

# Course Requirements for Individual Graduate Programs

## Biomedical Engineering (BME)

Director of Graduate Studies: Eric I. Altman

The requirements for a Ph.D. in Engineering and Applied Science (ENAS) are described in detail at [www.eng.yale.edu/graduate/Qualification-05-06.doc](http://www.eng.yale.edu/graduate/Qualification-05-06.doc) and summarized briefly here. For clarifications, please contact the Engineering Registrar, Ms. Cara Gibilisco at [cara.gibilisco@yale.edu](mailto:cara.gibilisco@yale.edu).

### **Course Requirements (6):**

The Ph.D. in Engineering and Applied Science generally requires eight lecture courses; M.D./Ph.D. students are allowed to apply two of their Medical School courses towards this total reducing the requirement to six. Each of the Engineering Departments and Programs has identified several required core courses. In Biomedical Engineering these are: Physiological Systems (ENAS 550a), Physical and Chemical Basis of Sensing and Imaging (ENAS 510a), and Advanced Engineering Mathematics (ENAS 505a or 500a); M.D./Ph.D. students can substitute a more advanced physiology course for ENAS 550a. Of the remaining three courses, one must be in engineering or a closely related field. Students must obtain a grade of Honors in any two of these courses and maintain an average of High Pass. Courses must be completed in the first two years of the combined program. In the case of students accepted into the MD/PhD Program during their first year of medical school, a letter from the faculty member in charge of the first-year course indicating the grade achieved in the course is required and an official transcript from the Medical School must be submitted to the Graduate School.

### **Qualifying Exam:**

There are no qualifying exams in ENAS.

### **Teaching Requirements:**

There is no teaching requirement for MD/PhD students, but Teaching Fellow (TF) positions are available for interested students. Students with an interest in teaching as a career goal are strongly encouraged to participate as Teaching Fellows at some point in the MD/PhD Program. All students are compensated for any teaching they perform.

### **Research:**

Students are encouraged to begin research towards their PhD thesis as soon as they start their ENAS course work. At the end of the first two semesters they will provide a brief oral review of their research to their thesis committee which will satisfy the ENAS Special Investigation requirement.

### **Thesis Prospectus, Area Exam and Admission to Candidacy:**

MD/PhD students must complete and submit their thesis prospectus by the end of the fifth semester as an affiliated graduate student. Thus, if the student affiliates at the customary point of year 3.5, they must submit the approved prospectus before the end of the spring semester of the fifth year (at the beginning of year 3 as an affiliated graduate student). After submitting the prospectus, students present their results to date and their proposed research to their thesis

committee in an Area Exam. Students are given two opportunities to pass this exam. Passing the Area Exam is the final requirement for admission to candidacy in the Graduate School.

**Other requirements:**

All graduate students who are admitted to candidacy are required to have an annual Thesis Committee meeting.

**Cell Biology**  
**Director of Graduate Studies: Carl Hashimoto**

**Required Courses (5):**

Students are required to take a total of 5 graduate-level courses including Molecules to Systems: Cell Biology and Microscopic Anatomy (CBIO 502), The Molecular and Cellular Basis of Human Disease (CBIO 601), and a seminar course such as Advanced Seminar Course (CBIO 606b or 727b) that involves the reading and class discussion of research papers.

The 2 remaining courses can be in areas such as Genetics, Neurobiology, Immunology, Microbiology, Pharmacology, and Physiology.

Students must meet the Graduate School requirement of a grade of Honors in 2 courses, if necessary taking additional courses beyond the 5 required in the department to fulfill this requirement.

Students must also maintain an average grade of High Pass in all courses.

**One semester of teaching**

**Qualifying exam:**

The qualifying exam in Cell Biology consists of 1) a research proposal based on the thesis project, 2) two reading periods on topics broadly relevant to the thesis project, and 3) an oral exam in which the student is examined on the research proposal as well as the reading periods by the qualifying exam committee. The qualifying exam committee consists of 3 faculty members, with at least one having a primary or secondary appointment in Cell Biology. This committee may become the student's thesis committee. The members of the committee are chosen by the student in consultation with the thesis advisor and with approval from the DGS. The student will read with two committee members and write the proposal with guidance from the third committee member. See the Cell Biology Graduate Student Handbook for further information (<http://info.med.yale.edu/cellbio/html/graduate/handbook.shtml>).

