MD/PhD Student Handbook

University of Rochester School of Medicine and Dentistry

2022 Edition

Matriculated class for Fall 2021 at the annual White Coat Ceremony, August 13, 2021

Preface

This handbook presents information germane to MD/PhD students at the University of Rochester. It is intended as a guide for curriculum, a resource for transition periods, and a listing of committees, students and advisors who actively participate in the program. New to this edition are revised guidelines for the use of training funds, curriculum updates, and faculty and staff leadership contact information. **As students in the MD/PhD Program, you are also expected to keep yourselves apprised of your responsibilities as outlined in the School of Medicine Student Handbook .** We fully anticipate as the program grows and new issues arise that some of these contents will be modified and new materials incorporated. Please help us in this process by providing feedback about the contents. Thanks in advance for your contributions to this ongoing process.

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Director, Medical Scientist Training Program

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Associate Director, Medical Scientist Training Program

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Mission Statement

The MD/PhD program at the University of Rochester trains a diverse community of students dedicated to the advancement of biomedical sciences and practice of compassionate medicine. The unique combination of the Double Helix curriculum, rigorous training in scientific research, and acquisition of clinical skills prepares students to be independent, visionary physician-scientists who promote human health through the integration of basic and clinical sciences.

Alumni

Of the over 200 MSTP trainees graduating from the University of Rochester between 1977 and 2022, at least 172 remain in the academic track with 84 currently holding faculty appointments or working in research intensive careers (e.g. Pharma/Biotech) with 48 still in fellowship or residency training. In a 2015 survey, 84% of alumni in full-time academic or research-associated positions reported spending 50% or more of their time engaged in research. Many former trainees have assumed positions of leadership within their institutions. For example, Bradford Berk (1981) is Distinguished University Professor in Medicine, Neurology, Pathology, and Pharmacology & Physiology as well as Director, Rochester Neurorestorative Institute at the University of Rochester Medical Center (URMC). He is former Senior Vice President for Health Science and CEO at the University of Rochester Medical School. John Dipersio (1980) is Deputy Director of the Alvin J. Siteman Cancer Center at Washington University; Edward Rubin (1980) is Director, US Department of Energy Joint Genome Institute, Lawrence Berkeley National Laboratory; Richard Gallo (1986) is Chief of Dermatology at the University of California, San Diego; Paul Love (1987) is Section Head of Cellular and Developmental Biology at NICHD; Akiko Shimamura (1991) is Director of the Bone Marrow Failure Clinic at Seattle Children's Hospital.; Alison Bertuch (1993) is Director of the Bone Marrow Failure Program at the Baylor College of Medicine; and Virginia Winn (1996) is Director of Perinatal Biology at Stanford University School of Medicine. Other graduates assume important leadership roles in the pharmaceutical/biotech industry including Leonard Dragone (1996), Senior Director of Experimental Medicine, Merck Research Laboratories.

A full list of recent alumni, their residency positions and current positions can be found on the Alumni page of the MSTP website.

Committees and Program Structure

The organization of the MD/PhD program serves the needs of our trainees as well as integrates the larger role that the MD/PhD Student Council plays in the program. Drs. O'Banion, Steiner, Alysha Taggart, and Becca Smarcz work with three different committees to assure the smooth operation of the program. These include an Internal Advisory Committee that provides program oversight, an Admissions Committee that assists in the important job of student selection, and the MD/PhD Student Council, which provides a critical venue for student input and a mechanism for implementation of student-centered activities. Membership for each of these committees is provided in the following tables, accompanied by information about meeting schedules and specific roles.

MD/PhD Program Internal Advisory Committee

Name	Academic Position and Title
Laura Calvi, MD	Professor of Medicine, Neurosurgery, Pathology and Pharmacology & Physiology
Diane Dalecki, PhD	Chair and Professor, Biomedical Engineering; Professor, Electrical & Computer Engineering; Director, Rochester Center for Biomedical Ultrasound
Stephen Dewhurst, PhD	Chair & Dean's Professorship, Microbiology & Immunology; Vice Dean for Research, SMD; Associate Vice President for Health Sciences Research, URMC
David Linehan, MD	Chair and Professor, Surgery and Cancer Center, Oncology

- Provides oversight of program, program committees and program directors
- Meets as needed

MD/PhD Program Admissions Committee

Admission Committee Member	Academic Position
Benoit Biteau, PhD	Associate Professor of Biomedical Genetics
Michael Meadow	MSTP Student Representative, G2, BIO
Victor Zhang	MSTP Student Representative, G2, BME
W. Richard Burack, MD, PhD	Professor, Pathology and Laboratory Medicine; Director, Hematopathology Unit; Vice Chair for Clinical Operations, Pathology
Paul Dunman, PhD	Professor, Microbiology & Immunology; Associate Professor, Ophthalmology
Michelle Dziejman, PhD	Associate Professor, Microbiology & Immunology
Sina Gharmmaghami, PhD	Associate Professor of Biology
Stephen Hammes, MD, PhD	Professor, Medicine, Pharmacology & Physiology; Chief, Endocrinology & Metabolism Division; Vice Chair for Academic Affairs and Research, Department of Medicine
Laurel Carney, PhD	Professor, Biomedical Engineering
Gregory DeAngelis, PhD	George Eastman Professor; Department of Brain & Cognitive Sciences
Todd Jusko, PhD	Associate Professor of Public Health Sciences, Pediatrics, & Environmental Medicine
Gail V. W. Johnson, PhD	Professor, Anesthesiology, Pharmacology & Physiology, and the Center for Neurotherapeutics Discovery
Richard T. Libby, PhD	Professor, Ophthalmology, Pathology, Pathology, and Biomedical Genetics; Senior Associate Dean, Graduate Education & Postdoctoral Affairs
David Mathews, MD, PhD	Professor, Biochemistry & Biophysics; Director, Biophysics, Structural & Computational Biology Graduate Program; Associate Director, Center for RNA Biology
Margot Mayer-Proschel, PhD	Professor, Biomedical Genetics and Neuroscience
Christine Mhorag Hay, MD	Associate Dean for Medical Admissions; Associate Professor of Medicine
Cynthia Monaco, MD, PhD	Assistant Professor, Infectious Diseases and Microbiology & Immunology
Craig Morrell, DVM, PhD	Professor, and Acting Director of Medicine; Aab Cardiovascular Research Institute (CVRI); Professor, Pathology and Microbiology & Immunology
M. Kerry O'Banion, MD, PhD (*Chair)*	Professor and Vice Chair, Neuroscience; Director, Medical Scientist Training Program (MSTP)
Michael O'Reilly, PhD	Professor, Pediatrics (Neonatology) and Environmental Medicine
Laurie Steiner, MD	Associate Professor, Pediatrics (Neonatology) Associate Director, Medical Scientist Training Program (MSTP)
Kristin Scheible, MD	Associate Professor of Pediatrics and Microbiology & Immunology
Ruchira Singh, PhD	Associate Professor of Ophthalmology and Biomedical Genetics

- All interviewed students meet with at least one committee member
- Committee meets four times during recruiting season to evaluate and rank interviewed applicants
- The Medical School Admissions Committee provides a separate evaluation for MD/PhD applicants, which Dr. O'Banion will participate in as needed.

- Student representatives provide evaluations of each applicant based on the student interviewer notes

MD/PhD Program Student Council

Position	Council Member	Role
President	John Bennett (G4)	Schedules and runs meetings Follows up with other Council members
Events	Alison Livada (G3) and Sam Weisenthal (G6)	Arranges chalk talk and seminar schedules Arranges Fall and other retreats (e.g. Upstate New York student retreat)
Admissions	Michael Meadow (G2) and Victor Zhang (G2) To be appointed by Co-Chairs To be appointed by Co-Chairs To be appointed by Co-Chairs	Representatives to Admissions Committee Applicant Dinner Organizers Hosting Coordinator Applicant Greeting Coordinator
MSRS	Briaunna Minor (G5)	Organizes and coordinates annual Medical Scientist Research Symposium (MSRS). Requests nominations for keynote speakers from MSTP student body. Invites speakers two years in advance.
Curriculum	Fara Zakusilo, PhD (M3) Michael Vera (M1) Alison Livada (G3) Maya Anand (G2)	Medical School Curriculum Committee Honor Board
Social	Emily Isenstein (G3) and Sophie Troyer (M2)	Organize social events (e.g. picnic, dinners, etc.)
Public Relations Chair	Thomas Delgado (G2) and Jithin George (M1)	Maintains and distributes minutes from Student Council meetings, maintains program social media pages & assists in Newsletter preparation
Outreach Chair	Maya Anand (G2)	Works closely with the Program Director to promote awareness among undergraduate and high school students about biomedical/ translational sciences and opportunities afforded by MD/PhD training.
APSA	Anna Kolstad (M2) Institutional Representative Nora Gilliam (M1) Working Group	Represents the MSTP at annual, regional and national conferences of the American Physician Scientist Association
Wellness and Resilience Committee	Bryan Redmond (G3)	Represents the MSTP student body by attending meetings and reporting back with any relevant updates. Responsible for gathering/maintaining relevant data on those in program to ensure overall student wellbeing.

Information Technology Chair	Matt Sipple (G3)	Trains others on the use of and helping to maintain the MSTP Red Cap account. Gives updates on new technologies and their implementation as necessary to the student council.

- Student Council meets once a month during academic year
- Disseminates information to all MD/PhD students
- Provides an important forum for discussion of student concerns and representation on other committees

MD/PhD Student Council Guidelines: 2022-2023

1. Overview

The MD/PhD Student Council represents the voice of MSTP students and acts as a liaison between the MST Program and its students. In addition, the Student Council provides support for social and scholastic activities while fostering a community among students. To these effects, the Council is composed of several officers, and the MD/PhD student body as a whole. Regular meetings, events, and the annual retreat provide opportunities for the Council to help make this program meaningful and enjoyable for all involved.

2. Events

2.1 Council Meetings

In order to keep the MD/PhD student body informed of Council activities and to elicit feedback for the Council or the program, regular Student Council meetings are held. These meetings are organized and run by the Council President and are open to all members of the program. A major goal of these meetings is to bring forth and discuss issues that are important to the students. These discussions serve to guide the president in properly representing student concerns at MSTP Executive Committee meetings. Minutes are recorded and distributed to the student body following the meeting by the Council public relations chair.

If more sensitive issues require discussion, the president may call special officer or MD/PhD Executive Council meetings, as appropriate. These include issues relating to the MST Program, the Council, or recommendations to the MD/PhD Executive Committee not endorsed by the entire student body. The minutes of these meetings may be distributed at the discretion of the officers present.

2.2 Seminars and Lectures

As part of the scholastic enrichment of the students in the program, and to further encourage student interaction, the Council sponsors various seminars and lectures throughout the year. These seminars and lectures will include speakers from the University, invited guest lecturers, or speakers from within the program.

As per the MD/PhD Executive Committee, all students in the program will be required to attend 2 out of the 3 seminars scheduled each semester. If one of the seminars includes a speaker from outside the University, attendance at this seminar will be required of all students.

2.3 Social Events

In keeping with the theme of bringing together students from throughout the program, the Council regularly sponsors social events. These events, including such activities as wine tours, berry picking, bowling, movie nights, special holiday gatherings & graduation parties, are organized and supported by Council funding. The Social Chair is charged with planning and organizing such events.

2.4 Applicant Events

There are several events associated with the applicants. These involve the dinners during each interview session, applicant greeting as appropriate, and the revisit weekend for accepted students. All of these events fall under the auspices of the Admissions Committee, which is headed by the Admissions Chair; individual members are assigned specific tasks to plan.

The Admissions Chair is charged with organizing the social events during the MSTP revisit weekend. These events, typically held on the second evening of the revisit, are an opportunity for current and accepted students to interact in a more informal environment and become acquainted.

2.5 Annual Retreat

Once a year, the MST Program holds a retreat to bring together current students and faculty while welcoming new MD/PhD students. A keynote speaker is invited to speak about his/her research and clinician-scientist career. The retreat also includes research presentations and discussion of Council issues. Council elections are held at the retreat. The planning of the retreat is tasked to the Events Chair, with the help of the program administration. ****Attendance is mandatory for this event and students must receive permission from the MSTP Director if they have a valid reason to miss the retreat**

3. Council Officers

Council officers are chosen each year at the retreat, and will guide the direction of the Council throughout the year. The officer positions are divided into the Executive Board positions, the admissions committee positions, and the other positions. Procedures for choosing the officers are outlined below (see Section 5).

3.1 Student Council Executive Board

3.1.1 President

The main duty of the president is to coordinate the activities of the Student Council with the MD/PhD program, including the MSTP Executive Committee. In addition to serving on the Executive Committee, the president is in charge of calling, planning, and running the monthly Student Council meetings. He/she will coordinate with the MD/PhD office on budget expenditures and will oversee the other duties to ensure responsibilities are fulfilled. The president will work with the other chairs to plan events, such as speakers, social events, and applicant events. He/she will also act as an advocate for any MD/PhD student issues or complaints to the MST Program regarding any aspects of medical or graduate education.

The term of the president is two years, with the first year being served as president, and the second as outgoing president in an advisory capacity to the incoming president. An individual shall be limited to serving only one term. Additionally, the outgoing president will also serve in an advising capacity and sit on the Executive Committee during the second year as outgoing president. These rules serve to maintain continuity in the Student Council and provide guidance for the incoming president.

3.1.2 Public Relations Chair

The Public Relations (PR) Chair provides communication to the MD/PhD student body, regularly updating them on events and activities via e-mail, social media, and other platforms. He/she records minutes at Council meetings and promptly relays them to the student body after each meeting. The Public Relations Chair will assist the program administrator in writing the MSTP newsletter as requested.

The term of the PR Chair is one year. There are no term limits.

3.1.3 Events Chair

The events chair is charged with planning and organizing scholastic events for the MD/PhD students. These events typically include faculty member seminars, as well as the yearly retreat. If his/her term falls in a year in which the Upstate NY MD/PhD conference is held at UR, he/she will also be in charge of planning this event. The scheduling of these events, securing faculty presenters, advertising, planning location & food (if necessary), and ensuring a smooth execution all fall under the auspices of the events chair. If desired, the chair can form and work with an events committee for these activities.

The term of the Events Chair is one year. There are no term limits.

3.1.4 Admissions Chairs

The Admissions Chairs are the MD/PhD student representatives to the MD/PhD Admissions Committee. The Admissions Committee meets after interviews begin to determine which students will be offered a position in the following year's MD/PhD class. The Admissions Chairs will perform student interviews, and act as the Student Council representative on the committee. Additionally, the Admissions Chairs appoint a Student Council admissions committee (described below) and work with the program administrators in organizing revisit weekend.

Two Admissions Chairs hold the position each year: one who was elected the previous year and one the current year. The Admissions Chair term is two years. There are no term limits.

3.1.5 Social Chair

The Social Chair is in charge of planning and organizing social events for the MD/PhD students. The scheduling, planning, securing of funding, and execution of these events all fall under the auspices of the social chair. If desired the chair can form and work with a social committee for these activities.

The Social Chair term is one year. There are no term limits.

3.2 Student Admissions Committee

The Admissions Committee is chaired by the Admissions Chairs, but generally functions as a separate entity. It includes the following positions:

3.2.1 Applicant Dinner Coordinator

The Dinner Coordinator is charged with planning and organizing the applicant dinners. This includes signing up MSTP students to attend, sending out schedules and reminder emails, scouting and reserving the restaurant, and securing payment if necessary. Typically 9 - 10 dinners are held per year on the first night of each interviewing session.

3.2.2 Hosting Coordinator(s)

The Hosting Coordinator(s) are tasked with organizing the hosting for applicants who request a student host. This involves signing up MSTP students before interview season starts and being listed as the student host contact for applicants. When an applicant contacts the coordinator, they will find an appropriate student host for this applicant.

3.2.3 Greeting Coordinators

On the morning of the first day of each interview session, the Greeting Coordinators are responsible for ensuring that current MD/PhD students are available in the admissions lobby to talk with MD/PhD interviewees. The coordinators provide an opportunity to provide a good first impression and "sell" Rochester to the applicants.

3.3 Other Positions

These positions do not fall under the direction of any committee or chair, but are still vital representatives of the Council.

3.3.1 Curriculum Committee Representatives

The MD/PhD program sends three representatives to the School of Medicine Curriculum Committee meetings: one from the first year medical school class, one from the second year medical school class, and one representing the third and fourth year medical school classes. Two new representatives will be selected each year: one from the first year medical school class for a 2-year term on the M1-M2 committee, and one from either the graduate training phase or the upper medical school classes for a 1-year term on the M3-M4 committee.

These individuals are charged with representing the interests of the MD/PhD students at bi-monthly committee meetings with students from the medical school classes and faculty. Students filling these positions will attend and report on any relevant issues to the MD/PhD students.

3.3.2 Honor Board Representative

The Honor Board Representative attends Honor Board Meetings and provides the MSTP student voice at these meetings.

The Honor Board Representative and an alternate are elected from the student body in graduate training. These individuals serve for the duration of their graduate school training. The alternate replaces the representative when the representative is unable to perform his/her duties due to personal, professional, and/or time conflicts. When the representative re-enters medical school training, the alternate will take his/her place and a new alternate will be elected. In a case in which both the representative and alternate will re-enter medical school, both positions will be elected. In cases in which the alternate re-enters medical school before the representative, a new alternate will be elected.

3.3.3 MSRS Chairperson

The MSRS Chairperson organizes and coordinates the annual Medical Scientist Research Symposium (MSRS). This position can be held by one elected chairperson or two co-chairs. The MSRS Chairperson requests nominations for keynote speaker from the MSTP student body, invites speakers two years in advance, and is responsible for appointment and management of the MSRS Committee, which assists with planning and implementation.

3.3.2 APSA Institutional Representative

This individual represents the MSTP at annual regional and national conferences of the American Physician Scientists Association and reports back to the MSTP Student Council with feedback and relevant information. He/she also facilitates collaboration between APSA regional, national, and local chapters, and schedules University-wide events for current APSA members, medical school students and fellows, as well as others interested in APSA and physician-scientist Training.

3.3.5 Outreach Chair

The Outreach Chair will serve as MSTP Institutional Representative, to aid in providing information to prospective students both within and outside the University of Rochester. If the position is held during a year in which the MSTP hosts an Outreach Conference for prospective student, the Chair will plan this event in collaboration with the department Administrator and sub-committee. This position will attend local and national-level recruitment events in an effort to promote and recruit the program goals of increased diversity.

Trainee Advising

Advising for MD/PhD students has evolved to best serve students during each phase of their training and takes advantage of the open and accessible advisors, administrators and faculty of our school. This provides a flexible approach tailored to each individual student. Key components are described below.

Trainees will utilize an MSTP-specific Individual Development Plan (IDP) throughout all years of training to reflect on short term and long-term goals, and to provide a record of milestones as they progress through the program. Each student's IDP is to be updated at least once annually, and submitted electronically for review. Upon initial review by the Program Director, if further advising is recommended, trainees will meet individually with **Dr. O'Banion** to discuss any areas of concern and/or clarification. Additionally, trainees will meet individually with Dr. O'Banion at least once during particular phases of training for a formal review of progress. The review is documented in a written note produced by the student and Dr. O'Banion. Specific topics to be covered are stage dependent and include:

- Med 1 and 2: Transition to graduate training, including selection of graduate program, rotations, and thesis mentors
- Grad Years 1 and 2: Progress in identifying thesis topic, graduate coursework requirements, progress in research, timing of qualifying examinations, grant writing, exploration of meeting and funding opportunities, and longitudinal clerkship selection
- Grad Years 3 (and 4): Research progress, productivity (abstracts, meetings attended and manuscripts), timing of thesis defense, transition into clinical phase

Current trainees meet with their Advisory Dean, specifically assigned for MD/PhD students, Dr. David Kaufman. They meet as a group during regularly scheduled Advisory Dean Lunches in Med Years 1 and 2, and individually to discuss academic progress and return to the clinical phase, including planning of clerkship timing. Drs. O'Banion, Kaufman, and Lambert work closely together to assure that student issues are addressed and that the transition to clinical work is smooth and efficient.

