Opportunities in the fields of genetics and molecular biology in academia, government, and in the private sector have increased with the incredible acquisition of genetic information and the potential to use this information for developing novel medical therapies and diagnostic procedures. To use this information both today and in the future, there is a need to train the next generation of geneticists and molecular biologists with fundamental and cutting-edge skills. With this in mind, the goal and philosophy of the Genetics and Molecular Biology (GMB) Ph.D. training program at Emory University is to provide the best training in a particular core area of genetics and molecular biology while at the same time providing broad-based training in the related disciplines of biochemistry, cell biology, statistics, and bioinformatics. This training program draws its faculty and students from the interdepartmental graduate program in Genetics and Molecular Biology (GMB). The GMB program is highly interdisciplinary with its faculty coming from the ranks of 11 basic science and clinical departments. Our students have opportunities to perform genetics research in six core areas, including Bioinformatics and Comparative Genomics; Cancer Genetics; Control of Genome Integrity; Developmental Genetics and Differentiation; Epigenetic Regulation and Gene Expression; and Human Genetics. A host of model genetic organisms are used in these areas. The program offers a comprehensive curriculum that provides a solid foundation in classical and modern molecular genetics. Following a series of laboratory rotations, students begin their Ph.D. dissertation and engage in cutting-edge scientific inquiry. Training in scientific writing, oral presentation, and teaching is an integral part of the program. A career development series, exciting seminar series, student hosted speaker program, and annual scientific retreats provide opportunities for the students to gain experience as scientists, interact, and to develop to their maximum potential.

1. Coursework
The goal of our curriculum is to provide students with the basic knowledge and skill set to pursue doctoral dissertation research and a career in genetics. A series of required and elective courses taken over the first two years provides this foundation. A Table summarizing the required curriculum / schedule for the first two years is provided on the right. The average time to Ph.D. for GMB students in the last 10 years is 5.7 years.

2. Required Courses
*IBS 555 – Principles of Basic Biological & Biomedical Sciences I (Fall – 1st year)*; 6 credit hrs. This introductory course in biochemistry and molecular biology includes the following topics: nucleic acid structure and manipulation; protein structure, purification and properties; enzyme kinetics and mechanisms; carbohydrate and lipid structure and properties; transcription, translation, and DNA replication, repair, and recombination. A large number of GMB faculty teach in this course.
IBS 561 – *Eukaryotic Chromosome Structure and Function* (Spring – 1st year); credit 4 hrs. This course focuses on fundamental principles of genetics from the eukaryotes perspective and includes topics on: nucleosomes structure and function, euchromatin/heterochromatin, DNA methylation, silencing, imprinting, changes in chromatin organization and transcription, replication/repair, crossing over, gene conversion, and mutations.

IBS 546r – *Presenting Genetics* (Fall/Spring – all years); 1 credit hr. This is a multipurpose course and covers several aspects of student presentation training. In the first semester, the course has two goals. In September, the faculty present their research in 25 minute sessions to the students so that the students can pick rotation labs. For the remainder of the semester, the students are assigned a research paper from which they prepare a presentation to the class. This presentation is critiqued by the faculty teaching the course and by their peers. Thus, it is their first step in how to critique a paper and how to prepare a research talk. In the remaining semesters, students get credit for attending the GMB seminar series through this course title.

GMB 570r – *Introduction to Graduate Seminar* (Spring – 1st year); 2 credit hrs. The topics of this course rotate with the four faculty who volunteer to teach it. Each faculty is assigned three weeks of classes for which they organize a group of papers for the students to study, critique, and discuss. The format changes with the faculty but is never didactic in nature. Typically, the students have to present a paper to the group for discussion.

For the first semester, incoming students must choose between IBS 746 – Graduate Human Genetics and IBS 504 – Introduction to Prokaryotic Molecular Biology. Those students choosing one of these could take the other in their second year.

