

**DO MORE**  
**THAN JUST**  
**RESEARCH**



EMORY

LANEY  
GRADUATE  
SCHOOL

# LEARNING THAT ADVANCES

At Emory, you'll do more than just scientific research. You'll investigate, innovate, and lead.

In Emory's Graduate Division of Biological and Biomedical Sciences (GDBBS), you'll benefit from the perspective of interdisciplinary learning, collaborate with global research leaders, and enrich your work with the resources of a major biological research center.

## Eight Interdisciplinary Programs

- 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

## Innovative Interdepartmental Training

Access research resources that span Emory University, our School of Medicine, and our affiliates.

- 300+ faculty
  - 30+ departments and research buildings
- |                                    |  |
|------------------------------------|--|
| -Biochemistry                      | -Epidemiology                                    |
| -Biology                           | -Medicine  |
| -Cell Biology                      | -Neurology                                       |
| -Human Genetics                    | -Pediatrics                                      |
| -Microbiology and Immunology       | -Psychiatry                                      |
| -Pathology and Laboratory Medicine | -Behavioral Sciences                             |
| -Pharmacology                      | -Psychology                                      |
| -Physiology                        | -Surgery   |
| -Anthropology                      | -Joint Georgia Tech-Emory Biomedical Engineering |
| -Chemistry                         |  |

## Unique Opportunities

Earn your PhD at Emory University, one of the major biological research and medical centers in the Southeast.

- More than 14,000 graduate, undergraduate, and professional students.
- Trends in NIH funding rank us among the fastest growing medical centers in the US.
- Nationally, over the past 10 years Emory typically has ranked 16th or 17th among medical schools that receive NIH research dollars.
- Emory has ranked at or near the top of institutions for students with NIH predoctoral fellowships.
- State-of-the-art facilities and investigators.
- Beautiful campus located six miles east of downtown Atlanta.

## World-Class Relationships

Work with world-renowned researchers located on or near our campus.

- American Cancer Society
- The Carter Center
- Centers for Disease Control and Prevention (CDC)
- Children's Healthcare of Atlanta
- Emory College of Arts and Sciences
- Robert W. Woodruff Health Sciences Center
- Rollins School of Public Health
- Veterans Administration Medical Center, Atlanta
- Winship Cancer Institute
- Yerkes National Primate Research Center

## Exceptional Results

Our resources and faculty will train you to excel.

- Our 400+ students are primary or coauthors on more than 200 research papers or abstracts each year, all of which appear in the top journals, and more than half of which are published in the top 7 percent of journals in the biological sciences (based on the impact factor).
- Our students are prepared for careers including faculty and postdoctoral positions at top research universities, working in prestigious institutions such as the CDC and the National Institutes of Health, and positions in government and the pharmaceutical industry, as well as careers in scientific communication, public policy, and research administration.

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At Emory we have a broad focus on student training. Our goal is to challenge trainees within the context of their research and also provide resources to train them in the skills required for success in a variety of biomedical career tracks. An example of this commitment is our 20-year history of training students with a rigorous formal scientific writing course that complements the individual training students obtain from their PhD mentor in how to compose a scientific paper or proposal. Students benefit from well-rounded training that goes beyond the design, execution, and interpretation of experiments to acquire critical complementary skills in scientific writing, communication, and networking that are absolutely essential for success in biomedical science.”

—Anita Corbett  
Professor of Biology

## Distinctive Research Resources

### The Transgenic Mouse and Gene Targeting Core

provides services to aid in the generation, transfer, or preservation of genetically altered mice. Its services include standard and BAC (bacterial artificial chromosome) transgenics, blastocyst injection, in vitro fertilization, embryo re-derivation, embryo or sperm cryopreservation, and now CRISPR/Cas9 injection, which can make precise changes in the DNA of living cells.

Our **Center for Systems Imaging** is a cross-disciplinary scientific, administrative, and educational home for imaging science. The center supports the advancement of scientific research focused on the development of imaging biomarkers, provides core services for animal and human imaging studies, and builds cross-cutting educational symposia and training programs.

### Emory Integrated Core Facilities

provide equipment and services for researchers throughout Emory University. The 14 core facilities encompass imaging, immunotherapy, genomics, proteomics, flow cytometry, transgenic mouse and animal models, electron microscopy, cancer tissue, biomarkers, and flow cytometry.

The **Emory Vaccine Center** is a center of academic research and vaccine development for chronic and infectious diseases. With more than 250 faculty members and staff, and labs in Atlanta and New Delhi, it's the largest and most comprehensive academic vaccine research center in the world.

The **Yerkes National Primate Research Center** conducts basic science and translational research to advance scientific understanding and to improve the health and well-being of humans and nonhuman primates.

# Modern, Multidisciplinary Training

At Emory, you'll benefit from a well-defined course of study, a smaller cohort of entering students in each program, and a community of faculty who are invested in the success of our students.

Our eight interdisciplinary and interdepartmental training programs each lead to a PhD, and 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 enter one of the eight 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, and students usually complete the coursework requirements prior to the end of the second year of study.

You'll develop a broad, multidisciplinary background, and master advanced concepts in your chosen field. And, you'll benefit from modern, competitive training that can offer you more than study in a traditional single-departmental program.



## Emory University

Train at the epicenter of scholarship and research

Ranked among the top 25 research universities in the nation, Emory leads in teaching, research, scholarship, health care, and social action among the world's top universities. Home to two undergraduate colleges as well as graduate and professional programs in law, business, nursing, theology, medicine, public health, and graduate studies, Emory also houses the most comprehensive health care system and sponsored research base of any university in Georgia. Distinctive among America's

top research universities for its culture of collaboration, Emory has close to 8,000 undergraduates and nearly 7,000 graduate and professional school students, with every state and more than 100 countries represented in the student body. Recognized for a commitment to sustainability as well as a dedication to service, our community is vibrant and engaged, and known for making positive change in the world.