The **thesis mentor** plays a critical role in guiding trainees in the selection of their thesis topic and in assessing research progress. Upon identifying a permanent mentor, each student will meet with their mentor(s), the MSTP Director and Associate Director, and the MSTP Administrator to discuss expectations. Following this discuss, a written mentor agreement will be signed off on by all parties acknowledging roles and responsibilities of mentor, student and MSTP leadership. A **thesis committee**, the composition of which depends on school and graduate program guidelines, augments the thesis mentor's role. Timing of committee meetings is program dependent, but is at least once every six months following the thesis qualifying examination. MD/PhD trainees are encouraged to schedule more frequent meetings and make full use of committee members in order to efficiently move through graduate training.

As trainees move through the various phases of the program, they are encouraged to engage other faculty and program directors to fulfill specific advising and mentorship roles. These individuals include:

- Graduate training program directors and basic science chairs for selection of rotations, thesis laboratories and graduate curricular issues
- Longitudinal clerkship mentors for exploration of clinical training opportunities
- Clinical residency directors, faculty and chairs for residency information

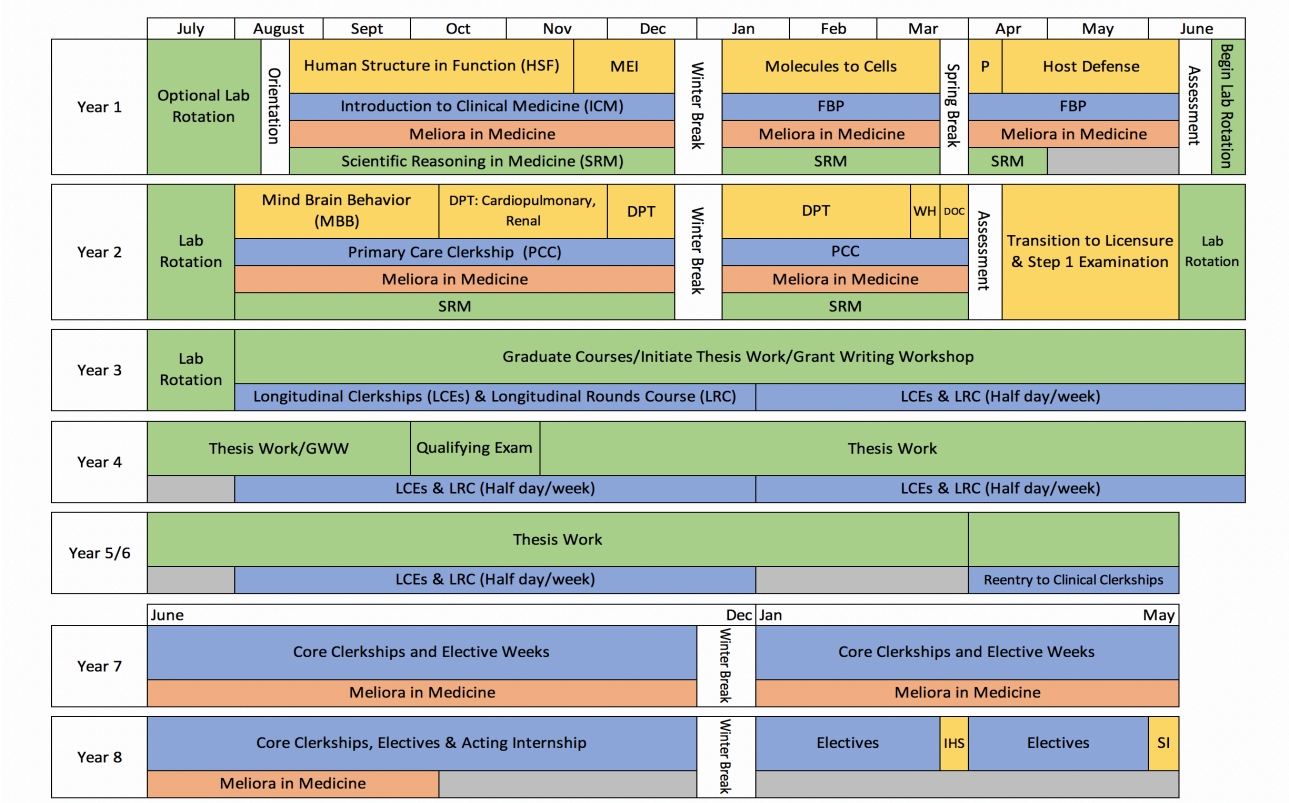
The MD/PhD Curriculum at the University of Rochester

Overview

The MD/PhD curriculum provides students with a longitudinal integration of basic and clinical sciences, punctuated by a period of rigorous graduate research training. The diagram below provides an outline for the major curricular components of the program. For most students it is anticipated that this program can be readily completed in 8 years, and that a significant proportion of students will complete the program in 7 years. Opportunities for conducting research rotations in the first years of the program, a shortened second medical school year, targeted clinical activities during graduate training, and significant flexibility in returning to medical school at the conclusion of graduate training all contribute to timely completion. Details for each phase of the curriculum as well as transitions between phases are summarized in the following sections.

MD/PhD Curriculum Diagram

Yellow Shaded areas are basic science periods.
Blue Shaded areas are clinical periods.
Green Shaded areas indicate periods devoted essentially full time to the PhD Program and Research Training



MEI – Medical Evidence and Inquiry
FBP – Foundations of Biopsychosocial Practice
P – Pharmacology
DPT – Disease Process and Therapeutics
WH – Women's Health
DOC – Disorders of Childhood
IHS – Improving Health Systems
SI – Successful Interning

Year One (Medical School)

MD/PhD students at the University of Rochester have the option of starting a laboratory rotation in the summer preceding the beginning of medical school. Students taking this option will receive a stipend during the summer. It is critical that such students identify themselves soon after acceptance in order to make the necessary arrangements. Dr. O'Banion will work closely with such students to select a rotation mentor. Lab rotation evaluation forms must be submitted by the student and faculty mentor upon completion of the rotation.

A day-long retreat is scheduled for all MD/PhD students and a subset of faculty involved in the program at an off-campus site early in the academic year, typically the Friday prior to the day medical school starts. Attendance is mandatory for this event and students must receive permission from the MSTP Director if they have a valid reason to miss the retreat. Planned by the MD/PhD Student Council, this event welcomes new students to the program and consists of a balance of research presentations (students and an invited scientist) and social activities. The event provides an opportunity to discuss programmatic issues that affect all students. Student Council elections are also held. Previous venues have been at a Finger Lakes winery, an Inn in Letchworth State Park, and the Rochester Yacht Club on Lake Ontario. The food and company are always outstanding.

MD/PhD students participate in the full Phase 1 medical school Double Helix Curriculum - Translations and Transitions, including all lectures, laboratories, Problem-Based-Learning sessions, ICM (Introduction to Clinical Medicine), Foundations of Biopsychosocial Practice (FBP), Meliora in Medicine, and the Primary Care Clerkship (PCC). For some classes (e.g. Molecules to Cells), MD/PhD students share the same PBL group with the expectation they will delve more deeply into basic science issues together.

All MD/PhD students participate in an additional class, Scientific Reasoning in Medicine (SRM), which meets for 6-8 sessions each semester. SRM is a credit-bearing course, with 1 credit each year that counts toward clinical elective time. Based on student feedback, the format for these sessions consists of a faculty presentation at noon on Friday followed by a student-run journal club the following Monday at noon. Faculty presenters are chosen from all disciplines within the medical center and are asked to present on research issues with clear clinical relevance. The journal club provides a forum for critical evaluation of primary scientific literature related to the research topic. Laurie Steiner, MD, directs and organizes this course, and attends most sessions. SRM is also required of students in the second year of the program. Thus students are introduced to the science of nearly 30 faculty in their first two years. If there are particular faculty presenters students are interested in having participate, please let the program Administrative Assistant, Becca Smarcz know.

Other opportunities for learning about faculty research interests include regular departmental seminars, MD/PhD organized seminars, specifically the MSTP Dinner Seminar Series comprising of three sessions each semester, of which attendance at two seminars per semester is required (see under "MD/PhD Program Events"). Interactions with faculty who teach in the medical curriculum, and student-initiated meetings with graduate program advisors and individual faculty further foster exposure to different research interests. These last mechanisms are particularly important for determining summer rotation options and ultimately, graduate department affiliation and thesis advisor. Dr. O'Banion also meets on an individual basis with trainees to gauge the progress of these important decisions as well as provide additional opportunities for advice about research options.

Although students may take on additional class-work during the first two years in medical school, this option is unlikely given the number of hours devoted to the Double Helix Curriculum

- Transitions and Translations. Students interested in additional class work generally take courses as “non-credit” and should speak to Dr. O’Banion and Dr. Kaufman to initiate the process.

During the summer following the first year of Medical School, MD/PhD students typically engage in a laboratory rotation of 8 to 10 weeks duration. Laboratory rotations provide outstanding opportunities for learning new systems and techniques, familiarizing oneself with specific laboratory and departmental environments, and establishing ties with potential thesis research mentors. Students are encouraged to participate in two or three rotations prior to settling into a thesis laboratory, and most do so. However, the MD/PhD program has no set requirement for number of laboratory rotations and students with very clear ideas about research direction may engage in fewer rotation experiences.[1] It is important to note that some graduate programs do not have a formal rotation mechanism; for example, those programs grouped under “Health and Population Sciences” (Epidemiology, Health Services Research, and Biostatistics & Computational Biology) offer other summer experiences. Students and rotation mentors should complete Lab Evaluation forms found on the Graduate Education website and linked here. These forms must be filled out by both student and mentor for any lab rotations completed. Individual graduate departments may have other requirements upon matriculation into their program.

Rotation choices are to be discussed with and approved by Dr. O’Banion prior to initiation.

[1]This should be cleared with specific graduate departments, since some may require a minimum number of rotations (see detailed graduate curricula in the Appendix).

NOTE: Community Service during all years of medical school is **optional**. However, if you wish to qualify for the Distinction in Community Health Award at commencement, you must have participated in a minimum number of hours of community service in **each of the 4 years**.
See link to SMD Handbook for details:
https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/education/md/documents/student-handbook.pdf

Procedure for Arranging Independent Clinical Experiences

All clinical experiences that are not part of the normal MD/PhD Curriculum must be approved by a special process, as outlined below, to ensure liability coverage for the student. This process must be completed before starting any such experience, including arrangements made for clinical exposure in the summers after first and second year medical school and experiences outside of the longitudinal clinical experience in graduate school. The policy is in place for all medical student contemplating such activities (normally summer activities for non-MD/PhD students).

Medical Student Liability Coverage for (Summer) Activities

University of Rochester medical students (with an eligible student status) can be given consideration for Medical Student Liability Coverage for Summer Activities. Described below is the approval process for all students engaging in **non-credit bearing electives** during the summer.

1. Students will be required to complete a special elective form for any summer clinical experience. This elective form must include a description of the activity.

2. Once the special elective form is completed, students will be required to have approval from a UR faculty member (in an appropriate clinical department) AND their Advisory Dean AND a representative from the Registrar's Office prior to the start of the elective. (**NO RETROACTIVE** approval will be accepted).

3. Students must have an evaluation form completed by the on-site mentor. This evaluation form will become part of the student's academic record. The special elective experience will be reflected on the student's transcript as a non-credit bearing elective.

4. For students who will be engaging in a community service activity as part of the longitudinal track of the Community Health Improvement Course*, the faculty course director will need to sign off on the special elective form (prior to initiation of the work) in addition to the Advisory Dean and Registrar sign offs.

*The Community Health Improvement Course (taken in Year 4 of medical school) is NOT required for MD/PhD trainees.

Year Two (Medical School)

MD/PhD students enter the Phase 2 with their medical school colleagues and participate in a modified Double Helix Curriculum - Translations and Transitions, while continuing to take SRM. Following completion of coursework in March and the Phase 2 Assessment in early April, students devote time to prepare for the USMLE Step 1 Examination. Once Step 1 is complete, this timing provides ample opportunity for students to participate on one or two additional laboratory rotations should they require additional time identifying a thesis laboratory before graduate school formally begins in September.

Year Three (Graduate School)

The transition from medical school to graduate school is aided by familiarity with graduate training and graduate faculty gained during the first two years of the program and by rotation experience(s). The late spring and summer following the second year provides an outstanding opportunity for students to finalize their choices for graduate degree program and thesis mentor. The extra time afforded by shortening the second year and the relatively late start of the graduate school calendar (September) allows students the option of completing two rotations, if desired. Alternatively, students who establish their mentor early can initiate studies leading to their thesis. Advising efforts are directed at helping students make program and mentor choices in order to efficiently take advantage of graduate courses starting in the fall. Indeed, MD/PhD students are required to declare a graduate program by the beginning of the Fall Semester, and a thesis advisor by January of that year (students can elect to do an additional rotation during the Fall Semester to help in this decision), although many declare earlier. Early planning, seeking advice, and multiple meetings with graduate program directors and potential thesis advisors are critical to this process. A list of graduate program information and website links is included in the "Contacts" section of this handbook.

The third year is typified by graduate program coursework and initiation of thesis research. Specific course requirements and other guidelines established for each degree program are provided in the Appendix. Program declaration and graduate course registration are handled through the office of Graduate Education and individual graduate program administrators (see contact information on pages 28). Note that these offices differ for students in River Campus programs (Chemistry, Biology, Optics, Physics and Brain & Cognitive Science). Components common to all guidelines include granting MSTP students 30 hours of credit toward coursework accomplished in the Double Helix Curriculum, core and advanced graduate courses specific to each program, and required participation in graduate student seminar series, journal clubs, and departmental/program seminar series. Students must complete IND 501, "Ethics and Professional Integrity" by fall of the third year in the program. Teaching requirements for many, but not all, graduate programs are waived for MD/PhD students, though students may elect to participate, and outstanding opportunities for teaching exist in most programs. Indeed, students are strongly encouraged to gain experience with teaching through graduate programs and the Medical Education Pathway.

Participation in all graduate student activities and required steps for obtaining the PhD degree, including qualifying examinations, ensures that MD/PhD students have regular opportunities for presentation of their work and evaluation of their progress. In addition to graduate student seminars and presentations at national scientific meetings, our students present their work at MD/PhD specific events, including poster or oral presentations at our Annual Retreat, Revisit Day, Medical Scientist Research Symposium, the Tri-Institutional MD/PhD Student Conference, the National MD/PhD Student Conference in Colorado, and the American Physician Scientists Association Annual meeting in Chicago.

Students in their first two years of graduate training are encouraged to participate in a series of sessions (Grant Writing Workshop), led by Dr. O'Banion and other graduate faculty in the Fall Semester that focuses on grant writing for MD/PhD Fellowships (e.g. F30s). The emphasis is on understanding the nuts and bolts of grant applications, generating a specific aims page, and discussing issues specific to fellowship training. Many of our trainees have gone on to submit these fellowships and obtain individual funding.

The Longitudinal Clinical Experience

Description

The MD-PhD program has a required Longitudinal Clerkship Experience (LCE) that is completed during the PhD portion of the training program. The two primary purposes of the LCE are to provide MSTP students with 1) clinical experience in direct patient care to further develop their communication, physical examination and clinical reasoning skills and 2) an opportunity to work in clinical settings with physician-scientists. For each LCE completed (see details below), students will be awarded two (2) medical school elective credits which apply to the graduation requirements for the M.D. degree.

Longitudinal Clerkships are clerkships generally conducted in the ambulatory/outpatient setting on a weekly or biweekly basis. These clerkships are completed by MSTP students during the graduate phase of training. Students, in consultation with a faculty preceptor, will identify 2-3 clinical knowledge areas and/or clinical skills in which the student will gain proficiency by the end of the LCE.

LCE Learning Objectives

1. Improve patient interviewing, physical examination and clinical reasoning skills.
2. Gain understanding of and experience in continuity of care relationships.
3. Gain exposure to career options by preferentially working with faculty preceptors who have direct experience and insight into the life of the physician-scientist.
4. Experience mentorship with the preceptor on balancing clinical and research activities.
5. Receive general career guidance from the faculty preceptor that complements other MSTP career counseling programs and opportunities.

LCE Requirements

1. All students are encouraged to complete a minimum of two (2) Longitudinal Clerkship Experiences -*before the end*- of their third year of graduate training (G3).
2. At least one of the LCEs must involve direct patient care and must be completed in an ambulatory, patient care-oriented setting.
3. LCEs must consist of either half-day or full-day clinics on a weekly or biweekly basis.
4. Students must complete a cumulative minimum of ten (10) full days of clinic time for credit.
5. LCEs must be completed in a longitudinal fashion and must each be completed over a period of no longer than twenty-four (24) weeks.
6. Attend at least three (3) Longitudinal Rounds Sessions (see below) during each LCE.

Longitudinal Rounds (LR)

- Longitudinal Rounds are interactive seminars during which MSTP students synthesize LCE clinical encounters into succinct patient presentations and discuss a variety of relevant diagnostic and therapeutic modalities. LR sessions will be held monthly and students must attend a minimum of three (3) LR sessions and present at least one (1) patient encounter during the course of each LCE.

LR Learning Objectives

1. Refine oral presentation skills and synthesis of patient histories and physical examinations.
2. Gain exposure to a broad range of medical sub-specialties via sharing of LCE experiences among students.
3. Improve differential diagnosis, assessment/plan, and team-based medical decision making skills in a wide variety of clinical disciplines.
4. Develop skills in the incorporation of relevant technology (e.g. eRecord review of lab values) into patient presentations, and review HIPPA regulations of patient privacy with respect to electronic patient information.

Guidelines
No more than one (1) Longitudinal Clerkship Experience may be completed per semester, and no more than two (2) Longitudinal Clerkships may be completed per academic year. No more than eight (8) total weeks of clinical elective credit may be earned for Longitudinal Clerkship Experiences. Students must register for the LCE before beginning as retroactive credit will not be given per medical school policy. Students who begin a longitudinal clerkship but fail to complete it within the allotted time (24 weeks as noted above) will be assigned a grade of "Withdraw" or "Withdraw Fail" by their preceptor. The grade will be noted on the student's medical school transcript in accordance with medical school policy and no credit, including partial credit will be given. Students are expected to complete all appropriate evaluations of the LCE.
Accepted Longitudinal Clerkship Experiences include:

- Ambulatory, clinical specialties (e.g., medicine, medicine subspecialties, neurology, psychiatry)
- Ambulatory, clinical component of a procedural or surgical specialty (e.g., OB/GYN, radiation oncology)
- Diagnostic specialties (e.g., pathology, radiology)

Any student seeking advice on identifying LC preceptors should reach out to the LC Director, Laurie Steiner, MD or the MSTP Administrator.