## **Cellular & Molecular Physiology**

**Director of Graduate Studies: Emile Boulpaep (last updated 2005)**

Students must pass at least three graduate-level courses in addition to the courses that are part of the Yale Medical School M.D program.

**Required Course:**

C&MP 560b, Cellular and Molecular Physiology: Molecular Machines in Human Disease

**Plus two elective graduate-level courses outside the regular medical school curriculum, subject to approval by the DGS.**

**One semester of teaching**

**Two rotations in two different laboratories over one summer.** Each rotation should last five weeks.

## **Epidemiology and Public Health**

**Director of Graduate Studies: Nancy Ruddle**

All MD-PhD students must meet with the Director of Graduate Studies in Epidemiology and Public Health as soon as they affiliate with EPH. Students in this program are expected to meet the guidelines listed below in the timeframe outlined. The Director of Graduate Studies must approve any variations to these requirements.

**Teaching:** One semester of teaching at a TA II (10 hours/week) will be required without pay. If students teach beyond this requirement, they can be compensated. If a student has served as a teaching assistant elsewhere on campus, this experience may be counted toward the requirement. **Department** approval is required to waive the teaching requirement based on previous Yale teaching experience.

**Rotations/Internships:** Students should do two four-week rotations/internships with potential advisors in EPH. These short-term research projects will **be with a specific Principal Investigator and can either be in a lab, fieldwork or analysis of an existing dataset.** **The purpose of these rotations/internships is to learn lab or field technique and to** allow the student time to determine if the P.I.'s research interests are compatible with his/her research interests. These rotations/internships are usually done during the summer between the first and second years of medical school coursework. In some cases students may need to defer this until the summer after the second year after taking certain courses and/or completing readings so that he/she possesses the background necessary for a successful rotation/internship.

**Required Coursework:** MD-PhD students are generally expected to take the same courses as traditional PhD students. Divisional requirements may vary; therefore students should confer with the **DGS and** their PhD advisor.

**Timeline for Qualifying Exam:** Students generally will take medical school courses years 1 and 2, then EPH doctoral course work years 3 and 4 (all or part of year 3). The qualifying exam is generally **completed** by the summer following the fourth year.

**Prospectus Timeline:** Students are encouraged to be developing their prospectus during their third and fourth years of study, while taking courses in EPH. Upon completion of the qualifying exam, students should focus entirely on completion of the prospectus, which should be submitted *no later than* 6 months after the completion of the qualifying exams.

## **Experimental Pathology**

### **Director of Graduate Studies: David Stern**

**Course requirements:**

Experimental Pathology students must take Pathology 650b, Cellular and Molecular Biology of Cancer, and Path 690a, Molecular Mechanisms of Disease. In addition course requirements include courses in biochemistry, genetics, immunology, cell biology, and pathology, to be chosen in consultation with the Director of Graduate Studies, according to the student's background and interest. Some of these requirements may have been met during didactic training in Medical School, and the Path690a requirement may be waived in consultation with the DGS. All requirements of the Graduate School of Arts and Sciences, including the Honors requirement, must be met.

**Qualifying examination:**

1. The student will read in three subject areas different from the dissertation topic. The student and advisor will jointly choose reading topics. A Qualifying Examination Committee consisting of three faculty members will then be chosen to examine the student, and one will be the designated chairperson. At least one of the Committee members must have a primary appointment in the Department of Pathology. Members of the Committee should have expertise in areas chosen for reading, and will act as resources for the student during the reading period. The Committee and topics must be approved by the DGS.
2. Prior to the examination, the student will prepare a three to five-page research proposal in one of the subject areas. The proposal will consist of a brief introduction, followed by a realistic research proposal for three years of work in the topic area by a single postdoctoral fellow.
3. At least four days prior to the examination, the student will be provided with two exam questions in each of the three topic areas and will prepare written answers to one of each of the two questions. (The Committee chair will organize the written exam with help from administrator JoAnn Falato.) Copies of all the research proposals and written exam answers will be distributed to the Examination Committee 48 hours prior to the exam.
4. The student will be orally examined to evaluate competency in the topic areas, and general problems of pathology and disease mechanisms. If the student does not pass the exam, the

Committee has the option of recommending an additional course of reading and/or written work. The DGS has final discretion in approving or modifying the recommendations of the Committee.

