

SACKLER SCHOOL OF GRADUATE BIOMEDICAL SCIENCES

CATALOG

2015-2016

PROGRAMS OF STUDY, COURSES AND REQUIREMENTS FOR ALL GRADUATE PROGRAMS

Graduate Programs

[CELL, MOLECULAR, AND DEVELOPMENTAL BIOLOGY](#)

[CLINICAL AND TRANSLATIONAL SCIENCE](#)

[GENETICS](#)

[IMMUNOLOGY](#)

[MOLECULAR MICROBIOLOGY](#)

[NEUROSCIENCE](#)

[PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS](#)

[Course Descriptions](#)

Every effort is made to ensure that the degree requirement and course information, applicable policies, and other materials contained in this catalog are accurate and current. The Sackler School of Graduate Biomedical Sciences reserves the right to correct errors of fact, and to make changes at any time without prior notice. The Catalog as it exists online at the Sackler School web site is the governing document, and contains the current policies and information about the graduation requirements for students entering in that academic year.

Tufts University is an equal opportunity educator and employer.

CELL, MOLECULAR, AND DEVELOPMENTAL BIOLOGY

The [Graduate Program in Cell, Molecular, and Developmental Biology](#) (CMDB) offers strong interdisciplinary training across a spectrum of biomedically-related translational areas. This training program has its roots in a highly successful integrated first year curriculum that provides a strong foundation in biomedical research. Students entering CMDB have the ability to select one of four concentration areas: Cancer Biology; Developmental & Regenerative Biology; Molecular & Cellular Medicine; and Structural & Chemical Biology. Each concentration is designed to give trainees in depth knowledge while preserving a breadth of exposure to contemporary research approaches in biomedical science. The CMDB program fosters the development of student-driven discoveries that will inform understanding of the cellular pathways, molecular signaling networks, and systems-based mechanisms that govern human development and disease and lead to the generation of innovative new therapies.

Note that these program progressions are specifically for students entering in Fall, 2015. The selection and timing of electives are flexible, based on course offerings and students' interest. Students should confer with their faculty mentors and the Program Advisor about options available before making final course selections.

PHD COURSE REQUIREMENTS AND PROGRESSION

Students in the CMDB program complete coursework designed to provide a strong knowledge base for their research. In the first year, students are required to take BCHM 0223 and 0230; ISP 209A, 209B, 210A, 210B, and 0220; SK 0275; as well as Journal Club and Seminar. They also complete four laboratory rotations.

All CMDB students must also complete the requirements for one of the four Specialization groups: Cancer Biology; Developmental & Regenerative Biology; Molecular & Cellular Medicine; or Structural & Chemical Biology. Each group requires a one-credit didactic course and two half-credit electives.

All students participate in journal clubs and seminars, and must pass a qualifying examination. In addition, fifth year students are required to complete an ethics refresher course. Students typically begin research after completing four lab rotations and successfully passing the qualifying examination. When the aims of the research project have been achieved, students write and defend their theses.

PhD

FIRST YEAR PhD

Fall

BCHM	0223	Graduate Biochemistry
CMDB	0291	Graduate Seminar
ISP	209A	Membranes and Trafficking
ISP	0234	Laboratory Rotations
ISP	0295	Journal Club
SK	0275	Applied Ethics for Scientists

Spring

BCHM	0230	Gene Expr & Signal Transduction
CMDB	0292	Graduate Seminar
ISP	209B	Cell Behavior
ISP	210A	Cell & Molecular Genetics
ISP	210B	Mol. Cell Biology of Development
ISP	0220	Prob. and Stat. for Basic Scientists
ISP	0235	Laboratory Rotations
ISP	0296	Journal Club

Summer

CMDB	0299	Graduate Research
<i>Elective</i>		

SECOND YEAR PhD

Fall

§Specialization Signature Course§

CMDB 0291 Graduate Seminar

CMDB 0295 Journal Club

CMDB 0297 Graduate Research

Elective

Spring

CMDB 0000 Qualifying Examination

§Specialization Signature Course§

CMDB 0292 Graduate Seminar

CMDB 0296 Journal Club

CMDB 0298 Graduate Research

Elective

Summer

CMDB 0299 Graduate Research

Elective

§Specialization Signature Courses§ are as follows:

Fall

Developmental & Regenerative Biology: CMDB 0235 Advanced Developmental Biology

Molecular & Cellular Medicine: CMP 0230 Pathobiology

Spring

Structural & Chemical Biology: BCHM 231A Molecular Recognition & BCHM 231B Drug Design

Cancer Biology: GENE 0203 Cancer Biology

After the second year, all students continue to enroll in Journal Club (0295/0296) for another two years, as well as Graduate Seminar (0291/0292) and Graduate Research (0297/0298/0299) until they have completed their thesis research.

MD/PHD COURSE REQUIREMENTS AND PROGRESSION

Students entering the CMDB program as part of the combined MD/PhD degree program complete two laboratory rotations in the summers before and during the first two years of medical school, and choose their thesis lab prior to their first year of coursework at Sackler. MD/PhD students complete an individualized didactic program of no less than 2.5 credit hours, which includes at least one of the electives designed for their research specialization. Students also enroll in Clinical Implications of Basic Research seminar (SKMD 0209/0210), which is taken every semester until completion of the PhD, beginning in the first year of medical school. Students who take longer than four years to complete their PhD will also be required to complete an ethics refresher course.

MD/PhD

FIRST YEAR MD/PhD

Summer

CMDB 0299 Graduate Research

Fall

CMDB 0291 Graduate Seminar

CMDB 0295 Journal Club

CMDB 0297 Graduate Research

SK 0275 Applied Ethics for Scientists

SKMD 0209 Clinical Impl of Basic Research

Required Coursework

Spring

CMDB 0292 Graduate Seminar

CMDB 0296 Journal Club

CMDB 0298 Graduate Research

SKMD 0210 Clinical Impl of Basic Research

Required Coursework

Summer

CMDB 0000 Qualifying Examination

CMDB 0299 Graduate Research

After the first year, MD/PhD students enroll in Journal Club (0295/0296) for two more years, and enroll in Graduate Seminar (0291/0292), Graduate Research (0297/0298/0299), and Clinical Implications of Basic Research (0209/0210) until they have completed their research.

QUALIFYING EXAMINATION

Students must pass a qualifying examination. 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.

RESEARCH & THESIS

Students enter their thesis lab and begin thesis research after completing the final laboratory rotation. Each student meets with their thesis advisory 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. 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 before they graduate.

WEB LINKS

- Cell, Molecular, and Developmental Biology [Program Faculty](#)
- Cell, Molecular, and Developmental Biology [Web Site, with Program Guide](#)

CLINICAL AND TRANSLATIONAL SCIENCE

The [Graduate Programs in Clinical and Translational Science](#) (CTS) train physicians and other clinicians who will develop, evaluate, apply, and implement clinical research techniques that will improve and enhance patient care. Program 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 CTS program offers full-time study leading to MS and PhD degrees and also offer a part-time Certificate program. The programs are 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.

Note that these program progressions are specifically for students entering in Fall, 2015. The selection and timing of electives are flexible, based on course offerings and students' interest. Students should confer with their faculty mentors and the Program Advisor about options available before making final course selections.

CERTIFICATE COURSE REQUIREMENTS AND PROGRESSION

The CTS 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. Required didactic courses include CTS 0500, 0523, 0525, 0540, 0561, 0566, 0581, and biostatistics (either 0506 and 0507, or 0527), as well as seminars, workshops, and a one-credit research project. Research efforts should result in a publishable manuscript, research proposal, or protocol.

Certificate Track

Summer

CTS 0506 Intro to Biostatistics I
CTS 0525 Intro to Clinical Care Research

Fall

CTS 0500 Study Design Seminar
CTS 0507 Intro to Biostatistics II
CTS 0523 Intro to Clinical Epidemiology
CTS 0561 Intro to Clinical Trials

Spring

CTS 0500 Study Design Seminar
CTS 0514 Clinical Research Project
CTS 0540 Ethics of Clinical Investigation
CTS 0566 Intro to Health Services Research
CTS 0581 Intro to Evidence-Based Medicine

For Certificate students who wish to continue in the Master's degree program, all required didactic credits transfer; additional elective credits do not transfer. Students who do not complete the Certificate program requirements may transfer a maximum of two courses into the CTS Master's program.