Enrollment
Graduate-phase MSTP students can enroll in LCs in MedSIS via the following link:
https://medsis.urmc.rochester.edu
Within the "Academics" tab, select "Add/Drop Requests"
Indicate the appropriate academic year, and select "New Request"
Request Action: "Add"
Course title: PHDCLK
Select the appropriate institution, dates, and preceptor from the drop down menus.
Note: All clinical electives completed in graduate school, regardless of format, must be approved by the student's Advisory Dean. Deviations from the policy stated above require advanced approval by both the student's advisory dean and graduate advisor.

Evaluation
To receive credit for the clerkship, students and their preceptor must complete evaluations to be reviewed by both the medical school and the MSTP.

For all clerkships beginning in the 2020-21 academic year, the MSTP staff will send an evaluation to the preceptor directly, immediately following completion of the clerkship hours through MedHub. Once submitted and reviewed, and all Longitudinal Rounds attendance and presentations have been accounted for, the student will receive credit. Students will also be sent a course evaluation to complete for both the LCE and LR experience(s).

For all clerkships completed prior to the 2020-21 academic year, students will fill out the "Evaluation Form for MD/PhD Longitudinal Clinical Experience" located under the Forms section of the MSTP website. They will then have their preceptor fill out the remaining section(s) and submit to the appropriate personnel listed on the form. Once submitted and reviewed, and all Longitudinal Rounds attendance and presentations have been accounted for, the student will receive credit.

Years 4, 5, (and 6) (Graduate School)

For most programs these years are filled with ongoing research towards the student's thesis and engagement in laboratory and departmental activities. Because MD/PhD trainees typically enter their graduate training phase with a thesis mentor already selected**, MD/PhD students are expected to complete their thesis qualifying examination by December of the second year in graduate training for most graduate programs**. Exceptions to this rule include programs such as Biostatistics and those affiliated with Health and Population Sciences, which have substantial course requirements and cumulative examinations. Once a student has passed their thesis qualifying examination, they are required to meet with their thesis committee every six months. Because of the nature of the research, students earning a degree in Epidemiology may complete the 3rd and 4th year of medical school while their data "matures", returning in the last year to write up results. Details are found in the Graduate Curricular Guidelines section.

Attending and presenting results at scientific conferences is another important part of training, and MD/PhD students are encouraged to attend the American Physician Scientists Association (APSA) regional and annual meetings, as well as the National MD/PhD Student Conference sponsored by the University of Colorado MSTP. The program helps cover costs associated with these two meetings. MD/PhD students continue to participate in MD/PhD seminars, MSRS, social events, MD/PhD Student Council service, and program retreats. Indeed, interaction between students at all phases in the program is a critical aspect of the training process. Students are also called upon to help with admissions and recruiting efforts, including conducting applicant interviews for the program.

As thesis research nears completion, students are encouraged to work closely with their thesis committee to ensure that the goals of graduate training have been reached. Submission and publication of manuscripts in peer-reviewed journals, presentation of work at national meetings, and completion of the thesis document represent important milestones in this process. Indeed, MD/PhD students are required to have a minimum of one first-author paper submitted at the time they defend their thesis. Students should consult with the graduate office regarding proper thesis formatting and the timing of thesis submission and scheduling the final thesis defense. This should be done well in advance since there are University imposed blackout dates for conducting the thesis examination.

Transition to Clinical Years

There is significant flexibility in entering Phase 3 and Phase 4 medical school clinical years of training. Coordination for reentry is accomplished in consultation with Drs. O'Banion and Kaufman, thesis committees, and the Medical School Registrar. Individual plans are established for each student based on their needs and status with regard to thesis completion. For students completing their thesis in the spring or summer, Core Clerkships (see below) can be initiated at several time points starting in June or September. In cases where students have turned in a thesis, provision may be made for clerkships to be started, with the stipulation that the thesis be defended during an early elective period. The Thesis Advisor, the Thesis Committee, and Drs. O'Banion, Lambert and Kaufman must approve all such arrangements in advance. Although it is possible to start Core Clerkships later in the year and still complete all requirements for graduation, this should only be attempted by students with very clear ideas about residency choices, so that proper sequencing of clerkships can be accomplished. Students who plan to enter residencies with early match may be at a particular disadvantage if they start later than the summer.

Drs. Lambert, Dr. O'Banion and Kaufman meet with all students in years 5 and 6 as a group in early spring to discuss possible strategies, coordinate efforts, and offer individualized opportunities for these students to sharpen their skills for hospital-based medicine prior to entering Phase 3. A variety of opportunities exist to facilitate the transition to the clinically intensive portion of the curriculum.

Years 6 and 7 or 7 and 8 (Medical School)

Please note that the curriculum presented below was rolled out for students who start Medical School in 2019; thus, specific changes in curricular structure (e.g. Phase 3 and 4) will take place in 2021-22 and 2022-23, respectively. For students who started medical school prior to 2019, and return to medical school in 2021 or later, the Phase 3 and 4 requirements will be used.

Core Clinical Clerkships occur over a one-year period and include clerkships in Obstetrics and Gynecology and Pediatrics (5 weeks each), Mind/Brain/Behavior II (4 weeks each of Neurology and Psychiatry); and Medicine (8 weeks) and Surgery (6 weeks). Each integrated clerkship has an associated one-week session devoted to the Scientific and Social Foundations of Medicine (3 total).

There is also elective time in Phase 3. This elective time provides flexibility for MD/PhD students needing to complete their thesis defense as well as providing an opportunity to pursue specialized areas of clinical medicine that may be important in career choice decisions. A complete list of required experiences in the final two years is provided on the next page. MD/PhD students can possibly meet all clinical requirements in a 1.5 year period and may receive up to 6 weeks elective credit for research conducted during their thesis preparation with prior approval. Thus there is ample opportunity for conducting residency interviews. In addition, students can elect to return to the laboratory in their last year to pursue additional research.

MD Program Phase 3 and 4 Requirements MD-PhD Students

Credit or Equivalent

Phase	Course/Clerkship	(Weeks)
Phase 3	Medicine Clerkship	8
	Surgery Clerkship	6
	Scientific and Social Foundations of Medicine	1
	Obstetrics and Gynecology Clerkship	5
	Pediatrics Clerkship	5
	Scientific and Social Foundations of Medicine Mind, Brain, Behavior	1
	Neurology Clerkship	4
	Psychiatry Clerkship	4
	Scientific and Social Foundations of Medicine	1
Phase 3 and/or 4	Electives (2 credits are from the Phase 1 and 2 MSTP SRM course; up to 8 credits can come from the Longitudinal Clerkship Experience and up to 6 weeks can be from research conducted after the PhD is completed)	28
	Family Medicine Clerkship	4
	Emergency Medicine Clerkship	4
	Surgical Subspecialty Selective	2
Phase 4	Acting Internship	4
	Critical Care Selective	2
	Improving Health Systems (Phase 4)	3
	Successful Interning (Phase 4)	2
Total		84

MD/PhD Program Events: Opportunities for Student and Faculty Interaction

- **Yearly Retreat** in August
- **MD/PhD Dinner Seminars**—held six times each academic year (typically three times per semester), these meetings alternate between an informal faculty presentation, a presentation by residents or fellows, and a visiting faculty lecture. The Events Chair of the Student Council is responsible for scheduling speakers and selecting food. These sessions represent outstanding opportunities for students to interact in a scientific, collegial forum. Students are expected to attend at least 2 sessions each semester as detailed in the Student Council Guidelines (page 9). Some sessions are devoted to career choices. A popular forum from past years is a round table discussion with faculty and fellows at different career stages discussing their integration of research and clinical training.
- **Medical Scientist Research Symposium (MSRS) and Revisit Weekend**—our MD/PhD students play a very active role in recruiting potential matriculants through their extensive involvement with hosting applicants, and planning/participating in both the MSRS and Revisit Weekend activities. Attendance at the half-day MSRS symposium is mandatory unless excused by Dr. O'Banion. Specific MSRS/Revisit Weekend activities include a combined luncheon and poster session by current MD/PhD students, as well as an elegant dinner at a historic mansion that is attended by a large number of faculty, program directors and administrators.
- **Local and National Meetings**—in addition to attending meetings in their specific fields, our students take advantage of opportunities to interact with MD/PhD students from other programs. Locally, Drs. O'Banion, Steiner and MD/PhD students attend the Annual Tri-Institutional MD/PhD Research Conference, held jointly with MD/PhD students from Syracuse and Buffalo. We also send 6 students to the National MD/PhD Student's Conference in Colorado each summer and encourage attendance at the American Physician Scientists Association Annual meeting held in Chicago each April. These represent outstanding opportunities to learn about other programs, current research, and career options. Details about student travel support are provided in the next section.
- **Longitudinal Rounds Course**— throughout their graduate years, MSTP students are required to participate in Longitudinal Clerkship Experiences. During each academic year, the MSTP hosts a Longitudinal Rounds Course once a month, which allows all graduate students currently in a Clerkship Experience to present medical cases with current faculty, and their fellow trainees. Students must attend a minimum of three (3) LR sessions and present at least one (1) patient encounter during the course of each LCE.
- **Social Events**—throughout the year, MSTP students organize events about every other month. These include outdoor activities such as white-water rafting or downhill skiing, an annual maple sugar pancake excursion, holiday parties, and dinner or brunch for students graduating from the program in May. These are always well attended and enjoyed by spouses, significant others, program directors and our administrators.

Support for MD/PhD Students at the University of Rochester

Funds supporting MD/PhD students come from a variety of sources. Our MSTP grant provides tuition and stipend support for a set number of students (currently 14) as well as some additional funds for programmatic and student expenses. Some students also receive support as Clinical Translational Science Award Fellows. Medical School Dean's funds cover a larger portion of support, including funds from the Graduate Program for the first 21 months of graduate training. Following this period, stipend support for students in the graduate phases is derived from departmentally based training grants, individual investigator (R01) or program project (P01) grants, or individual predoctoral fellowships obtained by the student. All MD/PhD students are encouraged to apply for these prestigious awards and should take the MSTP Grant-Writing Course in the graduate school years, as well as talk to departmental, thesis and program advisors to learn about these opportunities. **Because of new limits imposed by NIH, applications for *MD/PhD (F30) NRSA Fellowships must be made before the student has been in the program for 48 months* (note that this time includes summer rotations started before medical school and any graduate school or medical school training prior to entering the MD/PhD program). Thus, it is critical to plan applications for such fellowships early in graduate training, ideally near the beginning of the G2 year.**

Students are fully funded for their entire tenure in the MD/PhD Program. Specific items that are covered include:

- Tuition (for academic year 2022-2023 it is $65,920 for medical students; $60,480 for graduate students) estimated to increase 4% in future years.

- Stipend throughout both medical and graduate school. The stipend level for academic year 2022-23 is $32,300. The University is committed to maintaining a competitive stipend for its students, so this amount will likely increase in future years.

- Health Fees and Disability Insurance. Note that current policies, in compliance with the policies of the National Institutes of Health, allow us to cover health fees for students only. Health insurance coverage for spouses and minor dependents of our students will be available to purchase through the University, although this is a fairly expensive option. Fortunately, New York State has inexpensive or free coverage that most families should qualify for (Family Health Plus / Healthy New York and Child Health Plus or Medicaid).

- Technology fees in all years of Medical School (approximately $575/year)

Importantly, Student Activity and Service Fees (approximately $1,400 in Year 1, $310 in Year 2, $575 in Year 3, $925 in Year 4 medical school and $200 in graduate school; subject to modest change) are NOT covered by the Program. In addition, a one-time fee of approximately $550, collected prior to the start of medical school, covers purchase of equipment required to conduct physical exams. An additional fee relating to graduation is also billed during the fourth year of medical school.

Student Travel, Training and Research Funds Overview

The principal source of funding for travel and research related expenses of graduate students lies with their research laboratory. Recognizing the special situation of dual degree training, additional funds are provided by the MSTP in support of its students. These funds are meant to provide MSTP students with more flexibility, early on when they have not yet chosen a laboratory and later for travel, research or training related expenses that are not directly provided for by the thesis advisor's grants. Each student will receive a budget of $2400 ($1200 for each four years that they are matriculated in the MSTP). Unspent funds can be carried over from one 4-year period to the next. However no single expenditure can exceed $1000 and the total aggregate amount of funds available will not exceed $2400 per student. All spending is limited to expenses related to a student's travel, training, or research and is subject to the approval of the Program Director.

Participation in national conferences is a critical component of career development. Use of funds for the purpose of attending scientific conferences is therefore strongly encouraged. Travel related expenses include but are not limited to registration fees, airline tickets, car rental, food and lodging. Students wishing travel to participate in a conference, course or instructional program directly related to their thesis research may do so with prior approval from the thesis advisor. Students are strongly encouraged to use the MSTP funds to supplement or leverage travel funds from other sources (see below).

Research funds may also be used for purchase of research related equipment and services, software, scientific books or scientific periodicals (not available in the laboratory or University library). Funds cannot be used for travel, application materials, or examinations related to residency selection. A student wishing to purchase a computer may apply research funds towards 1/2 the cost, but may use no more than $1000; however students may only use research funds towards the purchase of one computer (one purchase of a desktop, laptop, or tablet) during their tenure, and if ISD support is desired, the computer must be purchased through the University Computer Store. There are no restrictions on the type of computer. Photocopying, or printing services that reasonably are needed for study, research and preparation of the thesis (e.g. poster printing, article requests, etc.) may also be covered.

Program Specific Travel Opportunities

National MD/PhD Student Conference in Colorado

Organized by the University of Colorado MSTP, this conference provides an opportunity for MD/PhD students to present their research to and interact with other MD/PhD students and prominent scientific investigators from across the nation. During one's tenure, every student will receive an invitation from the Program Director to represent the University of Rochester School of Medicine and Dentistry at the National MD/PhD Student Conference in Colorado. Expenses related to travel and attendance at the National MD/PhD Students' Meeting are completely covered by the MSTP, and are not counted toward the invited student's $2400 budget.

American Physician Scientists Association (APSA) Annual Meeting
The annual meeting held jointly with the American Society for Clinical Investigation and the Association of American Physicians, provides an extraordinary opportunity for MD/PhD students to present their research, address career development and gain invaluable perspectives on possible career paths. Because of this focus, preference will be given to more senior students who are nearing completion of their graduate work as well as to students who participate as institutional APSA representatives. Students wishing to attend this meeting should speak to the Program Director. Expenses related to travel and attendance at the APSA Annual Meeting are 50% covered by the MSTP; the remaining 50% can be covered by a portion of the student's $2400 budget. Expenses incurred by our institutional representatives to APSA are completely covered and are not counted toward the invited student's $2400 budget.

Buffalo, Upstate, Rochester Research Out West(ern) NY (BURROW) MD/PhD Conference
All students, regardless of year in training, are encouraged to attend the annual Tri-Institutional MD/PhD Conference which is hosted on a rotating basis by the MD/PhD Programs at Syracuse, Buffalo, and Rochester. The program will cover all reasonable expenses for travel to this meeting.

ABRCMS, SACNAS, and other Recruitment Conferences
The MSTP routinely participates in recruiting opportunities at national meetings and will invite current students to serve as program representatives. Travel costs are fully covered by the program.

Additional Resources for Students
Students are strongly encouraged to utilize all resources available for travel to conferences and participation in special courses. These include, but are not limited to the following:

- Application for travel awards from associations sponsoring the meeting or course. Our students have been particularly successful in competing for such awards.
- Travel supplements offered by the medical school
- Travel funds available as part of an individual (e.g. F30) or institutional training grant
- Departmental travel supplements

Contact Information

MD/PhD Program:

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Director, MSTP Principal Investigator
(585) 275-5185

Laurie Steiner, MD
Associate Director
(585) 276-5988

Alysha Taggart
Administrator
(585) 275-8721

Program Office Address: 601 Elmwood Avenue, Box 657, Rochester, NY 14642

Program Office Fax: (595) 756-5479

Medical School:

Name	Title	Ext.
Valerie Goodberlet	Bursar	x5-4672
Christine Mhorag Hay, MD	Associate Dean for Admissions	x5-4539
David Kaufman, MD	Advisory Dean	3-1911
David Lambert, MD	Senior Associate Dean for Medical Student Education	x5-4537
Evelyn Parker, MS CDP	Director, OMSIEP	x5-7203
Anne Nofziger, MD	Director of PCC	x3-5762
Michelle Vogl	Director, MD Admissions	x5-4542
Kathleen Kelly	Registrar	x3-5762

Graduate Programs:

School of Medicine and Dentistry PhD Program Contact List
AS&E PhD Programs

Link to important forms: (including Lab Rotation forms)

http://www.urmc.rochester.edu/education/graduate/home/forms.aspx

Graduate Curricula for MD/PhD Students at the University of Rochester – Appendix A

Contents: **Pages**

Note: The MSTP works with graduate programs to establish and regularly review curricular guidelines for MD/PhD students. Students should use these guidelines in consultation with graduate program directors to determine an optimal program of study. Students committed to a particular program are encouraged to meet with departmental program directors as early as possible.

Compiled: July 2016, Fall 2020, & Summer 2021 (note that guidelines for some curricula are still under review; most were last formally reviewed in 2021 as indicated in each section).

BIOCHEMISTRY & BIOPHYSICS

BIOCHEMISTRY

MD/PhD program students usually enter the PhD portion of their combined degree work after the basic science years of the MD curriculum. During the second year of the MD program students should discuss the PhD Program with prospective faculty advisors and the Biochemistry Program Director. It is optimal for the student to complete two research rotations before choosing a permanent advisor.

Curriculum

1) All of the following courses are required:

Course Title	Course Description	Semester
BCH 412 (5)	Advanced Topics in Biological Macromolecules	Spring
IND 408(4)	Advanced Biochemistry	Fall
IND 501 (1)	Ethics in Research	Fall
BCH 501, 502 (1)	Biochemistry Seminar*	(each semester)
BCH 595	PhD Research	(each semester)

*includes yearly presentation

2) Additional requirement

An (advisor and program director) approved alternative elective

NOTE: MD/PhD students are granted 30 credits toward the 96 credit hour requirement for the PhD on the basis of their basic sciences curriculum.

Other requirements:

No Teaching Assistantship is required.

The Qualifying Examination is required at the end of the second year of PhD studies.

Thesis preparation and defense.

Updated November 2020

BIOPHYSICS

Students in the MD/PhD program who are considering a PhD in Biophysics are encouraged to meet with the Biophysics Program Director and potential thesis mentors as early as is convenient but no later than the middle of the second year of the MD program.

Curriculum:

All MD/PhD students in the Biophysics program must complete the following courses:

Course Title	Course Description	Credits
BPH 411	Methods in Structural Biology	2
BPH 509	Molecular Biophysics	2
IND 501	Ethics in Research	1
BPH 571,572	Biophysics Seminar (each semester)	1
BPH 595	PhD Research (each semester)	

Elective course: At least one elective course must be taken. The choice must be approved by the PhD advisor and Program Director. Recommended courses are listed below.

Course Title	Course Description	Credits
IND 408	Advanced Biochemistry	4
BCH 412	Advanced Topics in Biological Macromolecules	5
BCH 521	Bioinformatics for Life Scientists	4
IND 431	Foundations in Modern Biology I	5
IND 432	Foundations in Modern Biology II	5

Other requirements:
Two research rotations should be conducted prior to joining a laboratory for dissertation research. Students are encouraged to complete these rotations during the first two years of the MD program.

