BCHM 224: ADVANCED GRADUATE BIOCHEMISTRY (1 CR)

Advanced Graduate Biochemistry is intended to allow students with strong biochemistry backgrounds to explore areas of biochemistry relevant to their interests in a more detailed way. It is offered in parallel with BCHM223 Graduate Biochemistry. It is intended for MD/PhD students who have taken Medical Foundations I and for PhD students coming to the Sackler School with a substantial background in biochemistry. PhD students would be allowed to substitute (transfer to) this course after the first BCHM223 examination if they meet the performance requirements set by the Course Director and wish to do so. Fall. A-F. *Schaffhausen*

BCHM 230: BIOCHEMISTRY OF GENE EXPRESSION AND SIGNAL TRANSDUCTION (2 CR)

This course covers the molecular mechanisms of gene expression and signal transduction. The fundamental mechanisms underlying transcription, RNA processing, translation, and DNA replication are highlighted, and the integration of these fundamental mechanisms into molecular and cellular regulation of proliferation and signal transduction is discussed. Current literature is emphasized. Spring. A-F. *Yee, Program faculty*

BCHM 230A: BIOCHEMISTRY OF GENE EXPRESSION (1 CR)

The fundamental mechanisms underlying transcription, RNA processing, translation, and DNA replication are highlighted in this course. Current literature is emphasized. This course represents the first part of Biochemistry 230 and may be taken as a separate course. Spring. A-F. *Yee, Program faculty*

BCHM 230B: BIOCHEMISTRY OF SIGNAL TRANSDUCTION (1 CR)

The integration of fundamental mechanisms into molecular and cellular regulation of proliferation and signal transduction is discussed. Current literature is emphasized. This course represents the second part of Biochemistry 230 and may be taken as a separate course. Spring. A-F. *Yee, Program faculty*

BCHM 231: MOLECULAR RECOGNITION IN BIOLOGY AND DRUG DESIGN (1 CR)

This course includes discussion of the association of biological molecules. Complexes of proteins with other proteins, with lipids, and with nucleic acids are emphasized. There are discussions on drug screening and optimization techniques as they have been applied in a number of detailed, real-world cases. Spring. A-F. *Bachovchin, Program faculty*

BCHM 231A: MOLECULAR RECOGNITION IN BIOLOGY (0.5 CR)

This course represents the first part of a discussion of the association of biological molecules. Complexes of proteins with other proteins, with lipids, and with nucleic acids are emphasized. This course represents the first part of Biochemistry 231 and may be taken as a separate course. Spring. A-F. *Bohm, Program faculty*

BCHM 231B: DRUG DESIGN (0.5 CR)

This course represents the second part of a discussion of drug screening and optimization techniques as they have been applied in a number of detailed, real-world cases. This course represents the second part of Biochemistry 231 and may be taken as a separate course. Spring. A-F. *Bachovchin, Program faculty*

BCHM 234: MACROMOLECULAR CRYSTALLOGRAPHY (0.5 CR)

This course is an introduction to practical macromolecular crystallography. It includes some theoretical material but emphasizes the practical aspects of the technique. Students grow protein crystals and use them to learn crystallographic data collection, phasing, and molecular replacement methods. Spring. A-F. *Bohm*

BCHM 235: FUNDAMENTALS OF NUCLEAR MAGNETIC RESONANCE (0.5 CR)

Fundamentals of NMR is a course designed to teach advanced topics in NMR spectroscopy. Fall. A-F. *Baleja*

BCHM 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Program faculty*

BCHM 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

BCHM 295, 296: JOURNAL CLUB (0.5 CR)

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. Fall and Spring. S/U. *Program Faculty*

BCHM 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. A-F. *Program faculty*

BCHM 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. S/U. *Program faculty*

CELL, MOLECULAR AND DEVELOPMENTAL BIOLOGY

The [Graduate Program in Cell, Molecular and Developmental Biology](#) supports rigorous training of students in developmental biology. This discipline integrates the study of dynamic cellular and molecular processes into an organismal context and forms the basis for investigation of reproductive and embryonic, fetal and neonatal, genetic and teratologic diseases. Research focused on development and developmental diseases often reveals the mechanisms underlying normal and aberrant tissue remodeling in the mature organism in areas such as wound healing, the menstrual cycle, cardiovascular disease, tissue regeneration, and in fundamental disturbances in cell behavior such as aging and cancer. Our trainees will be prepared to solve problems through experimental approaches and be ready to pursue postdoctoral training leading to positions in academia or the biotechnology industry upon completion of their studies.

View a list of [Cell, Molecular and Developmental Biology Faculty](#).

CURRICULUM OVERVIEW

During the first year, students interested in the Cell, Molecular and Developmental Program participate in the Integrated Studies Program (ISP), a single portal of entry and common first-year curriculum for Sackler programs in Biochemistry; Cell, Molecular and Developmental Biology; Cellular and Molecular Physiology; and Neuroscience. In the first year, students complete required ISP didactic courses (BCHM 223 and 230, CNP 209 and 210, ISP 220 and SK 275). They also participate in weekly ISP journal clubs and seminars, and complete four laboratory rotations. A complete description of the Integrated Studies Program can be found [here](#).

Students electing to pursue a PhD in the Cell, Molecular and Developmental Biology Program declare this intention when they select a thesis adviser at the end of May in the first year of graduate school. During the second and subsequent years, students must complete an additional required didactic course (CELL 235) and one elective credit. Students also participate in Molecular and Developmental Biology journal clubs and seminars and must pass a qualifying examination. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Students must pass a qualifying examination by March 31 of their first year in the Cell, Molecular and Developmental Biology Program. The exam requires the preparation and defense of an original research proposal that is not related to future dissertation work or to prior research experiences. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Admission to candidacy is based on achievements in didactic courses and lab rotations, participation in seminars, and satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students begin preliminary research when they enter the Cell, Molecular and Developmental Biology Program and their dissertation laboratory. The student and mentor, in consultation with the student adviser and program director, select a thesis advisory committee of at least three Cell, Molecular and Developmental Biology Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student

meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body once a year. When the thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

TEACHING

Each student has the option (with the approval of the Program Director and the thesis adviser) to participate in mentored teaching of a one-semester professional course. All course assignments are determined by a consensus of the student, his/her adviser, the course director, and the Program Director. To promote the acquisition of communication skills in this phase of the program, the student is expected to be actively involved in laboratories, tutorials and teaching meetings, and to prepare and deliver introductions to laboratories and/or formal lectures.

PUBLICATION

Students are expected to publish their research in scientific journals appropriate to their topic. Typically, students publish one or more papers.

COURSES

CELL 000: QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. Spring. S/U. *Program faculty*

CELL 203: MEDICAL HISTOLOGY (2 CR)

This is an elective course that introduces the student to the organization of a variety of cells, tissues, and organ systems. The lectures present information on the relationships between structure and function (i.e., physiology, biochemistry, and development), while the laboratories involve tissue and organ identification, providing both a practical background in cell and tissue biology. Fall. A-F. *Castellot*

CELL 235: DEVELOPMENTAL BIOLOGY (1 CR)

This course introduces students to modern developmental biology with an emphasis on the cellular and molecular mechanisms involved. General topic areas include fertilization and early development, mechanisms of cell determination and differentiation, and cell-cell and cell-matrix interactions. Fall. A-F. *Hatini*

CELL 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Program faculty*

CELL 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

CELL 295, 296: JOURNAL CLUB (0.5 CR)

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. Fall and Spring. S/U. *Program Faculty*

CELL 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. *S/U. Program faculty*

CELL 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. *S/U. Program faculty*

CELLULAR AND MOLECULAR PHYSIOLOGY

The [Graduate Program in Cellular and Molecular Physiology](#) seeks to train outstanding scientists and physician-scientists to pursue careers in biomedical research in both academic and industrial settings. The program focuses on basic cellular processes and their relationship to human disease. Situated on the Health Sciences campus of Tufts University, home to the School of Medicine, School of Dental Medicine, Friedman School of Nutrition Science and Policy, the USDA Human Nutrition Research Institute on Aging and Tufts Medical Center, the program takes advantage of an extensive array of disease-related research. The program's trainees learn to incorporate current medical problems into their research and enhance their ability to impact human health.

View a list of [Cellular and Molecular Physiology Faculty](#).

CURRICULUM OVERVIEW

During the first year, students interested in the Cellular and Molecular Physiology Program participate in the Integrated Studies Program (ISP), a single portal of entry and common first-year curriculum for Sackler programs in Biochemistry; Cell, Molecular and Developmental Biology; Cellular and Molecular Physiology; and Neuroscience. In the first year, students complete required ISP didactic courses (BCHM 223 and 230, CNP 209 and 210, ISP 220 and SK 275). They also participate in weekly ISP journal clubs and seminars, and complete four laboratory rotations. A complete description of the Integrated Studies Program can be found [here](#).

