UMass Chan Medical School

Morningside Graduate School of Biomedical Sciences

2023-2024 Academic Catalog

UMass Chan MEDICAL SCHOOL | Morningside Graduate School of Biomedical Sciences

Advancing the health and well-being of the people of the Commonwealth of Massachusetts and the world through pioneering education, research, and health care delivery.

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Overview

Message from the Chancellor

Welcome to the University of Massachusetts Chan Medical School, an integral part of the five-campus UMass System and the Commonwealth's only public medical school. Rooted in Worcester, entrenched in the region, embedded throughout the state and engaged across the globe, UMass Chan Medical School is here for a reason!

We are here for our local and global communities, and we are especially here for our students, who add so much vitality and energy to our academic community. You have joined a special campus, marked by a collaborative orientation, defined by committed and dynamic faculty and distinguished by outstanding students like you who are imbued with a commitment to service, discovery and life-long learning.

As a student of the Morningside Graduate School of Biomedical Sciences, you are a member of a valued and vibrant component of UMass Chan Medical School. Morningside Graduate School of Biomedical Sciences lies at the heart of our world-class research enterprise, which consistently produces noteworthy and impactful advances in basic, translational and clinical research. Today, our dynamic research programs attract over $400 million in annual research awards, more than 70% of which come from federal funding sources such as the National Institutes of Health.

The Morningside Graduate School of Biomedical Sciences offers a truly unique academic experience for its students. Throughout your educational journey here, you will be encouraged, enabled and empowered to pursue an advanced biomedical science degree and realize your professional aspirations. The school's innovative and inter-disciplinary training and research programs are anchored and driven by internationally renowned faculty members, among them a Nobel Prize Winner in Medicine, a recipient of the Breakthrough Prize in the Life Sciences, a Lasker Award winner, four investigators of the Howard Hughes Medical Institute, and eight members of the National Academies.

The faculty and leadership of Morningside Graduate School of Biomedical Sciences are invested in this campus, our public mission and, most importantly, your success as a graduate student. You will learn, train and conduct research in a supportive and nurturing environment where the collaborative gene is fully expressed. As the faculty-initiated graduate programs continue to grow and evolve to respond to new frontiers of science, Morningside Graduate School of Biomedical Sciences remains steadfastly committed to its core responsibility of training the next generation of biomedical scientists, physician investigators, research educators and industry leaders who will be prepared to conduct

research that elevates the human condition.

As UMass Chan Medical School reaches new heights in furtherance of our education and research missions in the years ahead, we will continue to be guided by principles that place the highest priority on respecting the dignity and diversity of every member of the campus community. We are committed to supporting your professional, intellectual and emotional growth so that you may fulfill your potential and achieve your personal and professional goals.

I invite you to read this catalogue and take advantage of the unique and outstanding opportunities described herein. Also, I wish you all the best for a most successful, fulfilling and rewarding educational experience at UMass Chan Medical School.

Michael F. Collins, MD

Chancellor

University of Massachusetts Chan Medical School

Senior Vice President for the Health Sciences, University of Massachusetts

Message from the Dean

Welcome to the Morningside Graduate School of Biomedical Sciences at the University of Massachusetts Chan Medical School. Our mission is to develop future leaders in all sectors of biomedicine including research, education, policy and entrepreneurship. We are proud to be in the top 25 percent of medical schools and number 2 in New England in National Institutes of Health funding.

Whether your research interests lie in discovery of fundamental principles underlying biology, the translation of these discoveries into therapies, or innovating health care delivery, you will work alongside internationally recognized leaders in areas including RNA biology, systems and computational biology, neuroscience, immunology, metabolic biology, quantitative and population health sciences, cancer biology, and gene regulation. Our faculty recognition includes a Nobel Prize, a Lasker Award, four Howard Hughes Medical Institute awards, eight National Academy members, three Keck Awards, and four Presidential Early Career Awards for Science/Engineering.

Our world-class faculty is dedicated to training future science leaders in our learner-centered curriculum. You will have access to regular seminars with research leaders from all over the world, and participate in our nationally recognized career development program, to prepare to put your education to full use in a wide range of scientific careers.

We provide students with a generous stipend, outstanding health insurance and exemplary student support services. We are located in Worcester, a wonderful city with a minor league baseball stadium, museums, fine arts venues, beautiful parks, an ever-expanding number of cafes and restaurants, and direct access to Boston and other New England destinations.

You are encouraged to watch my introductory video for more and engage with our website. Thank you for visiting.

Mary Ellen Lane, Ph.D.

Dean, Morningside Graduate School of Biomedical Sciences

Donna M. and Robert J. Manning Chair in Biomedical Sciences

University of Massachusetts Chan Medical School

About UMass Chan Medical School

Welcome to UMass Chan Medical School, the commonwealth's first and only public academic health sciences center.

Our mission is to advance the health and wellness of our diverse communities throughout Massachusetts and across the world by leading and innovating in education, research, health care delivery and public service.

- On Sept. 7, 2021, a $175 million donation from The Morningside Foundation to the Medical School was announced. The transformative gift, which is unrestricted, will allow the Medical School to recruit renowned and innovative faculty; conduct more breakthrough biomedical research; offer financial support to highly qualified and diverse students; and be ever more expansive in fulfilling our public service mission. In recognition of the historic gift and of the deep commitment to education, research and health care by the Chan family of investors, entrepreneurs and philanthropists, UMass Medical School was renamed UMass Chan Medical School. Its three graduate schools were renamed: the T.H. Chan School of Medicine; the Tan Chingfen Graduate School of Nursing; and the Morningside Graduate School of Biomedical Sciences. UMass Chan was founded in 1962 to provide affordable, high-quality medical education to state residents and to increase the number of primary care physicians practicing in underserved areas of the state.
- It is consistently ranked by *U.S.News & World Report* as one of the leading medical schools in the nation for primary care education.
- The research enterprise received approximately $291 million in federal and private research grants and contracts in fiscal year 2022.
- The institution is committed to enhancing health and science education, ensuring community health, building a diverse workforce and enriching lives through extensive community outreach.
- Located in Worcester, Massachusetts, UMass Chan Medical School is one of five University of Massachusetts campuses.

The three UMass Chan graduate schools are the T.H. Chan School of Medicine, the Morningside Graduate School of Biomedical Sciences and the Tan Chingfen Graduate School of Nursing.

- The T.H. Chan School of Medicine is committed to training in the full range of medical disciplines, with an emphasis on practice in the primary care specialties, in the public sector and in underserved areas of Massachusetts.
- The Morningside Graduate School of Biomedical Sciences students receive a broad

background in the basic medical sciences and are trained in their selected specialty area in preparation for research with direct relevance to human disease.
- The Tan Chingfen Graduate School of Nursing offers master's, post-master's and doctoral degrees, providing high quality education to prepare registered professional and advanced practice nurses in nurse practitioner and nurse educator specialties and for faculty, research and other nursing leadership positions.

UMass Chan is a world-class research institution, consistently producing noteworthy advances in clinical and basic research.

- In 2006 the **Nobel Prize in Physiology or Medicine** was awarded to UMass Chan professor **Craig C. Mello**, PhD, and his colleague Andrew Fire, PhD, of Stanford University, for their discoveries related to RNA interference (RNAi), a cellular process that offers astounding potential for understanding and, ultimately treating, human disease.
- Our research programs are central to the Massachusetts Life Sciences Initiative, with major funding from the $1 billion Massachusetts Life Sciences Bill signed into law in 2008.
- Our researchers have made pivotal advances in HIV, cancer, diabetes, infectious disease, and in understanding the molecular basis of disease.
- Programs and centers include the RNA Therapeutics Institute, the Gene Therapy Center, Program in Gene Function and Expression, Systems Biology and Neurotherapeutics.

We invite you to learn more about why UMass Chan Medical School is a great place to work and study.

Educational Objective

The Morningside Graduate School of Biomedical Sciences offers ten programs of doctoral study and one Masters program in Clinical Investigation. The doctoral programs train students in their selected specialty area and emphasize the importance of a broad background in the basic biomedical sciences, in preparation for research with direct relevance to human disease. Graduates are equipped to collaborate with scientists and physicians involved in basic, translational and clinical research and are prepared to initiate careers as educators in schools of the health professions or in the biotechnology industry.

The basic and translational research programs emphasize the molecular basis of cellular, tissue and organismal biology in health and disease. The clinical research programs address the national need to move health care research from laboratory to bedside and from

individual patients and health care sites to systems of care.

These programs emphasize translational, clinical and health sciences research skills and provide students the tools to translate discoveries in the laboratory into effective patient outcomes.

The Morningside Graduate School of Biomedical Sciences offers students an exceptional opportunity to obtain a contemporary education in the biomedical and translational sciences through multidisciplinary core curricula, laboratory rotations and advanced elective coursework. With a current enrollment of approximately 400 very select students and more than 300 faculty members, the graduate school promotes interactions between faculty and students and emphasizes a personalized educational process.

Since accepting its first class in 1970, the primary responsibility of the T.H. Chan School of Medicine has been to provide our students with an accessible, comprehensive and personally rewarding medical education of the highest quality and one which optimally prepares them to excel as tomorrow's physicians--caring, competent, productive and fulfilled in their chosen career serving a diversity of patients, communities and the health sciences. The school is committed to training in the full range of medical disciplines, with an emphasis on practice in the primary care specialties, in the public sector and in underserved areas of Massachusetts. Our educational program, nationally recognized for excellence in primary care training by U.S. News & World Report, has benefited from recent investments in state-of-the-art educational technology and medical simulation, and an array of expanded elective offerings to complement our new competency-based curriculum. Our education program provides outstanding clinical training and preparation for graduates' diverse career choices beyond medical school, whether in primary care or the medical specialties, and our fast-paced growth and leadership in health science research offers exceptional research opportunities for our students.

The Tan Chingfen Graduate School of Nursing offers master’s, post-master’s and doctoral degrees, providing high quality education to prepare registered professional and advanced practice nurses within nurse practitioner and nurse educator specialties and for faculty, research and other nursing leadership positions.

Public Service Mission

ForHealth Consulting at UMass Chan Medical School

UMass Chan Medical School is distinguished by its unwavering support of public service. ForHealth Consulting at UMass Chan Medical School works in unison with state and local agencies, and non-profit and managed care organizations to increase the value and quality of publicly funded health expenditures and to improve access and delivery of care to at-risk and uninsured populations. Drawing on UMass Chan Medical Schools' depth and breadth of academic, research, management and clinical resources, ForHealth Consulting assists health care providers in the public sector to optimize efficiency and effectiveness.

ForHealth Consulting facilitates educational opportunities for UMass Chan Medical School students; the division partnered with the Morningside Graduate School of Biomedical Sciences to develop the PhD program in Clinical & Population Health Research, one of the first in the nation to promote graduate study that fosters the analytic skills and methods necessary to conduct both health services and clinical research. For more information, visit https://forhealthconsulting.umassmed.edu/about/

Research Mission

Currently supporting more than 300 investigators, the growth of the UMass Chan Medical School research enterprise has led to stimulating advancements in the treatment of disease and injury, as UMass Chan Medical School scientists undertake research to discover the causes of and cures for the most devastating diseases of our time.

Accomplished faculty members include a Nobel Prize winner, a Lasker Award recipient; eight members of the National Academy of Sciences, a member of the Royal Society, four Howard Hughes Medical Institute Investigators, two Banting Medal awardees, Pew and Keck scholars; MERIT awardees, a Fellow of the American Association for the Advancement of Science, and many other winners of scientific accolades.

UMass Chan Medical School is proud to be at the forefront biomedical research, with near constant expansion since 1990. In addition to increases in the number of educational programs, academic departments and programs/institutes, UMass Chan Medical School has benefitted from the acquisition of the former Worcester Foundation for Biomedical Research and the Massachusetts Biologic Laboratories. The Lazare Research Building opened in 2001 and the original medical school and hospital buildings were extensively renovated and expanded to include new meeting, educational, emergency and surgical spaces. Research funding grew for a time at a rate faster than any other academic health sciences center in the

country, fueled by recruitment of basic science faculty drawn to the institution's prominence in several fields, including cancer biology, gene function and expression, neurobiology, biochemistry, and molecular medicine. Two major facilities investments on the UMass Chan Medical School campus followed and laid the groundwork for the next generation of life sciences education and research: the 278,000 square-foot Ambulatory Care Center, home to Centers of Excellence in Diabetes, Cardiovascular Medicine, Orthopedics and Cancer, which opened in 2010; and the 500,000 square foot Albert Sherman Center, which opened in 2013 and houses state of the art facilities for medical education, including homes for the learning communities; the standardized patient program; dedicated seminar and conference space; and six floors of wet and dry laboratory space for new research initiatives in population health, RNA biology, gene therapy and neurodegenerative disease.

Growth at UMass Chan Medical School continues with the construction of the New Education and Research Building, a 350,000-square-foot structure that will complete the west face of the Campus Green. It will be a LEED Gold building with aspirations to a net zero energy use. Slated to open in late 2023, initial plans call for the co-location of the Horae Gene Therapy Center, the Departments of Neurology and Neurobiology, the Molecular Medicine and the new Program in Human Genetics & Evolutionary Biology. In addition, UMass Chan Medical School is proud to partner with the Veteran's Association Central Western Massachusetts Healthcare System to operate a new, LEED silver certified community-based outpatient clinic (CBOC) for veterans that opened in 2021 on the UMass Chan Medical School campus. The CBOC occupies 53,000 square feet on the first two levels of a new, four-story clinical building, which totals over 100,000 square feet. Michael F. Collins, MD, Chancellor of UMass Chan Medical School and senior vice president for the health sciences, noted, "As the commonwealth's first and only public medical school, for years we have felt a particular urgency to step forward as a willing and innovative partner with the VA to reduce wait times and improve access to primary and specialty health care for veterans in our community. We recognize the privilege of caring for those who serve our nation and look forward to discussing how we can enhance learning and research opportunities in the future that will benefit veterans and our faculty, medical and nursing students, and researchers alike."

Statement of Non-Discrimination

See https://www.umassmed.edu/dio/about/equal-employment-opportunity-statement/

UMass Chan Medical School does not discriminate on the basis of race, color, creed, religion, gender (including pregnancy, childbirth, or related medical conditions), age, sexual orientation, gender identity and expression, genetic information, national origin, covered

veteran status, disability, ancestry or any other characteristic protected by law in employment, admissions, participation in its programs, services and activities, and selection of vendors who provide services or products to UMass Chan Medical School. Further, UMass Chan Medical School is firmly committed to ensuring that all who work, study, visit or seek treatment here may do so in an environment free of harassment and/or discrimination. Further information is available at https://www.umassmed.edu/dio/about/equal-employment-opportunity-statement/.

Questions may be directed to the Diversity and Inclusion Office:

University of Massachusetts Chan Medical School
55 Lake Avenue North (S1-710)
Worcester, MA 01655
Diversity and Inclusion Office Phone: 508 856-2179
Diversity and Inclusion Office Fax: 508 856-1810

Campus Life

Advising & Support

Academic Advisors

First year Morningside Graduate School of Biomedical Science students are assigned a general faculty advisor who assists the student in their integration into the UMass Chan Medical School and Morningside Graduate School of Biomedical Sciences community.

First year students are advised on selection of research mentors and curriculum choices by their faculty advisors, the Morningside Graduate School of Biomedical Science Dean, and the Morningside Graduate School of Biomedical Science Associate Dean for Academic Affairs. Research mentors also advise students on curricular choices. Morningside Graduate School of Biomedical Science Teaching Assistants are also available to mentor students in the Basic Biomedical Sciences division through their curriculum.

Second year students are advised by their Thesis Advisor(s), by their Morningside Graduate School of Biomedical Science Program Director and by the Morningside Graduate School of Biomedical Science Associate Dean for Academic Affairs. Second year students are mentored through the qualifying examination process by their Qualifying Examination Committee.

Third year students and beyond are mentored through their thesis research by their Thesis Research Advisory Committee and by their Thesis Research Advisor.

Career Advisors

The Center for Biomedical Career Development http://www.umassmed.edu/gsbs/career/

takes an interdisciplinary, scholarly approach to develop, implement, and evaluate new career and professional development resources that support the training experience of Ph.D. students and postdoctoral scholars in the Morningside Graduate School of Biomedical Sciences.

The Center for Academic Achievement

The goal of the Center for Academic Achievement is to help all learners in the T.H. Chan School of Medicine, Tan Chingfen Graduate School of Nursing, Morningside Graduate School of Biomedical Sciences, and Graduate Medical Education achieve the most comprehensive and meaningful educational experience possible. We encourage you to access the resources of the Center for Academic Achievement.

The CAA is made up of the Center for Academic Achievement as well as Academic

Enrichment Programs that work together to provide comprehensive services to students, residents, and fellows. Students seen for academic enrichment may be encouraged to receive clinical enrichment services and vice versa. For more information visit https://www.umassmed.edu/oea/center-for-academic-achievement/

Campus

Situated on Lake Quinsigamond in Worcester, the UMass Chan Medical School campus comprises the Aaron Lazare Medical Research Building and the complex that houses the T.H. Chan School of Medicine, Morningside Graduate School of Biomedical Sciences, Tan Chingfen Graduate School of Nursing and the University Campus of UMass Chan Medical School's clinical partner, UMass Memorial Health. The Ambulatory Care Center (ACC) houses the orthopedics, radiology and Cancer Center patient services, as well as the Heart and Vascular Center of Excellence and the Diabetes and Endocrinology Center of Excellence. The Albert Sherman Center houses the T.H. Chan School of Medicine and Tan Chingfen Graduate School of Nursing Learning Communities, approximately 400,000 sq. feet of research space and the Health and Fitness Center.

UMass Chan Medical School's extended campus includes the Massachusetts Biotechnology Research Park in Worcester, sites in Shrewsbury and Auburn, and the Massachusetts Biologic Laboratories in Jamaica Plain and Mattapan.

A campus map is available at https://www.umassmed.edu/about/directions/campusmap/

Campus Parking

The campus offers ample parking for employees, students and visitors. Students are offered discounted parking rates. For more information see https://www.umassmed.edu/parking/contact-us/

Campus Safety

The University of Massachusetts Police Department in Worcester is committed to provide a safe and secure environment in which students, faculty, staff, patients and visitors can conduct their activities. The Department uses a community-oriented philosophy, and our Officers patrol the University and adjacent roads 24 hours a day, seven days per week in cruisers, on foot and on bikes.

All Police Officers are sworn under Massachusetts General Law Chapter 75. Section 32A, have the same law enforcement authority as Municipal Police, and are trained at Municipal

Police Academies. For more details see https://www.umassmed.edu/publicsafety/

Clery Act

The Annual Report on Campus Security can be viewed at https://www.umassmed.edu/globalassets/public-safety/annual-security-report.pdf

Childcare & Parenting Resources

UMass Chan Medical School sponsors a Child Care Center, Bright Horizons Family Solutions, which provides care for infants, toddlers and preschool children in a safe, nurturing environment that promotes physical, social, emotional and cognitive development. Bright Horizons Family Solutions is located in the Shaw Building on 419 Belmont Street in Worcester. For more information, contact Lori Carroll, Center Director, UMass University Campus, Child Care Center at Lori.carroll@brighthorizons.com or 774-455-KIDS or Alison Smith, Office Manager, at Umass.university@brighthorizons.com.

The Employee Assistance Program can advise students on personalized childcare referral for their families. See https://www.umassmed.edu/eap/employee-and-family/work-and-life/child-care/

Dining

The cafeteria and dining room are located on the first floor of the Albert Sherman Center. In addition, a cafeteria is located on the first floor of the main UMass Memorial Medical Center–University Campus building, which is contiguous with the School building. For more details see https://www.nexdine.com/sherman

Housing

Students of the Morningside Graduate School of Biomedical Sciences reside in the local community or commute, as housing facilities are not available on campus. Bus transportation to the campus is available via Worcester Regional Transit Authority routes. Those who wish to park on campus are required to register with the Office of Public Safety and pay an annual parking fee. For more information visit https://www.umassmed.edu/parking/contact-us/

Information Technology

The Information Technology (IT) department at the University of Massachusetts Chan Medical School is composed of six main sub-departments – Academic Technology, Data

Sciences & Technology, Customer Services, Engineering, Infrastructure Services and IT Security. Although each of the sub-departments have their own projects and focuses, they all work together in order to accomplish the ultimate goal of serving the UMass Chan Medical School community in the most proficient, efficient and innovative way. For more information visit https://www.umassmed.edu/it/

Lamar Soutter Library

The Lamar Soutter Library (LSL) is a cornerstone of the University of Massachusetts Chan Medical School and University of Massachusetts Memorial Health systems. The library is an essential partner exercising creative leadership to provide equitable service to all in teaching, learning, and accessing information in support of education, research, and healthcare.

Librarians and other library staff provide multiple opportunities to help students, faculty, researchers, and administrative staff succeed in their endeavors, including assistance with search strategies and/or systematic reviews, managing information resources, establishing and maintaining a research profile, disseminating and tracking research outcomes, publishing, author's rights, and copyright issues, scientific writing, open science tools, data management, and ensuring research reproducibility. Additionally, librarians sit on the IRB, IACUC, Council for Scientific and Research Affairs, and other committees throughout campus.

The LSL subscribes to more than 5,000 electronic journals, 6,000 electronic books, and more than 125 electronic indexes, abstracts, bibliographic and full text databases including Scopus, SciVal, SciFinder, MEDLINE, MDConsult, UpToDate, Micromedex, and Harrison's Online. Interlibrary loan is also available, free of charge, to students. The LSL hosts and maintains eScholarship@UMassChan, our institutional repository that collects and showcases the scholarly output of the University, as well as publishes multiple journals and texts. The library's membership in the Boston Library Consortium and the Academic and Research Collaborative of the Central Massachusetts Regional Library System expands student access to academic and medical libraries throughout the state.

The Lamar Soutter Library serves as the Regional Medical Library (RML) for Region 7 of the National Network of Library of Medicine (NNLM), National Library of Medicine, National Institutes of Health. The RML provides programs, services, and dedicated support for NNLM Members in Connecticut, Massachusetts, Maine, New Hampshire, New York, Rhode Island, and Vermont. The Region 7 is also home to the NNLM Public Health Coordination Office, a national program providing access to electronic journals and other resources to public health departments across the country. For more details see

https://library.umassmed.edu/

Medical Services

The Student Health Service (SHS) seeks to preserve and enhance students' well-being at UMass Chan Medical School by providing programs that effectively respond to students' health care needs. Students are required to undergo a pre-matriculation health history and medical examination. The form to document this process is available through the SHS and must be completed by students' health care providers prior to registration, effectively putting the SHS on notice of students' pre-existing health conditions for which they may require ongoing medical care.

The Student Health Plan (SHP) is the administrative entity funded by the student health fee, providing routine primary health care coverage to students under the direction of physicians or nurse practitioners. With an additional fee, students may elect to have their immediate family members (i.e. spouse, children) covered under the SHP. Students are covered by the SHP during their period of enrollment, from registration though August 31 of the following school year. A brochure describing the plan and its services is available through the Student Health Service.

The University requires all students to carry supplemental insurance to cover specialty consultations, diagnostic evaluations and inpatient services. Such a policy may be provided by the student's guardians (up to and including age 26), by the Morningside Graduate School of Biomedical Sciences (year 1 of graduate study) or by the student's thesis research advisor (years 2 of doctoral study and beyond).

For further details please see https://www.umassmed.edu/studenthealth/

Student Services

The Office of Student Life is on the first floor of the main school building. The goal of the Office of Student Life is to facilitate optimal learning in a collaborative environment by helping students to reach their goals and thrive. Assistance is available in the areas of academic success, health promotion, financial wellness. Opportunities for community engagement and on-campus student activities are also found in this site https://www.umassmed.edu/studentlife

Diversity and Inclusion

The Diversity and Inclusion Office (DIO) is the primary vehicle for guiding the diversity, equity, and inclusion efforts of the academic health sciences center. The DIO team joins with

faculty, administrative, clinical and support staff, residents, postdocs, and students in achieving a high performing, inclusive academic learning community. Through the DIO, resources and services are available that creates an organizational culture that maximizes the potential for diversity to achieve our vision of being one of the nation's most distinguished academic health science centers. The DIO coordinates diversity and inclusion programming and provides oversight of compliance for equal opportunity plans. We embrace diversity in its many dimensions and strive to create an organizational structure that meets the needs of every individual who makes up our community. See https://www.umassmed.edu/dio/

Americans with Disabilities Act

As part of our commitment to diversity, UMass Chan Medical School seeks to attract and educate students and trainees who will make the population of health care professionals representative of the national population. We are, therefore, committed to the full and meaningful inclusion of qualified students, trainees, and employees with disabilities.

The University of Massachusetts Chan Medical School through the Office of Management is firmly committed to providing full access to individuals with disabilities. UMass Chan Medical School intends to fully comply with the Americans with Disabilities Act (ADA) of 1990 as amended 2008, Diversity and Equal Opportunity Office guidelines, and Human Resources policies. Policies and procedures are in place to ensure that disabled applicants, students, staff, faculty, visitors, volunteers, and vendors do not experience discrimination in any way.

According to The Americans with Disabilities Act Amendments Act ("ADA" – 42 USCA 1211 and following), an "individual with a disability" is defined as a person who has a physical or mental impairment that substantially limits one or more major life activities, a person who has a history or record of such an impairment, or a person who is perceived by others as having such an impairment. The ADA does not name all "impairments" that are covered under the Act. UMass Chan Medical School intends to fully comply with the ADA as well as all other applicable federal and state laws, codes and regulations, including but not limited to Massachusetts General Laws, Chapter 151C.

The Accommodations Services Director serves as the ADA Student Coordinator. Once admitted, the student is responsible for notifying the Student ADA Coordinator of his/her disability, requesting academic accommodations in writing and providing appropriate documentation of the disability. A student may request accommodations at any time during matriculation. However, accommodations cannot be applied retrospectively. Therefore, any

student requiring academic accommodations is best served by seeking such accommodations prospectively. All requests for accommodations are reviewed and acted on by the Academic Accommodations Committee. It is always the student's choice whether or not to accept any recommended accommodation. Confidentiality is a strict practice of the Academic Accommodations Committee. Accommodation under ADA will not be in conflict with the fundamental nature of the academic programs of UMass Chan Medical School. For further details please see https://www.umassmed.edu/ADA

Appropriate Treatment of Learners

UMass Chan Medical School is committed to providing a supportive and respectful learning environment that fosters mutual trust and understanding between learners and members of the educational community. Accordingly, UMass Chan Medical School has developed this Appropriate Treatment of Learners ("ATL") policy to address concerns regarding the inappropriate treatment of learners by any member of the educational community.

To the extent possible, it is the policy of UMass Chan Medical School to provide a learning environment that fosters mutual trust and understanding between teachers and students. When all participants in the educational process at UMass Chan Medical School understand and uphold the standards of appropriate treatment of students, the environment enhances teaching, learning and professional development, to the benefit of all.

The purpose of this complaint policy is to provide an avenue for prompt follow-up on allegations of inappropriate treatment, and to do so in a non-adversarial and respectful manner that satisfies all parties involved. Should investigation of a complaint be warranted, UMass Chan Medical School is committed to conducting it thoroughly, promptly, and impartially.

This policy is designed for any student who believes s/he has been subjected to inappropriate treatment under the standards defined for this campus. These standards, which adhere to AAMC guidelines and LCME accreditation requirements, apply to the T.H. Chan School of Medicine, Morningside Graduate School of Biomedical Sciences, Tan Chingfen Graduate School of Nursing, Graduate Medical Education, and to any UMass Chan Medical School hereinafter established. See https://www.umassmed.edu/studentaffairs/policies/appropriate-treatment-of-learners/

Student Counseling Service

The goal of Student Counseling Service (SCS) is to provide counseling, psychotherapy, assistance with stress management, and educational programs on emotional well-being for students. Students may receive individual or couples' therapy. The SCS maintains strict

standards of privacy and confidentiality. The service cost is covered by the Student Health Plan fee. See https://www.umassmed.edu/psychiatry/clinicalservices/studentcounseling/

Financial Aid

The Financial Aid Office at the University of Massachusetts Chan Medical School is part of the division of School Services and administers Federal and Institutional student loans and gift aid for the T.H. Chan Medical School, the Morningside Graduate School of Biomedical Sciences and the Tan Chingfen Graduate School of Nursing. Additionally, the Financial Aid Office collects campus-based loans and the Medical School Learning Contract. To be eligible for financial assistance, students must be accepted for admission or enrolled in good standing and making satisfactory academic progress. See https://www.umassmed.edu/financialaid/

Registrar

The Registrar's Office at the University of Massachusetts Chan Medical School maintains all official academic records for enrolled and former students of the T.H. Chan School of Medicine, Morningside Graduate School of Biomedical Sciences and Tan Chingfen Graduate School of Nursing. The office is responsible for all enrollment statistics, registrations, verification of attendance, management of all student records and issuance of official transcripts.

Services for current students include certification of student status for USMLE Steps 1 and 2 examinations, veteran educational benefits, loan deferments and graduation requirements. Services for alumni may include verification of graduation, documentation for licensure and diploma verification. For more details see https://www.umassmed.edu/registrar/

Student Government

The Graduate Student Body Council (GSBC) is a group of elected students who serve as the voice of graduate students on campus. By serving on committees with faculty, we represent student interests and help in decision-making. An important goal of the GSBC is to keep graduate students informed about new policies regarding their thesis work. The GSBC gains insight from students about changes they would like to see happen at UMass Chan Medical School and work hard to implement these changes. One of their major goals is to further relationships between graduate students on campus, in addition to interprofessional relationships with both the medical and nursing students. The GSBC encourages fellow colleagues in their studies, hosting events for first year students during their core coursework. GSBC offers social events throughout the year to foster friendships and support

groups and hold local volunteer activities such as Working for Worcester and Habitat for Humanity. GSBC also partner with the Career and Professional Development group and host events for students that help prepare them for their career path of interest.

For more information, see https://www.umassmed.edu/studentlife/student-government/gsbs-student-body-committee/

Graduate Education

Admissions

Requirements for Admission

Each candidate for admission to the Morningside Graduate School of Biomedical Sciences is required to have a bachelor's degree in one of the physical or biological sciences. Senior undergraduates may be admitted pending successful completion of their baccalaureate programs; proof of completion will be required prior to matriculation. While no minimum grade point average is required, students applying for admission should have demonstrated strong performance in their undergraduate studies, particularly in their scientific coursework. The GRE is neither required nor considered. Applications are reviewed holistically.

Recommended prerequisites for admission into the BBS Umbrella programs and BBS track of the PREP program

- Introduction to Biology I and II with labs
- General Chemistry I and II with labs
- Organic Chemistry I and II with labs
- General Physics I and II with labs
- Biochemistry I
- One semester of Math, including Calculus or Statistics
- Advanced Biology such as Genetics or Immunology

Recommended prerequisites for admission into the Population Health Sciences program and the CPHR track of the PREP

Applicants to the PhD Program in Population Health Sciences are expected to have received a master's degree in Public Health, Clinical Research, or in one of the social, psychological, physical or biological sciences, and to have completed adequate introductory coursework in biostatistics and epidemiology. Strong applicants may be admitted conditionally prior to completing such coursework. Additional admission information can be found at https://www.umassmed.edu/gsbs/academics/phd-biomedical-sciences/clinical-and-population-health-research/

Recommended prerequisites for admission into the MSCI

Applicants must be a UMass Chan-affiliated MD, DO, DVM, DNP, PharmD, or PhD or MD

student. U.S. citizens, U.S. permanent residents and international visa holders are eligible to apply. Additional admission information can be found at https://www.umassmed.edu/gsbs/admissions/overview/MSCI-requirements/.

Application Process

All admissions take place through an admission process in which successful applicants are admitted to the Morningside Graduate School of Biomedical Sciences. Evaluation of applicants is undertaken by the appropriate Graduate Admissions Committee (Umbrella Admissions, POPULATION HEALTH SCIENCES , MSCI, MD/PhD or PREP admissions). Applicants accepted as graduate students will receive official notification from the Dean. No other statements, verbal or in writing, will constitute acceptance into the Morningside Graduate School of Biomedical Sciences.

Specific application materials include:

Completed application for admission. Applicants should use the online application, which can be accessed at https://www.umassmed.edu/gsbs/admissions/overview/

- Official transcripts from all undergraduate and graduate institutions attended.
- Three letters of recommendation from individuals who are able to assess the applicant's past academic performance and prospective success in graduate-level work. Recommenders are required to use the online recommendation form contained within the online application.

The application fee is currently $80.

Please Note: Applications cannot be considered until all of these materials have been received. The deadline for receipt of completed applications to the Basic & Biomedical Sciences Division is December 1. The deadline for applications to the Program in Population Health Sciences is March 1, with applications received by January 1 given priority. PREP applications are due February 28. Decisions will be made no later than April 15 for fall admission. The deadline for applications to the Master of Science in Clinical Investigation and the Millennium PhD Programs is June 1. Decisions for these programs will be made no later than July 15 for fall admission.

Transfer Students

The Morningside Graduate School of Biomedical Sciences does not accept transfer students who have been admitted into doctoral candidacy at other institutions. If such a student accompanies a newly recruited faculty member to UMass Chan Medical School, they must retain their matriculation status with their originating institution.

Pre-candidacy first and second year doctoral students matriculated elsewhere may petition the Morningside Graduate School of Biomedical Sciences for admission by submitting an application to the Morningside Graduate School of Biomedical Sciences in the usual way (see above). Admission is not guaranteed and students matriculating by this route may be required to take all mandatory Morningside Graduate School of Biomedical Sciences courses in order to be eligible to take their qualifying examination.

Costs

Tuition and fees[*]	$0
Estimated room and board	$17125
Miscellaneous	$12024
Books and supplies	$519
Loan fees	$102
Transportation	$4084
Total Budget for Financial Aid	$33854

[*] tuition and fees are not paid by the student.

Tuition and Fees

BBS, MMPP, CPHR, MSCI, MD/PhD (GSBS years)[^]

Tuition[*]	
In State[**]	$15,856
Out of State[***]	$34,826
Continuing Registration Fee (Per Term)[****]	$108
Health/Counseling Fee	$926
Student Services Fee	$208
Health Insurance (waivable) (charged in fall term)	
14-month, 7/1/2023-8/31/2024 (year 1 July-start)	$6,092
13-month, 8/1/2023-8/31/2024 (year 1 Aug-start)	$5,657
12-month, 9/1/2023-8/31/2024 (returning)	$5,222
Late Registration Fee (per term, if registering late)	$104
Late Payment Fee (per term, if registering late)	$104
Commencement Fee (once, in graduating term)	$272

[^] For students in these Programs, tuition (net amount) and all fees are paid by Morningside Graduate School of Biomedical Sciences or student's PI, except for Late Fees and Commencement Fee that students pay out-of-pocket.

[*] Students receiving VA educational benefits are charged Tuition at In-State rate.

[**] $11,540 to be credited against Tuition, net amount remaining $4,316.

[***] $30,510 to be credited against Tuition, net amount remaining $4,316.

[****] Charged in lieu of Tuition after completing nine (9) semesters for BBS, MMPP, CPHR and after completing six (6) semesters for MD/PhD.

PREP[^]

PREP Course Fee (per unit per term)	$118
Health/Counseling Fee	$926
Student Services Fee	$208
Health Insurance (waivable) (charged in fall term)	
14-month, 7/1/2023-8/31/2024 (year 1 July-start)	$6,092
13-month, 8/1/2023-8/31/2024 (year 1 Aug-start)	$5,657
12-month, 9/1/2023-8/31/2024 (returning)	$5,222
Late Registration Fee (per term, if registering late)	$104
Late Payment Fee (per term, if registering late)	$104

Please refer to our website for more information.

[^] For students in this Program, all fees are paid by GSBS Office except for Late Fees that students pay out-of-pocket.

Academic Standards

Core Competencies

The Morningside Graduate School of Biomedical Sciences has concluded that 4 competencies are central to successful doctoral training. These competencies describe the knowledge, skills and attitudes students will develop through our curriculum and research training programs. Proficiency in these competencies and their related objectives is assessed in individual required courses for each academic program, Qualifying Exams, thesis-mentor Research Evaluations, annual TRAC meetings, and at the Dissertation Defense. Graduating students will have acquired mastery in all the following competencies.

Academic Standards Committee
Members:
Dan McCollum, Catherine Dube, Milena Bogunovic, Heidi Tissenbaum, Michael Volkert, Haley Melikian, Daryl Bosco (Chair)

1. Knowledge-based problem-solving ability and critical thinking: identify important biomedical and/or population health problems and conduct original research.

Demonstrate knowledge mastery; integrate information from prior research experiences and the literature to identify novel, unanswered biomedical and/or population health questions as the basis for one's original thesis research project.
Design a research strategy, including appropriate quantitative, analytical, qualitative, or theoretical methodologies, to explore components of the problem and begin to address the question.
Independently analyze, assess, and critically evaluate one's own scientific work and the work of others to determine research directions.
Demonstrate mastery and appropriate application of a range of research approaches and techniques used in their field.
Generate original research outcomes that meet dissertation standards.
Demonstrate the ability to conduct and lead research efforts in a productive and efficient manner.

2. Communication: successfully engage in written and oral scientific discourse

Describe scientific information accurately; articulate the outcomes, progress, limitations and challenges of one's own scientific work.

Compose and deliver accurate, organized oral and written communications of scientific ideas, analyses, and arguments.

Articulate the background, significance and impact of one's research and place it in the context of their field as well as more broadly in the context of scientific advancement.

Demonstrate the ability to respond to and address scientific inquiries and constructive criticisms from others, including from colleagues, peers and members of the scientific community.

Exhibit proficiency for listening to and considering others' views, including views from diverse backgrounds and/or that may appear different from their own.

3. Responsible Conduct of Research: students comprehend and apply ethical standards to research and decision-making

Adhere to ethical principles and recognize potential sources of bias applicable to research, free from scientific misconduct.

Demonstrate an understanding of and compliance with appropriate regulations and institutional policies regarding lab biosafety protocols, and protection of animal and/or human subjects.

Adhere to the highest ethical standards related to honesty, integrity, and transparency.

Identify and use appropriate attribution in in both oral and written communications, including but not limited to presentations and publications.

Conduct research with scientific rigor and ensure reproducibility.

4. Professionalism and career advancement: students exhibit professional behavior and attitudes

Demonstrate the ability to work in collaborative and team settings involving colleagues with expertise in other disciplines.

Recognize the value of diverse teams and engage in efforts that support a diverse, equitable and inclusive environment.

Demonstrate professional and organizational skills including time management, setting and meeting deadlines, and project management.

Apply leadership principles including creating a vision, planning strategies to determine and achieve short- and long-term goals, fostering collaboration, empowering others, and guiding decision making.

Seek and leverage mentorship and professional networks to advance one's professional development and career goals.

Mission

The Morningside Graduate School of Biomedical Sciences at the University of Massachusetts Chan Medical School is a faculty-initiated and faculty-organized school with a mission to:

- Engage in leading-edge research that advances our understanding of human biology in health and disease;
- Translate discovery into treatments that transform the practice of medicine;
- Determine the effectiveness and outcomes of primary, secondary and tertiary health interventions on patients and populations; and
- Train the next generation of scientific leaders, teachers and advocates who will continue with this calling.

Technical Standards

Technical standards refer to non-academic proficiencies that are essential for meeting the academic requirements of the Morningside Graduate School of Biomedical Sciences. Students must demonstrate proficiency in intellectual and physical tasks that together represent the fundamentals of biomedical research. Students must possess abilities and skills that allow for observation, intellectual and conceptual reasoning, motor coordination, and communication. Students must meet the prescribed technical standards, with or without accommodations that may be prescribed by the Academic Accommodations Committee. A student's judgment must be based on their own powers of selection and observation, leaving use of a trained intermediary unacceptable in many situations. Service animals, as defined by the Americans with Disabilities Act, are allowed in campus facilities in accordance with federal law and institutional guidelines.

More detailed descriptions of these standards are available in the Morningside Graduate School of Biomedical Sciences Handbook at: https://www.umassmed.edu/globalassets/morningside-graduate-school-of-biomedical-sciences/documents/gsbs-student-handbook.pdf

Family and Health Accommodation

Students can request up to eight weeks of time for the care of a child or other family member or to manage serious medical needs. During this time, the student will remain enrolled as a full-time student with a minimum of nine credits. The student will continue to receive a stipend for up to eight weeks plus any unused academic break days. The advisor or Department paying the stipend remains responsible for the stipend during family and health accommodation time. The timing of family and health accommodation can be consecutive

or nonconsecutive.

After eight weeks, the student will return to full-time student responsibilities or will initiate a Leave of Absence.

Family Accommodation may not be used to extend enrollment in the time periods post-PhD defense or post-transition to the MS completion pathway.

Academic Performance

Satisfactory Academic Progress

Satisfactory Academic Progress status for PhD students is determined at the end of each academic year as described in the table below.

Satisfactory Academic Progress status is conferred at the end of the indicated year when

Year of Study	**Requirements**
Year 1	the student has obtained a thesis advisor commitment for thesis research by June 1
Year 2	the student has passed the Qualifying Exam and is enrolled in Thesis Research
Year 3	the student has successfully completed course requirements and the annual TRAC requirement
Years 4-6	the student has completed the annual TRAC requirement
Years 7 +	No student in this category is making Satisfactory Academic Progress unless so indicated by the TRAC

Review of Academic Standing

All students who fall out of Good Academic Standing or are not making Satisfactory Academic Progress are reviewed by the Academic Standards Committee. Reviews are initiated by the Dean or the Associate Dean for Academic Affairs. Pathway or Program Directors, TRAC Chairs, or research mentors may request that a review be made.

There are two possible outcomes: continue in graduate studies with an approved remediation plan, or withdrawal from the Morningside Graduate School of Biomedical Sciences. The Academic Standards Committee is charged with developing a remediation

plan in collaboration with the Pathway or Program Director, a specific course director, the research advisor and/or the Thesis Research Advisory Committee (TRAC). The remediation plan will contain specific benchmarks and expected times of completion. The Academic Standards Committee will review progress toward remediation and will advise the Dean whether it finds the remediation to have been successful.

Leave of Absence (LOA)

Initiating LOA

Students may request a leave of absence (LOA) for a period of up to one year. All leaves of absence require a meeting with the Dean or Dean's designee. Students may be provided with specific conditions of return set by the Dean, the Thesis Advisor, and/or TRAC.

Types of LOA

There are 2 types of LOA: Personal and Medical.

Personal LOA is a leave for any reason of the student's choice.

Medical LOA requires a letter from a medical professional with appropriate expertise relevant to the diagnosis who (1) prior to Medical LOA being approved, attests that a medical condition prevents the student from being able to participate in their educational training, and (2) prior to approval of return from Medical LOA, attests that the medical condition that warranted a Medical LOA has resolved to a sufficient degree for the student to be able to participate fully in their educational training.

During LOA

During a LOA, the student remains enrolled, but does not receive stipend. The stipend end date is the effective date of the LOA. Enrollment requires that the student show proof of health insurance coverage. The Student Health Insurance plan is available for purchase in the event that the leave of absence extends past the time covered by the annual premium.

Return from LOA

Four weeks prior to return from LOA, a student must indicate in writing to the Dean and the Assistant Dean for Student Affairs their intention to return. A meeting with the Dean or the Dean's designee is also required.

A student may only return from a LOA on the first day of a semester. If the leave of absence was initiated less than six weeks prior to the end of a semester, the LOA must extend

through the following semester. For students taking a continuous, one-year LOA, the return would be the start date of the first semester following the one-year LOA period.

If the student does not return to school at the end of the one-year LOA period, the student will be withdrawn by the Graduate School. A single request for an extension beyond one year may be made via a written communication to the Dean that includes a proposed new enrollment date and justification for the extension.

A Leave of Absence will invalidate visas for international students. Return from LOA will require acquisition of a new visa. International students wishing to take a LOA must coordinate the leave and the return with Immigration Services

Withdrawal and Dismissal from the Morningside Graduate School of Biomedical Sciences

A student may voluntarily withdraw from the Morningside Graduate School of Biomedical Sciences at any time by informing the Dean in writing.

The Dean may request that a student withdraw from the Morningside Graduate School of Biomedical Sciences or may dismiss a student from the Morningside Graduate School of Biomedical Sciences. If a student refuses a formal request for withdrawal, they will be dismissed.

A request for withdrawal or a dismissal can occur for continued unsatisfactory academic performance that is documented by evaluation(s) from the Academic Standards Committee and/or for Honor code violation(s).

Honor Code

All students accepting appointment to the Morningside Graduate School of Biomedical Sciences agree to follow the guidelines of the Honor Code. Procedures for and consequences of violations of the Honor Code are detailed in the policy.

See Morningside Graduate School of Biomedical Sciences Honor Code: https://www.umassmed.edu/globalassets/graduate-school-of-biomedical-sciences/documents/honor-code.pdf

Academic Procedures and Institutional Regulations

Institutional policies for UMass Chan Medical School Morningside Graduate School of Biomedical Sciences students cover the following areas:

- Access, Solicitations, Demonstrations
- Access to UMass Chan Medical School Facilities
- Alcohol Policy
- Alcohol and Drug Abuse (Summary of Legal Sanctions)
- Drug-Free Schools and Community Act Amendments of 1989
- Americans with Disabilities Act
- Academic Accommodations Committee
- Appropriate Treatment of Students
- Clery Act
- Consensual Amorous Relationships (Guidelines For)
- Credit Hour Definitions and Audit Process
- Faculty and Student Notifications
- Morningside Graduate School of Biomedical Sciences Course Credit Hour Assignments
- Credit Hour Audit Process
- Criminal Background Checks (CBC)/ Criminal Offender Records Information Checks (CORI) Checks
- Dress Code
- Electronic Mail Use Guidelines
- Hazing
    - Section 17
    - Section 18
    - Section 19
- Identification of Students
- International Travel under the auspices of the University of Massachusetts Chan Medical School
    - International Travel Registration
    - International Travel Forms and Information
    - International Travel Insurance
- Jury Duty
- Logos, Usage of UMass Chan Medical School Logos
- Patient Rights under HIPAA
- Confidentiality of Patient Information - Related Materials Used in Teaching Breaches

of Protected Patient Information
- Issues of Confidentiality
- Snow and Other Weather Emergencies Notification
- Financial Conflict of Interest Policy
- Faculty and Student Vendor Relations Conflict of Interest Policy

More information can be found here: https://www.umassmed.edu/globalassets/graduate-school-of-biomedical-sciences/documents/institutional-policies-for-umms-gsbs-students.pdf.