The qualifying examination must be completed by the end of the second year of PhD studies.

The teaching assistant requirement is waived.

At least one meeting per year with the thesis advisory committee (normally held after the student's Biophysics Seminar presentation).

A satisfactory thesis must be written and successfully defended. Details of these requirements are given elsewhere in this handbook.

Updated November 2020

BIOLOGY

The Department of Biology at the University of Rochester offers PhD degrees in the areas of Molecular, Cellular and Developmental Biology and Evolutionary Biology. The Department is united by a common interest in genetic processes that creates a continuum of research interests among the different laboratories. For example, our evolutionary biologists use molecular biological approaches, and some of our cell biologists publish in the areas of development and evolution. The Biology Department is housed in Hutchison Hall, together with Earth and Environmental Sciences and the Chemistry Departments. The Department is only a five-minute walk from the Medical Center which is home to the Departments of Biochemistry and Biophysics, Biomedical Genetics, Microbiology and Immunology, Neurobiology and Anatomy, the Cancer Center, and related medical service departments. The physical closeness of these groups facilitates intellectual exchange and collaboration among the graduate programs of the basic and biomedical disciplines. Interdepartmental programs such as the Office of the Graduate Education and Postdoctoral Affairs, the MD/PhD Program and the Genetics Program serve to increase communication and training opportunities for our students.

I. COURSE WORK

A. Credit Hours

90 credit hours are required for completion of the PhD degree. Credit hours include both coursework and research. Once a research advisor has been selected, students must register each semester for a sufficient number of credit hours in Biology 595 (PhD Research in Biology) to bring the total to 12 credits. After a total of 90 credits has been achieved, the student should register for Biology 999 (Doctoral Dissertation). Students do not formally register for credit during the summer, but are required to do full-time research during this period.

B. Course Requirements

Students whose interests are in cell, developmental or molecular biology must take a minimum of six courses during their graduate career, selected according to background and research interests. Each course must be > three credits. Students whose interests are in ecology and evolutionary biology are required to take five lecture or reading courses (each > three credits). Courses will be selected, in consultation with a faculty advisor, to assure appropriate depth and breadth of preparation. A list of courses available in the Department is provided at the end of this document.

Students who have taken graduate courses prior to entering the PhD program may petition the GAAC for a reduction in the number of required courses. MD/PhD students typically take fewer courses because of their work in the first two years of medical school.

C. Laboratory Rotations

Rotations are not required. Students may rotate through research laboratories in order to become acquainted with faculty and to aid in selection of a research advisor.

D. Seminar Requirements

All students are required to participate in a minimum of four seminar courses in which they make oral presentations. EEB students will meet this requirement in BIO 584 and CMD students will meet this requirement by taking three BIO 516 seminars and presenting in BIO 517 every Spring semester. First year students and advanced students who will defend their dissertation by the end of the following Fall semester are not required to present in BIO 517. Both EEB and CMD students may petition the GAAC to have <u>one</u> <u>oral</u> presentation at a <u>national</u> or <u>international</u> meeting count towards the seminar requirement. Students must complete the seminar requirement by the end of their fourth year in order to avoid tuition charges.

II. TEACHING

MD/PhD candidates are exempt from teaching.

III. QUALIFYING EXAMINATION

The PhD Qualifying Examination consists of a written thesis proposal and an oral examination. The oral exam is intended to determine whether a student is prepared to pursue a professional career in science, as demonstrated by successful defense of the proposal. The exam also will test general knowledge of biology and, in greater depth, knowledge within the students' field of interest.

Preparation of the thesis proposal for the Qualifying Examination should be a realistic training experience that involves developing a feasible research project and presenting it in concise and cogent prose. The suggested format for the thesis proposal is that used for a research grant. It should include an introduction providing a brief background to the research, a list of specific aims, a description of experimental procedures, and presentation of preliminary data that have been obtained by the student to demonstrate the feasibility of the approach. The advisor must sign the thesis proposal, indicating that (s)he is willing to allow the research to be carried out in her/his laboratory. The advisor should also indicate his/her level of input into the proposal. This might include, for example: provision of a recently submitted proposal or one in preparation; suggestions to expand and/or clarify specific parts of the proposal; discussions on the preliminary data to be included, and its interpretation; identification of missing background information; and text editing for grammar, syntax or clarity.

A copy of the thesis proposal must be distributed to the examining committee and filed with the secretary of the GAAC at least one week prior to the oral exam. The proposal should be less than or equal to 10 pages, single-spaced, excluding figures and references.

The examining committee is selected by the GAAC and approved by the Associate Dean of Graduate Studies of the College. It will consist of four members, one of whom may be from outside the Department. The student's advisor will not be present. The committee will be chaired by the most appropriate faculty member.

After the questioning is concluded, the candidate will be asked to leave the room and each committee member in turn will discuss the strengths and weaknesses of responses to his/her questions. The committee will also list major strengths and weaknesses of the research proposal. When discussion has been completed to everyone's satisfaction, an anonymous written, pass-fail vote will be taken.

IV. RESEARCH

The most important part of the work leading to the PhD degree is the independent research that leads to the preparation of a thesis. The following sections outline the formal mechanisms for guiding thesis research and monitoring its progress

A. Selection of a Research Sponsor

Students become familiar with the research of faculty through lab rotations, seminars, reading published work, and conversations with individuals.

B. Thesis Advisory Committee and Progress Reports

Following completion of the Qualifying Exam, the student will meet with his or her Thesis Advisory Committee (TAC), which need not include the same members as the Qualifying Examination Committee. The first meeting should be held by the end of the fifth semester. Subsequently, the Thesis Advisory Committee must meet at least once a year to review the candidate's progress. More frequent meetings may be held at the request of the student or any member of the Thesis Advisory Committee.

The Thesis Advisory Committee is normally selected by the student and the research advisor to include faculty members especially knowledgeable in the research area. The committee is formally appointed by the Associate Dean of Graduate Studies. It must include at least three faculty members from the Department (one of whom is the research advisor) and a faculty member from outside the Department. The outside member is usually from another department at

the University of Rochester, but may be from another institution, if sufficient expertise is not available at the University.
At least one week before each meeting, the candidate will provide TAC members with a written report of work completed since the previous meeting. This report should be no more than five pages long (double-spaced, typed). A copy of the report should be filed with the secretary of the GAAC for retention in the student's record. Written assessments of the candidate's progress will be submitted to the GAAC by members of the Thesis Advisory Committee after every meeting. These reports will form the basis for the Department's recommendation regarding continuation in the PhD Program. If more than two semesters and one summer elapse without a progress meeting, the student will not be allowed to register for the next semester.
TAC meetings are intended to be a constructive mechanism to assist the student in his/her progress toward an outstanding thesis. They should be used as opportunities to review results and focus research plans. However, they are not the only mechanism. Students are encouraged to consult with their sponsor, with members of the TAC, and with any faculty member or student whose expertise is of use.

C. Preparation and Defense of the Thesis
Once a student has completed the work agreed upon by the advisor and TAC, he/she writes a thesis. Students are strongly encouraged to begin writing sections of their theses dealing with completed work, even while final research projects are being carried out. The style of the thesis (e.g., chapters based on papers, or a continuous results narrative) should be agreed upon by the student and the TAC at least six months prior to the intended submission date.
The final version of the thesis (as approved by all members of the thesis advisory committee) must be registered with the Associate Dean for Graduate Studies of the School of Arts and Sciences at least fifteen full working days prior to the date of the final oral examination. The Dissertation Examining Committee will normally consist of the members of the student's Thesis Advisory Committee and a chairman to be appointed by the University Dean of Graduate Studies. If the Thesis Advisory Committee did not include an outside member of the Department, the student and advisor must select a faculty member from outside the Department to sit on the Dissertation Advisory Committee.
The final oral examination will consist of a one-hour public seminar, followed by an open question and answer period. The candidate and the examining committee will then meet in private for additional discussion and the formal defense.

Courses Offered by the Department of Biology

Course Title	Course Description
402	Molecular Biology
405	Evolution: Fundamentals of Evolution
420	Advanced Cell Biology
422	Biology of Aging
426	Developmental Biology
443	Eukaryotic Gene Regulation
453	Computational Biology
460	Animal Behavior
463	Ecology
468	Laboratory in Molecular, Cell and Developmental Biology
457	Applied Genomics
471/472/473/474	Advanced Ecology and Evolutionary Biology A-D

Reviewed: 2016

BIOMEDICAL ENGINEERING

Students earning a PhD in Biomedical Engineering through the MD/PhD program will begin PhD training in the third year of graduate school after two years of medical school training. Unless explicitly stated below all requirements and definitions for the PhD in Biomedical Engineering apply to students in the MD/PhD program.

A. Curricular requirements

Because the medical school training emphasizes biology and physiology, the BME PhD requirement for 11 credits of Approved Biology is waived. Additionally, only 4 credits of Advanced BME courses are required, and the preliminary exam is waived. A teaching assistantship is encouraged but not required. The BME faculty believe that experience and training in teaching is a valuable part of doctoral education for biomedical engineers, however the program does not require TA service in order to be consistent with MD/PhD requirements in other departments. BME 402 is not required for MD/PhD students, although they are welcome to take the course if they are interested. At least two rotations are required by the MD/PhD program and these are typically completed before beginning the PhD training. The following summarizes the full non-research requirements for BME PhDs in the MD/PhD program:

- 12 credits of approved engineering
- *BST 467: Applied Statistics in the Biomedical Sciences (3 credits)*
- 4 credits of Advanced BME
- The proposals writing course (2 credits; spring term)
- Research ethics (1 credit; fall term)
- *BME 496: Current Research Seminars* (0 credit)
- Three formal presentations in a public forum

A student should complete the curricular requirements in one academic year, and it is expected that 2-3 additional years will be required to complete the PhD thesis. Students must select a research advisor by the beginning of the spring term, and research should be underway by the spring term so that the proposal writing class is most effective. The qualifying exam should be taken in the fall of the second year of PhD study.

Reviewed November 2020

BIOSTATISTICS AND COMPUTATIONAL BIOLOGY

The Department of Biostatistics and Computational Biology offers programs leading to the Doctor of Philosophy, Master of Arts, and Master of Science degrees. The department conducts a program of teaching and research in statistical theory and statistical methodology oriented toward the health sciences. Department faculty have research interests and expertise in virtually all areas of modern theoretical and applied statistics. Faculty are involved in wide-ranging collaborative activity with basic science and clinical departments in the School of Medicine and Dentistry. This environment is ideally suited for training in research in statistical methodology, collaborative research, and consulting.

The curriculum is designed to provide students with a thorough grounding in statistical theory, which provides the necessary foundation for the successful conduct of research in statistical methodology. Included are core courses in Probability Theory, Stochastic Processes, Statistical Inference I and II, and Bayesian Inference. The curriculum also provides students with an appreciation for applied problems in biomedical research and the skills necessary to succeed in collaborative research environments. Core courses focused on applications include Biostatistical Methods I and II and Design of Clinical Trials, in addition to formal training in the use of statistical software. Additional core courses including Linear Models, Generalized Linear Models, Survival Analysis, and Analysis of Longitudinal and Dependent Data provide a mix of theory and application. Courses in High Dimensional Data Analysis and Genomic Data Analysis are designed for those interested in a concentration in Bioinformatics and Computational Biology. Several elective courses are also offered. An important goal is to produce graduates with a command of technical skills and the ability and experience to use them appropriately.

Program for the Degree of Doctor of Philosophy in Statistics (Traditional)

The department administers the doctoral program in statistics. The department interprets the term “statistics” very broadly. The program permits specialization in probability, statistical theory and analysis, biostatistics, and interdisciplinary areas of application. Students have opportunities for supervised teaching and supervised consulting experience, requiring approximately 12 to 15 hours of effort per week.

A candidate for admission to the PhD program should have a strong background in mathematics, including three semesters of calculus (through multivariable calculus), a course in linear and/or matrix algebra, and a year of probability and mathematical statistics. A course in real analysis is encouraged; a course in statistical methods is also recommended. Promising students may make up deficiencies after matriculation. A background in biology may be helpful for some research areas, but is not required.

Doctoral students are expected to attain some competence in each of the following (overlapping) areas: I. statistical inference; II. statistical analysis (theory and methods); III. probability and stochastic processes. In addition, each student is expected to qualify at a more advanced level in two areas, designated major and minor. Minor areas, in addition to those three above, include IV. mathematics; V. epidemiology; VI. biostatistics; and VII. a specific field of application, such as econometrics, psychometrics, computer science, genetics, computational biology, engineering, etc. Students are required to acquire some proficiency in statistical computation, using at least one high-level language and several statistical packages. There is no formal specific language requirement, but students undertaking certain areas of research may find it necessary to undertake appropriate language study.

Students are required to take a minimum of 16 formal courses, including:

1. Basic courses: at least two courses in each of the areas I, II, and III and at least three in areas IV–VII combined.
2. Major area: at least three additional courses (12 credits), ordinarily at the 500 level, in

one of the areas I–III (or IV–VII with permission).
3. Minor area: at least two additional courses in another one of the seven areas.

Beginning students should expect to spend all of their first year, most of their second year, and some of their third year taking formal courses. This includes a minimum of four semesters of BST 487, a one-credit seminar course designed to give students extensive practice in searching the statistical literature and preparing and delivering presentations. The balance of time is spent on reading and research. Students entering with advanced training in statistics may transfer credits at the discretion of their advisors and in accordance with University policy. A typical program for an entering student without previous advanced training is as follows:

Course Title (credits)	Course Description
Year 1: Fall	
BST 401 (4 credits)	Probability Theory
BST 411 (4 credits)	Statistical Inference I
BST 430 (4 credits)	Introduction to Statistical Computing
BST 461 (4 credits)	Biostatistical Methods I
Year 1: Spring	
BST 412 (4 credits)	Statistical Inference II
BST 413 (4 credits)	Bayesian Inference
BST 426 (4 credits)	Linear Models
BST 462 (4 credits)	Biostatistical Methods II
Year 2: Fall	
BST 432 (4 credits)	High Dimensional Data Analysis
BST 479 (4 credits)	Generalized Linear Models
BST 487 (1 credit)	Seminar in Statistical Literature
BST 511 (4 credits)	Advanced Bayesian Inference (alternating years: BST 516 Causal Inference)
BST 590 (2 credits)	Supervised Teaching
IND 501 (1 credit)	Ethics and Professional Integrity in Research
Year 2: Spring	
BST 487 (1 credit)	Seminar in Statistical Literature
BST 513 (4 credits)	Analysis of Longitudinal and Dependent Data (alternating years: BST 514 Survival Analysis)
BST 591	Reading Course(s) at the PhD Level
	Elective(s)

Year 3+
Mostly reading and research, with some 400-level and 500-level courses.

Notes:
1. All PhD students are required to have at least four credits of supervised teaching and/or supervised consulting (BST 590, 592).
2. All students in the doctoral program are required to take IND 501 Ethics and Professional Integrity in Research (1 credit).
3. Usually in year two, students begin exploring potential research topics by taking reading courses with faculty (BST 591). The structure, content, and number of credit hours for these courses are flexible and determined by mutual agreement between the students and faculty member.

4. Advanced topics courses in statistical inference, data analysis, and biostatistics (BST 511, 512, 550, or 570), for varying numbers of credits, are offered depending on interests of students and instructors. Recent examples include:
    - Missing Data
    - Introduction to Spatial Data Analysis
    - Semiparametric Inference
    - Functional Data Analysis
    - Statistical Analysis of Cell Mixtures
    - ROC Curve Analysis
    - Smoothing Methods
    - The Bootstrap, the Jackknife, and Resampling Methods
    - Model Selection and Validation

Students also have the option of taking relevant courses that are offered through other doctoral programs at the University, such as Mathematics (e.g., MTH 471–Real Analysis), Epidemiology (e.g., PM 416–Epidemiologic Methods), and Health Services Research (e.g., PM 472–Measurement and Evaluation of Research Instruments).
These requirements are to be interpreted as guidelines, rather than as regulations. A balanced program is worked out with the student's advisor and the graduate advisor.

The examination requirement consists of:

1. Written examination in two parts. The basic part covers basic material in areas I–III, based on undergraduate preparation and some of the first-year graduate courses. It is taken after one year of study. The advanced part covers advanced material from two to three core courses in each of areas I–III taken during the first two years of graduate study. This part is usually taken after two years of study.
2. Qualifying examination (oral) on the general area of proposed research and other topics as necessary.
3. Final examination on the completed dissertation.

The dissertation will consist of substantial scholarly contribution, worthy of publication, in one of the areas I–III or in any other area approved by the faculty committee.

Program for the Degree of Doctor of Philosophy in Statistics with Concentration in Bioinformatics and Computational Biology

The Bioinformatics and Computational Biology (BCB) concentration is designed to educate the next generation of biostatisticians with the knowledge required to address critical scientific and public health questions and, in particular, equip them with the skills necessary to both develop and use quantitative and computational methodologies and tools to manage, analyze, and integrate massive amounts of complex biomedical data. Students learn core statistical methods and obtain training in data analysis methodologies and computational skills and techniques necessary for handling big data in the biomedical and public health sciences. In addition to this training in core methods, the program also places great emphasis on cross-training: (1) training students with quantitative/computational science backgrounds to enhance their understanding of biological questions and biological interpretation; and (2) training students with biomedical science backgrounds to proficiently use bioinformatics and computational methods and tools to address scientific questions.
Entering PhD students should have a strong background mathematics, including three semesters of calculus (through multivariable calculus), a course in linear and/or matrix algebra, and a year of probability and mathematical statistics. Basic courses in computer science and/or biology are also required. A course in real analysis is encouraged; a course in statistical methods is also recommended. Promising students may make up deficiencies after matriculation.
Formal course and examination requirements for students in the BCB concentration are essentially the same as those for students in the traditional program, with the main differences being in the courses taken in areas IV-VII (with a heavier focus on courses related to

bioinformatics and computational biology) and in the material covered on the written examination (advanced part).
Students entering with advanced training in statistics, bioinformatics, or computational biology may transfer credits at the discretion of their advisors and in accordance with University policy. A typical program for an entering student without previous training is as follows:

Course Title (credits)	Course Description
Year 1: Fall	
BST 401 (4 credits)	Probability Theory
BST 411 (4 credits)	Statistical Inference I
BST 430 (4 credits)	Introduction to Statistical Computing
BST 461 (4 credits)	Biostatistical Methods I
Year 1: Spring	
BST 412 (4 credits)	Statistical Inference II
BST 413 (4 credits)	Bayesian Inference
BST 426 (4 credits)	Linear Models
BST 462 (4 credits)	Biostatistical Methods II
Year 2: Fall	
BST 432 (4 credits)	High Dimensional Data Analysis
BST 479 (4 credits)	Generalized Linear Models
BST 487 (1 credit)	Seminar in Statistical Literature
BST 511 (4 credits)	Advanced Bayesian Inference (alternating years: BST 516 Causal Inference)
BST 590 (2 credits)	Supervised Teaching
IND 501 (1 credit)	Ethics and Professional Integrity in Research
Year 2: Spring	
BST 434 (4 credits)	Genomic Data Analysis (alternating years: Intro to Quantitative Biology
BST 487 (1 credit)	Seminar in Statistical Literature
BST 513 (4 credits)	Analysis of Longitudinal and Dependent Data (alternating years: BST 514 Survival Analysis)
BST 591	Reading Course(s) at the PhD Level
	Elective(s)

Year 3+
Mostly reading and research, with some 400-level and 500-level courses.