## The City of Atlanta

Take advantage of our progressive, global city

Our 704-acre campus is located in a historic neighborhood six miles from downtown Atlanta. A progressive, global city, Atlanta is the business, tech, and health care center of the Southeast, giving you many ways to learn, gain experience, and have fun while you're here. The city is home to internationally known educational facilities such as the Jimmy Carter Presidential Center and Library, the Martin Luther King Jr. Center for Nonviolent Social Change, and the National Center for Civil and Human

Rights. Arts in Atlanta include the Atlanta Ballet, the Atlanta Symphony Orchestra, the Alliance Theater, and the High Museum of Art. The Atlanta Botanical Gardens, Zoo Atlanta, and the Georgia Aquarium are also located here. Atlanta has three professional sports teams and is easily accessible by a convenient bus and rail system. For outdoor activities, the Appalachian Mountains are located just north of the city, and Atlantic and Gulf Coast beaches are just a few hours away.

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There are several things that distinguish Emory from many other graduate programs. Our philosophy at both the faculty and program level is to invest in our students and commit all our resources to helping each student fulfill their potential. This is achieved through assistance with academic studies, an emphasis on mentoring at various levels, and also through professional development activities like our grant-writing courses and opportunities to investigate different careers and prepare for them.”

—Eddie Morgan,  
Professor of Pharmacology



## Focused Career Development

The Graduate Division of Biological and Biomedical Sciences and Laney Graduate School have a strong focus on career development, and our Professional Development and Career Planning program helps position our well-rounded and competitive candidates for a wide variety of fields.

### Targeted Career Resources

- Grant Writing
- Strategic Communication including:
  - Three-Minute Thesis Competition
  - Potential Matters
  - Communication training events
- Career Exploration including:
  - The Versatile PhD
  - Pathways Beyond the Professoriate
  - Campus Connections
  - Career Exploration Group
  - Career Exploration Events
- Career Resources including:
  - Mentors on Call
  - Interfolio
  - Career resources events
- Professional Development Support Funds

Information on our career development resources can be found at [www.gs.emory.edu/professional-development/career-exploration/index.html](http://www.gs.emory.edu/professional-development/career-exploration/index.html).

### Training for Your Future

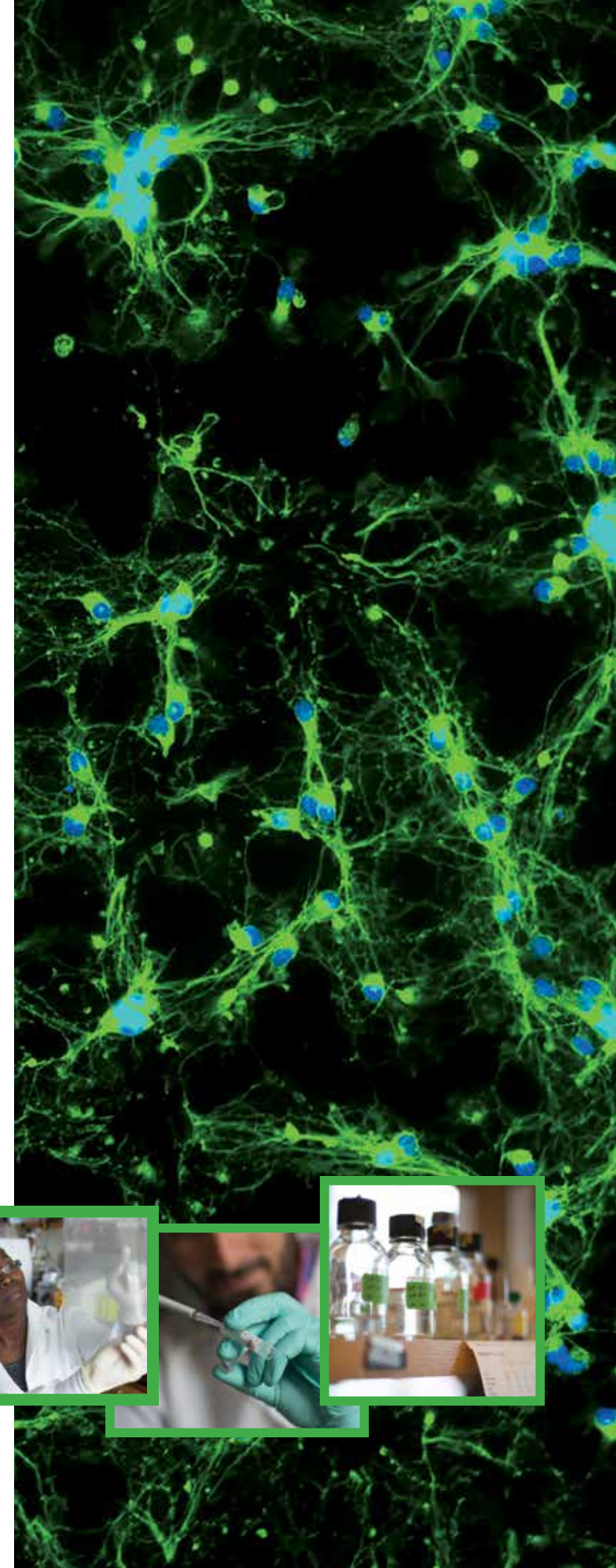
All Graduate Division of Biological and Biomedical Sciences students receive training in scientific communication, in part through a **grant writing class**. Through this class, students learn tools for effective communication in both academic and nonacademic research venues, while also honing their skills in hypothesis testing. Many students are able to submit those proposals for extramural funding through agencies including the National Institutes of Health, the American Heart Association, and the National Science Foundation. In recent years, Emory has ranked at or near number one for the most NIH individual predoctoral training grants (so-called F31 grants) received by our students. Obtaining such extramural funding helps to set our students on a path of success, differentiating them from students at other institutions.