Academic Calendar

The Morningside Graduate School of Biomedical Sciences Academic calendars are available at https://www.umassmed.edu/gsbs/academic-student-affairs/resources--forms/calendars/.

The Morningside Graduate School of Biomedical Sciences Events calendar is available at https://umassmed.sharepoint.com/sites/gsbs

Policies & Procedures

The Morningside Graduate School of Biomedical Sciences Operational policies are outlined in the Morningside Graduate School of Biomedical Sciences Handbook. See

https://www.umassmed.edu/globalassets/morningside-graduate-school-of-biomedical-sciences/documents/gsbs-student-handbook.pdf

The Morningside Graduate School of Biomedical Sciences Governance is outlined in the Morningside Graduate School of Biomedical Sciences Bylaws https://www.umassmed.edu/globalassets/morningside-graduate-school-of-biomedical-sciences/documents/bylaws_gsbs.pdf

Privacy of Student Records

This information constitutes your official notification of rights granted to you under the Family Educational Rights and Privacy Act (FERPA). FERPA is a Federal law that is administered by the Family Policy Compliance Office in the U.S. Department of Education. 20 U.S.C. § 1232g; 34 CFR Part 99. FERPA applies to all educational agencies and institutions (e.g. schools) that receive funding under any program administered by the Department of Education.

In compliance with FERPA, the University of Massachusetts Chan Medical School does not disclose personally identifiable information contained in student education records, except as authorized by law. Information about students' rights under FERPA and UMass Chan

Medical School implementation of FERPA is set forth:

https://www.umassmed.edu/registrar/FERPA/FERPA/

Graduation

Degrees are awarded by the University of Massachusetts Chan Medical School in August, December, March and at the annual Commencement Exercises (Sunday following Memorial Day) upon recommendation of the Faculty. Favorable faculty action is based upon approval by the Dissertation Examination Committee and the Morningside Graduate School of Biomedical Sciences Dean.

A degree will not be awarded unless all financial obligations to the Institute are clear and there are no pending disciplinary actions.

More information is available at
https://www.umassmed.edu/universityevents/commencement/

Registration & Course Load

Registration

All Morningside Graduate School of Biomedical Sciences students matriculated in a Morningside Graduate School of Biomedical Sciences degree program are required to register each Morningside Graduate School of Biomedical Sciences semester (Fall, Spring, Summer) until they graduate. To remain eligible for a Tuition Waiver, students are required to register each semester for one of the following Morningside Graduate School of Biomedical Sciences Research Courses: Laboratory Rotation, Pre-Qualifying Research, Thesis Research, or Graduate Research. All students are expected to contribute to the University's academic, teaching and/or research functions as part of these courses. Students are not required to register while withdrawn or on a leave of absence. Failure to register may result in assessment of late fees, termination of stipend and/or withdrawal.

For details regarding the registration process please see:
https://www.umassmed.edu/gsbs/academic-student-affairs/registration/

Course Load

All Morningside Graduate School of Biomedical Sciences students matriculated in a Morningside Graduate School of Biomedical Sciences degree program are considered full-time students. As a general rule, prior to completion of nine semesters of enrollment a student will register for at least nine credits in the fall semester and in the spring semesters

and at least four credits in the summer semester After nine semesters of enrollment, a student registers for Graduate Research – BBS990 or CTS990, unless the student has not yet accumulated 90 credits.

Prior to completion of nine semesters of enrollment, the student must receive permission from the Dean to enroll in less than 9 credits in the fall and spring semesters and 4 credits in the summer semester.

Due to U.S. Department of State regulations, students in the United States on visas must always meet the minimal credit requirements.

To qualify for Financial Aid or a Stafford loan "in school" deferment, a student must be making satisfactory academic progress. Prior to nine semesters of enrollment a student must be registered for at least five credits per semester in the fall and spring semesters and at least two credits in the summer semester. After nine semesters of enrollment a student must be registered for Graduate Research.

Programs of Study

PhD programs

Mission

The Morningside Graduate School of Biomedical Sciences at the University of Massachusetts Chan Medical School is a faculty-initiated and faculty-organized school with a mission to:

- Engage in leading-edge research that advances our understanding of human biology in health and disease
- Translate discovery into treatments that transform the practice of medicine;
- Determine the effectiveness and outcomes of primary, secondary and tertiary health interventions on patients and populations;
- Train the next generation of scientific leaders who will continue with this calling.

The research undertaken by our students and faculty ranges from the study of single, isolated molecules to population genomics and health outcomes. As a result, Morningside Graduate School of Biomedical Sciences faculty interests and student training modalities span the full spectrum of contemporary health sciences.

A great number of our faculty engage in research that extends from the bench to the bedside to the community. This research progression—from molecule to cell to organ system to organism to population and clinical trial—is central to our training philosophy. Morningside Graduate School of Biomedical Sciences students and faculty focus on the biology and/or pathology that define their central question and apply any and all approaches to resolve the problem. This results in a highly collaborative and interdisciplinary training environment that enriches all of our research programs. For more information on admission, please visit https://www.umassmed.edu/gsbs/admissions/overview/

Umbrella Admissions Programs

The objective of the Umbrella Admissions programs is to educate students in the theory and practice of molecular, cellular and organismal biology, with the goal of enabling them to apply this knowledge to the exploration of fundamental and translational biological research. The Umbrella Admissions program is based on the principle that graduates who choose careers in biomedical research and/or teaching are more successful when they obtain a solid foundation in the fundamentals of contemporary biomedical sciences and their application to problem solving.

Research toward the PhD dissertation may be done under the direction of a Morningside

Graduate School of Biomedical Sciences faculty member actively engaged in research in a basic or clinical science department. Students select a thesis advisor and research problem prior to completion of Year 1. At that time, the student and their thesis research advisor will discuss thesis research projects, plan an advanced curriculum of study and select one of the Morningside Graduate School of Biomedical Sciences Umbrella Programs that will be most beneficial to the student's development and research goals. Program selection will require approval by the appropriate Morningside Graduate School of Biomedical Sciences Program director and by the Morningside Graduate School of Biomedical Sciences Dean. The program director recommends and the Dean approves the appointment of the thesis advisor.

Course Requirements

Core Curriculum

This program of study consists of an interdisciplinary core curriculum taken by all BBS students. The core curriculum provides all students with an integral foundation in the sciences basic to human biology and medicine, emphasizing the development of skills required by professional scientists and by gaining proficiency in the stated learning objectives. Each section of the core course will have specific learning objectives based on the content and concepts covered.

Students are also required to take a Professionalism and Research Conduct (PARC) course which reviews ethical considerations in research, scientific writing, professional skills development and the preparation of Individual Development Plans for research, professional skills development and career planning. PARC is normally completed in Year 3. Career pathway workshops are scheduled annually.

Laboratory Rotations

First-year students undertake laboratory research rotations during the fall and spring semesters during specified rotation periods. Each rotation lasts seven to eight weeks, allowing students to take one rotation in the fall and two rotations in the spring. Laboratory rotations are intended to familiarize students with the principles of scientific inquiry and the concepts and techniques of several scientific fields. They allow faculty members to observe and evaluate the research aptitudes of students and permit students to evaluate the types of projects that might be developed into dissertation projects. Upon completion of each rotation, students submit a written abstract or an oral presentation on the research accomplished. By the end of the spring semester, students should have identified a lab for thesis research.

Elective/Specialized Curriculum

All Umbrella Division students must undertake at least 1 Keystone Elective Course (3 credit hours) and 2 additional Elective Courses (2 credit hours or more). Typically, two of these courses are taken in the spring of Year 1 and coursework is completed in the fall or spring of Year 2. Some programs have additional course requirements.

Qualifying Exam

In Year 2, students will undertake the Qualifying Examination (QE) in which they develop a written research proposal (typically, but not always on their proposed thesis research) and then defend their research proposal before a Qualifying Examination Committee comprising Morningside Graduate School of Biomedical Sciences faculty selected by the student's Program Director and by the Morningside Graduate School of Biomedical Sciences Dean. The QE evaluates the student's development in 4 areas:

- Background knowledge
- Formulation of hypotheses, discovery goals and aims
- Experimental approach
- Document preparation and oral communication

Upon passing the QE, the student is admitted into doctoral candidacy and focuses on their doctoral research.

Prequalifying Research, Thesis Research and Graduate Research

Year 2 students register for and undertake prequalifying research in all semesters preceding and including the semester in which the QE is taken and passed. Thereafter, the student registers for Thesis Research. Students who have earned 90 credits, typically year 4 students and beyond, register for Graduate Research.

Annual Thesis Research Advisory Committee Meetings

Each student's research progress is evaluated at least once per academic year by a Thesis Research Advisory Committee. which is approved by the Dean, taking into account the recommendations of the thesis advisor and the program director. This committee consists of the advisor and three other faculty members.

Dissertation Examination

The dissertation examination in the program is a defense of the completed dissertation. Candidates for the PhD degree present a public seminar on the dissertation project and defend the dissertation before the thesis Dissertation Examination Committee, which consists of four Morningside Graduate School of Biomedical Sciences faculty and one external member who is an expert in the field and a member of a PhD-conferring academic institution. This committee is recommended by the thesis advisor and the program director

and is approved by the Dean.

Passing of the final examination, satisfactory completion of all program requirements, and submission of the approved dissertation to the Dean result in the award of a PhD degree.

Summary of Umbrella Admissions Program Requirements

The following requirements, including the interdisciplinary courses described below, apply to all Umbrella Admissions Program students. Specific requirements for specialization are detailed in Graduate Programs, Courses and Faculty Research Interests, beginning on page 44. Graduate Program Directors are responsible for overseeing these aspects of their programs.

First Year Students

All first-year students must complete:

- Scientific Inquiry in Biomedical Research (SIBR)
- Three laboratory rotations
- At least one elective course of 2 or more credits

Year 1 Credits: 30

Specialization - Year 2

- Elective courses to be selected within guidelines set by the program of specialization. All students must take at least three elective courses of 2 or more credits.
- Prequalifying Research

Qualifying Examination - Year 2

- Presentation and defense of an original research proposal

Year 2 Credits: 30

Total credits: 60

Year 3

- Professionalism and Research Conduct (1 credit)
- Thesis Research
- Thesis Research Advisory Committee meetings

All Year 3 students and beyond must hold annual fall Thesis Research Advisory Committee meetings in which they present and discuss their research progress and individual development plans for their research advancement, professional skills development and career planning.

Year 3 Credits: 31

Total credits: 91

Year 4 and beyond

- Graduate Research
- Thesis Research Advisory Committee meetings

Final Examination

- Presentation and defense of the research dissertation

Programs of Study

PhD programs

Mission

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The research undertaken by our students and faculty ranges from the study of single, isolated molecules to population genomics and health outcomes. As a result, Morningside Graduate School of Biomedical Sciences faculty interests and student training modalities span the full spectrum of contemporary health sciences.

A great number of our faculty engage in research that extends from the bench to the bedside to the community. This research progression—from molecule to cell to organ system to organism to population and clinical trial—is central to our training philosophy. Morningside Graduate School of Biomedical Sciences students and faculty focus on the biology and/or pathology that define their central question and apply any and all approaches to resolve the problem. This results in a highly collaborative and interdisciplinary training environment that enriches all of our research programs. For more information on admission, please visit https://www.umassmed.edu/gsbs/admissions/overview/

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The objective of the Umbrella Admissions programs is to educate students in the theory and practice of molecular, cellular and organismal biology, with the goal of enabling them to apply this knowledge to the exploration of fundamental and translational biological research. The Umbrella Admissions program is based on the principle that graduates who choose careers in biomedical research and/or teaching are more successful when they obtain a solid foundation in the fundamentals of contemporary biomedical sciences and their application to problem solving.

Research toward the PhD dissertation may be done under the direction of a Morningside

Graduate School of Biomedical Sciences faculty member actively engaged in research in a basic or clinical science department. Students select a thesis advisor and research problem prior to completion of Year 1. At that time, the student and their thesis research advisor will discuss thesis research projects, plan an advanced curriculum of study and select one of the Morningside Graduate School of Biomedical Sciences Umbrella Admissions Programs that will be most beneficial to the student's development and research goals. Program selection will require approval by the appropriate Morningside Graduate School of Biomedical Sciences Program director and by the Morningside Graduate School of Biomedical Sciences Dean. The program director recommends and the Dean approves the appointment of the thesis advisor.

Course Requirements

Core Curriculum

This program of study consists of an interdisciplinary core curriculum taken by all students and a specialization and research phase selected by the individual student. The core curriculum provides all students with an integral foundation in the sciences basic to human biology and medicine, emphasizing contemporary topics in molecular biophysics/biochemistry, molecular genetics, and cellular architecture and regulation. A scientific proposal writing course is also part of the core curriculum. Students should complete these core requirements in their first year, but no later than two years after admission.

Students are also required to take a Professionalism and Research Conduct (PARC) course which reviews ethical considerations in research, scientific writing, professional skills development and the preparation of Individual Development Plans for research, professional skills development and career planning. PARC is normally completed in Year 3. Career pathway workshops are scheduled annually.

Laboratory Rotations

First-year students undertake laboratory research rotations during the fall and spring semesters. Each rotation lasts eight to nine weeks, allowing students to take two rotations in the fall and two in the spring. Laboratory rotations are intended to familiarize students with the principles of scientific inquiry and the concepts and techniques of several scientific fields. They allow faculty members to observe and evaluate the research aptitudes of students and permit students to evaluate the types of projects that might be developed into dissertation projects. Upon completion of each rotation, students submit a written abstract or an oral presentation on the research accomplished. By the end of the spring semester, students should have identified a lab for thesis research.

Advanced/Specialized Curriculum

All Umbrella Admissions students must undertake at least 1 Keystone Advanced Course (3 credit hours) and 2 Elective courses (2 credit hours or more). Typically, two of these courses are taken in the spring of Year 1 and coursework is completed in the fall or spring of Year 2. Some programs have additional course requirements.

Qualifying Exam

In Year 2, students will undertake the Qualifying Examination (QE) in which they develop a written research proposal (typically, but not always on their proposed thesis research) and then defend their research proposal before a Qualifying Examination Committee comprising Morningside Graduate School of Biomedical Sciences faculty selected by the student's Program Director and by the Morningside Graduate School of Biomedical Sciences Dean. The QE evaluates the students development in 4 areas:

- Background knowledge
- Formulation of hypotheses, discovery goals and aims
- Experimental approach
- Document preparation and oral communication

Upon passing the QE, the student is admitted into doctoral candidacy and focuses on their doctoral research.

Prequalifying Research, Thesis Research and Graduate Research

Year 2 students register for and undertake prequalifying research in all semesters preceding and including the semester in which the QE is taken and passed. Thereafter, the student registers for Thesis Research. Year 4 students and beyond register for Graduate Research.

Periodic Thesis Research Advisory Committee Meetings

Each student must develop a detailed research proposal that must be approved by the student's Thesis Research Advisory Committee, which is approved by the Dean, taking into account the recommendations of the thesis advisor and the program director. This committee consists of the advisor and three other faculty members.

Dissertation Examination

The dissertation examination in the program is a defense of the completed dissertation. Candidates for the PhD degree present a public seminar on the dissertation project and defend the dissertation before the thesis Dissertation Examination Committee, which consists of four Morningside Graduate School of Biomedical Sciences faculty and one external member who is an expert in the field and, normally, a member of a PhD-conferring academic institution. This committee is recommended by the thesis advisor and the program

director, and is approved by the Dean.

Passing of the final examination, satisfactory completion of all program requirements, and submission of the approved dissertation to the Dean result in the award of a PhD degree.

Summary of Umbrella Admissions Program Requirements

The following requirements, including the interdisciplinary courses described below, apply to all Umbrella Admissions Program students. Specific requirements for specialization are detailed in Graduate Programs, Courses and Faculty Research Interests, beginning on page 49. Graduate Program Directors are responsible for overseeing these aspects of their programs.

First Year Students

All first-year students must complete:

- Foundations
- Laboratory rotations (three rotations minimum)
- At least one 2- or 3-credit advanced elective course

Year 1 Credits: 30

Specialization - Year 2

- Advanced and elective courses to be selected within guidelines set by the program of specialization.
- Prequalifying Research
-

Qualifying Examination - Year 2

- Presentation and defense of an original research proposal

Year 2 Credits: 30

Total credits: 60

Year 3

- Professionalism and Research Conduct (1 credit)

Year 3 and beyond

- Thesis Research Advisory Committee meetings

All Year 3 students and beyond must hold annual fall Thesis Research Advisory Committee meetings in which they present and discuss their research progress and individual development plans for their research advancement, professional skills development and

career planning.

Year 3 Credits: 31

Total credits: 91

Final Examination

- Presentation and defense of the research dissertation

Program in Biochemistry & Molecular Biotechnology

The Program in Biochemistry & Molecular Biotechnology offers graduate study and research focused in the areas of molecular, cellular and regulatory biochemistry, molecular biophysics, chemical biology, and structural biology. Students receive a rigorous foundation in modern biomedical science through an integrated program of laboratory research, advanced coursework, and attendance and participation in seminar programs. Students also organize and participate in a weekly informal seminar series in which they present recent research results.

Specific areas addressed within program laboratories include virology, regulation of gene expression and epigenetics, RNA processing and trafficking, protein synthesis and transport, ion channel function, membrane trafficking, signal transduction, structural basis of protein and enzyme function, viral structure and function, computational investigation of protein dynamics, cell cycle control, DNA replication and repair, and neural development and neurodegenerative disease.

Requirements for Specialization

Students in the Biochemistry & Molecular Biotechnology program take 3 elective courses, two of which must be part of the BMP Program Core Curriculum https://www.umassmed.edu/bmp/education/gradprog/courses. The third elective course can be another BMP course or a relevant course offered by other Morningside Graduate School of Biomedical Sciences programs. The plan of coursework is designed to be flexible in order to accommodate each student's needs and areas of interest.

Qualifying Exam

The Qualifying Exam project may be based on the students proposed thesis research or any other topic approved by the student's QE committee. The committee is chosen in consultation with the student's advisor, subject to approval by the Program Director. The student may collaborate with their advisor on the scope and aims of the proposal up until the Abstract Meeting; however, the project should not directly include aims from the advisor's grants. After the Abstract Meeting, the student may seek advice and feedback from

their QE committee, lab mates and other colleagues, but not from their advisor.

Courses in Biochemistry & Molecular Biotechnology:

Chemical Biology

Chemical biology uses the power of chemistry to ask and answer questions of biological significance, typically using molecular tools designed to inhibit, activate, or report on the function of biomolecules. In this class we will cover a wide range of chemical biology topics. We will start with a basic chemistry review, then cover peptide and nucleic acid chemistry and synthesis, post-translational modification of proteins, optical imaging, chemoselective chemistry in water, and approaches to lead discovery for drug development. In the second half of the course, we will cover chemical genetics, orthogonal ligands and receptors, DNA recognition and modification, unnatural amino acids, enzyme inhibitors, rational drug design, nanoparticles, and synthetic biopolymers.

Molecular Biophysics

The goal of this course is to give students a strong foundation in physical principles that underlie the thermodynamic and mechanistic properties of biological macromolecules and macromolecular complexes. In addition to providing theoretical background, lectures and discussion groups will focus on the application of physical chemical principles in contemporary biomedical research. Topics include spectroscopic and computational approaches to studying protein and nucleic acid structures; thermodynamics and kinetics of protein folding; the solution behavior of macromolecules; and principles that govern molecular recognition.

Structural Biology

The goal of this course is to provide students with a theoretical and practical understanding of techniques used to determine the three-dimensional structures of biological macromolecules. The primary methods explored will be X-ray crystallography and Nuclear Magnetic Resonance (NMR), but also including discussions of computational methods and cryo electron microscopy (cryo-EM). Emphasis will be placed on both structural determination and analysis of dynamics, which can be crucial for macromolecular function.

Regulatory RNA Biology

This course covers current research in the general area of RNA biology. Topics include RNA synthesis; modification and processing pathways; RNA structure; RNA transport and subcellular localization; translational regulation; RNAi and microRNAs; RNA decay; RNA aptamers; RNA catalysts; RNA and early evolution; and RNA as a drug and/or drug target. The format of this course will center on group discussion of papers from the primary

literature.

Cellular Biochemistry

Cellular Biochemistry takes an inside-out approach to teaching the molecular biological underpinnings of DNA replication, gene transcription, translation, protein folding, glycosylation, metabolism, secretion, autophagy, membrane structure and transport, and cell signaling.

Seminar in Biochemistry

This course provides students with the opportunity to develop skills in public speaking necessary for scientific presentations. This experience will facilitate both formal and informal presentations of students' individual research. All students that qualify in the BMP program are required to present a seminar annually and are automatically enrolled in the course. Non-BMP graduate students wishing to present in the seminar series should contact the BMP Program Director before enrolling.

Tutorial in Biochemistry & Molecular Biotechnology

Individual instruction on selected topics is arranged by student and instructor.

Faculty:

Program Director

Brian Kelch, PhD (Biochemistry & Molecular Biotechnology) – Structural mechanisms of large macromolecular machines

Professors

Ingolf Bach, PhD (Molecular Medicine) – Neuronal cell fate specification

Jennifer Benanti, PhD (Molecular, Cellular and Cancer Biology) – Mechanisms that control cell growth and proliferation, and in understanding how these pathways are disrupted in cancer cells

Alexei Bogdanov, Jr., PhD (Radiology) – Molecular imaging in cancer models and models of inflammatory vascular disease; development of imaging probes for detecting enzymatic activity in vivo

Daniel Bolon, PhD (Biochemistry & Molecular Biotechnology) – Role of molecular chaperones in biology and disease

Daryl A. Bosco, PhD (Neurology) – Mechanisms of amyotrophic lateral sclerosis; protein misfolding

Lucio Castilla, PhD (Molecular, Cellular and Cancer Biology) – The mechanisms governing

normal blood formation and leukemia development

Daniel R. Caffrey, PhD (Medicine) – The evolution and function of innate immune genes, host-pathogen interactions, and lncRNAs in inflammation

Rigel Chan, PhD (Neurology) – Use in-vitro systems from a population of donor individuals to model human genetic diseases and phenotypes

Michael P. Czech, PhD (Molecular Medicine) – Transmembrane signaling elicited by the insulin receptor tyrosine kinase and its dysfunction in obesity and type 2 diabetes

Roger J. Davis, PhD (Chair, H. Arthur Smith Chair in Cancer Research; Howard Hughes Medical Institute Investigator; Molecular Medicine) – Signal transduction by the epidermal growth factor receptor; mechanisms by which growth factors regulate cellular proliferation

Job Dekker, PhD (Howard Hughes Medical Institute Investigator; Co-Director, Program in Systems Biology) – Spatial organization of genomes

Merk Dershwitz, MD, PhD (Anesthesiology and Perioperative Medicine) – Anesthesia

Raymond Dunn, MD (Surgery) – Plastic surgery methods

Wenwen Fang, PhD (RNA Therapeutics Institute) – Mechanisms of RNA recognition

Thomas G. Fazzio, PhD (Molecular, Cellular and Cancer Biology) – Regulation of chromatin structure and gene expression in pluripotent cells

William Flavahan, PhD (Molecular, Cellular and Cancer Biology) – How defects in chromatin can affect the expression of cancer related genes.

Josue Flores-Kim, PhD (Biochemistry & Molecular Biotechnology) – Defining the regulatory networks that control cell envelope biogenesis in bacteria

Terence R. Flotte, MD (Provost, Dean, T.H. Chan School of Medicine; Celia and Isaac Haidak Professor of Medicine; Pediatrics, Microbiology and Physiological Systems) – Gene therapy for cystic fibrosis, alpha-1 antitrypsin deficiency and other single gene defects

Accalia Mai-Wan Fu, PhD (Molecular Medicine) – Metabolic interplay between pancreatic beta cells and immune cells

Manuel Garber, PhD (Program in Bioinformatics & Integrative Biology; Director, Bioinformatics Core) - The evolution of transcriptional control and non-coding RNAs in mammals through development and analysis of sequence-based molecular biology approaches.

Heinrich Gottlinger, MD PhD (Molecular, Cellular and Cancer Biology) – Assembly mechanisms of infectious HIV-1 virus particles

Matthew Gounis, MD (Radiology) – Neuroendovascular surgery

Michael R. Green, MD, PhD (Lambi and Sarah Adams Chair in Genetic Research; Chair, Molecular, Cell & Cancer Biology; Molecular Medicine) – Eukaryotic gene regulation and cancer molecular biology

Nikolas Grigorieff, PhD (Howard Hughes Medical Institute Investigator, RNA Therapeutics Institute) – Using electron cryo-microscopy (cryo-EM) to investigate molecular architecture in biology

David Grunwald, PhD (RNA Therapeutics Institute) – Evaluation of mRNA trafficking in the nucleus by microscopic methods

Gang Han, PhD (Biochemistry & Molecular Biotechnology) - Synthetic nanomaterials for siRNA delivery and biomolecule imaging.

Gang Han, PhD (Biochemistry & Molecular Biotechnology) – Designing synthetic/semi-synthetic nanomaterials or small molecules with unique programmable physical properties for basic science and biomedical applications.

Cole Haynes, PhD (Molecular, Cell & Cancer Biology) – Mitochondrial dysfunction focusing on a protective stress response known as the mitochondrial UPR.

Lawrence J Hayward, MD, PhD (Neurology) – Ion channelopathies, motor neuron disease, and neuromuscular channelopathies

Fiachra Humpries PhD (Medicine) – How cell metabolism regulates inflammation and infectious disease

Anthony N. Imbalzano (Biochemistry & Molecular Biotechnology) – Chromatin remodeling enzymes in transcriptional regulation of differentiation and oncogenesis

Yicktung Ip, PhD (Molecular Medicine) – How Drosophila intestinal stem cells mediate repair after tissue damage.

Paul Kaufman, PhD (Molecular, Cell & Cancer Biology) – Chromatin Proteins That Regulate Genome Stability

Brian Kelch, PhD, (Biochemistry & Molecular Biotechnology) The structural mechanisms of the macromolecular machines that carry out DNA replication.

Anastasia Khvorova, PhD (Molecular Medicine; RNA Therapeutics Institute) - Develop and characterize novel RNA chemistries to promote efficient oligonucleotide internalization and tissue distribution

William R. Kobertz, PhD (Biochemistry & Molecular Biotechnology) – Structure, function

and modulation of ion channels

Andrei Korostolev, PhD (RNA Therapeutics Institute) – Structure and function of the ribosome.

Nese Kurt Yilmaz, PhD (Biochemistry & Molecular Biotechnology) – Viral structural biology and drug resistance.

David G. Lambright, PhD (Molecular Medicine) – Structural determination of key intermediates in cellular signaling and vesicle trafficking pathways

Hong-Sheng Li, PhD (Neurobiology) – Neuronal regulation of membrane receptor signaling

Elaine Lim, PhD (Molecular, Cell & Cancer Biology) – Understanding the genetic mechanisms of complex neurological diseases through computational and statistical methods and experimental technology development

Shan Lu, PhD (Medicine) – Immunogenicity of protein antigens

Jeremy Luban, MD (Molecular Medicine) – Viral replication, pathogenesis, and immunity

Elisabet C. Mandon, PhD (Biochemistry & Molecular Biotechnology) – Gene therapy

Francesca Massi, PhD (Biochemistry & Molecular Biotechnology) – Protein dynamics, function and stability using NMR and computer simulation

Dannel McCollum, PhD (Biochemistry & Molecular Biotechnology) – Signaling pathways controlling cell growth and division

Haley E. Melikian, PhD (Neurobiology) – Regulation and membrane trafficking of cocaine and antidepressant-sensitive monoamine transporters

Stephen C. Miller, PhD (Biochemistry & Molecular Biotechnology) – Chemical approaches to study and control of cell biology

Amir Mitchell, PhD (Systems Biology) – Untangling host-drug-microbiome interactions: from core principles to emergent properties

James B Munro, PhD (Microbiology and Physiological Systems) – Biophysics of virus-host interactions

Mary Munson, PhD (Biochemistry & Molecular Biotechnology) – Regulation of vesicle targeting and fusion

Athma Pai, PhD (RNA Therapeutics Institute) – The regulation of mRNA expression and processing

Craig L. Peterson, PhD (Vice Chair, Molecular Medicine) – Roles of ATP-dependent

chromatin remodeling enzymes and chromatin in regulation of eukaryotic gene expression

Peter M. Pryciak, PhD (Biochemistry & Molecular Biotechnology) – Function of yeast heterotrimeric G proteins in signal transduction and cell polarity

Oliver Rando, MD, PhD (Biochemistry & Molecular Biotechnology) – Role of chromatin structure in transcriptional control and mechanism of inheritance of chromatin states; role of epigenetically inherited information in evolution, development and disease

Sy Redding, PhD (Biochemistry & Molecular Biotechnology) – Discovering the general physical principles that affect biological outcomes

Nicholas Rhind, PhD (Biochemistry & Molecular Biotechnology) – Studying DNA replication and cell size control in yeast

Joel Richter, PhD (Molecular Medicine) – Fragile X syndrome

Sean Ryder, PhD (Biochemistry & Molecular Biotechnology) – RNA regulation in development and disease regulatory networks, mechanisms of specificity and ribonucleoprotein complex assembly

Celia A. Schiffer, PhD (Biochemistry & Molecular Biotechnology) – How conformational adaptability affects molecular recognition in drug resistant variants of HIV protease using phage display, X-ray crystallography and molecular dynamics calculations

Kuang Shen, PhD (Molecular Medicine) – Cellular nutrient sensing

Jie Song, PhD (Orthopedics) – Synthetic tissue scaffolds assisting the repair and reconstruction of musculoskeletal tissue

Erik J. Sontheimer, PhD (RNA Therapeutics Institute; Molecular Medicine) – The roles of RNA molecules during gene expression

Jessica B. Spinelli, PhD (Molecular Medicine) – How cells sense and adapt to metabolic stress.

Lawrence J. Stern, PhD (Pathology) – Molecular recognition in the immune system

Andrew R Tapper, PhD (Neurobiology) – The neurobiology of addiction and addiction-related behaviors

Paul Thompson, PhD (Biochemistry & Molecular Biotechnology) - Techniques of chemical biology, biochemistry, and enzymology to develop inhibitors/drugs targeting disease associated enzymes as well as developing novel diagnostics for cancer

Jonathan K. Watts, PhD (RNA Therapeutics Institute) – Synthesis of novel nucleic acid-based molecules for basic research and medicine

Summer Thyme, PhD (Biochemistry & Molecular Biotechnology)) – Uncovering the mechanisms of intellectual disability using Zebrafish

Zhiping Weng, PhD (Director, Program in Bioinformatics & Integrative Biology) – To explore and understand biological data through the application and development of computational tools

Scot A. Wolfe, PhD (Molecular, Cell & Cancer Biology) – Protein-DNA recognition; targeted genome modification; transcriptional regulatory networks in metazoans

Zuoshang Xu, MD, PhD (Biochemistry & Molecular Biotechnology) – Structure, transport and function of neuronal cytoskeleton; neurodegenerative disease

Wen Xue, PhD (RNA Therapeutics Institute) – Genetic models of cancer

Phillip D. Zamore, PhD (Gretchen Stone Cook Chair in Biomedical Sciences, Howard Hughes Medical Institute Investigator, RNA Therapeutics Institute) – Control of mRNA stability and translation in development; molecular mechanisms of RNAi (post-transcriptional gene silencing)

Guocai Zhong, PhD (RNA Therapeutics Institute) – RNA switch engineering and regulatable gene therapy development.

Jill A. Zitzewitz, PhD (Radiology) – Folding and assembly of multimeric proteins and peptides using stopped-flow circular dichroism and fluorescence spectroscopies

Program in Bioinformatics & Computational Biology

The Program in Bioinformatics & Computational Biology offers graduate study and research focused on the development and application of computational and mathematical models to biological problems, with an emphasis on the high-throughput genomic and proteomic data increasingly available at single-cell level. Specific topics of research and study include genomics and epigenomics; gene regulatory networks; variations of the genome and comparative genomics; population genetics and molecular evolution; RNA expression and regulation; small silencing RNA biogenesis and function; protein-protein and protein-DNA interactions; structural biology; protein folding and modeling; and biological physics. Students receive a rigorous training in modern bioinformatics and computational biology through integration of guided research, coursework, and participation in seminar programs. The program aims to bridge the gap between wet-lab biologists and computational scientists to their mutual benefit, and prepares students for careers in cutting-edge, highly quantitative biomedical research.

Requirements for Specialization

Laboratory research is of primary importance in the PhD program, and starts with three laboratory rotations in the program's or the affiliated faculty's laboratories.

In addition to the required first-year Foundations course, students will take three Electives courses, two of which must be in Bioinformatics & Computational Biology. Elective advanced courses can be chosen from those offered by the program or other Morningside Graduate School of Biomedical Sciences programs as appropriate. The plan of the coursework is flexible in order to accommodate each student's needs and interests.

Qualifying Exam

Students are eligible to take their qualifying exam upon completion of the Foundations course, laboratory rotations, and two of the required Electives courses. The exam includes an oral presentation and defense of an original research proposal based on the student's potential thesis work or any relevant topic of the student's choosing. A student's plan for rotation projects, coursework, and qualifying exam can be prepared in consultation with the graduate director.

Courses in Bioinformatics & Computational Biology:

Courses in this new program will be added as the program develops. Current offerings include:

Advanced Topics in Bioinformatics

The course covers key topics in modern bioinformatics and computational biology. The course is aimed not only at students specializing in bioinformatics, but also at experimental students who would like to utilize bioinformatics tools in their daily research. The class starts with a primer on probability and statistics. It will then proceed to cover a broad range of machine learning techniques essential to modern bioinformatics, including linear regression, logistic regression, neural networks, random forests, support vector machines, Markov and hidden Markov models, and Bayesian networks. Topics at the intersection of biology and machine learning will also be covered, including genome-wide association studies. The course includes lectures, homework assignments, projects, and a final presentation. Reading and online teaching materials are assigned prior to each lecture. The homework is programming-based and designed to both reinforce concepts discussed in lecture as well as introduce students to working with real biological data. Some experience with programming and statistics is required. All homework and project assignments will be primarily programmed in Python.

An Empirical Introduction to Statistical Modeling

This course covers the most common approaches to modeling high-dimensional data. We begin with a brief introduction to linear algebra and methods that heavily rely on linear algebra—e.g., clustering and dimensionality reduction. We then focus on regression (linear, non-linear, and logistic) models as well as non-linear classification (support vector machines, neural networks) models. The goal is twofold: i) To understand both conceptually and mathematically, how and why the approach works and ii) To be able to apply the technique to a real dataset.

Molecular Evolution

This course will set the mathematical foundations of molecular evolution, explaining how genetic variability emerges and eventually spreads across populations via the mutation, recombination, and selection processes. Both phenomenological-statistical and first-principle biophysical approaches to selection will be considered. The course will introduce modern computational tools to detect and quantify signatures of natural selection in high-throughput genomic and structural data, and discuss specific applications of these tools to dissect evolutionary histories of several species. Patterns of genome duplications and copy number variations will be discussed, as well as their importance for disease resistance.

Faculty:

Program Director

Zhiping Weng, PhD (Professor, Bioinformatics & Integrative Biology; Biochemistry & Molecular Pharmacology) – Dr. Weng develops and applies computational algorithms for analyzing genomic, epigenomic, and transcriptomic data, in particular, high-throughput sequencing data associated with experiments that detect regulatory regions of the genome, nucleosome positioning, genomic locations of histone modifications and histone variants, DNase I hypersensitivity, DNA methylation, small silencing RNAs, and genome sequencing.

Professors

Victor Ambros, PhD (Silverman Chair in Natural Sciences; Molecular Medicine) – Gene regulatory mechanisms controlling the timing of animal development using the C. elegans model system, including microRNAs that control stage-specific expression of key transcription factors; molecular mechanisms of post-transcriptional gene regulation by microRNAs; how microRNAs function in regulatory networks affecting development and disease.

Dan Bolon, PhD (Biochemistry & Molecular Pharmacology) – The role of molecular chaperones in biology and disease.

Robert H. Brown, MD, PhD (Leo P. and Theresa M. LaChance Chair in Medical Research, Neurology) – Identification of gene defects that elucidate the molecular pathogenesis of selected neuromuscular diseases, including amyotrophic lateral sclerosis, muscular dystrophy, adrenoleukodystrophy, hereditary neuropathy, and hyperkalemic periodic paralysis; creation of mouse and cell-based models of these disorders to study therapeutic strategies using conventional small molecule approaches a nd new modalities such as inhibitory RNAi.

Michael Czech, PhD (Molecular Medicine) – Discovery of molecular mechanisms whereby insulin signaling regulates energy homeostasis, including RNAi screens, digital imaging and TIRF microscopy, phenotyping mice with gene knockouts, and analysis of human adipose tissues.

Job Dekker, PhD (Howard Hughes Medical Institute Investigator; Co-Director, Program in Systems Biology; Biochemistry & Molecular Pharmacology) – Spatial organization of genomes.

Manuel Garber, PhD (Program in Bioinformatics & Integrative Biology; Director, Bioinformatics Core) – Transcriptional control of immune responses and how common variants that affect elements that control immune transcription responses impact the onset and progression of autoimmune skin diseases.

Nikolaus Grigorieff, PhD (RNA Therapeutics Institute) – High-resolution electron cryo-microscopy of macromolecular machines to understand their molecular mechanisms and the cellular processes they are involved in.

Andrei Korostolev, PhD (RNA Therapeutics Institute) – Structure and function of the ribosome.

Nathan Lawson, PhD (Molecular, Cell & Cancer Biology) – Modeling vascular development and disease in the zebrafish.

Craig Mello, PhD (Howard Hughes Medical Institute Investigator; Blais University Chair in Molecular Medicine; RNA Therapeutics Institute; Molecular Medicine) – Using the nematode worm C. elegans as a model organism to investigate how embryonic cells differentiate and communicate during development; investigating the mechanism of RNA interference, a form of sequence-specific gene silencing triggered by double-stranded RNA.

Oliver Rando, MD, PhD (Biochemistry & Molecular Pharmacology) – Role of chromatin structure in transcriptional control and mechanism of inheritance of chromatin states; role of epigenetically inherited information in evolution, development and disease.

Nick Rhind, PhD (Biochemistry & Molecular Pharmacology) – Checkpoint regulation in

the fission yeast cell cycle.
Evgeny Rogaev, PhD (Brudnick Neuropsychiatric Research Institute; Psychiatry) – Molecular genetics of neuropsychiatric disease and dementia.

Sean Ryder, PhD (Biochemistry & Molecular Pharmacology) – RNA regulation in development and disease; regulatory networks, mechanism of specificity, and ribonucleoprotein complex assembly.

Celia Schiffer, PhD (Biochemistry & Molecular Pharmacology) – How conformational adaptability affects molecular recognition in drug-resistant variants of HIV protease; tools are phage display, X-ray crystallography, and molecular dynamics calculations.

William Theurkauf, PhD (Molecular Medicine) – Addressing RNA localization and embryonic patterning, the response of mitotic cells to DNA damage and small RNA function in germline development, using high-resolution imaging, genetic, and molecular approaches in Drosophila and mammalian cultured cell systems.

Marian Walhout, PhD (Co-Director, Program in Systems Biology; Molecular Medicine) – Regulatory networks control of animal development, function, and homeostasis, and how dysfunctional networks affect or cause diseases like diabetes, obesity, and cancer; a combination of experimental and computational systems biology methods are used to map, characterize and manipulate regulatory networks, most notably in the nematode C. elegans.

Scot Wolfe, PhD (Molecular, Cell & Cancer Biology) – Creation of improved genome editing technologies to facilitate both efficient and precise editing of vertebrate genomes.

Phillip D. Zamore, PhD (Howard Hughes Medical Institute Investigator; Gretchen Stone Cook Chair of Biomedical Sciences; Chair, RNA Therapeutics Institute) – Control of mRNA stability and translation in development; molecular mechanisms of RNAi (post-transcriptional gene silencing).

Associate Professors

Robert Brewster, PhD (Program in Systems Biology; Microbiology and Physiological Systems) – Dissecting and understanding the implications of resource sharing to cellular decision-making.

Elinor Karlsson, PhD (Program in Bioinformatics & Integrative Biology; Molecular Medicine) – Comparative genomics in hundreds of mammalian species to find out how exceptional mammalian phenotypes like hibernation evolved. Building large data resources through community science and exploring connections between genetics, environment and disease. Developing new technologies for diagnosing and treating cancer in dogs and humans.

Michael Lee, PhD (Program in Systems Biology; Molecular Medicine) – Using a combination of experimental and computational approaches to study the organization and function of signaling networks controlling the growth, survival, and death of cancer cells.

Rene Maehr, PhD (Diabetes Center of Excellence; Molecular Medicine) – The molecular pathways that govern thymus organogenesis and function, and to translate this knowledge to stem cell approaches to recapitulate and investigate human immune syndromes associated with this organ, including type 1 diabetes.

Francesca Massi, PhD (Biochemistry & Molecular Pharmacology) – Protein dynamics, function, and stability using NMR and computer simulation.

Elizabeth Shank, PhD (Program in Systems Biology; Microbiology and Physiological Systems) – Dissecting microbial cell-cell interactions to understand how secreted specialized (or secondary) metabolites contribute to the establishment, dynamics, and stability of these microbial communities.

Hyun Youk, PhD (Molecular Medicine) – Research focuses on addressing two questions: (1) what principles allow cells and organisms to re-enter a replicative (active) state from an inactive state?; and (2) why and how do cells autonomously or collectively survive and/or die?

Assistant Professors

Nezar Alexander Abdennur, PhD (Systems Biology)

Daniel Caffrey, PhD (Medicine, Infectious Diseases and Immunology) – Using genomic and computational methods to investigate various aspects of the immune response and host-pathogen interactions.

Yingleong Rigel Chan, PhD (Neurology) – Population modeling of complex genetic diseases via high-throughput multiplex in-vitro models to better understand the effect of genetic variants on human phenotypes.

Andrés Colubri (Program in Bioinformatics & Integrative Biology; Microbiology and Physiological Systems) - Digital epidemiology and outbreak simulations; machine learning models for infectious disease risk prediction models; interactive visualization of complex biomedical datasets; STEM education and outreach.

Oliver King (Neurology) – Research interests in algorithm development and the analysis of high-throughput datasets. As part of a Wellstone Center focusing on facioscapulohumeral muscular dystrophy (FSHD), studies transcriptional and epigenetic changes associated with disease, and genetic modifiers of disease severity.

Li Li, PhD (RNA Therapeutics Institute) – Integrating the power of evolution and chemistry with classic biochemistry to better understand the role of RNA in translation and to advance

RNA-based therapeutics.

Teng-Ting (Elaine) Lim, PhD (Program in Bioinformatics & Integrative Biology; Molecular, Cell & Cancer Biology) – Quantitative human genomics of common neurodegenerative and neuropsychiatric disorders using induced pluripotent stem cell models.

Michael Lodato, PhD (Molecular, Cell & Cancer Biology) – Rates, causes, and consequences of somatic mutations in the human brain.

Amir Mitchell, PhD (Program in Systems Biology; Molecular Medicine) - Studying the response of cellular networks to changing environments in health and disease.

Jill Moore, PhD (RNA Therapeutics Institute)

Athma Pai (RNA Therapeutics Institute) – Using computational genomics and systems biology approaches to understand the speed and efficiency at which RNA molecules are created and processed to ensure proper cellular functions.

Chan Zhou, PhD (Population Health Sciences) - Developing novel computational methods and pipelines for analyzing large-scale high-throughput data to understand noncoding RNA epigenomics in genetics and disease toward advancing precision medicine.

Program in Cancer Biology

The Program in Cancer Biology provides:

- A strong emphasis on cancer biology, cell signaling, genetics, immunology, and therapy
- A combination of rigorous basic science with exposure to clinical cancer medicine
- Mentoring by faculty who are basic scientists and clinician scientists

Cancer biology is an academic discipline with a tangible end point: improving the prevention, diagnosis and treatment of human cancers. The Cancer Biology Program provides students interested in pursuing a career in cancer biology with rigorous training in biochemistry, genetics, molecular and cell biology, as well as an understanding of the clinical aspects of cancer. The program is based in the Department of Molecular, Cell & Cancer Biology, but it also includes faculty from most basic science departments and several clinical departments. The strength and diversity of the faculty enable students to explore different approaches to the study of cancer in their laboratory rotations and to develop interdepartmental and interdisciplinary collaborations during their thesis research. This program is also an integral component of the UMass Chan Medical School Cancer Center and it affords students the opportunity to participate in disease-based programs of the

Cancer Center that are designed to translate achievements from the basic sciences to the clinical management of human cancers.

Requirements for Specialization

In addition to the core first year coursework, students are required to take the *Cancer Biology and Medicine* course and two elective courses of their choice (with 2 to 4 credits each) in areas that will strengthen their anticipated thesis research.