Notes:

1. All PhD students are required to have at least four credits of supervised teaching and/or supervised consulting (BST 590, 592).
2. All students in the doctoral program are required to take IND 501 Ethics and Professional Integrity in Research (1 credit).
3. Usually in year two, students begin exploring potential research topics by taking reading courses with faculty (BST 591). The structure, content, and number of credit hours for these courses are flexible and determined by mutual agreement between the student and faculty member.
4. As with the traditional PhD program, advanced topics courses in statistical inference, data analysis, and biostatistics (BST 511, 512, 550, or 570), for varying numbers of credits, are offered depending on interests of students and instructors.

The written examination requirements for students in the BCB concentration are the same as for students in the traditional PhD program, except that BCB concentration students are required to answer certain questions that are optional for students in the traditional PhD program.

Considerations for Students in the MD/PhD Program

Students admitted to the MD/PhD program follow essentially the same course of study as students in the PhD program, except that coursework in statistics begins during the fall of the third year in the program. During the first year, students spend three months (June–August) with a mentor to begin the process of orientation toward research in statistical methodology. This may be implemented either as an informal (noncredit) reading course or as involvement in an applied project that may motivate a methodological research problem. This is repeated during the second year of the program (March–August) just prior to the start of coursework. The main goals of these interactions are to provide the student some insight regarding the process of research in statistical methodology and to facilitate the process of choosing a research advisor.

Reviewed: August 2021

BRAIN AND COGNITIVE SCIENCES

The Department of Brain and Cognitive Sciences (BCS) offers a PhD degree that can be combined with the MD. After two years of the MD curriculum, students complete two years of coursework in BCS and at least a 3rd year (or more) of dissertation research before returning to complete the MD.

The full complement of required courses in BCS has been reduced slightly to accommodate the additional coursework and training for the MD. The requirements are listed below.

Core courses
Students must take three of the following six core courses (reduced from the normal requirement of four), with at least one core course from each of the three pairs.

BCSC 501: Language
BCSC 502: Cognition

BCSC 504: Sensory Systems
BCSC 505: Perception and Motor Systems

BCSC 508: Cognitive Neuroscience
NSC 531: Integrative and Systems Neuroscience
NSCI 512: Cellular Neuroscience

Experimental Design and Statistics. One course from the following list:

PSYC 504: Data Analysis I
BST 464: Applied Linear Regression
PSYC 519: Data Analysis: General Linear Applications II
STAT 422: Design of Experiments and STT 441: Applied Multivariate Analysis (together these 2 courses form one semester)

Methodology. One course from the following list:

BCSC 511: Behavioral Methods in Cognitive Science
BCSC 512: Computational Methods in Cognitive Science
BCSC 513: Intro to fMRI: Imaging, Computational Analysis and Neural Representations
BCSC 547: Introduction to Computational Neuroscience

Professional Development
Students must take all three courses below:

BCSC 582: Grant Writing in BCS
BCSC 599: Professional Development and Career Planning
IND 501: Ethics and Professional Integrity in Research Biomedical Sciences

Teaching Assistantship
A one-semester TA experience in a relevant undergraduate course in BCS or NSC (to be determined based on TA needs and the skills and background of the student), with simultaneous enrollment in BCSC 598: Supervised Teaching

Elective Courses and Seminars
In addition to the above course requirements, the student must complete a minimum of 90 credit hours of formal coursework or readings/research courses. Enrollment in the following courses should be used to meet the 90 credit-hour requirement for the PhD.

BCSC 595: Research at the PhD level
BCSC 999: Doctoral Dissertation

Research Activities
In contrast to other GEBS programs, BCS does not have a formal lab rotation requirement. Students are encouraged to move as quickly as possible into a lab (after suitable negotiation with the faculty mentor) and engage in research activities for the entire duration of the 3 (or more) years spent in BCS fulfilling course requirements and completing the dissertation.
Students are also required to make a formal presentation about their on-going research to the Department (students, postdocs, and faculty) at the biweekly BCS Lunch no later than their third semester in the program.

Written Qualifying Exam
At the end of the second year, students must take a multi-day, open book, written examination based on their coursework and a custom reading list negotiated with their faculty mentor and two other BCS faculty of their choosing. The qualifying exam for MD/PhD students is 2/3 the length of the normal BCS qualifying exam. A passing grade on this exam enables the student to be formally admitted to candidacy in the University's Graduate School for a PhD in BCS.

Dissertation
Once admitted to candidacy for the PhD, the student forms a dissertation committee consisting of the faculty mentor, two other faculty members in BCS, and one faculty member in a non-BCS department (or program). A formal presentation of the dissertation proposal, both in written form and orally, is made to this dissertation committee well in advance of completion of the dissertation research. Upon completion of the dissertation research, and having met all course and credit hour requirements, the written dissertation is filed with the Graduate Dean who schedules the final oral examination and appoints an outside Chair to monitor the examination. This examination consists of a public lecture to the entire Department, followed by a closed oral exam by the dissertation committee.

Reviewed: August 2021

CHEMISTRY

1. Course Requirements. All students enrolled in the PhD program must demonstrate breadth and depth in their coursework. For graduate students matriculated into the PhD program, a total of 20 credit hours of coursework is required. For MD/PhD students, courses taken during the first two years are taken into account and the required number of Chemistry course credit hours is reduced to 12.

Programs of study can be modified to best address a student's research needs and interests. For their first year in Chemistry, students develop a program of study in consultation with their research adviser, who is typically chosen in December of the student's first year of Chemistry concentration.

Courses within the department include those given below.

402. Biophysical Chemistry I (4 credits)
404. Biophysical Chemistry II (4 credits)
406. Interface of Chemistry & Biology (2 credits)
411. Inorganic Chemistry I (4 credits)
414. Biological Inorganic Chemistry (4 credits)
415. Group Theory (2 credits)
416. X-ray Crystallography (2 credits)
421. Basic Organometallic Chemistry (2 credits)
422. Organometallic Chemistry (2 credits)
423. Nuclear Magnetic Resonance Spectroscopy- Survey (2 credits)
425. Physical Methods in Inorganic Chemistry (4 credits)
427. Organic Structure Determination (2 credits)
433. Advanced Physical Organic Chemistry I (4 credits)
434. Advanced Physical Organic Chemistry II (4 credits)
435. Organic Reactions (4 credits)
436. Applications of Organometallic Chemistry to Synthesis I (2 credits)
437. Synthetic Design: Strategy and Tactics (2 credits)
438. Applications of Organometallic Chemistry to Synthesis II (2 credits)
440. Bioorganic Chemistry and Chemical Biology (4 credits)
441. Physical Chemistry I (4 credits)
444. Advanced Nuclear Science Educational Laboratory (ANSEL) (4 credits)
451. Quantum Chemistry I (4 credits)
455. Thermodynamics and Statistical Mechanics (4 credits)
456. Chemical Bonds: From Molecules to Materials (4 credits)
458. Spectroscopy and Kinetics (4 credits)
462. Biological Chemistry (4 credits)
469. Computational Chemistry (2 credits)
470. Computational Chemistry II: Electronic Structure Theory & Quantum Dynamics (2 credit)
475. Chemistry of Poisons (4 credits)
476. Polymer Synthesis and Characterization (4 credits)
477. Advanced Numerical Methods: Theory to Implementation (4 credits)
486. Energy: Science, Technology & Society (4 credits)
489. Electrochemical Biosensor Design (4 credits)

2. Seminar & Colloquium - All Chemistry students register each semester for graduate Seminar & Colloquium. For the first year, students will register for CHM 511 & CHM 513 and will earn one credit per semester, accumulating a total of two (2) credit hours. After this, students continue to register for and attend seminars and colloquium, but register for CHM 583 for zero credits.

3. 1st Year Graduate Workshop- This course has been designed specifically to address topics of interest to our incoming graduate students. All students entering the graduate program will

register for CHM 585 for 1 credit for each of the first two semesters accumulating a total of two (2) credit hours.

4. Teaching - All graduate students in Chemistry participate in the teaching program as teaching assistants in undergraduate and graduate courses for a total of three semesters. Teaching time for MD/PhD students is decreased to one semester.

5. PhD Research in Chemistry - Students register each semester for a sufficient number of credit hours of CHM 595 PhD Research in Chemistry to bring the total credit hours for the semester to 12, until a total of 90 credit hours has been achieved.

6. Doctoral Dissertation - After students accumulate 90 total credit hours, they register for CHM 999 Doctoral for zero credits, as well as for the appropriate seminar and colloquium courses.

Qualifying Examinations

1. Written Qualifying Examinations - These examinations are based on material from undergraduate course work, first-year graduate course work, seminars, colloquia, and the literature. These examinations serve to stimulate review of past and current materials, and are designed to encourage reading of current literature. First-year students entering in September must begin the Written Qualifying Examinations series between October and April of their first year. They then have twelve consecutive months to obtain the necessary points to pass the Written Qualifying Examinations.

2. Oral Qualifying Examination - The Oral Qualifying Examination for admission to PhD candidacy is based on, but not limited to, a written report of the student's research problem outlining research objectives, important background (including key references) and progress to date. The Oral Qualifying Examination must be completed by the end of the student's second year in the program.

Seminar Presentation

During the third year of study, students present a departmental seminar on a research topic as defined by the requirements of the student's sub-discipline.

Reviewed: September 2021

EPIDEMIOLOGY

INTRODUCTION

The School of Medicine and Dentistry at the University of Rochester Medical Center (URMC) seeks to improve health through *caring, discovery, teaching, and learning*. Education has traditionally been the centerpiece of the URMC; our history has been marked by the education of renowned academic leaders including Nobel Laureates and deans of prestigious universities throughout the U.S. The University of Rochester remains committed to integrating excellence in education into the ever increasingly complex environment of health care. Comprehensive educational programs are well established in the laboratory, clinical, and public health sciences.

Scholarly research has also been a critical component in the history of URMC. Clinical advances emanating from today's science require the knowledge and skills from a broad spectrum of independent, scientific disciplines including some outside of the 'traditional' basic sciences. Such disciplines as epidemiology, biostatistics, health services research, and behavioral sciences have a unique theoretical core while also possessing the tools and methodologies for significant applicability to the study of health. Epidemiology has a distinct philosophy and a unique set of scientific concepts and methods, which are utilized to conduct independent community and population research, focusing on the delineation of disease causation and the prevention of morbidity and mortality. It also provides the principles and tools necessary for the practice of preventive medicine and the formulation of public health practice.

Doctoral Program in Epidemiology

Our PhD program in Epidemiology was established in 2002 within the Division of Epidemiology, Department of Public Health Sciences. The primary objective of the epidemiology doctoral program is to train epidemiologists in a wide variety of skills and methods which can be applied to all areas of epidemiology (i.e., cancer, neuro-, occupational, etc. epidemiology) and other areas of human biomedical research. The doctoral program also provides course offerings in advanced epidemiologic methods and specialized areas of epidemiologic and population health research.

Specific objectives are to:

- Educate individuals in the basic science of epidemiology;
- Teach the skills required to conduct population research;
- Provide intense mentoring to assure a productive and satisfying educational and research experience;
- Prepare students to successfully transition into a role of an independent investigator by providing opportunities for peer mentoring, writing grant proposals, publishing work in scientific journals, and reviewing the work of peers;
- Provide educational role models and opportunities that encourage students to develop and cultivate their own teaching skills; and
- Nurture a research environment in which accuracy, integrity and ethical practices are highly valued.

The educational experience within the doctoral program provides a comprehensive blending of a didactic curriculum of theory and methods for epidemiologic research with an intensive mentored research experience. Epidemiology students have access to experiences and opportunities across numerous departments and scientific centers within the University. Quality education is provided through innovative approaches in a supportive, integrated environment.

Research Opportunities

The research component of the doctoral training has been planned as an intense, carefully mentored process. The program faculty represent most clinical departments within URMC as well

as basic science departments. Also represented are government agencies such as the Health Department and private corporations such as Kodak, Xerox and Blue Cross/Blue Shield, each of which has expressed interest in public health/health care issues. Collaborations with these institutions have been developed and nurtured by the Department of Public Health Sciences because of the diversity that they bring to the department activities as well as the rich data sources each holds. The program faculty provides the primary source of research opportunities for students to share in during their training as well as serving as the foundation on which dissertation research investigations may be built. The federally funded research studies led by program faculty provide ample options for doctoral students, however, students are not limited to these programs. Areas of active research among epidemiology faculty include:

- Environmental and occupational epidemiology
- Nutritional epidemiology
- Cardiovascular epidemiology
- Epidemiology of aging and neuroepidemiology
- HIV, COVID-19, and infectious disease epidemiology
- Maternal and child health
- Psychiatric epidemiology

Combined MD/PhD in Epidemiology Program

This MD/PhD option in epidemiology extends the longstanding commitment of the University and the Department to improve health through research and education, with a particular emphasis on community and population-based research. The interest in epidemiology throughout both the medical education and graduate education programs at the University mirrors the growing need for epidemiologists nationally who can both act as independent investigators and make significant contributions to medical research.

This combined program may be integrated into the establish Epidemiology /PhD program at the University of Rochester School of Medicine & Dentistry and culminates in the award of both an MD and a PhD in Epidemiology. The overall goal of this program is to prepare individuals for an academic career in medicine, which will focus on the conduct of epidemiology-oriented, population-based research.

The major components of the program design are outlined below:

1. Students seeking admission to the Doctoral program in Epidemiology as part of the combined MD/PhD program are held to the same academic standards for admission and performance as the students in the established PhD Program. Requirements for admission are similar. Student interviews with the Executive Committee of the epidemiology program (responsible for program admissions) are integrated into the admission process as conducted by the MD/PhD program. Faculty provide the MD/PhD Admissions Committee with an evaluation as to the student's eligibility and potential contributions to the program.
2. Given the year 1 and 2 medical school curriculum (and perhaps completed master's degrees), some of the epidemiology course requirements in the standard doctoral program may be waived for the MD/PhD students. A maximum of 30 credits may be waived. Courses which may be waived are specified on the attached MD/PhD program worksheet below and are at the discretion of the Director of the Epidemiology Graduate Program.
3. The first 2 years of the medical school curriculum will be completed by the student. During this time, as schedules allow, students will participate in selected Division of Epidemiology activities such as seminars, journal clubs, etc. Emphasis will be placed on integrating the epidemiology student in program and division activities as much as

possible to maximize the student's exposure to epidemiologic principles/methods and research opportunities.

4. In year 3 of the program the student will transition to the doctoral program in epidemiology. At this time, he/she will complete most of the required coursework for the PhD program and will complete elected courses from the epidemiology-specific offerings. It is expected that the student will complete 5 courses during each of the two semesters. Due to scheduling, additional courses may need to be completed in year 4.

After the student has completed the required coursework (after 3 semesters), they will complete both the written and oral comprehensive examinations. The written examination, which is developed each year by the Executive Committee of the program, is administered within a one-day classroom setting. The oral examination is also administered by the Executive Committee on an adjacent day. Based on both the written and oral examination, a vote of the members to pass the candidate is required; all votes are recorded. In the case of failure, approval may rarely be given for a second qualifying examination after a minimum period of 6 months has elapsed. No further opportunities for examination are provided. Any student not successfully completing the examination is counseled to complete the requirements for a Master of Science (MS) in Epidemiology, as appropriate.

5. During year 4 (year 2 of PhD program) the student will focus on the development of their dissertation research, perhaps writing a pre-doctoral grant to support these research activities. Students are also encouraged to serve as a Teaching Assistant for one introductory course.
6. In years 5 and 6, the student will continue to work on their dissertation. Since original data collection is required to complete their dissertation, this period will be used to collect, analyze, and write-up research results, and publicly defend the thesis work.
7. In year 7 the student will return to medical school to complete their final 2 years of their MD degree.

The program director and steering committee in Epidemiology work closely with the directors of the MD/PhD program to refine the educational process to allow for flexibility and integration of the two program missions. Our program is committed to the development of strong clinical investigators with the research skills to contribute to the translation of scientific knowledge from the bench to the bedside *and* to the community.

REQUIRED COURSES

The doctoral program in Epidemiology includes 61 credits of required coursework. According to University policies, MD/PhD students may receive up to 30 credits from the first 2 years of medical school curriculum that will be applied to the doctoral degree requirements. They are therefore required to take a minimum of 31 additional credits of coursework specific to the doctoral degree. The 31 required credits must include the 6 advanced courses and grantsmanship required of <u>all</u> doctoral students and 3 additional elective courses (or non-waived required courses) <u>in epidemiology</u>.

Expected time to completion: 4 yr. MD + 4 yr. PhD

Semester	Course Title and Description (Credit)
Possible Waiver	PM 410 Intro to Data Management and Data Analysis Using SAS (3)^
Possible Waiver	PM 412 Survey Research (3)
	PM 413 Field Epidemiology (3)
Possible Waiver	PM 414 History of Epidemiology (3)
Possible Waiver	PM 415 Principles of Epidemiology (3)
	PM 416 Epidemiological Methods (3)
Possible Waiver	PM 426 Social and Behavioral Medicine (3)
	PM 469 Multivariate Models for Epidemiology (3)
	PM 472 Measure and Evaluation of Research Instruments (3)
	PM 438 Grantsmanship (3)
Possible Waiver	BST 463 Introduction to Biostatistics (4)
	PM 464 Introduction to Regression Methods
	BST 465 Design of Clinical Trials (4)
Possible Waiver	IND 503 Ethics (1; preferably taken in 2nd year of medical school)
	PM _ _ _ Epidemiology Content Course (3)
	PM _ _ _ Epidemiology Content Course (3)
	PM _ _ _ Epidemiology Content Course (3)
Possible Waiver	PM _ _ _ Elective* (3)
Possible Waiver	PM _ _ _ Elective* (3)
Possible Waiver	PM _ _ _ Elective* (3)

Semester	Epidemiology Content Course (Credit)
	PM 418 Cardiovascular Epidemiology (3)
	PM 424 Chronic Disease Epidemiology (3)
	PM 442 Nutritional Epidemiology (3)
	PM 451 Infectious Disease Epidemiology (3)
	PM 466 Cancer Epidemiology (3)
	PM 470 Environmental & Occupational Epidemiology (3)
	PM 494 Injury Epidemiology & Emergency Care Research Methods (3)

Total Required Credits = 61

^Students are strongly encouraged to gain practical experience with data management and analysis prior to starting the PhD program (e.g., during summers)

*Additional courses within and outside of the department that are judged to significantly contribute to the student's specific area of epidemiologic research may also be taken as electives with approval from the Epidemiology Program Director. Related basic science courses are encouraged.

Revised August 2021

BIOMEDICAL GENETICS

M.D./Ph.D. program students usually enter the Ph.D. portion of their combined degree work after the basic science years of the M.D. curriculum. *During the second year of the M.D. program, they should discuss the Ph.D. Program with prospective faculty advisors and the Genetics Program Director*. It is optimal for the student to complete two research rotations before choosing a permanent advisor.

A total of 96 credit hours are required for the Ph.D. Program course requirements are meant to be sufficiently flexible to accommodate students with diverse backgrounds and career goals.

