The Graduate Division of Biological and Biomedical Sciences
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The Graduate Division of Biological and Biomedical Sciences (GDBBS) at Emory University provides students with unique opportunities to work with world-renowned researchers who are located on, or near, the Emory campus.

The GDBBS programs are interdisciplinary, thus giving students access to the considerable research resources of Emory University, the School of Medicine, and several university affiliates. The O. Wayne Rollins Research Center, Whitehead Biomedical Research Building, and Rollins School of Public Health (including Epidemiology and Global Health) are adjacent to one another and house faculty from more than 30 departments, including Biochemistry, Biology, Cell Biology, Human Genetics, Microbiology and Immunology, Pathology and Laboratory Medicine, Pharmacology, and Physiology. GDBBS faculty also are drawn from the departments of Anthropology, Chemistry, Medicine, Neurology, Pediatrics, Psychiatry and Behavioral Sciences, as well as Psychology and Surgery.

GDBBS students also have opportunities for collaborative training and research in major components or affiliates of the university. These affiliates include the Yerkes National Primate Research Center, Winship Cancer Institute, various university hospital and clinical research facilities, several programs within the Georgia Institute of Technology and Georgia State University, as well as the CDC, which is located one block from the primary research buildings on the Emory campus.

**Interdisciplinary Programs Train You for Success**

The resources and faculty available to our graduate students provide them with the necessary training to excel. The GDBBS has more than 400 students in various stages of graduate training. In a typical year GDBBS students are primary or co-authors on more than 200 research papers or abstracts. The publications appear in the top journals; indeed, more than half of them are published in the top 7 percent of journals in the biological sciences (based on the “impact factor” compiled by the Institute for Scientific Information). The training our students receive prepares them for jobs in many different career areas, including faculty and postdoctoral positions at top research universities, prestigious institutions such as the CDC and the National Institutes of Health, and positions in government and the pharmaceutical industry.

**PhD Training Programs**

The GDBBS encompasses eight interdisciplinary training programs, each leading to the PhD. Each program focuses on a major area of contemporary biology and emphasizes the interdisciplinary approach that
has proven to be successful in advancing research in the life sciences. Students develop a broad, multidisciplinary background, as well as master advanced concepts and in-depth skills from at least two of the traditional biological or biomedical sciences. Here at Emory, students benefit from more modern and competitive training than readily can be achieved through education in a traditional single-departmental program. Faculty research interests alone expose students to so many more areas than is possible within a single department. There is great flexibility in tailoring graduate education to the particular needs and interests of each student. Students enter one of the eight GDBBS programs and typically perform three research rotations before affiliating with a lab for their dissertation research. Each program has its own Executive Committee that oversees student progress. Students typically complete the course-work requirements prior to the end of the second year of study. The GDBBS structure ensures that every student potentially has access to training with any of the more than 325 faculty members affiliated with the training programs.

Financial Information

Students receive a tuition scholarship, a competitive stipend, and health insurance coverage. Funding is assured for all students who are making satisfactory progress toward their degree. Applications that are complete by the deadline will be considered for a number of competitive fellowships, including the Emory Graduate Diversity Fellowship, Woodruff Fellowship, and the Division Scholar Fellowship. Each fellowship provides students with a supplement to their stipend that ranges from $2,500 to $5,000 per year for five years. Students who apply for and receive external funding that provides for at least 75 percent of their stipend receive a $2,000 supplement to their stipend for the duration of the award. The cost of living in suburban Atlanta compares very favorably to other university cities.

Admission Requirements

Students are admitted to the GDBBS as trainees in one of the eight PhD training programs. It usually requires approximately 5.5 years to complete the requirements for the PhD. However, holders of MS, MD, DDS, or DVM degrees—upon recommendation of the program governing committees—may be admitted in advanced standing, allowing completion of the PhD program in a shorter period of time.

Applicants should have strong undergraduate backgrounds in the physical, biological, or behavioral sciences; hold a cumulative average of B+ or better in major science courses; and be highly motivated for a career in biological or biomedical research. Students are admitted in the fall semester, and the application deadline is December. Minority students are encouraged to

THE PROGRAMS IN THE DIVISION
- Biochemistry, Cell, and Developmental Biology
- Cancer Biology
- Genetics and Molecular Biology
- Immunology and Molecular Pathogenesis
- Microbiology and Molecular Genetics
- Molecular and Systems Pharmacology
- Neuroscience
- Population Biology, Ecology, and Evolution

In addition, GDBBS participates in a Medical Scientist Training Program, which allows students to obtain both the MD and PhD degrees during a training period of six to eight years. The MD/PhD Program provides the initial training for a career in academic medicine. It is designed to provide highly qualified students with the in-depth, high-caliber research training and medical education that will be required of future academicians.
apply. In addition, all applicants (including international applicants) must submit scores from the Graduate Record Examination General Test. Scores must be less than five years old. International applicants whose native language is not English must also complete the Test of English as a Foreign Language (TOEFL). TOEFL scores must be no more than two years old. Students who have strong qualifications in all but one of these predictors of graduate performance and who can provide evidence of a productive experience in laboratory or field science also will be considered for admission.

Applicants must submit three letters of recommendation, a statement of purpose, and transcripts from the universities they have attended, as well as required test scores.

Students applying to the MD/PhD Program should have an outstanding academic background in science or mathematics, as well as research experience as undergraduates. Application to the MD/PhD Program is accomplished through the American Medical College Application Service to Emory University School of Medicine. All supplemental materials and letters of recommendation must be received by the Emory School of Medicine Office of Admission by December 1. Applications may be received between June 1 and October 15. Applicants are encouraged to submit their applications early, preferably in the summer. Acceptance into the MD/PhD Program usually occurs prior to entering the first or second year of medical school.

Degree Requirements

In addition to meeting the general requirements for the PhD degree, GDBBS students participate in research seminars and laboratory training rotations with selected faculty members. There are two types of research seminars: (1) those presented by outstanding scientists from inside and outside the university that acquaint the student with current research problems and (2) those where the student participates as a speaker and discussant, a format that helps develop the student’s organizational and communication skills. To develop these skills further, students also participate in the planning and presentation of courses in the biological sciences. Finally, students must prepare a PhD research dissertation proposal, most in the form of a National Institutes of Health or National Science Foundation research grant application, which is then critiqued by GDBBS faculty who serve as members of, or consultants to, the review panels of these major research-funding institutions. These requirements provide GDBBS students with skills that are essential for success in academic or industrial research careers but are often overlooked in graduate training programs.

Career Development

GDBBS is committed to providing career-development opportunities for its students. Career Opportunities in the Biological and Biomedical Sciences (COBBS) is a program that informs students about career paths outside academia. A group of students and administrators form the Career Development Committee. As part of a monthly seminar series, guest speakers discuss their own careers and provide insight and advice. Students may take coursework in other PhD programs, such as biostatistics, epidemiology, and computer science. The committee is also investigating joint-degree opportunities, which are currently handled on an individual basis. The goal of the COBBS Program is to graduate students who are well-rounded, competitive candidates in a wide variety of fields.