Through **Mentors on Call**, students can access a searchable database and contact appropriate alumni who can provide important guidance on activities such as preparing CVs, managing work/life balance, and negotiating salaries. In **Pathways Beyond the Professoriate**, alumni from a variety of fields return to Emory to network with students to help them identify positions they may not have considered, and to discuss their own career pathways. The focus of the **Versatile PhD** is to help graduate students identify and prepare for possible nonacademic careers.

The NIH-funded **IMSD program** (Initiative for Maximizing Student Development) is a reflection of our commitment to increase the diversity of the scientific workforce. The program focuses on multilevel mentoring, research integrity, and career preparation and planning to foster competitive graduate school and postdoctoral applications. Fellows are appointed to the grant, but all students are welcome to attend program events and workshops ([imsd.emory.edu](http://imsd.emory.edu)).

The **joint master of science in clinical research** is available to PhD students who desire comprehensive training in clinical and/or translational research. An additional year of coursework is required. The degree will prepare students to participate in large clinical studies and to engage in research that will translate the findings from the research laboratory to the patient's bedside.

The **Certificate in Translational Research** program is a multidisciplinary program of the Emory Laney Graduate School for PhD students, Emory postdocs, and faculty members who seek to conduct research at the interface between basic science and clinical medicine.





The **Center for Science Education** has developed a new Teaching Certificate program to train PhD students to teach science at all levels. Courses, seminars, and practical teaching experience will be part of the curriculum.

The **Molecules to Mankind** pathway (M2M) is a distinct pathway that involves two existing PhD programs for each student, one in laboratory science and one in population science. M2M students are admitted to one of the PhD programs and then choose a second mentor in the other program.

The **Master of Arts in Bioethics program** at Emory University's Center for Ethics provides rigorous, advanced, and interdisciplinary training for professionals and students interested in social and ethical challenges in health care and the life sciences. Students in the program are connected with a dynamic network of experts, like-minded professionals, scholars, and resources in order to prepare themselves professionally to address ethical considerations in biomedicine.

Some students take advantage of **courses offered in other departments and disciplines**. Students have taken courses in areas including business, law, public health, and math and computer science while pursuing a PhD. Other courses at Georgia Tech also are available through the ARCHE program. New cross-disciplinary programs also are now being developed in big data, microbiome research, and other

areas. The Laney Graduate School also offers the Jones Program in Ethics, which provides students with cross-disciplinary and field-based ethics training, and the Teaching Assistant Training and Teaching Opportunity (TATTO), which provides a general course in teaching, experience as a teaching assistant, and mentoring opportunities.

Emory also offers a **combined MD/PhD program** that provides students the opportunity to acquire both clinical and basic research training in order to pursue careers in academic medicine. Students are enrolled in both the Laney Graduate School and the School of Medicine throughout the approximately eight years required to complete the program. Applicants to the MD/PhD program apply to the medical school through AMCAS. For more information, visit [med.emory.edu/MDPHD/](http://med.emory.edu/MDPHD/). There are many **student groups focused on career development or support**, as well as community service. SciComm was created to foster the development of professional science writers at Emory University. SciComm is dedicated to providing an open venue where young scientists can participate in the creation of popular media including writing, editing, publishing, photo, video, podcasts, and design, and learn from guest speakers and workshops. Students also publish in both the student and alumni newsletters. ESCAN (Emory Science Advocacy Network) is a graduate student group that seeks to promote biomedical research funding through advocacy and education. The Divi-



## Experience That Sets You Apart

sion Student Advisory Committee consists of a representative from each of the eight graduate programs and is charged with working with the Graduate Division of Biological and Biomedical Sciences director to address student concerns and other issues. In addition, they sponsor regular student functions that help build a sense of community and interactions among and between programs. The Black Graduate Association has been established to serve as a foundation for building unity, support, and academic excellence among African American students as well as the greater Emory community. The mission of the Latina/o Graduate Student Association is to build, sustain, and connect the Latin community at Laney Graduate School, at Emory University, as well as the greater Atlanta area. The mission of **GIVE** (GDBBS Involved in Volunteerism at Emory) is to foster civic responsibility and engagement from the Graduate Division of Biological and Biomedical Sciences community through outreach activities organized by faculty, staff, and students. The activities planned by this organization hope to foster a spirit of altruism and the development of a deeper connection within our communities by donating our time, efforts, talents, leadership, and service skills.

Students also have numerous opportunities to enhance their teaching

skills and engage students. There are several **teaching and mentoring fellowships** available, and students have taught through SIRE (Scholarly Inquiry and Research at Emory); OLLI, which is a continuing education program for those who are 50+; and Emory's Pre-College program for high school students.

Information on our career development resources can be found at [biomed.emory.edu/academics/index.html](http://biomed.emory.edu/academics/index.html).

Students in GDBBS programs receive training in critical thinking, creative problem solving, effective communication, and technical skills relevant to their field, all in preparation for exciting careers in academic or nonacademic venues. Some of our students continue their training as postdoctoral fellows at top research institutions around the world. Other students go on to positions in industry, in scientific communication, in public policy, in commercialization, in education and outreach, in nonacademic lab science, and more. Our goal is to help you acquire the skills needed for success in the career of your choice."