Students electing to pursue a PhD in Cellular and Molecular Physiology declare this intention when they select a thesis adviser at the end of May in the first year of graduate school. During the second and subsequent years, students must complete an additional required didactic course (CMP 230) and two elective courses. Students also participate in Cellular and Molecular Physiology journal clubs and seminars and must pass a qualifying examination. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Students must pass a qualifying examination by spring of their first year in the Cellular and Molecular Physiology Program. The exam requires the preparation and defense of an original research proposal that is not related to future dissertation work or to prior research experiences. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Admission to candidacy is based on achievements in didactic courses and lab rotations, participation in seminars, and satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students begin preliminary research when they enter the Cellular and Molecular Physiology Program and their dissertation lab. The student and mentor, in consultation with the student adviser and program director, select a thesis advisory committee of three Cellular and Molecular Physiology Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body

once a year. When the thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

PUBLICATION

Students are required to publish a first author paper based on their thesis work before defending their thesis.

COURSES

CMP 000: QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty.

CMP 230: PATHOBIOLOGY (1 CR)

This is a discussion-based course that introduces graduate students to human disease, familiarizes them with pathological specimens and patients, provides examples of how scientific discovery and clinical practice have influenced each other, and uses clinical problems as a starting point for hypothesis-driven research. Fall. A-F. *Liscum*

CMP 245: BIOINFORMATICS AND GENOMICS IN BIOMEDICAL RESEARCH (1 CR)

This course provides information and in-depth training in the use of bioinformatics and genomics-related tools and resources as they relate to biological research. Topics include working with biological databases, gene sequence analysis, prediction of protein structure, molecular modeling, model genomes, expression array technology, proteomics and functional genomics, and molecular evolution. Prerequisites: familiarity with genetic approaches or consent of the course director. Spring. A-F. *Sahagian*

CMP 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. A-F. *Program faculty*

CMP 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

CMP 295, 296: JOURNAL CLUB (0.5 CR)

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. Fall and Spring. S/U. *Program Faculty*

A-F. *Faust*

CMP 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. A-F. *Program faculty*

CMP 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. S/U. *Program faculty*

CLINICAL AND TRANSLATIONAL SCIENCE

The [Graduate Programs in Clinical and Translational Science](#) train physicians and other clinicians who will be leaders and innovators to develop, evaluate, apply and implement clinical research techniques that will improve and enhance patient care, and trains those with careers in health services research. Our goals are achieved by teaching core research methods and skills and by facilitating each trainee's successful completion of an independent research project in an environment where innovation and excellence are expected and opportunities are plentiful. The Clinical and Translational Science Program confers MS and PhD degrees and also offers a Certificate Program. The Program is intended for individuals already trained in the medical sciences, most commonly fully-trained physicians. Others with similar backgrounds (e.g., DDS, DVM or PharmD) or advanced biomedical or clinical degrees may also be considered.

View a list of [Clinical and Translational Science Faculty](#).

MASTER'S AND PHD CURRICULUM OVERVIEW

The Clinical and Translational Science Master's Program provides a strong foundation of core methods and skills through required didactic courses (CRES 500, 523, 525, 527, 535, 537, 538, 540, 561, 566, and 581), 2.5 elective credits, seminars, hands-on computer labs, workshops and mentored research projects. Participants acquire a rigorous foundation that includes research methods, statistics, research conduct, research ethics, manuscript and grant writing, and other specialized areas. Because the ability to self-initiate and execute independent research is key to success as a researcher, a central requirement is the completion of an independent research project that leads to a master's thesis. Students have the opportunity to select one of three areas for focused concentration: Clinical Investigation, Evidence-based Medicine, and Health Services and Outcomes Research. For the Master's degree, 19.5 credits are required; 11 credits in the core curriculum, six credits for a publishable thesis, and 2.5 credits of elective credits. The Master's Degree typically takes two years to complete.

Students interested in pursuing PhD degrees in Clinical and Translational Science typically sit for their qualifying exams during the end of the first year or the beginning of the second year in the MS program. After satisfactory performance on the qualifying exam, PhD candidates complete additional courses deemed necessary by the students and faculty advisers, and create original dissertations of publishable quality. For the PhD degree, 39.5 credits are required: 15 credits in the core curriculum, 22 credits for a publishable thesis, and 2.5 credits for electives. PhD degrees typically take at least four years to complete.

As students progress in the MS or PhD programs, they will select Chairs for their thesis committees. Often, a Project Mentor with whom the student worked in the first year will agree to chair a thesis committee. The Thesis Committee Chair must be a member of the Sackler School Faculty. The Thesis Mentor should be identified by the end of the first semester of study. The purpose of the thesis or dissertation is to demonstrate research competence as a culminating project of the Clinical and Translational Science graduate program. Working under the supervision of the Thesis Committee, the student's work must be original and rigorous, and approved by the student's Thesis Committee and the Clinical and Translational Science Program Advisory Committee in order to graduate.

PUBLICATION

Publishing research is an important element of the scientific research process for both the Master's and PhD degrees. To encourage publication of the thesis or dissertation research findings, the Clinical and Translational Science Program will accept either a publishable manuscript format or a traditional monograph format. Students are encouraged to use the publishable format as a way to enhance their scholarship record. One article is required for the master's thesis (original research findings)

and a minimum of three articles are required for the doctoral dissertation (at least one of which must present original research findings).

CERTIFICATE CURRICULUM OVERVIEW

The Clinical and Translational Science Certificate Program is specifically designed for junior faculty of Tufts-affiliated hospitals, fellows in training, and mid-career clinicians who are considering a career change and want to strengthen their clinical research skills. The program begins in the summer and continues part-time for the next nine months. The curriculum includes required didactic courses (CRES 500, 504, 523, 525, 540, 561, 566, and 581), seminars, workshops, and customized final research projects. For the Certificate Program, eight credits are required: seven credits in the core curriculum and one credit of research. Research efforts should result in a publishable manuscript/brief report or proposal for pilot project.

COURSES

CRES 000: PHD QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. *S/U. Program faculty*

CRES 402: MASTER'S DEGREE ONLY (0 CR)

This course is taken during the summer term after completing all didactic and research courses. Students prepare and write their master's theses, Summer. *S/U. Program faculty*

CRES 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. *S/U. Program faculty*

CRES 500: STUDY DESIGN SEMINAR (0.5 CR)

These seminars meet weekly and use proposed and ongoing research projects to explore issues in study design. The course provides investigators and trainees the opportunity to present a research-related problem they are encountering and engages students in a discussion of the approach to the problem and an appropriate plan of action. Fall and Spring. A-F. *Kent, Pittas*

CRES 501: TRANSLATIONAL AND MOLECULAR EPIDEMIOLOGY (0.5 CR)

This course aims to address some of the main challenges of current translational research in the interface of epidemiology and molecular medicine. Spring. A-F. *Ioannidis*

CRES 502: BRIDGING THE BENCH-TO-BEDSIDE GAP (0.5 CR)

This course seeks to diminish the "bench-to-bedside" gap by exposing clinical graduate students to basic science research. Students focus on major questions that are ready for future scientific investigation, how scientific discoveries have influenced clinical practice, and how clinical practice has affected basic research. Examination of active projects at Tufts Medical Center introduces students to translational science in action. Spring. A-F. *Simon*

CRES 504: UNDERSTANDING BIOSTATISTICAL METHODS (1 CR)

This course presents the practical application of biostatistical methods for exploring and analyzing health data. Methods for working with data and exploring basic associations are presented through case examples and clinical research projects. Summer. A-F. *Griffith*

CRES 510: PREDICTIVE MODELS FOR HEALTH OUTCOMES (1 CR)

This course explores the use of statistical models to predict clinical outcomes for retrospective review and as prospective decision aids. Emphasis is placed on integrating statistical and clinical thinking to construct models that are both statistically and clinically sound and that give accurate predictions when generalized to other populations. Fall. A-F. *Griffith, Selker*

CRES 511: MACHINE LEARNING IN PREDICTIVE MEDICINE (1 CR)

This course introduces computer science students and clinicians to practical applications of machine learning to solving problems in clinical medicine through creation of collaborative research teams working on unsolved problems with a clinical researcher. The short-term goal is for each team to produce a report presented at the end of the course. The long-term goal is to build collaborative relationships and the advancement of interdisciplinary work between computer scientists and clinical researchers. Spring. S/U. *Schmid*

CRES 512: COMPARATIVE EFFECTIVENESS RESEARCH SURVEY (1 CR)

The course describes the current state of CER and evidence-based medicine (EBM). The tools of this kind of work are defined including various forms of CER from clinical trials, registry and observational research, technology assessments, and evidence reports. Methodologies used are explained, for example effectiveness trials, decision analysis, cost-effectiveness analysis, systematic review, and meta-analysis. Spring. S/U. *Selker*

CRES 514: CLINICAL RESEARCH PROJECT-CERTIFICATE CANDIDATES (1 CR)