5. The Committee chair will provide a written report to the DGS summarizing the consensus of the Committee.

**Prospectus:**

Upon successful completion of the qualifying examination, the student will constitute a Dissertation Committee including at minimum four members in addition to the dissertation advisor. At least two of the Committee members must be Pathology Department faculty. The membership of the Committee must be approved by the DGS.

The student will prepare a written thesis prospectus, consisting of a summary of background information in the field of interest, the specific questions to be answered, a rationale for choosing those questions, and a research plan for addressing those questions.

"Upon completing the course requirement with at least two terms of Honors, passing the qualifying examination, and submitting a thesis prospectus students will be admitted to candidacy." This should take place by the end of the third year, and preferably in the second year. Students must then submit a written thesis describing the research and present a thesis research seminar."

## **Genetics**

### **Director of Graduate Studies: Michael Stern**

MD-PhD students affiliate with the Department of Genetics Graduate Program via a different route than other incoming graduate students in the Genetics Department, resulting in some modification of the academic requirements for the PhD portion of the MD-PhD degree. Typically, one or more research rotations are done during the first two years of medical school (in many cases, the first rotation is done during the summer between years one and two). No set number of research rotations is required. MD-PhD students officially affiliate with the Department of Genetics after selecting a thesis advisor and consulting with the DGS. MD-PhD students interested in Genetics are required to consult with the DGS prior to formal affiliation to determine an appropriate set of courses tailored to the student's background and interests.

The courses, rotations, and teaching requirements for MD-PhD students entering the Genetics Graduate Program (see below) are modified from the normal requirements for PhD students. Besides the modifications in these three requirements, MD-PhD students in the Department of Genetics are subject to all of the same requirements as the other graduate students in the department.

**Coursework**

Four graduate level courses taken for a grade are required (two Yale graduate level courses taken for a grade during Medical School may be counted towards this requirement at the discretion of

the DGS). Coursework is aimed at providing a firm basis in genetics and in cellular molecular mechanisms, with graduate-level proficiency in genetics, cell biology and biochemistry. In addition to these four courses, all Genetics students are required to take two semesters of Graduate Student Seminar and Scientific Ethics.

### **Required Courses**

Basic Concepts of Genetic Analysis (GENE 625a)

Graduate Student Seminar (2 semesters; GENE 675, graded Sat/Unsat)

Scientific Ethics (as part of GENE 901b, graded Sat/Unsat)

### **Recommended Courses**

Molecular Genetics of Eukaryotes (MB&B 743b)

Human Molecular Genetics (GENE 810a)

Biochemical and Biophysical Approaches in Molecular and Cellular Biology (MCDB 630b)

Cellular Basis of Human Biology/and Histology Lab (CBIO 502)

Molecular and Cellular Basis of Human Disease (CBIO 601)

### **Electives**

Other courses may be taken in a wide variety of fields relevant to the biological and biomedical sciences.

**Laboratory Rotations:** One or more rotations are necessary to identify a thesis advisor. No set number of research rotations is required.

**Teaching:** One semester of teaching is required. Previous teaching while enrolled at Yale Medical School may count towards this requirement at the discretion of the DGS.

**Qualifying Exam:** MD-PhD students take their qualifying exam in the semester following the completion of their coursework. The structure of the qualifying exam is identical to that for other Genetics PhD students. Students read with three faculty members for five weeks, one of whom supervises the reading on the thesis research topic, but who is not the thesis advisor. The following two weeks are devoted to writing two research proposals, one on the thesis research topic. An oral exam follows in the eighth week. For details, see the Qualifying Exam section of the Genetics Graduate Program handbook.

**Prospectus:** MD-PhD students submit their prospectus once their qualifying exam has been completed, but no later than the 30<sup>th</sup> of June following their exam.

**Candidacy:** MD-PhD students will be admitted to candidacy once they have completed their coursework, obtained 2 Honors grades, passed their qualifying exam, and submitted their dissertation prospectus.

**Thesis Committee:** All students are required to have one thesis committee meeting per year, beginning the semester after passing their qualifying exam. However, students are strongly encouraged to consider having additional meetings if they feel their project could benefit from the assistance of members of the thesis committee.