—Nael McCarty,

Professor of Pediatrics, Emory University School of Medicine



# Biochemistry, Cell, and Developmental Biology

The program in Biochemistry, Cell, and Developmental Biology (BCDB) has a foundation in multidisciplinary approaches to biomedical research. BCDB encompasses state-of-the-art research in combination with innovative coursework emphasizing the mastering of primary scientific literature and training in professional development. BCDB faculty members are affiliated with multiple University departments, including basic science and clinical departments of the Emory School of Medicine and the Departments of Biology and Chemistry of Emory College. Graduates of the BCDB program are well positioned for careers in diverse settings.

## Educational and Research Opportunities

The first year of the BCDB program curriculum centers on a unique, intensive, small-group-discussion course, Foundations in BCDB, that covers key concepts and methods in the basic sciences. First-year students also participate in three research rotations, which provide hands-on research training and are designed to help students identify the lab and mentor for their dissertation research. The second-year curriculum includes a rigorous grant proposal writing course designed to train students in scientific writing and hypothesis design. Students also receive formal training in statistics.

Students begin their thesis research at the end of the first year. Additional training opportunities are provided (including program symposium, program retreat, seminars, journal clubs, and more) and are designed to fit into the schedules of upper-level students. BCDB is multidisciplinary, and one of the strengths of the program is the ability to combine multiple approaches to focus on areas of research that both address fundamental scientific questions and also have relevance to human disease. The areas of concentration in BCDB include these below.

## 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 intercellular junctions.

## Cell Biology

In cell biology, the focus is on the fundamental aspects of cellular behavior and regulation. Cell biology also serves as a link between biochemistry and developmental biology. Research groups in the BCDB program address many of the key questions of cell biology, ranging from the control of gene expression to understanding how cells interact to physiologically integrate their function. The laboratories of BCDB faculty use advanced molecular, genetic, computational, super-resolution, and live cell-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.

## Julia Omotade

Biochemistry, Cell, and Developmental Biology  
Fifth year

Fascinated by the “elegance and complexity of the brain,” Julia was drawn to study the cellular mechanisms that underlie synapse development and dysfunction. She chose Emory for her PhD study because it was evident from the beginning that the “BCDB program provides an excellent environment to learn and grow as a scientist. Moreover, Emory is at the forefront of providing students with tools that will help their professional development.”

**After Emory:** “My career goal is to become a principal investigator and faculty member at a leading research university.”



The 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.

## Cancer Biology

Research in cancer biology by BCDB faculty 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. Cancer biology research in BCDB incorporates all of the other disciplines represented in the program. In this way, cancer research in BCDB focuses on understanding the mechanistic framework for misregulation of cell growth and differentiation as a means to define potential therapeutic targets. Program members offer training opportunities in areas of cancer biology including signal transduction, function of 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.

## Developmental Biology

Developmental biology is an integrative area of biological research that aims to understand how an organism can develop from a single cell into a multicellular organism consisting of differentiated cells performing unique functions. Developmental biology also has relevance to how these processes promote healing and wound repair, as well as understanding the pathology of disease. Research in the BCDB program represents a diverse array of developmental processes, including pattern formation, cell-fate determination, organogenesis, cell migration, cell differentiation, and epigenetic regulation of gene expression. Researchers in BCDB use multiple state-of-the-art model organisms to study these processes, including *Drosophila*, *C. elegans*, *Xenopus*, zebrafish and mice, which is a significant strength of the program.

To learn about our Biochemistry, Cell, and Developmental Biology faculty, visit [biomed.emory.edu/BCDB\\_faculty](http://biomed.emory.edu/BCDB_faculty).





# Cancer Biology

The program in Cancer Biology (CB) provides outstanding training opportunities in every aspect of cancer research, from basic to translational, and clinical. 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. Students present their research findings at a weekly research-in-progress seminar series. The Winship Cancer Institute is a great resource for graduate students in the CB program. The institute hosts weekly seminars at the Elkin Cancer Biology lecture series 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 Graduate Division of Biological and Biomedical Sciences programs, and departments at Emory. The institute has several on-site, shared-resource laboratories to facilitate research, including cores in bioinformatics, imaging, animal models, 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 dysregulated transcription, an important component of tumor biogenesis. Complementary investigations 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 intracellular, cell-cell, and cell-matrix 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 uses the knowledge acquired from the study of cancer formation to develop novel therapeutics. These research teams investigate diverse molecular targets to discover various anticancer chemicals and test those candidate 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.

To learn about our Cancer Biology faculty, visit [biomed.emory.edu/CB\\_faculty](http://biomed.emory.edu/CB_faculty).



## Scott Wilkinson

Cancer Biology  
Sixth year and recent graduate

At Emory, Scott values the level of autonomy he has to develop and hone his own graduate career path, as well as the unique training within the Winship Cancer Institute. "In addition, the Cancer Biology program sponsors the Clinical Cancer Colloquium course, where we learn from clinicians and patients and hear directly about the consequences of a cancer diagnosis and cancer treatments."

**After Emory:** "My plans after graduation are to complete a postdoc and ultimately become an independent PI at a leading academic research institute. I currently have postdoc offers at the National Cancer Institute in Washington, D.C.; St. Jude in Memphis; the Scripps Research Institute in La Jolla, California; and Memorial Sloan Kettering in New York City."



# Genetics and Molecular Biology

The program in Genetics and Molecular Biology (GMB) offers exciting, broad-based training in the fields of genetics and molecular biology and their related disciplines. The program's faculty offer a wide range of research opportunities that combine strengths in model genetic systems with research in human disease. Students gain an essential foundation in genetics that is immediately applicable to research in human disease.

## Educational and Research Opportunities

Students obtain a strong knowledge base through introductory coursework, and a variety of practical research experiences during lab rotations, before choosing a lab for their dissertation research. Students further tailor their curriculum through advanced courses that emphasize hypothesis design and critical thinking, statistical analysis of data, critical 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 topic, approach, and model organism. The six major areas of the program are summarized below.