Qualifying Exam

- Students select their QE committee in consultation with their advisor, and this is subject to approval by the Program Director.
- The student's QE topic is their proposed thesis work.
- The student's thesis advisor is permitted to attend the Specific Aims meeting.
- The Chair of the QE committee will be a member of the Cancer Biology Program.

Courses in Cancer Biology

Cancer Biology and Medicine BBS725 (required course)

This course provides students with a rigorous and comprehensive understanding of the mechanisms that underlie the genesis and progression of human cancers. It builds on the basic science knowledge acquired in the core curriculum. The salient topics covered include stem cells, cell death mechanisms, oncogenes and tumor suppressor genes, cancer metabolism, tumor-host interactions, invasion, metastasis and angiogenesis. A major theme of the course is to integrate the biology of cancer with the clinical behavior of tumors. The course also includes an introduction to the basic principles of cancer therapy, including chemotherapy, immunotherapy and the use of systems biology to improve therapy. Faculty from the Department of Molecular, Cell & Cancer Biology and other basic science departments participate in the teaching of this course.

Histology and Tumor Pathology BBS 720 (elective course)

The overall goal of the course is to expose students to the pathology of different types of cancers that occur in humans and the methods used for diagnosis, including histology, cytology, immunohistochemistry, flow cytometry and molecular diagnostics. Faculty from the Departments of Pathology teach this course. The course starts with a review of normal tissue histology of all the major organ systems and an overview of diagnostic techniques. The remainder of the course consists of organ-based lectures in tumor pathology along with a hands-on microscopic review of pathologic tumor samples. The general format of the six-week course consists of a one-hour lecture followed by a one-hour laboratory session, given three days per week.

Other Program Activities

Seminars

The students of the Cancer Biology Program are required to present their research in progress once a year. Most of the students in the Program present at the weekly Department of Molecular, Cell & Cancer Biology in-house seminar series. This event is attended by students, postdocs and faculty of the Department, and it is open for all researchers on campus. This seminar series serves two important purposes: it provides students with the experience of presenting their work in a public setting and it allows for constructive criticism of their data.

Cancer Biology Program Journal Club

The Program has a monthly journal club organized by students that enables them to read and discuss papers of interest in cancer research.

Cancer Biology Program Retreat

The Program Retreat is a student organized annual event that seeks to enhance the networking between researchers communities, share their latest research, and exposes first year graduate students to cancer research opportunities.

This informal one day event combines research talks and a poster session from faculty, student and postdocs in the Program associated labs across campus and from other UMass campuses. Highlights of the retreat also include a keynote presentation by an invited external scientist (e.g. William Kaelyn Jr., 2023) , and the announcement of the best poster and stage presentation Awards.

Cancer Biology Program Open House

The Cancer Biology Program Open House is an annual event that takes place in early September to welcome the incoming GSBS and MSTP graduate students in an informal setting. During the 2 hour poster session, the first year students can chat with advanced students, postdocs and faculty in the Program and explore research rotation opportunities.

Cancer Biology Program Directors

Lucio Castilla, PhD – Program Director

William Flavahan, PhD – Deputy Program Director

Marcus Ruscetti, PhD – Deputy Program Director

Cancer Biology Faculty

Prabhani Atukorale, PhD (Adjunct Assistant Professor, Molecular, Cell & Cancer Biology)

Eric H. Baehrecke, PhD (Professor, Molecular, Cell & Cancer Biology) – Cell survival, death and autophagy

Jennifer Benanti, PhD (Associate Professor, Molecular, Cell & Cancer Biology) – Regulation of cell growth and division

Andreas Bergmann, Ph.D. (Professor, Molecular, Cell & Cancer Biology) – Genetic control of programmed cell death (apoptosis) in *Drosophila*

Michael Brehm, PhD (Associate Professor, Molecular Medicine) – Cancer immunology, 'humanized' mice in modeling cancer

Sharon B. Cantor PhD (Professor, Molecular, Cell & Cancer Biology) – DNA replication stress in hereditary breast cancer

Lucio Castilla, PhD (Professor, Molecular, Cell & Cancer Biology) – Genetics and therapies of human leukemias

Craig C. Ceol, PhD (Assistant Professor, Molecular Medicine) – Tumor initiation and maintenance, using zebrafish models and human tissue culture to focus on melanoma and other solid cancers

Yingleong (Rigel) Chan, PhD (Assistant Professor, Neurology) – Studying effect of genetic variation on cancer phenotypes using in vitro modeling

Roger J. Davis, PhD (Chair and Professor, Molecular Medicine) – Mechanisms by which growth factors regulate cellular proliferation

Thomas Fazzio, PhD (Professor, Molecular, Cell & Cancer Biology) – Chromatin regulation in stem cells

William Flavahan, PhD (Assistant Professor, Molecular, Cell & Cancer Biology) – Tumor epigenetics

Thomas Fitzgerald, MD (Chair and Professor, Radiation Oncology) – Cancer therapy

Accalia Mai-Wan Fu, PhD (Assistant Professor, Program in Molecular Medicine) – Metabolism and diabetes

Rachel M. Gerstein, PhD (Associate Professor, Microbiology and Physiological Systems) – Developmental regulation of V(D)J recombination and B cell development.

Jonathan Gerber (Professor, Medicine) - Heme malignancies

Nikolaus Grigorieff, PhD (Professor, RNA Therapeutics Institute) – Cryo-EM investigation of structures relevant to cancer

David A. Guertin, PhD (Professor, Molecular Medicine) – Signal transduction in development and cancer

Cole Haynes, PhD (Professor, Molecular, Cell & Cancer Biology) – Mitochondrial function and dysfunction in cancer

Matthew Hemming, MD PhD (Assistant Professor, Medicine) – Sarcoma biology and epigenetics

Fiachra Humphries, PhD (Assistant Professor, Medicine) – Innate immunity and the tumor microenvironment

Mark D. Johnson, MD PhD (Chair and Professor, Neurosurgery) – Brain tumors

Michelle A. Kelliher Ph.D. (Interim Chair and Professor, Molecular, Cell & Cancer Biology) – Genetics and therapy of human leukemias

Dohoon Kim, PhD (Associate Professor, Molecular, Cell & Cancer Biology) – Cancer Metabolism

Eric Chi Ching Ko, MD PhD (Associate Professor, Radiation Oncology)

Timothy F. Kowalik, PhD (Professor, Microbiology and Physoilogical Systems) – Regulation of cellular proliferation control during viral infection

Nathan Lawson, PhD (Professor, Molecular, Cell & Cancer Biology) -

Michael Lee, PhD (Associate Professor, Molecular Medicine; Program in Systems Biology) – Systems Pharmacology of anti-cancer therapies

Brian Lewis, PhD (Professor, Molecular, Cell & Cancer Biology) – Molecular genetics of pancreatic and liver cancers

Shaoguang Li, MD, PhD, (Professor, Medicine) – Understanding the biology of leukemia stem cells and identifying target genes for eradicating these stem cells

Elaine Lim, PhD (Assistant Professor, Bioinformatics & Integrative Biology) – Cancer research computational and statistical methods and experimental technology development.

Stephen Lyle, MD PhD (Associate Professor, Molecular, Cell & Cancer Biology) – histopathology

Junhao Mao, PhD (Professor, Molecular, Cell & Cancer Biology) – Developmental signaling pathways and cancer

Arthur M. Mercurio, PhD (Professor, Molecular, Cell & Cancer Biology) – Molecular cell biology of aggressive carcinomas

Amir Mitchell, PhD (Associate Professor, Program in Systems Biology) – Tumor microbiome

Peter E. Newburger, MD (Professor, Pediatrics) – Global analysis and regulation of phagocyte gene expression; mechanisms of translation of selenium-containing proteins such as glutathione peroxidase

Jason Pitarresi, PhD (Assistant Professor, Medicine) - Tumor Cell Plasticity

Nick Rhind, PhD (Professor, Biochemistry & Molecular Pharmacology) – DNA replication and replication checkpoints; cell size control; fission yeast comparative genomics

Marcus Ruscetti, PhD (Assistant Professor, Molecular, Cell & Cancer Biology) – Tumor immunology

Leslie M. Shaw, PhD (Professor, Molecular, Cell & Cancer Biology) – Mechanisms of breast cancer metastasis

Kuang Shen, PhD (Assistant Professor, Molecular Medicine) – nutrient sensing, mTOR signaling in cancer

Karl Simin, PhD (Associate Professor, Molecular, Cell & Cancer Biology) – Breast cancer genetics and cancer models

Rachael Sirianni, PhD (Professor, Neurological Surgery) - Nanoparticle Engineering for Cancer Drug Development and Targeted Delivery

Merav Socolovsky, PhD, MBBS (Professor, Molecular, Cell & Cancer Biology) – Molecular mechanisms regulating the homeostasis of hematopoietic progenitors

Eric Sontheimer, PhD (Professor, RNA Therapeutics Institute) – CRISPR/Cas9 genome editing

Jessica Spinelli, PhD (Assistant Professor, Molecular Medicine) - Metabolism

Paul Thompson, PhD (Professor, Biochemistry & Molecular Pharmacology) – chemical biology and structure of enzymes

Eduardo Torres, PhD (Assistant Professor, Molecular, Cell & Cancer Biology) – Aneuploidy's effects on cellular physiology and metabolism and how it influences cell evolution

Emma Watson, PhD (Assistant Professor, Systems Biology) – Cancer chromosome genetics

Wen Xue, PhD (Associate Professor, Molecular Medicine; RNA Therapeutics Institute) – Functional dissection of cancer mutations in mouse models of liver cancer and lung cancer

Interdisciplinary Graduate Program

The Interdisciplinary Graduate Program is characterized by:

- A flexible graduate curriculum tailored to the specific needs of individual students;
- Participation from more than 130 UMass Chan Medical School labs; and
- Encouragement of students' rapid initiation into full-time thesis research.

The Interdisciplinary Graduate Program (IGP) was established to support interdisciplinary approaches to graduate training in biomedical research. The more than 130 laboratories that participate in the program are directed by a distinguished group of faculty affiliated with 13 basic science and clinical departments at the Medical School. Program investigators employ a wide range of instrumentation and experimental approaches to their research including: classical and molecular genetics; proteomics and genomics; X-ray crystallography and nuclear magnetic resonance; and digital imaging and laser confocal microscopy of single cells and tissues.

Characterized by a flexible graduate curriculum that is tailored to the specific needs of individual students, the IGP encourages rapid initiation of full-time thesis research. A weekly student seminar series, sponsored by Molecular Medicine, provides students with opportunities to present their research to a large audience including numerous faculty and IGP leadership.

Requirements for Specialization

Students perform three laboratory rotations to ensure that they are exposed to a variety of experimental approaches and laboratory environments. Advanced coursework, journal clubs and other enrichment activities beyond the SIBR course are tailored to the requirements of each student and are determined after discussion between the faculty advisor and student. A minimum of three Elective courses are required.

Qualifying Exam

As students prepare for the qualifying examination, members of the QE committee should be selected after consultation with their thesis advisor, subject to approval by the Program Director. The student is encouraged to prepare their QE proposal based on their thesis project, but other topics are acceptable. The thesis advisor is permitted to attend the Specific Aims meeting.

Courses in Interdisciplinary Graduate Program:

Cancer Biology and Medicine

This course will provide students with a rigorous and comprehensive understanding of the mechanisms that underlie the genesis and progression of human cancers. It will build on the basic science knowledge acquired in the SIBR course and establish an appreciation of cancer as a disease. The salient topics to be covered include cancer stem cells; oncogenes and tumor suppressor genes; tumor-host interactions, invasion and metastasis, cancer metabolism and anti-tumor immunity. A major theme of the course will be to integrate the biology of cancer with the clinical behavior of tumors.

Principles of Light and Electron Microscopy

This course is designed to teach the biologist how microscopes work and how to optimize image quality; principles and applications of microscopy in biomedical research will apply for graduate students at all levels. Demonstrations and laboratory exercises will be incorporated into blocks of instruction.

Eukaryotic Gene Expression

This course encompasses current topics in eukaryotic gene regulation including the study and discussion of current research articles. Course goals are to improve skills in reading, presenting, discussing, and critically analyzing research articles as well as to obtain an up-to-date understanding of some key topics in eukaryotic gene regulation.

Introduction to Cellular Metabolism and Disease

This intense 3-week course will expose students to a variety of topics related to cellular metabolism. The course will cover material ranging from foundational principles to current leading-edge research. The principles and mechanisms regulating metabolism will be explored from multiple perspectives, including biochemistry, biophysics, genetics, molecular biology, and cell biology.

Systems Biology of the Cell Cycle

This course covers genetic, biochemical, and cellular mechanisms of cell cycle control. Topics include genetic screens for cell cycle regulators, cell cycle checkpoints, cell cycle regulation of DNA replication and chromosome structure, and the cell cycle in development and cancer.

Systems and Computational Biology

This is a lecture and paper-discussion based course covering a broad range of topics in Systems Biology and Computational biology.

RNA Biology Journal Club

The RNA Biology Journal Club discusses recent and classical papers covering various topics

in RNA biology. Students will choose from a list of papers provided by course coordinators or from recent literature with approval from coordinators.

Current Topics in Aging

This is a journal club offered every two weeks to discuss papers on aging and genomic stability. Topics will include mechanisms of aging with a focus on genetics. The objective is to cover a large number of papers that identify genes that act to promote or limit life span and theories of aging.

Educational Outreach to High Schools and Middle Schools

Middle and high school educational outreach coordinated through the Interdisciplinary Graduate Program, Worcester Pipeline, and Regional Science Resource Center. IGP coordinated activities include development of in-class presentations and experiments in collaboration with high school teachers, and one-on-one and small group mentoring of high school science students. The Worcester Pipeline Collaborative coordinates a range of programs with the Worcester Public Schools dedicated to educating and challenging underrepresented and/or economically disadvantaged students for success in the STEM professions. Course is not available to Morningside Graduate School of Biomedical Sciences first-year students. Students need to make an appointment with the course coordinator to discuss outreach opportunities prior to the start of semester.

Tutorial in the Interdisciplinary Graduate Program

Tutorial arranged with individual faculty.

Faculty:

Graduate Directors

Craig L. Peterson, PhD (Molecular Medicine) – Regulation of nuclear functions by chromatin and chromatin remodeling enzymes

Heidi A. Tissenbaum, PhD (Molecular, Cell & Cancer Biology) – Molecular mechanisms of aging in C. elegans

Professors

Victor R. Ambros, PhD (Molecular Medicine) – Molecular and genetic control of animal development; microRNA regulatory mechanisms

Raffi Aroian, PhD (Molecular Medicine) - Cures for major diseases afflicting humankind, namely intestinal roundworms, and bacterial pathogens

Ingolf Bach, PhD. (Molecular, Cell & Cancer Biology) - Molecular and epigenetic mechanisms that regulate differential gene expression during cell fate specification.

Eric Baehrecke, PhD (Molecular, Cell & Cancer Biology) – Cell death and autophagy

Andreas Bergmann, PhD (Molecular, Cell & Cancer Biology) - Genetic control of programmed cell death (apoptosis) in Drosophila

Daniel Bolon, PhD (Biochemistry & Molecular Biotechnology) – Computational design and experimental dissection of macromolecular systems

Daryl Bosco, PhD (Neurology) – Elucidating the factors involved in sporadic AL

Michael Brehm, PhD (Molecular Medicine and Diabetes Center of Excellence) - Human immune responses to investigate approaches to downregulate as well as activate the human immune system for treatments of type 1 diabetes (T1D) and cancer

Edwin D. Boudreaux, PhD, (Emergency Medicine) - Substance cessation suicide prevention, health information

Robert Brown, MD, PhD (Neurology) – Amyotrophic lateral sclerosis

Vivian Budnik, PhD (Neurobiology) – Molecular mechanisms of synapse assembly and plasticity

Sharon Cantor, PhD (Molecular, Cell & Cancer Biology) – Hereditary breast cancer

Lucio H. Castilla, PhD (Molecular, Cell & Cancer Biology) – Genetics of leukemia in mouse models

Silvia Corvera, MD (Molecular Medicine) – Molecular mechanisms involved in the regulation of endocytosis and exocytosis by growth factors

Michael P. Czech, PhD (Molecular Medicine) – Transmembrane signaling mechanisms elicited by the insulin receptor tyrosine kinase related to membrane trafficking of glucose transporters

Roger J. Davis, PhD, FRS (Molecular Medicine) – Signal transduction by the epidermal growth factor receptor; mechanisms by which growth factors regulate cellular proliferation

Job Dekker, PhD (Biochemistry & Molecular Pharmacology and Program in Systems Biology) – Spatial organization of genomes

Thomas Fazzio, PhD (Molecular, Cell & Cancer Biology) – Chromatin regulation in stem cells

Katherine Fitzgerald, PhD (Medicine) – Innate immune signaling

Terence R. Flotte, MD (Pediatrics and Horae Gene Therapy Center) – Gene therapy for cystic fibrosis, alpha-1 anti-trypsin deficiency and other single gene defects

Manuel Garber, PhD (Molecular Medicine and Program in Bioinformatics & Integrative Biology) - Immune transcriptional response

Fen-Biao Gao, PhD (Neurobiology)- Understanding Frontotemporal Dementia and Neuronal microRNAs

Guangping Gao, PhD (Microbiology and Physiological Systems and Horae Gene Therapy Center) – Adeno-associated virus vectors for gene therapy of genetic diseases

Douglas Golenbock, MD (Medicine and Microbiology and Physiological Systems) – Toll receptors; pathophysiology of sepsis and pelvic inflammatory disease

Heinrich Göttlinger, MD, PhD (Molecular, Cell & Cancer Biology) – Molecular biology of HIV-1

Dale L. Greiner, PhD (Molecular Medicine and Diabetes Center of Excellence) – Transplantation tolerance and autoimmune diabetes

David Guertin, PhD (Molecular Medicine) – Signal transduction in development and cancer

Gang Han, PhD (Biochemistry and Molecular Biotechnology) -Nanoparticles for cancer imaging and therapy

John Harris, MD, PhD (Dermatology) – Inflammatory skin disease, including vitiligo

Lawrence J. Hayward, MD, PhD (Neurology) – Hyperkalemic periodic paralysis, motor neuron degeneration in ALS

Eric S. Huseby, PhD (Pathology) – Development of T cell tolerance of self and the autoimmune consequence of when it fails

Anthony N. Imbalzano, PhD (Biochemistry & Molecular Pharmacology)– Effects of chromatin structure on the regulation of gene expression and the control of cell growth and differentiation

Tony Ip, PhD (Molecular Medicine) – Regulatory mechanisms in Drosophila innate immunity

Allan Jacobson, PhD (Microbiology and Physiological Systems) – Post-transcriptional regulation of gene expression in yeast

Paul Kaufman, PhD (Molecular, Cell & Cancer Biology) – Assembly and function of eukaryotic chromosomes

Michelle A. Kelliher, PhD (Molecular, Cell & Cancer Biology) – Genetic analysis of programmed cell death in the mouse

Anastasia Khvorova, PhD (RNA Therapeutics Institute) - Develop and characterize novel RNA

chemistries to promote efficient oligonucleotide internalization and tissue distribution

Jason Kim, PhD (Molecular Medicine) – Role of inflammation in obesity, diabetes, and cardiovascular complications

Hardy Kornfeld, MD (Medicine) – Bacterial and viral respiratory pathogens relating to tuberculosis

Andrei Korostelev, PhD. (Biochemistry & Molecular Biotechnology; RNA Therapeutics Institute) – Structural basis for translation and translation regulation

Timothy F. Kowalik, PhD (Microbiology and Physiological Systems) – Regulation of cellular proliferation control during viral infection

David G. Lambright, PhD (Molecular Medicine) – Structural determination of key intermediates in cellular signaling and vesicle trafficking pathways

Jeanne Lawrence, PhD (Neurology; Pediatrics) – Genome organization and the functional relationship of DNA/RNA with nuclear structure

Nathan Lawson, PhD (Molecular, Cell & Cancer Biology) – Determining the signals responsible for blood vessel development using zebrafish

Stuart M. Levitz, MD (Medicine; Infectious Disease and Immunology) – Interplay between host immune system and opportunistic fungal pathogens

Brian Lewis, PhD (Molecular, Cell & Cancer Biology) – Molecular genetics of pancreatic and liver cancers

Ryan Logan, PhD (Psychiatry and Neurobiology) - Novel mechanisms in the brain that underlie both vulnerability to opioid use disorder and the impact of chronic opioid use on sleep and circadian rhythm-related pathways in the brain that could be involved in craving and relapse.

Shan Lu, MD, PhD (Medicine) – Immunogenicity of protein antigens

Jeremy Luban, MD (Molecular Medicine) – Viral replication, pathogenesis, and immunity

Pranoti Mandrekar, PhD (Medicine) – Macrophage activation in liver diseases

Dannel McCollum, PhD (Biochemistry & Molecular Biotechnology) – Signaling pathways controlling cell growth and division

Haley E. Melikian, PhD (Neurobiology) – Cocaine and antidepressant-sensitive monoamine transporters

Craig C. Mello, PhD (RNA Therapeutics Institute) – Analysis of fate specification in C. elegans embryonic development; analysis of RNA interference in C. elegans

Arthur M. Mercurio, PhD (Molecular, Cell & Cancer Biology) – Define mechanisms that control the genesis and function of cancer stem cells

Stephen Miller, PhD (Biochemistry & Molecular Biotechnology) – Chemical dissection of cellular GTPase function

Ann Moormann, PhD (Medicine) – Pediatric immunity

Mary Munson, PhD (Biochemistry & Molecular Biotechnology) – Regulation of vesicle targeting and fusion

Peter Newburger, MD (Pediatrics) – Molecular basis of phagocyte function and selenoprotein biosynthesis

Gary Ostroff, PhD. (Molecular Medicine) - Nanomaterial science and biology

Gregory J. Pazour, PhD (Molecular Medicine) – Function of the Mammalian Primary Cilium and Mechanisms of Eukaryotic Ciliary Assembly

Read Pukkila-Worley, MD, FIDSA (Medicine/infectious Diseases and Immunology) - **The genetics of immune activation and regulation in intestinal epithelial cells**

Oliver J. Rando, MD, PhD (Biochemistry & Molecular Biotechnology) – Genomic approaches to chromatin structure and function, and to epigenetic inheritance

Nicholas Rhind, PhD (Biochemistry & Molecular Biotechnology) – Checkpoint regulation of the fission yeast cell cycle

Joel D. Richter, PhD (Molecular Medicine) – Regulation of maternal mRNA expression in early development

Katherine F. Ruiz de Luzuriaga, MD (Pediatrics; Medicine) – Viral and host factors in the pathogenesis of vertical HIV-1 infection; HIV-1 specific cytotoxic T lymphocytes in naturally infected or immunized infants; development of therapeutic agents/strategies for HIV-1 infection

Sean Ryder, PhD (Biochemistry & Molecular Biotechnology) – Post-transcriptional regulation of maternal mRNAs in early development

Leslie M. Shaw, PhD (Molecular, Cell and Cancer Biology) – Mechanisms of breast cancer progression.

Celia A. Schiffer, PhD (Biochemistry & Molecular Biotechnology) - Structural basis for molecular recognition in HIV Protease

Neal Silverman, PhD (Medicine) – Signal transduction during the insect immune response

Rachael Sirianni, PhD (Neurological Surgery) – Nanoparticle engineering for cancer drug development and targeted delivery

Jie Song, PhD (Orthopedics & Physical Rehabilitation) – Musculoskeletal tissue engineering: A biomimetic synthesis approach

Erik Sontheimer, PhD (RNA Therapeutics Institute) - Biology and mechanism of RNA-based gene regulation; CRISPR interference; RNA-directed genome editing and gene control

Lawrence Stern, PhD (Pathology) – Molecular recognition in the immune system

Andrew R. Tapper, PhD (Neurobiology) – Neuronal nicotinic acetylcholine receptors in addiction and neurological disease

Heidi Tissenbaum, PhD (Molecular, Cell & Cancer Biology) – Using C. elegans to study the aging process

William E. Theurkauf, PhD (Molecular Medicine) – Control of chromosome segregation in early development

Paul Thompson, PhD (Biochemistry & Molecular Biotechnology) - Techniques of chemical biology, biochemistry, and enzymology to develop inhibitors/drugs targeting disease associated enzymes as well as developing novel diagnostics for cancer

Chinmay Trivedi, MD, PhD (**Medicine/Cardiology**) **-** Identify cellular processes and regulatory mechanisms involved in human cardiac and vascular diseases

Marian Walhout, PhD (Molecular Medicine; Program in Systems Biology) – Mapping transcription regulatory circuits in the nematode C. elegans

Jonathan Watts, PhD (RNA Therapeutics Institute) – Platform technology for oligonucleotide therapeutics.

David Weaver, PhD (Neurobiology) – Molecular physiology of circadian rhythms

Zhiping Weng, PhD (Biochemistry & Molecular Biotechnology; Program in Bioinformatics & Integrative Biology) – Bioinformatics and computational genomics

Scot A. Wolfe, PhD (Molecular, Cell & Cancer Biology) – Creating artificial DNA-binding domains for targeted gene regulation and gene modification

Lihua Zhu, PhD (Molecular, Cell and Cancer Biology) – Developing novel tools for mining and integrating high-throughput datasets to investigate gene regulation in cancer

Zuoshang Xu, MD, PhD (Biochemistry & Molecular Biotechnology) – Mechanism and therapy of neurodegenerative diseases

Phillip D. Zamore, PhD (RNA Therapeutic Institute) – Dissecting the RNAi and miRNA Pathways

Associate Professors

Jennifer Benanti, PhD (Molecular, Cell & Cancer Biology) – Regulation of cell growth and division

Robert C. Brewster, PhD (Systems Biology and) – Transcriptional regulation in bacteria through a combination of theory, using molecularly detailed statistical mechanics models

Darryl Conte, PhD (RNA Therapeutics Institute) – Gene silencing in *C. elegans*

Miguel Esteves, PhD (Neurology and Horae Gene Therapy Center) – Treatment of neurodegenerative lysosomal storage diseases

Kensuke Futai, PhD (Neurobiology) - The roles of Inhibitory neurons in neuropsychiatric diseases

Stefania Gallucci, MD (Medicine – Program in Innate Immunity) – Innate immunity responses in host defense autoimmunity

Rachel M. Gerstein, PhD (Microbiology and Physiological Systems) – Developmental regulation of V(D)J recombination and B cell development; defective B cell development and function in Btk-deficient mice; the extent to which homology can constrain coding exon diversity in V(D)J recombination

Javier E. Irazoqui, PhD (Microbiology and Physiological Systems) - Host-*microbe interactions, brain-gut-microbiota axis, COVID19*

Hong-Sheng Li, PhD (Neurobiology) – Neuronal regulation of membrane receptor signaling

Elinor Karlsson, PhD (Molecular Medicine; Program in Bioinformatics & Integrative Biology) - Infectious disease resistance in humans

Brian Kelch, PhD (Biochemistry and Molecular Biotechnology) – Structural studies of DNA replication and repair proteins Involved in cancer

Dohoon Kim, PhD (Molecular, Cell and Cancer Biology) – Cancer Metabolism and Metabolic Toxicity

Michael Lee, PhD (Molecular Medicine; Program in Systems Biology) –Systems Pharmacology of anti-cancer therapies

Stephen Lyle, MD, PhD (Molecular, Cell & Cancer Biology) – Stem cells and cancer

Rene Maehr, PhD (Molecular Medicine) – Autoimmune destruction of insulin producing, pancreatic beta cells results in Type I Diabetes (T1D)

Peter M. Pryciak, PhD (Biochemistry & Molecular Biotechnology) – Function of yeast

heterotrimeric G proteins in signal transduction and cell polarity

Claudio Punzo, PhD (Ophthalmology and Visual Sciences) - Retinitis Pigmentosa & Age-related Macular Degeneration

Ann R. Rittenhouse, PhD (Microbiology and Physiological Systems) – Characterization of the role of calcium channels and their modulators in nerve cell plasticity using molecular, biochemical, and patch-clamp techniques

Miguel Sena-Esteves, PhD (Neurology) Gene therapy for neurological diseases and brain tumors

Elizabeth Shank, PhD (Systems Biology) - Investigating the molecules and mechanisms of bacterial cell-cell interactions

Eduardo Torres, PhD (Molecular, Cell & Cancer Biology) – Aneuploidy's effects on cellular physiology and metabolism and how it influences cell evolution

Amy Walker, PhD (Molecular Medicine) – How is transcriptional regulation of lipogenesis linked to diet and environment in C. elegans and mammals

Yong-Xu Wang, PhD (Molecular Cell & Cancer Biology) – Transcriptional control of energy metabolism and metabolic diseases by the nuclear receptor PPAR subfamily

Wen Xue, PhD (RNA Therapeutics Institute) – To functionally dissect cancer mutations in mouse models of liver cancer and lung cancer

Lutfu Yilmaz, PhD (Systems Biology) – Metabolic network modeling with the nematode C. elegans

Hyun Youk, PhD (Molecular Medicine; Program in Systems Biology) – Understand how living systems bidirectionally transition between being alive and being either truly dead or seemingly dead

Hong Zhang, PhD (Pediatrics) – Molecular mechanisms of senescence and its roles in cancer and aging and its roles in cancer and aging

Assistant Professors

Michael H. Brodsky, PhD (Molecular, Cell & Cancer Biology) – Drosophila p53 and DNA damage-induced apoptosis

Alexandra Byrne, PhD (Neurobiology) - Investigating Mechanisms of Axon Regeneration in the Aging Nervous System

Craig Ceol, PhD (Molecular Medicine) – Genetic regulators of melanoma formation

using the zebrafish

Yingleong Chan, PhD (Molecular, Cell and Cancer Biology) - Multifactional inheritance, Genome-Wide Association Study; Phenotype, and Whole Genome sequencing

Andreas Colubri, MFA, PhD (Microbiology and Physiological Systems) – Hemorrhagic fever, Ebola, and Lassa fever

Wenwen Fang, PhD (RNA Therapeutics Institute) – MicroRNA biogenesis and RNA sensing in innate immunity

William a. Flavahan, PhD (Molecular, Cell and Cancer Biology) – Epigenetics and chromatin topology in cancer

Accalia Fu, PhD (Molecular Medicine) - Understand pancreatic beta cell metabolism in the context of inflammation, immune cell interactions and diabetes

Paul Greer, PhD (Molecular Medicine) – How animals sense and interpret exteroceptive and interoceptive chemical signals to generate appropriate organismal responses

Fiachra Humphries, PhD (Division of Innate Immunity) - How metabolic pathways can regulate key mediators of cell death and inflammatory responses elicited by our innate immune system

Allison M. Keeler-Klunk, PhD (Gene Therapy Center) - Gene Therapy, T-REGS and immune response to AAVs

Li Li, PhD (RNA Therapeutics Institute) - RNA Based Therapeutics.

Michael Lodato, PhD (Molecular, Cell and Cancer Biology) - Rates, causes, and consequences of somatic mutations in the human brain

William McDougall, PhD (Microbiology and Physiological Systems) - Host-virus interactions, with the goal of identification and mechanistic determination of novel strategies that viruses employ to exploit host pathways or subvert host defense against viral infection

Amir Mitchell, PhD (Molecular Medicine) – The response of cellular networks to changing environments in health and disease, using both experimental and theoretical approaches

Athma Pai, PhD (RNA Therapeutics Institute) – The efficiency of mRNA regulation in cancer

Jason Pitarresi, PhD (Medicine/Division of Hematology-Oncology) – Cellular plasticity in pancreatic cancer

Zaida Ramirez Ortiz, PhD (Medicine) – Role of scavenger receptors in the innate immune

response

Sy Redding, PhD (Biochemistry and Molecular Biotechnology) - Discover general physical principles that affect biological outcomes

Marcus Ruscetti, PhD (Molecular, Cell and Cancer Biology) - Harnessing intrinsic tumor suppressor pathways to restore anti-tumor immunity

Kuang Shen (Molecular Medicine) – Nutrient sensing in cells by the mTORC1 pathway, using biochemical and biophysical tools including cryoEM and single molecule biophysics

Hayla Sluss, PhD (Molecular, Cell & Cancer Biology) – Tumor suppressors and metabolic control

Jessica Spinelli, PhD (Program in Molecular Medicine) – Metabolic flexibility in the tumor microenvironmen

Caterina Strambio De Castillia, PhD (Molecular Medicine) - Dissecting the interplay between HIV-1 and human cells during viral entry

Phillip Tai, PhD (Microbiology and Physiological Systems) - Development of next-gene sequencing methodologies to profile AAV vector genome quality, and discovery and characterization of natural AAV capsid isolates for vectorization and gene therapy

Emma V. Watson, PhD (Systems Biology) - Utilizing high-throughput genetic screens to study chromosomal aberrations in tumorigenesis

Maria L. Zapp, PhD (Molecular Medicine; Microbiology and Physiological Systems) – Regulation of nuclear transport of viral and cellular mRNAs by cellular factors

Jin Zhang Ph. D (Molecular Medicine). Molecular analysis of mammalian taste receptors

Guocai Zhong, PhD (RNA Therapeutics Institute) – RNA switch engineering and regulatable gene therapy development

Contributing Faculty:

Professors

Thoru Pederson, PhD (Biochemistry & Molecular Biotechnology) – Eukaryotic gene expression at the level of RNA processing; RNA-protein interactions and RNA traffic

Steven M. Reppert, PhD (Neurobiology) – Circadian clockwork of animals

John L. Sullivan, MD (Pediatrics and Molecular Medicine) – Virological and immunological studies of HIV-1 pathogenesis; development of a vaccine and therapeutic agents for HIV-1 infection; early HIV-1 envelope-specific cytotoxic T lymphocyte responses in vertically infected infants

Immunology & Microbiology Program

The IMP Program features cutting-edge research in:

- Innate immunity and inflammation
- Host responses to infection and vaccine development
- Fundamental molecular and cellular immunology
- The mechanisms underlying bacterial, parasitological and viral pathogenesis
- Diabetes and transplantation immunology
- Autoimmunity
- Systems biology of host-pathogen dynamics
- Microbiome Sciences
- Molecular mechanism of virus cell entry, assembly, and replication

Immunology, virology, and bacterial pathogenesis are interdisciplinary biomedical fields that employ methods ranging from molecular biology to clinical trials. The Immunology & Microbiology Program (IMP) is administered by an interdepartmental group that includes faculty with diverse research interests, including the molecular and cellular basis of innate immunity, adaptive immunity, molecular mechanisms of viral replication, host-pathogen interactions, and the control of viral, bacterial and parasitic infections.

The major purpose of the Program is to recruit talented and highly motivated graduate students and postdoctoral fellows and give them first-rate preparation for competitive careers in academic research and industry. Currently there are approximately 35 graduate students in the program, and program faculty are training 80 – 100 postdoctoral fellows.

All BBS Graduate students acquire a broad base of knowledge in immunology, innate immunity, biochemistry, genetics, and cellular and molecular biology through the Scientific Inquiry in Biomedical Research (SIBR) course. IMP students gain a deeper and more specialized training in immunology, virology, and bacteriology through the Spring first-year course, Infection and Immune Response, which introduces students to the immune system, basic principles of bacteriology and virology, and the interaction of bacteria and viruses with the host. Emphasis is placed on experimental systems and analysis of primary research papers. Further training continues in the fall of the second year with availability of three courses: Advanced Virology, Advanced Molecular and Cellular Immunology, or Advanced Bacterial Pathogenesis. Advanced courses emphasize reading and critical analysis of recent research papers and which advanced course is taken depends on the student's area of interest. Additional training in the second year and beyond includes seminars, journal clubs, and tutorials all of which explore the most active areas of current research and support important networking opportunities for IMP students. Laboratory rotations help familiarize students

with current research methods and facilitate the selection of an area of interest and a laboratory in which students can pursue their dissertation research.

Requirements for Specialization

All BBS students must complete the Scientific Inquiry in Biomedical Research (BBS 614) course as well as electives required by their program. All BBS students must take 3 elective courses, and IMP students should include Infection and Immune Response (BBS755) in Spring of the first year, and, in the second year, at least one advanced level course offered by the Immunology and Microbiology program (BBS821, BBS822, or BBS823). Equivalent advanced level courses offered by other departments or programs can be substituted with permission. All students, except for those in the final stages of their dissertation research, are required to take Graduate Student Seminar (BBS 833) each fall semester, and Immunobiology and Microbiology Seminar and Discussion (BBS 834), or an equivalent guest scientist seminar program, for two semesters. BBS834 provides a broad perspective on current research topics in the field and offers students unique networking opportunities with national and international leaders.

Specific questions about IMP should be directed to the Program or Course Directors.

Qualifying Exam

The IMP Qualifying Exams (QE) follows all Morningside Graduate School of Biomedical Sciences guidelines, with Exam Committee membership set by Program Director/Designee.

Courses in Immunology & Microbiology Program:

Infection and Immune Response (BBS 755)

This course presents a modern view of the fundamental biology of bacterial and viral disease in the context of molecular mechanisms of host defense. A detailed knowledge of cellular and molecular components of the immune system will be integrated with current understanding of microbial virulence strategies, to provide a working understanding of biological mechanisms important in health and disease. The course is organized as three integrated sections focusing on the fields of virology, bacterial pathogenesis, and immunology. Students will obtain a background for advanced course work in each of these disciplines. We will focus on three themes; (1) basic properties of viruses and bacteria and the innate and adaptive immune defenses that have evolved to respond to them, (2) the interplay—in both dynamic and evolutionary sense—between host defenses and microbial virulence, and (3) the mechanisms of pathogenesis during infection. Comparative clinical and epidemiological pictures of selected diseases will be presented and will serve as a framework for development of key molecular, cellular, and physiological concepts.

Introduction to Virology

This is the virology component of BBS 755 Infection and Immune Response.

Bacterial Pathogenesis

This is the bacteriology component of BBS 755 Infection and Immune Response.

Introduction to Immunology

This is the immunology component of BBS 755 Infection and Immune Response.

Advanced Molecular and Cellular Immunology (BBS 821)

Some of the most active areas of current immunology are investigated through the reading and discussion of research papers. Students further develop the ability to pose questions and design experiments to answer them through writing a research proposal. A component of this course is training in scientific writing and grantsmanship similar to the QE prep course (BBS602). Therefore, students taking BBS821 can chose not to take BBS 602. Topics to be covered include: innate and inflammatory immune responses, regulation of lineage specification/commitment and antigen receptor gene recombination; mechanisms of immunological tolerance and lymphocyte activation, cellular transactions and their consequences (e.g., APC:T cell); and immune responses in infectious diseases.

Advanced Animal Virology (BBS 822)

This is a paper reading-based course discussing in depth new findings in animal virology, including viral biochemistry and molecular biology, genetics, oncogenesis, and pathogenesis. The course will be team-taught by UMass Chan faculty. The course will begin with introductory lectures to provide background for more advanced readings. Students will then cover different specific areas chosen by the professors in detail with paper readings. At the end of the course the students will write a research proposal and present it to the class and faculty. Students taking BBS 822 are required to take the QE prep course BBS 602.

Advanced Bacterial Pathogenesis (BBS 823)

This course introduces students to cutting-edge topics in bacterial pathogenesis in a class format designed to encourage both critical analysis and concentration on experimental design, which will aid students in preparation for qualifying exams. The course meets once per week for 2.5-3 hours. Depending on class size and on a rotating basis, groups of two or three students lead discussions of selected topics. Presenting students are required to prepare written reviews to focus the discussion. The bulk of class time is devoted to open discussion and critical analysis of the literature, and constructive criticism of student reviews. Each student develops and presents a research proposal on one of the topics discussed. Students taking the course for 2 credits will not be required to prepare the research proposal and

research plans. Grading is based on written reviews, quality of presentations, and class participation (all students) and on the quality of the research outline (students taking the class for 3 credits). Students taking BBS 823 are required to take QE prep course BBS 602.

Immunology and Microbiology Graduate Student Fall Seminars (BBS 833)

Advanced Immunology & Microbiology Program graduate students present seminars on their thesis research.

Immunobiology and Microbiology Spring Seminar Series (BBS 834)

Leading national and international researchers present a weekly seminar on a basic or clinical immunology and virology topic. Prior to each seminar, students read papers suggested by the seminar speaker and discuss the papers in class. Following the seminar, graduate students meet with the speaker for a discussion of the formal seminar. This course surveys the most important areas of basic and clinical immunology and virology including, but not limited to, innate responses, antigen presentation; gene rearrangements; and expression of the genes for antigen receptors, immune tolerance, cytokines, immune cell development, immunodeficiency diseases, autoimmune diseases, human immune system malignancies and immune response to infectious agents such as viruses, parasites and bacteria.

Immunology and Microbiology Summer Tutorial (BBS 846)

This course is designed to help first-year students prepare for the Immunology & Microbiology Program advanced topics courses in the fall, learn how to think critically about articles, and meet senior students in the program. Students in the class will read one primary and one review paper the week before each class. The topic, paper and review will be chosen by two student mentors. In a brief presentation; the mentors will describe the current state of the field and summarize the review. The class will then discuss the chosen article and critically analyze the positives and negatives of techniques, systems, conclusions, etc.

Faculty:

Program Director

Ann Moormann, PhD, MPH (Medicine, Division of Infectious Diseases and Immunology) – Adaptive and Natural Killer cell immune responses to infectious diseases focusing on *Plasmodium falciparum* malaria, Epstein Barr virus (EBV) and EBV-associated cancers

Deputy Program Director

Andrea Reboldi, PhD (Pathology) – Mucosal immunology, host-microbiome interaction and lipid metabolism

Professors

Raffi Van Aroian, PhD (Program in Molecular Medicine) - Human/animal parasitic nematodes as well as bacterial toxins

Samuel M. Behar, MD, PhD (Microbiology and Physiological Systems) - Innate and acquired immunity to Mycobacterial tuberculosis

Roberto Caricchio, MD (Medicine, Division of Rheumatology) – Lupus and Innate immunity

Lisa Ann Cavacini, PhD (Medicine, Division of Innate Immunity) - Humoral immunity and human monoclonal antibodies (HMab) for infectious disease, cancer, and autoimmune disease

Richard W. Dutton, PhD (Pathology) - the role of naïve and memory CD8 T cells in providing protection against potentially lethal influenza infection.

Richard T. Ellison III, MD (Medicine, Division of Infectious Diseases and Immunology) - Identification and treatment of nosocomial infections, infections in the ICU setting, sepsis, and clinical care of patients with HIV disease

Katherine A. Fitzgerald, PhD (Medicine, Division of Innate Immunity) - Molecular basis of inflammation in health and disease

Terence R. Flotte, MD (Pediatrics, Division of Pediatric Pulmonology) - Gene therapy approaches for treatment of cystic fibrosis, alpha-1 antitrypsin (AAT) deficiency, type I diabetes, and disorders of fatty acid oxidation

Stefania Gallucci, MD (Medicine, Division of Innate Immunity) – Lupus and dentrictic cells

Gaungping Gao, PhD (Microbiology and Physiological Systems) - adeno-associated virus vectors for gene therapy of genetic diseases and the study of miRNA functions in mammals.

Manuel Garber, PhD (Program in Bioinformatics & Integrative Biology; Molecular Medicine) - Evolutionary non-coding genomics

Ricardo T. Gazzinelli, DSc, DVM (Medicine, Division of Infectious Diseases and Immunology) - Innate and acquired immunity to protozoan infections

Douglas T. Golenbock, MD (Medicine, Division of Infectious Diseases and Immunology) - Toll like receptors and Inflammasomes in infectious disease and Alzheimer's disease

Heinrich Gottlinger, MD, PhD (Molecular, Cell and Cancer Biology) - Host cell interactions with human immunodeficiency virus (HIV)

Dale L. Greiner, PhD (Program in Molecular Medicine) - Transplantation, autoimmunity,

and the use of humanized mice to study human diseases and infections

Nikolaus Grigorieff, PhD (RNA Therapeutics Institute) - Three-dimensional protein structures using high resolution cryo-electron microscopy associated with RNA biology

John P. Haran, MD (Emergency Medicine) Elder gut microbiome interaction with infectious pathogens and cognitionJohn E. Harris, MD, PhD (Dermatology) - Pathogenesis of the autoimmune disease Vitiligo

Jean Marie Houghton, MD, PhD (Medicine, Division of Gastroenterology) - Host immune response to Helicobacter pylori infection, immune modulation of gastric cell signaling and growth regulation in response to Helicobacter infection

Eric Huseby, PhD (Pathology) - Development of T cell tolerance of self and the autoimmune consequence of when it fails

Ronald M. Iorio, PhD (Microbiology and Physiological Systems) – Pathogenic mechanisms of paramysoviruses, which include clinically important human pathogens such as measles, mumps, parainfluenza, and respiratory syncytial viruses.

Allan S. Jacobson, PhD (Microbiology and Physiological Systems) – Translation termination and the development of therapeutic nonsense expression using yeast Saccharomyces cerevisiaeas a model system.