Students interested in teaching can take advantage of the Graduate School’s TATTO Program (Teaching Assistant Training and Teaching Opportunity). ORDER (On Recent Discoveries by Emory Researchers) is a selective program available to students with an interest in teaching. It provides experience teaching at the undergraduate level. In addition to writing articles for major journals, students can enhance their scientific writing skills through Hybrid Vigor, a magazine involving students in every aspect of its publication, as well as writing articles for the student and alumni newsletters.

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The Larger University

Committed to courageous leadership in teaching, research, scholarship, health care, and social action, Emory University empowers the active, passionate pursuit of learning for a better world. Combining nine undergraduate, graduate, and professional schools with the largest health care system and sponsored research base of any university in Georgia, Emory is recognized as one of the world’s great institutions of higher learning.

Emory’s main campus in the suburban Atlanta neighborhood of Druid Hills is home to the undergraduate Emory College of Arts and Sciences, as well as undergraduate programs in business and nursing. Also housed on this walkable campus are graduate and professional programs in law, business, nursing, theology, medicine, public health, and graduate studies, as well as Emory University Hospital and the associated medical clinics and institutes. The Druid Hills campus features historic buildings of pink and gray Georgia marble, as well as contemporary LEED-certified residence and academic halls.

Twenty percent of Emory undergraduates choose to begin their education at Oxford College, Emory’s historic 1836 campus, located 38 miles east of Atlanta. Oxford offers these students a small-campus, liberal-arts-intensive education for the first two years of the Emory undergraduate degree.

Today Emory has its base in Atlanta, the business hub of the Southeast and an exciting global city. The city connects Emory to opportunities for wider networking, jobs, research, service, and learning. And when it is time for play, the metro area is rich with a mix of diverse cultures, entertainment, and the arts.

Reputation

Emory is numbered among the top 20 national universities by US News & World Report and is ranked 75th among the top 200 universities worldwide by the Times Higher Education World University Rankings. With an Emory degree in hand, students go on to choice graduate and professional schools and find meaningful jobs.

The university is one of the major biological research and medical referral centers in the Southeast and is among the fastest-growing medical centers in the United States. Emory is the largest private employer in DeKalb County and the third-largest private employer in metro Atlanta. To learn more, access the most recent community-impact study: http://impact.emory.edu/.

Emory provides a unique environment for its students and has attracted noteworthy faculty, including the Dalai Lama, Salman Rushdie, former President Jimmy Carter, and US Poet Laureate Natasha Trethewey. An excellent faculty attracts students of exceptional promise, nurtures the next generation of scholar-teachers, and pursues the common good. Through their research, service, and teaching, Emory faculty members shape the community in every way imaginable. Discover the profiles

STATISTICS

- Enrollment: 13,893 (from 50 states and 127 countries)
- Undergraduate: 7,441
- Graduate and professional: 6,452
- International students and scholars: 3,400
- Degrees awarded: 3,935
- Undergraduate: 2,025
- Graduate: 1,910
of Emory faculty members and sample their work from across the disciplines at “Great Scholars, Great Work,” http://www.emory.edu/PROVOST/greatscholars/index.html.

Libraries

The Emory Libraries include the Robert W. Woodruff Library and libraries for health sciences, law, theology, business, and Oxford College. The libraries include 3.7 million volumes and provide access to more than 56,000 e-journal titles. The Woodruff Library includes a learning commons, e-classrooms, a distance-learning classroom, Emory’s Center for Interactive Teaching, the Heilbrun Music and Media Library, the Electronic Data Center, group study rooms, and wireless access throughout the building.

Emory’s Manuscript, Archives, & Rare Book Library is one of the fastest growing literary archives in the country and offers rich collections in areas such as the Irish literary revival; 20th-century poetry; African American literature, history, and culture; and the social and cultural history of the American South, with an emphasis on Georgia and Atlanta. The literary collection includes the works of poets Ted Hughes and W. B. Yeats, Flannery O’Connor, Langston Hughes, Salman Rushdie, and the Raymond Danowski Poetry Collection, which is believed to be the largest private poetry collection ever assembled.

The Robert W. Woodruff Health Sciences Center Library has more than 225,000 bound volumes and provides access to more than 38,000 electronic journals and more than 235 electronic medical textbooks. The Emory wireless network is accessible throughout the library; workstations, laptops for in-library use, educational software, and assistance in creating multimedia presentations are also available. The library offers classes in database-searching techniques, bibliographic management software such as ENDNOTE and QUOSA, and efficient use of electronic information resources; moreover, librarians will schedule research consultations. The library provides facilities for study and research that include student group-study rooms and faculty carrels. Reference librarians collaborate with faculty to provide customized instruction sessions to suit the requirements of a particular class or group of students; they also assist faculty in developing library-based assignments. Branch libraries include student group-study rooms and in Emory Hospital.

Michael C. Carlos Museum

The Michael C. Carlos Museum is Georgia’s premier museum devoted to the art and history of world cultures. Founded in 1919, it is home to the Southeast’s most distinguished collection of art and artifacts from ancient Egypt, Greece, Rome, Nubia, the Near East, Asia, Africa, and the Americas. In addition, a works-on-paper collection spans from the Renaissance to the present. The Carlos Museum offers an array of educational opportunities, including special exhibitions, audio tours, family guides, gallery talks, children’s programs and summer camps, interactive technology, films, internships, and much more.

Arts

Music, theater, visual arts, dance, film, creative writing, and art history bring together students, scholars, and community members to focus on the artistic experience. In Emory’s premier showcase for the performing arts—the Donna and Marvin Schwartz Center for Performing Arts—teaching, learning, and performance merge for the entire community. The 98,000-square-foot facility houses an 825-seat concert hall, 150-seat studio spaces for both dance and theater, classrooms, practice spaces, and administrative offices. Emory offers more than 300 arts-related events a year. More than 100,000 people visited the Michael C. Carlos Museum galleries or attended arts events last year.

Sustainability

Emory’s commitment to sustainability seeks to restore local and global environments, foster healthy living, and reduce the university’s impact using the triple bottom line of social, environmental, and economic values. In 2011 Emory was awarded a gold rating by the Association for the Advancement of Sustainability in Higher Education STARS Program for its leadership in institutional sustainability. The university has developed a comprehensive Climate Action Plan to meet long- and short-term emissions and energy-reduction goals, and boasts more than two million square feet of LEED-certified building space. Its shuttle fleet vehicles are 100 percent alternatively fueled, and the university continues improving public health through its Sustainable Food Initiative, with a goal of serving 75 percent locally or sustainably grown food in its cafeterias and hospitals by 2015.

Strategic Plan

Emory’s future is guided by an ambitious strategic plan titled “Where Courageous Inquiry Leads.” The university is combining its unique resources to reach new understandings of what makes us human and to
address some of the toughest challenges and greatest opportunities facing the world today—from religion, conflict, and peace building, to issues of race and social difference, to global health, and to new frontiers in science and technology. One of the five major themes of the strategic plan is “Exploring New Frontiers in Science and Technology,” of which Computational and Life Sciences (CLS) is a part, along with sister initiatives in Predictive Health and Neuroscience. CLS is advancing the frontiers of science by harnessing Emory’s strengths in interdisciplinary research and informatics by integrating three diverse pillars of modern scientific discovery: Computational Science and Informatics, Synthetic Sciences, and Systems Biology.