## 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. GMB students use a variety of techniques and systems to investigate 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 roles in disease and cancer.

## Regulation of Gene Expression

The regulation of gene expression is the key to adaptation and normal differentiation and development. Developmental disorders and tumors arise from abnormal gene regulation. GMB student research in this area focuses on the molecular mechanisms behind the genetic and epigenetic control 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 basis for development and cellular differentiation is key to defining many disease processes. GMB students use a variety of model organisms to investigate the networks of molecular processes that guide the formation of multicellular organisms. Topics include muscle development, sperm development and fertilization, and germ cell specification and maintenance in *C. elegans*; development of the nervous system and sensory organs in mouse, *Drosophila*, and zebrafish; and the genes regulating formation of the *Drosophila* and mammalian eye.

## Cancer Genetics and Biology

Cancer is a disease with both genetic and epigenetic origins. Alterations in genome integrity such as changes in DNA ploidy, chromosome rearrangements, genetic deletions, and point mutations are observed in tumors. Defective epigenetic regulation of genes controlling cell proliferation and genome repair can also drive carcinogenesis. 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 faculty are members of the Winship Cancer Institute, an NCI-designated Cancer Center, which allows comprehensive training from the bench to the clinic.



## Crystal Grant

Genetics and Molecular Biology  
Third year

Crystal appreciates Emory's ability to create a forward-thinking graduate division, one that is working to accommodate students' shifting interests and a changing job market. "Students need and want to have the opportunity to have internships or other experiences outside academia before finishing their PhD, and they need to be able to perform data analysis and communicate clearly with non-scientists and scientists alike, all in addition to being excellent lab scientists with stellar publication records."

**After Emory:** "I'm interested in science policy and advocacy."

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 has brought 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 science faculty 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 such as autism and other behavioral 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 used by GMB students to assess the genetic and environmental factors involved in disease traits.

## Bioinformatics and Comparative Genomics

GMB students collect, develop, and analyze genome-based data sets to investigate genome evolution, the occurrence of genetic variations in human disease genes, the identification of disease traits, and the predictive nature of complex genomic analyses. State-of-the-art facilities aid our students in investigating gene-expression profiles, copy-number variation, genetic polymorphisms, and transcription factor binding patterns across the genome, using advanced DNA and RNA sequencing technologies.

To learn about our Genetics and Molecular Biology faculty, visit [biomed.emory.edu/GMB\\_faculty](http://biomed.emory.edu/GMB_faculty).







# 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.

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.

## 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 adviser 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 advisers 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.

## Immunobiology

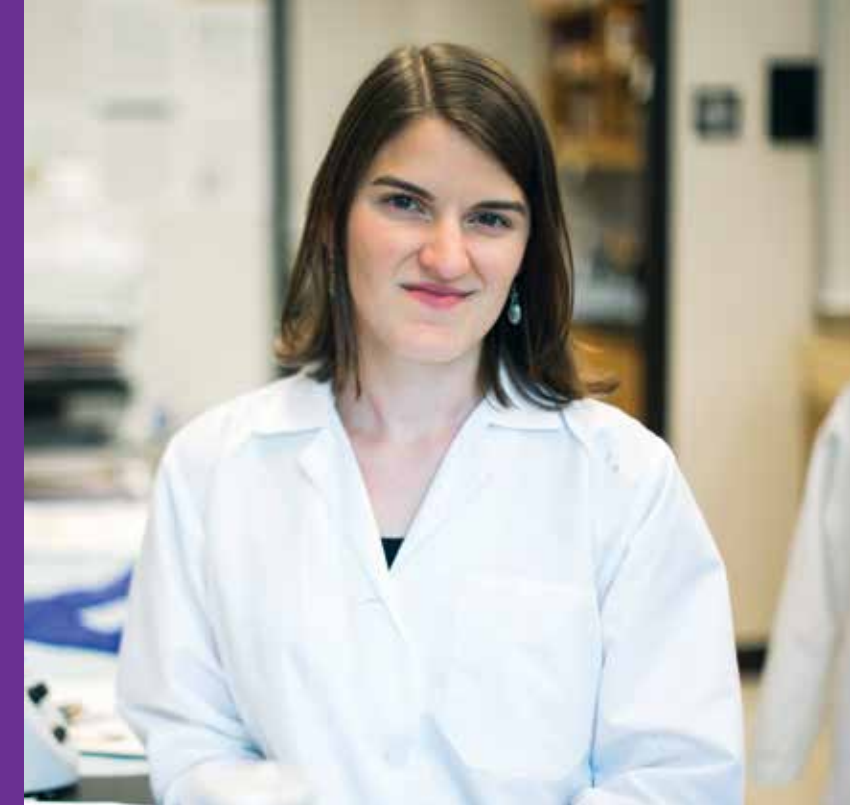
Research interests of the IMP immunology faculty cover a large spectrum of this broad scientific discipline. Topics include the molecular regulation of gene expression, regulation of immunological memory, tumor immunology, autoimmunity, mucosal immunology, innate immunity, transfusion immunobiology, 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.

## Madelyn Houser

Immunology and Molecular Pathogenesis  
Fourth year

Madelyn was attracted to Emory by the quality of the research being done within the IMP program. Outside the lab, she's involved in the IMP community. "This past year, I helped to found the Immunology Graduate Group, a student-run organization that enriches the IMP students' experience through social events, professional development opportunities, increased interaction with students in other programs, and greater representation of student perspectives to the program administration."

**After Emory:** "I plan to seek out a postdoctoral position, and I am interested in remaining in academia, either as an independent researcher or a staff scientist."