MASTER'S COURSE REQUIREMENTS AND PROGRESSION

The CTS Master's program curriculum provides a strong foundation of core methods and skills, including research methods, statistics, research conduct, ethics, and manuscript and grant writing. Students are required to complete CTS 0500, 0523, 0525, 0537, 0538, 0540; two courses from CTS 0561, 0566, and 0581; and two biostatistics courses, typically 0527 and 0575 (for students entering the MS program from the Certificate program, only one additional biostatistics course is required). Students must also complete 2.5 elective credits. In addition,

students participate in seminars, hands-on computer labs, workshops, and mentored research projects. Because the ability to self-initiate and execute independent research is key to success as a researcher, a central degree requirement is the completion of an independent research project that leads to a Master's thesis. The Master's Degree typically takes two years to complete.

<i>FIRST YEAR MS</i>	
Summer	
CTS	0525 Intro to Clinical Care Research
Fall	
CTS	0500 Study Design Seminar
CTS	0515 Mentored Research Project/Thesis
CTS	0523 Intro Clinical Epidemiology
CTS	0527 Biostatistics I
CTS	0537 Scientific Manuscript Writing
CTS	0561 <i>Intro to Clinical Trials*</i>
Spring	
CTS	0500 Study Design Seminar
CTS	0515 Mentored Research Project/Thesis
CTS	0537 Scientific Manuscript Writing
CTS	0540 Ethics of Clinical Investigation
CTS	0566 <i>Intro to Health Services Research*</i>
CTS	0575 Advanced Epi & Regression
CTS	0581 <i>Intro to Evidence-Based Medicine*</i>

<i>SECOND YEAR MS</i>	
Fall	
CTS	0500 Study Design Seminar
CTS	0516 Mentored Research Project/Thesis
CTS	0538 Scientific Grant Writing
<i>Elective</i>	
Spring	
CTS	0500 Study Design Seminar
CTS	0516 Mentored Research Project/Thesis
CTS	0538 Scientific Grant Writing
<i>Elective</i>	

*choose two of these three courses

PHD COURSE REQUIREMENTS AND PROGRESSION

Students in the CTS PhD program develop the necessary competencies for a career in academic medicine that involves significant translational research. There are two ways to gain admission to the CTS PhD program. A Master's degree candidate may request permission to sit for the PhD qualifying exam and be granted permission to do so by the Advisory Committee after review of the candidate's academic record and overall contributions to the Master's Graduate program. Alternatively, beginning Summer 2016 individuals may enter the PhD program directly.

Students in the CTS Master's degree program may request permission to sit for the PhD qualifying exam after completing the first year. Candidates who satisfactorily complete the qualifying exam will finish the second year of the Master's curriculum and subsequently register for CTS 0500, 0539, and 0517 each Fall and Spring term, and 0517 in the Summer, until they have completed their thesis research. The PhD program is typically completed in approximately four and a half years.

<i>FIRST YEAR PHD & SECOND YEAR MS</i>	
Summer	
CTS	0000 Qualifying Examination
Fall	
CTS	0500 Study Design Seminar
CTS	0516 Mentored Research Project/Thesis
CTS	0538 Scientific Grant Writing
<i>Elective</i>	

Spring	
CTS	0500 Study Design Seminar
CTS	0516 Mentored Research Project/Thesis
CTS	0538 Scientific Grant Writing
<i>Elective</i>	

SECOND YEAR PHD & BEYOND

Summer

CTS 0517 Mentored Research Project/Thesis

Fall

CTS 0500 Study Design Seminar

CTS 0517 Mentored Research Project/Thesis

CTS 0539 Scientific Writing/Peer Review

Elective

Spring

CTS 0500 Study Design Seminar

CTS 0517 Mentored Research Project/Thesis

CTS 0539 Scientific Writing/Peer Review

Elective

QUALIFYING EXAMINATION

The CTS Program Advisory Committee reviews a candidate's academic record and overall contributions to the Master's program to determine if the candidate will be allowed to sit for the qualifying exam. The exam is designed to measure originality and independence and requires that the student suggest a feasible research project, 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.

RESEARCH & THESIS

MS and PhD thesis committees are formed during the first term of study. Thesis work must be original and rigorous, and approved by the student's thesis committee and the CTS Program Advisory Committee in order for the student to graduate. The thesis must be presented in the official University format, which is different from the format of an article or paper.

After the Program Advisory Committee has approved the thesis topic, each student meets with the thesis 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 their research 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.

PUBLICATION

Students are expected to publish their research in scientific journals appropriate to their topic. Master's students submit at least one paper, and PhD students submit three or more before they graduate.

WEB LINKS

- Clinical and Translational Science [Program Faculty](#)
- Clinical and Translational Science [Web Site, with Program Guide](#)

GENETICS

The [Graduate Program in Genetics](#) (GENE) is designed to train scientists in the basic principles and applications of classical and molecular genetics for careers in research, teaching, and biotechnology. The goal of the program is to train talented individuals to think critically, identify important issues in genetics, and design and conduct original 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 (JAX) in Bar Harbor, Maine.

Note that these program progressions are specifically for students entering in Fall, 2015. The selection and timing of electives are flexible, based on course offerings and students' interest. Students should confer with their faculty mentors and the Program Advisor about options available before making final course selections.

PHD COURSE REQUIREMENTS AND PROGRESSION

Students in the Genetics program complete coursework designed to provide a strong knowledge base for their research. Students in the traditional Genetics track are required to take BCHM 0223 and 0230A; GENE 0201, 205A, 205B; and SK 0275. Students must also complete two elective courses.

Students in the Mammalian Genetics Track matriculate July 1 and complete an additional required course, GENE 0208, and one laboratory rotation in Bar Harbor during their first summer. JAX students are only required to take one elective course.

All students participate in journal clubs, seminars, and research presentations, and must pass a qualifying examination after their first year of coursework. In addition, fifth year students are required to complete an ethics refresher course. Students typically begin thesis research after completing four lab rotations and successfully passing the qualifying examination. When the aims of the research project have been achieved, students write and defend their theses.

Regular Track

FIRST YEAR PhD

Fall

BCHM 0223 Graduate Biochemistry
GENE 0201 Introduction to Genetics
GENE 205A Mammalian Genetics I
GENE 0234 Laboratory Rotations
GENE 0289 Research Presentations
GENE 0291 Graduate Seminar
GENE 0295 Journal Club
SK 0275 Applied Ethics for Scientists

Spring

BCHM 230A Gene Expression
GENE 205B Mammalian Genetics II
GENE 0235 001 Laboratory Rotations
GENE 0290 Research Presentations
GENE 0292 Graduate Seminar
GENE 0296 Journal Club

Summer

GENE 0000 Qualifying Examination
GENE 0299 001 Graduate Research

SECOND YEAR PhD

Fall

GENE 0289 Research Presentations
GENE 0291 Graduate Seminar
GENE 0295 Journal Club
GENE 0297 001 Graduate Research
Elective

Spring

GENE 0290 Research Presentations
GENE 0292 Graduate Seminar
GENE 0296 Journal Club
GENE 0298 001 Graduate Research
Elective

Summer

GENE 0299 001 Graduate Research

Mammalian Genetics Track

FIRST YEAR PhD

Summer

GENE 0208 Mammalian & Experimental Genetics
GENE 0236 Laboratory Rotation

Fall

BCHM 0223 Graduate Biochemistry
GENE 0201 Introduction to Genetics
GENE 205A Mammalian Genetics I
GENE 0234 Laboratory Rotations
GENE 0289 Research Presentations
GENE 0291 Graduate Seminar
GENE 0295 Journal Club
SK 0275 Applied Ethics for Scientists

Spring

BCHM 230A Gene Expression
GENE 205B Mammalian Genetics II
GENE 0235 002 Laboratory Rotations
GENE 0290 Research Presentations
GENE 0292 Graduate Seminar
GENE 0296 Journal Club
GENE 0298 002 Graduate Research

SECOND YEAR PhD

Summer

GENE 0000 Qualifying Examination
GENE 0299 002 Graduate Research

Fall

GENE 0289 Research Presentations
GENE 0291 Graduate Seminar
GENE 0295 Journal Club
GENE 0297 002 Graduate Research
Elective

Spring

GENE 0290 Research Presentations
GENE 0292 Graduate Seminar
GENE 0296 Journal Club
GENE 0298 002 Graduate Research

Summer

GENE 0299 002 Graduate Research

After the second year, all students continue to enroll in Journal Club (0295/0296) for two more years, and Research Presentations (0289/0290), Graduate Seminar (0291/0292), and Graduate Research (0297/0298/0299) until they have completed their thesis research.