**IBS 746 – Graduate Human Genetics** (Fall – 1st or 2nd year); 4 credit hrs. Using Socratic discussions of primary literature and some didactic lectures, this course explores the fundamental principles of contemporary human genetics. Topics include: genes and chromosomes, regulation and epigenetics, Mendelian and non-Mendelian traits, human origins and genetic diversity, comparative genomics, clinical genetics, direct to consumer genetic testing, linkage and association studies, genes and environment, pharmacogenetics, behavioral genetics, and a short grant proposal activity.

**IBS 504 – Introduction to Prokaryotic Molecular Biology** (Fall – 1st or 2nd year); 6 credit hrs. This Socratic taught course uses the literature to examine fundamental principles in prokaryotic genetics. The topics include: DNA structure and synthesis; mutation, recombination, complementation, genetic analysis; phage, transduction, F plasmid and conjugation; plasmids, transposition, restriction and modification; and gene cloning and regulation. The students are required to participate in an active discussion of the assigned papers. It is their first real experience in reading and evaluating the literature.

**IBS 515 – Current Topics in Molecular Genetics** (Fall – 2nd year); 4 credit hrs. This course is unique among the graduate-level courses offered at Emory. Each year, a different area of genetics is chosen and funds are available to invite five prominent researchers who specialize in the chosen area. Prior to their visit, the speakers identify a small set of their publications for the students to read. The students enrolled in the course meet with a faculty organizer(s) of the course to discuss the papers. This is done in a “pass the pointer” style where the students present and discuss the work. After the visiting speaker’s formal seminar to the GMB program, the students meet with the speaker in an extended luncheon session to learn about the speaker’s career path and to hear about work going on in the speaker’s lab that is not quite ready for presentation. These close interactions have provided students with one-on-one connections that have led to postdoctoral appointments with the speakers.

**IBS 522r – Grant Writing and Professional Development** (Spring – 2nd year); 4 credit hrs. This new fast pace GMB course, which draws on an established course in the GDBBS, is specifically designed to teach students the basics of scientific and grant writing. The course focuses on the students own research project involving the development of a hypothesis, specific aims, and then a research strategy. The course is taught with the F31 NIH NRSA format as a guide and takes place in the spring prior to students submitting their dissertation
proposals during the summer of the second year (see below). Student proposals are reviewed and critiqued by a panel of faculty reviewers.

3. Elective Coursework
The GMB program and the GDBBS offer a large assortment of elective courses. Electives are taken beginning in the second semester. Lower level electives (500 level) are offered either every year or every other year; whereas 700 level electives are offered every 2-3 years. A list of electives is shown on the right.

4. Course Hours and Completion of Coursework
As illustrated in the “Genetics and Molecular Biology Program Coursework Table”, the curriculum for the first semester is fixed. Electives can be taken in the second semester and many of the students take IBS 524, Cancer Biology. After completing the first year, all graduate students must receive credit for 12 additional hours of formal coursework and 24 hours of dissertation research to reach candidacy. The large number of electives provides a great deal of flexibility in designing the advanced curriculum. Most students complete their course work by the end of year 2. Seminar attendance is required throughout their tenure in the program and students get credit for attending the seminar in IBS 546r, Presenting Genetics (described above). They also must complete our Responsible Conduct in Research requirement described below.

5. Teaching Assistant Training and Teaching Opportunity Program (TATTO) (2nd Year)
The Laney Graduate School requires that all Ph.D. candidates receive formal instruction and gain experience in teaching. This training helps students in their ability to function as teachers and to train them in the art of oral presentation, a skill required to communicate science. The Teaching Assistant Training and Teaching Opportunity Program (TATTO) is administered by the Laney Graduate School to provide teacher training and experience for doctoral students in the GDBBS. Successful completion of the TATTO program is a requirement for the doctoral degree. GMB students fulfill this requirement as follows:

- Students at the beginning of Year 2 attend a 2-day teaching training workshop sponsored by the Laney Graduate School (TATT 600). Topics include methods and ethics of teaching as well as content-specific practice sessions tailored to the discipline of the student.
- Each second year student is required to serve as a Teaching Assistant (TA) for at least one semester. Students may request specific undergraduate or graduate teaching assignments and every effort is made to grant these requests. The GDBBS evaluates the quality of the teaching experience via reports from the course directors.