Additionally, the Global Health Institute—led by former CDC director Jeffrey P. Koplan—will address the most pressing health challenges around the world and help Emory broaden and deepen its capacity in fields as varied as infectious diseases, chronic disease, vaccine and drug discovery, leadership development, health economics, and workforce development. The institute builds on Emory’s considerable strengths in global health and is creating and enhancing partnerships with governments and academic and private institutions in the most needy parts of the world.

Emory and the Georgia Institute of Technology have joined forces to build a new model of health and healing for the 21st century that concentrates on preventing disease before it develops. Through the Emory/Georgia Tech Predictive Health Initiative, clinicians, scientists, and engineers are using advances in bioscience and technology to gain a better understanding of what good health looks like at the molecular, genetic, and cellular levels.

Emory’s Center for Health Discovery and Well-Being identifies disease biomarkers in program participants and recommends lifestyle changes and other interventions to preempt illness.

University Resources

The O. Wayne Rollins Research Center was constructed in the early 1990s and signaled the beginning of a new phase in Emory’s mission to become a leader in biological and biomedical science research. A multidisciplinary research facility eight times the size of most Emory buildings, the Rollins Research Center is designed to accommodate innovative research. In working with the architects who designed the building, university officials stressed a keen desire to optimize opportunities for researchers to interact and share knowledge. The 256,250-square-foot building is organized around a dual-corridor system, permitting easy access to researchers’ offices and laboratories.

Whitehead Research Building is the largest building on campus at 325,000 square feet, excluding Emory University Hospital. Three basic science departments within Emory University School of Medicine—Cell Biology, Human Genetics, and Physiology—occupy the Whitehead Research Building, in addition to interdisciplinary research programs from the Department of Medicine and the Department of Pathology and Laboratory Medicine. An entire floor of the building is devoted to the Center for Neurodegenerative Diseases, comprising interdisciplinary programs from the departments of Neurology, Neurosurgery, Pathology and Laboratory Medicine, Psychiatry and Behavioral Sciences, as well as several basic science departments. The building’s interdisciplinary components address a key goal of the new strategic plan for research, which emphasizes the need for interdisciplinary research.

Winship Cancer Institute of Emory University is Georgia’s first and only cancer center designated by the National Cancer Institute (NCI), joining an elite cadre of 66 other cancer centers in earning this distinction. NCI designation for Winship gives Georgians improved access to clinical trials and resources that may not be available elsewhere. Winship is a “gateway” to cancer care at Emory. The building is a patient-friendly facility in which clinical care areas are centrally located and easily accessible. It also encourages collaboration between researchers and clinicians, in turn leading to better treatment for patients. Winship is part of the Georgia Cancer Coalition, which is a groundbreaking public-private partnership uniting Georgia’s leading hospitals, universities, biotech firms, civic groups, and nonprofit and government agencies. Several GDBBS faculty are Georgia Cancer Coalition Distinguished Cancer Clinicians and Scientists.

Yerkes National Primate Research Center is an international leader in biomedical and behavioral research. For more than eight decades, Yerkes researchers have conducted essential basic science and translational research to advance scientific understanding and improve human health. It is one of only eight National Institutes of Health–funded national primate research centers. Researchers at Yerkes are developing vaccines for infectious and noninfectious diseases, improving transplant medicine techniques and the immunosuppressive medications given post surgery, increasing understanding of and treatment options for progressive illnesses and stimulant addiction, advancing knowledge about the links between biology and behavior, and interpreting brain activity and vaccine development–related immunological function through imaging.

AIDS vaccine research at Yerkes and at the Emory Vaccine Research Center brings together some of the nation’s most respected immunologists and virologists, furthering the development of new vaccines and
fostering communication among nearly 100 Emory researchers studying AIDS. Yerkes scientists also examine complex social behaviors such as aggression and affiliation at molecular, cellular, and systems levels in diverse species and at different stages of development. The center’s state-of-the-art facilities include the Imaging Core, Microarray Core, Biomarkers Core, and the Tetramer Core Facility.

In addition, Yerkes has formed the Living Links Center, a behavioral-research component, to study human and ape evolution. Scientists there are improving understanding about the roots of such human behaviors as peacemaking and conflict resolution, communication, and reproduction. They are increasing our knowledge of the human species through the study of learning, memory, and cognitive processes in apes. Many scientists at Yerkes collaborate in joint research and educational endeavors and serve as GDBBS faculty.

The Vaccine Research Center is located adjacent to the Yerkes National Primate Research Center. It is one of the largest academic vaccine centers in the world and is renowned for its expertise in cellular immunity and immune memory. The center provides a focus for interdisciplinary research in immunology and vaccinology for basic science and clinical investigators throughout the university. Research is focused on microbiology and immunology, AIDS, malaria, genomics, and neuroscience.

The Robert W. Woodruff Health Sciences Center includes the Emory University School of Medicine, the Nell Hodgson Woodruff School of Nursing, the Rollins School of Public Health, the Yerkes National Primate Research Center, and Emory Healthcare, the center’s system of clinical facilities. Emory Healthcare is the rapidly growing clinical arm of the Health Sciences Center and is the most comprehensive healthcare system in metropolitan Atlanta. The center includes components of Emory responsible for the education of health professionals, research affecting health and illness, patient care, and policies for the prevention and treatment of disease.

The Carter Center of Emory University addresses national and international issues of public policy and draws on the resources of virtually the entire university community, including former President Jimmy Carter, who is an Emory University Distinguished Professor. Its programs bring to campus a wide range of international scholars, government leaders, business executives, and other professionals, and provide an opportunity to merge the knowledge of the academic community with the practice of public affairs. Areas of interest include international security and arms control, health care and health policy, the possibilities for peace in the Middle East, the world economy, Latin American affairs, human rights, and conflict mediation and resolution. Emory students regularly participate as volunteers and interns in planning and implementing center projects, engage in research projects with center fellows, and have opportunities to attend center consultations and conferences. Although the center does not offer an academic degree program, fellows and associates teach in the various schools of the university.

Computer support for research at Emory is located in several different units. As a teaching and research center, Emory has facilities and services specifically available to graduate students and faculty. Prime among them are the Office of Information Technologies High-Performance Computing Group and the Cherry L. Emerson Center for Scientific Computing (Emerson Center), both of which provide high-end computational facilities and expertise to the scientific research community at Emory.

In addition, Emory is one of 107 universities that interconnect at top speeds as a member of Internet2, a project to provide high-performance network support for next-generation research and education applications. Linking together institutions across North America, Internet2 provides the backbone for large-bandwidth connections and collaborations. On campus, the Computing Center at Cox Hall is a state-of-the-art computing lab designed around enabling group work. Whether one wishes to review material with colleagues or create a presentation with co-authors, the facility provides large screens, ample workspace, and collaborative software to offer some of the finest support for team-based efforts available at any institution.