## 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

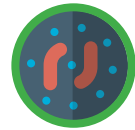
being studied include *Salmonella*, *Listeria*, *Neisseria*, and *Mycobacterium tuberculosis*. Protozoa pathogens being studied include malaria.

## 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.

To learn more about our Immunology and Molecular Pathogenesis faculty, visit [biomed.emory.edu/IMP\\_faculty](http://biomed.emory.edu/IMP_faculty).





# 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 members are well funded and have 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, basic 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 presentations. After these talks, first-year students choose at least three research rotations that 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, as well as writing grants 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 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

consists of faculty chosen by the student and 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.

MMG faculty contribute to and have leadership positions in the Emory Antibiotic Resistance Center and an NIH/NIAID training grant (Antimicrobial Resistance and Therapeutic Discovery Training program) that supports students in GDBBS programs, including MMG.

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, Caltech, UCSE, the CDC, the National Institutes of Health, and the Food and Drug Administration.

## Elizabeth Littauer

Microbiology and Molecular Genetics  
Fifth year

Elizabeth praises the spirit of mentorship and encouragement among faculty and students here, saying, "It's very important to me to represent the students of my program on the MMG Executive Committee and also in the Atlanta Society of Mentors." She says she chose Emory "both because of its global significance in virology research and vaccine development and also for the collegiality I experienced during my interviews."

**After Emory:** "My career goal would be to lead a research lab as a principal investigator at a research university, hopefully focusing on viral structure and pathogenesis in the respiratory tract."



## Three Areas of Dissertation Research

### Gene Expression and Physiology of Bacteria and Viruses

Research in this area involves the regulation of genes involved in antibiotic resistance, virulence, motility and the differentiation of microbes, as well as viral multiplication and host genes influenced by the environment and during infection. Microbes are used to study fundamental physiological processes including sporulation, antibiotic resistance, transport, biofilm formation, bacterial communication systems, and metabolism. Research in virology focuses on fundamental aspects of the biology of 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

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 Escherichia coli*, *Proteus spp*, *Staphylococcus aureus*, *Clostridium difficile*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Burkholderia cepacia* complex, *Helicobacter pylori*, and *Mycobacterium tuberculosis*), use of microbial genomics to understand mechanisms of virulence and antibiotic resistance, and how bacteria evade host defenses. MMG faculty also investigate the microbiome in health and disease.

### Viral Pathogenesis

MMG faculty with interests in virology conduct basic research that addresses important, contemporary problems in the areas of antiviral development, mechanisms of antiviral resistance and transmission, viral replication, roles of viruses in oncology, 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. Viruses important for human disease that are investigated include HIV/AIDS, Zika, West Nile, and influenza.

To learn more about our Microbiology and Molecular Genetics faculty, visit [biomed.emory.edu/MMG\\_faculty](http://biomed.emory.edu/MMG_faculty).





# Molecular and Systems Pharmacology

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).

Pharmacology is an exciting field of study for students with diverse undergraduate science backgrounds, including chemistry, biology, biochemistry, molecular and cellular biology, physiology, neuroscience, or psychology. If your undergraduate background is in any of these areas, and you are intrigued by the idea of pursuing a field of study that integrates and broadens your understanding of biological processes to help develop new therapeutics, then you should consider the program in Molecular and Systems Pharmacology (MSP).

## Training for Many Career Paths

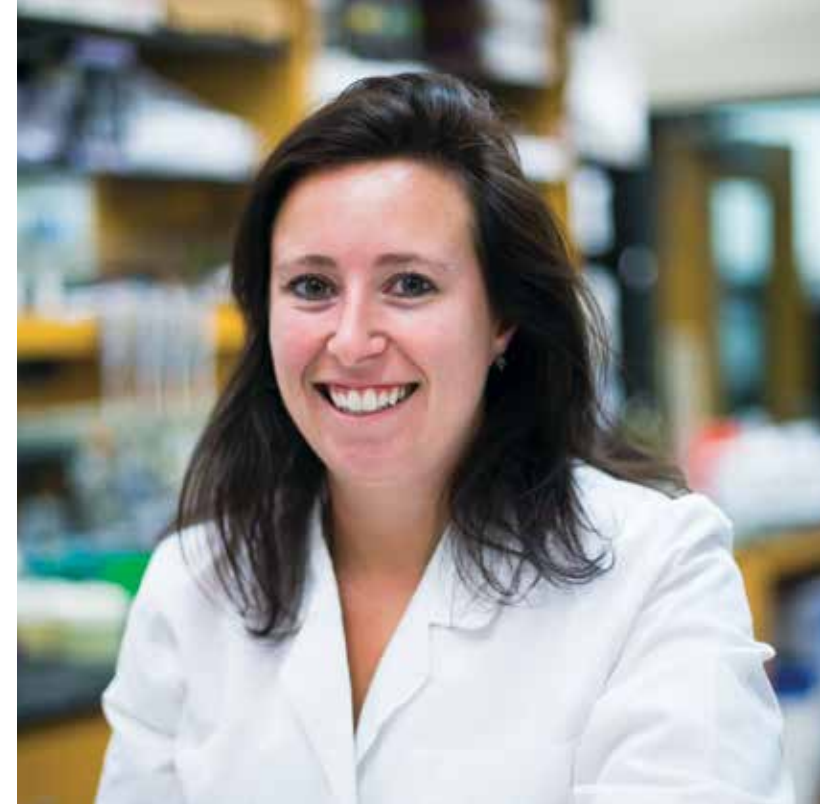
A graduate of the MSP program emerges with broad training in basic biomedical sciences, encompassing such disciplines as biochemistry, molecular biology, physiology, and neuroscience, and also has training and expertise in the specialized principles and approaches of pharmacology. This combination is increasingly sought after by the pharmaceutical, biotechnology, and government sectors, as well as being excellent preparation for an academic or nonacademic career. The program also offers specializations in toxicology, which focus 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 variety 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 neuropharmacology, cancer pharmacology, AIDS research, blood disorders, cardiovascular biology, endocrinology, toxicology, structural biology, and chemical biology.