Joonsoo Kang, PhD (Pathology) - Molecular and cellular mechanisms of T cell lineage commitment

Jonathan Kay, MD (Medicine, Division of Rheumatology) – rheumatoid arthritis

Michelle A. Kelliher, PhD (Molecular, Cell and Cancer Biology) - Mechanisms of T cell leukemogenesis and the role of RIP kinases in TNF- and TLR- signaling and cell death

Hardy Kornfeld, MD (Medicine, Division of Pulmonary, Allergy and Critical Care Medicine) - Macrophage apoptosis in TB defense as well as impact of diabetes and hyperlipidemia on TB defense

Timothy F. Kowalik, PhD (Microbiology and Physiological Systems) - Cellular activation by DNA viruses

Evelyn A. Kurt-Jones, PhD (Medicine, Division of Infectious Diseases and Immunology) - Receptor-mediated events in the pathogenesis of infectious and inflammatory processes

Stuart M. Levitz, MD (Medicine, Division of Infectious Diseases and Immunology) - Immune response to fungal pathogens

Egil Lien, PhD (Medicine, Division of Infectious Diseases and Immunology) – Immune

activation and evasion by *Yersinia pestis* and other bacterial pathogens

Craig M. Lilly, MD (Medicine, Division of Pulmonary, Allergy and Critical Care Medicine) – point of care diagnostics

Shan Lu, MD, PhD (Medicine, Division of General Internal Medicine) - The immunogenicity of protein antigens and DNA vaccines

Jeremy Luban, MD (Program in Molecular Medicine) - HIV replication and immune system evasion

Pranoti Mandrekar, PhD (Medicine, Division of Gatroenterology) Signaling mechanisms involved in innate immune cell activation during liver injury and cancer

Dannel McCollum, PhD (Biochemistry and Molecular Biotechnology) – The Hippo signaling pathway and control of cellular responses to mechanical forces

Beth A. McCormick, PhD (Microbiology and Physiological Systems) - Host-pathogen interface at mucosal surfaces

Arthur M. Mercurio, PhD (Molecular, Cell and Cancer Biology) - initiation and progression of epithelial-derived tumors (carcinomas), especially aggressive, poorly differentiated tumors

Ann M. Moormann, PhD, MPH (Medicine, Division of Infectious Diseases and Immunology) - Adaptive and Natural Killer cell immune responses to infectious diseases and infection-associated cancers

John P. Mordes, MD (Medicine, Division of Endocrinology, Diabetes and Metabolism) - Basic and clinical research in type 1 diabetesTrudy G. Morrison, PhD (Microbiology and Physiological Systems) - Glycoprotein processing and assembly and mechanisms of paramyxovirus membrane fusion

Alan C. Mullen, MD, PhD (Medicine, Division of Gastroenterology) - long non-coding RNAs in normal liver function, disease, and malignancy

Mary Munson, PhD (Biochemistry and Molecular Biotechnology) - The Exocyst complex and vesicle trafficking in neutrophils

Peter E. Newburger, MD (Pediatrics, Division of Hematology Oncology) - Leukocyte disorders, molecular hematology, pediatric oncology

Lee J. Quinton, PhD (Medicine, Division of Infectious Diseases and Immunology) - Liver-Dependent Lung Remodeling during Systemic Inflammation

Sanjay Ram, MD (Medicine, Division of Infectious Diseases and Immunology) - Complement system interactions with *Neisseria gonorrhoeae* and *N. meningitidis*

Peter A. Rice, MD (Medicine, Division of Infectious Diseases and Immunology) - Unique determinants present on bacterial surfaces as vaccine candidates to protect against infection in humans

Kenneth L. Rock, MD (Pathology) - Antigen presentation and immune surveillance

Ann M. Rothstein, PhD (Medicine, Division of Rheumatology) - Factors regulating T and B lymphocyte activation, function, longevity, and apoptosis in systemic autoimmune disease

Katherine Ruiz De Luzuriaga, MD (Program in Molecular Medicine) - Viral and immunopathogenesis of persistent viral infections

Christopher M. Sassetti, PhD (Microbiology and Physiological Systems) - Pathogenesis of tuberculosis

Celia A. Schiffer, PhD (Biochemistry and Molecular Biotechnology) – Molecular basis for drug resistance in HIV and more recently Hepatitis C

Liisa K. Selin, MD, PhD (Pathology) - Mechanisms of viral immunology

Neal Silverman, PhD (Medicine, Division of Infectious Diseases and Immunology) – Innate immune signaling

Merav Socolovsky,MD, PhD (Molecular, Cell and Cancer Biology) – Mammalian red cell formation (erythropoiesis) in health and disease

Lawrence Stern, PhD (Pathology) – Molecular recognition in the immune system

Susan L. Swain, PhD (Pathology) – CD4 T cell differentiation, effector function and memory

Paul R. Thompson, PhD (Biochemistry and Molecular Biotechnology) – Target-based design of novel anti-cancer and anti-rheumatoid arthritis chemotherapeutics

Michael Volkert, PhD (Microbiology and Physiological Systems) – DNA repair and damage prevention genes

Jennifer Wang, MD (Medicine, Division of Endocrinology, Diabetes and Metabolism) – Virus interactions with pattern recognition receptors, including Toll-like receptors and RIG-I-like receptors

Bruce A. Woda, MD (Pathology, Division of Anatomic Pathology) - Biology of autoimmune diabetes, disorders of the hemopoietic system with a focus on histiocytic proliferative disorders, myelodysplastic syndromes and lymphoma

Associate Professors

Milena Bogunovic, MD, PhD (Pathology) - Macrophages and dendritic cells in enteric infections, inflammatory bowel disease and irritable bowel syndrome

Michael Brehm, PhD (Molecular Medicine) - Human immune responses to infectious agents and transplanted non-self tissues

Vanni Bucci, PhD (Microbiology and Physiological Systems) - Host-microbiome interaction, computational biology, synthetic biology

Rachel M. Gerstein, PhD (Microbiology and Physiological Systems) - Developmental regulation of V(D)J recombination

Sharone Green, MD (Medicine, Division of Infectious Diseases and Immunology) - Immunopathogenesis of flaviviral infectionsDavid Grunwald, PhD (RNA Therapeutics Institute) - mRNA and nucleocytoplasmic transport

Javier Elbio Irazoqui, PhD (Microbiology and Physiological Systems) - Host-pathogen interactions and neural control of innate immunity

Darren James Lee, PhD (Ophthalmology and Visual Sciences) - discover and develop novel effective therapies for Autoimmune Uveitis

James B. Munro, PhD (Microbiology and Physiological Systems) - quantitative biophysical approaches to visualize virus replication, and probe the functions of proteins and RNAs

Peter M. Pryciak, PhD (Biochemistry and Molecular Biotechnology)- Signal Transduction and Cell Polarity

Read Pukkila-Worley, MD (Medicine, Division of Infectious Diseases and Immunology) - Host-pathogen interactions in *Caenorhabditis elegans*

Andrea Reboldi, PhD (Pathology) Mucosal immunology, host-microbiome interaction and lipid metabolism

Dorothy P. Schafer, PhD (Neurobiology) - Glial cells in synapse development and plasticity in the healthy and diseased nervous system

Carol E. Schrader, PhD (Microbiology and Physiological Systems) - B cell biology and immunology

Elizabeth Anne Shank, PhD (Microbiology and Physiological Systems) - Microbial interspecies interactions

Jae-Hyuck Shim, PhD (Medicine, Division of Rheumatology) – Osteoporosis, gene therapy and inflammatory arthritisHyun Youk, PhD (Systems Biology) - Systems-level dynamics of life-death transitions

Assistant Professors

Prabhani Upeka Atukorale, PhD (Molecular, Cell and Cancer Biology) - immunostimulatory nanoparticles by immune cells in the microenvironment of cancer

Rigel Chan, PhD (Neurology) - In-vitro population genetics of human patients by phenotyping viruses and inflammatory pathways in Alzheimer's and other neurological diseases

Kiera Leigh Clayton, PhD (Pathology) – HIV, NK cell-mediated killing, macrophages, T cell immunityAndres Colubri, MFA, PhD (Microbiology and Physiological Systems) - Digital epidemiology, clinical ML, next-gen genomic visualization, and STEAM educational outreach

Wenwen Fang, PhD (RNA Therapeutics Institute) – Sensing RNA

Josue Flores Kim, PhD (Biochemistry and Molecular Biotechnology) - antibiotic function using an interdisciplinary approach to genetically and biochemically characterize their regulatory networks

Accalia Mai-Wan Fu, PhD (Program in Molecular Medicine) – Metabolic dialogue of pancreatic beta and immune cells

Fiachra Emanuel Humphries, PhD (Medicine, Division of Innate Immunity) - The inflammasome in autoinflammatory syndromes

Allison May Keeler-Klunk, PhD (Pediatrics) – Immune responses to AAV gene therapy

Milka Koupenova, PhD (Medicine, Division of Cardiovascular Medicine) - Mechanisms of viral sensing by platelets and their contribution to immunothrombosis and platelet reprogramming

Elaine Lim, PhD (Molecular, Cell and Cancer Biology) - Host genetics and DNA viruses in neurological diseases

Ana L. Maldonado-Contreras, PhD (Microbiology and Physiological Systems) - Gastrointestinal microbiome, diet-microbiome interactions

William M. McDougall, PhD (Microbiology and Physiological Systems) - CRISPR genetic screens to discover host-virus interactions

Kenan C. Murphy, PhD (Microbiology and Physiological Systems) - Double-stranded DNA break repair in Escherichia coli, recombineering technology for gene replacement in bacterial pathogens

Kerstin Nundel, PhD (Medicine, Division of Rheumatology) - B cell differentiation during

autoimmune diseases and infection, Crosstalk between B cell receptor and innate immune receptors (TLR, STING)

Megan Horn Orzalli, PhD (Medicine, Division of Infectious Diseases and Immunology) - Host-pathogen interactions and innate immune responses to infection at barrier surfaces.

Zaida Gisela Ramirez Ortiz, PhD (Medicine, Division of Infectious Diseases and Immunology) - Understanding the role and the molecular mechanisms of mammalian Scavenger Receptors in the capture and clearance of apoptotic debris

Mehdi Rashighi Firoozabadi, MD (Dermatology) – Vitiligo pathogenesis and treatments

Jillian M. Richmond, PhD (Dermatology) - T cell migration and function in autoimmunity and dermatology

Marcus Ruscetti, PhD (Molecular, Cell and Cancer Biology) - Tumor intrinsic mechanisms of immune escape

Melanie I. Trombly, PhD (Medicine) - Autoimmune Diabetes

Gowthaman Uthaman, PhD (Pathology) - Immunobiology of allergic response

Maria L. Zapp, PhD (Program in Molecular Medicine) - Regulation of gene expression at the level of RNA nucleocytoplasmic transport

Guocai Zhong, PhD (RNA Therapeutic Institute) – Gene Therapy

Program in Neuroscience

Neuroscience investigators focus on:

- The neural, molecular and genetic mechanisms that underlie nervous system development and function, learning and memory, addiction, glial function, and circadian rhythmicity;
- Mechanisms of synaptic neurotransmitter release, analysis of how neurotransmitter receptors and membrane channels operate, and how drugs act on these processes to modify cellular function and behavior;
- Disorders of the central nervous system, with special emphasis on neurodegenerative disorders, amyotrophic lateral sclerosis, autism spectrum disorders, mental retardation and other developmental disabilities.
- Development of new methods and therapies for neurological diseases, including disruption of mutant gene expression using chemically modified oligonucleotides, gene knock-down or replacement with adeno-associated viral vectors, and CRISPR-mediated gene correction.

The **Graduate Program in Neuroscience** brings together many components of the neuroscience community at UMass Chan Medical School. Like the Graduate Program, the neuroscience community at UMass Chan Medical School is truly interdepartmental and interdisciplinary. A critical and unique feature of the research environment at UMass Chan Medical School is that departmental affiliations affect letterheads but not interactions or collaborations. This atmosphere is especially conducive to the scientific growth of graduate students obtaining their degrees in an interdisciplinary field like neuroscience.

Participating faculty have primary appointments in 15 different departments, with the largest concentrations of faculty (≥ 10 each) located in the Departments of Neurobiology, Neurology and Psychiatry. Clusters of neuroscientists are located in many other Departments, with 3 or more Program members in each of eight other departments: Program in Molecular Medicine, Biochemistry & Molecular Biotechnology, Molecular, Cell & Cancer Biology, the RNA Therapeutics Institute, Microbiology & Physiological Systems, Radiology, Neurological Surgery and Pediatrics. This diversity of affiliations reflects the diversity of research interests in the Program, which range from investigation into basic mechanisms of neuronal function in model organisms and identifying novel disease genes to development of therapies for neurodegenerative diseases and improving clinical care for children with developmental disabilities.

Requirements for Specialization

Graduate students who specialize in Neuroscience will acquire a broad background in the concepts of contemporary neuroscience, gain exposure to state-of-the-art techniques and will acquire a foundation in the function of the nervous system through an integrated program of advanced coursework, laboratory research, and seminar and journal club attendance.

All graduate students within the BBS division of the Morningside Graduate School of Biomedical Sciences must complete the Biomedical Sciences Core Curriculum, consisting of *Scientific Inquiry in Biomedical Research* (Fall, Year 1), *Preparation for Qualifying Exam* (Fall, Year 2), and *Professionalism and Research Conduct* (Year 3). Students explore research areas of interest to them by participating in three rotations and then will select the faculty mentor who will supervise their thesis research. Thesis Research Advisory Committee meetings are required annually during thesis research. Students in the third year and beyond are also required to complete an annual Individual Development Plan, and the TRAC meeting will include discussion of progression toward both research and professional development goals.

In addition to the Morningside Graduate School of Biomedical Sciences Core Curriculum, students in the Graduate Program in Neuroscience are required to take at least three (3) Elective courses during their graduate career, of which one must be *Cellular, Molecular and*

Developmental Neuroscience (BBS 780). This introductory course is usually taken in the Spring semester of the first year and covers topics including ionic mechanisms underlying neuronal excitability, neurosecretion, neurotransmitters and receptors, mechanisms of neuronal development and research methods in neuroscience. Two other elective courses are offered by the Program: *Systems and Circuits Neuroscience (BBS 820)* and *Bases of Brain Disease (BBS 782*). Elective courses offered by other graduate programs can also be taken to meet the elective course requirements. The Advance Topics courses are selected to yield a program of study tailored to meet the needs of each student.

Program in Neuroscience students are expected to attend the weekly Neuroscience Program Seminar Series lectures, featuring visiting experts from outside the university, and to participate in a seminar series in their home department. Students are also required to enroll in *Neuroscience Seminar* for two semesters. (Two discontinued courses, *Communicating Neuroscience: Learning by Doing*, and *Journal Club in Neuroscience* are treated as equivalent to *Neuroscience Seminar* in meeting this requirement).

Qualifying Exam

The Neuroscience Program Qualifying Exam (QE) procedure is entirely consistent with the Basic Biomedical Science Umbrella Pathway procedures, including composition and format:

- The QE Committee (QEC) consists of 4 faculty members, 3 appointed by the Program Director (one of which serves as Chair and must be tenured) and one tenured General Examiner appointed by the Morningside Graduate School of Biomedical Sciences.
- The exam will be in the format of an NIH F31 proposal.

Several program-specific aspects of the process are described below.

Committee Selection Process and Timeline

Students are welcome to discuss potential QE Committee (QEC) members with the Program Director. The Thesis Advisor and Student will develop a slate of at least 5 QEC nominees and propose this slate to the Program Director by January 25. The list must include at least two potential Chair candidates (tenured). The Program Director will determine willingness of nominees to serve and to confirm lack of conflicts of interest. Additional nominees may be solicited from the Student and Advisor if the number of 'acceptable' nominees is inadequate. Additional members may be proposed by the Program Director, with the Student and Thesis Advisor having rights of refusal. The Program Director will select 3 members from among the nominees by January 31, and will forward this information to Morningside Graduate School of Biomedical Sciences and the Student. Committee selection will take into consideration the desire to distribute the QE workload among faculty while

having at least one member with 'content expertise.'

QE Topic

The Student's QE topic may be either their proposed thesis work or an outside topic.

Aim Meetings

The Student's Thesis Advisor may be present during the Aims Meeting, and this is highly recommended, but is not required. The purpose of the Thesis Advisor's presence is for them to be able to listen to the issues raised by the QEC so they can have a constructive de-briefing meeting with the student within 1-3 days of the Aims meeting. The Thesis Advisor may be asked specific questions by the Committee but is otherwise there to observe, not participate.

Courses in Neuroscience:

Keystone Course: Cellular, Molecular and Developmental Neuroscience (BBS 780)

This 3-credit course will have two parts. Part I will focus on electrical properties of neurons, transmitters, receptors, and neurotransmitter release. Part 2 will focus on neurodevelopment. Videos, problem sets, paper discussions and take-home assignments will be integrated with faculty providing topic introductions for efficient but active learning. Modern methods and research preparations will be introduced along with subject matter to prepare students for thesis research.

Other Advanced Topics Courses in Neuroscience

These courses offer in-depth instruction on cutting-edge research in contemporary neuroscience.

Systems and Circuits Neuroscience (BBS 820)

This 3-credit Advanced Topics course will cover sensory and motor systems, integrative neuroscience, motivated behaviors, and model organisms. The course (BBS 820) will consist of lectures, student presentations, and paper discussions. The course is intended to follow *Cellular, Molecular and Developmental Neuroscience*, but that course (BBS 780) is not a prerequisite. Strongly recommended for Program in Neuroscience students; others are welcome.

Bases of Brain Disease (BBS 782)

This 2-credit advanced topics course presents an in-depth study of nervous system diseases, including their neurochemical, anatomical, cell biological and genetic basis. Students will further develop their skills in reading literature critically and in the presentation of research material. The topics cover the cell and molecular biological processes of brain function in health and disease.

Other Courses in Neuroscience (Not Advanced Topics Courses):

Neuroscience Seminar

Exposure to new areas of research through attending seminars is an important component of graduate study. Students enrolled in *Neuroscience Seminar* (BBS 814) are expected to attend the Neuroscience Program Seminar series and to meet with external speakers (at least 70% of the time). Program in Neuroscience students are required to take 2 semesters of Neuroscience Seminar. (Neuroscience Journal Club (now discontinued) is equivalent to Neuroscience Seminar in meeting this requirement.)

Tutorial in Neuroscience

Tutorials are arranged by students with individual faculty in the Neuroscience Program and are designed to be flexible. They are usually one-on-one or small group meetings and in the format of discussions, but other configurations are possible. Meetings are usually once a week for a full semester, but more frequent or longer meetings for part of a semester are also possible. Subject matter is anything in the field of neuroscience, but should not be what the student is required to do as their rotation or thesis research, e.g., it should not be attending the lab meeting that all lab members attend, but may be a session to discuss "classic" papers even if related to the area of research. Other possibilities include discussion of a hot paper from last week; Nobel laureates; grant writing and the NIH peer review system; how to use specific methods; and directed readings. Tutorials can have multiple faculty members. To allow flexibility, a generic tutorial is listed in the registration materials, with the graduate Program Director as the faculty member. The graduate Program Director must approve the proposed tutorial activity, usually presented as a proposed syllabus developed jointly by the faculty member(s) and student(s). Students may enroll for multiple occurrences of Tutorial in Neuroscience.

Faculty:

Program Director

David R. Weaver, PhD (Professor of Neurobiology) – Molecular physiology of circadian rhythms

Professors

Mark J. Alkema, PhD (Neurobiology) – *C. elegans* behavioral genetics

Raffi V. Aroian, PhD (Molecular Medicine) – Assessing how vertebrate hosts and their immune system interact with intestinal nematodes, with the goal of controlling autoimmune diseases including MS; cognitive impact of parasitic nematodes

Neil Aronin, MD (Higgins Family Professor of Neuroscience; Medicine) – Neurodegenerative diseases, especially Huntington's disease

Ingolf Bach, PhD (Molecular, Cell & Cancer Biology) – Neuronal cell fate specification

Daryl A. Bosco, PhD (Neurology) – Mechanisms of amyotrophic lateral sclerosis; protein misfolding in ALS

Robert H. Brown, Jr., DPhil, MD (Leo P. and Theresa M. LaChance Chair in Medical Research; Neurology) – Amyotrophic lateral sclerosis

Silvia Corvera, MD (Endowed Chair in Diabetes Research; Molecular Medicine) – Mechanisms of human adipose tissue development and their relationship to metabolic diseases

Roger J. Davis, PhD, FRS (H. Arthur Smith Chair in Cancer Research; Howard Hughes Medical Institute Investigator; Chair, Molecular Medicine) – Signal transduction by the epidermal growth factor receptor; mechanisms by which growth factors regulate cellular proliferation

Charles P. Emerson, Jr., PhD (Neurology; Wellstone Program) – Muscular dystrophies

Patrick Emery, PhD (Neurobiology) – Circadian rhythms and photoreception in *Drosophila*

Michael M. Francis, PhD (Neurobiology) – Mechanisms of neuronal signaling in *C. elegans*

Jean A. Frazier, MD (Robert M. and Shirley S. Siff Chair in Autism; Psychiatry) – Neurodevelopmental disorders

Fen-Biao Gao, PhD (Governor Paul Cellucci Chair in Neuroscience Research; Neurology) – Neuronal MicroRNAs and Neurodegeneration

Guangping Gao, PhD (Penelope Booth Rockwell Chair in Biomedical Research; Director, Horae Gene Therapy Center; Microbiology and Physiological Systems) – Adeno-associated virus vectors for gene therapy of genetic diseases including Canavan Disease; study of miRNA function

Matthew J. Gounis, PhD (Radiology) – Minimally invasive neuroendovascular surgery

Nikolaus Grigorieff, PhD (Investigator, Howard Hughes Medical Institute; RNA Therapeutics Institute) – Cryo-electron microscopy

John P. Haran, MD, PhD (Emergency Medicine) – Microbiome-gut-brain axis and Alzheimer's disease; drug-resistant pathogens including *C. difficile*

Lawrence J. Hayward, MD, PhD (Neurology) – Ion channelopathies; motor neuron disease

Mark D. Johnson, MD, PhD (Maroun Semaan Chair in Neurosurgery; Chair, Neurological Surgery) – microRNAs, glioblastoma and normal-pressure hydrocephalus

David N. Kennedy, PhD (Psychiatry) – Neuroimaging and Neuroinformatics

Anastasia Khvorova, PhD (Remondi Family Chair in Biomedical Research; RNA Therapeutics Institute) – Novel oligonucleotide therapeutics; therapeutic gene silencing

William R. Kobertz, PhD (Biochemistry & Molecular Pharmacology) – Structure, function and modulation of ion channels

John E. Landers, PhD (Neurology) – Genetics of familial and sporadic ALS

Jeanne B. Lawrence, PhD (Neurology) – Chromosome silencing, Down Syndrome, and Alzheimer Disease

Ryan W. Logan, PhD (Psychiatry) – Molecular and cellular mechanisms underlying the relationships between sleep, circadian rhythms, and psychiatric disorders

Haley E. Melikian, PhD (Neurobiology, Brudnick Neuropsychiatric Research Institute) – Cocaine- and antidepressant-sensitive monoamine transporters

Stephen C. Miller, PhD (Biochemistry & Molecular Pharmacology) – Illuminating the brain with bioluminescence

Mary Munson (Biochemistry & Molecular Pharmacology) – Regulation of vesicle targeting and fusion

Joel D. Richter, PhD (Arthur F. Koskinas Chair in Neuroscience; Molecular Medicine) – Translational control of synaptic plasticity, learning and memory

Evgeny I. Rogaev, PhD, Dr Sci (Psychiatry; Brudnick Neuropsychiatric Research Institute) – Molecular genetics of neuropsychiatric diseases and neurodegeneration

Anthony J. Rothschild, MD (Irving S. and Betty Brudnick Chair in Psychiatry; Director, Center for Psychopharmacologic Research and Treatment; Psychiatry) – Clinical studies of affective disorders, psychoPharmacology

Sean P. Ryder, PhD (Biochemistry & Molecular Pharmacology) – RNA binding proteins; post-transcriptional regulation of myelination and nematode development

Manojkumar Saranathan, PhD (Radiology) – High-resolution brain imaging

Rachael W. Sirianni, PhD (Neurological Surgery) – Development of therapeutic nanoparticles

Andrew R. Tapper, PhD (Neurobiology; Director, Brudnick Neuropsychiatric Research Institute) – Neurobiology of addiction

Jonathan K. Watts (RNA Therapeutics Institute) – Therapeutic gene silencing with

chemically modified antisense oligonucleotides

Zuoshang Xu, MD, PhD (Biochemistry & Molecular Pharmacology) – Neuronal cytoskeleton and motor neuron disease

Ronghua ZhuGe, PhD (Microbiology and Physiological Systems) – Intracellular localized Ca2+ signaling

Associate Professors

Milena Bogunovic MD, PhD (Pathology) – Macrophages and the enteric nervous system in intestinal health and disease

David M. Cochran, MD, PhD (Barrett Family Term Chair in Neurodevelopmental Disorders; Psychiatry) – Neurodevelopmental disorders and neuroimaging

E. Kale Edmiston, PhD (Psychiatry) – Sensory perception in people with or at risk for mood and anxiety disorders, imaging

Kensuke Futai, PhD (Neurobiology, Brudnick Neuropsychiatric Research Institute) – Molecular determinants of synapse formation and stabilization

Lisa L. Hall-Anderson, PhD (Neurology) – Epigenetic regulation and nuclear structure

Nils Henninger, MD, PhD (Neurology) – Stroke and brain injury

Javier E. Irazoqui, PhD (Marcellette G. Williams Scholar; Microbiology and Physiological Systems) – Neural-immune communication

Elinor K. Karlsson, PhD (Molecular Medicine) – identification of genetic risk factors for infectious diseases and psychiatric disorders

Dohoon Kim, PhD (Molecular, Cell & Cancer Biology) – identifying alterations to metabolic pathways supporting cancer cells (gliomas) and exploring their utility for therapeutics

Darren J. Lee, PhD (Ophthalmology and Visual Sciences) – Auto-immune uveitis; rocular immunology

Gilles Martin, PhD (Neurobiology, Brudnick Neuropsychiatric Research Institute) – Drugs of abuse; synaptic plasticity

Claudio Punzo, PhD (Ophthalmology and Visual Sciences) – Neurodegeneration in the retina

Ann R. Rittenhouse, PhD (Microbiology and Physiological Systems) – Calcium channels and neuronal plasticity

Dorothy Schafer, PhD (Neurobiology; Brudnick Neuropsychiatric Research Institute) – Neuron-glia interactions regulating synaptic circuit development and plasticity

Miguel S. Sena-Esteves, PhD (Neurology; Horae Gene Therapy Center) – Preclinical gene therapy for neurological disorders

Hong Zhang, PhD (Pediatrics) – aging and cellular senescence

Jill A. Zitwewitz, PhD (Radiology) – protein misfolding and disease; graduate education

Assistant Professors

Gabriella L. Boulting, PhD (Neurobiology) – Activity-dependent gene expression in the primate brain

Michael H. Brodsky, PhD (Molecular, Cell and Cancer Biology) – Gene editing to correct disease genes

Alexandra Byrne, PhD (Neurobiology) – Mechanisms of axon regeneration and degeneration in the aging nervous system

Yingleong (Rigel) Chan, PhD (Neurology) – Using induced pluripotent stem cells from patient samples to model Herpes viral infection as a cause of Alzheimer's disease and Hearing-loss due to Cisplatin treatment.

Janice A. Dominov, PhD (Neurology) – Neuromuscular Disease Pathogenesis and Therapeutics

Heather A. Gray-Edwards, DVM, PhD (Radiology; Horae Gene Therapy Center) – large animal models of neurological diseases; gene therapy

Paul L. Greer, PhD (Molecular Medicine) – Non-GPCR Chemosensors for Mammalian Olfaction

Fiachra E. Humphries, PhD (Medicine) – Innate immunity

Alison M. Keeler-Klunk, PhD (Pediatrics) – Gene therapy, T-REGS and immune response to Adeno-associated viruses (AAV's)

Sohye Kim, PhD (Psychiatry) – Human brain development and maternal-infant bonding

Oliver D. King, PhD (Neurology; Wellstone Program) – Bioinformatic approaches in neurological diseases

Elaine T. Lim, PhD (Molecular, Cell & Cancer Biology) – To understand the genetic mechanisms of complex neurological diseases (ASD and Alzheimer's) through computational and statistical methods and experimental technology

Michael A. Lodato, PhD (Molecular, Cell & Cancer Biology) – Somatic mutations and mosaicism in aging and neurological disease

Sumeda Nandadasa, PhD (Pediatrics) – Primary cilia and extracellular matrix

Stephanie Puig, PhD (Psychiatry) – Opiate tolerance, addiction and withdrawal

Travis C. Thomson, PhD (Neurobiology) – retroviruses and viral-like signaling in neuronal health and disease

Summer B. Thyme, PhD (Biochemistry and Molecular Biotechnology) – Neuronal development and behavior

Dan Wang, PhD (RNA Therapeutics Institute) – AAV gene therapy of neurological and metabolic diseases

Yang Xiang, PhD (Neurobiology) – Molecular and neural circuit mechanisms underlying behavior

Hongwei Yang, MD, PhD (Neurological Surgery) – microRNAs, glioblastoma and normal-pressure hydrocephalus

Eviatar I. Yemini, PhD (Neurobiology) – Neural activity and behavioral changes during development

Jin Zhang, PhD (Molecular Medicine) – Interplay of sensory systems and internal states; taste

Professors Emeritus

Vivian Budnik, PhD (Worcester Foundation for Biomedical Research Chair; Neurobiology) – Molecular mechanisms of synapse assembly and plasticity

Michael P. Czech, PhD (Isadore and Fannie Foxman Chair in Medical Research; Molecular Medicine) – Molecular and genetic regulation of insulin signaling in type 2 diabetes and obesity; neuro-adipose interactions

Adjunct Faculty:

Assistant Professors

Mo H. Modarres, PhD (Psychiatry) – Development of methods for quantifying sleep and brain function abnormalities

Program in Translational Sciences

A major goal of biological research is to acquire insight and tools to solve problems in medicine. The program in Translational Sciences was developed to address this goal and train graduate students to bring the power of cutting-edge biological tools to bear upon

clinical problems. Program faculty members possess broad expertise in basic and clinical research and are drawn from 15 different academic departments and programs at UMass Chan Medical School.

The program incorporates several unique features to provide focused training at the interface between basic and clinical sciences. Program students are co-mentored by both basic and clinical scientists on their thesis advisory committee. Regular meetings with both mentors will ensure the student gains a broad understanding of applying basic biological methods to clinical problems. The Molecular Basis of Disease course has been developed to provide students with an understanding of the principles of translational science and tools for carrying out translational research.

Requirements for Specialization

Students in the Translational Science program must complete the Molecular Basis of Disease (BBS-786) electives course. In addition, all Translational Science students must complete the core curriculum and at least two graded elective courses of 2-4 credits each offered by any Morningside Graduate School of Biomedical Sciences program. The selection of elective courses is tailored to the requirements of each student and is determined after discussion between the thesis advisor and the student. As part of the student's training, they must also present their research data once a year in a translational science seminar series or a research retreat.

Qualifying Exam

The qualifying examination is arranged in consultation with the Graduate Director. It can only be taken after completing the required course of the Morningside Graduate School of Biomedical Sciences, the Translational Science Molecular Basis of Disease advanced topics course, and three laboratory rotations. Based on the student's planned thesis research or another topic of the student's choosing, the qualifying exam includes a written original research proposal and an oral defense of this proposal.

Courses in Translational Science:

Molecular Basis of Disease

This course aims to introduce Morningside Graduate School of Biomedical Sciences graduate students to i) the experimental approaches used to understand the molecular causes of representative diseases and ii) the application of such knowledge toward developing rational therapies. We bring together basic, clinical, and physician-scientists from several departments and the biomedical industry to provide the necessary background and to participate in the discussion of key articles. The course is designed to include many disease

areas with a primary focus on the bench (basic science knowledge) to bedside (clinical understanding of the disease) and back to the bench (planning translational approaches). Interspersed within various disease areas will be speakers who will discuss clinical aspects as well as translational/pre-clinical approaches, drug design process, and novel approaches to therapy, including gene-, RNA-, cell-based interventions, biologics, and small molecules. In addition to faculty presentations for the first 120 minutes of the class, students will work in teams to present a research article in the last 60 minutes, facilitating an interactive discussion. Class discussions will help prepare students to participate effectively in presentations and team-oriented translational science. For final exams, student teams will write a research proposal addressing a disease mechanism or therapy development of their interest and defend the proposal during the last week of class.

Faculty

Program Directors

Chinmay Trivedi, MD PhD – (Medicine) – Molecular mechanisms to therapies of cardiac and vascular diseases – including, Lymphedema, Vascular tumors - Epithelioid Hemangioendothelioma (EHE), Congenital cardiovascular diseases, Hepatic vascular hemangiomas, Connective tissue disorders, and Cardiomyopathies.

Pranoti Mandrekar, PhD (Medicine) – Translational/Pre-clinical targets to modulate innate immune cell responses in liver diseases such as fatty liver, inflammation, fibrosis and cancer.

Professors

Neil Aronin, MD (Medicine) – Huntington's disease and Parkinson's disease - Our lab research focuses on the molecular therapeutics for Huntington's disease. We use three approaches for molecular therapy: siRNA infusion into the cerebrospinal fluid, AAV-miRNA injection directly into the neo-striatum (brain region affected initially by the disease), and gene editing by CRISPR/Cas9.

Ingolf Bach, PhD (Molecular, Cell & Cancer Biology; Molecular Medicine) – Neuronal cell fate specification

Eric H. Baehrecke, Ph.D. (Molecular, Cell & Cancer Biology) – Ataxia and Dystonia - Our lab studies the regulation and function of autophagy (self-eating) in the context of normal animal development and in models of disease. Defects in autophagy have been associated with a wide variety of human disorders, including rare diseases. Modulation of autophagy is being considered for a wide variety of disease therapies.

Jeffrey Bailey MD, Ph.D. (Medicine) – The Bailey lab is interested in infectious disease genetics and tropical disease. Our work focuses on how gene duplication and conversion

affect the interplay of host and pathogen assessing such features as host immunity, pathogen virulence, and pathogen drug resistance. We mainly work on malaria with current funding to understand the role of host copy number variation to protect against severe disease and the study of copy number variation and drug resistance in the parasite. All of this work leverages high-throughput genomics and improving computational approaches in the analysis of the host and pathogen. (web site: baileylab.umassmed.edu/)

Bruce A. Barton, PhD, (Population Health Sciences) Biostatistics and health services research, director, and quantitative methods core.

Daryl Bosco, Ph.D. (Neurology) - Amyotrophic lateral sclerosis (ALS) - My lab uses a multidisciplinary approach involving biochemistry, cell biology (including iPS cell technology), biophysics and *in vivo* model systems for investigating the pathogenic mechanisms underlying ALS. We study the effects of ALS-mutations on protein shape and conformation, and try to understand how these changes convert a normal protein into a toxic species. We also aim to correct or neutralize the toxic protein shape using small molecules and biologics. Our lab is also interested in the role of stress in neurodegenerative disease pathogenesis. We are developing new and innovative methods for studying the effects of stress *in vivo,* in order to understand how stress contributes to disease onset and progression.

Robert H. Brown, MD, DPhil, (Neurology) - Amyotrophic lateral sclerosis (ALS), Gene defects, Muscular dystrophy, Neuromuscular disease - Dr. Brown's laboratory has focused on the identification of gene defects that elucidate the molecular pathogenesis of selected neuromuscular diseases including amyotrophic lateral sclerosis (ALS, also known as Lou Gehrig's disease), muscular dystrophy, adrenoleukodystrophy, hereditary neuropathy and hyperkalemic periodic paralysis. Knowledge of theses disease genes has facilitated the creation of mouse and cell-based models of these disorders. In turn, these resources have allowed study of therapeutic strategies using conventional small molecule approaches and new modalities such as inhibitory RNAi.

Silvia Corvera, MD, (Molecular Medicine) - Metabolic diseasesType-2 diabetes - Metabolic diseases, such as type-2 diabetes, non-alcoholic fatty liver disease (NASH), and hypertension are an emerging worldwide epidemic associated with substantial human suffering and a large economic burden. We are interested in understanding the cellular and molecular mechanisms that underlie metabolic diseases, and enable therapeutic strategies to be developed.

Roger Davis, PhD (Molecular Medicine) The Davis laboratory studies responses to biological stress that are mediated by the cJun NH2-terminal kinase (JNK) signaling pathway during

the development of cardiovascular disease, cancer, and diabetes. The goal of the research program is to identify new therapeutic approaches for the treatment of these diseases.

Michael Czech, PhD (Molecular Medicine) The Czech laboratory group uses gene silencing and genome editing techniques to identify, characterize and validate molecules and cellular pathways that mediate metabolic dysfunction in diseases such as obesity, type 2 diabetes and atherosclerosis.

Kate Fitzgerald, PhD (Medicine) - Inflammatory diseases - Our lab is interested in understanding how the type I interferon response is regulated during infection. Our discovery that nucleic acids play a central role in the interferon response has paved the way for greater understanding of the earliest inflammatory response to infection by viruses. Recently, nucleic acid driven innate pathways have been linked to human disease. A family of rare single-gene disorders has been defined as caused by disturbances in intracellular nucleic acid metabolism or in cytosolic nucleic acid-sensing pathways. These diseases have a devastating impact on patients and there are currently no cures to treat them.

Terence Flotte, MD (Dean, T.H. Chan School of Medicine) - Alpha-1 antitrypsin deficiency Single gene disorders - Our lab has developed a number of approaches to gene therapy for alpha-1 antitrypsin deficiency (genetic emphysema), using AAV gene therapy vectors, several of which we have tested in human trials. We have also developed vectors for a number of other single gene disorders, including fatty acid oxidation disorders and cystic fibrosis.

Jean A. Frazier, MD, (Psychiatry) - Early onset bipolar disorder (BPD), Schizophrenia and Autism - Research addresses a variety of scientific problems relevant to advancing the understanding, diagnosis and treatment of individuals with neurodevelopmental disorders.

Fen-Biao Gao, Ph.D. (Neurology) - Amyotrophic lateral sclerosis (ALS)Frontotemporal dementia (FTD) - Our lab has been at the forefront of investigations of the pathogenic mechanisms of FTD and related neurodegenerative disorders such as ALS. We generated the first induced pluripotent stem cell (iPSC) models of FTD and also use genetic model organisms such as Drosophila and mice. In recent years, we have contributed to the discovery of a number of molecular defects in ALS/FTD with genetic mutations in *C9ORF72*, *CHMP2B* and *GRN*.

Manuel Garber, PhD, (Program in Bioinformatics & Integrative Biology; Molecular Medicine) - Dr Garber's group strives to develop the tools to analyze, integrate and fully leverage the advancements in genome wide experimental technologies. We have developed and continue to enhance the Scripture toolkit for short read analysis (ChIP-Seq and RNA-Seq) and the SiPhy suite for comparative sequence analysis. Both tools have been critical in our exploration of the functional landscape of the human genome. Our lab also aims to

integrate functional data such us protein-RNA, RNA-DNA and RNA-RNA interactions with comparative analysis to understand the evolution of these interactions and how they have changed the molecular circuitry of the cell.

Rachel Gerstein, PhD (Microbiology and Physiological Systems) We investigate pathogenesis and new treatments for Non-Hodgkin's B cell Lymphoma. We identified epigenetic suppression of the senescence regulator SMURF2 as a novel pathway promoting c-myc over-expression in Diffuse Large B cell Lymphoma (DLBCL). Current efforts are aimed at further defining this pathway in DLBCL as well investigating the basis of metastasis and chemotherapeutic resistance in a range of B cell Lymphomas.

Dale Greiner, Ph.D. (Molecular Medicine) – Auto-immune disorders - Our laboratory focuses on the study of human immunity and autoimmunity using humanized mice to investigate human immune responses without putting individuals at risk.

Robert Goldberg, PhD (Population Health Sciences) Cardiovascular epidemiology; preventive cardiology; epidemiologic methods

Douglas Golenbock, MD, (Medicine) - Pathophysiology of sepsis and pelvic inflammatory disease

Lawrence Hayward, MD, PhD. (Neurology) - Facioscapulohumeral dystrophy (FSHD) - Research group focuses on defining molecular mechanisms that cause selected neuromuscular diseases, including ALS (amyotrophic lateral sclerosis), FSH (facioscapulohumeral) muscular dystrophy, and hyperkalemic periodic paralysis.

David Harlan, MD (Medicine) – Basic research focuses on better understanding of beta cell biology, and his clinical research focuses on developing better diabetes care delivery models. Clinical research focuses on developing better diabetes care and developing novel communication tools to better engage patients in their own care.

Allan Jacobson, Ph.D. (Microbiology and Physiological Systems) - Nonsense-mediated mRNA decay - Our lab studies post-transcriptional control of gene expression, yielding fundamental insights in three broad areas: poly(A) function, mRNA stability determinants and translation termination mechanisms. Our work led to the development of a first-in-class medicine for the treatment of nonsense-mediated Duchenne muscular dystrophy (DMD). The drug is now being used in more than 25 countries and is being evaluated as a therapeutic for similar genetic disorders.

Catarina Kiefe, MD, PhD (Population Health Sciences) – Lab objective is to improve healthcare outcomes for individuals and populations.

Anastasia Khvorova, PhD (RNA Therapeutics Institute) - Medicinal chemistry of therapeutic

oligonucleotides. In particular lab is interested in expanding chemical diversity of siRNA for treatment of neurodegenerative disorders.

Timothy Kowalik, PhD (Microbiology and Physiological Systems) The Kowalik laboratory studies basic and translational science aspects of viral infections, in particular infections caused by cytomegalovirus and influenza virus. Our goals are to better understand the disease process associated with these infections and to use our basic research program to improve antiviral therapies and vaccines.

Brian Lewis, PhD (Molecular, Cell & Cancer Biology) - A primary goal of our laboratory is to elucidate the molecular mechanisms essential for the development and progression of pancreatic and hepatocellular carcinomas, with the goal of informing novel treatment strategies for these malignancies. We perform a combination of in vivo studies utilizing genetically engineered mouse models, cell culture phenotypic assays performed on primary cell cultures and cancer cell lines, and molecular biology and biochemical approaches to address these questions.

Katherine Luzuriaga, MD (Pediatrics) As a physician-scientist, I use scientific investigation to inform the development of prevention and treatment strategies for persistent viral infections in children. HIV pathogenesis studies focus on the genetic and biologic characterization of viruses that are transmitted from women to their infants and on defining the effects of early combination antiretroviral therapy on HIV latent reservoirs. Epstein Barr virus pathogenesis studies focus on defining the role of EBV-specific immune response (neutralizing antibodies, CD8+ T cells) in controlling viral replication and on evolution of the viral quasispecies.

Pranoti Mandrekar, PhD (Medicine) – *Fatty liver disease, Inflammation, Fibrosis and cancer* - Research in my laboratory focuses on understanding the signaling mechanisms involved in innate immune cell activation during liver injury and cancer. The physiological function of the liver is elimination of pathogens and antigens from the blood for which mounting of an immune response is required. To avoid unnecessary activation of the immune system, the liver develops a local immune response followed by induction of peripheral tolerance towards the antigen. When stressful agents such as pathogens or environmental insults challenge the liver for extended periods of time and their elimination is not possible, inflammation and injury follows. The onset of inflammation in the liver is followed by fibrosis, cirrhosis and liver cancer. Thus, studying the molecular mechanisms involved in liver inflammation will provide major insights into pathogenesis of liver disease and progression.

Beth McCormick (Microbiology and Physiological Systems) - Dr. McCormick's academic career has been largely dedicated to gastrointestinal research and she has made seminal

contributions toward the understanding of how enteric bacteria (commensal, pathogenic, or probiotic) colonize the intestine and interact with the host. Dr. McCormick's research is largely centered on her discovery of a novel innate immune pathway involving an hepoxillin A3-mediated neutrophilic infiltration. This is a conserved mechanism present at mucosal surfaces that is acts as a sensor for protection from pathogenic bacteria but if this pathway is not properly controlled can also drive a damaging inflammatory response with severe pathological outcomes. Her work in this topic area has advanced the finding of a novel set of therapeutic targets that are currently being exploited for potential clinical intervention, and in addition, led to the discovery of a new paradigm in bacterial pathogenesis involving type III secretion systems.

Haley Melikian, PhD (Neurobiology) - Our laboratory is interested in the molecular mechanisms that regulate presynaptic dopamine reuptake by the dopamine transporter (DAT). DAT is the primary target for addictive and therapeutic psychostimulants, and DAT regulatory mechanisms may have a significant impact on monoamine-related neuropsychiatric disorders, including ADHD and addiction. The lab uses a variety of biochemical, molecular and in vivo approaches to explore these possibilities, including RNAi, chemo-genetics and optogenetics.

Stephen Miller, PhD (Biochemistry & Molecular Biotechnology) - Work in the Miller lab applies organic chemistry and optical imaging to the non-invasive interrogation of fundamental biological processes and disease states in live cells and animals.

Arthur Mercurio (Molecular, Cell & Cancer Biology) - We are interested in the initiation and progression of epithelial-derived tumors (carcinomas), especially aggressive, poorly differentiated tumors. Our research projects emphasize molecular cell biology but they derive from the analysis and clinical behavior of carcinomas. Our goal is to identify mechanisms that account for the loss of differentiation and the highly aggressive behavior of these tumors, and to exploit these mechanisms to improve prognosis and therapy. A major focus of this work is to define mechanisms that control the genesis and function of cancer stem cells with an emphasis on the role of integrin and VEGF signaling.

Mary Munson, Ph.D. (Biochemistry & Molecular Biotechnology) My laboratory is interested in understanding the basic mechanisms of intracellular membrane trafficking—how do proteins, lipids and RNA move around inside the cell to the correct destination organelles, or get secreted to the outside of the cell? We study exocytosis, endocytosis and mRNA transport, which are highly regulated, fundamental processes for cell growth, division, polarity and communication. Our multidisciplinary research uses a wide variety of techniques (from biochemistry and structural biology, microscopy (fluorescent and EM), to cell biology and genetics/CRISPR) in several different organisms. Interests include the role

of trafficking in yeast, the differentiation and function of neutrophils and platelets, the development of neurodegenerative diseases, and in viral and bacterial pathogenesis.