CURRICULUM

1) All of the following courses are required:

Year 1 Fall Semester *(16 Credits)*

Course Number	Title
IND 431 (5 Credits)	Foundations in Modern Biology I
IND 501 (1 Credit)	Ethics & Professional Integrity
GEN 503 (1 Credit)	Genetics Seminar*
GEN 507 (4 Credits)	Advanced Genetics & Genomics
GEN 595 (5 Credits)	Ph.D. Research Rotation**

Year 1 Spring Semester *(16 Credits)*

Course number	Title
IND 432 (5 Credits)	Foundations in Modern Biology II
IND 419 (3 Credits)	Intro to Quantitative Biology
GEN 504 (1 Credit)	Genetics Seminar*
GEN 595 (7 Credits)	Ph.D. Research Rotation**

Year 2 Fall Semester *(total 16 Credits)*

Course Number	Title
GEN 503 (1 Credit)	Genetics Seminar*
GEN 595	Ph.D. Research**
Electives	

Year 2 Spring Semester *(total 16 Credits)*

Course number	Title
GEN 504 (1 Credit)	Genetics Seminar*
GEN 595	Ph.D. Research**

* Required each semester throughout the course of study and includes yearly presentations beginning at the end of year 2
** The number of credits given for GEN 595 varies depending on if an elective is taken and how many credits is given for the elective. A total of 16 credits in the fall and spring semesters must be maintained.

2) Additional requirement: One elective is required. Below is a list of approved electives. The advisor and the program director may approve other electives.

Fall Semester

Course Number	***Title***
BIO 426 (4 Credits)	Developmental Biology
GEN 508 (4 Credits)	Biological Systems: from Conception to Decline

IND 426 (2 Credits)	Science Communication
MBI 406 (3 Credits)	Biomanufacturing
MBI 473 (3 Credits)	Immunology
NSC 512 (5 Credits)	Cellular Neuroscience
PTH 507 (3 Credits)	Cancer Biology

Spring Semester

Course Number	***Title***
BCH 412 (5 Credits)	Advanced Topics in Biological Macromolecules
BIOL 414 (4 Credits)	Biostatistics
BIOL 443 (4 Credits)	Eukaryotic Gene Regulation
BST 467 (3 Credits)	Applied Statistics in the Biomedical Sciences (R)
GEN 506 (4 Credits)	Stem Cell Biology (alt years-even)
IND 439 (2 Credits)	Leadership and Management for Scientists
IND 447 (4 Credits)	Signal Transduction
MBI 421 (3 Credits)	Microbial Genetics and Physiology
MBI 456 (4 Credits)	General Virology
NSC 525 (3 Credits)	Biology of Neurological Disease
PHP 447 (4 Credits)	Signal Transduction

OTHER REQUIREMENTS

A. Two research rotations should be conducted prior to joining a laboratory for dissertation research. Students are encouraged to complete these rotations during the first two years of the M.D. program.
B. The Qualifying Examination is required at the end of the second year of the Ph.D. studies.
C. The teaching assistant requirement is waived.
D. At least one meeting per year with the thesis advisory committee (normally held after the student's Genetics Seminar presentation).
E. A satisfactory thesis must be written and successfully defended.

Reviewed: September 2021

HEALTH SERVICES RESEARCH & POLICY PROGRAM–CURRICULUM OUTLINE

The curriculum for the Health Services Research and Policy PhD is shown in the following table.

Term	Curriculum (Credits)
2 Weeks Prior to Year 1, Fall	• 2-week Mathematics and Statistics Review Course (Math Camp)
Year 1, Fall	• PM 421 US Health Care System: Financing, Delivery, Performance (3.0 credits) • PM 428 Health Services Research Seminar (1.0 credit) • PM 430 Psychology in Health Services Research (3.0 credits) • PM 445 Introduction to Health Services Research and Policy (3.0 credits) • PM 463 Introduction to Mathematical Statistics, Part I (3.0 credits) • IND 503 Ethics in Research (1.0 credit)
Year 1, Spring	• PM 428 Health Services Research Seminar (1.0 credit) • PM 464 Introduction to Regression Analysis (3.0 credits) • PM 472 Measurement & Evaluation of Research Instruments (3.0 credits) • PM 484 Medical Decision Analysis & Cost Effectiveness Research (3.0 credits)
Year 1, Summer	• PM 410 Introduction to Data Management and Analysis (3.0 credits)
Year 2, Fall	• PM 412 Survey Research (3.0 credits) • PM 420 American Health Policy & Politics (3.0 credits) • PM 428 Health Services Research Seminar (1.0 credit) • PM 456 Health Economics I: Introduction to Health Economics (3.0 credits) • PM 465 Stats III: Advanced models (3.0 credits)
Year 2, Spring	• PM 422 Quality of Care and Risk Adjustment (3.0 credits) • PM 428 Health Services Research Seminar (1.0 credit) • PM 472 Measurement & Evaluation of Research Instruments (3.0 credits) • PM 483 Advanced Health Economics II (3.0 credits) • PM 487 Fundamentals of Science Technology & Health Policy (3.0 credits • PM 494 Health Policy Analysis Lab

Reviewed: September 2021

MICROBIOLOGY & IMMUNIOLOGY (MBI)

Departmental requirements for the M.D./Ph.D. degrees reflect the fact that most students enter the Ph.D. program after completion of two years of the Medical School Curriculum.

- Typical MD/PhD students enter the PhD portion of their combined degree program after the basic science years of the MD curriculum. During their first and/or second year of the MD program, they should discuss the PhD program in Microbiology and Immunology with the departmental faculty including the director of graduate studies in this department. During this period, they should also be considering possible dissertation research mentors. Research rotations in two (or more) of the prospective labs are conducted, typically in the summers before their entry into the Ph.D. program. This results in a waiver for MBI 507 (Laboratory Rotations) and MBI 506 (Scientific Writing in Research).

- Depending on their research focus, MD/PhD candidates, like all doctoral candidates in the Department of Microbiology & Immunology, enter either the Immunology Track, the Microbiology Track, or the Virology Track; required and elective course offerings in each track are described below. In addition, each student is required to take the Microbiology & Immunology Student Research Seminar (MBI 501) given every semester, and Biomedical Ethics (IND 501).

- PhD research training focuses on the following major topics of cluster faculty members' interest such as: microbial pathogenesis; molecular genetics; microbial physiology; oral microbiology; molecular virology; neurovirology; viral immunology; vaccine biology; autoimmunity, tumor immunology; lymphocyte biology; developmental immunology; cytokines and immune regulation; psychoneuroimmunology; immunogenetics; and phylogeny of immunity. MD/PhD students typically begin their dissertation research upon entry into the PhD program. Their research focus intensifies in subsequent years during which time there is also an emphasis on presentation of research results locally, at national and international scientific meetings, and in journal articles. Didactic course work is usually completed before the end of the second year. Additional required courses are typically small group seminars and journal clubs (1-2 credits) where students learn how to critically evaluate and orally present recent literature in their chosen field of study.
- Based on their basic science courses in the Medical School Curriculum, MD/PhD students are granted 30 credits toward the 96-credit requirement for the PhD. This results in a waiver for IND 431 and IND 432 (Foundations of Modern Biology I&II). Of course, any portions of these courses may be audited as needed.

- **MD/PhD students must take an oral qualifying examination on their proposed thesis research by the October 1 of their second year in the PhD Program**. The qualifying exam tests both the baseline level of knowledge of the field of study and well as a working knowledge of areas such as genetics, cell biology and biochemistry. Additionally, and critically, the qualifying exam tests the student's ability to integrate this knowledge in the design and interpretation of experiments. **See page 10 in the Microbiology and Immunology handbook for instructions on the PhD oral qualifying exam.**

- The doctoral program typically takes four years for combined degree students to complete. **M.D./Ph.D. students will not be allowed to enter the clinical years until their thesis has been submitted to ProQuest and approved.**

Track specific requirements:

Immunology Track

Track Requirements

MBI 515	**Advanced Immunology**	**4.0 credits**
MBI 580	**Immunology Research in Progress (RIPS) + Journal Club-Each semester for at least six semesters**	**1.0 credits**
MBI 540	**Advanced Topics in Immunology-One semester**	**1.0 credits**

Electives:
Chosen after consultation with the research advisor and PhD committee, to best serve the needs of the student's
program, background, and interests. Electives taken by students have included:

MBI 456	**General Virology**	**4.0 credits**
MBI 414/514	**Mechanisms of Microbial Pathogenesis + Co –Seminar**	**5.0 credits**
MBI 421/521	**Microbial Genetics and Physiology + Co-Seminar**	**5.0 credits**
PTH 507	**Cancer Biology**	**3.0**
MBI 403	**Drug Discovery**	**2.0**

Virology Track

Track Requirements

MBI 456	**General Virology**	**4.0 credits**
MBI 588	**Virology Research Seminar Series – At least three semesters**	**1.0 credits**
MBI 589	**Advanced Topics in Virology –– At least three semesters**	**1.0 credits**

Electives:
Chosen after consultation with the research advisor and PhD committee, to best serve the needs of the student's
program, background, and interests. Electives taken by students have included:

MBI 473/573	**Immunology + Co-Seminar**	**5.0**
MBI 414/514	**Mechanisms of Microbial Pathogenesis + Co –Seminar**	**5.0 credits**
MBI 421/521	**Microbial Genetics and Physiology + Co-Seminar**	**5.0 credits**
PTH 507	**Cancer Biology**	**3.0**
MBI 403	**Drug Discovery**	**2.0**

Microbiology Track

Track Requirements

MBI 414/514	**Mechanisms of Microbial Pathogenesis + Co –Seminar**	**5.0 credits**
MBI 421/521	**Microbial Genetics and Physiology + Co-Seminar**	**5.0 credits**
MBI 570	**Advanced Topics in Molecular Microbiology – At least six semesters**	**1.0 credit**

Electives:
Chosen after consultation with the research advisor and PhD committee, to best serve the needs of the student's
program, background, and interests. Electives taken by students have included:

MBI 403	**Drug Discovery**	**2.0**

Updated September 2021

NEUROSCIENCE

The primary goal of the Neuroscience Graduate Program (NGP) is to provide state-of-the-art research-intensive training for students seeking to obtain a PhD degree in the study of the nervous system. Typically MD/PhD students enter the PhD portion of their combined degree program after the basic science years of the MD curriculum. During their first and/or second year of the MD program, they should discuss the two PhD degree tracks in NGP with the program faculty including the director of graduate studies. During this period, they should also be considering possible dissertation research mentors. Research rotations in two (or more) of the prospective labs are conducted, typically in the summers before their entry into the PhD program. Students usually have selected a dissertation research mentor at the time of matriculation into the graduate portion of their training. At this same time, students choose one of two PhD degree tracks: Neuroscience or Neurobiology & Anatomy.

Program-Sponsored Activities
NGP students participate fully in program-sponsored functions in addition to their own department/center-sponsored activities and seminars.

- Annual Retreat: The NGP sponsors an all-day retreat for students, postdocs, and faculty from across the University who share an interest in neuroscience. The retreat, planned by students and faculty, is typically held in the fall at an off-campus site.

- Neuroscience Colloquium: The program co-sponsors a number of seminars each year that bring visiting scientists from around the world to the University to present their latest research findings. The Colloquium supplements the numerous department and center-sponsored seminars by aiming to invite speakers that will appeal to a broad cross-section of the Neuroscience community. Speakers are selected by a committee of students and faculty.

- Neuroscience Luncheons: The program sponsors a luncheon for NGP graduate students on the second Wednesday of each month during the academic year. In addition to free food and drink, the monthly lunch provides a forum for students to discuss topics related to graduate education with the NGP directors and other guests.

- NGP Qualifying Exam and Thesis Defense Seminars: All NGP students are expected to attend these special presentations to support their colleagues as they pass through important milestones in their training.

- Poster Sessions: Throughout the year, various departments, centers, and programs sponsor poster sessions to showcase their research and to provide a forum for exchanging ideas. NGP students who have passed their qualifying exams are expected to present their work at these sessions, and all students are expected to attend and actively participate.

- Mandatory Lecture Attendance: All NGP students are expected to attend named lectures Doty, Notter, etc.

Curriculum
Based on their basic science courses in the medical curriculum, MD/PhD students are granted 30 credits toward the 96-credit requirement for the PhD.

a. Required Coursework: All NGP students complete a core curriculum during their first year that includes: *Cellular Neuroscience* (NSC 512), *Integrative and Systems Neuroscience* (NSC 531), *Ethics in Research* (IND 501), *Human Brain Anatomy* (NSC 511)[1], *Introduction to Programming* (NSC 410), and 3-4 laboratory rotations of their own choosing. During years 1 and 2, NGP students must also complete 2 Fall semesters of *Current Topics in Cellular Neuroscience* (NSC 592), 2 Spring semesters of *Critical Reading In Integrative and Systems Neuroscience* (NSC 592), *Applied Statistics in the Biomedical Sciences* (BST 467), serve as a teaching assistant for one semester (NSC 581 - usually in year 2 or 3) and register for *NSC Student Seminar* (NSC 503) each semester they are in the program.

At the end of the first year, students formally declare whether they will follow the ***Neuroscience* (NSC)** or ***Neurobiology & Anatomy* (*NBA*)** track. The two tracks accommodate distinct training objectives:

- ***Neuroscience* track** – maximum flexibility to tailor advanced coursework to fit individual education and research objectives

- ***NBA* track** – comprehensive exposure to human physiology and anatomy or medical neuroscience through participation in the medical school curriculum

b. Medical Scientist Training Program – M.D./Ph.D.
- M.D./Ph.D. students are allowed to waive the required Neuroscience Graduate Program electives.
- NSC 511 is not required for M.D./Ph.D. students. Email the course instructor for approval to waive this requirement.
- M.D./Ph.D. students are exempt from the TA requirement but may do so if interested.
- M.D./Ph.D. students need to complete only one rotation report – instructions on page 8-10 of the NGP handbook.

c. Electives: In addition to the coursework listed above, **students must complete a minimum of 10 elective credits of coursework[2]**. For most students, 4 elective credits will come from either *Foundations in Modern Biology (modules 2, 3 and 4)* (IND 431), *Biochemistry* (IND 408), *Molecular Biology and Genetics* (IND 410), or *Foundations in Cellular and Molecular Biology* (ANA 511) and all students are strongly encouraged to enroll in *Introduction to Computational Neuroscience* (NSC 547). The remaining 3 (or more) elective credits are earned in upper level graduate courses and are chosen in consultation with the NGP Director and/or the student's thesis advisor.

Sample Curriculum

1st Year—All students

Fall Semester		*Credit Hours*[3]
NSC 592	**Current Topics in Cellular Neuroscience**	**1**
NSC 503	**NSC Student Seminar**	**1**
IND 501	**Ethics & Professional Integrity in Research**	**1**
NSC 512	**Cellular Neuroscience**	**5**

[1] NSC 511 is not a requirement for M.D/Ph.D. students
[2] M.D./Ph.D. students can use 10 credit hours of medical school coursework to fulfill the electives requirement.
[3] Students register for 16 credit hours/semester.

NSC 590	**Lab Rotations**	**variable credits**
IND 431	**Foundations in Modern Biology (Modules 2, 3, 4)**	**3**
	Elective (*optional)*	**variable credits**

Spring Semester

NSC 592	**Critical Reading in Integrative and Systems NSC**	**1**
NSC 503	**NSC Student Seminar**	**1**
NSC 511	**Human Brain Anatomy**	**1**
NSC 531	**Integrative & Systems NSC**	**6**
NSC 410	**Introduction to Programming**	**1**
NSC 590	**Lab Rotations**	**variable credits**
	Elective	**variable credits**

2nd year—Neuroscience track

Fall Semester *Credit Hours*

NSC 592	**Current Topics in Cellular Neuroscience**	**1**
NSC 503	**NSC Student Seminar**	**1**
NSC 547	**Introduction to Computational Neuroscience**	**3**
NSC 595	**PhD Research**	**variable credits**
	Elective	**variable credits**

Spring Semester

NSC 592	**Critical Reading in Integrative and Systems NSC**	**1**
NSC 503	**NSC Student Seminar**	**1**
[4]BST 467	**Appl. Stats in Biomed. Sci.**	**4**
[5]NSC 581	**Teaching Tutorial**	**3**
NSC 595	**PhD Research**	**variable credits**
	Elective	**variable credits**

2nd year—NBA track

Fall Semester *Credit Hours*

[6]ANA 526	**Human Structure & Function**	**16**
Or		
NSC 592	**Current Topics in Cellular Neuroscience**	**1**
NSC 503	**NSC Student Seminar**	**1**
ANA 525	**Mind, Brain and Behavior**	**8**
ANA 595	**PhD Research**	**6**

Spring Semester

NSC 592	**Critical Reading in Integrative and Systems NSC**	**1**
NSC 503	**NSC Student Seminar**	**1**
[6]NSC 581	**Teaching Tutorial**	**3**
[5]BST 467	**Appl. Stats in Biomed. Sci.**	**4**
ANA 595	**PhD Research**	**variable credits**
	Elective	**variable credits**

[4] BST 467 may be replaced with either *Intro to Biostatistics* (BST 463) or *Data Analysis I* (BCS 510) offered in the fall semester.
[5] Students may elect to fulfill the TA requirement (NSC 581) in the fall or spring of year 2 or 3.
[6] Students taking ANA 526 cannot register for any other courses that semester.

Irrespective of track, students should strive to complete all coursework by the end of the fifth semester of study.