Students develop mentored research plans with mentors (or mentoring teams) that permits them to demonstrate these skills through the development of a protocol, a report, or research manuscript. The mentoring teams are required to have at least one member who is on the faculty of the Sackler CTS program. The project design is led by students, so they learn the role of principal investigator. This course is required for the Certificate Program, and is not available to non-certificate students. Fall. S/U. *Program faculty*

CRES 515: CLINICAL RESEARCH PROJECT/THESIS RESEARCH - FIRST YEAR (1 CR)

First year master's students begin to learn how to complete comprehensive independent clinical research project, which includes framing a research question and specific project aims, identifying useful data sources, developing appropriate methods, identifying and defending against sources of bias, implementing/managing a project, and writing up a thesis in the form of a publishable article or monograph. Fall and Spring. S/U. *Program faculty*

CRES 516: CLINICAL RESEARCH PROJECT/THESIS RESEARCH- SECOND YEAR (2 CR)

Second year master's students continue and complete their independent clinical research projects. Students gain additional skills in framing a research question and specific project aims, identifying useful data sources, developing appropriate methods, identifying and defending against sources of bias, implementing/managing the project, and writing up the thesis in the form of a publishable article or monograph. Fall and Spring. S/U. *Program faculty*

CRES 517: CLINICAL RESEARCH PROJECT/THESIS RESEARCH – PHD CANDIDATES (4 CR)

PhD students to complete comprehensive independent clinical research doctoral-level project, which includes framing a research question and specific project aims, identifying useful data sources, developing appropriate methods, identifying and defending against sources of bias, implementing/managing the project and writing up the thesis in the form of a publishable article and PhD thesis. Fall, Spring, and Summer. S/U. *Program faculty*

CRES 518: CLINICAL RESEARCH ADVANCED THESIS RESEARCH (1-4 CR)

The course is for students who do not complete their theses in the customary timeframe and wish to pursue further research. The Program Director, in consultation with the student's thesis committee and program mentor, determines the number of credits. Fall, Spring, and Summer. *S/U. Program faculty*

CRES 519: CONCENTRATION PRACTICUM (0.5-2 CR)

Students are required to take core courses essential to developing the necessary competencies to become an independent clinical researcher. In addition, students may elect a concentration: Clinical Investigation, Evidence-based Clinical Effectiveness Research, and Health Services and Outcomes Research to develop a greater depth of knowledge and skills in a selected area. Spring. *S/U. Program faculty*

CRES 523: INTRODUCTION TO CLINICAL EPIDEMIOLOGY (1 CR)

This course provides students with an overview of the epidemiologic approach to the study of disease causation, its natural history, and epidemiologic methods. This course reviews the application of various observational and experimental research designs and strategies utilized in clinical and epidemiological research. Didactic instruction, readings, and problem sets are used to create each module: investigation of disease outbreaks, sources of health information, observational studies, randomized clinical trials, measures of morbidity and mortality, sources of and controls for bias evaluation of diagnostic and screening tests, and development of surveillance studies. Fall. A-F. *Goldberg*

CRES 525: INTRODUCTION TO CLINICAL CARE RESEARCH (2 CR)

This course, meeting three hours daily over a four-week summer session, teaches students how to formulate a clinical research hypothesis and to develop it into a clinical research project. Students acquire an understanding of basic and advanced principles of study design and issues in conducting biomedical research involving human subjects. Summer. A-F. *Kent*

CRES 527: BIOSTATISTICS I (1 CR)

This course introduces basic principles and applications of statistics to problems in clinical research. Topics covered include descriptive statistics, probability and random variation, sampling, hypothesis testing, proportions, measures of frequency, t-tests, chi-square tests, one-way analysis of variance, correlation, linear regression and nonparametric statistics. Fall. A-F. *Schmid*

CRES 530: BIOSTATISTICS III (1 CR)

This seminar covers topics selected by the instructor based on the statistical research needs of students. Possible choices include factor and principal components analysis, longitudinal data models, neural networks, time-series analysis and advanced survival analytic methods. Spring. A-F. *Schmid*

CRES 535: BIOSTATISTICS II (1 CR)

This course surveys regression techniques for outcomes common in public health data, including continuous, binary, count and survival data. Emphasis is on developing a conceptual understanding of the application of these techniques to solving problems and to cogently summarize the results, rather than numerical details. Spring. A-F. *Schmid*

CRES 537: SCIENTIFIC MANUSCRIPT WRITING (0.5 CR)

This course focuses on principles of scientific manuscript writing. The student learns how to develop a manuscript by reviewing the specific issues of style, authorship and volume of information that should be incorporated into a research paper. Fall and Spring. A-F. *Goldberg*

CRES 538: SCIENTIFIC GRANT WRITING (0.5 CR)

The purpose of this course is to teach the principles of clinical research grant writing. Participants learn the importance of, and how to select, investigators and co-investigators as well as the identification of potential funding sources and other important aspects of grant writing. Fall and Spring. A-F. *Goldberg*

CRES 539: SCIENTIFIC WRITING, PEER REVIEW AND PRESENTATIONS (0.5 CR)

Students focus on principals of scientific review and grant peer review. This involves critiquing manuscripts and reviewing research grants for mock study section meetings. Students are encouraged and given an opportunity to present their scientific writings and oral presentations for critique on an ongoing basis. Fall and Spring. A-F. *Program faculty*

CRES 540: ETHICS OF CLINICAL INVESTIGATION (0.5 CR)

The goal of this course is to increase awareness of research ethics and their practical applications by medical practitioners and researchers – specifically with regard to clinical investigations. The curriculum addresses the interrelationships between ethics, law and professional practice standards and explores the role and workings of Institutional Review Boards. Fall. A-F. *Program faculty*

CRES 545: PSYCHOMETRICS AND OUTCOMES MEASUREMENT (1 CR)

This course reviews health assessment tools and other patient-reported outcome measures that are used to ascertain functional health, well-being and health-related quality of life. Spring. A-F. *Lerner*

CRES 555: PRINCIPLES OF DRUG DEVELOPMENT (1 CR)

This course examines the important economic, political, legal and scientific issues that face academic clinical investigators who work in partnership with industry sponsors and government regulators to design and conduct clinical studies. Fall. A-F. *Kaitin*

CRES 556: PRINCIPLES OF PHARMACOECONOMICS (0.5 CR)

This is an elective course on methods and uses of pharmacoeconomic analyses and other economic evaluations of medical technologies in health care. Pharmacoeconomics is the application of economic evaluation (i.e., cost analysis, cost-effectiveness, cost-benefit analysis, etc.) to pharmaceutical therapies. Spring. A-F. *Neumann*

CRES 561: INTRODUCTION TO CLINICAL TRIALS (0.5 CR)

This course considers the various problems and options available in the design and conduct of clinical trials, including classical efficacy trials and "effectiveness trials." Issues to be covered include ethics, experimental design, coordination and operations, database development, interim analysis, safety monitoring and analysis, and reporting. Fall. A-F. *Snydman*

CRES 562: SPECIAL TOPICS IN CLINICAL TRIALS (0.5 CR)

This is a seminar course that explores special topics in clinical trials. Topics include internet-based clinical trials, N of 1 trials, trials in special populations and overseas, industry sponsored trials and multicenter trials. Spring. S/U. *Snydman*

CRES 566: INTRODUCTION TO HEALTH SERVICES RESEARCH (0.5 CR)

This course introduces students to the concepts and methods that distinguish health services and health policy research from other fields. Faculty cover major topics in health services/health policy research including outcomes research design and methods, health economics, pharmacoeconomics, access and payment for health services, healthcare quality and quality improvement. Spring. A-F. *Lerner, Parsons*

CRES 567: HEALTH POLICY (1 CR)

This course examines the forces that influence the health policy process in terms of policy formulation, implementation and outcomes. Consideration is given to the roles of various stakeholders: healthcare professionals, consumers and public and private payers. Spring. A-F. *Lerner*

CRES 571: ADVANCED EPIDEMIOLOGY (1 CR)

This course includes advanced topics in epidemiologic study design and analysis. The first module focuses on study design, beginning with the randomized clinical trial and proceeding to examine observational designs in depth, including prospective and retrospective cohorts, and those sampling from an underlying cohort. Design, sampling and analysis strategies and the biases that are specific to each study type are discussed. The second course module examines topics in study analysis, interpretation and bias, including confounding, matching, propensity scores, instrumental variables, effect modification, misclassification, and directed acyclic graphs for causal inference. A prior introductory course in epidemiology is required for enrollment. Spring. A-F. *Paulus*

CRES 581: INTRODUCTION TO EVIDENCE-BASED MEDICINE (0.5 CR)

This course covers the principles of systematic review processes, evaluation of studies and bodies of evidence as used in the conduct of systematic reviews, meta-analyses and the development of evidence-based clinical practice guidelines. The course focuses on studies of treatment efficacy. Spring. A-F. *Lau, Program faculty*

CRES 582: GENETIC EPIDEMIOLOGY (1 CR)

This course is an introduction to the concepts and methodology of genetic epidemiology, including novel methods of molecular biology, quantitative genetics, study design for genetic traits, segregation analysis and linkage analysis. Spring. A-F. *Program faculty*

CRES 584: INTRODUCTION TO DECISION ANALYSIS (0.5 CR)

This course is a working overview of the principles of decision analysis as applied to medicine, making optimal choices in the face of uncertainty. Formal decision analysis has become a well-recognized and accepted research discipline for examining clinical options facing patients, physicians and policymakers. Spring. A-F. *Pauker, Wong*

CRES 593, 594: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

GENETICS

The [Graduate Program in Genetics](#) is designed to train scientists in the basic principles and applications of classical and molecular genetics for careers in research, teaching and biotechnology. Our goal is to train talented individuals to think critically, identify important issues in genetics, and design and conduct original research. Our interdisciplinary program includes courses and thesis research in prokaryotic, eukaryotic, mammalian and human genetics. Strong emphasis is placed on the laboratory experience and hands-on research training.