Ira Ockene MD, (Medicine) – Preventive Cardiology Program - Risk factor modification using behavioral and nutritional interventions; systems-based interventions for risk factor control and for improvement of adherence to medications; intervention for the prevention of diabetes; seasonal/cultural patterns of lipids and of the underlying factors; studies of foods with lipid-altering pharmacologic effects

Gary Ostroff, Ph.D. (Molecular Medicine) – Cryptococcosis coccidioidomycosis histoplasmosis candidiasis and blastomycosis fungal infections, Gaucher disease - As the inventor of the deployment of the glucan particle delivery technology, I have worked on many drug and vaccine projects targeting unmet medical needs. Having led groups that developed drugs, devices and diagnostics that have saved countless lives, I left industry to return to my academic roots. At UMass Chan Medical School, I've collaborated to develop a treatment for soil transmitted helminths, and on vaccine development for diseases including fungal infections, plague and tularemia.

Craig Peterson, Ph.D. (Molecular Medicine) Our research is focused on the role of chromosome structure on transcription and genome stability pathways, with particular emphasis on ATP-dependent chromatin remodeling enzymes. We employ a combination of molecular genetics, genomics, chromatin biochemistry, and biophysical methodologies.

Claudio Punzo, Ph.D. (Ophthalmology and Gene Therapy Center) - Retinitis pigmentosa (RP) - RP causes massive loss of photoreceptors and consequently blindness. We are targeting the common mechanism of cone death so that it may allow for the development of vision therapies with broad clinical significance. A therapy that intervenes at the level of cone death by either halting or delaying further degeneration can be applied at any stage of the disease progression and benefits all patients with RP.

William Royer, PhD (Biochemistry & Molecular Biotechnology) – Structural basis for inter-subunit communication and macromolecular interactions in biology; currently focusing on the impact of C-terminal binding proteins on cell fate and cancer and interferon regulatory factors in innate immunity.

Sean Ryder, PhD (Biochemistry & Molecular Biotechnology) Mechanisms that govern post-transcriptional regulation of gene expression during development and complex disease, including: 1. Post-transcriptional regulatory mechanisms involved in axis polarization and cell fate specification during *Caenorhabditis elegans* embryogenesis. 2. Post-transcriptional mechanisms that guide oligodendrocyte differentiation and myelin formation in the vertebrate central nervous system. 3. Identification of small molecule inhibitors of RNA-

binding protein function using high throughput screening approaches.

Neal Silverman, PhD (Medicine) The Silverman lab is focused on deciphering the molecular mechanisms involved the innate immune response. Basic research focuses on the recognition of microbial pathogens by germline encoded receptors and the ensuing signal transduction cascade. *Drosophila melanogaster* is often used a model system for discovery and detailed molecular work with the goal of subsequent translation to human systems.

Chris Sassetti, PhD (Microbiology and Physiological Systems) By understanding the biology that underlies tuberculosis pathogenesis, my lab hopes to rationally design more effective therapies for this disease.

Celia Schiffer, PhD, (Biochemistry & Molecular Biotechnology) Structural basis for molecular recognition in HIV and HCV Protease - *Research in our laboratory is centered around understanding and combatting drug resistance.* While our research is focused on the molecular basis of antiviral resistance, we are passionate about discovering the parallels that can be drawn between disease states – with the goal of devising rational design strategies to limit occurrence of resistance. With this vision, Dr. Schiffer leads the Institute for Drug Resistance, which has established a vibrant interdisciplinary community of researchers and clinicians pursuing strategic solutions to drug resistance in quickly evolving diseases.

Chinmay Trivedi, MD PhD – Cardiovascular Medicine – The Trivedi lab's research focuses on identifying regulatory mechanisms and rational therapies for congenital cardiac and vascular diseases affecting patients. Using murine models and patient samples, his laboratory has identified causal roles of chromatin-modifying enzymes and signaling pathways in congenital cardiac anomalies, lymphatic malformations, lymphedema, chylothorax, hepatic vascular hemangiomas, cardiac valve defects, cardiomyopathies, heart failure, and epithelioid hemangioendothelioma. Many of his findings have opened up new areas of investigation, identified fundamental developmental processes, and informed the development of novel therapies.

Jennifer Wang MD – (Diabetes Research Center of Excellence)

Dr. Wang is an infectious disease and immunology physician-scientist. Her ongoing research involves the study of human islets as well as rodent models to identify autoimmune and inflammatory pathways which could potentially be blocked to prevent disease development.

Zhiping Weng, PhD (Program in Bioinformatics and Integrative Biology; Biochemistry & Molecular Biotechnology) - Dr. Weng develops and applies computational algorithms for analyzing genomic, epigenomic and transcriptomic data, in particular, high-throughput

sequencing data associated with experiments that detect regulatory regions of the genome, nucleosome positioning, genomic locations of histone modifications and histone variants, DNase I hypersensitivity, DNA methylation, small silencing RNAs and genome resequencing. She collaborates closely with experimentalists to study a wide variety of biological problems.

Zuoshang Xu, MD, PhD (Biochemistry & Molecular Biotechnology) – Structure, transport and function of neuronal cytoskeleton; neurodegenerative disease.

Jill Zitzewitz, PhD (Radiology) – Dr. Zitzewitz is interested in the folding of a set of ALS-linked proteins to understand how misfolding contributes to disease pathogenesis. By leveraging our biophysical understanding of the unique protein conformations that link productive folding and function to misfolding and dysfunction in disease, we can develop small molecule therapeutics to inhibit misfolding and biomarkers to follow disease progression.

Doctoral Programs with directed admissions pathways

Population Health Sciences

Key frameworks required to address current health care challenges demonstrate the need for a new paradigm for research that attempts to understand health and disease in a complex set of contextual environments in which risk and causal factors for disease are nested one within another, along with environmental factors, genetic factors, lifestyle behaviors and social contexts. Increasingly complex conceptual models and sophisticated study designs and statistical methodology are required to tackle research problems. It also calls for a new paradigm of research conduct. In response to this need, our doctoral program in Population Health Sciences provides rigorous training in epidemiology, biostatistics and health services research methods. The goal is to prepare individuals to be independent investigators and team scientists intending to pursue careers focused on reducing the risk of disease, improving health care and conducting important and relevant research that may be translated into practice and policy. Students may tailor their coursework to provide a concentration in: Behavioral Epidemiology, Aging, Cardiovascular Disease, Digital Medicine, Health Disparities, or Pharmacoepidemiology.

Typically, applicants are expected to have received a master's degree in public health, clinical research or in one of the social, psychological, physical or biological sciences, or a clinical degree (e.g., PharmD, MD), and to have completed one-year of introductory graduate level coursework in biostatistics and epidemiology.

Requirements for Specialization

Underscoring the proposed research and training activities is expertise in epidemiological, statistical, experimental, and quasi-experimental research methods, cutting-edge analytic techniques for analysis of large datasets, economic evaluations, state-of-the-art patient reported outcomes methods, health informatics, community engagement, and intervention research to promote health equity and to change patient and provider behavior. The program has a competency-based curriculum which builds upon the methodological foundation of epidemiology and biostatistics, but extends beyond this core foundation to incorporate the basics in social science theory pertinent to health services research and epidemiology. Students will achieve competence in seven core areas:

- Theory and context,
- Study design,
- Analysis, interpretation, and presentation of data,
- Ethics,
- Information and data acquisition and management,
- Bias, and
- Effective scientific communication.

Opportunities for achieving these competencies are provided through core and elective courses. All students are required to take one year of advanced epidemiology and biostatistics, ethics, and a proposal development seminar. Students complete a mentored teaching experience. Students are required to select a minimum of two theory courses, three substantive electives, and eight additional methods credits tailored to their research goals. Students must actively participate in journal clubs, seminars, grand rounds, and workshops throughout their training experience.

The doctoral program is a full-time program. Students are matched to mentors on acceptance into the program and are fully immersed into the research labs on the first day of the program. The average time to degree completion is 4 years.

The competency-based curriculum includes:

Required Courses

- CT605A Introduction to Clinical and Translational Research (3 credits)
- CTS602A Advanced Epidemiology (3 credits)
- CTS603A Generalized Linear Models (4 credits)
- CTS603B Statistical Methods for Survival and Longitudinal Data Analysis (4 credits)
- CTS702 Ethics for Clinical Research (2 credits)
- CTS875 Proposal Development (3 credits)

- 4 credits of theory (selected based on research interests)
- 6 credits substantive electives (selected with advising team based on research interests)
- 8 credits of methods electives (selected with advising team based on research interests, CTS602B Advanced Epidemiology strongly encouraged)

All students are expected to attend twice monthly methods seminars, monthly journal clubs, and monthly research in progress meetings. All students are expected to devote ~18 hours weekly to research assistantships and to serve as a Teaching Assistant for one term.

Beyond performance in courses and research assistantships, four evaluation milestones are required: comprehensive project, written qualifying exams, dissertation proposal development, oral qualifying exam, and dissertation defense. For the comprehensive project held in the summer of the first year, doctoral students must complete an independent project using existing data sources. The project will allow the student to demonstrate competence in organizing, pacing, and producing a research project within a set time frame. The manuscript undergoes internal faculty review and students revise and resubmit their manuscript draft. Each student gives a professional oral presentation and defends their work. The written qualifying exam takes place in December of the second year. Each student is provided the opportunity to demonstrate methodological competence in fundamental and advanced epidemiological methods and biostatistics as evaluated via the written qualifying exams. The reading list for this portion of the exam will be the texts and materials covered in the core epidemiology and biostatistics courses. The student prepares and defends their proposed specific aims for their dissertation. The oral qualifying exam occurs after the student completes writing their dissertation proposal – typically in the early summer of the second year. The purpose of the oral exam is to provide a forum for hearing the justification and design of the proposed doctoral research. However, the examination is not simply a presentation of a thesis proposal as questions related to substantive and methodological issues in the student's specialization may be asked. After completing the three dissertation research papers, the final evaluation milestone is the dissertation defense.

Qualifying Exam

In the summer between Years 1 and 2, students in the Population Health Sciences doctoral program first undergo a comprehensive evaluation of their progress in the summer after completing their first year of coursework (CTS604). Students complete a comprehensive project which includes conducting an analysis and writing a manuscript suitable for publication in a peer-reviewed journal. The purpose of this evaluation milestone is to provide students with an opportunity to demonstrate that they are able to apply topics covered in the first-year curriculum to their own first-author research paper. As the goal of this exercise is <u>not</u> to evaluate the extent to which students have developed the skills to ask

relevant scientific questions, the mentors help students select a relevant study question which will have value-add to the research portfolio and contribute to the scientific literature. The student must be first author on this manuscript and must do all the work required to warrant first position on the manuscript. Mentors may suggest the use of one of their research datasets provided it is of sufficient readiness for the proposed research (cleaned, have at least one publication, in a usable format). Students may use any of the publicly available well-documented datasets (e.g. NHANES, BRFSS). Students will not have time to spend cleaning untapped data or acquiring data use agreements.

Students prepare the manuscript (May and the end of July). Led by a faculty member, weekly meetings with the cohort provide structure and opportunities for peer review and feedback. Students prepare a 15-minute public presentation of the work followed by 15 minutes of questions and answers. Faculty reviewers are sent the manuscript one week before the presentation and send their manuscript review to the Population Health Sciences Program Director the night before the presentation, attend the presentation, and ask the student questions. After the presentation, the Population Health Sciences Program Director sends the student the three manuscript reviews. The students spend approximately 2-3 weeks revising their manuscript and preparing a written response to the reviewers' comments.

Evaluation: The Population Health Sciences Program Director selects three faculty members for each student based on the research area of interest, methods, and data used. Members of this committee conduct a manuscript review as if they were reviewing for the student selected journal, attend the presentation and ask questions, and review the revised manuscript and response to the reviewers' comments. Each member votes: Pass, Conditional Pass, No Pass. If any faculty reviewer expresses concerns about the student's performance, the Population Health Sciences Program Director develops a plan to address these concerns in the fall semester (e.g., independent study, additional course work). Students must achieve a Pass before proceeding to the Written Qualifying Exam in December of Year 2.

In December of Year 2, students take the Written Qualifying Exams. In preparation, the students hold weekly review sessions to prepare for the Written Qualifying Exam throughout the fall semester. The Written Qualifying Exams are developed by a committee comprised of the Population Health Sciences Program Director and at least two full faculty members in the Population Health Sciences program. The Written Qualifying Exam is identical for all students in a given year. The exam includes a set of questions selected from materials covered in the epidemiology and biostatistics coursework from the first-year curriculum. Questions may be related to emphasize study design (e.g., cross-sectional, case-control, case-crossover, clinical trials), measures of disease frequency, effect measures, confounding, effect measure modification, matching, interpretation of data, decision making in analytic approaches,

causal diagrams, other sources of bias in public health research (misclassification, measurement error, selection bias, etc.), conceptual frameworks, and applied biostatistical methods. While it is not possible for to comprehensively cover all these topics, students must be prepared to answer questions on all topics. The Written Qualifying Exam is a closed book exam.

Evaluation: The Written Qualifying Exams are evaluated by a committee comprised of the Population Health Sciences Program Director and at least two faculty members in the Population Health Sciences program. For the morning session exams, faculty evaluators are blinded to the student name. Each exam has at least two members of the committee conduct the initial grading, with additional members of the committee weighing in if consensus is not reached. Each member votes: Pass, Conditional Pass, No Pass. If students receive a Conditional Pass, the Population Health Sciences Program Director develops a plan to address these concerns in the spring semester (e.g., independent study, additional course work). If the student receives a No Pass, they must retake and pass the Written Qualifying Exam within 8 weeks of the initial attempt. If they do not pass the second attempt, they are dismissed from the program.

In Spring of Year 2, students in the PhD program in Population Health Sciences take CTS875. Students arrive to the first class with three draft specific aims, having received feedback on their ideas from their mentor in the fall semester. Within the context of the class, students present their draft specific aims and outlines of their significance and innovation sections to several Population Health Sciences full faculty members for feedback. The students develop their proposals in accordance with a funding mechanism (e.g., R36, F31), receiving peer feedback and feedback from the course instructor. Students practice their presentation for the Oral Qualifying Exam in the context of the class and receive feedback from peers and the course instructor. The purpose of the oral exam is to provide a forum for hearing the justification and design of the proposed doctoral research. However, the examination is not simply a presentation of a thesis proposal as questions related to substantive and methodological issues in the student's specialization may be asked.

The Oral Qualifying Exam Committee is formulated by the Population Health Sciences Program Director in consultation with the student and mentor. The Oral Qualifying Exam Committee is comprised of a General Examiner, Chair (tenured professor), and two additional full faculty members. The student sends their dissertation proposal to committee about 2 weeks before their Oral Qualifying Exam. Mentors do not attend the Oral Qualifying Exam. The Oral Qualifying Exam votes Pass or No Pass, and provides feedback to the student that may be useful as they implement their dissertation research.

Courses In Population Health Sciences:

Research Assistantship- PREP

Laboratory rotations are defined periods of research experience under the direction of a faculty member. They are intended to familiarize the student with concepts and techniques in several areas of research and to assist the student in evaluating research laboratories and projects that might be developed into a dissertation project. The student will participate in an on-going research project; gain familiarity with concepts underlying the research; acquire a working knowledge of techniques used in the research; and write a report and present an oral summary of the results of the research.

Advanced Epidemiology & Research Methods-A

Building on basic skills in epidemiology and scientific research methods, this two-semester course will cover research design, sampling, hypothesis development and testing. Students will develop skills in use of clinical and epidemiological databases and national health surveys. In addition, methodological strengths of various quantitative and qualitative techniques and designs will be explored. Students will have problem sets to complete, in addition to assignments to develop original research approaches to specific scientific and clinical questions.

Advanced Epidemiology & Research Methods-B

The purpose of this class is to learn advanced epidemiologic techniques, to learn how and when to apply them, and to learn to design rigorous epidemiologic studies. Students will gain experience in reading the primary epidemiologic methods literature. Course objectives will be met through class lecture, class discussion, problem sets, exams, application of selected principles to one's research and the development of a mini-lecture.

Generalized Linear Models

This course provides an overview of multivariable analysis and advanced analytical strategies for clinical and population health research. Emphasis is on developing an understanding of multivariable modeling in the context of linear, logistic and Poisson regression. Computational lab assignments and two exams will be completed.

Statistical Methods for Survival & Longitudinal Data Analysis

Course provides a foundation for statistical thinking in clinical and population health research involving time to event data and longitudinal data. Students will learn statistical models used for estimation and inference; understand advanced statistical techniques; and develop modeling strategies and analysis plans for specific research questions.

Comprehensive Project

This course will provide structure and support for students completing their first major evaluation milestone. Students come to the first day of class with a research study question approved by their mentor and an existing dataset to use to evaluate the study question. Students will develop a manuscript and write it up according to the instructions for authors for the target journal. Students will conduct their own data analysis and will be evaluated on summative competencies expected to be achieved by the end of their first year of Population Health Sciences core coursework and research experiences. Students present their work in an open forum in the form of a 10-15 minute presentation followed by questions and answers. The manuscripts are sent out for review by three faculty. Students have two weeks to write a rebuttal and prepare a revised manuscript.

Introduction to Clinical & Translational Research

This course reviews basic principles of epidemiology, investigation of disease outbreaks, and the application of various observational and experimental research designs and strategies to clinical, epidemiological, and translational research. Didactic instruction, readings, and problem sets (including lab-based analyses) are utilized to more fully understand epidemics and their causes, as well as various study designs including cross-sectional studies, case-control studies, cohort designs, and randomized clinical trials. Students also will learn how to design surveillance systems and develop and evaluate screening and diagnostic tests. Students are graded on in-class participation and two writing assignments (write-up of lab exercise and in-class student presentation). This is a full semester course with a total of 30 contact hours.

Community Engagement in Research

Students will learn how to: create and sustain cohesive research teams; develop a productive program of research; develop good mentor and mentee relationships; engage in transdisciplinary science; understand the NIH Roadmap; and hear about different forms of clinical and community research from local investigators who conduct it.

Design of Clinical Trials

The course considers the scientific and practical considerations in the design and conduct of observational studies and clinical trials. Topics to be covered include: study designs (cohort studies, case-control studies and clinical trials); confounding and bias; ethical considerations; patient recruitment and retention; interim analysis and safety monitoring; and analysis and reporting. Course objectives will be met through a combination of lecture, discussion and development of a proposal in the student's area of interest.

Scientific Writing

This course teaches students how to develop a peer reviewed scientific manuscript, through the review of elements of style, authorship and extent of information that needs to be incorporated into a scientific research paper. Students will learn how to develop the elements that go into a successful scientific manuscript, submit an article for peer review and respond to reviewers' concerns. During each session, students will critique the work of others enrolled in the course to obtain hands on experience in the write-up of the introduction, methods, results and discussion sections of a manuscript. This course will also teach students how to put together a successful oral, as well as poster, scientific presentation.

Systematic Review

The purpose of this class is to teach students how to conduct a systematic review, including development of a question of appropriate scope and clinical relevance; development of abstraction tool; selection of articles; and drafting of all sections of the review, including tables and figures. The end product will be a journal style and length systematic review in the topic area of the student's substantive interest area that is 75 percent ready for submission to a peer-reviewed journal.

Ethics for Clinical Research

This course is designed to provide students with a basic knowledge of ethics that will prepare them to understand and address problems in the ethical conduct of research involving human subjects, as well as understand and address scientific misconduct, including fraud, misrepresentation and conflict of interest. The course also addresses authorship guidelines, IRB regulations and UMass Chan Medical School regulations. Students will also focus on how to design ethical research and evaluate treatment risk, placebo control, ethics of recruitment, dilemmas of informed consent, potential scientific contribution and issues for special populations and conducting research internationally.

Advanced Topics in Epidemiology

Course will cover a focused set of issues in advanced epidemiology such as conducting community based, surveillance-based randomized controlled trial. Skills will be developed in the practical and scientific issues as well as analysis plans and presentation of results.

Advanced Topics in Biostatistics

This course will cover an advanced topic in biostatistics (for example, longitudinal data analysis, survival analysis, graphical information systems and spatial statistics). The purpose of the course is to provide students with emersion in one particular area of biostatistics, providing the theoretical background necessary and the practical hands-on data-analyze

experience.

Advanced Analytical Methods in Health Outcome Studies

This advanced methods course is focused on learning methods for addressing confounding and bias. The goals for students taking this course are: to become comfortable recognizing and discussing bias and confounding; to gain experience in using a variety of techniques that help in identifying and minimizing bias and confounding; and to be able to assess the potential impact of residual bias and confounding on study results. This course is organized as topic lectures followed by applications of the topic. Students independently apply what is introduced in the lecture to their own data and share their learning with classmates.

Randomized Clinical Trials in Behavioral Medicine Research

The purpose of this course is to provide opportunities for the student to understand the foundations of randomized clinical trials (RCTs) in behavioral medicine research. Topics related to theory, design, implementation, and evaluation of behavioral randomized clinical trials will be discussed. Students will develop a research project where concepts can be applied and practice reviewing behavioral RCTs in the published literature.

Introduction to the U.S Healthcare System: How Policies & Practice Affect Health

This course provides an in-depth look at the U.S. health care system. Students will apply constructs of structure, process, and outcomes of care to understanding and evaluating health care quality and cost, and learn how health care policies and payment practices impact the accessibility, effectiveness and cost of care.

Design & Conduct of Studies of Chronic Disease

The course will discuss fundamental concepts in chronic disease epidemiology; common research methods used in the design and conduct of studies of chronic disease epidemiology; and the application of these methods for the major chronic diseases affecting industrialized countries. Topics will include cardiovascular disease, cancer, cerebrovascular disease, diabetes and lifestyle practices to promote health.

Use of Existing Population-Based Public Health & Health Care Data

Students will become familiar with existing population-based public health, electronic medical record and claims data. Topics include advantages and disadvantages, complex sampling and weighting, and obtaining limited-access data. Using a population-based dataset, students will develop and implement an analytic plan to answer a research question of their choosing.

Psychiatric Epidemiology

This course will provide students with fundamental knowledge of psychiatric epidemiology. We will cover epidemiological principles specific to psychiatric epidemiology such as assessment and diagnostic validity in the absence of a gold standard. Students will be given the opportunity to conduct original research and will gain knowledge of particular psychiatric illnesses through student preparation of course presentations.

Social Epidemiology

We will cover the main societal causes implicated in affecting the health of human populations, including hierarchy, racism, gender hierarchy, heteronormativity and ableism. We will focus on methodological approaches to measuring and interpreting these forces and their effects, on both minority and dominant populations.

Behavioral Determinants

The purpose of this class is to learn models of disease prevention; multilevel determinants of health behaviors; and major theories of health behavior change and their application to interventions to address major public health problems.

Qualitative Methods for Health Research

This course examines uses of qualitative methods in mixed-qualitative or mixed-qualitative/quantitative health studies. Essential qualitative research components are explored: study community, theory, rigor, research questions, data collection methods, writing open-ended questions, sampling, data analysis, publishing and writing proposals. Students apply concepts covered in class by collecting data for written assignments.

Pharmacoepidemiology

The purpose of this class is to learn pharmacoepidemiology, including: rigorous methodologic approaches to the measurement of medication exposure, adherence and adverse events; pharmacoepidemiologic study design; choices for pharmacoepidemiology data resources; and the role of quality of life measurements and pharmacoeconomics.

Place & Health

In this class, we will explore the influence of place on population health, including physical environment (e.g., air, water, soil, food), built environment (e.g., neighborhood structure, traffic, green space), social environment (e.g., cohesion, safety, deprivation, segregation), and legal and civic structure (e.g., policy, law, representation). We will also learn to implement (and critique) methodologic approaches that are particularly adapted to understanding how individuals and places interact, specifically multilevel thinking and modeling, and spatial analytic methods.

Introduction to Implementation Science: Moving Research into Practice in Healthcare & Community Settings

This class provides an introduction to what is often referred to as translational, dissemination or implementation research, as well as the broad field of implementation science. Students will learn about the significance and major initiatives associated with moving research into practice, and will be introduced to conceptual and analytic tools (e.g., theories, frameworks) to support work in this area.

Independent Study

The purpose of an independent study elective is to gain in depth knowledge of a specific topic by working closely with a faculty member with expertise in that area. Typically independent studies cover areas not addressed in the core curriculum and advanced topics or other electives. However, the level of effort and objectives for an independent study must be equivalent to that of a regular three-credit course. The student and sponsoring faculty member must propose a framework and outcome for the independent study, in the semester prior to the semester in which the student will be enrolled, to the program director for prior approval.

Research Assistantship

Research rotations are defined periods of research experience under the direction of a faculty member. They are intended to familiarize the student with the theory, background, concepts and techniques in several areas of research and to assist the student in evaluating projects and areas that might be developed into a dissertation project. The student will participate in an ongoing research project; gain familiarity with a field of study; acquire a working knowledge of techniques used in the research; and write a report and make an oral presentation on the results of their work.

Written Qualifying Exam

This course number is used for students sitting for the written qualifying exam—an evaluation milestone typically conducted in Fall of their second year of graduate study.

TRAC Meeting

All graduate students are required to have a TRAC meeting each academic year in the Fall . After passing their Qualifying Exam in January of the second year and the Thesis Proposal Defense in the Spring or Summer of second year, students are required to register for this course each Fall semester until their Dissertation Examination Committee is formed.

Pre-Thesis Research

All graduate students are required to have a TRAC meeting each academic year in the Fall .

After passing their Qualifying Exam in January of the second year and the Thesis Proposal Defense in the Spring or Summer of second year, students are required to register for this course each Fall semester until their Dissertation Examination Committee is formed.

Proposal Development

The purpose of this course is to allow doctoral students in Population Health Sciences to gain experience writing NIH-style grant proposals in a systematic fashion under faculty guidance. The course is designed to walk the student through each of the NIH grant proposal requirements. The course will include detailed overviews of the grant process, participation in a mock proposal review session and the completion of each of the written scientific components of an NIH grant.

Thesis Research

Students register for Thesis Research after passing a Qualifying Examination. They will take Thesis Research each semester until they have accumulated 90 credits.

Graduate Research

Students register for Graduate Research after completing the requisite number of credits to meet graduation requirements. They will take this course each semester until they complete all remaining requirements.

Qualitative Methods

This course is designed to provide students with an in-depth study of major qualitative designs and methods used to build substantive knowledge in nursing. Emphasis is placed upon experiential learning of methods and techniques to design studies along with analysis and interpretation of data.

Survey Methods & Measurement in Health Research

This course focuses on survey methods, measurement theory and the processes of instrument evaluation, refinement and development. There will be an emphasis on the interaction of conceptual, methodological, cultural and pragmatic considerations that are essential to understand when measuring variables among clinical populations. Topics include survey design; scale development, item construction, psychometric evaluation of scales, data collection procedures and sampling strategies.

Faculty:

Program Director, Associate Dean, Clinical and Population Health Research

Kate L. Lapane, PhD MS (Population Health Sciences)- pharmacoepidemiology, epidemiologic methods, aging, nursing home research

Professors

Jeroan Allison, MD, MS (Population Health Sciences) – Clinical epidemiology; quality measurement and outcomes research; health services delivery to medically indigent populations

Arlene S. Ash, PhD, (Population Health Sciences) – Professor and division chief, biostatistics and health services research, advanced statistical methods, trial design

Bruce A. Barton, PhD, (Population Health Sciences) –Biostatistics and health services research, director, and quantitative methods core

Edwin D. Boudreaux, PhD, (Emergency Medicine) – Psychiatry and Population Health Sciences

Nancy Byatt, DO, MBA, (Psychiatry) – perinatal depression

Carol Bova, PhD (Graduate School of Nursing) - HIV

Robin E. Clark, PhD (Family Medicine & Community Health) – Economic evaluation; mental health and substance abuse policy; health care financing

Sybil L. Crawford, PhD (Medicine) – Women's health, particularly menopause; ethnic differences in health and health care utilization; applied statistical techniques, including missing-data methods and longitudinal modeling

Carol Curtin, MSW, PhD (Family Medicine and Community Health)- developmental disabilities/psychiatric disorders and their families in a variety of settings and using a variety of clinical modalities

Sarah Cutrona, MD, MPH (Population Health Sciences) -Professor in Health Informatics and Implementation Science and the Department of Medicine in the Division of General Internal Medicine

Maryann Davis, PhD (Psychiatry) – youth mental health

Jeff Driban, PhD (Population Health Sciences) –Division of Epidemiology, osteoarthritis

Catherine E. Dube, EdD, (Population Health Sciences) –Division of Epidemiology , nursing home research, communication

Terence R. Flotte, MD (Dean, T.H. Chan School of Medicine; Celia and Isaac Haidak Professor of Medicine; Pediatrics, Molecular Genetics & Microbiology) – Gene therapy for cystic fibrosis, alpha-1 antitrypsine deficiency and other single gene defects

Peter Friedmann, MD, MPH, DFASAM, FACP, (Baystate)- substance abuse

Benjamin Gerber, MD, MPH (Population Health Sciences)- Health Informatics and Implementation Science

Arvin Garg, MD. MPH, (Pediatrics)- Health disparities

Robert J. Goldberg, PhD (Population Health Sciences) – Cardiovascular epidemiology; preventive cardiology

David C. Hoaglin, PhD, (Population Health Sciences) – Biostatistics and health services research

Catarina Kiefe, MD, PhD (Population Health Sciences) – Health care quality measurement and outcomes research

Jason J. Kim, PhD, (Molecular Medicine) – Research obesity, diabetes and its complications using elegant metabolic procedures and transgenic mouse models of altered metabolism

Stephenie C. Lemon, PhD (Medicine) – Primary health care delivery; cancer detection and control; chronic disease management and treatment adherence; patient/clinician communication; clinical decision making

Honghuang Lin, PhD (Medicine)- Clinical informatics

Shan Lu, MD, PhD (Medicine) – Immunogenicity of protein antigens

Lawrence C. Madoff, MD (Medicine) – infectious disease

Kristin Mattocks, PhD, MPH (Population Health Sciences) – Health informatics and implementation science; associate chief of staff for research and development, VA Central Western Massachusetts

Kathleen Mazor, EdD, (Clinical & Population Health Research, MS in Clinical Investigation)

Dave McManus, MD (Medicine)- Chair of the Department of Medicine, Professor; Rapid Acceleration of Diagnostics, or RADx which seeks to identify new methods and tools for addressing the coronavirus pandemic

Tiffany Moore Simas, MD (Obstetrics & Gynecology) – Pregnancy risks and complications

Ann M. Moormann, PhD, (Molecular Medicine) – Pediatric immunity to infectious diseases focusing on Plasmodium falciparum malaria and Epstein Barr Virus (EBV), molecular epidemiology, Global Health Research, and the etiology of endemic Burkitt lymphoma in Africa

Ira S. Ockene, MD (David J. and Barbara D. Milliken Professor of Preventive Cardiology; Medicine) – Risk factor modification using behavioral and nutritional interventions;

systems-based interventions for risk factor control and for improvement of adherence to medications; intervention for the prevention of diabetes; seasonal/cultural patterns of lipids and of the underlying factors; studies of foods with lipid-altering pharmacologic effects

Judith K. Ockene, PhD, MEd, MA (Population Health Sciences) – Women's health; obesity; multiple risk behaviors; quality of life; population health; tobacco/alcohol use; relationship of lifestyle behaviors to disease; community-based interventions for lifestyle behaviors

Lori Pbert, PhD (Population Health Sciences) – Evaluation of clinic-based interventions for health promotion and disease prevention; tobacco treatment in adolescents and adults; training and certification programs for Tobacco Treatment Specialists; obesity prevention and treatment; asthma management

Sharina Person, PhD (Population Health Sciences, Vice Chair) - senior faculty member in the Quantitative Methods Core which provides consultative services to UMass Chan Medical School investigators in the areas of study design, sample size, power calculations, statistical analysis plans, statistical programming, data entry and management, and project coordination

Milagros Rosal, PhD (Population Health Sciences) – Treatment adherence; health behavior change (smoking, diet, physical activity); stress; women's health; minority health; adjustment to chronic illness, diabetes and cardiovascular disease prevention; diabetes self-management; mood and anxiety disorders

Rajani Sadasivam, PhD (Population Health Sciences)- digital health research is primarily focused on treating tobacco use

Johanna Seddon, MD, ScM (Opthalmology and Visual Sciences)- macular degeneration

Jen Tjia, MD (Population Health Sciences)- Division of Epidemiology; Chronic prescription medication by older adults, particularly in nursing home residents with advanced dementia and near the end-of-life, deprescribing

Linda Weinreb, MD, (Clinical & Population Health Research, MS in Clinical Investigation)

Associate Professors

Karim Alavi, MD, (Surgery) – Surgical outcomes research

Matt Alcusky, PharmD, PhD (Population Health Sciences)- Division of Epidemiology, Pharmacoepidemiologist and health services researcher

Melissa Anderson, PhD (Psychiatry)- research to make behavioral healthcare accessible to members of the U.S. Deaf community

Jonggyu Baek, PhD (Population Health Sciences)- Biostatistics and Health Services

Research

Eric O. Mick, ScD, (Population Health Sciences) –psychiatric epidemiology, ADHD

Hoa Nguyen, MD, MS, PhD (Population Health Sciences)-Associate Professor in Epidemiology

Mayra Tisminetzky, MPD, MD, PhD (Medicine)- Geriatric Medicine; Cardiovascular epidemiology, epidemiology of mental disorders, epidemiology of aging

Chengwu Yang, MD, MS, PhD(Population Health Sciences)- Novel Study Design & Analysis and Measurement in Health

Adrian H. Zai, MD, PhD, MPH (Population Health Sciences)- healthcare informatics and population health management

Assistant Professors

Dan Amante, PhD, MPH (Population Health Sciences)- Assistant Professor, Health Informatics and Implementation Science

Maira A. Castaneda Avila, PhD (Population Health Sciences)- Division of Epidemiology, Colorectal cancer, mixed methods, health disparities, multimorbidity

Karen Clements, ScD (Population Health Sciences)- hepatitis C, pregnancy, patient acceptance of health care

Jamie Faro, PhD (Population Health Sciences)- Informatics and Implementation Science; behavioral and implementation science researcher, with an emphasis on physical activity, diet and smoking cessation

Sarah Forrester, PhD, (Population Health Sciences) Division of Epidemiology, health disparities, structural racism, allostatic load

William M. Jesdale, PhD, (Population Health Sciences) – Division of Epidemiology, environmental health, health disparities research, LGBT health

Nathaniel S. Hafer, PhD (Program in Molecular Medicine)- clinical and translational science

Sohye Kim, PhD (Psychiatry)- discover early neural markers in the infant's social brain that predict long-term developmental outcomes, identify potentially modifiable early-life factors that influence the trajectory of the developing social brain, and translate these discoveries into innovative strategies for early diagnosis, prevention, and treatment in high-risk children and families for enduring impact.

Aimee R. Kroll-Desrosiers, PhD (Population Health Sciences)- research in veterans, pregnancy outcomes in veterans

Celine Larkin, PhD (Emergency Medicine)- implementation research, suicide

Feifan Liu, PhD (Population Health Sciences)- AI techniques to advance health equity, assessing and mitigating potential biases related to data processing and algorithmic training

Shao-Hsien Liu, MPH, PhD (Population Health Sciences)- Division of Epidemiology, musculoskeletal epidemiologist, application of advanced epidemiological and statistical methods to generate knowledge to ultimately improve quality of care for patients with arthritis

Tony Nunes, PhD (Population Health Sciences)- Division of Epidemiology; Pharmacoepidemiology, studies of drug safety, utilization, and comparative effectiveness

Apurv Soni, MD, PhD (Medicine)- digital medicine

Elise Stevens, PhD (Population Health Sciences)- tobacco products, public service announcements

Chan Zhou, PhD (Population Health Sciences)- novel computational methods and pipelines for analyzing large-scale high throughput data to understand noncoding RNA epigenomics in genetics and disease toward advancing precision medicine

MD/PhD

The goal of the MD/PhD Program is to develop an outstanding workforce of physician scientists able to identify important problems in human health and apply effective research approaches to enable their solution.

Requirements for Specialization

The program combines curricular elements from the T.H. Chan School of Medicine, the Morningside Graduate School of Biomedical Sciences, and specific MD/PhD courses and activities to train physician scientists. To complete the MD/PhD training, students must fulfill the curriculum described below. They must successfully defend a PhD thesis and complete all requirements for the T.H. Chan School of Medicine, including USMLE Step One and Step Two. Residents and non-residents of Massachusetts are eligible for admission to the joint MD/PhD Program through the Morningside Graduate School of Biomedical Sciences and the T.H. Chan School of Medicine. Students must complete both the MD and PhD degree at the University of Massachusetts Chan Medical School to be eligible for the benefits (tuition and fee waiver, stipend) of the program.

Qualifying Exam

The QE is conducted in three parts which must be completed by May 1 of Morningside Graduate School of Biomedical Sciences year 1.

1. Specific aims meeting 2. Creation and submission of a written proposal 3. Oral examination. Specific guidelines may be found here.

Mentorship

Each student entering the MD/PhD Program at UMass Chan Medical School is assigned a to a Learning Community and longitudinal preceptors associated with that Learning Community. In addition, MD/PhD students are assigned an advisor who is associated with the Learning Community and remains with them for the entire program throughout both medical and graduate school. Their role is to advise and support the student during all phases of the program. Current advisors are listed here.

Students will be expected to meet with their MD/PhD advisor biannually to discuss the relevant elements of the Professionalism Benchmark Checklist.*

In addition, students entering full-time thesis research will have a primary Thesis Advisor who will be an experienced investigator with a record of recent publications. Under some circumstances, a secondary Thesis Advisor will be required (such asor example, when the primary Thesis Advisor is a junior faculty member with no record of recent publications).*

* Any deviation from these guidelines should be discussed with MD/PhD Program Director, or MD/PhD Program Associate Director

Curriculum

The curricular components of the MD/PhD degree are detailed below. These must be completed to be awarded the MD/PhD degree.

MD/PHD Specific Courses:

Developing Solutions to Research Problems A- FOM1

Course Goal: This course is designed to help students discern study design approaches appropriate to the area of inquiry, consider biological variability in study design, prospectively design, and select valid data collection instruments, prospectively identify appropriate statistical methodologies and alternative analytical approaches, identify data sharing and publication strategies, accurately communicate facts and interpret results, and fairly acknowledge specific contributions to research studies. As part of the course, students are expected to achieve a minimum competency in the programing language “R”. These course activities will be conducted in a manner that enables the student’s intellectual contribution to the University’s academic and research functions.

Course Objectives:

- Review the elements of experimental design, tools, and standards.

- Provide an overview of quality procedures for biomedical research, including authentication procedures.
- Review reporting guidelines used for manuscript preparation
- Present a workflow that promotes transparency including detailed record keeping and data management.
- Demonstrate understanding of how to conduct reproducibility/replication studies and effectively communicate results
- Basic of downloading data and essential dataset manipulation
- Basics of descriptive visualizing data once cleaned
- Basics of most common statistical analyses
- Basics of visualization and graphing

Developing Solutions to Research Problems B- FOM2

Course Goals: Facilitate application of standards and requirements for rigor and responsibility and research as applied to the student's potential thesis project. In coordination with identified Thesis advisor, the student will elaborate thoughts on questions/problem to be analyzed, approaches to hypothesis generation, strategy for hypothesis testing, and strategy for data storage, analysis, and reporting. These course activities will be conducted in a manner that enables the student's intellectual contribution to the University's academic and research functions.

Learning Objectives:

- Identify the question or problem that is the topic of the research
- To enumerate current hypotheses related to the research question
- To justify the need for further hypothesis generation
- To explain how specific hypotheses will be derived from hypothesis generating approach
- To define the timeline for hypothesis generation
- To describe specific assays to test specific hypothesis
- To describe and justify statistical tests that will be used
- To describe how reproducibility will be ensured
- To describe where and how data will be stored
- To describe anticipated timelines for reporting and publication

Developing Solutions to Research Problems C- CCE & AS Years Following Completion of PhD

Course Goals: The goal for the course is to continue to support MD/PhD student connection to research activities during their Core Clinical Experiences (CCE). This will allow the student to conduct research in a manner that enables their intellectual contribution to the

University's academic and research functions. The second goal is to support students in preparing to apply to research intensive residency programs. These activities will involve a minimum of one hour per week over the course of the semester (15 hours total).

Learning Objectives:

- Propose an approach to investigate novel research questions arising from their clinical observations
- Continue interactions with Thesis lab to conclude any in progress research publications
- In consultation with MD/PhD mentors, explore potential areas of specialization that will be compatible with long-term research career goals
- In consultation with MD/PhD mentors and Thesis advisor, work on Personal Statement appropriate for application to residency programs

Curricular Expectations:

- The student will develop a presentation appropriate for the requirement for the Capstone Scholarship Discovery Program.

Introduction to Translational Medicine- All Full Time Research Years in Morningside Graduate School of Biomedical Sciences

Course Goals: The MD/PhD program stresses the importance of maintaining clinical involvement during students' dissertation research. The first goal of this course is to allow students to maintain clinical skills in a variety of clinical settings. The second goal is to help students identify an appropriate specialty in which to pursue residency training. Sessions should reinforce clinical skills learned during the first two years of medical school, as well as during the first 16 weeks of Core Clinical Experiences (CCE).

Curricular Expectations: Students will engage in a minimum 15 hours of clinical experiences during each of the fall, spring, and summer terms. Students will also participate in the Physician Scientist Forum, which is held weekly on Monday evenings. Students will be evaluated by their designated Learning Community MD/PhD mentor at the end of each term.

Prior to the end of each term during their dissertation research, students will record their clinical hours in the OASIS system using a dedicated form that will include the date, time, term, preceptor, and number of hours.

Preceptors must have a faculty appointment at UMass Chan Medical School, and clinical sessions must take place at a facility that is affiliated with UMass Chan Medical School. The student's designated Learning Community MD/PhD mentor must approve the choice of

preceptor.

MD/PhD HIPPA & OSHA Certification- All Full Time Research Years in Morningside Graduate School of Biomedical Sciences (Fall Only)

Certification module of HIPPA and OSHA that students enrolled in the PhD portion of the program are required to maintain annually (within the first two weeks of Morningside Graduate School of Biomedical Sciences Fall semester) each year. This is an online WebCt class which can be accessed by each MD/PhD student registered for this course in PSSA. The scores will be monitored by the MD/PhD program administrator during the student's PhD years.

Preparation for Thesis Research- 1st Thematic Section of CCE Following FOM2 (Summer)

Preparation of MD/PhD students to enter Morningside Graduate School of Biomedical Sciences full time research in Fall term after completing 16 weeks of clinical clerkships from May through August prior to Morningside Graduate School of Biomedical Sciences start. This includes meetings with the future PI, literature review and, when scheduling permits, attendance at lab meetings. For students who have not yet selected a PI, the requirements are to work with MD/PhD and Morningside Graduate School of Biomedical Sciences leadership to target and meet with potential lab rotation mentors during the summer term.

MD/PhD Physician Scientist Forum- All Years

Course Goals:

- To foster skills that MD/PhD students need to be maximally competitive for research intensive residency programs.
- To guide MD/PhD students regarding postgraduate training opportunities through interactions with residents, fellows, and faculty.
- To highlight connections between basic and clinical science through the presentation and discussion of patient cases.
- To expose postgraduate trainees to research conducted by MD/PhD students and promote opportunities for potential collaboration.

Curricular Expectations: This seminar is offered weekly for 1.5 hours every Monday evening. It is organized by MD/PhD students, and participation is required of students in all years of the MD/PhD program who are not otherwise scheduled for clinical rotations.

Graduate Research for Students Post-Dissertation (Continuing Registration)- MS3 &MS4

Goal: To continue to develop insights and output from Thesis research during the last clinical years.

Students will be automatically registered for this course by MD/PhD administration.

Course Offering: These courses are offered Fall, Spring, and Summer.

BBS Specific Courses:

Professional & Research Conduct (PARC)- Morningside Graduate School of Biomedical Sciences Fall

This is a required course for all third year Basic Sciences students and all MD/PhD students entering doctoral study but who are not on the Population Health Sciences track. The PARC course helps to center our students in areas that are foundational to success in research: responsible data management; management of intellectual property; the ethical use of research subjects; recognizing and resolving conflicts of interest, professionalism in peer review and publishing; engaging mentors; and career exploration and planning. The PARC course comprises faculty-led presentations and small group discussions with case studies and workshop material.

Preparation for Qualifying Exam- Morningside Graduate School of Biomedical Sciences

This course seeks to help prospective scientists in the biological and medical sciences communicate their work effectively, in writing, graphics and oral presentations. The course teaches how to prepare and write a grant proposal, how to present orally to scientific peers, and how to give and receive scientific feedback. Students will write, peer edit and present an early draft of a potential qualifying proposal to help them prepare for their QE.

Laboratory Rotation- Pre FOM1 & FOM1 (Summer)

Laboratory rotations are defined periods of research experience under the direction of a faculty member. They are intended to familiarize the student with concepts and techniques in several areas of research and to assist the student in evaluating research laboratories and projects that might be developed into a dissertation project. The student will participate in an ongoing research project, gain familiarity with concepts underlying the research, acquire a working knowledge of techniques used in the research, write a report, and present an oral summary of the results of the research.

BBS TRAC Meeting- All Morningside Graduate School of Biomedical Sciences 2+ Yrs

All graduate students are required to have at least one Thesis Research Advisory Committee (TRAC) meeting each academic year. After passing their Qualifying Examination and selection of their TRAC, students are required to register for this course each fall semester until their Dissertation Advisory Committee is formed.

MDP Goals:

- To periodically review progress along thesis research project advised by content experts

- To provide guidance for establishing a thesis research project consistent with the MD/PhD Program goals

MDP Curricular Expectations:

Two Thesis Research Advisory Committee (TRAC) meeting each academic year as define by the Professionalism Benchmark Checklist.