MD/PHD COURSE REQUIREMENTS AND PROGRESSION

Students entering the Genetics program as part of the combined MD/PhD degree program complete two laboratory rotations in the summers before and during the first two years of medical school, and choose their thesis lab prior to their first year of coursework at Sackler. MD/PhD students also have adjusted didactic requirements including Clinical Implications of Basic Research seminar (SKMD 0209/0210), which is taken every semester until completion of the PhD, beginning in the first year of medical school. Required didactic courses include BCHM 230A; GENE 0201, 205A, 205B; and SK 0275. Students who take longer than four years to complete their PhD will also be required to complete an ethics refresher course. Genetics MD/PhD students are not usually required to take electives.

MD/PhD

FIRST YEAR MD/PhD

Summer

GENE 0299 001 Graduate Research

Fall

GENE 0201 Introduction to Genetics

GENE 205A Mammalian Genetics I

GENE 0289 Research Presentations

GENE 0291 Graduate Seminar

GENE 0295 Journal Club

GENE 0297 001 Graduate Research

SK 0275 Applied Ethics for Scientists

SKMD 0209 Clinical Implications of Basic Research

Spring

BCHM 230A Gene Expression

GENE 205B Mammalian Genetics II

GENE 0290 Research Presentations

GENE 0292 Graduate Seminar

GENE 0296 Journal Club

GENE 0298 001 Graduate Research

SKMD 0210 Clinical Implications of Basic Research

Summer

GENE 0000 Qualifying Examination

GENE 0299 001 Graduate Research

After the first year, MD/PhD students enroll in Journal Club (0295/0296) for three more years, and Research Presentations (0289/0290), Graduate Seminar (0291/0292), Graduate Research (0297/0298/0299), and Clinical Implications of Basic Research (0209/0210) until they have completed their research.

QUALIFYING EXAMINATION

Students must pass a qualifying examination. 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.

RESEARCH & THESIS

Students enter their thesis lab and begin thesis research after completing the final laboratory rotation. Each student meets with their thesis advisory 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. 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. They are also expected to have presented their work at one or more national or international meetings before defending their thesis.

WEB LINKS

- Genetics [Program Faculty](#)
- Genetics [Web Site, with Program Guide](#)

IMMUNOLOGY

The [Graduate Program in Immunology](#) (IMM) 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 experts 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, prevention, 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.

Note that these program progressions are specifically for students entering in Fall, 2015. The selection and timing of electives are flexible, based on course offerings and students' interest. Students should confer with their faculty mentors and the Program Advisor about options available before making final course selections.

PHD COURSE REQUIREMENTS AND PROGRESSION

Students in the Immunology program complete coursework designed to provide a strong knowledge base for their research. Students in the traditional Immunology track are required to take BCHM 0223, IMM 0212, 0215/0216, 0245, 0250, 0252, and SK 0275.

Students in the MERGE-ID track begin their program in July with MMB 0223. They are also required to take BCHM 0223; IMM 0212, 0215/0216, 0245, 0250; MMB 0241/0242; and SK 0275.

All students must complete one elective course, and participate in Journal Club through their fourth year in the program. Students also participate in seminars and research presentations and must pass a qualifying examination. In addition, fifth year students are required to complete an ethics refresher course. Students typically begin thesis research after completing four lab rotations and successfully passing the qualifying examination. When the aims of the research project have been achieved, students write and defend their theses.

Regular Track

<i>FIRST YEAR PhD</i>	
Fall	
BCHM	0223 Graduate Biochemistry
IMM	0212 Introduction to Immunology
IMM	0217 First Year Journal Club
IMM	0234 Laboratory Rotations
IMM	0245 Advanced Cellular Immunology
IMM	0289 Research Presentations
IMM	0291 Graduate Seminar
SK	0275 Applied Ethics for Scientists
Spring	
IMM	0000 Qualifying Examination
IMM	0235 Laboratory Rotations
IMM	0250 Immunochem. – Signaling & Dynamics
IMM	0252 System Approaches to Immunology
IMM	0290 Research Presentations
IMM	0292 Graduate Seminar
IMM	0296 Journal Club
Summer	
IMM	0299 Graduate Research
<i>SECOND YEAR PhD</i>	
Fall	
IMM	0289 Research Presentations
IMM	0291 Graduate Seminar
IMM	0295 Journal Club
IMM	0297 Graduate Research
<i>Elective</i>	
Spring	
IMM	0290 Research Presentations
IMM	0292 Graduate Seminar
IMM	0296 Journal Club
IMM	0298 Graduate Research
Summer	
IMM	0299 Graduate Research

MERGE-ID Track

<i>FIRST YEAR PhD, MERGE-ID</i>	
Summer	
MMB	0223 Introduction to Infectious Diseases
Fall	
BCHM	0223 Graduate Biochemistry
IMM	0212 Introduction to Immunology
IMM	0217 First Year Journal Club
IMM	0234 Laboratory Rotations
IMM	0245 Advanced Cellular Immunology
IMM	0289 Research Presentations
IMM	0291 Graduate Seminar
MMB	0241 Microbial Genetics & Microbiology I
SK	0275 Applied Ethics for Scientists
Spring	
IMM	0000 Qualifying Examination
IMM	0235 Laboratory Rotations
IMM	0250 Immunochem – Signaling & Dynamics
IMM	0290 Research Presentations
IMM	0292 Graduate Seminar
IMM	0296 Journal Club
MMB	0242 Microbial Genetics & Microbiology II
<i>SECOND YEAR PhD</i>	
Summer	
IMM	0299 Graduate Research
Fall	
IMM	0289 Research Presentations
IMM	0291 Graduate Seminar
IMM	0295 Journal Club
IMM	0297 Graduate Research
<i>Elective</i>	
Spring	
IMM	0290 Research Presentations
IMM	0292 Graduate Seminar
IMM	0296 Journal Club
IMM	0298 Graduate Research
Summer	
IMM	0299 Graduate Research

Students entering in 2015 will take IMM 0215/0216 in their third year. After the second year, students continue to enroll in Journal Club (0295/0296) for two more years, and continue Research Presentations (0289/0290), Graduate Seminar (0291/0292), and Graduate Research (0297/0298/0299) until they have completed their thesis research.

MD/PHD COURSE REQUIREMENTS AND PROGRESSION

Students entering the Immunology program as part of the combined MD/PhD degree complete two laboratory rotations in the summers before and during the first two years of medical school, and choose their thesis lab prior to their first year of coursework at Sackler. MD/PhD students also have adjusted didactic requirements including the Clinical Implications of Basic Research seminar (SKMD 0209/0210), which is taken every semester. Required didactic courses include BCHM 0224; IMM 0245, 0250, 0252; and SK 0275. Students who take longer than four years to complete their PhD will also be required to complete an ethics refresher course. Immunology MD/PhD students are not usually required to take electives.

MD/PhD

FIRST YEAR MD/PhD

Summer

IMM 0299 Graduate Research

Fall

BCHM 0224 Advanced Graduate Biochemistry

IMM 0245 Advanced Cellular Immunology

IMM 0289 Research Presentations

IMM 0291 Graduate Seminar

IMM 0295 Journal Club

IMM 0297 Graduate Research

SK 0275 Applied Ethics for Scientists

SKMD 0209 Clinical Implications of Basic Research

Spring

IMM 0000 Qualifying Examination

IMM 0250 Immunochemistry – Signaling & Dynamics

IMM 0252 System Approaches to Immunology

IMM 0290 Research Presentations

IMM 0292 Graduate Seminar

IMM 0296 Journal Club

IMM 0298 Graduate Research

SKMD 0210 Clinical Implications of Basic Research

After the first year, MD/PhD students continue to enroll in Journal Club (0295/0296) for two more years and continue Research Presentations (0289/0290), Graduate Seminar (0291/0292), Graduate Research (0297/0298/0299), and Clinical Implications of Basic Research (0209/0210) until they have completed their research.

QUALIFYING EXAMINATION

Students must pass a qualifying examination. 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.

RESEARCH & THESIS

Students enter their thesis lab and begin thesis research after completing the final laboratory rotation. Each student meets with their thesis advisory 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. 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. They are also expected to have presented their work at one or more national or international meetings before defending their thesis.

WEB LINKS

- Immunology [Program Faculty](#)
- Immunology [Web Site, with Program Guide](#)

MOLECULAR MICROBIOLOGY

The [Graduate Program in Molecular Microbiology](#) (MMB) 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, prevention, 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.

Note that these program progressions are specifically for students entering in Fall, 2015. The selection and timing of electives are flexible, based on course offerings and students' interest. Students should confer with their faculty mentors and the Program Advisor about options available before making final course selections.