In addition to the traditional PhD program, the Program in Genetics also offers a [Mammalian Genetics](#), track which is offered in conjunction with The Jackson Laboratory in Bar Harbor, Maine.

View a list of [Genetics Program Faculty](#).

CURRICULUM OVERVIEW

Students in the Genetics Program complete a series of required and elective didactic courses designed to provide a strong knowledge base for their research. Required didactic courses include BCHM 223 and 230A, GENE 205, MBM 220 and SK 275. Students must complete two elective courses. Students in the Mammalian Genetics track, offered in conjunction with The Jackson Laboratory in Bar Harbor, Maine, are required to take GENE 208. They also participate in weekly journal clubs, seminars and research presentations and must pass a qualifying examination. Students typically select their research mentor at the end of May of the first year and begin dissertation research after completing four lab rotations and successfully passing the qualifying examination. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Students must pass a qualifying examination in the summer of the first year. The exam requires the preparation and defense of an original research proposal that is not related to future dissertation work or to prior research experiences. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Admission to candidacy is based on achievements in didactic courses and lab rotations, participation in seminars, and satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students enter their dissertation lab and begin thesis research after completing the final laboratory rotation. The student and mentor, in consultation with the student adviser and program director, select a thesis advisory committee of three Genetics Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body once a year. When the thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

PUBLICATION

Students are expected to publish their research in scientific journals appropriate to their topic. Typically, students publish one or more papers.

COURSES

GENE 000: QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. Summer. S/U. *Program Director*

GENE 203: CANCER GENETICS (1 CR)

The course reviews widely-held ideas and current research on the genetic aspects of carcinogenesis. An introduction to cancer concepts is followed by a focus on specific mechanisms and models illustrating the ways in which normal cellular processes are disrupted in particular types of cancers. The course emphasizes problem solving and readings from the current literature. Spring-alternate years. A-F. *Program faculty*

GENE 205: MAMMALIAN GENETICS (1CR)

The course reviews the genetic principles that apply to mammals and explores the methodologies that are currently used to perform genetic analysis of mammals. Genetic phenomena that are addressed include mechanisms of sex determination, genetic imprinting, and mitochondrial inheritance. Throughout the course, attention is focused on the ways in which mutation is manifested in disease phenotypes in humans. The course is taught in a format that includes faculty lectures, student presentations, and discussion. Spring. A-F. *Poltorak*

GENE 208: MEDICAL AND EXPERIMENTAL MAMMALIAN GENETICS (2 CR)

The course is an intensive workshop-style immersion into mammalian genetics over a period of approximately two weeks. The faculty present background and current research in important areas of mammalian genetics and its impact on health and disease. This course is offered at The Jackson Laboratory, Bar Harbor, ME. Summer. A-F. *Handel*

GENE 234, 235, 236: LABORATORY ROTATIONS (1 CR)

Four 8-10 week laboratory rotations for first-year students are designed to provide experience with experimental design and theoretical aspects of the diverse research problems under investigation in various laboratories. Fall and Spring. A-F. *Moore*

GENE 289, 290: RESEARCH PRESENTATIONS (0.5 CR)

Students present progress reports on their research for questions and constructive criticism as well as gain experience in presenting data and leading discussion. Fall and Spring. S/U. *Moore*

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GENE 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Selsing*

GENE 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

GENE 295, 296: JOURNAL CLUB (0.5 CR)

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. Fall and Spring. S/U. *Program Faculty*

GENE 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. S/U. *Moore, Program faculty*

GENE 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. S/U. *Program faculty*

IMMUNOLOGY

The [Graduate Program in Immunology](#) offers training focused on immunologic aspects of disease. The faculty brings together talented investigators studying infectious disease, autoimmunity and normal and abnormal development of the immune system; they are committed to training the future intellectual leaders who will drive discovery and translate basic immunological concepts into new treatment approaches. Our trainees learn to define and solve such problems and become expert in the laboratory techniques required to achieve these goals. We expect them to design critical experiments, be creative but self-critical, and to make original scientific contributions that will enhance our understanding of important questions in immunologically-related research. When they finish the program, our graduates will be ready for rigorous postdoctoral research training that will place them in positions of leadership in academic medical centers, universities, or in the biotechnology and pharmaceutical industry.

In addition to the traditional PhD program, Immunology students may also pursue the [MERGE-ID](#) (MEDically-oriented Research in Graduate Education – Infectious Disease) track, which is offered in the Graduate Programs in Immunology and Molecular Microbiology. It is specifically designed to provide strong training in the basic microbiology and immunology of pathogenic organisms and host interactions as well as knowledge of the pathogenesis, diagnosis, prevent, treatment and epidemiology of infectious diseases. Trainees complete a medically relevant thesis that is co-mentored by a basic research scientist and a clinician-scientist, and complete a curriculum specifically designed to provide students with strong grounding in a biomedical scientific discipline as well as the knowledge to understand the clinical implications of their work and move their discoveries to the bedside.

View a list of [Immunology Program Faculty](#).

CURRICULUM OVERVIEW

Students in the Immunology Program complete a series of required and elective didactic courses designed to provide a strong knowledge base for their research. Required didactic courses include BCHM 223, IMM 212, 215/216, 225/226, 227/228 and SK 275. Students in the Immunology MERGE-ID track are also required to take MBM 223, MBM 224 and ISP 220, but are not required to take IMM 227. All students must complete one elective course. They also participate in weekly journal clubs, seminars and research presentations and must pass a qualifying examination. Students typically select their research mentor at the end of May of the first year and begin dissertation research after completing four lab rotations and successfully passing the qualifying examination. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Student must pass a qualifying examination in June of the first year. The exam requires the preparation and defense of an original research proposal that is not related to future dissertation work or to prior research experiences. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Admission to candidacy is based on achievements in didactic courses and lab rotations, participation in seminars, and satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students enter their dissertation lab and begin thesis research after completing the final laboratory rotation. The student and mentor, in consultation with the student advisor and program director, select a thesis advisory committee of three Immunology Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body once a year. When the thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

TEACHING

Advanced students are required to participate in teaching a semester of immunology courses to graduate students. Students typically complete this requirement in the third or fourth year of study. These are generally small group tutorials and discussion sections that help to provide valuable training and experience.

PUBLICATION

Students are required to publish a first author paper based on their thesis work before defending their thesis. They are also expected to have presented their work at one or more national or international meetings before defending their thesis.

COURSES

IMM 000: QUALIFYING EXAMINATION (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. Spring. S/U. *Program faculty*

IMM 212: INTRODUCTION TO IMMUNOLOGY (1 CR)

This is a survey based on lectures, texts, problem-solving and small group tutorials. Topics include the cellular basis of innate and adaptive immune responses, the mechanism of antigen receptor gene rearrangement, principles of tissue transplantation and the genetic and mechanistic problems underlying autoimmune and hypersensitivity diseases. Fall. A-F. *Wortis, Brodeur, Bunnell, Poltorak*

IMM 215, 216: IMMUNOLOGICAL MECHANISMS IN DISEASE I AND II (1 CR)

The course covers the pathogenesis of major infectious diseases including current knowledge of immune responses and approaches to prevention, diagnosis and treatment. Current studies of autoimmunity, hypersensitivity, leukemia and lymphoma are also covered. Fall and Spring. A-F. *Perrin, Program faculty*

IMM 217, 218: FIRST YEAR JOURNAL CLUB (1 CR)

First-year students meet with the course director to discuss articles essential for an understanding of contemporary immunology. The development of analytic skills is emphasized. Fall and Spring. S/U. *Imanishi-Kari*

IMM 225, 226: IMMUNOGENETICS I AND II (0.5 CR)

The course covers the genetic basis for lymphocyte differentiation, receptor gene rearrangement, T and B cell antigen-receptor diversity and selection, tolerance, autoimmunity and gene expression. Fall and Spring. Y/A-F. *Huber, Selsing, Roy, Poltorak*

IMM 227, 228: IMMUNOCHEMISTRY I AND II (0.5 CR)