Students who are interested in furthering their teaching experience and establishing additional credentials may request additional teaching experiences if they are making satisfactory progress in their dissertation research subject. These options include the following programs:

- **Paid teaching assistantships** offered through the GDBBS
- **Dean’s Teaching Fellows**: Dean’s Teaching Fellows have complete responsibility for a course in the award year.
- **On Recent Discoveries by Emory Researchers (ORDER)**: Graduate and postdoctoral students teach about their research to undergraduates.
- **Scholarly Inquiry and Research at Emory (SIRE)**: Graduate fellows are responsible for supporting undergraduate researchers in the SIRE program with educational programming and one-on-one mentoring.
• PRISM (Problems and Research to Integrate Science and Mathematics): This program offers annual fellowships to Emory University graduate students and middle/high school teachers to develop and implement innovative science and math lessons using problem-based learning. PRISM intends to influence the next generation of scientists by providing graduate students with opportunities to practice teaching, communication, and research dissemination skills, and by fostering scientific literacy in public school students.

• HHMI Curriculum Development Fellowships: Graduate students and postdocs work with faculty to develop new courses or enhance existing syllabi.

6. Additional Features of the GMB Program

Research Seminars: During the course of their graduate training, GMB students are provided with the opportunity to attend numerous seminars and lectures by visiting scientists. The GMB program sponsors an active seminar schedule that is held weekly. In addition to the GMB program, many of the other GDBBS programs and most departments sponsor seminar programs that are open to all on the campus. In addition, faculty searches in the Departments of Human Genetics, Biochemistry, Microbiology & Immunology, Cell Biology, and Biology have resulted in many seminars of interest to GMB students. These job candidate seminars are expected to continue over the next several years. A weekly e-mail posting by the GDBBS lists all seminars for the upcoming week.

Responsible Conduct in Research: The Emory Laney Graduate School has centrally organized a three-part requirement for training all of its graduate students in research ethics. The program consists of 1) PSI 600, Program for Scholarly Integrity; 2) a program specific course; and 3) a requirement for attendance at 4 PSI 610 workshops.

1) All GMB students take PSI 600, Program for Scholarly Integrity in their first year. This is a broad based course consisting of 6 one-hour sessions and focuses on recognizing research ethical issues among multiple disciplines; emphasizing the importance of scholarly integrity; how to face these issues; working through case studies; and how to meet the challenges of analyzing an ethical issue.

2) Because PSI 600 is a broad based course, all 1st and 2nd year students take an additional set of classes, which is part of GMB 706, Ethical Conduct in Research. GMB 706 focuses on issues associated with authorship, data manipulation, record keeping, data ownership, peer review and confidentiality, human and animal subjects research, and mentor/trainee rights and relationships. This set of classes meets biweekly in the spring semester and uses case studies and discussions led by student teams as a means to work through the issues being presented. The GMB faculty rotate through this with a new faculty rotating on and off as co-Director/Director each year.

3) As part of its program to provide some consistency across disciplines and programs, the Laney Graduate School organizes a series of workshops that consist of lecture and discussion on a broad array of topics that are centrally critical for trainees to develop principles in responsible conduct. Each student must attend a minimum of four of these workshops, which are recorded on their transcript. A list of the 2012-2013 sessions is presented to the right.