PHD COURSE REQUIREMENTS AND PROGRESSION

Students in the MMB program complete coursework designed to provide a strong knowledge base for their research. Students in the traditional Molecular Microbiology track are required to take BCHM 0223 and 231A; MMB 0206, 207B, 0241/0242; and SK 0275. In addition, students must choose two courses from BCHM 230A, MMB 0210/211, and MMB 0214.

Students in the MERGE-ID track begin their program in July with MMB 0223. In their first two years, they are required to take BCHM 0223; IMM 0212; MMB 0241/0242 and 0214; and SK 0275. In addition they must complete two elective courses, either IMM 0215/0216 or MMB 0210/0211, and either MMB 0206 or MMB 207B.

Students also participate in weekly journal clubs, seminars, and research presentations and must pass a qualifying examination. In addition, fifth year students are required to complete an Ethics refresher course. Students typically begin thesis research after completing four lab rotations and successfully passing the qualifying examination. When the aims of the research project have been achieved, students write and defend their theses.

Regular Track

<i>FIRST YEAR PhD</i>	
Fall	
BCHM 0223	Graduate Biochemistry
MMB 0234	Laboratory Rotations
MMB 0241	Microbial Genetics & Microbiology I
MMB 0291	Graduate Seminar
MMB 0295	Journal Club
SK 0275	Applied Ethics for Scientists
Spring	
BCHM 231A	Molecular Recognition in Biology
MMB 207B	Microbial Physiology & Differentiation
MMB 0235	Laboratory Rotations
MMB 0242	Microbial Genetics & Microbiology II
MMB 0292	Graduate Seminar
MMB 0296	Journal Club
<i>Elective</i>	
Summer	
MMB 0299	Graduate Research
<i>SECOND YEAR PhD</i>	
Fall	
MMB 0291	Graduate Seminar
MMB 0295	Journal Club
MMB 0297	Graduate Research
<i>Elective</i>	
Spring	
MMB 0206	Molecular Bio of Episomes & Plasmids
MMB 0292	Graduate Seminar
MMB 0296	Journal Club
MMB 0298	Graduate Research
<i>Elective</i>	
Summer	
MMB 0000	Qualifying Examination
MMB 0299	Graduate Research

MERGE-ID Track

<i>FIRST YEAR PhD</i>	
Summer	
MMB 0223	Introduction to Infectious Diseases
Fall	
BCHM 0223	Graduate Biochemistry
IMM 0212	Introduction to Immunology
MMB 0234	Laboratory Rotations
MMB 0241	Microbial Genetics & Microbiology I
MMB 0291	Graduate Seminar
MMB 0295	Journal Club
SK 0275	Applied Ethics for Scientists
Spring	
MMB 0214	Animal Virology
MMB 0235	Laboratory Rotations
MMB 0242	Microbial Genetics & Microbiology II
MMB 0292	Graduate Seminar
MMB 0296	Journal Club
Summer	
MMB 0299	Graduate Research
<i>SECOND YEAR PhD</i>	
Fall	
MMB 0291	Graduate Seminar
MMB 0295	Journal Club
MMB 0297	Graduate Research
<i>Elective</i>	
Spring	
MMB 0292	Graduate Seminar
MMB 0296	Journal Club
MMB 0298	Graduate Research
<i>Elective</i>	
Summer	
MMB 0000	Qualifying Examination
MMB 0299	Graduate Research

After the second year, students continue to enroll in Journal Club (0295/0296), Graduate Seminar (0291/0292), and Graduate Research (0297/0298/0299) until they have completed their thesis research.

MD/PHD COURSE REQUIREMENTS AND PROGRESSION

Students entering the Molecular Microbiology program as part of the combined MD/PhD degree complete two laboratory rotations in the summers before and during the first two years of medical school, and choose their thesis lab prior to their first year of coursework at Sackler. MD/PhD students also have adjusted didactic

requirements including the Clinical Implications of Basic Research seminar (SKMD 0209/0210), which is taken every semester. Required didactic courses include BCHM 0224 and 231A; MMB 0241/0242; and SK 0275. Students who take longer than four years to complete their PhD will also be required to complete an ethics refresher course. Molecular Microbiology MD/PhD students are required to take two elective courses; note that MMB 0210/0211 counts as one elective.

MD/PhD

<i>FIRST YEAR MD/PhD</i>	
Summer	
MMB	0299 Graduate Research
Fall	
BCHM	0224 Advanced Graduate Biochemistry
MMB	0241 Microbial Genetics & Microbiology I
MMB	0291 Graduate Seminar
MMB	0295 Journal Club
MMB	0297 Graduate Research
SK	0275 Applied Ethics for Scientists
SKMD	0209 Clinical Implications of Basic Research

Spring	
BCHM	231A Molecular Recognition in Biology
MMB	0242 Microbial Genetics & Microbiology II
MMB	0292 Graduate Seminar
MMB	0296 Journal Club
MMB	0298 Graduate Research
SKMD	0210 Clinical Implications of Basic Research
Summer	
MMB	0000 Qualifying Examination
MMB	0299 Graduate Research

After the first year, MD/PhD students continue to enroll in Journal Club (0295/0296), Graduate Seminar (0291/0292), Graduate Research (0297/0298/0299), and Clinical Implications of Basic Research (0209/0210) until they have completed their research.

QUALIFYING EXAMINATION

Students must pass a qualifying examination. 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.

RESEARCH & THESIS

Students enter their thesis lab and begin thesis research after completing the final laboratory rotation. Each student meets with their thesis advisory 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. 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.

WEB LINKS

- Molecular Microbiology [Program Faculty](#)
- Molecular Microbiology [Web Site, with Program Guide](#)

NEUROSCIENCE

The [Graduate Program in Neuroscience](#) (NRSC) provides interdisciplinary training that emphasizes classical neurobiological and modern neurogenetic approaches. The faculty research programs cover a wide range of topics and employ cutting edge molecular-genetic, cellular, behavioral, and bioinformatic approaches to understanding nervous system function and dysfunction. The course of study has been designed to provide students with in-depth, multidisciplinary training that will allow them to unravel the complicated mechanisms underlying the physiology and pathophysiology of nervous system function.

Note that these program progressions are specifically for students entering in Fall, 2015. The selection and timing of electives are flexible, based on course offerings and students' interest. Students should confer with their faculty mentors and the Program Advisor about options available before making final course selections.

PHD COURSE REQUIREMENTS AND PROGRESSION

Students in the Neuroscience program complete coursework designed to provide a strong knowledge base for their research. Required courses include NRSC 0200, 0233, 0251, 0310, 0312; ISP 209A, 209B, 0220; and SK 0275. Students must complete one elective credit.

Students also participate in weekly journal clubs, student research presentations, and seminars, and must pass a qualifying examination. Students typically begin thesis research after completing three lab rotations and successfully passing the qualifying examination. In addition, fifth year students are required to complete an ethics refresher course. When the aims of the research project have been achieved, students write and defend their theses.

PhD

FIRST YEAR PhD

Fall

ISP	209A Membranes and Trafficking
NRSC	0200 Cell & Mol Tutorials in Neuroscience
NRSC	0233 Neuroscience Research Techniques
NRSC	0234 Laboratory Rotations
NRSC	0251 Biochem Foundations in Neuroscience
NRSC	0289 Research Presentations
NRSC	0291 Graduate Seminar
NRSC	0295 Journal Club
SK	0275 Applied Ethics for Scientists

Spring

ISP	209B Cell Behavior
ISP	0220 Probability and Stat for Basic Scientists
NRSC	0235 Laboratory Rotations
NRSC	0290 Research Presentations
NRSC	0292 Graduate Seminar
NRSC	0296 Journal Club
NRSC	0310 Systems Neuroscience
NRSC	0312 Tutorial in Neural Sys & Disease Mech

Summer

NRSC	0299 Graduate Research
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SECOND YEAR PhD

Fall

NRSC 0289 Research Presentations
NRSC 0291 Graduate Seminar
NRSC 0295 Journal Club
NRSC 0297 Graduate Research
Elective

Spring

NRSC 0000 Qualifying Examination
NRSC 0290 Research Presentations
NRSC 0292 Graduate Seminar
NRSC 0296 Journal Club
NRSC 0298 Graduate Research
Elective

Summer

NRSC 0299 Graduate Research

After the second year, all students continue to enroll in Journal Club (0295/0296) for two more years, Research Presentations (0289/0290), Graduate Seminar (0291/0292), and Graduate Research (0297/0298/0299) until they have completed their thesis research.