The chemical basis for specificity of antigen-antibody reactions and structure/function analysis of lymphocyte proteins is addressed. As part of the course, each student prepares and delivers a presentation describing the development and use of an FDA-approved therapeutic antibody. Fall and Spring. Y/A-F. *Brodeur, Thorley-Lawson*

IMM 233: SCIENTIFIC AND GRANT WRITING (0.5CR)

This course provides graduate students with the opportunity to develop the basic skills essential to the effective oral and written communication of scientific findings and research proposals. The course is a combination of lectures, writing assignments, and oral communication practice sessions with feedback provided by the faculty. Summer. S/U. *Hu*

IMM 234, 235, 236: LABORATORY ROTATIONS (1 CR)

Four 8-10 week laboratory rotations for first-year students are designed to provide experience with experimental design and theoretical aspects of the diverse research problems under investigation in various laboratories. Fall and Spring. S/U. *Imanishi-Kari, Program faculty*

IMM 289, 290: RESEARCH PRESENTATIONS (0.5 CR)

Students present progress reports on their research for questions and constructive criticism as well as gain experience in presenting data and leading discussion. Fall and Spring. S/U. *Imanishi-Kari, Program faculty*

IMM 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Program faculty*

IMM 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

IMM 295, 296: JOURNAL CLUB (0.5 CR)

Students in the research portion of their training meet to present and discuss recent papers of importance. Fall and Spring. S/U. *Bunnell, Program faculty*

IMM 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. S/U. *Program faculty*

IMM 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. S/U. *Program faculty*

INTEGRATED STUDIES

The [Integrated Studies Program](#) (ISP) is the joint admissions and first year academic portal of four basic science PhD programs — Biochemistry; Cell, Molecular and Developmental Biology; Cellular and Molecular Physiology and Neuroscience. Students considering specializations in any of these areas of biomedical sciences require a basic core of knowledge, and the ISP is tailored to meet these needs. The ISP blends problem-based and didactic learning with abundant hands-on laboratory experience. This balanced approach is designed to empower the students as they make decisions about which area of research specialization they will choose at the end of their first year. To learn more about the PhD programs that make up the ISP, see their sections in this publication.

Beginning Fall 2012, the Neuroscience Program will no longer be a member of the ISP. Students will be admitted directly to the Neuroscience Program and have a separate first year curriculum.

CURRICULUM OVERVIEW

In 2011-2012, four programs will participate in the Integrated Studies Program (ISP), a single portal of entry and common first-year curriculum for Sackler programs in Biochemistry; Cell, Molecular and Developmental Biology; Cellular and Molecular Physiology; and Neuroscience. In the first year, students complete required ISP didactic courses (BCHM 223 and 230, CNP 209 and 210, ISP 220 and SK 275). They also participate in weekly ISP journal clubs and seminars, and complete four laboratory rotations.

Students select rotations from the entire faculty of all participating programs. Students in the ISP select their graduate program and their dissertation adviser in May of their first year in graduate school. Specific requirements for each of the PhD programs and an overview of the curricula of these programs can be found in the sections that describe the four programs.

COURSES

ISP 220: PROBABILITY AND STATISTICS FOR BASIC SCIENTISTS (0.5 CR)

This course provides an introduction to the principles of Probability and Statistics and emphasizes the application of these disciplines to the analysis of basic science biomedical research data. Topics include: summarizing data, testing for differences between means, analysis of variance, laws of probability, common probability distributions, the analysis of categorical data, correlation, linear regression, nonlinear curve fitting, and exponential processes. Spring. A-F. *Cox*

ISP 234, 235, 236: LABORATORY ROTATIONS (1 CR)

Four 8-10 week laboratory rotations for first-year students are designed to provide experience with experimental design and theoretical aspects of the diverse research problems under investigation in various laboratories. Fall and Spring. S/U. *Program faculty*

ISP 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Program faculty*

ISP 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

ISP 295, 296: JOURNAL CLUB (0.5 CR)

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. Fall and Spring. S/U. *Program Faculty*

MOLECULAR MICROBIOLOGY

The interdisciplinary [Graduate Program in Molecular Microbiology](#) offers rigorous theoretical and experimental training in molecular biology and genetics of bacterial and viral growth and pathogen-host interactions, accomplished through a broad range of graduate courses and laboratories for academic study and scientific development. The program of study includes classes in genetics and biochemistry and courses or seminars in microbial genetics and physiology, microbial pathogenesis, eukaryotic gene expression, molecular virology, physical biochemistry, immunology and many other topics.

In addition to the traditional PhD program, Molecular Microbiology students may also pursue the [MERGE-ID](#) (MEdically-oriented Research in Graduate Education – Infectious Disease) track, which is offered in the Graduate Programs in Immunology and Molecular Microbiology. It is specifically designed to provide strong training in the basic microbiology and immunology of pathogenic organisms and host interactions as well as knowledge of the pathogenesis, diagnosis, prevent, treatment and epidemiology of infectious diseases. Trainees complete a medically relevant thesis that is co-mentored by a basic research scientist and a clinician-scientist, and complete a curriculum specifically designed to provide students with strong grounding in a biomedical scientific discipline as well as the knowledge to understand the clinical implications of their work and move their discoveries to the bedside.

View a list of [Molecular Microbiology Faculty](#).

CURRICULUM OVERVIEW

Students in the Molecular Microbiology Program complete a series of required and elective didactic courses designed to provide a strong knowledge base for their research. Required didactic courses for students in the regular Molecular Microbiology track include BCHM 223, MBM 220, BCHM 231A (or equivalent), MBM 224 and SK 275. Students in the MERGE-ID track are also required to take IMM 212 and ISP 220, but are not required to complete MBM 220. All students are required to complete four courses in addition to the required courses. Students must acquire expertise in prokaryotic molecular genetics (MBM 206, or MBM 207B, or suitable other course), eukaryotic molecular genetics (MBM 214, or BCHM 230, or suitable other course), pathogenic microbiology (MBM 210 and 211, or MBM 214, or suitable other course) and microbial physiology (MBM 207B or suitable other course) by taking at least one selective from each of the areas. Additional courses may be chosen from any Sackler program or from other schools that allow cross-registration.

Students also participate in weekly journal clubs, seminars and research presentations and must pass a qualifying examination. Students typically select their research mentor after completing four lab rotations at the end of May of the first year and begin dissertation research. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Students must pass a qualifying examination by August of their second year. The exam requires the preparation and defense of an original research proposal that is not related to future dissertation work. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Typically, students are considered for candidacy for the doctoral degree by either the fall or spring of their second year. Admission to candidacy is based on achievement in didactic courses and lab rotations, participation in seminars, and

satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students enter their dissertation lab and begin thesis research after completing the final laboratory rotation. The student and mentor, in consultation with the student adviser and program director, select a thesis committee of three other Molecular Microbiology Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body once a year. When the thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

TEACHING

As part of their training, students serve as discussion leaders, tutors, or lab instructors in courses given in the Schools of Medicine and Dental Medicine; two such experiences are required. Additional teaching experience is available for those who have a special interest in perfecting their teaching skills. In addition to serving as instructors and tutors for the medical, dental or graduate school, students may participate in programs outside Tufts that seek to bring science to neighborhood schools.

COURSES

MBM 000: QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. *S/U. Program faculty*

MBM 206: MOLECULAR BIOLOGY OF EPISOMES AND PLASMIDS (0.5 CR)

This course covers fundamental properties of F-factors and drug resistance factors; roles of transposons in antibiotic resistance and plasmid evolution; detailed examinations of DNA processing for transfer in prokaryotic systems; regulatory mechanisms for fertility, replication, and incompatibility; and use of plasmids in genetic engineering. Spring-alternate years. A-F. *Malamy*

MBM 207B: MICROBIAL PHYSIOLOGY AND DIFFERENTIATION (1 CR)

This course covers cellular controls of biosynthesis of DNA, RNA, and proteins; kinetics of cell division in bacteria; regulation of metabolism; and bacterial differentiation as a model system for development in higher organisms. Global regulatory mechanisms responsible for the control of gene expression are emphasized. Spring-alternate years. A-F. *Sonenshein*

MBM 210: HOST-PATHOGEN INTERFACE (0.5 CR)

The goal of this course is to critically read and evaluate the scientific literature on bacterial pathogens and host defenses, with particular but not exclusive emphasis on innate immune defenses. Students are required to read at least two papers per topic and discuss them in the group. Spring-alternate years. A-F. *Mecsas*

MBM 211: BACTERIAL-HOST CELL INTERACTION (0.5 CR)

The goal of this course is to critically read and evaluate the scientific literature on the cellular biology of bacterial pathogens, with particular emphasis on cultured cell models of microbial diseases. Students are required to read at least two papers per topic and discuss them in the group. Spring-alternate years. A-F. *Isberg*

MBM 214: ANIMAL VIROLOGY (1 CR)