Prequalifying Research- Morningside Graduate School of Biomedical Sciences 1

This course is for students who have selected a program and thesis advisor but who have not yet passed the Qualifying Examination.

Thesis Research- Morningside Graduate School of Biomedical Sciences 2

Students register for Thesis Research fall term of year three of the program, after passing the Qualifying Exam.

MDP Students: Fall term of year four in the program.

Graduate Research- Morningside Graduate School of Biomedical Sciences 3+

Students register for Graduate Research fall term of year four in the PhD Program and will continue to register each semester until they complete all remaining requirements.

MDP Students: Fall term of year five plus in the program until requirements are complete.

CPHR Specific Courses:

Introduction to Clinical & Translational Research- Pre FOM1 or Summer between FOM1/FOM2

This course reviews basic principles of epidemiology, investigation of disease outbreaks and the application of various observational and experimental research designs and strategies to clinical, epidemiological and translational research. Didactic instruction, readings and problem sets (including lab-based analyses) are utilized to more fully understand epidemics and their causes, as well as various study designs, including cross-sectional studies, case-control studies, cohort designs and randomized clinical trials. Students also will learn how to design surveillance systems and develop and evaluate screening and diagnostic tests. Students are graded on in-class participation and two writing assignments (write-up of lab exercise and in-class student presentation). This is a full semester course with a total of 30 contact hours.

Ethics for Clinical Research- BBS Students Fall Morningside Graduate School of Biomedical Sciences 3, CPHR Students Morningside Graduate School of Biomedical Sciences 1

This course uses a case-oriented approach to provide students and trainees with a basic knowledge of ethics that will prepare them to understand and address problems in the

ethical conduct of research involving human subjects, and to understand and address scientific misconduct, including fraud, misrepresentation and conflict of interest. The course also addresses publication ethics, IRB regulations and UMass Chan Medical School regulations. Students will also focus on how to design ethical research and evaluate treatment risk, placebo control, ethics of recruitment, dilemmas of informed consent, potential scientific contribution and issues for special populations and conducting research internationally.

Research Assistantship- Pre FOM1, Summer between FOM1/FOM2, Morningside Graduate School of Biomedical Sciences 1

Research rotations are defined periods of research experience under the direction of a faculty member. They are intended to familiarize the student with the theory, background, concepts and techniques in several areas of research and to assist the student in evaluating projects and areas that might be developed into a dissertation project. The student will participate in an ongoing research project; gain familiarity with a field of study; acquire a working knowledge of techniques used in the research; and write a report and make an oral presentation on the results of their work.

CTS TRAC Meeting- Morningside Graduate School of Biomedical Sciences 3+ (Fall, Spring)

All graduate students are required to have a TRAC meeting each academic year in the Fall. After passing their Qualifying Exam in January of the second year, and the Thesis Proposal Defense in the Spring or Summer of second year, students are required to register for this course each Fall semester until their Dissertation Examination Committee is formed.

Pre-Thesis Research- Morningside Graduate School of Biomedical Sciences 2

This course is for students who have selected a program and thesis advisor but who have not yet passed their Qualifying Examination.

Thesis Research- Morningside Graduate School of Biomedical Sciences 3

Students register for Thesis Research after passing a Qualifying Examination. They will take Thesis Research each semester until they have accumulated 90 credits.

Graduate Research- Morningside Graduate School of Biomedical Sciences 3+

Students register for Graduate Research after completing the requisite number of credits to meet graduation requirements. They will take this course each semester until they complete all remaining requirements.

MD/PhD Program Financial Commitment

The MD/PhD Program pays for 8 semesters in Medical School during which a student must

be in good standing and up to date with all their current requirements (i.e. no extending). All or part of any semester completed in the T.H. Chan School of Medicine is considered a whole term. For example, if a student takes one or two blocks of clinical skills sessions prior to starting clerkship rotations they are still enrolled in Medical School and the Program is billed for an entire term. If a course or clerkship is taking during any semester, or part of a semester, it is considered a full semester. If at any time a student must repeat part or all of a course during FOM1 and FOM2 by extending the medical school academic program, they will need to complete the requirement while on a Leave of Absence. Any terms completed on an LOA from the MD/PHD Program and Morningside Graduate School of Biomedical Sciences , which is also defined by the suspension of program benefits, will not count toward the 8 semesters.

Financial Support, Tuition and Fees

Tuition is waived and fees are set forth in the general schedule. The Special Program Fees are deferred and forgiven in full upon the successful completion of the MD and PhD degrees at UMass Chan Medical School.

MD/PhD students are eligible for graduate student stipends and health insurance throughout the program.

- Stipend - https://www.umassmed.edu/gsbs/admissions/financial-support/
- Tuition & Fees – https://www.umassmed.edu/education/graduate-school-of-biomedical-sciences/finances/

Faculty:

Program Director

Catarina Kiefe, PhD, MD, (Population Health Sciences) Health care quality measurement and outcomes research

Program Co-Directors

Mark Johnson, MD, PhD, (Cancer Biology, MD/PhD, Millennium PhD, Neuroscience, Translational Science)

Professors

Mark J. Alkema, PhD (Neurobiology) – C. elegans behavioral genetics

Jeroan Allison, MD, MS (Population Health Sciences) Clinical epidemiology; quality measurement and outcomes research; health services delivery to medically indigent populations

Victor Ambros, PhD, (Molecular Medicine) Molecular and genetic control of animal

development; microRNA regulatory mechanisms

Raffi Aroian, PhD, (Interdisciplinary, MD/PhD, Neuroscience, Postbaccalaureate Research Education Program)

Neil Aronin, MD, (Medicine) Huntington's disease

Arlene Ash, PhD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Eric Baehrecke, PhD, (Cancer Biology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program, Translational Science)

Samuel Behar, MD, PhD, (Microbiology and Physiological Systems)

Andreas Bergmann, PhD, (Cancer Biology, MD/PhD, Postbaccalaureate Research Education Program)

Daryl Bosco, PhD, (Neurology) Mechanisms of amyotrophic lateral sclerosis; protein misfolding

Edwin Boudreaux, PhD, (Clinical & Population Health Research, Interdisciplinary, MD/PhD, Millennium PhD, MS in Clinical Investigation)

Robert Brown, MD, DPhil, (Bioinformatics & Computational Biology, Clinical & Population Health Research, Interdisciplinary, MD/PhD, MS in Clinical Investigation, Neuroscience, Translational Science)

Nancy Byatt, DO, MBA, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Lucio Castilla, PhD, (Cancer Biology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program)

Sharon Cantor, PhD, (Cancer Biology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program)

Silvia Corvera, MD, (Molecular Medicine) Interdisciplinary, MD/PhD, Neuroscience, Postbaccalaureate Research Education Program, Translational Science

Michael Czech, PhD, (Molecular Medicine) Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD, Millennium PhD, Neuroscience, Postbaccalaureate Research Education Program, Translational Science

Roger Davis, PhD, (Molecular Medicine) Signal transduction by the epidermal growth factor receptor; mechanisms by which growth factors regulate cellular proliferation

Job Dekker, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD)

J. Kevin Donahue, MD, (MD/PhD, Translational Science) Characterization of and therapeutic development for cardiac arryhthmias

Patrick Emery, PhD, (Neurobiology) Circadian rhythms and their synchronization in Drosophila

Thomas Fazzio, PhD, (Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program)

Katherine Fitzgerald, PhD, (Medicine) Innate immune signaling

Terence Flotte, MD, (Biochemistry & Molecular Biotechnology, Clinical & Population Health Research, Immunology & Microbiology, Interdisciplinary, MD/PhD, Millennium PhD, MS in Clinical Investigation, Translational Science)

Michael Francis, PhD, (MD/PhD, Neuroscience, Postbaccalaureate Research Education Program)

Peter Friedmann, MD, MPH, DFASAM, FACP, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Fen-Biao Gao, PhD, (Immunology & Microbiology, Interdisciplinary, MD/PhD, Millennium PhD, Neuroscience, Postbaccalaureate Research Education Program, Translational Science)

Guangping Gao, PhD, (Microbiology and Physiological Systems) Adeno-associated virus vectors for gene therapy of genetic diseases

Douglas Golenbock, MD, (Immunology & Microbiology, Interdisciplinary, MD/PhD, Translational Science)

Dale Greiner, PhD, (Molecular Medicine) Study of normal and abnormal T cell development in animal models of autoimmunity; pathogenesis of autoimmune diabetes in BB rats and NOD mice; mechanisms of transplantation tolerance by co-stimulation blockade

Nikolaus Grigorieff, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Cancer Biology, Cell Biology, Immunology & Microbiology, MD/PhD, Neuroscience)

Gang Han, PhD, (Biochemistry & Molecular Biotechnology, Interdisciplinary, MD/PhD)

David Harlan, MD, (Clinical & Population Health Research, MD/PhD, Millennium PhD, MS in Clinical Investigation, Translational Science)

John Harris, MD, PhD, (Immunology & Microbiology, Interdisciplinary, MD/PhD,

Millennium PhD)

Cole Haynes, PhD, (Biochemistry & Molecular Biotechnology, Cancer Biology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program)

Lawrence Hayward, MD, PhD, (Neurology) Ion channelopathies, motor neuron disease, and neuromuscular channelopathies

Jean Marie Houghton, MD, PhD, (Medicine) Host immune response to Helicobacter pylori infection, immune modulation of gastric cell signaling and growth regulation in response to Helicobacter infection

Y. Tony Ip, PhD, (Molecular Medicine) Regulatory mechanisms in Drosophila innate immunity

Allan Jacobson, PhD, (Microbiology and Physiological Systems) Post-transcriptional regulation of gene expression in yeast

Mark Johnson, MD, PhD, (Cancer Biology, MD/PhD, Millennium PhD, Neuroscience, Translational Science)

Joonsoo Kang, PhD, (Immunology & Microbiology, MD/PhD)

Paul Kaufman, PhD, (Molecular, Cell & Cancer Biology) Assembly and function of eukaryotic chromosomes

Michelle Kelliher, PhD, (Molecular, Cell & Cancer Biology) Genetic analysis of programmed cell death in the mouse

David Kennedy, PhD, (Psychiatry, MD/PhD, Neuroscience)

Anastasia Khvorova, PhD, (RNA Therapeutics Institute) Develop and characterize novel RNA chemistries to promote efficient oligonucleotide internalization and tissue distribution

Catarina Kiefe, PhD, MD, (Population Health Sciences) Health care quality measurement and outcomes research

Jason Kim PhD, (Molecular Medicine) Research obesity, diabetes and its complications using elegant metabolic procedures and transgenic mouse models of altered metabolism

William Kobertz, PhD, (Biochemistry & Molecular Biotechnology) Structure, function and modulation of ion channels

Hardy Kornfeld, MD, (Medicine) Bacterial and viral respiratory pathogens relating to tuberculosis

Andrei Korostelev, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics &

Computational Biology, Interdisciplinary, MD/PhD)

Timothy Kowalik, PhD, (Cancer Biology, Immunology & Microbiology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program, Translational Science) Cellular and organismal studies of viral infections

Evelyn Kurt-Jones, PhD, (Medicine) Innate immunity and inflammation in infection and cancer; cellular and molecular basis of innate immunity; role of pattern recognition receptors, including Toll-like receptors, in triggering the synthesis and release of inflammatory cytokines in response to infection or injury; role of inflammation in the development of cancer

David Lambright, PhD, (Molecular Medicine) Structural determination of key intermediates in cellular signaling and vesicle trafficking pathways

John Landers, PhD, (Neurology) Genetics of familial and sporadic ALS

Kate Lapane, PhD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation, Postbaccalaureate Research Education Program)

Jeanne Lawrence, PhD, Cell and Developmental Biology Developmental genetics including chromosome mapping and the functional organization of DNA and RNA within the interphase nucleus

Nathan Lawson, PhD, (Molecular, Cell & Cancer Biology) Determining the signals responsible for blood vessel development using zebrafish

Andrew Leiter, MD, PhD, (Interdisciplinary, MD/PhD)

Stuart Levitz, MD, (Medicine) Interplay between host immune system and opportunistic fungal pathogens

Brian Lewis, PhD, (Cancer Biology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program, Translational Science) Elucidate the molecular mechanisms essential for the development and progression of pancreatic and hepatocellular carcinomas

Egil Lien, PhD, (Immunology & Microbiology, Interdisciplinary, MD/PhD) Signaling mechanisms that underlie organogenesis and tumorigenesis of the gastrointestinal tract

Jeremy Luban, MD, (Molecular Medicine) Viral replication, pathogenesis, and immunity

Pranoti Mandrekar, PhD, (Immunology & Microbiology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program, Translational Science) *S*tress responses and proteostasis regulators in liver inflammation and fibrosis

Junhao Mao, PhD, (Cancer Biology, MD/PhD, Postbaccalaureate Research Education

Program) Signaling mechanisms that underlie organogenesis and tumorigenesis of the gastrointestinal tract

Kristin Mattocks, PhD, MPH, (Cell Biology, Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Dannel McCollum, PhD, (Biochemistry & Molecular Biotechnology) Signaling pathways controlling cell growth and division

Beth McCormick, PhD, (Immunology & Microbiology, MD/PhD, Translational Science) Epithelial barrier function in the intestine and mucosal inflammation during enteric bacterial pathogen infection and inflammatory bowel diseases

David McManus, MD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation) Development and implementation of digital health solutions to improve cardiovascular health

Haley Melikian, PhD, (Biochemistry & Molecular Biotechnology, Interdisciplinary, MD/PhD, Neuroscience, Postbaccalaureate Research Education Program, Translational Science) Monamine transporters, neuropsychiatric disorders, and addiction

Craig Mello, PhD, Distinguished Professor, (Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD) Mechanisms of small-RNA-directed search pathways

Arthur Mercurio, PhD, (Molecular, Cell & Cancer Biology) Mechanisms of carcinoma progression

Tiffany Moore Simas, MD, MPH, Med, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation) Gestational diabetes research

Ann Moormann, PhD, MPH, (IMP) Viral immunology and epidemiology

Trudy Morrison, PhD, (Microbiology and Physiological Systems) Structure and intracellular processing of viral glycoproteins

Mary Munson, PhD, (Biochemistry & Molecular Biotechnology, Interdisciplinary, MD/PhD, Neuroscience, Postbaccalaureate Research Education Program) Regulation of vesicle targeting and fusion

Peter Newburger, MD, (Pediatrics) Global analysis and regulation of phagocyte gene expression; pattern recognition receptor expression and function in neutrophils

Ira Ockene MD, (Medicine) Risk factor modification using behavioral and nutritional interventions; systems-based interventions for risk factor control and for improvement of adherence to medications; intervention for the prevention of diabetes; seasonal/cultural

patterns of lipids and of the underlying factors; studies of foods with lipid-altering pharmacologic effects

Judith Ockene, PhD, MEd, MA, (Medicine) Women's health; obesity; multiple risk behaviors; quality of life; population health; tobacco/alcohol use; relationship of lifestyle behaviors to disease; community-based interventions for lifestyle behaviors

Gregory Pazour, PhD, (Molecular Medicine) Function of the Mammalian Primary Cilium and Mechanisms of Eukaryotic Ciliary Assembly

Craig Peterson, PhD, (Molecular Medicine) Roles of the SWI/SNF complex and chromatin in regulation of eukaryotic gene expression

Sanjay Ram, MD, (Immunology & Microbiology, MD/PhD) Interaction of the complement system with *Neisseria gonorrhoeae* and *N. meningitidis*

Oliver Rando, MD, PhD, (Biochemistry & Molecular Biotechnology) Genomic approaches to chromatin structure and function, and to epigenetic inheritance

Nicholas Rhind, PhD, (Biochemistry & Molecular Biotechnology) Checkpoint regulation of the fission yeast cell cycle

Peter Rice, MD, (Immunology & Microbiology, Interdisciplinary, MD/PhD)

Joel Richter, PhD, (Molecular Medicine) Regulation of maternal mRNA expression in early development

Kenneth Rock, MD, (Pathology) Antigen presentation on MHC Class I and Class II molecules; immune surveillance of viral infections and tumors; dendritic cells and antigen presenting cells; Immunological Danger; acute inflammation to sterile cell death

Evgeny Rogaev, PhD, (Bioinformatics & Computational Biology, MD/PhD, Neuroscience)

Milagros Rosal, PhD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation, Postbaccalaureate Research Education Program)

Max Rosen, MD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Ann Rothstein, PhD (Medicine) Factors regulating T and B lymphocyte activation, function, longevity, and apoptosis in systemic autoimmune disease

Katherine Ruiz De Luzuriaga, MD, (Molecular Medicine) How viruses, including human immunodeficiency virus (HIV) and Epstein Barr virus (EBV), establish persistent viral infections in children and development of prophylactic and therapeutic vaccine strategies for HIV

Sean Ryder, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Computational Biomedical Sciences and Engineering, Interdisciplinary, MD/PhD, Neuroscience, Postbaccalaureate Research Education Program)

Christopher Sassetti, PhD, (Microbiology and Physiological Systems) Genetic and genomic approaches to understand tuberculosis pathogenesis

Celia Schiffer, PhD, (Biochemistry & Molecular Biotechnology) Structural basis for molecular recognition in HIV Protease

Liisa Selin, MD, PhD (Pathology) Mechanisms of viral immunology

Leslie Shaw, PhD, (Molecular, Cell & Cancer Biology) Mechanisms of tumor metastasis

Neal Silverman, PhD, (Medicine) Signal transduction during the insect immune response

Merav Socolovsky, MD, PhD, (Cancer Biology, Immunology & Microbiology, Interdisciplinary, MD/PhD)

Jie Song, PhD, (Biomedical Engineering, Interdisciplinary, MD/PhD)

Erik Sontheimer, PhD, (Molecular Medicine) Biology and mechanism of RNA-based gene regulation; CRISPR interference; RNA-directed genome editing and gene control

Lawrence Stern, PhD, (Pathology) Molecular recognition in the immune system

Susan Swain, PhD, (Immunology & Microbiology, MD/PhD, Translational Science)

Andrew Tapper, PhD, (Biochemistry & Molecular Biotechnology, Interdisciplinary, MD/PhD, Neuroscience, Postbaccalaureate Research Education Program)

William Theurkauf, PhD, (Molecular Medicine) Control of chromosome segregation in early development

Paul Thompson, PhD, (Biochemistry & Molecular Biotechnology) Techniques of chemical biology, biochemistry, and enzymology to develop inhibitors/drugs targeting disease associated enzymes as well as developing novel diagnostics for cancer

Jennifer Tjia, MD, MSCE, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation, Postbaccalaureate Research Education Program)

Chinmay Trivedi, MD, PhD, (Interdisciplinary, MD/PhD, Translational Science)

Marian Walhout, PhD, (Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD)

J. Matthias Walz, MD, (MD/PhD) Critical care, vascular anesthesia, and perioperative outcomes research

Bo Wang, PhD, (MD/PhD)

Jennifer Wang, MD, (Immunology & Microbiology, MD/PhD, Translational Science)

Jonathan Watts, PhD, (Biochemistry & Molecular Biotechnology, Interdisciplinary, MD/PhD, Neuroscience, Translational Science)

David Weaver, PhD, (Neurobiology) Molecular physiology of circadian rhythms

Zhiping Weng, PhD, (Biochemistry & Molecular Biotechnology) Bioinformatics and computational genomics

Scot Wolfe, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program)

Phillip Zamore, PhD, (Biochemistry & Molecular Biotechnology) Dissecting the RNAi and miRNA Pathways

Associate Professors

Jong Gyu Baek, PhD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Jennifer Benanti, PhD, (Cancer Biology, Interdisciplinary, MD/PhD, Millennium PhD, Postbaccalaureate Research Education Program)

Michael Brehm, PhD, (Cancer Biology, Immunology & Microbiology, Interdisciplinary, MD/PhD)

Kensuke Futai, PhD, (Interdisciplinary, MD/PhD, Neuroscience)

David Grunwald, PhD, (Biochemistry & Molecular Biotechnology, Immunology & Microbiology, Interdisciplinary, MD/PhD)

Nils Henninger, MD, PhD, (MD/PhD, Millennium PhD, Neuroscience, Translational Science)

Javier Irazoqui, PhD, (Immunology & Microbiology, Interdisciplinary, MD/PhD, Neuroscience, Postbaccalaureate Research Education Program)

Elinor Karlsson, PhD, (Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD, Neuroscience)

Brian Kelch, PhD, (Biochemistry & Molecular Biotechnology) Biochemistry & Molecular Biotechnology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program

Dohoon Kim, PhD, (Cancer Biology, Interdisciplinary, MD/PhD, Neuroscience,

Postbaccalaureate Research Education Program)

Michael Lee, PhD, (Molecular Medicine) Bioinformatics & Computational Biology, Cancer Biology, Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program

Hong-Sheng Li, PhD, (Biochemistry & Molecular Biotechnology, Interdisciplinary, MD/PhD, Neuroscience)

Stephen Lyle, MD, PhD, (Molecular, Cell & Cancer Biology) Stem cells and cancer

Rene Maehr, PhD, (Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD)

Paulo Martins, MD, PhD, FAST, (MD/PhD, Translational Science)

Francesca Massi, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, MD/PhD, Postbaccalaureate Research Education Program) Protein dynamics, function, and stability using NMR spectroscopy and computer simulation

Christian Mueller, PhD, (Interdisciplinary, MD/PhD, Translational Science) Therapeutics for rare genetic disorders

James Munro, PhD, (Biochemistry & Molecular Biotechnology, Immunology & Microbiology, MD/PhD)

Peter Pryciak, PhD, (Biochemistry & Molecular Biotechnology) Function of yeast heterotrimeric G proteins in signal transduction and cell polarity

Read Pukkila-Worley, MD, (Immunology & Microbiology, Interdisciplinary, MD/PhD, Translational Science)

Claudio Punzo, PhD, (Interdisciplinary, MD/PhD, Millennium PhD, Neuroscience)

Andrea Reboldi, PhD, (Immunology & Microbiology, MD/PhD)

Dorothy Schafer, PhD, (MD/PhD, Neuroscience, Postbaccalaureate Research Education Program, Translational Science)

Miguel Sena Esteves, PhD, (Interdisciplinary, MD/PhD, Neuroscience)

Elizabeth Shank, PhD, (Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD)

Jason Shohet, MD, PhD, (Cancer Biology, MD/PhD)

Eduardo Torres, PhD, (Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program, Translational Science)

Michelle Trivedi, MD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Amy Walker, PhD, (Interdisciplinary, MD/PhD, Postbaccalaureate Research Education Program)

Yang Xiang, PhD, (MD/PhD, Neuroscience, Translational Science)

Wen Xue, PhD, (Biochemistry & Molecular Biotechnology, Cancer Biology, Interdisciplinary, MD/PhD, Millennium PhD, Postbaccalaureate Research Education Program)

Hyun Youk, PhD, (Bioinformatics & Computational Biology, Immunology & Microbiology, Interdisciplinary, MD/PhD)

Assistant Professors

Matthew Alcusky, PharmD, MS, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Yingleong (Rigel) Chan, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Cancer Biology, Immunology & Microbiology, Interdisciplinary, MD/PhD, Millennium PhD, Neuroscience, Translational Science)

William Flavahan, PhD, (Biochemistry & Molecular Biotechnology, Cancer Biology, Interdisciplinary, MD/PhD, Millennium PhD, Translational Science)

Sarah Forrester, PhD, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation, Postbaccalaureate Research Education Program)

Heather Gray-Edwards, PhD, (MD/PhD, Neuroscience)

Paul Greer, PhD, (Interdisciplinary, MD/PhD, Neuroscience)

Milka Koupenova, PhD, (Immunology & Microbiology, Interdisciplinary, MD/PhD, Translational Science)

Li Li, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Interdisciplinary, MD/PhD)

Teng-Ting (Elaine) Lim, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics & Computational Biology, Cancer Biology, Immunology & Microbiology, Interdisciplinary, MD/PhD, Millennium PhD, Neuroscience, Translational Science)

Amir Mitchell, PhD, (Bioinformatics & Computational Biology, Cancer Biology, Interdisciplinary, MD/PhD)

Megan Orzalli, PhD, (Immunology & Microbiology, MD/PhD)

Athma Pai, PhD, (Biochemistry & Molecular Biotechnology, Bioinformatics &

Computational Biology, Computational Biomedical Sciences and Engineering, Interdisciplinary, MD/PhD)Jillian Richmond, PhD, (Immunology & Microbiology, MD/PhD)

Marcus Ruscetti, PhD, (Cancer Biology, Immunology & Microbiology, Interdisciplinary, MD/PhD, Millennium PhD, Translational Science)

Kuang Shen, PhD, (Biochemistry & Molecular Biotechnology, Cancer Biology, Interdisciplinary, MD/PhD)

Gowthaman Uthaman, PhD, (Immunology & Microbiology, MD/PhD)

Zaida Ramirez-Ortiz, PhD, Assistant Professor, (Immunology & Microbiology, Interdisciplinary, MD/PhD)

Contributing Faculty:

Jonathan Kay, MD, Professor, (Clinical & Population Health Research, Immunology & Microbiology, MD/PhD, MS in Clinical Investigation)

Daniel Amante, PhD, Assistant Professor, (Clinical & Population Health Research, MD/PhD, MS in Clinical Investigation)

Dawn Carpenter, DNP, ACNP-BC, Associate Professor, (MD/PhD)

Tara Kumaraswami, MD, Associate Professor, (MD/PhD)

John Sullivan, MD, (Interdisciplinary, MD/PhD)

Millennium PhD Program

In its commitment to training physician-scientists, the T.H. Chan School of Medicine and the Morningside Graduate School of Biomedical Sciences created a unique PhD-granting program, the Millennium PhD Program (MPP). This track is designed for UMass-affiliated individuals with an MD or equivalent degree (DO, MBBS, DVM) who seek more rigorous biomedical research education, including formal coursework and thesis preparation. Eligible applicants include UMass Chan Medical School students, residents in any clinical department, residency graduates, clinical fellows, and junior faculty who have identified a willing thesis research mentor in the Morningside Graduate School of Biomedical Sciences faculty.

Unlike the traditional Morningside Graduate School of Biomedical Sciences programs, there is no period of laboratory rotations for the MPP. Candidates must have identified a Morningside Graduate School of Biomedical Sciences faculty member capable and willing to serve as their research mentor before applying to the program. There is no restriction to the

field of research in the MPP so that thesis research mentors may come from the entire pool of top-flight scientists and educators with a Morningside Graduate School of Biomedical Sciences faculty appointment. It is expected that candidates for the MPP will have spent elective time in medical school, residency, or fellowship pursuing research in their prospective mentor's laboratory.

The MPP accepts medical education as fulfilling most of the didactic requirements of graduate education. However, MPP participants are encouraged to select graduate courses tailored to their individual needs under the direction of their mentor, thesis research advisory committee (TRAC), and the Dean of the Morningside Graduate School of Biomedical Sciences. All MPP participants are required to take Responsible Conduct of Research.

As in conventional graduate programs, trainees are awarded their degree pending successful performance of a Qualifying Exam (QE) and successful thesis defense. The QE committee is formulated in consultation with the thesis research mentor and TRAC, subject to the approval of the Program Director and the Dean of Morningside Graduate School of Biomedical Sciences. The QE topic can be based on the trainee's thesis research topic or another topic in a field of research relevant to the planned thesis research. The thesis advisor is permitted to attend the Specific Aims meeting.

It is anticipated that completion of the MPP will typically require three to four years concurrent with the research period outlined in the Research Pathways options.

MPP students in clinical training must dedicate no less than 80 percent of their time to MPP training, with up to 20 percent time available for other pursuits. Graduates are awarded a PhD in Biomedical Sciences and will be well-positioned to compete for independent research funding. An application to the MPP can be submitted during the third or fourth year of medical education at UMass Chan Medical School, before or during residency or clinical fellowship for individuals accepted to UMass-affiliated programs, or after appointment to the UMass Chan Medical School faculty.

Complete information on the program can be found at:
https://www.umassmed.edu/gsbs/academics/phd-biomedical-sciences/millennium-phd/

Masters Programs

MSCI

The Master of Science in Clinical Investigation (MSCI) is a training program that prepares students for conducting independent clinical, public health, and translational research. This

program emphasizes the development of clinical investigation skills based on a solid foundation in study design, clinical epidemiology, and biostatistics. Typically, the MSCI degree is completed over 18 months to two years with one year of required graduate coursework and a second year of intensive mentored research and electives. For medical students or residents, this degree may be completed during an intense year of coursework and research.

All students are required to complete a structured series of courses, seminars, and workshops in topic areas related to the design, conduct, and analysis of clinical and public health research. Students are expected to attend events relevant to their research to enhance the core curriculum (e.g., seminars, grand rounds, and journal clubs offered on the UMass Chan Medical School campus, research conferences, workshops) and to have regular ongoing contact with their mentors regarding their research. Students must satisfactorily complete 36 credits to obtain the Master's degree. This includes a core curriculum, elective courses, and a thesis research project. For the satisfactory completion of their thesis, students must design a research project in close collaboration with their primary mentor and program director, defend a formal proposal, perform the proposed study, and prepare a scholarly scientific paper on the principal study findings.

The MSCI Program offers two concentration tracks in the areas of population-based clinical research and bench-to-bedside translational research. These concentrations allow students to enhance their knowledge based on their current interests and career objectives. The program positions students for careers as independent clinical, public health, and translational researchers and leaders in their fields. Candidates interested in enrolling in this program should have a strong interest in clinical investigation, with a particular emphasis on translational research, health services and outcomes research, and clinical epidemiology.

Requirements for Specialization

Applicants must be a UMass Chan-affiliated MD, DO, DVM, DNP, PharmD, or PhD or MD student who seek further training in pursuit of a career in clinical, public health, or translational research. Applicants must have successfully completed medical or graduate school from an accredited institution, with demonstrated superior academic performance. UMass Chan Medical School students applying to complete the MSCI during a one-year leave of absence (typically after having completed their third year of medical school training) must have demonstrated superior academic performance in medical school. Applicants with prior research experience are preferred.

Courses in the MSCI Program:

Introduction to Clinical and Translational Research

This course reviews basic principles of epidemiology and biostatistics. The course reviews the application of various observational and experimental research designs and strategies to systematically undertake clinical, epidemiological, and translational research. Didactic instruction, readings, and problem sets (including lab-based analyses) are used to more fully understand epidemics and their causes, as well as various study designs, including cross-sectional, case-control, and cohort observational study designs, and randomized clinical trials. Students also will learn basic principles of biostatistics and will be introduced to STATA for statistical computing. Students are graded on exams, problem sets, and lab assignments. Students without a year of epidemiology and biostatistics are required to take this course before entering CTS603A and CTS602A.

Advanced Epidemiology and Research Methods

Building on basic skills in epidemiology and scientific research methods, this course will cover research design, including hypothesis development, measurement, and analysis. Students will explore methodological strengths of various quantitative and qualitative techniques and designs. Students will have three examinations, weekly problem sets, and assignments to develop original research approaches to specific scientific and clinical questions.

Advanced Epidemiology and Research Methods

This class extends material covered in the fall semester to include additional study designs and techniques used in clinical and epidemiological research. The purpose of this class is to learn advanced epidemiologic techniques, to learn how and when to apply them, and to learn to design rigorous clinical and epidemiologic research studies. Students will gain experience in reading the primary epidemiologic methods literature. Course objectives will be met through class lecture, class discussion, problem sets, exams, application of selected principles to one's research, and how to develop and deliver a mini-lecture.

Generalized Linear Models

This course will provide a foundation for statistical thinking in clinical and population health research. Students completing this course should have a working knowledge of statistical models used for estimation and inference; understand advanced statistical techniques; be able to develop modeling strategies and analysis plans for specific research questions; and, be prepared to implement those plans and summarize and interpret findings. This is a classroom-based course and students are expected to actively participate in class discussions. Practical statistical knowledge is gained through the conduct of in-class

workshops where students are required to gain hands-on experience in statistical problem solving and analysis.

Statistical Methods for Survival & Longitudinal Data Analysis

This course will provide a foundation for statistical thinking in clinical and population health research involving time to event data and longitudinal data. Students completing this course should have a working knowledge of statistical models used for estimation and inference; understand advanced statistical techniques; be able to develop modeling strategies and analysis plans for specific research questions; and be prepared to implement those plans and summarize and interpret findings involving time to event data and longitudinal data.

Community Engagement in Research

Students will learn how to: create and sustain cohesive research teams; develop a productive program of research; develop good mentor and mentee relationships; engage in transdisciplinary science; understand the NIH Roadmap; and hear about different forms of clinical and community research from local investigators who conduct this type of research.

Design of Clinical Trials

This course is intended for the research scientist in training. The goal is to sharpen their methodologic skills in designing experimental studies for clinical investigators. The course addresses theoretical and practical methods in designing clinical trials with emphasis on design implications and development of individual study protocols. The course focuses on designing intervention studies to achieve research objectives by selecting appropriate study samples, primary and secondary trial endpoints, and trial designs. Specific topics include efficacy versus effectiveness trials and critiquing clinical trial protocols, with an emphasis on evaluating the strengths and weaknesses of the trial design used.

Ethics for Clinical Research

This course covers basic human subject's research issues, including NIH guidelines, required certification, and Institutional Review Board processes and procedures. In addition, topics include general research and data ethics. Students complete papers on specific ethical dilemmas and a final project relevant to their area of dissertation research.

Scientific Writing

This course teaches students how to develop a peer reviewed scientific manuscript, through the review of elements of style, authorship, and extent of information that needs to be incorporated into a scientific research paper. Students will learn how to develop the elements that go into a successful scientific manuscript, submit an article for peer review, and respond to reviewers' concerns. During each session, students will critique the work of

others enrolled in the course to obtain hands on experience in the write-up of the introduction, methods, results, and discussion sections of a manuscript. This course will also teach students how to put together a successful oral, as well as poster, scientific presentation.

Systematic Review

The purpose of this class is to learn how to conduct a systematic review including developing a question of appropriate scope and clinical relevance, development of abstraction tool, selection of articles, and drafting of all sections of the review including tables and figures. The end product will be a journal style and length systematic review in the topic area of the students' substantive interest area that is 75% of the way to being ready for submission to a peer-reviewed journal.

Advanced Topics in Epidemiology

This course will cover a focused set of issues in advanced epidemiology such as conducting community-based research, population-based surveillance studies, and individual and community-based randomized controlled trials. Skills will be developed in practical and scientific issues as well as data analysis plans and presentation of results.

Advanced Topics in Biostatistics

This course will cover an advanced topic in Biostatistics (for example, Longitudinal Data Analysis, Survival Analysis, Graphical Information Systems and Spatial statistics). The purpose of the course is to provide students with immersion in one particular area of biostatistics, providing the theoretical background necessary and the practical "hands-on" data analyze experience.

Advanced Analytical Methods for Health Outcomes Research

This advanced methods course is focused on learning methods for addressing confounding and bias. The goals for students taking this course are to: become comfortable recognizing and discussing bias and confounding; gain experience in using a variety of techniques that help in identifying and minimizing bias and confounding; and to be able to assess the potential impact of residual bias and confounding on study results. This course is organized as topic lectures followed by applications of the topic. Students independently apply what is introduced in the lecture to their own data and share their learning experiences with classmates.

Randomized Clinical Trials in Behavioral Research

The purpose of this course is to provide opportunities for the student to understand the foundations of randomized clinical trials (RCTs) in behavioral medicine research. Topics related to theory, design, implementation, and evaluation of behavioral RCTs will be

discussed. Students will develop a research project where concepts can be applied, and practice gained in reviewing behavioral RCTs in the published literature.

Survey Methods and Measurement in Health Research

This course focuses on survey methods, measurement theory, and the processes of instrument development, refinement, and evaluation. There will be an emphasis on the interaction of conceptual, methodological, cultural, and pragmatic considerations that are essential to understand when measuring variables in clinical populations. Topics include survey design, scale development, item construction, psychometric evaluation of scales, data collection procedures, and sampling strategies.

Introduction to the U.S Healthcare System: How Policies & Practice Affect Health

This course provides an in-depth look at the US healthcare system and its role in maintaining the health of US adults and provides a foundation for understanding and conducting health services research. We will introduce the constructs of structure, process, and outcomes of care to understand and evaluate health care quality and cost. Students will learn how health care policies and payment practices affect the accessibility, effectiveness and cost of care, and be introduced to studies using large administrative datasets that are not specifically designed for research. Students are expected to demonstrate basic knowledge and skills in course topics through class presentations, exercises and papers.

Design and Conduct of Studies of Chronic Disease

This course provides students with an overview of several chronic diseases of major public health and clinical importance, major chronic disease risk factors, and an in-depth understanding of the application of various epidemiological methods to design and conduct clinical/epidemiological studies on chronic disease and their primary and secondary prevention. The course will discuss fundamental concepts in chronic disease epidemiology, common research methods used in the design and conduct of studies of chronic disease epidemiology, and the application of these methods for the major chronic diseases affecting industrialized countries. Specific chronic diseases to be covered will vary from year to year but will include such diseases as cardiovascular disease, cancer, chronic pulmonary disease, chronic kidney disease, diabetes, and musculoskeletal disorders.

Use of Existing Population-Based Public Health Data & Health Care Data

Students will become familiar with existing population-based public health, electronic medical record, and claims data. Topics include advantages and disadvantages, complex sampling and weighting, and obtaining limited-access data. Using a population-based dataset, students will develop and implement an analytic plan to answer a research question

of their choosing.

Psychiatric Epidemiology

This course will provide students with fundamental knowledge of psychiatric epidemiology. The course will cover epidemiological principles specific to psychiatric epidemiology such as assessment and diagnostic validity in the absence of a gold standard. Students will be given the opportunity to conduct original research and will gain knowledge of particular psychiatric illnesses through student preparation of course presentations.

Social Epidemiology

This course covers the main societal causes implicated in affecting the health of human populations, including class hierarchy, racism, gender hierarchy, heteronormativity, and ableism. The course focuses on methodological approaches to measuring and interpreting these forces and their effects, on both minority and dominant populations.

Behavioral Determinants

The purpose of this class is to learn models of disease prevention, multilevel determinants of health behaviors, and major theories of health behavior change and their application to interventions to address major public health problems.

Qualitative Methods for Health Research

This course examines the use of qualitative methods in qualitative research studies or mixed-qualitative/quantitative studies. Essential qualitative research components are explored: theory, rigor, research questions, data collection methods, writing open-ended questions, sampling, data coding and analysis (with a focus on thematic analysis in health research), publishing and writing proposals. Students apply concepts covered in class by developing an original qualitative study.

Pharmacoepidemiology

The purpose of this class is to learn pharmacoepidemiology, including: rigorous methodologic approaches to the measurement of medication exposure, adherence and adverse events; pharmacoepidemiologic study design; choices for pharmacoepidemiology data resources; and the role of quality of life measurements and pharmacoeconomics.

Place & Health

In this class, the influence of place on population health, including physical environment (e.g., air, water, soil, food), built environment (e.g., neighborhood structure, traffic, green space), social environment (e.g., cohesion, safety, deprivation, segregation), and legal and civic structure (e.g., policy, law, representation) is explored. Students will learn how to implement (and critique) methodologic approaches that are particularly adapted to

understanding how individuals and places interact, through the use and understanding of multilevel thinking and modeling, and spatial analytic methods.

Introduction to Implementation Science: Moving Research into Practice in Healthcare and Community Settings

This class provides an introduction to what is often referred to as translational, dissemination or implementation research, as well as the broad field of implementation science. Students will learn about the significance and major initiatives associated with moving research into practice, and will be introduced to conceptual and analytic tools (e.g., theories, frameworks) to support work in this area.

Faculty

MSCI Program Director, Division of Epidemiology

Robert J. Goldberg, PhD (Population Health Sciences) – Cardiovascular epidemiology, preventive cardiology

Professors

Jeroan Allison, MD, MS (Population Health Sciences) – Clinical epidemiology; quality measurement and outcomes research; health services delivery to medically indigent populations

Arlene S. Ash, PhD (Population Health Sciences) – Professor and division chief, biostatistics and health services research, advanced statistical methods, trial design

Bruce A. Barton, PhD (Population Health Sciences) –Biostatistics and health services research, director, and quantitative methods core

Diane R. Blake, MD, (Pediatrics) – Contraceptive management, GLBT health, primary care

Edwin D. Boudreaux, PhD (Emergency Medicine) – Psychiatry and Population Health Sciences

Carol A. Bova, PhD (Tan Chingfen Graduate School of Nursing) – Interventions aimed at the primary care needs of HIV-infected adults; HIV prevention among African immigrants

Robin E. Clark, PhD (Family Medicine & Community Health) – Economic evaluation; mental health and substance abuse policy; health care financing

Sybil L. Crawford, PhD (Medicine) – Women's health, particularly menopause; ethnic differences in health and health care utilization; applied statistical techniques, including missing-data methods and longitudinal modeling

Carol Curtin, MSW, PhD (Family Medicine and Community Health)- developmental

disabilities/psychiatric disorders and their families in a variety of settings and using a variety of clinical modalities

Sarah Cutrona, MD, MPH (Population Health Sciences) -Professor in Health Informatics and Implementation Science and the Department of Medicine in the Division of General Internal Medicine

Maryann Davis, PhD (Psychiatry)- youth mental health

Jeff Driban, PhD (Population Health Sciences) –Division of Epidemiology, osteoarthritisCatherine E. Dube, EdD, (Population Health Sciences) –Division of Epidemiology , nursing home research, communication

Terence R. Flotte, MD (Dean, T.H. Chan School of Medicine; Celia and Isaac Haidak Professor of Medicine; Pediatrics, Molecular Genetics & Microbiology) – Gene therapy for cystic fibrosis, alpha-1 antitrypsine deficiency and other single gene defects

Peter Friedmann, MD, MPH (Baystate)- Substance abuse

Benjamin Gerber, MD, MPH (Population Health Sciences)- Health Informatics and Implementation Science

David C. Hoaglin, PhD (Population Health Sciences) – Biostatistics and health services research

Catarina Kiefe, MD, PhD (Population Health Sciences) – Health care quality measurement and outcomes research

Jason J. Kim, PhD (Molecular Medicine) – Research obesity, diabetes and its complications using elegant metabolic procedures and transgenic mouse models of altered metabolism

Kate L. Lapane, PhD MS (Population Health Sciences)- Division of Epidemiology, pharmacoepidemiology, epidemiologic methods, aging, nursing home research

Stephenie C. Lemon, PhD (Medicine) – Primary health care delivery; cancer detection and control; chronic disease management and treatment adherence; patient/clinician communication; clinical decision making

Honghuang Lin, PhD (Medicine)- Clinical informatics

Kristin Mattocks, PhD, MPH (Population Health Sciences) – Health informatics and implementation science; associate chief of staff for research and development, VA Central Western Massachusetts

Kathleen Mazor, EdD (Medicine)- physician-patient communication, health literacy, disclosure of medical errors, and decision-making

Dave McManus, MD (Medicine)- Chair of the Department of Medicine, Professor; Rapid Acceleration of Diagnostics, or RADx which seeks to identify new methods and tools for addressing the coronavirus pandemic

Ann M. Moormann, PhD, (Molecular Medicine) – Pediatric immunity to infectious diseases focusing on Plasmodium falciparum malaria and Epstein Barr Virus (EBV), molecular epidemiology, Global Health Research, and the etiology of endemic Burkitt lymphoma in Africa

Ira S. Ockene, MD (David J. and Barbara D. Milliken Professor of Preventive Cardiology; Medicine) – Risk factor modification using behavioral and nutritional interventions; systems-based interventions for risk factor control and for improvement of adherence to medications; intervention for the prevention of diabetes; seasonal/cultural patterns of lipids and of the underlying factors; studies of foods with lipid-altering pharmacologic effects

Judith K. Ockene, PhD, MEd, MA (Population Health Sciences) – Women's health; obesity; multiple risk behaviors; quality of life; population health; tobacco/alcohol use; relationship of lifestyle behaviors to disease; community-based interventions for lifestyle behaviors

Gary R. Ostroff, PhD (Program in Molecular Medicine)- vaccines

Lori Pbert, PhD (Population Health Sciences) – Evaluation of clinic-based interventions for health promotion and disease prevention; tobacco treatment in adolescents and adults; training and certification programs for Tobacco Treatment Specialists; obesity prevention and treatment; asthma management

Sharina Person, PhD (Population Health Sciences , Vice Chair) - senior faculty member in the Quantitative Methods Core which provides consultative services to UMass Chan Medical School investigators in the areas of study design, sample size, power calculations, statistical analysis plans, statistical programming, data entry and management, and project coordination

Milagros Rosal, PhD (Population Health Sciences) – Treatment adherence; health behavior change (smoking, diet, physical activity); stress; women's health; minority health; adjustment to chronic illness, diabetes and cardiovascular disease prevention; diabetes self-management; mood and anxiety disorders

Rajani Sadasivam, PhD (Population Health Sciences)- digital health research is primarily focused on treating tobacco use

Johanna Seddon, MD, ScM (Opthalmology and Visual Sciences)- macular degeneration

Tiffany Moore Simas, MD (Obstetrics & Gynecology) – Pregnancy risks and complications

Jen Tjia, MD (Population Health Sciences)-Professor, Division of Epidemiology of Chronic Diseases; Chronic prescription medication by older adults, particularly in nursing home residents with advanced dementia and near the end-of-life

Associate Professors

Karim Alavi, MD, (Surgery) – Surgical outcomes research

Matt Alcusky, PharmD, PhD (Population Health Sciences)- Division of Epidemiology, Pharmacoepidemiologist and health services researcher

Melissa Anderson, PhD (Psychiatry)- research to make behavioral healthcare accessible to members of the U.S. Deaf community

Jonggyu Baek, PhD (Population Health Sciences)- Biostatistics and Health Services Research

Mara M. Epstein, ScD, ScM, (Medicine) – cancer epidemiology, inflammation and cancer, prostate cancer and hematological cancers

Eric O. Mick, ScD, (Population Health Sciences) –Epidemiology of chronic diseases and vulnerable populations, psychiatric epidemiology, ADHD

Hoa Nguyen, MD, MS, PhD (Population Health Sciences)-Division of Epidemiology. International-based observational studies and clinical trials for cardiovascular disease prevention

Larry Rhein, MD, MPH (Pediatrics)- Chair and Associate Professor in the Division of Pediatric Neonatology; Newborn lung disease, screening and weaning protocols for infants with bronchopulmonary dysplasia; infant car seat challenge screening; assessments of infant pulmonary function; management for infants with apnea; and the only diaphragmatic pacing program in New England

Mayra Tisminetzky, MPD, MD, PhD (Medicine)- Geriatric Medicine; Cardiovascular epidemiology, epidemiology of mental health disorders, epidemiology of aging

Chengwu Yang, MD, MS, PhD(Population Health Sciences)- Novel Study Design & Analysis and Measurement in Health

Adrian H. Zai, MD, PhD, MPH (Population Health Sciences)- healthcare informatics and population health management

Assistant Professors

Dan Amante, PhD, MPH (Population Health Sciences)- Assistant Professor, Health Informatics and Implementation Science

Maira A. Castaneda Avila, PhD (Population Health Sciences)- Division of Epidemiology, Colorectal cancer, mixed methods, health disparities, multimorbidity

Karen Clements, ScD (Population Health Sciences)- hepatitis C, pregnancy, patient acceptance of health care

Jamie Faro, PhD (Population Health Sciences)- Informatics and Implementation Science; behavioral and implementation science researcher, with an emphasis on physical activity, diet and smoking cessation

Sarah Forrester, PhD (Population Health Sciences)- Assistant Professor in Epidemiology
Nathaniel S. Hafer, PhD (Program in Molecular Medicine)- clinical and translational science

William M. Jesdale, PhD, (Population Health Sciences)– Epidemiology of chronic diseases and vulnerable populations, environmental health, health disparities research, LGBT health

Sohye Kim, PhD (Psychiatry)- discover early neural markers in the infant's social brain that predict long-term developmental outcomes, identify potentially modifiable early-life factors that influence the trajectory of the developing social brain, and translate these discoveries into innovative strategies for early diagnosis, prevention, and treatment in high-risk children and families for enduring impact.