MD/PHD COURSE REQUIREMENTS AND PROGRESSION

Students entering the Neuroscience program as part of the combined MD/PhD degree program complete two laboratory rotations in the summers before and during the first two years of medical school, and choose their thesis lab prior to their first year of coursework at Sackler. MD/PhD students also have adjusted didactic requirements including the Clinical Implications of Basic Research seminar (SKMD 0209/0210), which is taken every semester. Required didactic courses include NRSC 0200, 251B, 0312; and SK 0275. Students who take longer than four years to complete their PhD will also be required to complete an ethics refresher course. Neuroscience MD/PhD students are also required to take one elective credit.

MD/PhD

FIRST YEAR MD/PhD

Summer

NRSC 0299 Graduate Research

Fall

NRSC 0200 Cell & Mol Tutorials in Neuroscience
NRSC 251B Receptor/Channel Mechanisms
NRSC 0289 Research Presentations
NRSC 0291 Graduate Seminar
NRSC 0295 Journal Club
NRSC 0297 Graduate Research
SK 0275 Applied Ethics for Scientists
SKMD 0209 Clinical Implications of Basic Research

Spring

NRSC 0000 Qualifying Examination
NRSC 0290 Research Presentations
NRSC 0292 Graduate Seminar
NRSC 0296 Journal Club
NRSC 0298 Graduate Research
NRSC 0312 Tutorial in Neural Sys & Disease Mech
SKMD 0210 Clinical Implications of Basic Research

Summer

NRSC 0299 Graduate Research

After the first year, MD/PhD students enroll in Journal Club (0295/0296) for two more years, and enroll in Research Presentations (0289/0290), Graduate Seminar (0291/0292), Graduate Research (0297/0298/0299), and Clinical Implications of Basic Research (0209/0210) until they have completed their research.

QUALIFYING EXAMINATION

Students must pass a qualifying examination. 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.

RESEARCH & THESIS

Students enter their thesis lab and begin thesis research after completing the final laboratory rotation. Each student meets with their thesis advisory 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. 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 before they graduate.

WEB LINKS

- Neuroscience [Program Faculty](#)
- Neuroscience [Web Site, with Program Guide](#)

PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

The [Graduate Program in Pharmacology and Experimental Therapeutics](#) (PPET) 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 PPET 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 biomedical sciences, medicine, veterinary medicine, dentistry, pharmacy, or medicinal chemistry 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 offers two degrees: a Master's in Pharmacology and Drug Development, and a PhD in Pharmacology and Experimental Therapeutics.

Note that these program progressions are specifically for students entering in Fall, 2015. The selection and timing of electives are flexible, based on course offerings and students' interest. Students should confer with their faculty mentors and the Program Advisor about options available before making final course selections.

MASTER'S COURSE REQUIREMENTS AND PROGRESSION

The Master's degree curriculum in [Pharmacology and Drug Development](#) (PDD) is a series of required and elective courses focusing on basic and clinical pharmacology as it relates to drug development. Required didactic courses include PPET 0211 and 0232, and SK 0275. Students must also complete three elective courses and participate in weekly journal clubs and program seminars. Students typically begin thesis research after completing two lab rotations. During the second year, emphasis is placed on thesis research, which leads to a publishable Master's thesis.

PDD MS

FIRST YEAR MS

Fall

PPET 0134 Laboratory Research Experience
PPET 0211 Translational Pharmacology I
PPET 0291 Graduate Seminar
PPET 0295 Journal Club
SK 0275 Applied Ethics for Scientists

Elective

Spring

PPET 0135 Laboratory Research Experience
PPET 0232 Translational Pharmacology II
PPET 0292 Graduate Seminar
PPET 0296 Journal Club

Elective

Elective

Summer

PPET 0299 Graduate Research

SECOND YEAR MS

Fall

PPET 0291 Graduate Seminar
PPET 0295 Journal Club
PPET 0297 Graduate Research

Spring

PPET 0292 Graduate Seminar
PPET 0296 Journal Club
PPET 0298 Graduate Research

Master's students who wish to apply for a PhD in the PPET program should confer with the Program Admissions Director and the Sackler Director of Enrollment Services about their specific circumstances. Applicants must meet the admissions requirements for the Sackler PhD degree programs, which are different from the MS program, before they will be reviewed by the PPET admissions committee along with all other PhD applicants.

PHD COURSE REQUIREMENTS AND PROGRESSION

Students in the PPET PhD program complete coursework designed to provide a strong knowledge base for their research. Required courses include BCHM 0223; PPET 0211, 0232, and 0233; and SK 0275. Students must complete two elective courses. They also participate in weekly journal clubs and seminars, and must pass a qualifying examination. In addition, fifth year students are required to complete an ethics refresher course. Students typically begin thesis research after completing four lab rotations and successfully passing the qualifying examination. When the aims of the research project have been achieved, students write and defend their theses.

PhD

<i>FIRST YEAR PhD</i>	
Fall	
BCHM	0223 Graduate Biochemistry
PPET	0211 Translational Pharmacology I
PPET	0233 Sci. Writing and Presentation Skills
PPET	0234 Laboratory Rotations
PPET	0291 Graduate Seminar
PPET	0295 Journal Club
SK	0275 Applied Ethics for Scientists
Spring	
PPET	0232 Translational Pharmacology II
PPET	0235 Laboratory Rotations
PPET	0292 Graduate Seminar
PPET	0296 Journal Club
Summer	
PPET	0000 Qualifying Examination
PPET	0299 Graduate Research

<i>SECOND YEAR PhD</i>	
Fall	
PPET	0291 Graduate Seminar
PPET	0295 Journal Club
PPET	0297 Graduate Research
<i>Elective</i>	
Spring	
PPET	0292 Graduate Seminar
PPET	0296 Journal Club
PPET	0297 Graduate Research
<i>Elective</i>	
Summer	
PPET	0299 Graduate Research

After the second year, students continue to enroll in Journal Club (0295/0296), Graduate Seminar (0291/0292), and Graduate Research (0297/0298/0299) until they have completed their thesis research.

MD/PHD COURSE REQUIREMENTS AND PROGRESSION

Students entering the PPET program as part of the combined MD/PhD degree program complete two laboratory rotations in the summers before and during the first two years of medical school, and choose their thesis lab prior to their first year of coursework at Sackler. MD/PhD students also have adjusted didactic requirements including the Clinical Implications of Basic Research seminar (SKMD 0209/0210), which is taken every semester. Required didactic courses include PPET 0211, 0232, 0233; and SK 0275. PPET MD/PhD students are also required to take one elective course. Students who take longer than four years to complete their PhD will also be required to complete an ethics refresher course.

MD/PhD

FIRST YEAR MD/PhD

Summer

PPET 0299 Graduate Research

Fall

PPET 0211 Translational Pharmacology I
PPET 0233 Sci Writing and Presentation Skills
PPET 0291 Graduate Seminar
PPET 0295 Journal Club
PPET 0297 Graduate Research
SK 0275 Applied Ethics for Scientists
SKMD 0209 Clinical Implications of Basic Research

Spring

PPET 0232 Translational Pharmacology II
PPET 0292 Graduate Seminar
PPET 0296 Journal Club
PPET 0298 Graduate Research
SKMD 0210 Clinical Implications of Basic Research
Elective

Summer

PPET 0000 Qualifying Examination

After the first year, MD/PhD students continue to enroll in Journal Club (0295/0296), Graduate Seminar (0291/0292), Graduate Research (0297/0298/0299), and Clinical Implications of Basic Research (0209/0210) until they have completed their research.

QUALIFYING EXAMINATION

PhD and MD/PhD students must pass a qualifying examination. 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.

RESEARCH & THESIS

Students enter their thesis lab and begin thesis research after completing the final laboratory rotation. Each student meets with their thesis advisory 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. 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

PhD and MD/PhD students are required to publish a first author paper based on their thesis work before defending their thesis.

WEB LINKS

- Pharmacology [Program Faculty](#)
- Pharmacology [Web Site, with Program Guide](#)

COURSE DESCRIPTIONS

BCHM 0202 Macromolecular Structural Determination

This is an intensive workshop covering the basic theory and practice of modern protein crystallography and NMR. The course alternates between lectures, hands-on demos, and computer exercises. 1 cr. A-F. Summer; last offered 2013.

BCHM 0223 Graduate Biochemistry

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. 2 cr. A-F. Fall; last offered 2015.

BCHM 0224 Advanced Graduate Biochemistry

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 are allowed to transfer to this course after the first BCHM223 examination if they meet the performance requirements set by the Course Director. 1 cr. A-F. Fall; last offered 2015.

BCHM 0230 Biochemistry of Gene Expression & Signal Transduction

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. 2 cr. A-F. Spring; last offered 2015.