## **Immunobiology**

### **Director of Graduate Studies: Alfred Bothwell**

When an MD-PhD student joins the Section of Immunobiology to work on his/her thesis, it is naturally assumed that this student is further advanced than the traditional first-year graduate student. Because of this, it is possible to be prepared to defend the Prospectus exam after one year.

**Required courses have a somewhat different format than the straight Ph.D. Program:**  
**7 graduate school courses for a grade.** Of the 7 courses, the following are required.

Biology of the Immune System (Ibio 530a)

Advanced Immunology (Ibio 531b)

Two Immunobiology seminar courses (Ibio 536a, Ibbio 537, Ibiio 538a, Ibio 539a) – The first seminar credit must be taken for a grade. If seven courses have been entered then the second seminar course can be audited.

\*Two honors grades must be earned by semester two.

#### **Additional Required Course:**

**Three electives** (decided in collaboration with DGS & Director of the MD-PhD Program). Yale University graduate courses that are taken for a grade during medical school may be counted towards the the 7 total required courses. Verification must be provided to the DGS.

Fundamentals of Research, Ethics (Ibio 601b). A note from the DGS of MD-PhD Program must be forwarded to the Immunobiology DGS stating that the student has taken Ibio 601b, or its equivalent in the Medical School. The information must include dates, titles and faculty. If the student has not taken Ibio 601b or the equivalent, then registration in this class is mandatory.

Introduction to Research Ibio600a is optional. Each week different faculty give short presentations on their research to familiarize students with the range of research opportunities. This is given every fall once per week. It is not necessary to take this course but you may if you wish.

**One semester of teaching is required.** Previously taught courses in the Medical School may count towards this requirement. To request credit for previous teaching experience, a note from the course director describing the teaching experience (duration of the teaching experience, frequency of class meetings, number of students taught, materials covered, dates and for whom) should be provided to the Immunobiology DGS.

Following successful completion of the Prospectus examination, the student will be entitled to the M.S. Degree. Once all the above requirements have been met, the student will advance to candidacy.

Following successful completion of the Prospectus examination and required coursework, the student will be entitled to the M.Phil. Degree.

**Mandatory for good standing:**

**Committee Meetings:**

Every six months an Immunobiology Graduate Student is required to have a committee meeting that the student organizes on his/her own behalf. The intention is to make sure that the science pursued is working in unison with what the Thesis Committee intends and to avoid any misunderstandings in the future. This meeting is also a format for the Committee to offer leadership and guidance. A letter from the thesis advisor is written on the student's behalf to the DGS and is recorded in the student's academic file.

**Dissertation Report:**

Every year in June, the Graduate School requires an annual dissertation progress report submitted by the student. This is not to be confused with the Medical School Progress Report. The Graduate School places students on academic hold and bars registration without completion of this yearly form.

**Interdepartmental Computational Biology and Bioinformatics  
Co-Directors of Graduate Studies: Mark Gerstein, Perry Miller**

**Course Requirements (9):** Nine courses are required plus a seminar on responsible conduct of research. Course distribution is: 3 graduate courses in CBB, 2 courses in biological sciences, 2 courses in informatics (computer science, statistics, applied math), and 2 electives from the above areas. It is likely that courses in the medical curriculum could satisfy the biological science and electives; students must receive a grade in such courses. Students must fulfill the Graduate School requirement of 2 honors grades.

**Laboratory Rotations:** To be determined in consultation with the CBB Directors of Graduate Studies.

**Teaching:** To be determined in consultation with the CBB Directors of Graduate Studies.

**Qualifying Exam:** During the Qualifying Exam, the student presents and discusses a dissertation research prospectus and is also questioned on several CBB topic areas previously identified by the qualifying exam committee. The Qualifying Exam should normally be held before the end of the 4<sup>th</sup> term after CBB affiliation.

**Admission to Candidacy:** MD-PhD students should normally be admitted to candidacy by the end of the 4<sup>th</sup> term after CBB affiliation.