Aimee R. Kroll-Desrosiers, PhD (Population Health Sciences)- research in veterans, pregnancy outcomes in veterans

Celine Larkin, PhD (Emergency Medicine)- implementation research, suicide

Feifan Liu, PhD (Population Health Sciences)- AI techniques to advance health equity, assessing and mitigating potential biases related to data processing and algorithmic training

Shao-Hsien Liu, MPH, PhD (Population Health Sciences)- Division of Epidemiology, musculoskeletal epidemiologist, application of advanced epidemiological and statistical methods to generate knowledge to ultimately improve quality of care for patients with arthritis

Tony Nunes, PhD (Population Health Sciences)- Division of Epidemiology; Pharmacoepidemiology, studies of drug safety, utilization, and comparative effectiveness

Apurv Soni, MD, PhD (Medicine)- digital medicine

Elise Stevens, PhD (Population Health Sciences)- tobacco products, public service announcements

Chan Zhou, PhD (Population Health Sciences)- novel computational methods and pipelines for analyzing large-scale high throughput data to understand noncoding RNA

epigenomics in genetics and disease toward advancing precision medicine

Pathway Programs

Postbaccalaureate Research Education Program (PREP)

For students seeking a career in biomedical research, the Postbaccalaureate Research Program (PREP) in the Morningside Graduate School of Biomedical Sciences at the University of Massachusetts Chan Medical School offers an outstanding opportunity to enhance student academic preparedness and laboratory-based or clinical research experience. The result is a graduate who is competitive for admission into top-tier graduate programs.

The PREP is a 12-month program which runs July through June. The program prepares students with a Bachelor's or Master's degree in the Physical or Life Sciences (if interested in Basic Biomedical Science study) or a Bachelor's or Master's degree in Public Health or related social science degree (if interested in Population Health Sciences) for doctoral study in the biomedical sciences. Admitted students interested in the Basic & Biomedical Sciences undertake a yearlong mentored research project while studying foundational principles in Molecular Biophysics, Molecular Genetics and Cell Biology. Students interested in Population Health Sciences undertake a yearlong mentored research project while studying foundational principles in biostatistics and epidemiologic research methods. Successful students are presented to the relevant admissions committee for consideration for admission into Morningside Graduate School of Biomedical Sciences PhD programs for the following fall semester.

The PREP is funded by a NIH Postbaccalaureate Research Education Program (PREP) grant (R25GM121220). Therefore, a goal of the PREP is to increase the diversity of the biomedical sciences graduate student population. To be eligible, students must be a US citizens or Permanent Resident and must be from backgrounds underrepresented in the biomedical sciences as defined by the NIH.

Requirements for Admission

US citizens and Permanent Residents who have achieved sound pre-doctoral academic performance in the biological and physical sciences, or who have received a masters degree in public health or in a related social science, but who seek to enhance their academic preparedness and research experience prior to embarking on a PhD, are eligible for admission to the Postbaccalaureate Research Education Program (PREP) in the Morningside Graduate School of Biomedical Sciences. Specific eligibility requirements as stipulated by the National Institutes of Health (NIH) are detailed below.

Financial Support

PREP students in good academic standing receive a salary, as well as health and dental insurance. Tuition and fees are covered by the program.

Application Procedures

Candidates for the PREP begin the application process at the Morningside Graduate School of Biomedical Sciences Web site. Requirements include submission of official transcripts from all undergraduate and graduate institutions attended and three letters of recommendation.

Areas of Research

PREP students, in consultation with the program directors, choose to perform research with any member of the Morningside Graduate School of Biomedical Sciences faculty. Students engage in a year-long laboratory research internship in which mentors expose students to every aspect of laboratory research.

This includes:

- Background reading; hypothesis development
- Design of experiments that challenge the hypothesis
- Learning new laboratory methodologies and instrumentation
- Data collection
- Analysis and interpretation
- Research presentations at lab meetings
- Writing the scientific paper

Core Curriculum

A key aspect of the PREP is to expose students to, and prepare them for, the rigors of the graduate school curriculum. Therefore, all PREP students undertake a core curriculum. The pathway selected by the student determines the specific academic curriculum.

The Basic Biomedical Sciences Pathway

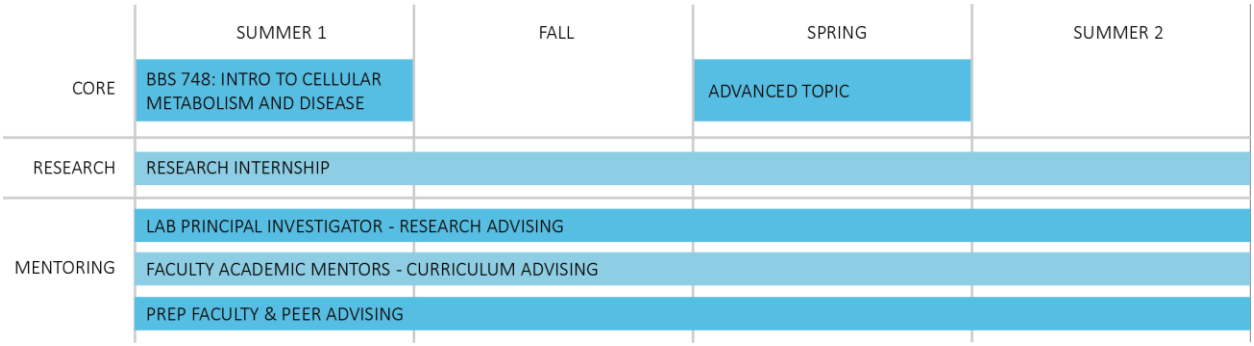
Students selecting the Basic & Biomedical Sciences pathway undertake a core curriculum that emphasizes independent learning, critical thinking and evaluation of the primary research literature.

At the beginning of the program in July, students take an intense 3-week course, BBS748: Introduction to cellular metabolism and disease. The purpose of this course is to prepare entering Morningside Graduate School of Biomedical Sciences students to the independent learning, critical thinking and written communication skills that facilitate success in the

graduate curriculum. This course consists of a combination of interactive lectures by Morningside Graduate School of Biomedical Sciences faculty and discussion of primary research literature relevant to the lecture topics.

In the fall semester, students participate in a journal club series that emphasizes critical reading of the primary scientific literature across a broad range of scientific areas relevant to the basic biomedical sciences.

In the spring semester, students take an advanced topics course in an area of specialization of their choosing. These courses typically consist of a combination of lectures and paper discussion sessions.

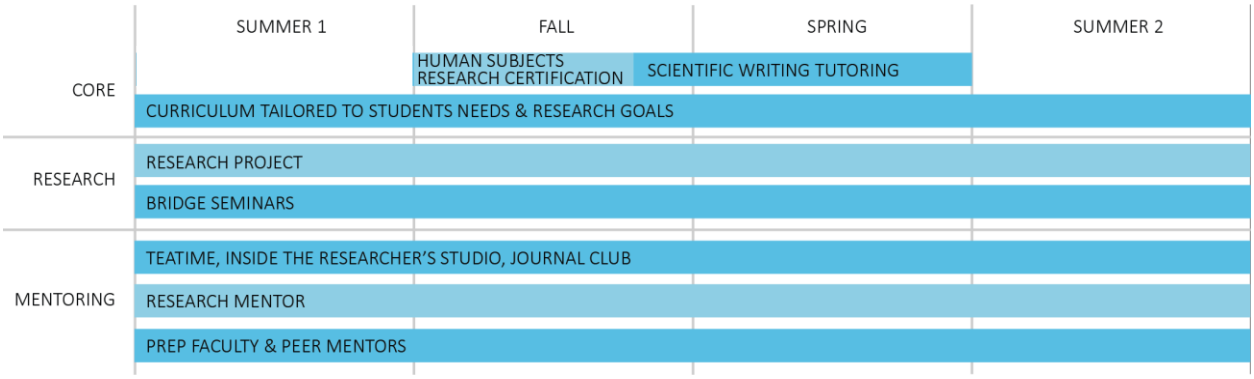


To maximize success, PREP students are assigned faculty and student mentors who meet with program participants on a regular basis, track their academic and research progress, and provide guidance regarding the transition to graduate study.

The Population Health Sciences Pathway

PREP students selecting the Population Health Sciences Pathway have a curriculum tailored to their academic experiences and research goals. PREP students take foundation courses in Epidemiology, Research Methods, and Biostatistics. Typically, courses in the Population Health Sciences Program consist of small group lectures and discussions, student papers and presentations, and hands on exercises. Students develop skills in use of clinical and epidemiological databases. They develop their applied research skills working with a research mentor for the full year where they will contribute to the mentor's work as well as develop an independent project.

Courses will be selected with the mentor. All PREP students must consider that some of the courses available have pre-requisites and students entering the courses must have met the prerequisites.



Faculty:

Mark Alkema, PhD (Neurobiology) – *C. elegans* behavioral genetics

Jeroan Allison, MD, MS (Population Health Sciences) – Clinical epidemiology; quality measurement and outcomes research; health services delivery to medically indigent populations

Victor R. Ambros, PhD (Silverman Chair in Natural Sciences; Molecular Medicine; RNA Therapeutics Institute) – Molecular and genetic control of animal development; microRNA regulatory mechanisms

Raffi Van Aroian, PhD (Program in Molecular Medicine) – Studies of human/animal parasitic nematodes as well as bacterial toxins

Eric H. Baehrecke, PhD (Molecular, Cell & Cancer Biology) – Studies of autophagy implicated in neurodegeneration and cancer.

Jennifer Benanti, PhD (Molecular, Cell & Cancer Biology) – Regulation of cell growth and division

Andreas Bergmann, PhD (Molecular, Cell & Cancer Biology) – Genetic control of programmed cell death (apoptosis) in *Drosophilia*

Daniel Bolon, PhD (Biochemistry & Molecular Biotechnology) – Role of molecular chaperones in biology and disease

Daryl A. Bosco, PhD (Neurology) – Mechanisms of amyotrophic lateral sclerosis; protein misfolding

Robert Brewster, PhD (Program in Systems Biology; Microbiology and Physiological Systems) – Dissecting and understanding the implications of resource sharing to cellular decision-making.

Alexandra Byrne, PhD (Neurobiology) – Investigating Mechanisms of Axon Regeneration in the Aging Nervous System

Sharon Cantor, PhD (Molecular, Cell & Cancer Biology) – Hereditary breast cancer

Lucio H. Castilla, PhD (Molecular, Cell & Cancer Biology) – Genetics of leukemia in mouse models

Silvia Corvera, MD (Molecular Medicine; Cell & Developmental Biology) – Molecular mechanisms involved in the regulation of endocytosis and exocytosis by growth factors

Michael P. Czech, PhD (Chair, Molecular Medicine) – Transmembrane signaling elicited by the insulin receptor tyrosine kinase and its dysfunction in obesity and type 2 diabetes

Catherine Dubé, EdD (Population Health Sciences) – Qualitative research methods, research ethics

Mara M. Epstein, ScD, ScM (Medicine) – cancer epidemiology, inflammation and cancer, prostate cancer and hematological cancers

Thomas Fazzio, PhD (Molecular, Cell & Cancer Biology) – Chromatin regulation in stem cells

Katherine Fitzgerald, PhD (Medicine, Infectious Diseases) – Innate immunity to viruses

Sarah Forrester, PhD (Population Health Sciences) – structural racism and health outcomes

Michael M. Francis, PhD (Neurobiology) – Mechanisms of neuronal signaling in C. elegans

Fen-Biao Gao, PhD (Neurobiology) - Understanding Frontotemporal Dementia and Neuronal microRNAs

Guangping Gao, PhD (Microbiology and Physiological Systems) – Adeno-associated virus vectors for gene therapy of genetic diseases

Cole Haynes, PhD (Molecular, Cell & Cancer Biology) – Mitochondrial function and dysfunction in cancer

Anthony Imbalzano, PhD (Biochemistry and Molecular Biotechnology) – Effects of chromatin structure on the regulation of gene expression and the control of cell growth and differentiation

Tony (Yicktung) Ip, PhD (Molecular Medicine) – Regulatory mechanisms in Drosophila innate immunity

Javier Irazoqui, PhD (Microbiology and Physiological Systems) – Host-pathogen interactions and neural control of innate immunity

Bill Jesdale, PhD (Population Health Sciences) – LGBT health, social epidemiology, health disparities research

Brian Kelch, PhD (Biochemistry and Molecular Biotechnology) – studies of how macromolecular machines work, with special emphasis on machines involved in DNA replication and repair

Michelle Kelliher, PhD (Molecular, Cell & Cancer Biology) – Genetic analysis of programmed cell death in the mouse

Anastasia Khvorova, PhD (Molecular Medicine; RNA Therapeutics Institute) – Develop and characterize novel RNA chemistries to promote efficient oligonucleotide internalization and tissue distribution

Catarina Kiefe, MD, PhD (Population Health Sciences) – health services research, cardiovascular disease health outcomes, systems to end suicide

Dohoon Kim, PhD (Molecular, Cell & Cancer Biology) – Cancer cell metabolism

Jason J. Kim, PhD (Molecular Medicine) – Research obesity, diabetes and its complications using elegant metabolic procedures and transgenic mouse models of altered metabolism

William R. Kobertz, PhD (Biochemistry & Molecular Biotechnology) – Structure, function and modulation of ion channels

Timothy F. Kowalik, PhD (Microbiology and Physiological Systems) – Regulation of cellular proliferation control during viral infection

Kate Lapane, PhD (Population Health Sciences) – pharmacoepidemiology, epidemiologic methods, aging, nursing home research

Michael Lee, PhD (Molecular Medicine; Program in Systems Biology) –Systems Pharmacology of anti-cancer therapies

Stephenie C. Lemon, PhD (Population Health Sciences) – Primary health care delivery; cancer detection and control; chronic disease management and treatment adherence; patient/clinician communication; clinical decision-making

Brian Lewis, PhD (Molecular, Cell & Cancer Biology) – Molecular genetics of pancreatic and liver cancers

Jeremy Luban, MD (Molecular Medicine) – Viral replication, pathogenesis, and immunity

Pranoti Mandrekar, PhD (Medicine) – Innate immune activation in liver diseases and cancer

Junhao Mao, PhD (Molecular, Cell and Cancer Biology) – study of signaling mechanisms that underlie tissue homeostasis and tumorigenesis

Francesca Massi, PhD (Biochemistry & Molecular Biotechnology) – Protein dynamics, function and stability using NMR and computer simulation

Dannel McCollum, PhD (Biochemistry & Molecular Biotechnology) – Signaling pathways controlling cell growth and division

Haley E. Melikian, PhD (Psychiatry; Biochemistry & Molecular Biotechnology) – Cocaine and antidepressant-sensitive monoamine transporters

Arthur M. Mercurio, PhD (Molecular, Cell & Cancer Biology) – Molecular cell biology of aggressive carcinomas

Stephen C. Miller, PhD (Biochemistry & Molecular Biotechnology) – Chemical approaches to study and control of cell biology

Trudy G. Morrison, PhD (Molecular Genetics & Microbiology) – Mechanisms of enveloped virus entry and virus assembly; structure, function and intracellular processing of viral glycoproteins; vaccine development

Mary Munson, PhD (Biochemistry & Molecular Biotechnology, Molecular, Cell & Cancer

Anthony Nunes, PhD (Population Health Sciences) – pharmacoepidemiology, epidemiologic methods

Judith K. Ockene, PhD, MEd, MA (Barbara Helen Smith Chair in Preventive and Behavioral Medicine; Population Health Sciences) – Women's health, obesity, multiple risk behaviors, quality of life, population health, tobacco/alcohol use, relationship of lifestyle behaviors to disease, community-based interventions for lifestyle behaviors

Gregory J. Pazour, PhD (Molecular Medicine) – Function of the mammalian primary cilium and mechanisms of eukaryotic ciliary assembly

Sharina D. Person, PhD (Population Health Sciences) – Biostatistics and health services research, health disparities research

Craig L. Peterson, PhD (Vice Chair, Molecular Medicine) – Roles of the SWI/SNF complex and chromatin in regulation of eukaryotic gene expression

Peter M. Pryciak, PhD (Biochemistry & Molecular Biotechnology) – Function of yeast heterotrimeric G proteins in signal transduction and cell polarity

Nick Rhind, PhD (Biochemistry & Molecular Biotechnology) – DNA replication and replication checkpoints; cell size control; fission yeast comparative genomics

Milagros Rosal, PhD (Population Health Sciences) – Treatment adherence, health behavior change (smoking, diet, physical activity), stress, women's health, minority health, adjustment to chronic illness, diabetes and cardiovascular disease prevention, diabetes self-management, mood and anxiety disorders

Ann Rothstein, PhD (Medicine) – Factors regulating T and B lymphocyte activation, function, longevity, and apoptosis in systemic autoimmune disease

William E. Royer Jr., PhD (Biochemistry & Molecular Biotechnology) – X-ray crystallographic imaging of macromolecular structures; structural basis for inter-subunit communication and macromolecular interactions

Sean Ryder, PhD (Biochemistry and Molecular Biotechnology) – Post-transcriptional regulatory mechanisms involved in axis polarization and cell fate specification during Caenorhabditis elegans embryogenesis, characterization of post-transcriptional regulatory mechanisms that guide oligodendrocyte differentiation and myelin formation in the vertebrate central nervous system, identification of small molecule inhibitors of RNA-binding protein function using high throughput screening approaches

Christopher Sassetti, PhD (Microbiology and Physiological Systems) – Genetic and genomic approaches to understand tuberculosis pathogenesis

Dorothy Schafer, PhD (Neurobiology) – Glial cells in synapse development and plasticity in the healthy and diseased nervous system

Celia A. Schiffer, PhD (Biochemistry & Molecular Biotechnology) – How conformational adaptability affects molecular recognition in drug resistant variants of HIV protease using phage display, X-ray crystallography and molecular dynamics calculations

Leslie M. Shaw, PhD (Molecular, Cell & Cancer Biology) – Mechanisms of breast cancer metastasis

Neal Silverman, PhD (Medicine) – Signal transduction during the insect immune response

Erik Sontheimer, PhD (Molecular Medicine; RNA Therapeutics Institute) – Biology and mechanism of RNA-based gene regulation, CRISPR interference, RNA-directed genome editing and gene control

Lawrence Stern, PhD (Pathology; Biochemistry & Molecular Biotechnology) – Molecular recognition in the immune system

Andrew Tapper, PhD (Neurobiology) – studies to elucidate the brain areas, circuits, and molecular mechanisms underlying addiction and addiction-related behaviors

William E. Theurkauf, PhD (Molecular Medicine) – Regulation of mitotic chromosome segregation

Paul Thompson, PhD (Biochemistry & Molecular Biotechnology) – Techniques of chemical biology, biochemistry, and enzymology to develop inhibitors/drugs targeting disease associated enzymes as well as developing novel diagnostics for cancer

Jennifer Tjia, MD, MSCE (Population Health Sciences) – Effect of state and federal prescription drug policies on elder health outcomes and health service utilization; understanding the predictors of medication uptake and adherence among older adults

Eduardo Torres, PhD (Molecular, Cell & Cancer Biology) – Aneuploidy's affects on cellular physiology and metabolism and how it influences cell evolution

Amy Walker, PhD (Molecular Medicine) – How is transcriptional regulation of lipogenesis linked to diet and environment in C. elegans and mammals

David Weaver, PhD (Neurobiology) – Molecular physiology of circadian rhythms

Zhiping Weng, PhD (Biochemistry & Molecular Biotechnology; Bioinformatics & Integrative Biology) – Bioinformatics and computational genomics

Scot A. Wolfe, PhD (Biochemistry & Molecular Biotechnology, Program in Gene Function) – Protein-DNA recognition; targeted genome modification; transcriptional regulatory networks in metazoans

Wen Xue, PhD (Molecular Medicine; RNA Therapeutics Institute) – To functionally dissect cancer mutations in mouse models of liver cancer and lung cancer

Hong Zhang, PhD (Cell & Developmental Biology) – Molecular mechanisms of cell senescence and relationships to cancer and aging

Jin Zhang, PhD (Program in Molecular Medicine, Neurobiology) – studies of the mammalian taste pathway to understand how the nervous system integrates external and internal information to drive behavior and maintain homeostasis

Administration and Faculty

University of Massachusetts Chan Board of Trustees

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Catarina Kiefe, PhD, MD (PhD, Stony Brook School of Medicine; MD, University of California), Professor, Endowed Chair & Director of the MD/PhD Program

Neal Silverman, PhD (Massachusetts Institute of Technology), Professor, Umbrella Pathway Director

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Robert J. Goldberg, PhD, Master of Science in Clinical Investigation

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Faculty

Nezar Alexander Abdennur, PhD, Assistant Professor of Systems Biology; BS, University of Ottawa, 2009; MS, University of Ottawa, 2011; PhD, Massachusetts Institute of Technology, 2018

Ronald N. Adler, MD, Associate Professor of Family Medicine & Community Health; BA, Tufts University, BS, Tufts University, 1982; MD, UMass Worcester, 1989

Jeremy T. Aidlen, MD, FACS, Associate Professor of Surgery & Chief, Division of Pediatric Surgery; BS, University of Illinois, 1995; MD, University of Medicine & Dentistry of NJ, 1999

Karim Alavi, MD, Associate Professor of Surgery; BS, George Washington University; MD, George Washington University School of Medicine

Matthew J. Alcusky, PhD, PharmD, MS, Associate Professor of PQHS; MS, University of Rhode Island, 2014; PhD, UMass Chan Medical School, 2019; PharmD, University of Rhode Island, 2014

Mark Alkema, PhD, Professor of Neurobiology; BS, University of Amsterdam, 1985; MS, University of Amsterdam, 1990; PhD, University of Amsterdam, 1996

Jeroan J. Allison, MD, MS, Chair & Professor of Population Health Sciences MSCIEP; BS, Samford University; MS, Harvard Sch of Public Health, 1997; MD, University of Alabama, 1989

Daniel J. Amante, PhD, MPH, Assistant

Professor of PQHS; BA, College of the Holy Cross, 2007; MPH, Boston University School of Public Health, 2010; PhD, UMass Chan Medical School, 2016

Victor R. Ambros, PhD, Silverman Chair in Natural Sciences, Professor of Molecular Medicine; SB, Massachusetts Institute of Technology, 1975; PhD, Massachusetts Institute of Technology, 1979

Melissa Lee Anderson, PhD, Associate Professor of Psychiatry; BA, Boston University; BS, Boston University; MA, Gallaudet University; PhD, Gallaudet University

Raffi V. Aroian, PhD, Professor of Molecular Medicine; BS, Massachusetts Institute of Technology, 1983; PhD, California Institute of Technology, 1992

Neil Aronin, MD, Higgins Family Professor in Neuroscience, Professor of Medicine; BA, Duke University, 1970; MD, Pennsylvania State College of Medicine, 1974

Arlene S. Ash, PhD, Professor of Population Health Sciences ; Division: Biostatistics and Health Services Research; BA, Harvard University, 1967; MS, Washington University in St Louis, 1972; PhD, University of Illinois, Chicago, 1977

Prabhani Upeka Atukorale, PhD, Adjunct Assistant Professor of Molecular, Cell and Cancer Biology; BE, Vanderbilt University; ME, Johns Hopkins University; PhD, Massachusetts Institute of Technology

David C. Ayers, MD, Arthur M. Pappas, Chair and Professor of Orthopedics & Physical Rehabilitation; BS, Tufts University, 1978; MD, University of Rochester, 1982

Ingolf Bach, PhD, Professor of Molecular, Cell & Cancer Biology; BA, University of Konstanz; MA, University of Konstanz; PhD, University of Paris VII, 1993

Eric H. Baehrecke, PhD, Our Danny Cancer Fund Chair in Biomedical Research II, Professor of Molecular, Cell & Cancer Biology; BS, UMass Amherst, 1986; MS, Texas A & M University, 1988; PhD, University of Wisconsin, Madison, 1992

Jong Gyu Baek, PhD, Associate Professor of PQHS, Division: Biostatistics and Health Services Research; BS, University of Iowa; MS, University of Michigan, Ann Arbor; PhD, University of Michigan Ann Arbor, 2014

Bruce A. Barton, PhD, Professor of PQHS, Division: Biostatistics and Health Services Research; BA, Dickinson College; MA, Pennsylvania State University; MS, University of Pittsburgh; PhD, University of Pittsburgh

Samuel M. Behar, MD, PhD, Professor of Microbiology & Physiological Systems; BS, University of California, Berkeley, 1983; MD, Albert Einstein College of Medicine; PhD, Albert Einstein College of Medicine, 1990

Jennifer A. Benanti, PhD, Associate Professor of Molecular, Cell & Cancer Biology; BS, University of California, San Diego, 1996; PhD, University of Washington, 2003

Andreas Bergmann, PhD, Professor of Molecular, Cell & Cancer Biology; BS, Max Planck Institute for Developmental Biology, 1991; PhD, Universitat Tubingen, Germany, 1996

Steven B. Bird, MD, Professor of Emergency Medicine; BS, Yale University, 1991; MD, Northwestern University, 1995

Diane R. Blake, MD, Professor of Pediatrics, Division: Adolescent Medicine; BA, Smith College, 1986; MD, Johns Hopkins University, 1990

Alexei A. Bogdanov, PhD, Professor of Radiology, Division: Nuclear Medicine; BA, Moscow State University; MS, Moscow State University; PhD, Moscow State University, 1989

Milena Bogunovic, MD, PhD, Associate Professor of Pathology; PhD, Mount Sinai School of Medicine; MD, Russian State Medical University, Russia

Daniel N. Bolon, PhD, Professor of Biochemistry & Molecular Biotechnology; BS, Duke University, 1997; PhD, California Institute of Technology, 2002

Daryl A. Bosco, PhD, Professor of Neurology, BS, State University of New York, Birghamton, 1996; PhD, Brandeis University, 2003

Edwin D. Boudreaux, PhD, Professor of Emergency Medicine, Division: Research; BS, University of Louisiana; PhD, Louisiana State University, Baton Rouge, 1997

Gabriella Lutz Boulting, PhD, Assistant Professor of Neurobiology; BS, University of California, Los Angeles; PhD, Harvard University

Carol A. Bova, PhD, RN, ANP, Professor Emeritus of Tan Chingfen Graduate School of Nursing; BA, Salem State College; BS, Salem State College; MS (Nursing), Yale University School of Nursing, 1988; PhD, Boston College, 1998

Michael A. Brehm, PhD, Associate Professor of Molecular Medicine; BS, Philadelphia Col Pharmacology & Science, 1993; PhD, Pennsylvania State University, 1999

Robert Charles Brewster, PhD, Associate Professor of Microbiology & Physiological Systems; BS, University of Massachusetts Amherst; PhD, University of California, Los Angeles

Michael H. Brodsky, PhD, Assistant Professor of Molecular, Cell & Cancer Biology; BA, University of California, 1987; PhD, Massachusetts Institute of Technology, 1996

Robert H. Brown, MD, DPhil, Donna M. and Robert J. Manning Chair in Neuroscience, Professor of Neurology; BA, Amherst College; MD, Harvard Medical School, 1975; DPhil, University of Oxford

Vanni Bucci, PhD, Associate Professor of Microbiology & Physiological Systems; BS, University of Florence, 2006; MS, Northeastern University, 2008; PhD, Northeastern University, 2010

Vivian Budnick, PhD, Worcester Foundation for Biomedical Research chair I, Chair and Professor of Neurobiology; BS, University of Chile, 1983; PhD, Brandeis University, 1988

Nancy Byatt, DO, MS, MBA, Professor of Psychiatry; BA, Lehigh University; MBA, NY Institute of Technology, 2003; MS, Clinical Investigation at UMass Chan Medical School, 2015; DO, NY College of Osteopathic Medicine, 2003

Alexandra Catherine Byrne, PhD, Assistant Professor of Neurobiology; PhD, University of Toronto

Daniel R. Caffrey, PhD, Associate Professor of Medicine; Division: Infectious Diseases and Immunology; BS, Maynooth University 1997; PhD, Trinity College, Dublin, 2002

Sharon B. Cantor, PhD, Professor of Molecular, Cell & Cancer Biology; BS, University of Michigan, 1990; PhD, Sackler School of Graduate Biology, 1997

Roberto Caricchio, MD, Myles J. McDonough Chair in Rheumatology, Medicine, Division: Rheumatology; MD, Catholic University, 1993

Maira A. Castaneda Avila, PhD, Assistant Professor of PQHS; BS, Ana G. Mendez University, 2009; MS, University of Puerto Rico, Rao Piedras Campus, 2015; University of Massachusetts Chan Medical School, 2021

Lucio H. Castilla, PhD, Professor of Molecular, Cell & Cancer Biology MS, University of Buenos Aires, 1988; PhD, University of Michigan, 1995

Lisa Ann Cavacini, PhD, Professor of Medicine, Division: Massachusetts Biological Laboratory; BS, University of Scranton; PhD, Drexel University, 1988

Craig J. Ceol, PhD, Assistant Professor of Program in Molecular Medicine; BS, Yale University; MS, Yale University; PhD, Massachusetts Institute of Technology, 2002

Rigel Chan, PhD, Assistant Professor of Neurology; BS, National University of Singapore, 2002; MS, National University of Singapore, 2005; PhD, Harvard Medical School, 2014

Robin E. Clark, PhD, Professor of Family Medicine & Community Health; BA, Appalachian State University, 1974; MA, University of Connecticut, 1979; PhD, Brandeis University, 1991

Kiera Leigh Clayton, PhD, Assistant Professor of Pathology; BS, University of Toronto, 2009; PhD, University of Toronto, Canada, 2015

Karen Mara Clements, MPH, ScD, Assistant Professor of PQHS, Division: Biostatistics and Health Services Research;

BA, Wesleyan University; MPH, Boston University School of Public Health; SCD, Harvard University School of Public Health

David Micah Cochran, MD, PhD, Barrett Family Term Chair in Neurodevelopmental Disorders, Associate Professor of Psychiatry; BS, Georgia Institute of Technology; MS, Massachusetts Institute of Technology; MD, Harvard Medical School, 2007; PhD, Massachusetts Institute of Technology, 2005

Andres Colubri, MFA, PhD, Assistant Professor of Microbiology & Physiological Systems; MFA, University of California, Los Angeles, 2009; PhD, Universidad Nacional del Sur, 2001

Darryl Conte, PhD, Associate Professor of RNA Therapeutics Institute; BS, Rensselaer Polytech Institute, 1992; PhD, State University of New York at Albany, 2000

Silvia Corvera, MD, Endowed Chair in Diabetes Research, Professor of Program in Molecular Medicine; BS, Colegio Madrid, 1975; MS, Universidad Nacional Autonoma de Mexico; MD, National University of Mexico, 1981

Roger W. Craig, PhD, Professor of Radiology; BSC, Sydney University, 1970; PhD, University of London, 1975

Sybil L. Crawford, PhD, Professor of Medicine, Division: Preventive and Behavioral Medicine; BS, Carnegie Mellon University, 1983; MS, Carnegie Mellon University, 1985; PhD, Carnegie Mellon University, 1988

Carol Curtin, MSW, PhD, Professor of Family Medicine & Community Health; BA, Trinity College, 1980; MSW, Boston University, 1982; PhD, UMass Chan Medical School, 2015

Sarah L. Cutrona, MD, MPH, Professor of PQHS, Division: Health Informatics and Implementation Science; BA, Yale University; MPH, Harvard University School of Public Health; MD, Columbia College of Columbia University in the City of NY

Michael Paul Czech, PhD, Isadore and Fannie Foxman Chair in Medical Research, Professor Emeritus of Program in Molecular Medicine; BA, Brown University, 1967; MA, Duke University, 1969; PhD, Brown University, 1972

Chad E. Darling, MD, Professor of Emergency Medicine; BS, University of Pittsburgh, 1993; MD, Dartmouth Medical School, 1997

Maryann Davis, PhD, Professor of Psychiatry; BS, University of Massachusetts Amherst; MA, Emory University; PhD, Emory University, 1991

Roger J. Davis, PhD, FRS, H. Arthur Smith Chair in Cancer Research, Chair & Professor of Molecular Medicine; BA, Queens College, 1979; MA, Queens College, 1983; PhD, Queens College, 1983

Job Dekker, PhD, Joseph J. Byrne Chair in Biomedical Research, Professor of Systems Biology; BS, Utrecht University, 1993; PhD, Utrecht University

Mark Dershwitz, MD, PhD, Professor of Anesthesiology & Perioperative Medicine; BA, Oakland University, 1974; PhD, Northwestern University, 1982; MD, Northwestern University Feinberg School of Medicine, 1982

Janice A. Dominov, PhD, Assistant Professor of Neurology; BS, University of Rhode Island; PhD, Case Western Reserve University

J. Kevin Donahue, MD, Professor of Medicine; Division: Cardiovascular Medicine; BA, Washington University in St Louis, 1987; MD, Washington University School of Medicine, 1991

Jeffrey B. Driban, PhD, ATC, CSCS, Professor of PQHS

Catherine E. Dube, EdD, Professor of PQHS; BA, Boston College; MED, Boston University; EDD, Boston University

Raymond M. Dunn, MD, Professor of Surgery, Division: Plastic Surgery; BS, Worcester Polytech Institute, 1978; MD, Albany Medical College, 1982

Richard W. Dutton, PhD, Professor of Pathology; BA, University of Cambridge, 1952; MA, University of Cambridge, 1954; PhD, University of London, England, 1955

E. Kate Edmiston, PhD, Associate Professor of Psychiatry; BA, Hampshire College; PhD, Vanderbilt University

Richard T. Ellison III, MD, Professor of Medicine, Division: Infectious Diseases and Immunology; BA, University of VA Tech, 1973; MD, Hahemann Medical College, 1977

Charles P. Emerson Jr., PhD, Professor of Neurology; BA, Princeton University; PhD, University of California, San Diego

Patrick Emery, PhD, Professor of Neurobiology; BS, University of Geneva; MS, University of Geneva; PhD, University of Geneva, 1996

Mara Meyer Epstein, ScD, ScM, Associate Professor of Medicine, Division: Geriatric Medicine; BS, Emory University, 2005; MS, Harvard University School of Public Health, 2007; ScD, Harvard University School of Public Health, 2010

Lori Pbert Etzel, PhD, Professor of PQHS, Division: Preventive and Behavioral Medicine; BA, University of Connecticut, 1982; MA, West Virginia University Morgantown; PhD, West Virginia University, 1987

Wenwen Fang, PhD, Assistant Professor of RNA Therapeutics Institute; BS, Fudan University, 2007; PhD, Princeton University, 2012

Jamie Marie Faro, PhD, Assistant Professor of PQHS, Division : Health Informatics and Implementation Science; BS, Lasell University, 2008; MS, George Washington

University, 2010; PhD, University of Massachusetts Boston, 2018

Thomas G. Fazzio, PhD, Professor of Molecular, Cell & Cancer Biology; BS, University of Utah; PhD, University of Washington, 2004

Daniel Z. Fisher, MD, PhD, Professor of Medicine, Division: Cardiovascular Medicine; BA, Swarthmore College; PhD, The Rockerfeller University; MD, Weill Cornell Graduate School of Medical Sciences, 1988

Kimberly A. Fisher, MD, Associate Professor of Medicine, Division: Pulmonary, Allergy and Critical Care Medicine; BA, Brown University; MD, University of Pennsylvania Pereleman School of Medicine

Thomas J. FitzGerald, MD, Chair and Professor of Radiology Oncology; BS, University of San Francisco; MD, UMass Chan Medical School

Katherine A. Fitzgerald, PhD, Worcester Foundation for Biomedical Research Chair III, Professor of Medicine, Division: Infectious Diseases and Immunology; BSC, University College Cork, 1995; PhD, Trinity College, 1999

William Alexander Flavahan, PhD, Assistant Professor of Molecular, Cell & Cancer Biology; BE, Case Western Reserve University, 2007; PhD, Case Western Reserve University, 2014

Josue Flores Kim, PhD, Assistant Professor of Biochemistry and Molecular Biotechnology; BS, University of Puerto Rico; PhD, New York University

Terence R. Flotte, MD, Celia and Isaac Haidak Professor, Professor of Pediatrics, Division: BS, University of New Orleans; BS, University of New Orleans, 1982; MD, Louisiana State University, 1986

Sarah N. Forrester, PhD, Assistant Professor of PQHS; BS, Southern Adventist University, 2005; MS, Capella University, 2011; PhD, Johns Hopkins Bloomberg School of Public Health, 2016

Michael M. Francis, PhD, Professor of Neurobiology; BA, University of Virginia, 1992; PhD, University of Florida, 1998

Jean A. Frazier, MD, Robert M. and Shirley S. Siff Chair in Autism, Professor of Psychiatry; BA, Wellesley College, 1982; MD, Dartmouth Medical School, 1987

Peter D. Friedmann, MD, MPH, DFASAM, FACP, Professor of Medicine at UMass Chan Medical School-Baystate; BA, Boston University; MD, Boston University School of Medicine, 1988

Accalia Mai-Wan Fu, PhD, Assistant Professor in Program in Molecular Medicine; PhD, University of Ottawa

Kensuke Futai, PhD, Associate Professor of Neurobiology; BS, Kyushu University; MS, Kyushu University; PhD, University of Tokyo, 2001

Stefania Gallucci, MD, Professor of Medicine, Division: Infectious Diseases

and Immunology; MD, Catholic University, 1992

Fen-Biao Gao, PhD, Governor Paul Cellucci Chair in Neuroscience Research, Professor of Neurology; BS, Peking University; MS, Tsinghua University; PhD, Duke University

Guangping Gao, PhD, Penelope Booth Rockwell Chair in Biomedical Research, Professor of Microbiology and Physiological Systems; MBBS, West China University of Medicine, 1982; MS, Florida International University, 1990; PhD, Florida International University, 1994

Manuel Garber, PhD, Professor of Program in Molecular Medicine; BS, Universidad SimÃ³n BolÃ-var, 1993; PhD, Brandeis University, 1999

Arvin Garg, MD, MPH, Professor of Pediatrics; MPH, Boston University School of Public Health; MD, Boston University School of Medicine

Ricardo T. Gazzinelli, DSc, DVM, Professor of Medicine, Division: Infectious Diseases and Immunology; DVM, Federal University of Minas Gerais, 1985; DSc, Federal University of Minas Gerais, 1989

Ben Steven Gerber, MD, MPH, Professor of PQHS, Division: Health Informatics and Implementation Science; BS, University of Illinois, Urbana-Champaign, 1991; MD, University of Chicago School of Medicine, 1995; MPH, University of Illinois, Chicago, 2005

Rachel M. Gerstein, PhD, Associate Professor of Microbiology and Physiological Systems; BA, Smith College, 1984; PhD, Brandeis University, 1990

Laura L. Gibson, MD, Associate Professor of Medicine, Division: Infectious Diseases and Immunology; BA, Yale University, 1987; MD, UMass Chan Medical School, 1994

Edward I. Ginns, MD, PhD, Professor of Psychiatry; BS, Rensselaer Polytech Institute, 1967; BA, Rochester Institute of Technology; PhD, Rensselaer Polytech Institute, 1971; MD, Johns Hopkins University, 1976

Robert Joel Goldberg, PhD, Professor Emeritus of PQHS; BS, UMass Amherst, 1972; MS, Tufts University, 1973; PhD, Johns Hopkins University, 1978

Douglas T. Golenbock, MD, Neil and Margery Blacklow Chair in Infectious Diseases and Immunology, Professor of Medicine, Division: Infectious Diseases and Immunology; BS, University of Michigan, Ann Arbor, 1975; MD, University of Michigan Medical School, 1980

Heinrich Gottlinger, MD, PhD, Professor of Molecular, Cell & Cancer Biology; BS, Thomas-Mann Gymnasium; MD, Ludwieg Maximilians Universitat, Munchen, 1983; PhD, Ludwieg Maximilians Universitat, Munchen, 1984

Matthew J. Gounis, PhD, Professor of Radiology; BS, State University of New

York, Buffalo; MS, State University of New York, Buffalo, 2000; PhD, University of Miami, 2004

Heather Leigh Gray- Edwards, DVM, PhD, Assistant Professor of Radiology; BS, University of Arizona; DVM, Auburn University, 2007; PhD, Auburn University, 2011

Sharone Green, MD, Associate Professor of Medicine, Division: Infectious Diseases and Immunology; BA, Queens College, 1983; MD, Eastern Virginia Medical School, 1986

Paul Lieberman Greer, PhD, Assistant Professor of Program in Molecular Medicine; BA, Harvard College; PhD, Harvard University

Dale L. Greiner, PhD, Dr. Eileen L. Berman and Stanley I. Berman Foundation Chair in Biomedical Research, Professor of Program in Molecular Medicine; BS, University of Iowa, 1974; PhD, University of Iowa, 1978

Nikolaus Grigorieff, PhD, Professor of RNA Therapeutics Institute; PhD, University of Bristol, United Kingdom

David Grunwald, PhD, Associate Professor of RNA Therapeutics Institute; BS, Humboldt University; PhD, Ludwig Maximilian University of Munich, 2006

David A. Guertin, PhD, Professor of Program in Molecular Medicine; BS, Saint Michael's College; PhD, UMass Chan Medical School, 2002

Jerry Howard Gurwitz, MD, Dr. John Meyers Professor in Primary Care Medicine, Professor of Medicine, Division: Geriatric Medicine; AB, Dartmouth College, 1978; MD, UMass Chan Medical School, 1983

Nathaniel S. Hafer, PhD, Assistant Professor, Program in Molecular Medicine; BS, Pennsylvania State University, 2000; PhD, Princeton University, 2007

Lisa L. Hall-Anderson, PhD, Associate Professor of Neurology; BA, Colorado College, 1988; PhD, University of California, Davis, 1996

Gang Han, PhD, Professor of Biochemistry & Molecular Biotechnology; BS, Nanjing University, 1999; MS, Nanjing University; PhD, University of Massachusetts Amherst, 2007

John P. Haran, MD, Professor of Emergency Medicine; BS, Rensselaer Polytechnic Institute; MD & PhD, UMass Chan Medical School

J. Lee Hargraves, PhD, Associate Professor of Family Medicine & Community Health; BS, University of Great Falls, 1982; MA, University of Montana, 1985; PhD, Boston College, 1994

David M. Harlan, MD, William and Doris Krupp Professor in Medicine, Professor of Medicine, Division: Diabetes; BS, University of Michigan, Ann Arbor, MD, Duke University, 1980

John E. Harris, MD, PhD, Chair & Professor of Dermatology; BS, Gordon College; MD & PhD, UMass Chan Medical School, 2005

Cole M. Haynes, PhD, Professor of Molecular, Cell & Cancer Biology; BS, Truman State University; PhD, University of Missouri-Kansas City, 2003

Lawrence J. Hayward, MD, PhD, Professor of Neurology; BA, Washington University in St Louis; BS, Washington University School of Medicine, 1982; PhD, Baylor College of Medicine, 1987; MD, Baylor College of Medicine, 1989

Matthew Louis Hemming, MD, PhD, Assistant Professor of Medicine, Division: Hematology Oncology; BS, University of San Diego School of Medicine, 2003; PhD, Harvard University, 2007; MD, Harvard Medical School, 2012

Gregory M. Hendricks, PhD, Associate Professor of Radiology; BA, Arizona State University; BS, Arizona State University, 1976; MA, Arizona State University; MS, Arizona State University, 1983; PhD, University of Vermont, 2000