BCHM 230A Biochemistry of Gene Expression

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. 1 cr. A-F. Spring; last offered 2015.

BCHM 230B Biochemistry of Signal Transduction

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. 1 cr. A-F. Spring; last offered 2015.

BCHM 231A Molecular Recognition in Biology

This course covers the association of biological molecules. Complexes of proteins with other proteins, with lipids, and with nucleic acids are emphasized. 0.5 cr. A-F. Spring; last offered 2015.

BCHM 231B Drug Design

A discussion of drug screening and optimization techniques as they have been applied in a number of detailed, real-world cases. 0.5 cr. A-F. Spring; last offered 2014.

BCHM 0291/0292 Graduate Seminar

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. 0 cr. S/U. Fall/Spring.

BCHM 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

BCHM 0295/0296 Journal Club

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. 0 cr. S/U. Fall/Spring.

BCHM 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. A-F. Fall/Spring/Summer.

BCHM 0403/0404/0405 PhD Degree Only

Students are enrolled in this course when they receive permission to write from their thesis committee, and represents the effort in the final preparation and writing of the doctoral thesis. A grade of "S" is automatically awarded upon completion of the thesis 0 cr. S/U. Fall/Spring/Summer.

CMDB 0000 Qualifying Exam

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. 0 cr. S/U. Spring.

CMDB 0203 Medical Histology

This elective Medical School course 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. 2 cr. A-F. Fall; last offered 2015.

CMDB 0235 Developmental Biology

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. 1 cr. A-F. Odd fall; last offered 2015.

CMDB 0291/0292 Graduate Seminar

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. 0 cr. S/U. Fall/Spring.

CMDB 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. Fall and Spring. 0.5 cr. A-F. Fall/Spring.

CMDB 0295/0296 Journal Club

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. 0 cr. S/U. Fall/Spring.

CMDB 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. A-F. Fall/Spring/Summer.

CMDB 0403/0404/0405 PhD Degree Only

Students are enrolled in this course when they receive permission to write from their thesis committee, and represents the effort in the final preparation and writing of the doctoral thesis. A grade of "S" is automatically awarded upon completion of the thesis. 0 cr. S/U. Fall/Spring/Summer.

CMP 0230 Pathobiology

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. 1 cr. A-F. Fall; last offered 2015.

CMP 0291/0292 Graduate Seminar

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. 0 cr. S/U. Fall/Spring.

CMP 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

CMP 0295/0296 Journal Club

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. 0 cr. S/U. Fall/Spring.

CMP 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. A-F. Fall.

CMP 0403/0404/0405 PhD Degree Only

Students are enrolled in this course when they receive permission to write from their thesis committee, and represents the effort in the final preparation and writing of the doctoral thesis. A grade of "S" is automatically awarded upon completion of the thesis 0 cr. S/U. Summer.

CTS 0000 Qualifying Examination

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. 0 cr. S/U. Summer.

CTS 0231 Applying Quality Improvement Methods in Healthcare and Public Health

This course aims to provide a broad overview of current trends, core concepts, and methods in quality improvement (QI) and demonstrate their application to healthcare and public health. The course focuses on application, and includes didactic instruction, group discussions, and individual and group projects. 1 cr. A-F. Spring; last offered 2015.

CTS 0500 Study Design Seminar

These seminars 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. 0.5 cr. A-F. Fall/Spring.

CTS 0506/0507 Introduction to Biostatistical Methods I & II

This course is a two-part course which 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. CTS 0506 and 0507 are considered equivalent to 0527. 0.5 cr. A-F. Summer/Fall; last offered 2015.

CTS 0510 Predictive Models

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. 1 cr. A-F. Fall; last offered 2015.

CTS 0511 Machine Learning in Predictive Medicine

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. 1 cr. S/U. Spring; last offered 2011.

CTS 0512 Comparative Effectiveness Research Survey

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. 1 cr. S/U. Spring; last offered 2011.

CTS 0514 Clinical Research Project-Certificate Candidates

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. 1 cr. S/U. Spring.

CTS 0515 Clinical Research Project/Thesis Research- First Year

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. 1 cr. S/U. Fall/Spring.

CTS 0516 Clinical Research Project/Thesis Research- Second Year

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. 2 cr. S/U. Fall/Spring.

CTS 0517 Clinical Research Project/Thesis Research- PhD Candidates

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. 4 cr. S/U. Fall/Spring/Summer.

CTS 0518 Advanced Thesis Research

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. 0.5-2 cr. S/U. Fall/Spring/Summer.

CTS 0519 Concentration Practicum

This course is an independent mentored experience for students interested in advanced study and skill development in a particular area. This course requires written approval of the Program Director in order to register. 1-4 cr. S/U. Fall/Spring/Summer.

CTS 0523 Introduction To Clinical Epidemiology

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. 1 cr. A-F. Fall; last offered 2015.

CTS 0525 Introduction to Clinical Care Research

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. 2 cr. A-F. Summer; last offered 2015.

CTS 0527 Biostatistics I

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. 1 cr. A-F. Fall; last offered 2015.

CTS 0533 Advanced Topics in Biostatistics

This course provides background in advanced applied statistical methods in clinical research. Topics in the course include Poisson, multinomial, and ordinal regression, competing risk survival models, longitudinal data analysis, and hierarchical mixed models. The course provides students with the statistical foundations of these methods and their applications in clinical research. The seminar allows participants to explore advanced statistical topics and provides clinical and translational scientists with exposure to methods that may be applicable in their own research. 0.5 cr. A-F. Fall; last offered 2015.

CTS 0537 Scientific Manuscript Writing

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. 0.5 cr. A-F. Fall/Spring.

CTS 0538 Scientific Grant Writing

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. 0.5 cr. A-F. Fall/Spring.

CTS 0539 Scientific Writing, Peer Review & Presentations

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. 0.5 cr. A-F. Fall/Spring.

CTS 0540 Ethics Of Clinical Investigation

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. 0.5 cr. A-F. Spring.

CTS 0555 Principles Of Drug Development

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. 1 cr. A-F. Fall; last offered 2015.

CTS 0556 Principles of Pharmacoeconomics

Pharmacoeconomics is the application of economic evaluation (i.e., cost analysis, cost-effectiveness, cost-benefit analysis, etc.) to pharmaceutical therapies. This is an elective course covers methods and uses of pharmacoeconomic analyses and other economic evaluations of medical technologies in health care. 0.5 cr. A-F. Fall; last offered 2012.

CTS 0561 Introduction To Clinical Trials

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. 0.5 cr. A-F. Fall; last offered 2015.

CTS 0562 Topics In Clinical Trials

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. 0.5 cr. S/U. Spring; last offered 2012.

CTS 0566 Introduction to Health Services Research

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. 0.5 cr. A-F. Spring; last offered 2015.

CTS 0575 Advanced Epidemiology & Regression Methods: An Integrated Approach

This course serves as an introduction to more advanced topics in epidemiologic study design and biostatistical modeling with a focus on multivariate regression methods. This course will begin with the randomized clinical trial as a paradigm, and proceed to examine observational designs in depth, including prospective and retrospective cohorts, and those sampling from an underlying cohort (i.e. case-control). Design, sampling and analysis strategies and the biases that are specific to each study design will be discussed. Epidemiologic topics in analysis and interpretation will be covered including confounding, information bias and effect modification, as well as tools available to limit bias such as matching, propensity scores, and directed acyclic graphs (DAGs). The corresponding biostatistical topics will emphasize developing an understanding of the assumptions, limitations, and interpretation of regression results for clinic and public health data arising from continuous, binary, and time-to-event data. 2 cr. A-F. Spring; last offered 2015.

CTS 0581 Introduction to Evidence Based-Medicine

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. 0.5 cr. A-F. Spring; last offered 2015.

CTS 0582 Genetic Epidemiology

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. 1 cr. A-F. Spring.

CTS 0584 Introduction to Decision Analysis

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. 0.5 cr. A-F. Spring; last offered 2014.

CTS 0593/0594 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

GENE 0000 Qualifying Exam

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. 0 cr. S/U. Spring.

GENE 0201 Introduction to Genetics

Basic principles and current issues in genetics are the subject of the course. The focus will be on basic genetic principles. Topics will include Mendelian analysis, linkage, recombination/gene conversion, chromosomal abnormalities, crossover and segregation, developmental genetics and differentiation, chromosome structure, chromatin, position effects, meiosis and mitosis. Student presentations of research papers are used to familiarize the class with the manner in which genetic approaches can be applied experimentally. 1 cr. A-F. Fall; last offered 2015.