**Other Requirements:** After admission to candidacy, students should have an annual Thesis Committee meeting.

## **Interdepartmental Neuroscience Program (INP)**

### **Director of Graduate Studies: Charles Greer**

#### **Course Requirements (5):**

Five courses are required, and students must obtain a grade of Honors in two of these courses. This must be achieved in the first two years of the combined program. Required courses are Principles of Neuroscience (Neuroscience 501a) and Structural and Functional Analysis of the Human Nervous System (Neurobiology 500b). Three more elective graduate level courses are required. The following courses taken during the first two years of medical school will count towards the student's elective requirements in the INP, provided the student has registered to receive a graduate grade in the course: CBIO 502a, CBIO 601, GENE 500b, IBIO 530a, MB&B 800a. In the case of students accepted into the MD-PhD Program during their first year of medical school, a letter from the faculty member in charge of the first-year course indicating the grade achieved in the course is required and an official transcript from the Medical School must be submitted to the Graduate School.

#### **Laboratory Rotations:**

Two rotations are required; rotations in another department/program will count towards this requirement upon approval of the INP Director of Graduate Studies.

#### **Teaching Requirements:**

MD-PhD students are required to TA one term; two terms are preferred. Previous teaching (as TA) in the histology labs or courses in MCDB does count toward this requirement as long as the student has taught while enrolled at Yale as an MD-PhD student.

#### **Qualifying Exam:**

MD-PhD students must complete their qualifying exam before the end of their first year as an affiliated graduate student. Thus, if the student affiliates at the customary point of year 3.5 (beginning of the spring semester of the third year of matriculation at Yale), they must complete the examination before registering for the spring semester of the fourth year at Yale.

#### **Prospectus:**

MD-PhD students must complete and submit their thesis prospectus by the end of the second year as an affiliated graduate student. Thus, if the student affiliates at the customary point of year 3.5, they must submit the approved prospectus before registering for the spring semester of the fifth year (at the beginning of year 3 as an affiliated graduate student).

Please note that every thesis prospectus MUST be approved by the Thesis Committee.

#### **Admission to Candidacy:**

MD-PhD students are required to have been admitted to candidacy by the end of the second year as an affiliated graduate student. Generally, the submission of the thesis prospectus is the final requirement for admission to candidacy and paperwork for both is submitted to the Graduate School at the same time.

**Other requirements:**

All graduate students who are admitted to candidacy are required to have an annual Thesis Committee meeting. All graduate students are required to give a student research presentation annually and are expected to attend rotation/student research talks as well as INP-sponsored journal clubs.

**Affiliation requirement:** A copy of the student's application to the MD-PhD program, a copy of the student's current transcript and notation of rotations completed must be submitted to the INP office. The DGS must have this information in hand before the official MD-PhD student affiliation form can be approved. The INP Office requests that copies of transcripts for all affiliated MD-PhD students be forwarded when they are received by the MD-PhD Office.

**Timeline:**

**Year One:** MD-PhD students complete courses in the Medical School and register for selected courses in the Graduate School. Most who identify Neuroscience as their probable Ph.D. field will take the required course, Principles of Neuroscience, in the fall semester. This is the recommended timing. MD-PhD students should take Neurobiology 500b in the spring for graduate school credit/grade. Other electives as listed above may be taken for graduate school credit to fulfill our requirements and indeed, it is recommended that this be done. Two laboratory rotations should be completed in the summer. The DGS and the Neuroscience Office may be of assistance in identifying appropriate laboratories based on the student's interests.

**Year Two:** Courses in the Medical School are typically taken. Part 1 of the Boards is taken.

**Year Three:** By January of the third year, a thesis lab should be identified and all paperwork should be completed (affiliation form completed and copy of student's academic record including application transferred to Neuroscience Office). Student's stipend is supplemented by PI/PI's primary department at time of affiliation.

**Year Four:** Qualifying Examination must be completed within one year of laboratory/program affiliation. This is a graduate school rule and graduate school registration for the following semester may be held up if this requirement is not fulfilled in a timely manner. Typically this will be fulfilled before the spring semester of the fourth year.

**Year Five:** The Thesis Prospectus must be approved and submitted to the Graduate School by the end of the second year of laboratory/PI affiliation. Typically, this is by the end of the fall semester of Year five. Registration for the following semester may be held up if this requirement is not fulfilled in a timely manner. The Thesis Committee approves the prospectus and required paperwork is then delivered to the INP Office by the student. The INP Office will then complete the Admission to Candidacy paperwork and submit it to the Graduate School. The Prospectus must be submitted to the Graduate School at least six months before the dissertation is submitted.

**Year Six:** Typically an MD-PhD student will complete and defend the dissertation at the end of the fall semester or the beginning of the spring semester. We require that MD-PhD students defend their dissertations before returning to fulfill the remaining Medical School requirements.