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<tr>
<th>LGS Research Conduct Workshops (2012-2013 Sessions)</th>
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<tr>
<td>• Ethics of Publishing in the Sciences</td>
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<td>• Mentoring</td>
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<td>• Ethical Issues Related to Research Collaborations</td>
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<td>• The Ethics of Teaching</td>
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<td>• The Lab: Avoiding Research Misconduct</td>
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<td>• Monstrously Bad Research Cases</td>
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<td>• The Ethics of Using Sources in Research and Teaching</td>
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<td>• Ethics in International Research</td>
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<td>• The Ethics of Big Data</td>
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<td>• Scholarly Misconduct in the Physical and Life Sciences</td>
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<td>• The Ethics of Using Animals in Research</td>
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Professional Development: The GMB program has initiated the incorporation of Individual Development Plans (IDPs) into the program’s graduate training. Students are both required and encouraged to develop a career trajectory roadmap using resources made available to them by the program and the Laney Graduate School (LGS). Within the program students are required by their second year to try the web-based career-planning tool that is available at myIDP.sciencecareers.org. This forms the basis for initiating the process of
making sure they are thinking about their near- and long-term goals. This is reinforced at their twice-yearly
thesis committee meetings in which they are required to present template slides that list a) their short term
experimental goals; b) their long term career goals, c) the milestones for these goals, and d) their progress
towards each specific goal. The GDBBS also provides a number of career planning and professionalization
workshops throughout the year, which are heavily promoted to the students who are strongly encouraged to
attend. The workshops titles have included: Professionalism, Individual Personalities and Dealing with
Different Personalities; Diversity, Teamwork, and Leadership to enable your career preparation;
Choosing Rotations, Informational Interview Techniques; Study Skills, Time Management, Professional
Expectations; and Choosing a Mentor, Selecting Advanced Courses, Finding Career Information (for
calendar of events go to http://www.gs.emory.edu/professional_development/program_calendar.html).
Finally, each year the GMB program has a retreat that features numerous social, scientific, and professionalization
roundtable discussions, workshops, or invited speakers that are designed for students to ask questions and
receive information about various career paths and details about those paths. The expectation is that students
will, from a mix of required and encouraged participation, be able to benefit from this important aspect of
graduate training without creating an imbalance with the many other requirements of their scientific training.

MILESTONES

1. Standards of Performance in Coursework: Students with an average semester grade of less than B, or
who receive a grade of less than B in a required course, are placed on academic probation, subject to review
by the Executive Committee. Students on academic probation due to their grade point average have one
semester to bring their GPA above the minimum. Those who have received an unacceptable grade may not
receive a grade less than B in any subsequent coursework. Failure to satisfy these criteria is grounds for
dismissal from the GMB program.

2. First Year Advising and Laboratory Rotation Program: The Director of Graduate Studies (DGS) of GMB
serves as the Advisor to all entering students. During the first year, each student is expected to perform
experimental work in the laboratory of three program faculty members. The rotations are scheduled in ~8 week
intervals. A fourth rotation may be performed if the student is still undecided. Students plan their laboratory
rotation program with the DGS. As discussed above in the description for Presenting Genetics, all first-year
students have the opportunity to meet with GMB faculty members in a formal research presentation setting.
This enables the students to familiarize themselves with the available research opportunities before choosing
their rotation laboratories. Five page research reports, evaluated by the DGS, are required from the student
after each rotation. The GMB website, http://www.biomed.emory.edu/PROGRAM_SITES/GMB/index.html,
provides descriptions of the research interests of the faculty. It should be emphasized that students are free to
rotate in the laboratory of members of the other programs in the GDBBS. If the student elects to perform
his/her dissertation research in the lab of a non-GMB faculty, the student can remain in GMB or switch to the
program most represented by that lab.

A number of students also elect to enter our EarlyStart program, in which they perform their first rotation in the
summer before officially matriculating. Stipends are provided. EarlyStart allows the beginning students to
settle in and complete a research rotation without having a course load. Two to three students take advantage
of this program each year.

3. Laboratory Assignment/Dissertation Research: At the end of the Rotation Program, students choose an
Advisor and negotiate acceptance into a laboratory. A “contract” is signed by the advisor to mentor and
support the student. Additionally, the GMB Director, the Director of the GDBBS, and the departmental chair
must approve this selection. In approving the decision, the departmental chair guarantees resources for
continuing financial support of the student if the advisor’s funding is lost.