## Understanding How Therapeutics Work

Many MSP labs focus on studying key targets for therapeutics such as cell surface receptors, neurotransmitters, transporters, ion channels, intracellular signaling pathways, and factors regulating phosphorylation and gene expression. This mechanistic research provides insights into the pathogenesis and treatment of diseases such as cancer, epilepsy, atherosclerosis, drug addiction, neurodegenerative disorders, and cystic fibrosis.



## Lauren Shapiro

Molecular and Systems Pharmacology  
Fifth year

Lauren loves that at Emory she has “the flexibility to rotate in any lab where the PI is associated with GDBBS,” she says. “For students like myself, who have interdisciplinary interests, having unfettered freedom to explore labs allows for greater self-discovery and a more personalized rotation experience.” She chose Emory because the Molecular and Systems Pharmacology program is “incredibly interdisciplinary and allows students to study pharmacology in the context of cancer research, gene therapy, cardiovascular research, and neuroscience.”

**After Emory:** “I plan to pursue a postdoc with the ultimate goal of teaching at the undergraduate level.”

## 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.

## Novel Therapeutic Approaches

MSP faculty and students work to identify novel molecular drug targets for the development of new therapies that treat many different types of diseases. These studies include new approaches for treating inflammation, cancer, and viral infections, as well as cutting-edge approaches to gene therapy. Moreover, the new Drug Discovery Center provides faculty and students with state-of-the-art resources to discover 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.

To learn more about our Molecular and Systems Pharmacology faculty, visit [biomed.emory.edu/MSP\\_faculty](http://biomed.emory.edu/MSP_faculty).





# 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.

## Educational and Research Opportunities

The first-year core curriculum focuses on basic cellular, molecular, and systems neuroscience, coupled with research rotations that lead to selection of a thesis adviser. Subsequent years of study are flexible and can be tailored to each student's specific interests and individualized program of study. The program's research is highly interactive, with multidisciplinary collaborations between investigators and students. A hallmark feature of the Neuroscience program is leveraging the breadth of the program's interdisciplinary research to generate compelling thesis projects.

## Neuroscience Program Research Portfolio

Research in the Neuroscience 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 neuroscience 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 Department of Psychiatry and Behavioral Sciences 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, the neuroinflammatory 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.

### Molecular, Cellular, and Developmental Neuroscience

The faculty uses a broad range of experimental approaches to assay function. They include molecular, proteomic, biochemical, pharmacological, electrophysiological, imaging, drug discovery, and computational modeling. Areas of specialty among faculty include apoptosis, axon growth and guidance, G protein-coupled receptors, signal transduction and  $Ca^{2+}$  signaling, homeostatic and Hebbian synaptic plasticity, ion channel structure and function, mitochondrial impairment and oxidative stress, protein synthesis and transport, neurovirology, membrane transporters, and also vesicle trafficking and synaptic transmission. 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.

## Desiree De Leon

Neuroscience  
Third year

Desiree appreciates the collaborative, interdepartmental structure of GDBBS. "There's a great degree of flexibility," she says, "and the fact that you end up working alongside students who are trainees of many different programs is also great for collaborating and bringing diverse training expertise to your own project." She came here because "Emory has excellent science," she says. "On top of that, Emory neuroscience also has a strong culture of student involvement and a progressive approach to graduate training beyond the lab bench."

**After Emory:** "My goal would be to curate a science museum or continue the legacy of Bill Nye the Science Guy's awesome science videos with some sort of science-media career."



## Neuroengineering and Computational Neuroscience

Neuroengineering and computational neuroscience attract a large community of investigators, including many in the renowned joint Emory/Georgia Tech Biomedical Engineering department and the Department of Biology at Emory. Areas of research encompass a diverse set of approaches in which mathematical, computational, and engineering applications are used to understand the nervous system better. Computer-modeling studies range from simulation of ion channel kinetics; to biologically realistic single-neuron models in basal ganglia, cerebellum, and spinal cord; to network models of invertebrate pattern-generating circuits. Scientists also study the principles underlying the neuronal computation of movement and models of information processing that include those of cognitive processes. Additional experimental approaches in this research category include the design of bioactive scaffolds, injury biomechanics, and tissue engineering. The creation of hybrid systems that interface neurons with computer-simulated or microengineered components are being implemented in closed-loop stimulation and recording technologies. Researchers are also further refining noninvasive biomedical imaging techniques in primates and rodents, including techniques in magnetic resonance imaging (MRI) (functional MRI [fMRI] and diffusion tensor imaging [DTI]) and radiotracer development in positron emission tomography (PET) and single photon emission computed tomography (SPECT).

## Systems, Behavioral, and Cognitive Neuroscience

There is also very strong faculty representation in the systems, behavioral, and cognitive neuroscience research category. Commonly used experimental approaches embrace imaging (fMRI, 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.

To learn more about our Neuroscience faculty, visit [biomed.emory.edu/NS\\_faculty](http://biomed.emory.edu/NS_faculty).



# Population Biology, Ecology, and Evolution

The program in Population Biology, Ecology, and Evolution (PBEE) integrates biological mechanisms across many levels of organization—from genes underlying complex traits to interactions between species in complex ecosystems. The central goal of the PBEE graduate program is to provide the multidisciplinary training required for a successful career, with emphasis on quantitative skills that can be applied broadly. Students can pursue careers in teaching, in academic research, in government, or in industry depending on the focus of their individual course of study and goals.