Molecular aspects of viral replication and host-cell interactions are emphasized. Topics include virion structure; mechanisms of nucleic acid replication, transcription, and translation; virion assembly and release; genetics; mechanisms of transformation by oncogenic viruses; responses of the host to viral infection, tumor viruses and tumor cells; and mechanisms of persistent and slow virus infections. Prerequisites: a course in molecular biology or working knowledge of molecular techniques. Spring-alternate years. A-F. *Coffin, Rosenberg*

MBM 220: GENETIC ANALYSIS (1 CR)

This is a survey course with an emphasis on the application of genetic techniques to the study of both eukaryotic and prokaryotic organisms and their viruses. Students are introduced to genetic approaches through a combination of problem solving, group discussion and lectures. Student presentations of classical and modern research papers are used to familiarize the class with the manner in which genetic approaches can be applied experimentally. Fall. A-F. *Kumamoto, Camilli*

MBM 223: INTRODUCTION TO INFECTIOUS DISEASES (1 CR)

This course is comprised of three integrated components; a Medical Microbiology Tutorial designed to introduce students to pathogens and pathophysiology of infectious diseases, Infectious Diseases Problem-Based Learning designed to introduce students to clinical cases, and a Teaching Clinic designed to expose students to real clinical cases and treatment options. Summer. A-F. *Camilli, Hu*

MBM 224: MICROBIOLOGY (1 CR)

The goal of this course is to learn about the structure, growth, genetics and manipulation of microorganisms including viruses, bacteria, fungi and parasites, with emphasis on bacteria. This course consists of text book reading, lectures and presentation and discussion of journal articles. Students are required to read one or two papers per topic and be prepared to discuss them in the group. Fall. A-F. *Camilli*

MBM 234, 235, 236: LABORATORY ROTATIONS (1 CR)

Four 8-10 week laboratory rotations for first-year students are designed to provide experience with experimental design and theoretical aspects of the diverse research problems under investigation in various laboratories. Fall and Spring. S/U. *Program faculty*

MBM 275: APPLIED ETHICS FOR SCIENTISTS (0.5 CR)

This course is a discussion/seminar course that treats selected topics related to ethical behavior in scientific work. Topics covered include fraud, plagiarism, data selection and analysis, record keeping, animal welfare, personnel issues, genetic screening and gene therapy, and conflict of interest. Enrollment is restricted to third and fourth year graduate students. Spring. S/U. *Program faculty*

MBM 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Heldwein*

MBM 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

MBM 295, 296: JOURNAL CLUB (0.5 CR)

These courses provide in-depth study and discussion of specific topics involving the critical review of current literature in a small group format. Given by faculty and graduate students (year's two through four) and attended by all program members. Fall and Spring. *S/U. Coffin*

MBM 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. *S/U. Program faculty*

MBM 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. *S/U. Program faculty*

NEUROSCIENCE

The [Graduate Program in Neuroscience](#) provides interdisciplinary training that emphasizes classical neurobiological and modern neurogenetic approaches. The program provides a broad exposure to multi-disciplinary studies that are at the forefront of neuroscience research. Students first acquire a strong basic science background and then are trained to use a variety of new techniques and methodologies important to this rapidly developing field. A major strength of the program is its cohesive faculty committed to maintaining an open, eclectic, intellectual environment.

Beginning Fall 2012, the Neuroscience Program will no longer be a member of the ISP. Students will be admitted directly to the Neuroscience Program and have a separate first year curriculum.

View a list of [Neuroscience Program Faculty](#).

CURRICULUM OVERVIEW

Students entering the Neuroscience Program Fall 2011 will participate in the Integrated Studies Program (ISP), a single portal of entry and common first-year curriculum for Sackler programs in Biochemistry; Cell, Molecular and Developmental Biology; Cellular and Molecular Physiology; and Neuroscience. In the first year, students complete required ISP didactic courses (BCHM 223 and 230, CNP 209 and 210, ISP 220 and SK 275). They also participate in weekly ISP journal clubs and seminars, and complete four laboratory rotations. A complete description of the Integrated Studies Program can be found [here](#).

Students electing to pursue a PhD in Neuroscience declare this intention when they select a thesis adviser at the end of May in the first year of graduate school. During the second and subsequent years, students complete an additional required didactic course (NRSC 212) and two elective courses. Students also participate in Neuroscience journal clubs, student presentation class and must pass a qualifying examination. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Students must pass a qualifying examination by spring of their first year in the Neuroscience program. The exam requires the preparation and defense of an original research proposal. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution, and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Typically, students are considered for candidacy for the doctoral degree in the spring semester of their first year in the Neuroscience Program. Admission to candidacy is based on achievements in didactic courses and lab rotations, participation in seminars and satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students begin preliminary thesis research when they enter the Neuroscience Program and their dissertation laboratory. The student and mentor, in consultation with the student adviser and program director, select a thesis advisory committee of at least three Neuroscience Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body once a year. When the

thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

PUBLICATION

Students are expected to publish their research in scientific journals appropriate to their topic. Typically, students publish one or more papers.

COURSES

NRSC 000: QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. Spring. S/U. *Program faculty*

NRSC 205: DEVELOPMENTAL NEUROBIOLOGY (1 CR)

This is a small group, interactive course exploring the mechanisms underlying the formation of the differentiated nervous system. Morphological, biochemical, immunological, and molecular approaches are examined, with an emphasis on the utility of experimental model systems. Spring. A-F. *Jacob*

NRSC 212: BASIC PRINCIPLES OF SYSTEMS NEUROBIOLOGY (1 CR)

This course focusing on the structural and functional organization of the integrated nervous system with significant exposure to neurological disease processes. Spring. A-F. *Rios/Tesco*

NRSC 213: SYNAPSE NEUROBIOLOGY (1 CR)

This small group discussion course provides students with an in-depth understanding of how synapses function, how activity modulates function, and how synaptic ensembles coordinate simple behaviors. Fall. A-F. *Dunlap*

NRSC 220: SCIENTIFIC WRITING PRINCIPLES (0.5 CR)

A discussion and workshop-style course underscoring the fundamental principles underlying expository writing. This course centers on the improvement of each student's existing skills through interactive writing exercises. Enrollment is limited to 10 students. Spring. A-F. *Program faculty*

NRSC 289, 290: RESEARCH PRESENTATIONS (0.5 CR)

Students present progress reports on their research for questions and constructive criticism as well as gain experience in presenting data and leading discussion. Fall and Spring. S/U. *Jacob*

NRSC 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Program faculty*

NRSC 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

NRSC 295, 296: JOURNAL CLUB (0.5 CR)

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. Fall and Spring. S/U. *Program Faculty*

NRSC 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. A-F. *Program faculty*

NRSC 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. S/U. *Program faculty*

PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

The [Graduate Program in Pharmacology and Experimental Therapeutics](#) is designed to prepare scientists who will be able to understand mechanisms of drug action in biochemical, cellular, and molecular terms and to develop new therapeutic modalities. The Program focuses on the interrelationship of pharmacology, therapeutics, toxicology and the pathophysiological basis of disease and includes training in the most up-to-date methods of pharmacokinetics and drug metabolism. Because the interests of the faculty cover a broad range of subjects and much of the research is interdisciplinary, the program is flexible enough to meet the needs of students from different backgrounds. Individuals with previous training in medicine, veterinary medicine, dentistry or pharmacy are particularly welcome. Students who complete the program are equipped for careers in teaching and research in academic, clinical, governmental and industrial settings. The program emphasizes basic research on the Health Sciences campus of Tufts University, located in downtown Boston. The Center for the Study of Drug Development is an additional resource.

View a list of [Pharmacology Program Faculty](#).

CURRICULUM OVERVIEW

Students in the Pharmacology and Experimental Therapeutics Program complete a series of required and elective didactic courses designed to provide a strong knowledge base for their research. Required didactic courses include BCHM 223; PHRM 211, 232, and 233; and SK 275. Students must complete two elective courses (one course must be in the Pharmacology Program). They also participate in weekly journal clubs and seminars and must pass a qualifying examination. Students typically select their research mentor at the end of May of the first year and begin dissertation research after completing four lab rotations and successfully passing the qualifying examination. During the second and subsequent years, emphasis is placed on dissertation research. When the aims of the research project have been achieved, students write and defend their dissertations.

QUALIFYING EXAM AND CANDIDACY

Students must pass a qualifying examination in June of their first year. The exam requires the preparation and defense of an original research proposal. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project on a biologically significant problem, outline a potential experimental approach to its solution and discuss the likely data that could be obtained. An oral defense of this proposal is designed to probe the ability of the student to integrate and evaluate material learned in more abstract settings.

Admission to candidacy is based on achievements in didactic courses and lab rotations, participation in seminars, and satisfactory performance on the qualifying exam. Based on these measures, the faculty evaluates the student's potential and ability to do original research and votes on admission to candidacy.