4. Dissertation Proposal: GMB students compose a proposal that outlines the aims, background, and
experimental design of their dissertation research. The proposal may be produced as a requirement of the IBS
522r, Grant Writing and Professional Development course. The proposal will be submitted to the student's
dissertation committee, which is formed by April 1 or immediately after a student has passed their written
qualifying exam. A copy of the dissertation proposal will also be submitted to all members of the student's oral
qualifying exam committee at least one full week before their scheduled oral exam. Students may receive
advice on the contents of their proposal from any source, including their Dissertation Advisor. Dissertation committee members will provide critiques of the proposal and its content, with respect to organization, writing style, and the feasibility and value of the proposed science.

To help students with the preparation of their dissertation proposals the **IBS 522r, Grant Writing and Professional Development** course was developed and instituted in 2012. Using a standard F31 NRSA grant proposal format, the course focuses on how to develop and describe a hypothesis, write a specific aims page, and provide/write the appropriate significance and research strategy sections of a grant. Mentors are responsible for working with their students on the drafts, and the faculty teaching the course, review and critique the proposals throughout. At the end of the course, a panel of faculty reviews each student’s grant providing both criticism and feedback on the research and proposal format.

5. **Comprehensive Qualifying Exam**: The GMB qualifying examination consists of two components: a Written Exam that covers basic concepts in genetics and molecular biology in a problem solving setting; and an Oral Exam that focuses on basic concepts in genetics, as well as concepts that are directly related to the student’s dissertation research.

**Timing of the Qualifying Exams**
- **Early January, Year 2**: Written Exam
- **March 1, Year 2**: Deadline for Written Exam retakes
- **April 1, Year 2**: Deadline for students to submit their approved list of four committee member names to the GMB Oral Exam Chairperson
- **Second Half of May, Year 2**: Oral Exam
- **Before Start of Academic Year 3**: Deadline for completion of any Oral Exam retakes (recommended 4-6 weeks after original exam)

6. **Candidacy to Degree**: Students apply for candidacy after passing their Comprehensive Qualifying Exam and completing 36 hours of course credit hours in Advanced Standing (typically at the end of the third year).

**MONITORING OF STUDENT PROGRESS**

1. **Dissertation Committee Formation**: By the Spring of the second year, each student and advisor select a dissertation committee composed of four faculty with at least three being derived from the GMB faculty. Additional members can be added if their research expertise is needed to complement that of the members of the committee. Dissertation committees are approved by the GMB DGS.

2. **Committee Meetings**: The first dissertation committee meeting occurs in the Fall semester as the student enters his/her third year. This first meeting is devoted to the presentation and assessment of the proposed dissertation project as described above. **Subsequent dissertation committee meetings take place, at minimum, twice annually.** A **Dissertation Committee Report** that evaluates the student’s progress (satisfactory/unsatisfactory) is signed by each committee member. The Progress Report includes the expected date of the next meeting and details progress that is expected to be accomplished before the next committee meeting. A new online form to monitor student progress and auto-fill a progress spreadsheet is currently under development.

Students entering year 6 and above must have committee meetings in August, December, and May. Satisfactory progress and an “exit strategy” must be documented from these meetings for continuance of the student’s stipend for the following semester. These additional requirements are in place to make sure that the student, advisor, and committee are in synch with the student’s progress, project, and plans to complete his/her dissertation.

3. **Research in Progress Seminars**: From year three and beyond, all GMB students present their work-in-progress to the GMB program at large each year. These formalized 30-minute presentations provide the students with a speaking experience and group feedback for their projects. All GMB students are required to attend, as it is a required course (IBS 546r) and all program faculty are expected to attend as a condition of their continued membership in the GMB program. **Students often schedule one of their two annual dissertation**
committee meetings immediately after their presentations.

4. Dissertation Defense: Students must receive permission in their penultimate committee meeting to defend their dissertation. While each case is unique, it is expected that students will have published (or have in press) multiple manuscripts in credible journals describing their graduate work and that they will be first author on at least one. After completing the written dissertation and delivering a public seminar, students defend their work in a public venue and then meet with their Dissertation Committee for a final oral exam/conversation about their work. Finalized versions of the dissertation are approved by committee members and submitted to the Laney Graduate School.

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