## Educational and Research Opportunities

Core courses and seminars provide a common background for all students. Research opportunities are tailored for each student. First-year rotations allow students to work with 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, microbes within a microbiome). 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.



## Erica Harris

Population Biology, Ecology, and Evolution  
Fourth year

Erica was introduced to Emory through participating in the University's Summer Undergraduate Research Experience program in her current lab. "I also really admired the depth of the Population Biology, Ecology, and Evolution program in disease ecology, as it has a strong emphasis on quantitative and molecular techniques while asking questions rooted within a natural ecological evolutionary context."

**After Emory:** "My short-term plan is to obtain a postdoctoral research position in a lab that examines how different environmental factors influence animal gut microbial communities. My long-term plan is to obtain a research or teaching position at a university."

## 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 faculty in 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 high throughput sequencing and genotyping technologies, and analyze data using bioinformatic and computational biology tools.

To learn more about our Population Biology, Ecology, and Evolution faculty, visit [biomed.emory.edu/PBEE\\_faculty](http://biomed.emory.edu/PBEE_faculty).



## Ryan Martinez

Immunology and Molecular Pathogenesis  
Fourth year  
MD/PhD Program

Ryan chose the Immunology and Molecular Pathogenesis program because, he says, "it has many faculty experts in T-cell biology, and coming to Emory allowed me to work with many of these leaders in the field. I also found that the IMP students enjoyed being at Emory, which I feel revealed how the program supported and nurtured the students."

**After Emory:** "I will be going back to medical school this summer for graduation in 2018. I want to become a physician scientist at an academic institution."



## To Apply

### Admission Requirements

Students are admitted to the Graduate Division of Biological and Biomedical Sciences as trainees in one of the eight PhD training programs. It usually requires approximately five and a half to six 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 the preceding December 1. 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. All application material is due by the December 1 deadline.

Emory University values diversity. As a community we recognize that students from groups not traditionally present in the university bring new perspectives that enrich the fields of graduate study and enhance the educational experience of all students. We encourage applications from all qualified students, including minority students, economically disadvantaged students, and students with disabilities. The GDBBS has a proven track record of enrolling and graduating minority students, including ranking in the top 10 nationally for graduating African American students from our PhD programs.

### Degree Requirements

All students receive didactic instruction specific to their field. Coursework is kept to a minimum, such that students have the opportunity to learn from experience as they focus on their research endeavors. All programs emphasize learning how to think critically, solve problems, and answer important questions that are relevant to their field.

In addition to meeting the general requirements for the PhD, 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, receiving training through the "Teaching Assistant Training and Teaching Opportunity" (TATTO) program. 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 faculty who serve as members of, or consultants to, the review panels of these major research-funding institutions. These requirements provide our students with skills essential for success in academic or industrial research careers but often overlooked in graduate training programs.

### Financial Information

Students receive a tuition scholarship, a competitive stipend, health insurance coverage, and access to Professional Development Support funds. 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 Laney Graduate School 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.

### For More Information

Recruitment and Admission  
Graduate Division of Biological  
and Biomedical Sciences

Emory University  
1462 Clifton Road, Suite 314  
Atlanta GA 30322  
404-727-2547  
gdbbs@emory.edu  
www.biomed.emory.edu

## MD/PhD

The School of Medicine MD/PhD program provides the opportunity for exceptionally bright and dedicated students to acquire both clinical and basic research training in order to pursue challenging careers in academic medicine. The program is designed to provide students with the in-depth, high-caliber research training and medical education required of future leaders in biomedical research. Students are enrolled in both the Laney Graduate School and the School of Medicine during the approximately eight years required to complete both degrees in the program.

Solving the mysteries of health and disease requires leaders trained in both the methods of fundamental 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 a MD through the School of Medicine and may choose to pursue a PhD from one of the programs in the GDBBS. PhD studies also may be pursued in the Laney Graduate School within one of its natural, social science, or humanities departments; the School of Public Health; or the joint Department of Biomedical Engineering that Emory shares with Georgia Tech. Students complete rotations during their first two years and immediately begin their thesis research when they move to the PhD portion of their training.

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 a tuition scholarship and a competitive annual stipend.

Applicants 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 within the first two months of the opening date. Upon receipt and review of the AMCAS application, candidates will receive access to the online Emory Supplemental Application Form, including an application to the MD/PhD program.



# Graduate Division of Biological and Biomedical Sciences

Emory University is accredited by the Southern Association of Colleges and Schools Commission on Colleges to award associate, baccalaureate, master's, doctorate, and professional degrees. Contact the Commission on Colleges at 1866 Southern Lane, Decatur, Georgia 30033-4097, call 404-679-4500, or visit the web at [www.sacscoc.org](http://www.sacscoc.org) for questions about the accreditation of Emory.

Emory University is an equal opportunity/equal access/affirmative action employer fully committed to achieving a diverse workforce and complies with all applicable Federal and Georgia State laws, regulations, and executive orders regarding nondiscrimination and affirmative action in its programs and activities. Emory University does not discriminate on the basis of race, color, religion, ethnic or national origin, gender, genetic information, age, disability, sexual orientation, gender identity, gender expression, and veteran's status. Inquiries should be directed to the Office of Equity and Inclusion, 201 Dowman Drive, Administration Bldg, Atlanta, GA 30322. Telephone 404-727-9867 (V) 404-712-2049 (TDD).



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Emory University  
1462 Clifton Road, Suite 314  
Atlanta GA 30322  
404-727-2547  
[gdbbs@emory.edu](mailto:gdbbs@emory.edu)  
[www.biomed.emory.edu](http://www.biomed.emory.edu)