The CDC, as mentioned, is next door to the Emory campus. Close collaborations between GDBBS faculty and scientific staff at the CDC broadly enhance the research opportunities and educational experiences available for students. Many CDC researchers have joint appointments in the GDBBS, which allow students a greater choice of training opportunities.
The Program in Biochemistry, Cell, and Developmental Biology

A multidisciplinary approach to biomedical research underlies the Program in Biochemistry, Cell, and Developmental Biology (BCDB), which encompasses state-of-the-art research in biochemistry and cell and developmental biology as well as cancer biology. The program has 60 faculty members who come from the basic science departments, clinical departments in the School of Medicine, and the Emory College Biology and Chemistry departments. Such diversity provides students an unparalleled opportunity to develop new interests and explore a broad range of research areas during their graduate training experience.

Educational and Research Opportunities

Given the broad range of opportunities available within the BCDB Program, each individual can tailor research opportunities to his or her own interests. The first year is dominated by a unique, intensive, small-group-discussion course that covers key concepts and methods in the basic sciences, as well as three research rotations, which are designed to identify the lab and mentor with whom the student will perform thesis research. The second-year curriculum includes a rigorous proposal-writing course designed to train students in grantsmanship, hypothesis design, and scientific writing, as well as statistics. Students begin their thesis research at the end of the first year. Additional training opportunities exist (e.g., program symposium, program retreat, seminars, journal clubs, etc.) and are designed to fit into the schedules of upper-level students. Areas of research include but are not limited to:

Biochemistry/Structural Biology

Biochemistry seeks to understand the properties and regulation of macromolecules relevant for biological function. The ultimate goal of such studies is the molecular description of the cell, with details of the temporal and spatial regulation of its chemistry and interactions. In this way, one can marvel at its beauty and consider the design of molecules capable of altering or maintaining specific functions. One important piece of this puzzle is developing an understanding of the relationship between macromolecular structure and function. In the BCDB Program several faculty members employ physical, chemical, and spectroscopic approaches to defining molecular structure and enzymological approaches to understanding function. Other faculty members are applying these approaches to study protein-DNA and protein-protein interactions, and the behavior of supramolecular complexes. BCDB faculty also are studying pathways and processes such as the regulation of transcription and translation, secretion and vesicular traffic, signal transduction pathways, protein synthesis and degradation, and cell-cell contacts.

Cancer Biology

Research in cancer biology seeks to discover molecular mechanisms that govern the regulation of cell growth, differentiation, genetic stability, and the properties that distinguish neoplastic cells from normal cells. An additional research goal is to translate the newly acquired basic
understanding of cancer biology to improved anticancer therapeutic strategies. Program members offer training opportunities in wide-ranging areas of cancer biology, including signal transduction, oncogenes and tumor suppressors, DNA damage and repair, angiogenesis, regulation of reactive oxygen species and hypoxia in tumors, tumor-microenvironment interactions, and anticancer drug discovery.

**Cell Biology**

Cell biology deals with understanding the fundamental aspects of cellular behavior and regulation. Research groups in the BCDB Program are addressing many of the key questions of cell biology. The laboratories of BCDB faculty are using advanced molecular, genetic, computational, and imaging techniques to analyze and determine the molecular components critical for regulating cellular structure and behavior, and to dissect the signal transduction pathways involved in these processes. The varied research interests of the faculty include regulation of cell polarity, cell motility, cell-cell interactions, membrane traffic and secretion, nuclear transport, stem cell production and maintenance, and establishment of cell identity, as well as other important areas of cell biological research.

**Developmental Biology**

Developmental biology is an integrative area of biological research that aims to understand how cells coordinate their activities to form a functional organism. In the BCDB Program a number of research groups are investigating a diverse array of developmental processes, including pattern formation, cell-fate determination, organogenesis, cell migration, cell differentiation, and gene regulation. These research groups use a variety of model organisms to study these processes, including Drosophila, C. elegans, Xenopus, mouse, and zebrafish.

Alumna Tiffany Roberts-Wilson received the Paul E. Standjord Young Investigator Award from the Academy of Clinical Laboratory Physicians and Scientists.
The Program in Cancer Biology

The Program in Cancer Biology (CB) provides outstanding training opportunities in every aspect of cancer research, from basic to translational. This includes molecular and cellular biology, genetics and epigenetics, signal transduction, genetic engineering, nanotechnologies, and many other disciplines used to understand the development and progression of cancer. Many different approaches are applied to a range of model systems to address how a normal cell becomes a cancer cell, how cancer progresses to a metastatic state at the molecular level, and how our understanding of these mechanisms can be exploited for the design of new cancer therapies or novel ways to apply existing anticancer agents in the clinic.

Educational and Research Opportunities

During their first year students will rotate through at least three independent laboratories. Those rotations allow students to acquire experimental knowledge in various disciplines addressing cancer biology. At the end of these rotations, students select a laboratory for their dissertation research. Required courses are typically completed by the second year. The Winship Cancer Institute is a great resource for graduate students in the CB Program. The institute hosts weekly seminars in which Emory faculty and leaders in cancer research from various institutions present their findings. In addition, the institute sponsors a yearly symposium in which various research focus groups sponsor scientists of international stature. An important component of the symposium is a career-development workshop. Members within the institute also host the annual Jean Sindab Triple Negative Breast Cancer Symposium. Additional cancer-related seminars are presented on a weekly basis throughout the School of Medicine, the various GDBBS programs, and departments at Emory. The institute has several on-site, shared-resource laboratories to facilitate research, including cores in bioinformatics, imaging, cancer genomics, pathology, and tissue banking. The institute actively participates in drug development and clinical trials, facilitating bench to bedside translation. The CB doctoral program provides outstanding training in three main research areas.

Cancer Genetics and Genomics

Research in this area focuses on genetic and epigenetic alterations that ultimately result in cancer initiation and progression. This encompasses the study of DNA damage-managing systems, including DNA repair and DNA damage recognition. DNA damage includes damage induced by mutagens, as well as chromosome instability and aneuploidy triggered by oncogenes and tumor suppressors. The epigenetics components of this research include transcription factors, DNA methylation, and chromatin modifications leading to deregulated transcription, an important component of tumor biogenesis. Complementary investigations
In only its second year, the new Cancer Biology Program has received two prestigious endowments for its program.

use cancer genomics, in which the changes in gene expression, DNA methylation, mutations, amplifications, and deletions are examined on a global scale to understand the mechanisms of cancer initiation and progression.

Cancer Signal Transduction

Research in this area concentrates on the signaling events by which cancer cells establish themselves in the host organism and form neoplastic tissue. The biological mechanisms by which cancer cells proliferate, overcome apoptosis, develop self-sufficiency from growth factors, evade the immune system, become invasive and metastatic, and induce tumor vasculature are studied along with other hallmarks of cancer.

Cancer Therapeutics

Research in this area utilizes the knowledge acquired from the study of cancer formation to develop novel therapeutics. These research teams investigate diverse molecular targets to discover various anticancer drugs and test those drugs in animal models with the goal of establishing clinical trials. Research approaches include signaling pathway investigation, medicinal chemistry, natural product manipulation, pharmacology, high-throughput screening technology for small-molecule discovery, biomarker-driven clinical-trial design, pathology, and biostatistical evaluation.