GENE 205A Mammalian Genetics I

The course reviews the genetic principles that apply to mammals, including genetic mechanisms of sex determination, genetic imprinting, and mitochondrial inheritance. Attention is focused on the ways in which mutation is manifested in disease phenotypes in humans. 0.5 cr. A-F. Fall; last offered 2015.

GENE 205B Mammalian Genetics II

The course explores the methodologies that are currently used to perform genetic analysis of mammals. 0.5 cr. A-F. Spring; last offered 2015.

GENE 0208 Medical & Experimental Mammalian Genetics

The course is an intensive workshop-style immersion into mammalian genetics over a period of approximately two weeks. The faculty presents 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. 2 cr. A-F. Summer; last offered 2015.

GENE 0234/0235/0236 Laboratory Rotations

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. 0.5 or 1 cr. A-F. Fall/Spring/Summer.

GENE 0289/0290 Research Presentations

Students present progress reports on their research for questions and constructive criticism as well as gain experience in presenting data and leading discussion. 0 cr. S/U. Fall/Spring.

GENE 0291/0292 Graduate Seminar

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. 0 cr. S/U. Fall/Spring.

GENE 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

GENE 0295/0296 Journal Club

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. 0 cr. S/U. Fall/Spring.

GENE 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. S/U. Fall/Spring/Summer.

GENE 0403/0404/0405 PhD Degree Only

Students enroll in this course when they receive permission to write and defend their theses from their thesis committees. This course represents the effort in the final preparation of the doctoral thesis. A grade of "S" is automatically awarded upon completion of the thesis. 0 cr. S/U. Fall/Spring/Summer.

GENE 0410 Systems Genetics

This one-week course covers computational and experimental approaches to genetic studies that utilize whole genome approaches. Individuals seeking to gain a deeper understanding of statistical and computational methods as well as biological problems are welcome. Topics to be covered include genetic mapping, gene expression microarray analysis and computational modeling of complex systems. This course is offered at The Jackson Laboratory, Bar Harbor, ME. Permission of the Genetics program director required. 1 cr. A-F. Fall; last offered 2015.

GENE 0450 Experimental Models of Human Cancer

This ten-day graduate-level genetics course is designed for individuals entering the field of mouse genetics. The course focuses on the mouse as an experimental tool in cancer research. This course is offered at The Jackson Laboratory, Bar Harbor, ME. Permission of the Genetics program director required. 1.5 cr. A-F. Summer; last offered 2015.

IMM 0000 Qualifying Exam

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. 0 cr. S/U. Spring.

IMM 0212 Introduction to Immunology

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. 1 cr. A-F. Fall; last offered 2015.

IMM 0215 Immunological Mechanisms in Disease I

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. 1 cr. A-F. Fall; last offered 2013-2014.

IMM 0216 Immunological Mechanisms in Disease II

The course continues IMM 0215, covering 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. Prerequisite is IMM 0215. 1 cr. A-F. Spring; last offered 2013-2014.

IMM 0217 1st Year Journal Club

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. 0.cr. S/U. Fall.

IMM 0233 Scientific & Grant Writing

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. 0.5 cr. S/U. Summer; last offered 2011.

IMM 0234/0235/0236 Laboratory Rotations

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. 1 cr. A-F. Fall/Spring/Summer.

IMM 0245 Advanced Cellular Immunology

This course is designed to give students a solid background in contemporary Cellular Immunology. The course will be based on a lecture series supplemented by extensive readings from the current literature. Thirty minutes of each course is dedicated to discuss the assigned reading material, which is two papers per lecture. Prerequisite: IMM 0212 or equivalent. 1 cr. A-F. Fall; last offered 2015.

IMM 0250 Immunochemistry- Signaling and Dynamics

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. 1 cr. A-F. Spring; last offered 2015.

IMM 0252 System Approaches to Immunology

The course introduces mouse as the main model for studies of human biology. It starts with the mouse genetics, continues with classical genetic analysis in the mouse, and moves to genetic basis of immunological phenomena such as receptor editing, B-cell tolerance and autoimmunity. At the end, two lectures and hands-on workshops familiarize students with the basics of microarray analysis and next generation sequencing. 1 cr. A-F. Spring; last offered 2015.

IMM 0289/0290 Research Presentations

Students present progress reports on their research for questions and constructive criticism as well as gain experience in presenting data and leading discussion. 0 cr. S/U. Fall/Spring.

IMM 0291/0292 Graduate Seminar

Visiting speakers present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. 0 cr. S/U. Fall/Spring.

IMM 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

IMM 0295/0296 Journal Club

Students in the research portion of their training meet to present and discuss recent papers of importance. 0 cr. S/U. Fall/Spring.

IMM 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. S/U. Fall/Spring/Summer.

IMM 0403/0404/0405 PhD Degree Only

Students enroll in this course when they receive permission to write and defend their theses from their thesis committees. This course represents the effort in the final preparation of the doctoral thesis. A grade of "S" is automatically awarded upon completion of the thesis. 0 cr. S/U. Fall/Spring/Summer.

ISP 209A Membranes & Trafficking

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. 1.5 cr. A-F. Fall; last offered 2015.

ISP 209B Cell Behavior

This course covers major topics in cell biology, including cell motility and mitosis; cell-cell and cell-matrix interactions; and receptor-mediated endocytosis. 0.5 cr. A-F. Spring; last offered 2015.

ISP 210A Cellular & Molecular Genetics

This course covers molecular genetics and basic concepts in developmental biology. 0.5 cr. A-F. Spring; last offered 2015.

ISP 210B Molecular Cell Biology of Development

This course introduces students to the basic cellular and molecular mechanisms involved in gametogenesis, fertilization, early embryonic development, pattern formation, and organogenesis. The course emphasizes how human disease often recapitulates development. 0.5 cr. A-F. Spring; last offered 2015.

ISP 0220 Probability and Statistics for Basic Scientists

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. 0.5 cr. A-F. Spring; last offered 2015.

ISP 0234/0235 Laboratory Rotations

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. 1 cr. Fall/Spring.

MMB 0000 Qualifying Exam

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. 0 cr. S/U. Summer.

MMB 0206 Molecular Biology of Episomes & Plasmids

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. 0.5 cr. A-F. Spring; last offered 2015.

MMB 207B Microbial Physiology & Differentiation

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. 1 cr. A-F. Spring; last offered 2014.

MMB 0210 Host Pathogen Interface

Students read and evaluate the scientific literature on bacterial pathogens and host defenses. 0.5 cr. A-F. Spring; last offered 2015.

MMB 0211 Bacterial-Host Cell Interaction

Students critically read and evaluate the scientific literature on the cellular biology of bacterial pathogens, with particular emphasis on cultured cell models of microbial diseases. require 0.5 cr. A-F. Spring; last offered 2015.

MMB 0214 Animal Virology

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. 1 cr. A-F. Spring; last offered 2014.

MMB 0223 Introduction to Infectious Diseases

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. Restricted to incoming MERGE-ID students. 1 cr. A-F. Summer; last offered 2015.

MMB 0234/0235/0236 Laboratory Rotations

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. 1 cr. S/U. Fall/Spring/Summer.

MMB 0241 Microbial Genetics & Microbiology I

The goal of this course is to learn about the structure, growth, and genetics of bacteria and lambda bacteriophage. 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. 1 cr. A-F. Fall; last offered 2015.

MMB 0242 Microbial Genetics & Microbiology II

The goal of this course is to learn about genetic exchange, antibiotic resistance, small RNAs and special growth conditions of bacteria, as well as the structure, growth, and genetics of fungi, parasites, and eukaryotic viruses. 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. 0.5 cr. A-F. Spring; last offered 2015.

MMB 0275 Applied Ethics For Scientists

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. 0.5 cr. S/U. Spring; last offered 2014.

MMB 0291/0292 Graduate Seminar

Visiting speakers present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. 0 cr. S/U. Fall/Spring.

MMB 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

MMB 0295/0296 Journal Club

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 (years two through four) and attended by all program members. 0 cr. S/U. Fall/Spring.

MMB 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. S/U. Fall/Spring/Summer.

MMB 0403/0404/0405 PhD Degree Only

Students enroll in this course when they receive permission to write and defend their theses from their thesis committees. This course represents the effort in the final preparation of the doctoral thesis. A grade of "S" is automatically awarded upon completion of the thesis. 0 cr. S/U. Fall/Spring/Summer.

NRSC 0000 Qualifying Exam

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. 0 cr. S/U. Spring.

NRSC 0200 Cellular and Molecular Tutorials in Neuroscience

These small group tutorial sessions will introduce students to key principles in cellular and molecular neuroscience, provide students with the historical context in which key advances have been made, and engage students and faculty in informal, one-on-one discussions to deepen understanding of the material. 0.5 cr. S/U. Fall; last offered 2015.