[7]Partial list of graduate level electives taken by current students and recent graduates

ANA 405	Hearing & Balance: Structure, Function & Disease
ANA 411	Cellular and Molecular Bio Found
ANA 513	Neuroinflammation
ANA 518	Intro to Neuroengineering
ANA/NSC 591	PhD Readings *(Instructions on creating this course: Appendix B pages 26 & 27)*
BCS 502	Cognition
BCS 511	Behavioral Methods in Cognitive Science
BCS 512	Computational Methods in Cognitive Science
BCS 513	Intro to fMRI: Imaging, Computational Analysis & Neural Representations
BCS 521	Auditory Reception
BCS 532	Probabilistic theories of cognitive processing
BST 465	Design of Clinical Trials
GEN 507	Advanced Genetics
GEN 508	Genomics and Systems Biology
IND 420	Mastering Scientific Information
IND 447	Signal Transduction
MBI 403	Drug Discovery
MBI 456	General Virology
MBI 473	Immunology
MBI 492	Special Topics
MBI 515	Advanced Immunology
NSC 415	Introduction to Augmented and Virtual Reality
NSC 525	Biology of Neurological Disease
NSC 547	Topics in Computational Neuroscience
PHP 404	Principles of Pharmacology
PTH 507	Cancer Biology
PTH 509	Pathways of Human Disease
PTH 571	Molecular Basis of Disease
TOX 521	Toxicology I
TOX 522	Toxicology II

d. <u>Advising committees</u>: During the first year each student is assigned a first year advising committee comprised of two NGP faculty members and a senior NGP student. The goal of the first year advisory committee is to provide critical feedback to students early in their careers, before they choose a thesis lab. Since students may not have formed individual relationships with faculty and senior students at this point, the first year advisory committee provides an opportunity to forge such relationships and get mentorship at a critical time when students may have less access to meaningful input. Mentors provide advice on areas that include (but are not limited to): expectations in graduate school, balancing classes and lab work, study habits, choosing a rotation and eventually a thesis lab, reading the scientific literature, scientific writing, qualifying exams, interacting with faculty and students, networking and future career options. The first year advising committee also provides feedback on rotation reports (see below) and oral presentations in student seminar. By the start of the second year, this committee is

[7] Not all courses are offered each year and each semester.

replaced by the Part I Exam Committee and eventually by the Thesis Committee. Timing and guidelines for convening these committees are described later in the handbook.

e. Lab rotations: MSTP students will only be required to complete a fall written rotation report. The report can be written on a rotation completed earlier. Completion of the report will be required to obtain a passing grade in NGP Student Seminar (NSC 503).

f. Journal club: Participation in a Journal Club is required each semester a student is enrolled. During years one and two, students must register for NSC 592. This course, which focuses on both historic and recent findings in the neuroscience literature, provides experience with reading scientific papers, experimental design, data analysis, and critical thinking. The readings are often coordinated with materials being taught in the core Cellular and Systems Neuroscience courses. In years three and beyond, students are free to participate in a journal club related to their research area. If a journal club in a student's area of interest does not exist, students are encouraged to form one.

g. Student seminar: MSTP students are required to register for ANA 522 *NSC Student Seminar* every semester. This course provides a forum where students deliver, at least once per year, an oral presentation related to their research. Both students and faculty evaluate the talks and provide the presenter with feedback on various aspects of their presentation. Students must attend a minimum of 80% of the presentations each semester to receive a passing grade. Attendance includes NGP colloquia and named lectures such as the Notter and Doty. First year students must also satisfactorily complete a rotation report each semester (MSTP students complete one report in the Fall semester only). Students who miss seminar due to attending a scientific conference will be excused. Unexcused absences can be made up by written assignment after consultation with the course director.

h. Selection of Ph.D. Track: By July 1 following the first year of study, students declare which Ph.D. degree they will pursue, ***Neuroscience*** or ***Neurobiology & Anatomy***. It is strongly recommended that students seek advice from the NGP Director or Associate Director and their research advisor prior to making the choice of Ph.D. track, keeping in mind the eligibility of faculty in each track, course requirements, teaching requirements, etc. A form available from the NGP Coordinator is to be completed and returned indicating the student's choice. At that time, the NGP Coordinator will schedule a brief meeting between the student, his/her thesis advisor and the NGP Director to go over student and mentor guidelines and remaining degree requirements.

i. Part I exam: The student in consultation with his or her advisor selects a minimum of 50 papers relevant to the student's scientific area of interest to be read by the student over a period of not more than 2 months. At this time, the student meets with the committee, which will either approve the reading list or suggest further refinements to the scope of the exam. At the end of the reading period, the student formulates and submits in writing 5 broad hypothesis-driven research questions to their committee based upon the readings. The exam begins when the Committee returns a subset of these questions along with one or more of its own to the student. The student then has 1 week (7 calendar days) to compose written answers to these questions. As a guideline, a thorough answer to each question typically requires 2-4 single spaced pages. Students should take the Part I exam during the spring semester of the 2nd year. The exam must be started before April 1st and be completed by June 1st of the summer between years 2 and 3.

j. Part II exam – Thesis Proposal/Qualifying Exam: After passing the Part I Exam, the student is expected to formulate a thesis proposal with the guidance of his/her Thesis Advisor. The written proposal should include the specific aims and overall significance of the proposed

research, sufficient background for others to understand the research plan, key preliminary data that support the aims, and a description of the experimental design that will be used to accomplish the stated aims. **The thesis proposal must be written and the Qualifying Examination taken BEFORE October 1st of the fifth semester of graduate study (i.e., fall semester in year 3).** Successful completion of the Thesis Proposal/Qualifying Exam advances the student to candidacy for the Ph.D. degree.

Examining committee: The University Council on Graduate Studies has designated rules for the Committee. The student's committee must consist of 4 tenured or tenure-track faculty of assistant professor or higher rank and is subject to approval from the NGP Director.

Neuroscience track: 3 of the 4 members are chosen by the student in consultation with their thesis advisor. Of these, 2 MUST be from the NGP faculty list and 1 MUST be from **outside** of the primary department of the advisor and co-advisor. A holder of a secondary appointment in the advisor's and co-advisor's departments may serve as the external committee member, provided that his or her primary appointment is in another department. Please notice that faculty members of NGP can serve as external committee members for NGP students as long as the above mentioned stipulations are met. The chair may be external or internal to NGP and the advisors' primary departments. Note that the thesis advisor (and co-advisor if applicable) is NOT a member of the Examining Committee for students in the Neuroscience track, although he or she is expected to attend the closed session as a silent observer. The final fourth member of the Committee will be appointed by the NGP Director from the NGP core faculty and will be a member of the examining committee for the purpose of the thesis proposal only.

NBA track: 2 of the 4 committee members MUST have their primary appointment in the Department of Neuroscience. 1 of the 4 members MUST be from outside the Department of Neuroscience's primary faculty (secondary appointments in Neuroscience are acceptable as long as the primary appointment is in another department). The 4th member of the committee is the thesis advisor (who must have a primary or secondary appointment in the Department of Neuroscience). A co-advisor would serve as a 5th member of the committee. For NBA track students, the Chair can be within the Neuroscience Department.

An expert from outside the University of Rochester may be invited to join the Committee as the external member with ***prior written approval*** from the NGP Director and Associate Dean for Graduate Studies.

k. Ph.D. Dissertation and Final Exam: After completing the Qualifying Exam, the official Thesis Advisory Committee is formed and the remaining years of study are spent working on developing the research project that will form the Ph.D. dissertation. The Thesis Advisory Committee must consist of a minimum of 4 tenured/tenure-track faculty assistant professor or higher. One of these is the thesis advisor. While the Thesis Advisory Committee is distinct from and need not overlap with the Qualifying Exam Committee, often two to three of the members come from the student's Qualifying Exam Committee.

For neuroscience students, two of the remaining three members, MUST be from the NGP faculty list and one must be from **outside** of the primary department of the advisor and co-advisor. Please notice that NGP faculty members can serve as external committee members for NGP students.

For NBA students, at least two of the four members MUST have their primary appointment in the Department of Neuroscience while the external member must be from outside the Department of Neuroscience primary faculty. The thesis advisor (who must have a primary or secondary appointment in the Department of Neuroscience) is the fourth member of the Advisory Thesis Committee.

It is required that prior to the thesis defense, all students will have published or submitted for publication at least one first-author manuscript in a peer-reviewed journal describing their research findings. Review articles or published meeting presentations are NOT sufficient to fulfill this requirement. After the advisor and Thesis Committee approve the completion of the thesis research, the student submits a dissertation of his or her findings. In the form of an open lecture, the student publicly presents his or her thesis research and in a closed exam defends those findings to the Thesis Committee. See the *Guidelines for preparation and registration of the Ph.D. thesis defense* (section 10 in this handbook).

The full Nueroscience Graduate Program handbook can be found here:
https://www.urmc.rochester.edu/MediaLibraries/URMCMedia/education/graduate/phd/neurosciences/handbooks/2020-2021-NGP-Handbook-Final.pdf

Reviewed February 2021

OPTICS

The Institute of Optics offers a PhD degree that can be combined with the MD. The outline below illustrates a student's progress in the PhD program. Details are given in subsequent sections.

First Year
- Full time coursework and study
- Choose Thesis Advisor (by April 15th)
- Summer Research
- Preliminary Examination

Second Year
- Advanced specialized coursework
- Teaching Assistantship
- Research

Third Year
- Oral Qualifying Examination
- Elective Courses
- Research

Fourth Year and Beyond
- Research
- Elective Courses
- Thesis submission
- Oral Thesis Defense

Core courses

First-year financial support is usually in the form of a fellowship allowing the student to devote full time to course work. The full load is 16 hours of credit per semester. The purpose of this year's work is to provide a broad background in optical physics and engineering. The following is recommended to provide a broad survey of optics.

Fall	Spring
OPT 411 Mathematical Methods for Optics	OPT 442 Instrumental Optics
OPT 425 Radiation & Detectors	OPT 462 Electromagnetic Waves
OPT 441 Geometrical Optics	OPT 412 Quantum Mechanics for Optics
OPT 461 Fourier Optics	Elective

With the exception of the elective, these courses are core courses and are normally required for a PhD. They can be waived by petition to the Graduate Committee in those cases where they seem inappropriate for a student with an unusual background or interests

Preliminary Exam

The examination consists of three segments and is given one or two weeks before classes start in the fall semester. Faculty grade their respective exam questions. Thereafter, the scores are presented to a faculty review board. Passing the preliminary exam is dependent not only on proficiency shown on the test, but also on the student's entire body of work including past course work, past and current research activity within The Institute, and recommendation from his/her advisor and other faculty.

Teaching Assistantship
During the second year, students usually fulfill their TA requirement, which is two semesters of service. This service is required whether or not the student has received financial support from the University. It is the intent of the Optics faculty that this teaching should be more than merely grading papers for a course and should include some sessions in the classroom.

Elective Courses and Seminars
In addition to the above course requirements, the student must complete 28 credit hours of formal coursework, and 30 credit hours of research, totaling 90 credit hours.

Research Activities
Students typically secure a position in a lab during the spring semester of their first year, and start performing research the summer after their first year.

Qualifying Exam
1. The student finds a prospective thesis advisor and selects a topic for PhD research.
2. The student prepares a written document, which describes the proposed research. This Thesis Proposal shall be no longer than 12 pages in length, not counting additional page(s) for references. It includes a brief literature survey and should convince the reader that the candidate is aware of the problems he or she is attempting to solve and has some inkling of how to solve them.
3. The student prepares a 25-30 minute presentation for the oral examination. The committee members can ask questions during and following this presentation. The question session can take up to one and a half hours.

Dissertation
Once admitted to candidacy for the PhD, the student forms a dissertation committee consisting of the faculty mentor, two other faculty members in Optics, and one faculty member in a non-Optics department (or program). Upon completion of the dissertation research, and having met all course and credit hour requirements, the written dissertation is filed with the Graduate Dean who approves the final oral examination. This examination consists of a public lecture to the entire Department, followed by a closed oral exam by the dissertation committee.

Reviewed September 2021

PATHOLOGY

The Department of Pathology offers a program leading to a PhD in Pathology to students enrolled in the MD/PhD program. Degree requirements are somewhat modified to take into account the basic science curriculum completed by students during their first two years of medical school.

1. Laboratory rotations: MD/PhD students are expected to have completed 2-3 lab rotations during their first two years of medical school.

2. Course Requirements for MD/PhD Students: The following courses are required for a PhD degree in Pathology:

Select 1 Pathology elective course in consultation with program director

PTH 507	Cancer Biology	*Fall Semester Only*
BST 463	Introduction to Biostatistics	
CVS 401	Cardiovascular Biology & Disease	
MBI 473	Immunology	
IND 447	Signal Transduction	
IND 431	Foundations of Modern Biology I	
IND 432	Foundations of Modern Biology II	

Group C	(all are required)
PTH 504	Current Topics in Experimental Pathology – Student Seminar
IND 501	Ethics and Professional Integrity

Note: Additional courses may be considered depending on the background and future directions of the student.

3. Departmental and Student Seminar Series: Attendance at the Student Seminar Series (PTH 504) is mandatory for all Pathology graduate students. Students writing their thesis are exempt from PTH 504 during their final semester.

4. Oral qualifying exam: Students are expected to defend their thesis proposal before an oral exam committee by the end of their second year of graduate training. By this time, the student will have completed all course requirements and will have generated sufficient preliminary data in their chosen thesis laboratory to propose and defend before the committee the thesis question that they wish to pursue for the PhD.

5. Monitoring progress: Students who have passed their qualifying exam must meet with their thesis advisory committee at least yearly. The purpose of the committee is to monitor the student's progress and to provide advice and additional guidance to the student.

Reviewed August 2021

PHARMACOLOGY AND PHYSIOLOGY:

During their second year, MD/PhD students should discuss entry into the PhD program with the Director of Graduate Studies of the Department of Pharmacology and Physiology. The PhD portion of their combined degree program will begin after successful completion of the first two years of the Double-Helix Curriculum.

MD/PhD students should expect to successfully complete 2-3 laboratory research rotations, at least one with a primary faculty member in the Department of Pharmacology and Physiology, during the first two years of the Double-Helix Curriculum.

The PhD portion of the MD/PhD program will build on previous background acquired in the Medical School curriculum. Because of this, certain course requirements of the traditional PhD track will be waived and advanced courses may be substituted to provide depth in an area of specialization.

MD/PhD students are granted 30 credits toward the 96-credit requirement for the PhD on the basis of their basic science courses in the medical curriculum. Students who consider that their background may permit exemption from other core curriculum courses in Pharmacology and Physiology should request such an exemption.

Each MD/PhD student must complete at least one of the following two Core Courses:

IND 431	Foundations in Modern Biology I (5 credits)
IND 432	Foundations in Modern Biology II (5 credits)

MD/PhD students must complete each of the following additional courses:

IND 447	Signal Transduction (4 credits)
PHP 502	Seminar (4 semesters) (1 credit)
IND 501	Ethics and Professional Integrity (1 credit)

MD/PhD students must also complete a total of at least 4 credits of upper-level A/E credit selected from the following list of recommended courses:

IND 426	Science Communication for Diverse Audiences (2 credits)
PHP 550	Ion Channels and Disease (2 credits)
MBI 473	Immunology (3 credits)
NSC 525	Biology of Neurological Diseases (3 credits)
BST 463	Introduction to Biostatistics (4 credits)
PTH 507	Cancer Biology (3 credits)
PTH 509	Pathways to Human Disease I (4 credits)
PTH 510	Pathways to Human Disease II (4 credits)
PTH 571	Molecular Basis of Disease (3 credits)
CVS 401	Cardiovascular Biology and Disease (3 credits)

MD/PhD students must complete the Departmental Qualifying Examination by 10/1 of their 4th year of study in the MD/PhD program. After successful completion of the Qualifying Examination, MD/PhD students must meet with their Dissertation Advisory Committee at least once yearly. During these meetings, the committee will discuss the student's progress, clarify research problems, and outline priorities of future research directions.
(For information on thesis preparation and defense, see the student handbook)

Reviewed November 2020

TOXICOLOGY

The program is housed in the Department of Environmental Medicine, which also oversees the Environmental Health Sciences Center, one of 22 such Centers of Excellence sponsored by the National Institute of Environmental Health Sciences. This program consists of an interdisciplinary faculty, many of whom which are located in contiguous space, with basic science, translational and clinical expertise. Many faculty in this program serve as mentors in the Toxicology Training Program. In addition to providing research and training opportunities, this program supports a vibrant seminar series, journal club, and maintains a state-of-the art inhalation facility for exposing cells, animals, and human subjects to a variety of agents including infectious organisms, air pollutants, tobacco smoke, and other environmental agents. Finally, several Toxicology Training Program faculty and their trainees are involved in the Rochester Clinical and Translational Science Institute (CTSI).

Areas of strength include:

- Neurotoxicology
- Cardiovascular & Pulmonary Toxicology
- Osteotoxicology
- Nanotoxicology/Nanomedicine
- Developmental Toxicology
- Immunotoxicology
- Stem cells and Epigenetics

CURRICULUM FOR THE PhD

The Toxicology graduate curriculum consists of several components: (1) core course requirements, (2) seminar requirements, (3) elective course requirements, and (4) experimental research. It is our belief that research is the most important part of this doctoral training program. As such, the PhD degree is awarded only after a student has conducted an independent, hypothesis driven research project and then written a dissertation that demonstrates a high level of intellectual competence.

A total of 96 credit hours are required to complete the PhD program and The Graduate School requires an academic load of 16 credit hours per semester. A minimum of 30 graduate credit hours must be accumulated before taking the qualifying examination. The credits are accumulated from core courses, electives, seminars, and research (TOX 595, PhD Research in Toxicology); of the total, 24 credit hours must be course work credit. Given that toxicology is highly interdisciplinary, our curriculum reflects that a thorough grounding in basic sciences is indispensable. To ensure that our trainees obtain broad and in- depth knowledge necessary for success, in addition to the Core Curriculum, 6 credit hours as electives are required, and at least **3** of these credits must be from toxicology (TOX) electives.

Core Curriculum (required courses):

Course No.	Course Title	Credits
IND 431	Foundations in Modern Biology I	5
IND 432	Foundations in Modern Biology II	5
PHP 403	Human Cell Physiology	4
PHP 404	Principles of Pharmacology	4
TOX 521	Biochemical Toxicology	4
TOX 522	Organ Systems Toxicology	4
TOX 558	Seminar in Toxicology	1 (taken 4 times)
BST 467	Applied Biostatistics in the Biomedical Sciences	3
IND 501	Ethics and Professional Integrity in Research	1
TOX 597	Intro Faculty Research in Toxicology	0

Exemptions from the Core Curriculum: A student who is interested in an exemption from any core course listed above should discuss this with the Program Director, who will help determine whether this may be appropriate. Students should come to this meeting with the details about the content of prior graduate-level courses (description, syllabus) and the grade earned. After a review of this material, the Program Director may advise the student to take the required course, or the Program Director will give the green light for the student to request a formal exemption. To do this, the student must submit the request along with a comprehensive course description (i.e., including lecture syllabus) of a prior course, grade earned, and a little bit of other information. The request then needs to be reviewed and approved by the course instructor and the Senior Associate Dean of Graduate Education and Postdoctoral Affairs. The instructions and the form for making this request are found on the GEPA website on the forms page at the following link: https://www.urmc.rochester.edu/education/graduate/home/forms.aspx

MD/PhD Students in Toxicology

MD/PhD students typically enter the PhD portion after the basic science years of the MD curriculum. During their first and/or second year of the MD program, they should discuss the PhD program in toxicology with departmental faculty and the Director of the Toxicology Graduate program. During this period, they should evaluate possible dissertation research mentors. Research rotations in two or three prospective labs are conducted, typically in the summer before their entry into the PhD program.

Based on their basic science courses in the medical curriculum, MD/PhD students are granted 30 credits toward the 96-credit requirement for the PhD. Thus, many of the required courses for Toxicology PhD candidates (i.e., IND 431, IND 432, PHP 403, and PHP 404) are waived for most MD/PhD students. 30 credits can only be transferred IF the student earns more than 96 credit hours of PhD research. Please refer to the University policy on credit sharing between 2 degrees.

The required courses are: TOX 521, TOX 522, and BST 467. In addition, each student is required to take the Toxicology Student Research Seminar (TOX 558 – 1 credit hour) and Ethics (IND 501). Additional courses are typically small group seminars and journal clubs (1-2 credits) where students learn how to critically evaluate and orally present recent literature.

For the PhD portion of the combined MD/PhD, students take an oral qualifying examination based on their proposed thesis research at the end of their second year of study or by the end of their 5 semesters. Typically, the combined degree students complete the PhD portion in 3-4 years.

PhD Qualifying Examination

The Qualifying Examination consists of a closed session with the Thesis Advisory Committee, with one member selected by the Senior Associated Dean to serve as Chair of the Examination process. The oral examination usually lasts between 2 to 3 hours. The candidate is judged on the following criteria:

(1) Written and oral presentation of the thesis proposal;
(2) Grasp of the fundamental issues and theoretical basis for the experimental approaches;
(3) Knowledge of alternate approaches to achieve the outlined goals; and
(4) Ability to critically evaluate a research area, to propose a relevant hypothesis, to design critical experiments to test the hypothesis, and to critically assess potential results of proposed experiments.

The Committee will meet separately at the conclusion of the oral examination, determine whether or not the student has passed, and formulate a report to the Senior Associate Dean's office. Directly after this discussion, the committee, led by the committee Exam Chair, will meet with the student to discuss strengths and weaknesses of the exam, and may make specific recommendations. The student will be informed of the examination results at this time.