A number of CB faculty member research projects extend across several of these areas, providing students with ample opportunities for exceptional interdisciplinary training. Particular strengths in organ-specific cancer research are found in breast, lung, prostate, head and neck cancer, brain tumors, hematopoietic malignancies, and many others.
Educational and Research Opportunities

First-year students obtain a strong knowledge base through introductory coursework and practical research experience by participating in rotations in the faculty laboratories of their choice. Students further tailor their curriculum through advanced courses that emphasize hypothesis design and critical thinking, constructive literature evaluation, presentation skills, scientific writing, and ethical conduct in research. A seminar and research-in-progress series keeps students and faculty at the cutting edge of current developments in genetics. Research interests of the faculty vary in topical, approach, and model organism and are described in the six major foci that follow.

Genome Structure, Replication, Recombination, and Repair

The stability of our genomes and their ability to exchange information is critical to the survival and evolution of all organisms. This research focus includes studies that examine the mechanisms of DNA replication and recombination in model systems, the repair of DNA damage caused by mutagenic agents and the environment, and the mechanisms of centromere and telomere function and their role in disease and cancer.

Regulation of Gene Expression

Key to adaptation and normal differentiation and development is the ability to regulate genes. Developmental disorders and tumors arise from abnormal gene regulation. Research in this area focuses on the molecular mechanisms and the genetic and epigenetic principles of the regulation of gene expression. This involves transcription factor interactions with DNA, chromatin structure, and epigenetic regulation of all the above. Systems studied include regulation of human disease, the immune system, the visual system, mechanisms of transcriptional initiation and elongation, dosage compensation in Drosophila, regulation of gene expression in germ cell formation, role of oncogenes and tumor suppressors in gene expression, and genes involved in bacterial differentiation and pathogenesis. The GMB Program has a nationally recognized strength in epigenetic research with a large core of faculty involved in various aspects of this exciting area of research.

Development and Differentiation

Understanding the molecular genetic basis for development and cellular differentia-
tion is key to many disease processes. GMB faculty use a variety of model organisms to understand the major genetic events that occur to form multicellular organisms. Topics include muscle development, sperm development and fertilization, and germ cell specification and maintenance in *C. elegans*; development of sensory organs in mouse and zebrafish, and the enteric nervous system in zebrafish; genetic control of nervous system formation and sex determination in *Drosophila*; and the genes regulating formation of the *Drosophila* and mammalian eye.

### Cancer Genetics and Biology

Cancer is a genetic disease. Alterations in genome integrity such as changes in DNA ploidy, chromosome rearrangements, genetic deletions, and point mutations start the transformation process. At Emory cancer is studied from a variety of approaches, and basic, translational, and clinical investigators are united to find a cure through research. GMB cancer investigators are members of the Winship Cancer Institute, which allows comprehensive training from the bench to the clinic. Research topics include understanding cancer formation and malignant progression using bioinformatics and array technologies, understanding DNA methylation and epigenetic mechanisms of human carcinogenesis, genetic regulation of cell-cycle control, apoptosis, and angiogenesis as well as development of novel molecular genetic therapies using clinical material from human tumor patients and in animal models.

### Human and Medical Genetics

This century brings the promise of understanding and treating a large number of inherited human diseases. At Emory the impressive interaction between the clinical and public health faculty, diagnostic laboratories, and basic scientists offers a unique opportunity to study patient populations using innovative methods. Areas of research include studies of inborn errors of metabolism, chromosomal disorders, single-gene disorders, and multifactorial disorders. Cutting-edge molecular biological techniques, state-of-the-art genomics technology, stem cell technology, genetic epidemiological methods, and directed evolution studies are just some of the approaches in assessing the genetic and environmental factors involved in disease traits.

### Bioinformatics and Comparative Genomics

Researchers in this training focus collect, develop, and analyze genome-based data sets to understand the basis of evolution, the dissemination of disease and variations that occur with human disease genes, the identification of disease traits, the actions of retrotransposons on manipulating the genome, and the predictive nature of complex genomic analyses. State-of-the-art facilities aid scientists in investigating gene-expression profiles, copy-number variation, genetic polymorphisms, transcription factor binding across the genome, and advanced DNA and RNA sequencing methodologies.
The Program in Immunology and Molecular Pathogenesis

The Program in Immunology and Molecular Pathogenesis (IMP) offers exceptional interdisciplinary training in molecular and cellular immunology, the role of the immune system in the pathogenesis of infectious disease, and virology. Opportunities for dissertation research include many subjects in the fields of immunology and pathogenesis, along with overlapping areas of fundamental cell biology and molecular biology, and virology. The research programs of the IMP faculty members use a range of experimental approaches in immunobiology, molecular and cell biology, pathobiology, virology, and genetics. Faculty members are drawn from both basic science and clinical departments in the School of Medicine as well as from the CDC, which is located nearby.

Educational and Research Opportunities

This program provides students with a unique opportunity to study all aspects of pathogenesis, ranging from basic immunology to the molecular biology of viral and bacterial pathogens. Participating faculty have a range of research interests, which provides an opportunity to tailor coursework and research activities to fit the career goals of individual students. In the first year students take courses in immunology and virology. A number of elective courses are available, covering topics ranging from microbial pathogenesis to cell biology and genetics. During the first year, students take three 10-week laboratory rotations and then select an advisor and laboratory for dissertation research. Students typically complete this PhD program in approximately five years.

Opportunities for dissertation research include many subjects that encompass the fields of immunology and molecular pathogenesis. These areas often overlap with each other as well as with fundamental cell biology and molecular biology. In addition, a number of faculty advisors are actively working at the interface between basic and applied research (i.e., translational research). The research interests of the participating faculty may be characterized broadly into immunology and molecular pathogenesis, though their interests often span both disciplines. The IMP doctoral program provides outstanding training in the areas of immunobiology, pathogenesis of infectious disease, and molecular virology.
Research interests of the IMP immunology faculty cover a large spectrum of this broad scientific discipline. Topics include the molecular regulation of gene expression, regulation of immunological memory, tumor immunology, autoimmunity, mucosal immunology, innate immunity, transfusion immunobiology, and immunological aspects of vaccination. Other interests include basic and applied studies in transplantation immunobiology, which naturally integrate with the large clinical transplantation program at the School of Medicine. Fundamental and clinical studies in autoimmunity are also ongoing. In addition, there are vigorous multiproject efforts among IMP faculty to investigate the effects of aging on the immune system, development of novel vaccines for influenza virus infection, and efforts to understand the quality of the immune response in immunocompromised hosts.

Pathogenesis of Infectious Disease

The central focus of this area is the investigation of host-pathogen interactions using viruses, bacteria, and protozoa. The research of participating faculty at Emory and the Vaccine Research Center is strengthened by collaborative projects with scientists at the CDC. Faculty research interests include vaccine development, microbial evasion of host immune responses, and microbial virulence factors. Viruses studied include adenovirus, human immunodeficiency virus (HIV), simian immunodeficiency virus (SIV), dengue virus, lymphocytic choriomeningitis virus, herpesviruses, hepatitis C virus, measles virus, polyomavirus, influenza virus, vaccinia virus, yellow fever virus, and measles. Bacterial pathogens being studied include salmonella, listeria, neisseria, and mycobacterium tuberculosis. Protozoa pathogens being studied include malaria.