RESEARCH AND DISSERTATION

Students enter their dissertation lab and begin thesis research after completing the final laboratory rotation. The student and mentor, in consultation with the student adviser and program director, select a thesis committee of three other Pharmacology and Experimental Therapeutics Program faculty members. A précis of the thesis project is submitted to the committee, which must approve the topic as appropriate for dissertation research. Each student meets with the committee at least once a semester. The student prepares a report describing progress and goals for consideration by the advisory committee, which prepares a written assessment of progress. The student also presents a research seminar to the faculty and student body once a year. When the thesis committee determines that the aims of the project have been met, the thesis is prepared and defended. The committee, together with an additional invited non-Tufts scientist, sits as the examination committee.

TEACHING

After the first year, graduate students may assist in lecture and tutorial group teaching in Pharmacology courses where appropriate as part of their training. Participation is voluntary.

PUBLICATION

Students are required to publish a first author paper based on their thesis work before defending their thesis.

COURSES

PHRM 000: QUALIFYING EXAM (0 CR)

Students present and defend a proposal for research consisting of a statement of an original research problem in which a scientific question is asked and the experimental approach to answering the question is explained in a written proposal. The proposal is presented orally to the faculty. Spring. S/U. *Program faculty*

PHRM 211: TRANSLATIONAL PHARMACOLOGY I (2 CR)

This course is a survey of some of the major classes of drugs, with particular emphasis on mechanisms of action and relevant organ systems and cellular physiology. Students are introduced to the central concepts, models and techniques in Pharmacology. Fall. A-F. *Beinfeld, Pothos, Program faculty*

PHRM 212: CLINICAL PHARMACOLOGY (1 CR)

This course is devoted to the discussion and presentation of therapeutic topics and the basic principles of therapeutic pharmacology. Subjects that are highlighted include: therapeutic drug monitoring, evaluation of side effects and toxicity, critical evaluation of clinical trial data, pharmacokinetic design of dose regimens, drugs in special populations and medical and legal issues in clinical pharmacology. A mixture of lecture and clinical case-oriented problem-solving is used. Extensive independent study and reading is required. Spring. A-F. *Greenblatt, Program faculty*

PHRM 213: ADDICTION MEDICINE (1 CR)

This course provides an overview of the mechanisms of action of drugs of abuse and their treatment, as well as the fundamentals of treatment of addiction in clinical practice. Spring. A-F. *Pothos*

PHRM 218: PRINCIPLES OF IMMUNOPHARMACOLOGY (1 CR)

This course investigates the appraisal of molecular mechanisms by which drugs can affect cellular processes underlying clinical syndromes such as hypersensitivity, rejection, autoimmunity and neuroimmune disorders. Emphasis is placed on select cases of how certain compounds were chosen for drug development and why many such promising drugs failed. Spring-alternate years. A-F. *Theoharides, Program faculty*

PHRM 219: BEHAVIORAL PHARMACOLOGY (1 CR)

This course is an in-depth examination of the mechanisms by which selected psychoactive agents alter mood and behavior with emphasis on the role of neurotransmitters and their receptors. Fall-alternate years. A-F. *Shuster, Miczek*

PHRM 220: ADVANCES IN NEUROCHEMISTRY AND NEUROPHARMACOLOGY (1 CR)

This course focuses on the problem-based approach to the actions of neurotransmitters and neuromodulators and related drugs at the molecular and cellular level. Spring-alternate years. A-F. *Beinfeld, Program faculty*

PHRM 221: PHARMACOKINETICS IN BIOLOGICAL SYSTEMS (1 CR)

This course focuses on the uptake and clearance of drugs, using problem-solving exercises and computer modeling to analyze data from original experiments. Fall-alternate years. S/U. *Greenblatt, Program faculty*

PHRM 222: TOXICOLOGY (1 CR)

This course is an in-depth examination of the basic principles of toxicology based on discussion and presentation of selected examples. Subjects considered include apoptosis/necrosis, molecular mechanisms of neurotoxicities, species difference in toxicities, and chemical mutagenesis. Offered on request. A-F. *Ofner, Shuster, Program faculty*

PHRM 224: NEUROPEPTIDES (1 CR)

This course entails detailed reading and critical review of the classical and modern literature on the discovery, chemistry, anatomical distribution, biosynthesis, physiology, pharmacology and current and possible future clinical uses of neuropeptides. Spring-alternate years. A-F. *Beinfeld, Program faculty*

PHRM 225: AN INTRODUCTION TO DRUG METABOLISM (1 CR)

This is a readings and presentation course designed to illustrate the processes involved with drug metabolism, to describe the non-drug (non-substrate) factors influencing drug metabolism, and to review and critique methods used for the study of drug metabolism. Fall and Spring-alternate years. A-F. *Court, Greenblatt*

PHRM 232: TRANSLATIONAL PHARMACOLOGY II (2 CR)

This course continues with the topics covered in Translational Pharmacology I. It covers major classes of drugs and the concepts, models and techniques in Pharmacology. Spring. A-F. *Beinfeld, Pothos, Program faculty*

PHRM 233: SCIENTIFIC WRITING AND PRESENTATION SKILLS (0.5 CR)

This course provides graduate students with the opportunity to develop the basic skills essential to the effective oral and written communication of scientific findings and research proposals. The course is a combination of lectures, writing assignments, and oral communication practice sessions with feedback provided by the faculty and staff of the Program in Pharmacology and Experimental Therapeutics. Fall. S/U. *Court, Program faculty*

PHRM 234, 235, 236: LABORATORY ROTATIONS (1 CR)

Four 8-10 week laboratory rotations for first-year students are designed to provide experience with experimental design and theoretical aspects of the diverse research problems under investigation in various laboratories. Fall and Spring. A-F. *Program faculty*

PHRM 291, 292: GRADUATE SEMINAR (0.5 CR)

Visiting speakers from the Boston community and beyond present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. Fall and Spring. S/U. *Court*

PHRM 293, 294: SPECIAL TOPICS (0.5 CR)

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. A-F. *Program faculty*

PHRM 295, 296: JOURNAL CLUB (0.5 CR)

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. Fall and Spring. S/U. *Beinfeld, Program Faculty*

PHRM 297, 298, 299: GRADUATE RESEARCH (ARRANGED CR)

These courses provide guided research on a topic suitable for a doctoral dissertation. Fall, Spring and Summer. A-F. *Program faculty*

PHRM 403, 404, 405: PHD DEGREE ONLY (0 CR)

One of these courses is taken during a student's final semester, covering the final preparation and writing of the dissertation. Fall, Spring, and Summer. S/U. *Program faculty*

SURGICAL ANATOMY

The [Master's Program in Surgical Anatomy](#) is designed to address the chronic shortage of human anatomists trained to teach clinically relevant anatomy in the health sciences. Knowledge of applied (clinical) human anatomy, especially when coupled with research capabilities in related fields, provides excellent credentials for an academic position. This program affords a unique opportunity to study clinical anatomy, the "basis of medicine," in depth. Candidates must hold an MD (or equivalent such as M.B.B.S.,B.Ch.), or another relevant professional degree.

View a list of [Surgical Anatomy Faculty](#).

CURRICULUM

The two-year program comprises whole-body regional cadaveric dissection followed by study and demonstration of specific regional surgical approaches and procedures, with portfolio documentation.

Teaching technique is addressed in mentored teaching of Gross Anatomy and includes large and small group instruction techniques, computer-aided teaching, methods of evaluation and clinical correlation and imaging. The Department of Surgery provides practical application through grand rounds and the Surgical Research Laboratory Required didactic courses include SK 500, 501, 502, 503 as well as six of the nine Surgical Anatomy dissection courses (SK 504-512). Additional required courses for laboratory rotations and teaching methods are expected to be approved before the second year of the program.

COURSES

SK 500: GRAND ROUNDS (0.5 CR)

Students attend weekly grand rounds in the Department of Surgery where they hear lectures by leading practitioners of the surgical arts and the scientific basis for surgical treatment and methodology. Fall and Spring S/U. *Mackey*

SK 501: SURGICAL RESEARCH (0.5 CR)

The course includes lectures and lab-work in which the students participate in exercises to acquire basic surgical skills, learn the tools currently used in surgery, identify future directions in surgical research and assist in the development of new medical devices. Fall and Spring. A-F. *Perides*

SK 502: PROSECTIONAL ANATOMY (1 CR)

This course includes whole body cadaveric prosection of regions with demonstration, including embryological development and common anomalies to faculty, pre-clinical students, and surgical anatomy students. Fall. A-F. *El-Bermani*

SK 503: TEACHING PRACTICUM (1 CR)

In this course the student assists in the laboratory instruction of Clinical Anatomy to Medical Students, under the supervision of the Course Directors and Staff of the course. Attendance at lectures required. Advanced students in semesters 3 and 4 also prepare and deliver one or more lectures in the course at the direction and discretion of the Course Directors. Fall and Spring. A-F. *Willson*

SK 504: SURGICAL ANATOMY: THORAX (1 CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the thorax including the tracheotomy, left upper/ lower lobe (lobectomy), right upper/ lower lobe (lobotomy), thoracic sympathectomy, and thoracic splanchnic nerves (splanchnicectomy). This skill set is for teaching senior medical students advanced surgical anatomy. Fall. A-F. *El-Bermani*