Nils Henninger, MD, PhD, Associate Professor of Neurology; MD, Johannes Gutenberg University; PhD, UMass Chan Medical School

David C. Hoaglin, PhD, Professor of PQHS, Division: Biostatistics and Health Services Research; BS, Duke University; PhD, Princeton University

Jean Marie Houghton, MD, PhD, Professor of Medicine, Division: Gastroenterology; BA, Rutgers University, 1985; MD, University of Medicine; & Dentistry of New Jersey, 1989; PhD, University of Medicine; & Dentistry of New Jersey, 2001

Fiachra Emanuel Humphries, PhD, Assistant Professor of Medicine; BS, National University of Ireland, 2008; PhD, National University of Ireland, 2012

Eric S. Huseby, PhD, Professor of Pathology; BS, University of Washington; PhD, University of Washington, 2000

Anthony N. Imbalzano, Professor of Biochemistry & Molecular Biotechnology; BA, University of Pennsylvania, 1986; PhD, Harvard University, 1991

Ronald M. Iorio, PhD, Professor of Microbiology and Physiological Systems; BA, UMass Boston, 1969; MS, Boston College, 1972; PhD, Boston College, 1979

Y. Tony Ip, PhD, Professor of Program in Molecular Medicine; BS, National Defense University, 1984; PhD, University of Iowa, 1989

Javier Elbio Irazoqui, PhD, Marcellette G. Williams Scholar, Associate Professor of Microbiology & Physiological Systems; BS, National University of Rosario, 1997; PhD, Duke University, 2003

Allan S. Jacobson, PhD, Gerald L. Haidak, MD, and Zelda S. Haidak Professor in Cell Biology, Chair and Professor of

Microbiology and Physiological Systems; BA, Queens College, 1966; PhD, Brandeis University, 1971

William Michael Jesdale, PhD, Assistant Professor of PQHS; BA, Brown University; PhD, Brown University, 2007

Mark Damone Johnson, MD, PhD, Maroun Semaan Chair in Neurosurgery, Chair & Professor of Neurological Surgery, BA, Amherst College; MD, Harvard Medical School; PhD, Harvard University

Joonsoo Kang, PhD, Professor of Pathology; BSC, University of Toronto, 1986; PhD, University of Toronto, 1993

Elinor Kathryn Karlsson, PhD, Associate Professor of Program in Molecular Medicine; BA, Rice University, 2000; PhD, Boston University, 2008

Paul D. Kaufman, PhD, Professor of Molecular, Cell & Cancer Biology; BA, University of California, 1985; PhD, Massachusetts Institute of Technology, 1992

Jonathan Kay, MD, Timothy S. and Elaine L. Peterson Chair in Rheumatology, Professor of Medicine, Division: Rheumatology; AB, Harvard University, 1979; MD, University of California, San Francisco, 1983

Allison May Keeler-Klunk, PhD, Assistant Professor of Pediatrics; BS, Rochester Institute of Technology, 2005; PhD, University of Massachusetts Medical School, 2012

Brian Anthony Kelch, PhD, Associate Professor of Biochemistry & Molecular Biotechnology; BS, Pennsylvania State University; PhD, University of California, San Francisco

Michelle A. Kelliher, PhD, Our Danny Cancer Fund Chair in Biomedical Research I, Chair and Professor of Molecular, Cell & Cancer Biology; BA, Smith College, 1981; MS, Yale University, 1985; PhD, Tufts University School of Medicine, 1991

David N. Kennedy, PhD, Professor of Psychiatry AB, Radcliffe College, 1951; MD, Boston University, 1955

Anastasia Khvorova, PhD, Remondi Family Chair in Biomedical Research, Professor of RNA Therapeutics Institute; BS, Moscow State University; MS, Moscow State University; PhD, Russian Academy of Sciences, 1994

Catarina I. Kiefe, MD, PhD, Melvin S. and Sandra L. Cutler Chair in Biomedical Research, Professor of PQHS; BS, University of Porto; PhD, Stony Brook School of Medicine, 1973; MD, University of California, 1983

Dohoon Kim, PhD, Associate Professor of Molecular, Cell & Cancer Biology; BS, Korea Advanced Institute of Science; MS, Korea Advanced Institute of Science; PhD, Harvard University, 2007

Jason K. Kim, PhD, Professor of Program

in Molecular Medicine; BS, University of California, Irvine, 1991; PhD, Keck School of Medicine of the University of Southern California, 1996

Sohye Kim, PhD, Assistant Professor of Psychiatry; BA, Yonsei University, 2004; MA, Rosemead School of Psychology, 2007; PhD, Rosemead School of Psychology, 2011

Michael A. King, PhD, Professor of Radiology, Division: Nuclear Medicine; BA, State University of New York at Oswego, 1969; MS, State University of New York at Albany, 1971; PhD, University of Rochester, 1977

Oliver D. King, PhD, Assistant Professor of Neurology; BA, University of Hawaii, Manoa, 1992; MS, University of California, Berkeley, 1999; PhD, University of California, Berkeley, 2001

Eric Chi Ching Ko, MD, PhD, Associate Professor of Radiology Oncology; BS, Yale University; PhD, Roswell Park Cancer Institute; MD, University at Buffalo School of Medicine and Biomedical Sciences

William R. Kobertz, PhD, Professor of Biochemistry & Molecular Biotechnology; BS, University of California, 1991; PhD, Massachusetts Institute of Technology, 1998

Hardy Kornfeld, MD, Professor of Medicine, Division: Pulmonary, Allergy and Critical Medicine; BA, Bennington College, 1974; MD, Boston University, 1978

Andrei A. Korostelev, PhD, Professor of RNA Therapeutics Institute; BS, Moscow State University; MS, Moscow State University; PhD, Florida State University-Tallahassee

Milka S. Koupenova, PhD, Assistant Professor of Medicine, Division: Cardiovascular Medicine; BS, University of California, Los Angeles, 2003; PhD, Boston University School of Medicine, 2010

Timothy F. Kowalik, PhD, Marcellette G. Williams Scholar, Professor of Microbiology and Physiological Systems; BS, Belmont Abbey College, 1982; MS, Utah State University, 1986; PhD, Utah State University, 1989

Aimee R. Kroll-Desrosiers, PhD, Assistant Professor of PQHS; BA, Mount Holyoke College; MS, University of Massachusetts Amherst; PhD, University of Massachusetts Medical School

Tara Neubert Kumaraswami, MD, Associate Professor of Obstetrics & Gynecology, Division: General OB/GYN; BS, University of Massachusetts Amherst; MD, UMass Chan Medical School

Nese Kurt Yilmaz, PhD, Associate Professor of Biochemistry & Molecular Biotechnology; BS, Bogazici University; MS, Bogazici University; PhD, Bogazici University, Turkey, 2002

Evelyn A. Kurt-Jones, PhD, Professor of

Medicine, Division: Infectious Diseases and Immunology; BS, Tufts University, 1974; PhD, University of Connecticut, 1983

Jennifer LaFemina, MD, Associate Professor of Surgery, Division: Surgical Oncology; BS, University of California, Irvine, 1999; MD, University of California, Los Angeles, 2003

David G. Lambright, PhD, Professor of Program in Molecular Medicine; BS, University of Lowell, 1984; PhD, Stanford University, 1992

John E. Landers, PhD, Professor of Neurology; BS, Rensselaer Polytechnic Institute, 1990; PhD, University of Pennsylvania, 1995

Kate L. Lapane, PhD, Professor of PQHS; BA, Boston University; MS, University of Rhode Island; PhD, Brown University, 1995

Celine Maria Larkin, PhD, Assistant Professor of Emergency Medicine; BA, University College, Cork, 2007; PhD, University College, Ireland, 2012

Jeanne B. Lawrence, PhD, Leo P. and Theresa M. LaChance Chair in Medical Research, Professor of Neurology; BA, Stephen F Austin State University, 1973; MS, Rutgers University, 1975; PhD, Brown University, 1982

Nathan D. Lawson, PhD, Professor of Molecular, Cell & Cancer Biology; BS, University of Rhode Island, 1994; PhD, Yale University, 1999

Austin F. Lee, PhD, Professor of PQHS, Division: Biostatistics and Health Services Research; BA, University of Wisconsin, Madison; MA, University of Wisconsin, Madison; PhD, Taiwan Provincial Chung-Hsin University

Darren James Lee, PhD, Associate Professor of Ophthalmology and Visual Sciences; BS, University of California, Davis, 2001; PhD, University of New Hamphire, Durham, 2007

Jung Ae Lee, PhD, Assistant Professor of PQHS, Division: Biostatistics and Health Services Research

Michael J. Lee, PhD, Associate Professor of Systems Biology; BS, University of Washington, 2002; PhD, University of North Carolina Chapel Hill, 2008

Heidi Kay Leftwich, DO, Associate Professor of Obstetrics & Gynecology, Division: Maternal-Fetal Medicine; BS, Florida Southern College; DO, Edward Via College of Osteopathic Medicine

Stephenie C. Lemon, PhD, Marcellette G. Williams Scholar, Professor of PQHS, Division: Preventive and Behavioral Medicine; BS, UMass Amherst, 1995; MS, UMass Amherst, 1999; PhD, Brown University, 2002

Stuart M. Levitz, MD, Professor of Medicine, Division: Infectious Diseases and Immunology; BA, New York University, 1975; MD, New York

University, 1979

Brian C. Lewis, PhD, George F. Booth Chair in the Basic Sciences; Professor of Molecular, Cell & Cancer Biology; BS, University of California Los Angeles, 1991; PhD, Johns Hopkins University, 1997

Hong-Sheng Li, PhD, Associate Professor of Neurobiology; BS, Wuhan University, 1991; PhD, Shanghai Brain Research Institute, 1996

Li Li, PhD, Assistant Professor of RNA Therapeutics Institute; BS, Fudan University; PhD, University of Illinois at Urbana-Champaign, 2012

Shaoguang Li, MD, PhD, Professor of Medicine, Division: Hematology Oncology; MD, China Medical University; PhD, Tulane University

Egil Lien, PhD, Professor of Medicine, Division: Infectious Diseases and Immunology; MS, Norwegian Institute of Technology, 1992; PhD, Faculty of Medicine, 1998

Craig M. Lilly, MD, Professor of Medicine, Division: Pulmonary, Allergy and Critical Care Medicine; BS, University of Oregon; MD, Oregon Health Sciences University, 1984

Elaine (Teng-Ting) Lim, PhD, Assistant Professor of Molecular, Cell & Cancer Biology; BS, National University of Singapore, 2002; MS, National University of Singapore, 2005; PhD, Harvard Medical School, 2014

Honghuang Lin, PhD, FAHA, Professor of Medicine, Division: Clinical Informatics; BS, Peking University, 2003; PhD, National University of Singapore, 2007

Feifan Liu, PhD, Associate Professor of PQHS, Division: Health Informatics and Implementation Science; BS, Shandong University; MS, Shandong University; PhD, Chinese Academy of Sciences, China, 2006

Shao-Hsien Liu, PhD, Assistant Professor of PQHS; BS, National Yang-Ming College of Medicine; MPH, Emory University, 2012; PhD, UMass Chan Medical School, 2017

Michael Anthony Lodato, PhD, Assistant Professor of Molecular, Cell & Cancer Biology; BS, Hofstra University, 2005; PhD, Massachusetts Institute of Technology, 2012

Ryan W. Logan, PhD, Professor of Psychiatry; BA, University of Maine, Orono, 2004; PhD, University of Maine, Orono, 2009

Shan Lu, MD, PhD, Professor Emeritus of Medicine; Division: General Internal Medicine; MHA, Clark University, 1991; MD, Nanjing Medical College, 1982; PhD, UMass Chan Medical School, 1990

Jeremy Luban, MD, David J. Freelander Memorial Professor in AIDS Research; Professor of Program in Molecular Medicine; BA, State University of New York, Purchase, 1982; MD, Columbia University College of Physicians and

Surgeons, 1987

Stephen R. Lyle, MD, PhD, Associate Professor of Molecular, Cell & Cancer Biology; BA, University of Chicago, 1988; MS, University of Chicago, 1988; PhD, University of Chicago Medical School, 1995; MD, Pritzker School of Medicine

John Mark Madison, MD, Professor of Medicine, Division: Pulmonary, Allergy and Critical Care Medicine; BA, Carleton College, 1975; MD, Harvard Medical School, 1979

Lawrence C. Madoff, MD, Professor of Medicine, Division: Infectious Diseases and Immunology; MD, Tufts University School of Medicine, 1982

Rene Maehr, PhD, Associate Professor of Program in Molecular Medicine; PhD, Vrije Universiteit, Netherlands, 2005

Ana L. Maldonado-Contreras, PhD, Marcellette G. Williams Scholar, Professor of Microbiology and Physiological Systems; BA, University of Zulia; MS, Instituto Universitario de Tecnologia, 2006; PhD, University of Puerto Rico, 2009

Elisabet C. Mandon, PhD, Associate Professor of Microbiology & Physiological Systems; PhD, National University of La Plata, Argentina

Pranoti Mandrekar, PhD, Professor of Medicine, Division: Gastroenterology; BSC, University of Bombay, 1984; MSC, University of Bombay, 1986; PhD, University of Bombay, 1991

Junhao Mao, PhD, Professor of Molecular, Cell & Cancer Biology; BA, Zhejiang University; PhD, University of Rochester, 2003

Gilles E. Martin, PhD, Associate Professor of Neurobiology; BA, Pierre and Marie Curie University; MA, Pierre and Marie Curie University; MD, Pierre and Marie Curie University, 1992

Paulo Martins, MD, PhD, FAST, FEBS, FACS, Associate Professor of Surgery, Division: Organ Transplantation; MD, Federal University of Bahia, Brazil, 1998; PhD, University of Medicine, Germany, 2005

Francisca Massi, PhD, Associate Professor of Biochemistry & Molecular Biotechnology; MA, Boston University; PhD, Boston University, 2001

Zdenka Matijasevic, PhD, Assistant Professor of Pediatrics; BS, University of Zagreb, 1971; MS, University of Zagreb, 1979; PhD, University of Zagreb, 1982

C. Robert Matthews, PhD, Professor Emeritus of Biochemistry & Molecular Biotechnology; BS, University of Minnesota, 1968; MS, Stanford University, 1969; PhD, Stanford University, 1974

Kristin Michelle Mattocks, PhD, MPH, Professor of PQHS, Division: Health Informatics and Implementation Science; BA, Pacific Lutheran University, 1992; PhD & MPH, Yale University, 2005

Kathleen Mazor, EdD, Professor Emeritus of Medicine, Division: Geriatric Medicine; BA, University of Massachusetts Amherst; MS, Eastern Washington University; EdD, University of Massachusetts Amherst

Dannel McCollum, PhD, Professor of Biochemistry & Molecular Biotechnology; BA, University of Illinois, Chicago; BS, University of Illinois, 1987; PhD, University of California San Diego, 1993

Beth A. McCormick, PhD, Worcester Foundation for Biomedical Research Chair II, Professor of Microbiology and Physiological Systems; BA, University of New Hampshire, 1986; PhD, University of Rhode Island, 1990

William M. McDougall, PhD, Assistant Professor of Microbiology & Physiological Systems; BA, State University of New York, Buffalo, 2008; PhD, University of Rochester School of Medicine and Dentistry, 2014

David D. McManus, MD, Richard M. Haidack Professor in Medicine, Chair & Professor of Medicine; BS, Brown University, 1998; MS, University of Massachusetts Medical School, 2012; MD, UMass Chan Medical School, 2002

Haley E. Melikian, PhD, Professor of Neurobiology; BA, University of Massachusetts Amherst; BS, University of Massachusetts Amherst, 1984; PhD, Emory University, 1995

Craig C. Mello, PhD, Blais University Chair in Molecular Medicine, Distinguished Professor of RNA Therapeutics Institute; BS, Brown University, 1982; PhD, University of Colorado, 1984; PhD, Harvard University, 1990

Arthur M. Mercurio, PhD, Professor of Molecular, Cell & Cancer Biology; BS, Rutgers University, 1975; MA, Columbia University, 1976; MPhil, Columbia University, 1978; PhD, Columbia University, 1981

Eric O. Mick, ScD, Associate Professor of PQHS, Division: Biostatistics and Health Services Research; BA, College of the Holy Cross; ScD, Harvard University School of Public Health

Stephen C. Miller, PhD, Professor of Biochemistry & Molecular Biotechnology; BS, University of Wisconsin, Madison, 1991; PhD, University of California at San Francisco, 1998

Amir Zadok Mitchell, PhD, Associate Professor of Systems Biology; MS, Tel Aviv University, 2004; PhD, Weizmann Institute of Science, Israel, 2010

Mo Hammad Modarres, PhD, Adjunct Assistant Professor of Psychiatry; BS, Case Western Reserve University; MS, Case Western Reserve University; PhD, Case Western Reserve University

Jill Moore, PhD, Assistant Professor of RNA Therapeutics Institute; BS, University of Massachusetts Amherst, 2012; PhD, University of Massachusetts Medical School, 2017

Melissa J. Moore, PhD, Professor of RNA Therapeutics Institute; BS, College of William and Mary, 1984; PhD, Massachusetts Institute of Technology, 1989

Tiffany A. Moore Simas, MD, MPH, MEd, Donna M. and Robert J. Manning Chair in Obstetrics and Gynecology, Chair & Professor of Obstetrics & Gynecology; BA, Clarkson University, 1996; MPH, Harvard University School of Public Health; MED, University of Massachusetts Boston; MD, UMass Chan Medical School, 2000

Ann M. Moormann, PhD, MPH, Professor of Medicine, Division: Infectious Diseases and Immunology; BA, University of Minnesota, 1989; MPH, University of Michigan, 1995; PhD, University of Michigan, 1999

John P. Mordes, MD, Professor Emeritus of Medicine, Division: Endocrinology and Metabolism; AB, Harvard College, 1969; MD, Harvard Medical School, 1973

Trudy G. Morrison, PhD, Professor of Microbiology and Physiological Systems; BA, Wellesley College, 1967; PhD, Tufts University School of Medicine, 1972

Richard P. Moser, MD, Professor of Neurological Surgery; BS, Loyota University Chicago; MD, Loyola University, Chicago, 1974

Alan C. Mullen, MD, PhD, Mary C. DeFeudis Chair in Biomedical Research; Professor of Medicine, Division: Gastroenterology; BE, Vanderbilt University; MD, University of Pennsylvania Perelman School of Medicine; PhD, University of Pennsylvania Perelman School of Medicine

James B. Munro, PhD, Associate Professor of Microbiology & Physiological Systems; BA, Middlebury College, 2002; MS, University of Chicago, 2004; PhD, Cornell University, 2010

Mary Munson, PhD, Professor of Biochemistry & Molecular Biotechnology; AB, Washington University School of Medicine, 1989; PhD, Yale University, 1996

Kenan C. Murphy, PhD, Assistant Professor of Microbiology and Physiological Systems; BA, Catholic University of America, 1976; PhD, University of Maryland, 1983

Sumeda Nandadasa, PhD, Assistant Professor of Pediatrics; BA, Moorhead State University, 2005; PhD, University of Cincinnati College of Medicine, 2010

Peter E. Newburger, MD, Professor of Pediatrics, Division: Hematology Oncology; BA, Haverford College, 1970; MD, Harvard Medical School, 1974

Jeffrey Alan Nickerson, PhD, Associate Professor of Pediatrics; BS, Michigan State University, 1976; PhD, Michigan State University, 1985

Kerstin Nundel, PhD, Assistant Professor of Medicine, Division: Rheumatology;

M.Sc, Universitat Konstanz, 2001; PhD, Thomas Jefferson University, 2007

Anthony Phillip Nunes, PhD, Assistant Professor of PQHS; BS, University of Massachusetts Amherst, 2003; MS, University of Massachusetts Amherst, 2005; PhD, Brown University, 2011

Ira S. Ockene, MD, David J. and D. Milliken Professor in Preventive Cardiology, Professor of Medicine, Division: Cardiovascular Medicine; BS, City College of New York; MD, Albert Einstein College of Med, 1966

Judith K. Ockene, PhD, MEd, MA, Barbara Helen Smith Chair in Preventative & Behavioral Medicine, Professor of PQHS, Division: Preventative and Behavioral Medicine; BS, City College of New York; MEd, Boston College; MA, City College of NY; PhD, Boston College

Megan Horn Orzalli, PhD, Assistant Professor of Medicine, Division: Infectious Diseases and Immunology; BS, University of Washington, 2007; PhD, Harvard University, 2013

Gary R. Ostroff, PhD, Professor of Program in Molecular Medicine; BS. Delaware Valley College of Science and Agriculture; PhD, University of Delaware, 1982

Athma A. Pai, PhD, Assistant Professor of RNA Therapeutics Institute; BS, University of Pennsylvania, 2007; PhD, University of Chicago, 2012

Gregory J. Pazour, PhD, Professor of Program in Molecular Medicine; BA, South Dakota State University, 1986; BS, South Dakota State University, 1986; PhD, University of Minnesota, 1991

Thoru Pederson, PhD, Vitold Arnett Professor in Cell Biology, Professor of Biochemistry & Molecular Biotechnology; BA, Syracuse University, 1963; PhD, Syracuse University, 1968

Sharina D. Person, PhD, Marcellette G. Williams Scholar, Professor of PQHS, Division: Biostatistics and Health Services Research; BS, University of Alabama, Birmingham, 1997; MS, University of Alabama, Birmingham, 1997; PhD, University of Alabama at Birmingham, 1998

Craig L. Peterson, PhD, Professor of Program in Molecular Medicine; BS, University of Washington, 1983; PhD, University of California, Los Angeles, 1988

Jason Robert Pitarresi, PhD, Assistant Professor of Medicine, Division: Hematology Oncology; BS, State University of New York; PhD, Ohio State University Columbus, 2016

Peter M. Pryciak, PhD, Associate Professor of Biochemistry & Molecular Biotechnology; BA, University of California, Los Angeles; BS, California State University, Los Angeles, 1983; PhD, University of California at San Francisco, 1992

Stephanie Puig, PhD, Assistant Professor

of Psychiatry

Read Pukkila-Worley, MD, Associate Professor of Medicine, Division: Infectious Diseases and Immunology; BS, Indiana University Bloomington; MD, University of North Carolina Chapel Hill

Claudio Punzo, PhD, Associate Professor of Ophthalmology & Visual Sciences; BS, University of Basel; PhD, University of Basel, Switzerland, 2001

Lee J. Quinton, PhD, Professor of Medicine, Division: Infectious Diseases and Immunology; BS, University of Southern Mississippi, 1999; PhD, Louisiana State University Health Sciences Center, 2003

Sanjay Ram, MD, Professor of Medicine, Division: Infectious Diseases and Immunology; MD, Bombay University, 1991

Zaida Gisela Ramirez Ortiz, PhD, Assistant Professor of Medicine, Division: Infectious Diseases and Immunology; BS, University of Puerto Rico, 2004; PhD, UMass Chan Medical School, 2010

Oliver J. Rando, MD, PhD, Professor of Biochemistry & Molecular Biotechnology; BA, Harvard University; MD, Stanford University, 2002; PhD, Stanford University, 2002

Mehdi Rashighi Firoozabadi, MD, Assistant Professor of Dermatology; MD, Tehran University of Medical Sciences, 2004

Andrea Reboldi, PhD, Associate Professor of Pathology; BS, University of Padova; MS, University of Padova; PhD, Institute for Research in Biomedicine, Switzerland

Sy Redding, PhD, Assistant Professor of Biochemistry & Molecular Biotechnology; BS, Texas State University; PhD, Columbia University

Lawrence M. Rhein, MD, MPH, Stoddard Chair of Pediatrics, Chair & Associate Professor of Pediatrics, Division: Pediatric Neonatalogy; BS, Harvard University; MPH, Harvard University School of Public Health; MD, University of Pennsylvania Pereleman School of Medicine

Nicholas R. Rhind, PhD, Professor of Biochemistry & Molecular Biotechnology; BA, BSc, Brown University, 1989; PhD, University of California, 1995

Peter A. Rice, MD, Professor of Medicine, Division: Infectious Diseases and Immunology; BE, Yale University; MD, University of Pennsylvania, 1969

Jillian M. Richmond, PhD, Assistant Professor of Dermatology; BS, Johns Hopkins University, 2007; PhD, Boston University School of Medicine, 2011

Joel D. Richter, PhD, Arthur F. Koskinas Chair in Neuroscience, Professor of Program in Molecular Medicine; BA, Indiana University, 1974; MS, Arizona State University, 1976; PhD, Arizona State University, 1979

Ann R. Rittenhouse, PhD, Associate Professor of Microbiology and Physiological Systems AB, Mt. Holyoke College, 1976; PhD, Boston University, 1984

Kenneth L. Rock, MD, Chair and Professor of Pathology; BA, Washington University School of Medicine, 1974; MD, University of Rochester, 1978

Evgeny L. Rogaev, PhD, Professor of Psychiatry; MS, Lomonosov Moscow State University; PhD, Academy of Medical Science, 1988; DRSCI, Academy of Medical Science, 1998

Milagros C. Rosal, PhD, Imoigele P. Aisiku, MD'97 Chair in Health Equity and Diversity, Professor of PQHS, Division: Preventive and Behavioral Medicine; BA, Catholic University, 1981; MS, Nova University, 1986; PhD, Nova University, 1992

Max P. Rosen, MD, MPH, Chair & Professor of Radiology; BS, Brown University; MPH, Harvard University School of Public Health; MD, Tufts University School of Medicine

Alan G. Rosmarin, MD, Professor of Medicine, Division: Hematology Oncology; BA, Vassar College, 1977; MD, Rutgers Medical School, 1981

Anthony J. Rothschild, MD, Irving S. and Betty Brudnick Chair in Psychiatry, Professor of Psychiatry AB, Princeton University, 1975; MD, University of Pennsylvania, 1979

Ann M. Rothstein, PhD, Professor of Medicine, Division: Rheumatology; BA, Washington University in St. Louis; PhD, University of Pennsylvania, 1977

William E. Royer, PhD, Professor Emeritus of Biochemistry & Molecular Biotechnology; BS, Pennsylvania State University, 1976; PhD, Johns Hopkins University, 1984

Katherine Ruiz De Luzuriaga, MD, Umass Memorial Health Care Chair in Biomedical Research, Professor of Program in Molecular Medicine; BA, Massachusetts Institute of Technology; BS, Massachusetts Institute of Technology, 1978; MA, Massachusetts Institute of Technology; MS, Massachusetts Institute of Technology, 1980; MD, Tufts University School of Medicine, 1984

Marcus Ruscetti, PhD, Assistant Professor of Molecular, Cell & Cancel Biology; BA, University of Virginia, 2008; MAT, Johns Hopkins University, 2010; PhD, University of California, Los Angeles, 2015

Sean P. Ryder, PhD, Professor of Biochemistry & Molecular Biotechnology; BS, University of New Hampshire, 1995; PhD, Yale University, 2001

Rajani S. Sadasivam, PhD, Professor of PQHS, Division: Health Informatics and Implementation Science; BS, University of Madras, 1999; MS, University of Alabama, Birmingham, 2002; PhD, University of Alabama at Birmingham, 2007

Manojkumar Saranathan, PhD, Professor

of Radiology; MS, University of Washington; PhD, University of Washington

Christopher M. Sassetti, PhD, Professor of Microbiology and Physiological Systems; BS, Santa Clara University, 1990; PhD, University of California at San Francisco, 1999

Dorothy P. Schafer, PhD, Associate Professor of Neurobiology; BA, Mount Holyoke College, 2001; PhD, University of Connecticut, 2008

Celia A. Schiffer, PhD, Arthur F. and Helen P. Koskinas Professor of Biochemistry & Molecular Biotechnology, Chair & Professor of Biochemistry & Molecular Biotechnology; BA, University of Chicago School of Medicine, 1986; PhD, University of California, 1992

Carol E. Schrader, PhD, Associate Professor of Microbiology and Physiological Systems; BA, Wesleyan University, 1984; PhD, University of Pennsylvania, 1992

Johanna Margaret Seddon, MD, ScM, Chair and Professor of Ophthalmology and Visual Sciences; BS, University of Pittsburgh; MS, Harvard University School of Public Health; MD, University of Pittsburgh School of Medicine

Liisa K. Selin, MD, PhD, Professor of Pathology; BS, Dalhousie University; MD, Dalhousie University, 1979; PhD, University of Manitoba, 1993

Miguel S. Sena Esteves, PhD, Associate Professor of Neurology; BS, University of Porto, 1992; PhD, University of Porto, Portugal, 2000

Scott A. Shaffer, PhD, Professor of Biochemistry & Molecular Biotechnology; BS, Northern Arizona University, 1986; PhD, University of Washington, 1995

Elizabeth Anne Shank, PhD, Associate Professor of Microbiology & Physiological Systems; BS, Pennsylvania State University, 1998; PhD, University of California, Berkeley, 2005

Leslie M. Shaw, PhD, Professor of Molecular, Cell & Cancer Biology; BS, Trinity College, 1987; PhD, Harvard University, 1994; PhD, Harvard University School of Education, 1994

Kuang Shen, PhD, Assistant Professor of Program in Molecular Medicine; BS, University of Science Technology of China, 2007; PhD, California Institute of Technology, 2013

Jae-Hyuck Shim, PhD, Associate Professor of Medicine, Division: Rheumatology; BS, Yonsei University, 1996; MS, Yonsei University, 1998; PhD, Yale University School of Medicine, 2006

Jason Matthew Shohet, MD, PhD, Ali and John Pierce Chair in Pediatric Hematology/ Oncology, Associate Professor of Pediatrics; BA, Reed College, 1985; MD & PhD, Boston University School of Medicine, 1993

Neal S. Silverman, PhD, Professor of Medicine, Division: Infectious Diseases and Immunology; BA, University of California, 1989; PhD, Massachusetts Institute of Technology, 1996

Karl J. Simin, PhD, Associate Professor of Molecular, Cell & Cancer Biology; BS, University of Michigan, Ann Arbor, 1989; PhD, University of Utah School of Medicine, 2001

Rachael Sirianni, PhD, Professor of Neurological Surgery; BE, Arizona State University; MS, Yale University; PhD, Yale University

Hayla K. Sluss, PhD, Assistant Professor of Medicine, Division: Endocrinology and Metabolism; BA, Wheaton College; PhD, UMass Chan Medical School, 1997

David A. Smelson, PsyD, Professor of Medicine; BS, Illinois School of Professional Psychology at Argosy University; PsyD, Illinois School of Professional Psychology at Argosy University

Merav Socolovsky, MD, PhD, Professor of Molecular, Cell & Cancer Biology; BA, Cambridge University, 1983; MBBS, University College London, 1986; PhD, Cambridge University, 1993

Jie Song, PhD, Professor of Orthopedics & Physical Rehabilitation; BS, Fudan University, 1995; PhD, Michigan State University, 1999

Apurv V. Soni, MD, PhD, Assistant Professor of Medicine; BA, Boston University, 2011; MD & PhD, University of Massachusetts Medical School, 2021

Erik J. Sontheimer, PhD, Pillar Chair in Biomedical Research, Professor of RNA Therapeutics Institute; BS, Pennsylvania State University, 1987; PhD, Yale University, 1993

Jessica Brooke Spinelli, PhD, Assistant Professor of Program in Molecular Medicine; BS, Hofstra University; PhD, Harvard University

Lawrence J. Stern, PhD, Professor of Pathology; BA, Cornell University, 1983; PhD, Massachusetts Institute of Technology, 1989

Elise M. Stevens, PhD, Assistant Professor of PQHS; BS, Ithaca College, 2010; MA, Pennsylvania State University, 2013; PhD, University of North Carolina Chapel Hill, 2016

Susan L. Swain, PhD, Professor of Pathology; BA, Oberlin College; PhD, Harvard Medical School

Phillip Tai, PhD, Assistant Professor of Microbiology & Physiological Systems; BA, University of California, Berkeley, 2001; PhD, University of Washington

Andrew R. Tapper, PhD, Professor of Neurobiology; BS, University of California, Riverside; MS, University of California, Riverside; PhD, Vanderbilt University, 2001

William E. Theurkauf, PhD, Professor of

Program in Molecular Medicine; BA, Brandeis University, 1980; PhD, Brandeis University, 1988

Paul R. Thompson, PhD, Professor of Biochemistry & Molecular Biotechnology; BS, McMaster University, 1994; PhD, McMaster University, 2000

Travis Carle Thomson, PhD, Assistant Professor of Neurobiology; BS, University of Alberta, 1999; PhD, McGill University, Canada, 2008

Summer Thyme, PhD, Assistant Professor of Biochemistry and Molecular Biotechnology

Mayra S. Tisminetzky, MPH, MD, PhD, Associate Professor of Medicine, Division: Geriatric Medicine; MPH, University of Massachusetts Amherst; MD, University of Buenos Aires Medical School, Argentina; PhD, UMass Chan Medical School, 2009

Heidi A. Tissenbaum, PhD, Professor of Molecular, Cell & Cancer Biology; BSc, Concordia University, 1986; MSc, Ottawa University School of Medicine, 1988; PhD, Harvard University, 1997

Jennifer Tjia, MD, MSCE, Professor of PQHS; BA, Boston University; MS, University of Pennsylvania Perelman School of Medicine, 2003; MD, Boston University Medical School, 1994

Eduardo M. Torres, PhD, Associate Professor of Molecular, Cell & Cancer Biology; BS, City College of New York; PhD, Weill Cornell Graduate School of Medical Sciences, 2003

Khanh-Van Thi Tran, MD, PhD, Assistant Professor of Medicine, Division: Cardiovascular Medicine; BA, Smith College; MD and PhD, University of Massachusetts Medical School

Chinmay M. Trivedi, MD, PhD, Professor of Medicine, Division: Cardiovascular Medicine; MD, Gujarat University, India; PhD, University of South Carolina Columbia

Michelle K. Trivedi, MD, MPH, Associate Professor of Pediatrics, Division: Pediatric Pulmonology; BA, Washington University in St Louis; MPH, Harvard University School of Public Health; MD, UMass Chan Medical School

Melanie I. Trombly, PhD, Assistant Professor of Medicine; BA, Cornell University, 2000; PhD, Northwestern University, 2010

Gowthaman Uthaman, PhD, Assistant Professor of Pathology; BS, Madurai Kamaraj University, 2003, MS, Madurai Kamaraj University, 2005; PhD, Jawaharlal Nehru University, India, 2012

Michael R. Volkert, PhD, Professor of Microbiology and Physiological Systems; BS, University of Wisconsin, 1971; MS, Iowa State University; PhD, Rutgers University, 1977

Marian J. Walhout, PhD, Maroun Semaan Chair in Biomedical Research, Chair and Professor in Systems Biology; BS, Utrecht

University, 1992; MS, Utrecht University; PhD, Utrecht University, 1997

Amy K. Walker, PhD, Associate Professor of Program in Molecular Medicine; BS, Auburn University; PhD, State University of NY, Stony Brook

J. Matthias Walz, MD, Chair and Professor of Anesthesiology and Perioperative Medicine; MD, University of Tubingen, 1999

Bo Wang, PhD, Professor of PQHS, Division: Biostatistics and Health Services Research; BS, Lanzhou University; MPH, Kunming Medical University; PhD, Fudan University, China

Dan Wang, PhD, Assistant Professor of RNA Therapeutics Institute; BS, Fudan University, 2006; PhD, University of Alabama, Birmingham, 2012

Jennifer Wang, MD, Professor of Medicine, Division: Infectious Diseases and Immunology; BA, Harvard University, 1991; MD, University of Michigan, 1995

Yang Wang, MD, PhD, Professor of Medicine, Division: Massachusetts Biological Laboratory; PhD, Tufts University School of Medicine, 2007

Yong-Xu Wang, PhD, Associate Professor of Molecular, Cell & Cancer Biology; BS, Peking University; PhD, University of Iowa, 1999

Emma Watson, PhD, Assistant Professor of Systems Biology; BS, University of Connecticut, 2007; PhD, University of Massachusetts Medical School, 2015

Jonathan K. Watts, PhD, Professor of RNA Therapeutics Institute; BS, Dalhousie University, 2001; PhD, McGill University, Canada, 2008

David R. Weaver, PhD, Professor of Neurobiology; BS, Michigan State University, 1981; PhD, Michigan State University, 1985

Linda F. Weinreb, MD, Professor of Family Medicine; & Community Health; BA, Washington University School of Medicine, 1977; MD, Milton S. Hershey Medical School, 1981

Zhiping Weng, PhD, Li Weibo Chair in Biomedical Research, Professor of Biochemistry & Molecular Biotechnology; BS, University of Science & Technology, 1992; PhD, Boston University, 1997

George B. Witman, PhD, Professor Emeritus of Radiology; BA, University of California, Riverside, 1967; PhD, Yale University, 1972

Bruce A. Woda, Professor of Pathology; BS, Brooklyn College, 1971; MD, State University of New York at Downstate Med Ctr, 1975

Scot Wolfe, PhD, Professor of Molecular, Cell & Cancer Biology; BS, California Institute of Techology, 1990; AM, Harvard University, 1992; PhD, Harvard University, 1996

Yang Xiang, PhD, Assistant Professor of Neurobiology; BS, Nanjing University;

PhD, Chinese Academy of Sciences, China, 2003

Zuoshang Xu, MD, PhD, Professor of Biochemistry & Molecular Biotechnology; MD, Shanghai Medical College, 1982; PhD, Washington University in St Louis, 1990

Wen Xue, PhD, Associate Professor of RNA Therapeutics Institute; BS, Nanjing University, 2002; MS, Nanjing University, 2004; PhD, State University of New York, Stony Brook, 2009

Chengwu Yang, MD, MS, PhD, Associate Professor of PQHS, Division: Biostatistics and Health Services Research; MS, Sun Yat-sen University School of Public Health, 2000; PhD, Medical University of South Carolina, 1993; MD, Tongji Medical College, 1993

Hongwei Yang, MD, PhD, Assistant Professor of Neurological Surgery; MD, Topiwala National Medical College, India; PhD, University of Tokyo, Japan, 1999

Eviatar Isac Yemini, PhD, Assistant Professor of Neurobiology; BA, Columbia University; MS, University of California, San Diego, 2007; PhD, University of Cambridge, 2013

Lutfu S. Yilmaz, PhD, Associate Professor of Systems Biology; BS, Bogazici University; MS, Bogazici University; PhD, University of Wisconsin

Hyun York, PhD, Associate Professor in Systems Biology; BA, Columbia University; MS, University of California, San Diego; PhD, Massachusetts Institute of Technology

Adrian H. Zai, MD, PhD, MPH, Associate Professor of PQHS, Division: Health Informatics and Implementation Science; BA, Boston University, 1992; MD & PhD, Boston University School of Medicine, 2001; MPH, Harvard TH Chan School of Public Health, 2007

Phillip D. Zamore, PhD, Gretchen Stone Cook Chair in Biomedical Sciences, Chair & Professor of RNA Therapeutics Institute; AB, Harvard University, 1986; PhD, Harvard University, 1992

Maria L. Zapp, PhD, Assistant Professor of Program in Molecular Medicine; BA, Wilson College, 1980; PhD, Baylor College of Medicine, 1989

Hong Zhang, PhD, Associate Professor of Pediatrics; BS, Fudan University, 1991; PhD, Michigan State University, 1998

Jin Zhang, PhD, Assistant Professor of Program in Molecular Medicine; BS, Fudan University; PhD, New York University School of Medicine, 2013

Guocai Zhong, PhD, Assistant Professor of RNA Therapeutics Institute; PhD, Harbin Medical University

Chan Zhou, PhD, Assistant Professor of PQHS, Division: Biostatistics and Health Services Research; BS, Zhejiang University; PhD, Zhejiang University, China

Lihua Zhu, PhD, Professor of Molecular, Cell & Cancer Biology; BS, China Agricultural University; MS, China Agricultural University; PhD, University of Wisconsin, 1999

Ronghua Zhuge, PhD, Professor of Microbiology and Physiological Systems; BS, Zhejiang University, 1983; MS, Nanjing Agricultural University, 1986; PhD, Iowa State University, 1995

Jill A. Zitzewitz, PhD, Associate Professor of Radiology; BA, Carthage College, 1986; MS, Washington State University, 1988; PhD, Washington State University, 1991

Directions

The UMass Worcester Campus is located in Worcester Massachusetts just north of Route 9, on the west side of Lake Quinsigamond, between Plantation Street and Lake Avenue North. The campus is easily accessible from many major highways. See: http://www.umassmed.edu/about/directions/

Directions to the University Campus of UMass Worcester By Automobile

From the Mass Pike:

Eastbound: At exit 10, take I-290 east to exit 21, turn right at end of ramp and follow Plantation Street south.

Westbound: At exit 11, turn left onto Route 122 north for one mile, turn right at third light onto Sunderland Road, left at first light onto Lake Avenue for 2.5 miles and cross Route 9. Make U-turn at second break in divider, then turn right into campus.

From I-495:

Northbound: At exit 23, take Route 9 west. Follow Route 9 west for approximately 11 miles. After crossing the Lake Quinsigamond bridge, take first right onto Lake Avenue.

Southbound: At exit 25, take I-290 west to exit 22, turn right at end of ramp, at second traffic light turn left at onto Plantation Street and proceed south.

From I-190:

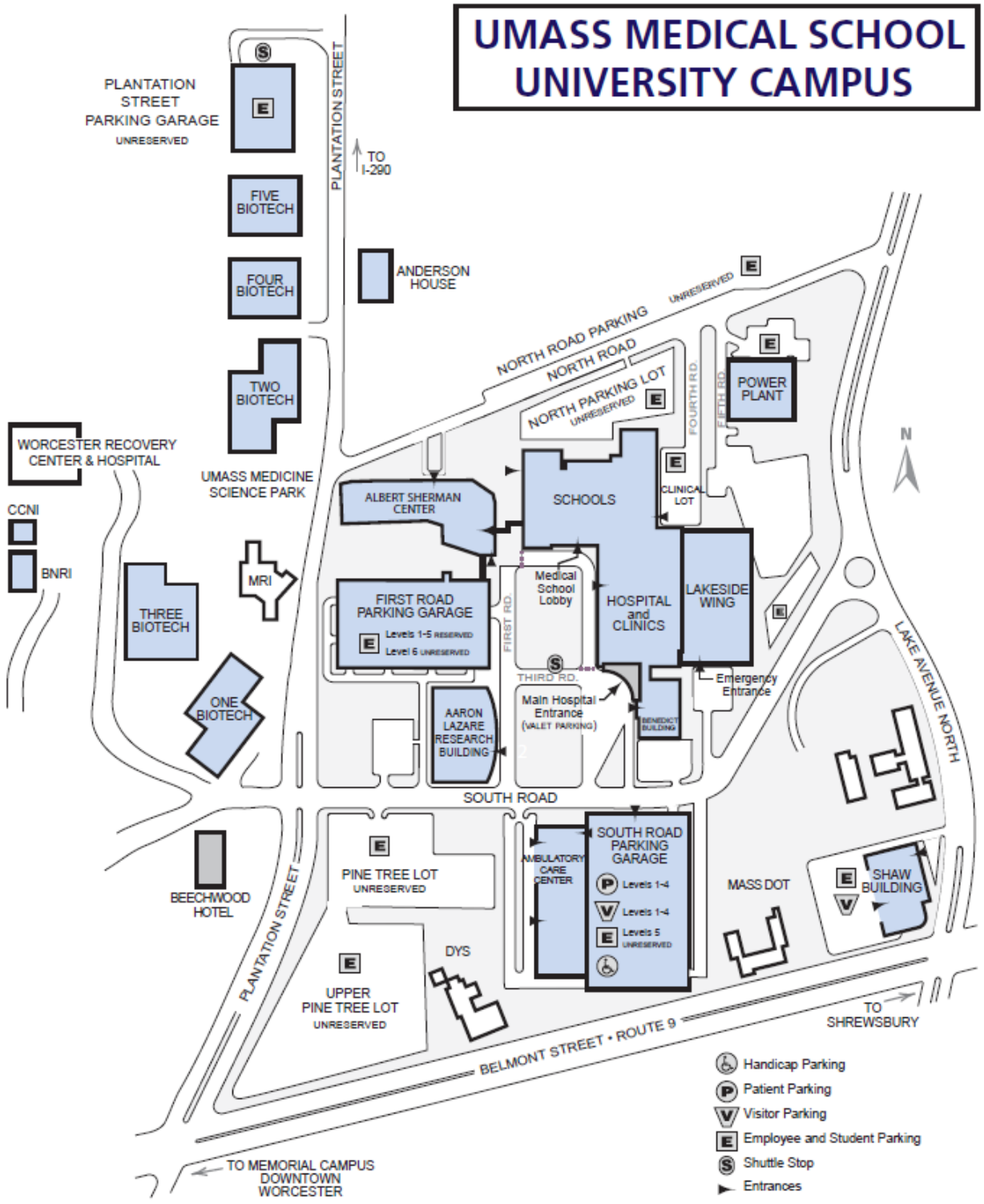
At the merge with I-290 Shrewsbury exit (watch for exit ramp on left), take I-290 east to exit 21, turn right at end of ramp and follow Plantation Street south.

From I-290:

Eastbound: At exit 21, turn right at end of ramp and follow Plantation Street south.

Westbound: At exit 22, turn right at end of ramp, at second traffic light turn left onto Plantation Street and proceed south.

University Campus Map



Contact us

Morningside Graduate School of Biomedical Sciences

University of Massachusetts Chan Medical School

55 Lake Avenue North

Room S1-824

Worcester, MA 01655-0002

Phone: 508.856.4135

Fax: 508.856.3659

email: gsbs@umassmed.edu

Morningside Graduate School of Biomedical Sciences Website

The most current Morningside Graduate School of Biomedical Sciences information is available at: https://www.umassmed.edu/gsbs/