Molecular Virology

The research interests of IMP faculty in this area involve investigations into viral packaging, the structure/function relationships of viral proteins, viral replication, and effects of viruses on cellular proliferation, transformation, and apoptosis.
The Program in Microbiology and Molecular Genetics

The Program in Microbiology and Molecular Genetics (MMG) provides training in the study of microorganisms as well as in the use of microbial models to investigate basic problems in molecular genetics, microbial physiology, and microbial pathogenesis. The program is designed not only for students interested in academic careers in teaching and research but also for those interested in careers in related aspects of medicine and industry. Research training is offered in the biology of microbes and the molecular biology of viruses and bacterial pathogens: bacterial genetics and physiology, microbial development, mechanisms of bacterial and viral pathogenesis, molecular biology of gene regulation, antibiotic resistance, and antiviral and vaccine development. The program faculty is well funded and has an outstanding training record. The program has considerable infrastructure and the technical expertise to perform cutting-edge research. The MMG faculty are drawn from the School of Medicine (Biochemistry, Microbiology and Immunology, Medicine, Pathology, and Pediatrics), the Rollins School of Public Health, science departments in Emory College, the CDC, and the Atlanta VA Medical Center.

Educational and Research Opportunities

The graduate experience in the MMG Program begins with an introduction to the faculty, current students, and their research through a series of short talks, discussions, and a poster session. During the first year students choose at least three research rotations that are designed to give them exposure to various research areas and techniques before choosing a direction and laboratory for their dissertation research. In the first and second years, students also participate in courses that prepare them for analyzing, critiquing, and presenting research in the areas of bacterial genetics, virology, biochemistry, microbial pathogenesis, molecular genetics in eukaryotic and prokaryotic systems, immunology, and molecular mechanisms for DNA rearrangements and gene regulation.

MMG graduate students teach for one semester in their second year; all students are prepared for this experience by attending a symposium on teaching strategies, techniques, and ethics. MMG students take their qualifying examination in the spring.
A semester of the second year. This examination consists of a written NIH-style grant and an oral defense conducted before faculty on the doctoral dissertation committee, which is constituted with faculty chosen by the student and consists of individuals who have general expertise in the student’s area of research. Journal clubs, seminars, and attendance at regional, national, and international meetings contribute to the graduate educational experience.

The goal of the faculty is to provide an atmosphere for the student that emphasizes creativity. Students learn how to test hypotheses, critically evaluate data, read and critique scientific literature, and communicate effectively with other scientists. Students usually complete their graduate work in approximately five years and then move on to excellent postdoctoral positions en route to academic, industry, and government research positions. Recent MMG graduates have received postdoctoral research positions at Princeton University, Harvard University, Yale University, the University of Washington, Oxford University, the CDC, the National Institutes of Health, and the Food and Drug Administration. Opportunities for dissertation research are grouped into two broad areas.

**Gene Expression and Physiology of Bacteria and Viruses**

Research in this area involves the transcription of genes involved in antibiotic resistance, virulence, motility and the differentiation of microbes, as well as viral multiplication and host genes influenced by infection. Microbes are used to study fundamental physiological processes including sporulation, antibiotic synthesis and resistance, transport, biofilm formation, bacterial communication systems, and metabolism. Research in virology focuses on viruses that are associated with disease in humans as well as animal models to understand better the host immune response to viral infection.

**Microbial Pathogenesis**

In this field important areas of research include the study of genes required for bacterial and viral pathogenesis and the response of the host to infection. MMG faculty with interests in bacteriology conduct basic research that addresses important, contemporary problems in the areas of microbial physiology (including sporulation, biofilm formation, mechanisms of antibiotic resistance and production, and cellular communication systems), microbial genetics (mechanisms of control of gene expression, transposition, and recombination), bacterial virulence factors (including those produced by the group A streptococci, streptococcus pneumoniae, neisseria gonorrhoeae, neisseria meningitidis, enteropathogenic bacteria, Proteus spp, staphylococcus aureus, and mycobacterium tuberculosis), use of microbial genomics to understand mechanisms of virulence and antibiotic resistance, and how bacteria evade host defenses.

MMG faculty with interests in virology conduct basic research that addresses important, contemporary problems in the areas of antiviral development, mechanisms of antiviral resistance, viral replication, roles of viruses in oncology, HIV/AIDS, influenza, mechanisms of viral pathogenesis, mechanisms of viral fusion with host cells, use of cryoelectron microscopy to study viral assembly and trafficking, escape from immune systems, and vaccine development.

**Program Accomplishments**

Raymond Schinazi is a 2012 inductee into the Technology Hall of Fame of Georgia. Schinazi is the Frances Winship Walters Professor of Pediatrics and director of the Laboratory of Biochemical Pharmacology. He is senior research career scientist at the Atlanta Department of Veterans Affairs and director of the scientific working group on viral eradication within the Emory Center for AIDS Research. Schinazi also has founded several biotechnology companies focusing on antiviral drug discovery and development.

Emory biologist Bruce Levin was elected to the National Academy of Sciences (NAS) in 2012 for his excellence in original scientific research. Membership in the NAS is one of the highest honors given to a scientist or engineer in the United States. Levin joins fellow MMG faculty member Rafi Ahmed in being elected to the NAS.
Pharmacology is the study of how drugs act on biological systems and is perhaps the original interdisciplinary science. The goals of pharmacology are to understand how drugs work, how drugs are processed in the body, and how this information might be used to develop new drugs in the future and also identify new drug targets to treat human disease better. Knowledge about drug interactions with known targets and the identification of novel drug targets (molecular pharmacology) is combined with information about how the effects of drugs on different organs and tissues are integrated to produce therapeutic or toxic effects (systems pharmacology).

**An MSP Degree Gives Students Many Career Options**

A graduate of the MSP Program emerges with broad training in basic biomedical sciences, encompassing such disciplines as biochemistry, molecular biology, physiology, and neuroscience, and also has training and expertise in the specialized principles and approaches of pharmacology. This combination is increasingly sought after by the pharmaceutical, biotechnology, and government sectors, as well as being excellent preparation for an academic career. The program also offers specializations in toxicology—which focuses on the adverse effects of drugs and chemicals—and a chemical biology concentration that provides interested MSP students with the opportunity to obtain simultaneous training and expertise in aspects of chemistry that are particularly relevant to pharmacology and drug development. Students choose their dissertation mentors from more than 50 internationally recognized MSP faculty members in 15 different academic departments who are studying in a host of research areas.

**Research Opportunities**

Research in the area of pharmacology often has a more direct connection to the field of medicine than does basic biology research. This is evident in the faculty's research interests, which broadly subdivide into the major programmatic themes that follow. They encompass diverse areas of research, including neuropsychopharmacology, cancer pharmacology, AIDS research, cardiovascular biology, toxicology, and chemical biology.