Thesis Defense

The final examination for the PhD portion of the degree requires a written dissertation, a public oral presentation of the research project, and a closed defense of this research before the Dissertation Advisory Committee. A faculty member from another graduate program at the University of Rochester serves as the official chair the final closed examination. The committee for the final examination decides on the acceptability of the quality of the research and the method of presentation (written and oral), following all University guidelines.

Reviewed November 2020

TRANSLATIONAL BIOMEDICAL SCIENCES

The goal of the program is to prepare individuals for academic and clinical careers relating to the translation of basic biomedical research into clinical strategies to improve health.
To improve human health, fundamental scientific discoveries and critically evaluated clinical observations must be translated into practical clinical applications. Important discoveries from "the bench" of basic biomedical research performed at the molecular or cellular level must progress to the clinical level, to the "bedside."
A flexible curriculum in basic, translational and population health sciences and a dual mentoring approach for dissertation research (a Clinical Translational Investigator and a Basic Science Investigator appropriate to the research area) provide the basics of disease pathophysiology and the skills to translate this knowledge to population health in a team science environment.

Specific program objectives include:
Prepare individuals in fundamentals of disease pathophysiology.
Provide in-depth mentoring to assure productive research training.
Teach fundamental theory and knowledge in the subject areas of biostatistics, epidemiology, laboratory methods, human subjects research and analytical procedures essential to clinical research.
Provide a critical environment fostering inquiry, integrity, teaching and communication skills, high productivity, and working in a multi-disciplinary environment.

Research Rotations
Students are required to do three rotations during the first year of study, one in the Fall and two in the Spring. These rotations introduce the student to the scientific thought and method. Students gain experience in research, attend research seminars, and practice their communication skills. Furthermore they become familiar with prospective research advisors for their thesis project. At the end of the first year, students choose a primary advisor and co-advisor (a Clinical Translational Investigator and a Basic Science Investigator appropriate to the research area) and embark on a Ph.D. thesis research program. Students may choose as their primary research advisor any faculty member on the School of Medicine and Dentistry Interdisciplinary Graduate Program faculty of designated mentors with an appropriate research program and funding mechanism to support the student.

Qualifying Examination
The qualifying examination at the end of the fourth semester (or with committee permission by the end of the fifth semester) consists of an oral examination by the student's advisory committee / mentoring committee, composed of co-advisors (a Clinical Translational Investigator and a Basic Science Investigator appropriate to the research area) and two additional faculty members from different disciplines relevant to translational research. The examination is based on a written proposal reflecting the chosen research project and will emphasize ability to utilize information to analyze and offer solutions to problems, and propose unique directions for future research. No comprehensive examination of formal coursework is intended, however, adequacy of knowledge and appreciation are assessed.

Curriculum

TBS Core Curriculum (required courses):

Course No.	Course Title	Semester
IND 501	Ethics & Professional Integrity	Fall
PM403	Research Team Science Seminar	Spring

---	One skills workshop	Fall or Spring
---	One communication workshop	Fall or spring
---	*Additional elective coursework is optional*	---

Population Health Core Curriculum (required courses):

Course No.	Course Title	Semester
PM415	Principles of Epidemiology	Fall
PM486	Medical Ecology in Global Context	Spring

Statistics Core Curriculum (choose one course to complete):

Course N	Course Title	Semester
PM401		Fall
BST463		Fall
BST467		Spring

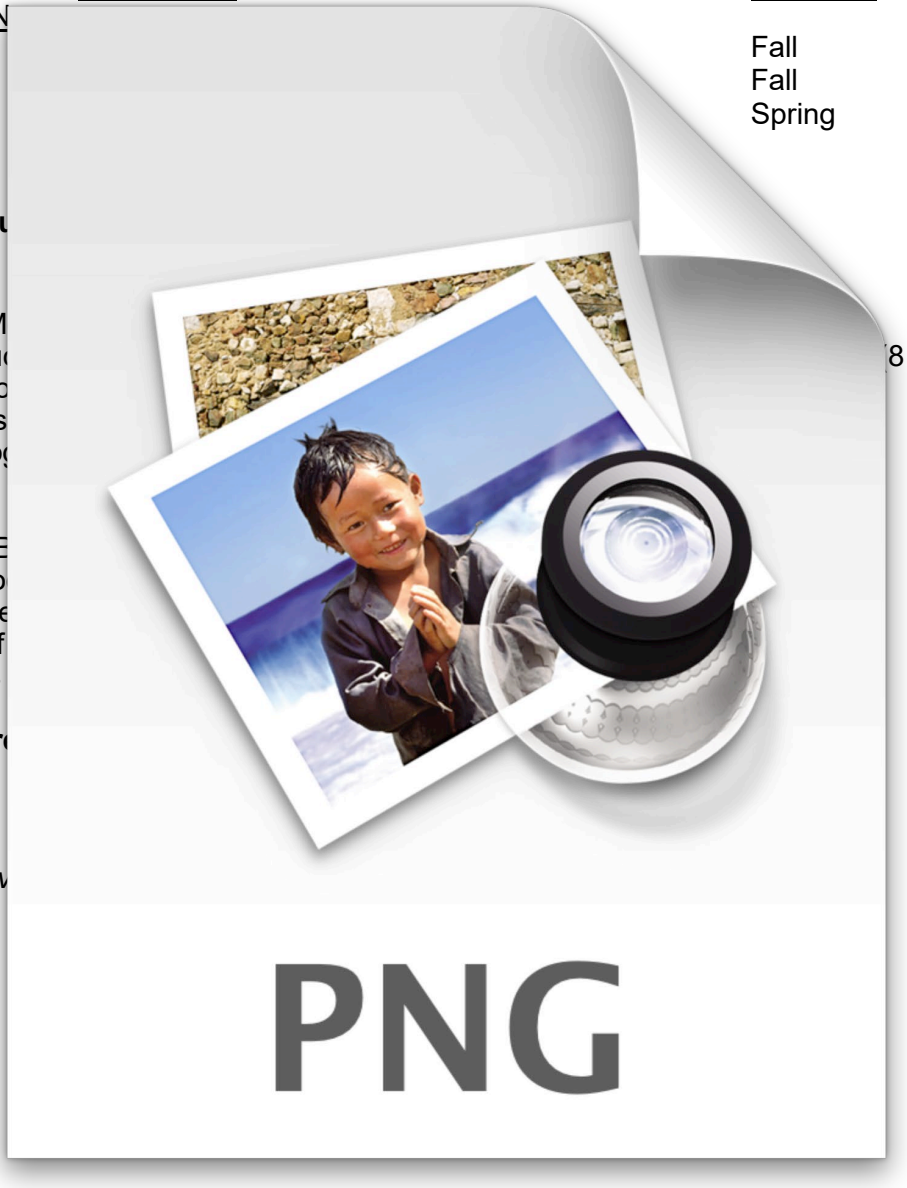
MSTP Curricu

Year 1:
Mastering M
Human Struc (8 cr)
Molecules to
Host/Defens
Pharmacolo

Year 2:
Mind/Brain/E
Disease Pro
Women's He
Disorders of
Adaptations

Total: 30 cr

Reviewed Nov



Student Travel and Reimbursement Guidelines, Alcohol, and Vacation/Holiday Policies – Appendix B

Trainee travel applies to the following types of trips: (1) gather data integral to the trainee's research project; (2) attend a scientific conference for the purpose of presenting results of the his/her research project; or (3) attend a scientific conference for the purpose of gaining additional knowledge about his/her research project. However, "trainee travel" **cannot** include travel between UR and the individual's home, and therefore, any relocation/moving costs or commuting costs are regarded as personal, and reimbursement of such costs constitutes additional taxable fellowship dollars.

The following applies to all reimbursement for trainees:

All trainees must calculate and fill out their own reimbursements using the University expense form. If you do not have direct deposit, you will need to request a check to be sent to your medical school box number. Be sure to fill in correct box. Leave “Company”, “Spend Category” and “FAO” columns blank. Administrator will fill those in. See example of form in attached pdf. The following link has the current form. Always use the EMPLOYEE expense report (F3), NOT Student expense report. www.rochester.edu/adminfinance/finance/accounts-payable/forms/

This form should then be sent electronically to Alysha Taggart, MSTP Administrator for approval and processing. The exception to this is if your graduate department is contributing funds toward your reimbursement; the form should then go to the Administrator/Accountant in your graduate department. Ask that person to contact Alysha Taggart for the MSTP account number.

All fourth year medical students in the MSTP who are graduating should plan on processing their training funds by end of JANUARY of their graduation year at the very latest. This is necessary in order to avoid last-minute scrambling to process paperwork in the weeks before commencement. It also alleviates the possibility of trainee being terminated prior to getting reimbursed. Reimbursements turned in after January 31 will not be processed.

Documentation

Original receipts will be required for all expense reimbursement items other than reasonable cash tips. Reimbursement for such costs (to the extent otherwise permitted by policy) will be made to the individual trainee after the trip. **Finance requires that all travel reimbursement requests must be submitted within 60 days of when the actual expense was incurred.**

- Alcohol must be on a separate receipt
- Tips should not exceed 18%
- Credit Card or Bank Statements must be provided to show proof of purchase if no receipt is included
  A "snapshot" of the expense is acceptable

Expenses

Although the University has recently instituted a per diem option, MSTP students must request payment based on actual incurred cost and include all receipts.

Except for the conference registration fee and special airline ticket requisition procedures referenced below, trainees will be responsible for travel expenses incurred in connection with their trainee travel.

Third Party Payments

Trainees should not pay costs on behalf of other individuals and expect to be reimbursed for the costs of those other individuals**. This rule applies to other MSTP students attending the same meal. ALWAYS request separate checks.**

Phone Calls

Cost of phone calls made by a trainee while in trainee travel status would not normally be allowable unless the trainee can document that the call was directly related to his/her traineeship project.

Conference Registration Fees

Conference registration fees for the trainee are normally paid directly by the trainee then reimbursed after the trip. In rare circumstances, advances can be processed by MSTP administration. Social/recreational activities associated with a business conference are not normally reimbursable.

Parking/Tolls

With receipts to document the expenditures, actual parking and toll charges directly associated with trainee travel may be reimbursed.

Mileage

Reimbursements for private car mileage must be based upon the IRS federal mileage rates. The private car mileage rate does not apply to rental cars or to UR-owned vehicles.

Rental Cars

Renting automobiles may be allowed for UR trainee travel purposes if public transportation is not available or is impractical to utilize. The original detailed receipt/agreement must be attached to the reimbursement request. In such cases, the traveler will not be reimbursed for the mileage allowance. However, if gas tank is filled by traveler prior to returning car to rental facility, UR will reimburse for that.

If attending the annual MD/PhD Student Conference in Colorado, you must rent as soon as you plan to go**. Rental agencies sell out in Denver, especially in July when the Conference is held so book EARLY**! The least costly available vehicle which holds the most students should be rented (an SUV is ideal or something with lots of room for suitcases and bodies). If not possible, then get a smaller vehicle in addition to the larger. When a more costly rental car is reserved, justification must be included in order to be reimbursed.

Rental Car Insurance

Automobile rental companies usually offer renters the option of purchasing various types of liability and physical damage insurance to address situations in which the rental car is involved in an accident or in which the rental car is stolen or vandalized. Whether a trainee would be reimbursed by UR for such insurance depends upon: (1) whether the car is being rented strictly for UR trainee travel purpose and (2) whether the travel is occurring inside the United States vs outside the United States. Domestic travelers on UR business are protected by special travel insurance and thus should not buy the extra accident or collision insurance offered by rental car agencies. The cost of this insurance will NOT be reimbursed. International travelers SHOULD buy the extra accident/collision insurance as they are not protected under the UR special travel insurance. The cost of this insurance WILL be reimbursable.

Airline Tickets

Airline tickets should be purchased as soon as a trip is planned in order to get the best fare. Advance airline tickets can be purchased thru Town & Country Travel but must be at least 30 days prior to the trip and an F2 form (Request for Advance Travel Tickets) must be completed and signed by both the individual traveler as well as their supervisor. This must then be faxed to Town & Country Travel **before the reservation will be confirmed.**

Transportation

First/business class airfare/transportation is generally unallowable for trainees, unless a legitimate medical justification is documented.

Taxi/Uber/Lyft/Other Rideshare

Request for reimbursement of taxi/rideshare fares should only be made when the taxi/rideshare trip was necessary for official UR trainee travel purposes and when more economical forms of public transportation were unavailable or impractical. For example, free or lower cost airport shuttle vans should be used if possible, and taxis/rideshares to/from meals would not normally be considered necessary if meal service was available in the traveler's hotel or within walking distance. Though documentation is not routinely required, trainees should be prepared to provide justification for the necessity and reasonableness of taxi/rideshare fares if requested by the traveler's department, central administration, or auditors. Receipts for reimbursable taxi/rideshare fares should be obtained and submitted with the trainee's reimbursement request. In addition, the traveler should list each taxi/rideshare trip on the travel voucher with a brief description of the purpose of the trip (e.g."taxi/rideshare from airport to hotel", "taxi/rideshare from hotel to meeting", etc.). If a trainee pays the taxi/rideshare fare for multiple persons, the documentation should also include a notation specifying everyone who was covered by that fare and the payment request numbers of those individuals, if applicable.

Meals

Receipts are required to document all meal expenditures for which the trainee is requesting reimbursement. **Itemized** receipts are required for reimbursement of a meal regardless of the dollar amount. Alcohol cannot be present on meal receipts. If alcohol is present, then a new meal receipt must be issued or the total amount needs to be deducted from the trainee reimbursement.

Allowable Meal Thresholds:

- Breakfast $25.00
- Lunch $25.00
- Dinner $50.00

Medical Scientist Training Program Alcohol Policy:

Trainees **cannot** be reimbursed for alcoholic beverages or alcohol-related costs under any circumstance unless pre-approved by the MSTP Director.

The MSTP will **not** reimburse students for alcoholic beverages consumed at regular applicant interview dinners or other events outside the University unless pre-approved by the MSTP Director. Candidates at or above the age of 21 may consume one alcoholic beverage, and the Program will fund this; however more than this amount is discouraged and will not be funded. It is the moral and legal responsibility of students who attend the dinners to adhere to this policy. A separate invoice specifying alcoholic beverages consumed by candidates, as well as a dinner invoice must be given to the MSTP Administrator for reimbursement.

The Medical Scientist Training Program will provide alcohol at certain MSTP-sponsored special social events throughout the year such as the applicant Revisit dinner.

Medical School Alcohol Policy (from SMD Student Handbook):

In the Medical Center and at all of its off-site locations, the non-patient use of alcoholic beverages is limited to events held at sites which occur outside patient care areas. These events and the use of alcohol, must be approved by the Office of the Senior Vice President for Health Affairs, catered by a catering service approved by the UR Sanitarian from Environmental Health and Safety, and holds a current liquor license, as well as liquor liability insurance approved by the Office of Counsel to the Medical Center

New York State Law: NY law prohibits the serving of alcohol to individuals actually or apparently under the age of 21, to intoxicated individuals or individuals who are known to habitually become intoxicated. It is illegal for individuals under the age of 21 to possess alcoholic beverages with the intent to consume such beverages.

Conference/Seminar Meals

When a trainee's meal is included in his/her conference/seminar registration fee, no additional reimbursement for that meal is allowable. Please review the conference agenda for included meals.

Lodging

The cost of the trainee's hotel room is normally reimbursable at the basic single occupancy room rate (plus tax). Almost all hotels accept a credit card number to guarantee a reservation and will only charge the card if the traveler fails to arrive on time without properly canceling the reservation. Therefore, trainees are expected to handle the room reservations with a credit card. Faculty and departments can reserve and pay for a trainee's hotel room with proper documentation provided at the time of reimbursement. Lodging outside of acceptable hotels needs to be approved prior to a reservation (e.g., apartments, houses, etc.).

Unallowable Costs

It is impossible to compile an all-inclusive list of costs which will not be reimbursed by UR, so when considering whether or not to make an expenditure while in travel status, the trainee should first assume that a cost will not be reimbursed unless the official Expenditure Guidelines clearly state that it is allowable for trainee travel. Unallowable costs should never be included on a request for reimbursement of trainee travel costs. Here are some examples of costs which will not be reimbursed by UR:

- Alcoholic beverages
- Clothing
- Credit card interest, finance charges, or penalties
- Family or friend costs
- Gym fees
- Housing outside of allowable lodging
- **Internet Access (WiFi)**
- Laundry services
- Life insurance
- Luggage repairs
- Luggage replacement
- Medical and dental expenses
- Movies or videos
- Passports
- Personal phone calls
- Sightseeing or souvenirs
- Shoe repair
- Ticket cancellation insurance
- Toiletry articles
- Traffic tickets or parking fines
- Umbrellas
- Vitamins

Travel and Standard Reimbursements

Reimbursements must be in the computer system within 30 days from the time of the transaction. Reimbursements must equal $25.00 or more before a payment request will be processed. Turn in all receipts as soon as possible upon your return or when the purchase was made. The documentation required includes the following:

- Flight itinerary indicating total airfare from travel agent/airline
- **Paid by cash:** Original register receipt indicating form of payment.
- **Paid by check:** Copy of an online banking record showing that specific payment circled.
- **Paid by credit card:** The original credit card receipt (showing at least the **name** and **last four digits** of the card used) and a transaction statement.

How will you receive your reimbursement?

Students being reimbursed will receive payment in the form of direct deposit. If a student does not opt for direct deposit, they will receive payment in the form of a check directly to their medical school box number or home address.

Vacation and Holiday Policy for MSTP (MD/PhD) Students

MSTP trainees in medical school will adhere to the same vacation and breaks as other medical students per the SMD Handbook. MSTP trainees in graduate school will adhere to the vacation & holiday policy for all graduate students, per the Graduate Education Handbook below.

The School of Medicine and Dentistry recognizes that time away from school is important to the individual. Vacations should be taken at times that do not interfere with students' course work and their research responsibilities in the lab/office and within the department. Students will abide by the following vacation policies:

- PhD students are permitted to take two weeks of vacation time (10 business days) each calendar year (January 1 through December 31). Vacation time does not automatically accrue and can be rolled over from year to year only with written permission of the advisor and program director.
- Vacation time must be approved well in advance by the appropriate advisor/program director. First year biomedical science students are required to receive written permission of the program director to ensure that the vacation period does not interfere with course work and laboratory rotations.
- Semester breaks are not automatic holidays. PhD students are expected to be in their labs or offices during breaks between semesters and during periods when no classes are held. See the SMD Graduate School Academic Calendar for exact dates.
- Vacations must not interfere with teaching assistant duties, including meetings prior to the start of classes.
- International students who plan to travel outside the United States must submit a Short Term Absence Notice. The information provided on this form will allow the School to assist the student in the event he/she is subject to an extensive security clearance prior to receiving the necessary clearance and documentation required for re-entry into the United States.
- Unauthorized absences may result in a prorated withholding of a student's stipend.

University Holidays

PhD students are entitled to paid time off for official University holidays:

- New Year's Day, January 1
- Memorial Day
- Independence Day, July 4
- Labor Day
- Thanksgiving Day and the Friday following Thanksgiving Day
- Christmas Day, December 25

Observance of Religious Holidays

As provided in New York Education Law Section 224-a, students who choose not to register for classes, attend classes or take exams on certain days because of their religious beliefs will be given an equivalent opportunity to register for classes or to make up the work requirements or exams they miss, without penalties or additional fees.