NRSC 0205 Developmental Neurobiology

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. 1 cr. A-F. Fall; last offered 2011.

NRSC 0213 Synapse Neurobiology

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. 1 cr. A-F. Spring; last offered 2014.

NRSC 0220 Scientific Writing Principles

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. 0.5 cr. A-F. Fall; last offered 2015.

NRSC 0233 Neuroscience Laboratory Techniques

The series of workshops exposes student to fundamental laboratory techniques, including tissue culture, genotyping, microscopy, immunohistochemistry, rodent handling, protein quantification, and experimental design. 0.5 cr. S/U. Fall; last offered 2015.

NRSC 0234/0235/0236 Laboratory Rotation

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. 0.5 cr. S/U. Fall/Spring/Summer.

NRSC 0251 Biochemical Foundations of Neuroscience

This course covers fundamental biochemical principles, with special emphasis on mechanisms of particular importance to nervous system function, including neural signaling and non-equilibrium processes. Students will also be exposed to quantitative molecular approaches to studying the nervous system. 2 cr. A-F. Fall; last offered 2015.

NRSC 251B BFN Receptor/Channel Mechanisms

This course is the middle section of the Biochemical Foundations in Neuroscience course, focusing predominantly on mechanisms of enzyme, receptor, and channel function in the nervous system. 0.5 cr. A-F. Fall; last offered 2015.

NRSC 0263 Neurogenetics

The course reviews principles of forward and reverse genetics, presents several animal model systems that are employed in neurogenetics research, and provides examples of genetic approaches that are used to study the molecules and neural circuits that regulate distinct neurobiological processes or are known to be altered in neurological disease states. 1 cr. S/U. Spring.

NRSC 0289/0290 Research Presentations

Students present progress reports on their research for questions and constructive criticism as well as gain experience in presenting data and leading discussion. 0 cr. S/U. Fall/Spring.

NRSC 0291/0292 Graduate Seminar

Visiting speakers present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. 0 cr. S/U. Fall/Spring.

NRSC 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

NRSC 0295/0296 Journal Club

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. 0 cr. S/U. Fall/Spring.

NRSC 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. S/U. Fall/Spring/Summer.

NRSC 0310 Systems Neuroscience

This course, a cross-listing with Tufts University School of Medicine, focuses on the structural and functional organization of the integrated nervous system with significant exposure to neurological disease processes. 1.5 cr. A-F. Spring; last offered 2015.

NRSC 0312 Tutorial in Neural Systems & Disease Mechanisms

This tutorial is designed as a companion course to NRSC 0310, in order to expand students' understanding of research approaches to common neurological diseases. In preparation for each discussion, students will read historical and recent publications relevant to the class topic, followed by critical discussions of past research advances made and future approaches that might prove most effective in translational research efforts. 0.5 cr. S/U. Spring; last offered 2015.

NRSC 0403/0404/0405 PhD Degree Only

Students enroll in this course when they receive permission to write and defend their theses from their thesis committees. This course represents the effort in the final preparation of the doctoral thesis. A grade of "S" is awarded upon completion of the thesis. 0 cr. S/U. Fall/Spring/Summer.

PPET 0000 Qualifying Exam

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. 0 cr. S/U. Summer.

PPET 0134/0135 Laboratory Research Experience

16-20 week laboratory rotations for Master's students are designed to provide experience with experimental design and theoretical aspects of the diverse research problems under investigation in various laboratories. 1 cr. A-F. Fall/Spring.

PPET 0211 Translational Pharmacology I

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. Spring term focuses on major classes of drugs and the concepts, models and techniques in pharmacology. 2 cr. A-F. Fall; last offered 2015.

PPET 0213 Addiction Medicine

This course is offered in conjunction with the Medical School. It 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. 1 cr. A-F. Spring; last offered 2015.

PPET 0218 Principles of Immunopharmacology

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. 1 cr. A-F. Fall; last offered 2015.

PPET 0221 Pharmacokinetics in Biological Systems

This course focuses on the uptake and clearance of drugs, using problem-solving exercises and computer modeling to analyze data from original experiments 1 cr. S/U. Variable; last offered 2015.

PPET 0225 Introduction to Drug Metabolism

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. 1 cr. A-F. Variable; last offered 2012.

PPET 0232 Translational Pharmacology II

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. Prerequisite: PPET 0211. 2 cr. A-F. Spring; last offered 2015.

PPET 0233 Scientific Writing and Presentation Skills

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. 0.5 cr. S/U. Fall; last offered 2015.

PPET 0234/0235/0236 Laboratory Rotations

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. 1 cr. A-F. Fall/Spring/Summer.

PPET 0281 Design and Analysis of Bioequivalence Studies

A generic drug is bioequivalent to a brand name drug when their bioavailabilities (assessed by the respective plasma concentration time curves) after administration in the same molar dose are essentially the same. The comparison of the bioavailabilities is examined by conducting a bioequivalence study. The course will train the students in the design and data analysis of bioequivalence studies. Prerequisite: PPET 0211. 0.5 cr. S/U. Spring; last offered 2015.

PPET 0291/0292 Graduate Seminar

Visiting speakers present their scientific research to all members of the program, including faculty, students, and post-doctoral fellows. 0 cr. S/U. Fall/Spring.

PPET 0293/0294 Special Topics

In-depth information is provided on selected topics. Students may also pursue guided individual study of an approved topic. 0.5 cr. A-F. Fall/Spring.

PPET 0295/0296 Journal Club

Students select articles from the current literature, analyze their significance, and present them for discussion in a seminar group. 0 cr. S/U. Fall/Spring.

PPET 0297/0298/0299 Graduate Research

These courses provide guided research on a topic suitable for a doctoral thesis. 4 cr. A-F. Fall/Spring/Summer.

PPET 0403/0404/0405 PhD Degree Only

Students enroll in this course when they receive permission to write and defend their theses from their thesis committees. This course represents the effort in the final preparation of the doctoral thesis. A grade of "S" is awarded upon completion of the thesis. 0 cr. S/U. Fall/Spring/Summer.

SK 0101 Basic Skills for Scientists I

This three-module course is designed to give trainees basic skills in oral and written presentation and in approaches to the reading of the scientific literature. 0.5 cr. S/U. Fall/Spring.

SK 0102 Basic Skills for Scientists II

This three-module course is designed to give trainees basic skills in designing experiments and interpreting quantitative data, in presenting data, and in writing grant applications. 0.5 cr. S/U. Fall/Spring.

SK 0115 Teaching Infectious Diseases

The course provides the background to teach about infectious disease in high school classrooms. The course is based on a 10th – 12th grade (Biology II) curriculum that has been developed by a partnership between a group of Boston teachers and infectious disease specialists from Tufts University. The goal of the course is to teach the key scientific concepts underlying the curriculum - how bacteria, viruses, and parasites cause infectious diseases and how the immune system defends the body against the attack, as well as the pedagogical strategies to deliver the content in the classroom using a variety of inquiry-based constructivist approaches. 1 cr. S/U. Summer.

SK 0202 Structural Biology

This course covers the basic theory and practice of Macromolecular Crystallography and NMR. 0.5 cr. A-F. Summer; last offered 2013.

SK 0205 Mentored Undergrad Teaching

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. 0.5 cr. S/U. By Request.

SK 0275 Applied Ethics for Scientists

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. Topics include: academic integrity issues and fraud; misconduct including plagiarism, data handling, and lab notebooks; mentoring; conflict resolution; and ethical use of animals and human subjects. 0.5 cr. S/U. Fall; last offered 2015.

SK 0299 Biomedical Techniques & Research

This course includes research with selected advisor. Prerequisite: Visiting Student status. 0 cr. S/U. Fall/Spring/Summer.

SK 0375 Advanced Scientific Ethics

This is an NIH-mandated refresher course for responsible conduct of research (RCR) for 5th year students. Students work in teams to develop a new case study addressing an RCR issue, provide a written in depth analysis, and teach the case study to a small group of students enrolled in SK 0275 under the supervision of the course director. Grading is based on the quality of the case study and analysis, teaching, effort and participation. 0.5 cr. S/U. Fall; last offered 2015.

SKMD 0209/0210 Clinical Implications of Basic Research

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 is to encourage and teach students to continually ask how basic research can impact clinical medicine and to enable students to sharpen their communication skills in a relaxed atmosphere. 0 cr. S/U. Fall/Spring.

SKMD 0299 Laboratory Rotations

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, Spring, Summer. 1 cr. A-F. Summer.