**Transmembrane Signaling**

This area includes research about cell surface receptors, neurotransmitters, intracellular signaling pathways, second messengers, protein phosphorylation and dephosphorylation, transcriptional and post-transcriptional gene expression regulation, G proteins, ion channels, and transporters. This mechanistic research provides insights into the pathogenesis and treatment of diseases such as epilepsy, atherosclerosis, drug addiction, Parkinson's disease, and cystic fibrosis.
Substance Abuse and Behavioral Pharmacology

In order to produce new and effective drugs for the treatment of central nervous system disorders and drug addiction, it is important to understand how the effects of drugs at the molecular and cellular level are integrated to produce effects on brain function and, eventually, behavior. This area of pharmacology includes research about behavioral pharmacology, mechanisms of drug abuse, neuronal pathways regulating cognition, memory, motor control, and diurnal rhythms.

Mechanisms and Therapies of Disease

MSP faculty work to identify novel molecular drug targets for the development of therapies for treatment of many different diseases. These studies include research related to muscle regeneration, inflammation, mechanisms of anticancer and antiviral drug action, mechanisms and drug treatment of cardiovascular and ocular diseases, and gene therapy. The new Drug Discovery Center provides faculty and students with state-of-the-art resources to find new drugs that act on the novel targets they discover.

Molecular Toxicology

Many drugs have unwanted adverse effects, and environmental toxins are drugs that have only undesirable effects. MSP scientists are working to understand the mechanisms of toxic drug actions, thereby providing knowledge that will help in the prevention and treatment of diseases and syndromes resulting from toxicant exposure. The molecular toxicology specialization includes research related to apoptosis and reactive oxygen species, radiotherapy and DNA repair, pulmonary toxicity of alcohol, environmental neurotoxicology and Parkinson's disease, and the regulation of drug-metabolizing enzymes.

The Institute for Drug Discovery carries out early-stage discovery and preclinical drug research aimed at developing small-molecule therapeutics and training new researchers in a multidisciplinary drug-discovery environment.
The Program in Neuroscience

The Program in Neuroscience (NS) provides broad interdisciplinary training in the study of the nervous system ranging from molecular/cellular/developmental to systems/behavioral/cognitive levels of organization. It includes more than 120 neuroscientists drawn from more than 20 separate departments and research centers. A significant training component is devoted to the understanding and treatment of neurological and psychiatric diseases.

Neuroscience Program Research Portfolio

Research in the NS Program spans multiple domains of scientific inquiry, and most faculty undertake projects that transcend individual categories. Nonetheless, research efforts can be broadly separated into the following categories.

Disease Mechanisms in Neurology and Psychiatry

Most NS faculty have prominent research interests in neurological and/or psychiatric disease mechanisms, and many are part of interdisciplinary research teams that study neurodegeneration, neuroprotection, brain repair, psychiatric disorders, and experimental therapeutics.

Yerkes National Primate Research Center is a premier research facility and has many cross-appointed researchers who provide a collaborative environment for translational research. Neurology is an acknowledged leader in the study of Parkinson’s and Alzheimer’s diseases with dedicated research centers that include the Centers for Neurodegenerative Disease, Alzheimer’s disease, and Amyotrophic Lateral Sclerosis.

The Psychiatry and Behavioral Sciences department has strong representation in research on the biology and treatment of the major psychiatric disorders and is renowned for its research in stress neurobiology as well as in mood and anxiety disorders. Its Mind-Body Program focuses on psychosocial stress in relation to brain, endocrine, and immune systems—especially in association with depression—and the therapeutic benefits of meditation.

Researchers in the Center for Translational Social Neuroscience explore the neurobiology of prosocial behaviors, including cooperation, compassion, bonding, and social reciprocity. Psychiatric disorders characterized by deficits in the social brain include Autism Spectrum Disorders and schizophrenia.

Other clinically relevant studies aligned with this category concern diabetes, drug addiction, dystonia, epilepsy, environmental toxicology, Fragile X syndrome, Frontotemporal Dementia (FTD), the neuro-inflammatory stress response, Huntington’s disease, learning and memory, macular degeneration, nerve regeneration and repair, pain, Posttraumatic Stress Disorder, sleep/wake disorders, spinal cord injury, and spinal muscular atrophy.
Biomedical Engineering department and the renowned joint Emory/Georgia Tech Neurology-Molecular and Biomedical Sciences Program. Additional research interests in developmental neuroscience include stem cell biology for transplantation, cell division and postmitotic neuronal differentiation, and the genetic control of cell fate. Development of spinal cord motor circuits, the mammalian auditory organ, and the enteric nervous systems are also rigorously pursued research areas.

Computational Neuroscience

There is also very strong faculty representation in the systems, behavioral and cognitive neuroscience research category. Commonly used experimental approaches embrace imaging (MRI, DTI, PET, and SPECT); behavioral analyses including rodent behavioral testing paradigms; electrophysiology, including multielectrode recordings; pharmacology; in vivo microdialysis; and neuroanatomical approaches that include electron and multiphoton fluorescence microscopy.

Programmatic strengths include recent advances in the neuroprotective effects of early administered neurosteroids after traumatic brain injury; the function of the basal ganglia and the role of pesticides in the development of Parkinson’s disease; functional imaging studies on drug dependence and addiction; the behavioral pharmacology of cocaine and related psychomotor stimulants; the neurobiology of cortical learning and memory; the psychobiology and neurochemical substrates of motivation, fear conditioning, and social behavior; the relationship between neuroendocrine function, neuropeptide signaling, and social behaviors; plasticity in tactile perception, including visual system cross-modal interactions; dysfunction in sleep/wake behaviors; retinal mechanisms of circadian control and ocular disease; and neuroendocrine/neuroimmune dysfunction in psychiatric disorders.

Motor-control researchers use functional imaging and transcranial magnetic stimulation to explore cortical reorganization following cerebrovascular injury and in rehabilitation. Others employ electrophysiology and biomechanics in rehabilitative studies after stroke or spinal cord injury. The role of basal ganglia, cerebellum, and spinal cord are studied in normal movements as well as in movement disorders, while the principles of motor-pattern-generating circuits are studied in model invertebrate systems (leech heartbeat and arthropod feeding) and mammalian systems for spinal cord locomotor rhythms. Also studied is the molecular basis of inherited neurological disorders, including epilepsy, and bird song as a model system of neural plasticity of a complex motor behavior.

Numerous neuroscientists are also interested in the biological processes associated with cognition. Research in this area includes understanding hominid brain evolution associated with human social cognition, the emergent field of neuroeconomics (the neurobiological basis for individual preferences and constraints on decision making), brain-region interactions in memories, and alterations in cognitive function with aging.
The Program in Population Biology, Ecology, and Evolution

The Program in Population, Biology, Ecology, and Evolution (PBEE) integrates biological mechanisms across many levels of organization—from the genetic basis of complex traits; to evolutionary genetics and molecular forces leading to the evolution of genome organization; to large, interconnected networks of species in complex ecological systems. The central goal of the PBEE graduate program is to provide the multidisciplinary training required for a successful research and teaching career. Students can pursue careers in the health sciences, government, or industry depending on the focus of their individual course of study and research.

**Educational and Research Opportunities**

Core courses and seminars provide a common background for all students. Research opportunities are specifically tailored for each student. First-year rotations allow students to work with three different faculty members and to be engaged in dissertation research by the end of the first year.