SK 505: SURGICAL ANATOMY: ABDOMEN AND PELVIS (1 CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the abdomen and pelvis including inguinal hernias (classic and laparoscopic repair), obturator and femoral hernias, paraduodenal hernias/ hernia of the lesser sac reduction, lumbar hernia, appendectomy, superior mesenteric artery (roux-en-y procedure), small intestine resection and repair, esophageal hiatus types repair, splenectomy, gall bladder (cholecystectomy), and choledochodenostomy. Spring. A-F. *El-Bermani*

SK 506: SURGICAL ANATOMY: MUSCULOSKELETAL COMPONENTS & ORTHOPEDICS OF UPPER LIMB (1 CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the upper limb and approaches for humeral repairs, anterior humeral dislocation repair, carpal tunnel syndrome (and similar) release, ulnar nerve entrapment and release, radial nerve entrapment and release, and digit repairs. Spring. A-F. *El-Bermani*

SK 507: SURGICAL ANATOMY: MUSCULOSKELETAL COMPONENTS & ORTHOPEDICS OF LOWER LIMB (1CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the lower limb including hip joint approaches – Anterior, posterior, approaches to fracture of the shaft of femur, knee and popliteal artery and fossa, compartments syndrome release, common peroneal release, and ankle joint repairs. Fall. A-F. *El-Bermani*

SK 508: SURGICAL ANATOMY: HEAD AND NECK (1 CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the head and neck including the parotid gland and facial nerve (parotidectomy), submandibular gland excision, thyroid and parathyroids (thyroidectomy, parathyroidectomy), cricothyroidotomy, and lymph nodes of the neck. Fall. A-F. *El-Bermani*

SK 509: SURGICAL ANATOMY: CRANIAL CAVITY AND SPINAL COLUMN (1CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the cranial cavity and spinal column including supra-orbital approach, temporal approach, retrosigmoidal approach, median posterior approach, anterior cervical repair approach, and lumbar spinal approach. Fall. A-F. *El-Bermani*

SK 510: SURGICAL ANATOMY: REGIONAL ANESTHESIA (1 CR)

Through dissection, students master the anatomy required for carrying out surgical procedures important in regional anesthesia for upper limb: cervical approach to brachial plexus, supraclavicular approach to brachial block, infraclavicular approach to brachial block, axillary approach to brachial block, wrist blocks, ulnar blocks, and radial block. Regional anesthesia of lower limb: femoral block, sciatic blocks, common peroneal blocks, tibial blocks, and ankle blocks. Fall. A-F. *El-Bermani*

SK 511: SURGICAL ANATOMY: MICRODISSECTION OF THE HAND (1 CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the hand and approaches to different fascial compartments of the hand; biomechanics of the musculoskeletal tissues of the hand, functional interactions of nervous, vascular and musculoskeletal systems. Fall. A-F. *El-Bermani*

SK 512: SURGICAL ANATOMY: MICRODISSECTION OF THE FOOT (1 CR)

Through dissection, students master the anatomy required for carrying out surgical procedures of the foot and approaches to different fascial compartments of the foot; biomechanics of the musculoskeletal tissues of the foot, functional interactions of nervous, vascular and musculoskeletal systems. Fall. A-F. *El-Bermani*

SK 513: LABORATORY ROTATIONS (1 CR)

This courses is not yet approved.

SK 514: ANATOMICAL TEACHING METHODS I (0.5 CR)

This course is not yet approved.

SK 515: ANATOMICAL TEACHING METHODS II (0.5 CR)

This course is not yet approved.

SACKLER INTER-PROGRAM DOCTORAL COURSE OFFERINGS

Several courses contain content that spans two or more program areas. These courses are taught by a team of inter-program faculty, required by some programs, and open to all Sackler graduate students. The Molecular Cell Biology courses are jointly-sponsored by the Cell, Molecular, and Developmental Biology Program; Neuroscience Program; and Cellular and Molecular Physiology Program. The designator for these courses is CNP. Courses in this section which are designated SK are not housed in a particular department, and are open to students from all programs.

COURSES

CNP 209: MOLECULAR CELL BIOLOGY I (2 CR)

This course provides a thorough survey of major topics in cell biology, including membrane structure and function; transport systems, ion channels, and membrane excitability; protein trafficking and organelle biogenesis; structure and function of the cytoskeleton, including cell motility and mitosis; cell-cell and cell-matrix interactions; and receptor-mediated endocytosis. Fall. A-F. *Castellot, Cox, Forgac*

CNP 209A: MEMBRANES AND TRAFFICKING (1.5 CR)

This course covers major topics in cell biology, including membrane structure and function; transport systems, ion channels, and membrane excitability; protein trafficking and organelle biogenesis. Fall. A-F. *Castellot, Cox, Forgac*

CNP 209B: CELL BEHAVIOR (0.5 CR)

This course covers major topics in cell biology, including cell motility and mitosis; cell-cell and cell-matrix interactions; and receptor-mediated endocytosis. Fall. A-F. *Castellot, Cox, Forgac*

CNP 210: MOLECULAR CELL BIOLOGY II (1 CR)

This course addresses signal transduction pathways; molecular genetics; cell cycle and cell proliferation control mechanisms; and basic concepts in developmental biology. Spring. A-F. *Castellot, Cox, Forgac*

CNP 210A: CELL AND MOLECULAR GENETICS (0.5 CR)

This course covers molecular genetics and basic concepts in developmental biology. Spring. A-F. *Castellot, Cox, Forgac*

CNP 210B: MOLECULAR CELL BIOLOGY OF SIGNAL TRANSDUCTION (0.5 CR)

This course covers signal transduction pathways, cell cycle and cell proliferation control mechanisms. Spring. A-F. *Castellot, Cox, Forgac*

SK 201: MOLECULAR BIOPHYSICS (0.5 CR)

This course covers Thermodynamics, CD, and DLS as well as Analytical Ultracentrifugation and Advanced Fluorescence Techniques and Surface Plasmon Resonance. Summer. A-F. *Program faculty*

SK 202: STRUCTURAL BIOLOGY (0.5 CR)

This course covers the basic theory and practice of Macromolecular Crystallography and NMR. Summer. A-F. *Bohm, Baleja*

SK 203: TISSUE ENGINEERING (0.5 CR)

This course covers Stem Cell Biology and Tissue Scaffolds, the Principles of Bioreactor Design and Integrative Approaches to Tissue Engineering. Summer. A-F. *Kaplan*

SK 204: IMAGING TECHNIQUES (0.5 CR)

This course covers Light Microscopy/Immunofluorescence, Confocal Microscopy and Electron Microscopy. Computer-based image analysis is incorporated into these modules. The samples generated during the Tissue Engineering module are used. Summer. A-F. *Castellot*

SK 205: MENTORED UNDERGRADUATE TEACHING (0.5 CR)

This course offers an opportunity for Sackler students to obtain mentored teaching experience. Each Sackler student collaborates with a TUSM and a Friedman student to develop a syllabus and three lectures on one of five disease topics (osteoporosis, breast cancer, asthma, metabolic syndrome, heart disease). Lectures are delivered to undergraduate Biology majors at Pine Manor College, Chestnut Hill, MA.

Prerequisites: Year 3 or above. Spring. S/U. *Liscum*

SK 206: CLINICAL CONNECTIONS (1 CR)

MD/PhD students work with a physician in a specialty of their choosing for the equivalent of eight periods (32 hours) during the course of one semester each year. This course helps the MD/PhD student to remain connected to clinical medicine during their PhD training. It is also designed to help students explore different aspects of clinical medicine before they return to medical school full time. Fall, Spring and Summer. S/U. *Rosenberg*

SK 209, 210: CLINICAL IMPLICATIONS OF BASIC RESEARCH (0.5 CR)

This journal club course for MD/PhD students is organized around the "Clinical Implications of Basic Research" column published in the New England Journal of Medicine. Students read a primary paper(s) highlighted in the column or one that is similar to those highlighted and discuss the work. The primary goal of this course, which meets for one hour every other week, is to encourage and teach students to continually ask how basic research can impact clinical medicine. The format also encourages students to sharpen their communication skills in a relaxed atmosphere. Fall and Spring. S/U. *Rosenberg*

sk 275: APPLIED ETHICS FOR SCIENTISTS (0.5 CR)

The course is built around case study reading material and requires highly interactive discussion in which students analyze specific scenarios of ethical issues encountered in a research environment. Scheduling for lectures and discussions are flexible to fit the diverse schedules of students across the different Sackler programs. Topics include: academic integrity issues/ fraud and misconduct/plagiarism/ data handling/notebooks, mentoring and conflict resolution and ethical use of animals and human subjects. Fall through Spring. Y, S/U. *Jay*

SK 299: BIOMEDICAL TECHNIQUES & RESEARCH (0 CR)

This course includes research with selected adviser. Visiting Students Only. Fall, Spring and Summer. S/U. *Program faculty*