PBEE researchers work with a variety of experimental systems, ranging from bacteria to humans; the central feature uniting these research programs is the application and testing of quantitative methods and models during the course of research, which is unique to the PBEE Program and not found in other GDBBS graduate programs. As a consequence, PBEE faculty members have substantial expertise in a number of quantitative and statistical areas that are routinely used and developed for their research programs. This theme is reflected in the design of the core curriculum and the research projects pursued by PBEE students. The graduate program has six main areas of inquiry.

**Bioinformatics and Biostatistics**

The rapid increase in the size and complexity of population biology datasets requires
novel tools and improved methods of analysis, visualization, and data handling. Developing and critically evaluating these tools and approaches is a core focus of faculty performing research in this area of inquiry. The types of population biology problems addressed are diverse. Some of these include inventing improved methods of genetic mapping for genome-wide association and family-based linkage studies, developing software frameworks for analyzing large genomics datasets, and developing web services to speed genome annotation.

**Biology of Species Interactions**

Interactions between species, whether beneficial or harmful, are ubiquitous in nature. These interactions may include two players (e.g., a host and its bacterial symbiont), multiple players (e.g., butterflies, their larval food plants, and protozoan parasites), or an entire community (e.g., plant-pollinator networks at the landscape scale). Faculty performing research in this area use experimental approaches to understand the dynamics of these interactions and the importance of ecological context in shaping these interactions. They also use genetic and genomic approaches to uncover population structure, molecular mechanisms, and genetic variation underlying the traits that shape species interactions. A major aim of the work is to understand how such interactions drive the population dynamics and evolution of the respective species, and faculty use this biological understanding to apply their work to conservation and management questions in a variety of settings.

**Disease Ecology**

The major focus of disease ecology is to gain a greater understanding of how diseases spread; the interactions between the hosts, pathogens, and environment; and ultimately the types of changes observed in natural populations. Faculty performing research in this area use experimental- and model-based approaches to address a diverse collection of problems, with the goal of gaining a greater understanding of the spatiotemporal dynamics of disease. Problems that disease ecology addresses include the phylogenetic history and origin of pathogens, the population dynamics and control of infectious diseases, and the processes contributing to the evolution of drug resistance.

**Ecological and Evolutionary Modeling**

Mathematical modeling of complex ecological and evolutionary processes can provide unique insights into biological systems, help elucidate unanticipated processes at work in populations, and provide testable predictions for empirical studies. Building and evaluating such models is central to research in this area of inquiry. Faculty performing research in this area use mathematical models to address a diverse collection of problems. These include within-host dynamics of the immune response, the evolution of drug resistance, models describing the spatiotemporal dynamics of infectious diseases, and dynamics of microbial populations.

**Genetics of Complex Traits**

Understanding the genetic basis of complex traits is a central challenge in contemporary biology. Research in this area aims to combine the latest genomics technologies with sophisticated statistical models in order to better understand how genomic variation leads to the phenotypic diversity observed in natural populations. Faculty performing research in this area address a wide variety of problems. These include the nature of complex disease traits in contemporary human populations; the genetic basis of pathogen virulence and toxin resistance; the structure, replication, and segregation of chromosomes; and processes contributing to adaptation and reproductive isolation in *Drosophila*.

**Population and Comparative Genomics**

Characterizing the patterns of genomic variation within and between species is a major goal of this research area. Faculty explore how these data can be used to test evolutionary hypotheses and identify genomic regions with unusual or novel functions. Researchers in this area work in a variety of systems, use the latest next-generation sequencing and genotyping technologies, and analyze data using bioinformatic and computational biology tools.
Solving the mysteries of health and disease requires leaders trained in both the methods of basic biomedical science and the methods of clinical medicine. Advances in biomedical knowledge require new patterns of training for physician/scientist researchers. To meet this challenge the MD/PhD Program combines the advantages of rigorous preparation in clinical medicine with interdisciplinary training in scientific research disciplines. The program design allows students considerable flexibility in arranging both the graduate and medical school phases of study.

Students in the program obtain their MD through the School of Medicine and may choose to pursue the PhD from one of the programs in the GDBBS. PhD studies also may be pursued in the Graduate School within one of its physical or social science departments, the School of Public Health, or the joint Department of Biomedical Engineering Emory shares with Georgia Tech.

The typical course of study for the combined degrees includes the first 18 months in the School of Medicine’s basic medical sciences and patient-based, clinical course curriculum, as well as six months of research and coursework designed to transition students to their graduate training program and project. The third through fifth years are spent in graduate training and the research required to obtain the PhD. The clinical education in the School of Medicine is then completed through approximately 18 months of required clerkships and elective courses. The clinical program is individually tailored—in consultation with the deans responsible for clinical education and student affairs—to fit each student’s educational needs and academic career goals. Additional MD/PhD programmatic activities, such as the MD/PhD Journal Club for M1/2 students, the MD/PhD Clinical Research Conference, the annual retreat, and numerous individual and group-mentoring meetings are planned throughout the year to provide a cohesive educational structure and environment for the program.

The MD/PhD Program provides the research training necessary to work at the forefront of a scientific field while concurrently developing outstanding clinical skills. Upon completion of the program, students receive appointments to the nation’s top residency and postdoctoral training programs, generally receiving their first choice of appointments. The profession looks to these individuals as leaders in delivering the latest discoveries to the bedside.

The MD/PhD Program is funded in part through the National Institutes of Health’s Medical Scientist Training Program. Additionally, funds from Emory University, the School of Medicine, and the Laney Graduate School support the program. Students accepted into the program receive full tuition and a competitive annual stipend.

Applicants desiring admission to the program should have an outstanding academic background. Evidence of strong research experience and a commitment to independent scholarship is essential in addition to the standard School of Medicine requirements.

Applicants to the MD/PhD Program should apply directly to Emory University School of Medicine through American Medical College Application Service (AMCAS). Applications may be received from June 1 to October 15. Applicants are encouraged to submit their applications early, preferably...
in the summer. AMCAS application packets may be obtained directly from the American Medical College Application Service, Association of American Medical Colleges, Section for Student Services, 2501 M Street NW, LBBY 26, Washington, D.C. 20037-1300, 202.828-0600, or from the health care professions advisor or the appropriate office at the applicant’s school. Upon receipt of the AMCAS application, candidates will receive access to the online Emory Supplemental Application Form, including an application to the MD/PhD Program.

MD/PhD applicants must submit their scores on the Medical College Admission Test in accordance with the admission policies of the School of Medicine. Applicants may choose (but are not required) to submit scores on the general test of the Graduate Record Exam (GRE). Graduate programs outside the GDBBS may have different application and GRE policies. Please inquire with the MD/PhD Program office about other graduate program application processes.

Applicants selected to interview attend a two-day session, which includes both the School of Medicine and Graduate School interviews. These interview sessions take place on the Emory campus from November through February in a rolling admission process.

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

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Kerry Ressler, the co-director of the program, is a Howard Hughes Junior Investigator.
Main cover image: John Nickerson and Micah Chrenek. Retinal pigmented epithelium from a donor that had advanced, age-related macular degeneration.