Year Seven: Student completes all remaining requirements and graduates in May.

While this is considered a guideline for a typical MD-PhD student, we recognize that not every student will follow this path. Any digression from this timeline must be discussed and approved by the DGS, with appropriate notes to the student's file and copies to the MD-PhD Office. Continued participation in the INP is subject to the satisfactory completion of requirements in a timely fashion and if any question arises about the satisfactory progress of a student and the qualifying examination committee or the thesis committee cannot agree on an appropriate resolution, then the INP Executive Committee will have the authority of the INP faculty to determine a course of action.

## **Microbiology**

### **Director of Graduate Studies: Joann Sweasy**

**Required Courses (6):** 3 of the courses must be Microbiology courses. Students must maintain a High Pass average and obtain 2 Honors grades. Credit may be given for advanced courses taken in Medical School that were graded and an Honors grade obtained in one of these courses may count toward the Honors requirement, at the discretion of the DGS.

**Laboratory Rotations:** Up to 3 rotations may be necessary in order to identify a mentor. Students will be required to present a short seminar on each rotation they complete, as outlined in the handbook for Ph.D. students.

**Teaching:** One semester of teaching. Previous teaching in Histology or MCDB may count towards this requirement at the discretion of the DGS.

**Qualifying Exam:** MD-PhD students are encouraged to take the qualifying exam once their coursework has been completed and they have identified a mentor and a thesis project. This should be completed before entering the third year of the MD-PhD Program.

**Prospectus:** MD-PhD students should submit their prospectus once their qualifying exam has been completed, and no later than the 30<sup>th</sup> of June following their exam.

**Candidacy:** MD-PhD students will be admitted to candidacy once they have completed their coursework and obtained 2 Honors grades, passed their qualifying exam, and submitted their dissertation prospectus.

**Thesis Committee:** MD-PhD and PhD students are required to have one Thesis Committee meeting per year. However, students are strongly encouraged to consider having additional meetings if they feel their project could benefit from the assistance of members of the Thesis Committee.

## **Molecular Biophysics & Biochemistry**

**Director of Graduate Studies: Mark Solomon**

**Required Courses (7):** Seven one-term graduate-level courses from any of the biological departments are required. Students are required to attain at least two grades of Honors and to maintain a High Pass average. Some medical courses also carry graduate course numbers and may be counted toward this total so long as the student has enrolled in the course and received a formal grade. Please consult the DGS for a discussion of individual circumstances. As part of these seven courses, students should take or have previously taken the equivalent of the following four courses:

MB&B 720a, Macromolecular Structure and Biophysical Analysis  
MB&B 721b, Macromolecular Interactions and Dynamic Properties  
MB&B 730a, Methods & Logic in Molecular Biology  
MB&B 743b, Advanced Eukaryotic Molecular Biology

Participation in a short discussion course in Responsible Conduct of Research (MB&B 676b) is required.

Rotations are not required for MD-PhD students, but are available.

Teaching is encouraged, but not required of MD-PhD students.

**Qualifying exam:** 2 proposals: 1 in a chemical/biophysical area and 1 in a biochemical/molecular biological area. One of these proposals must be a thesis topic. The other should be in a contrasting area, both in terms of subject and approach.

All experiments must be completed and approved by the Thesis Committee before resuming clinical training.

## **Molecular, Cellular and Developmental Biology**

**Director of Graduate Studies: Shirleen Roeder**

### **Course Requirements:**

There is no specific curriculum of courses required, however students must obtain a grade of Honors in at least two graduate-level courses to fulfill requirements set by the Graduate School. The student, with guidance from a faculty committee, can choose a specific program of courses that are best fitted to their individual needs and career goals. Most students complete at least 5 courses during their first two years of study.

### **Laboratory Rotations:**

3 rotations are required and rotations in other departments will count towards this requirement.

**One semester of teaching is required.**

**Qualifying exam:** The student will meet with a faculty committee in the third term of study to decide on a preliminary topic for dissertation work and to define the research areas in which he or she is expected to demonstrate competence. Each student then prepares a dissertation prospectus that outlines the research proposed for the Ph.D. The written and oral presentations must be successfully defended by the end of the second year before the student is admitted to candidacy for the Ph.D.

**Other requirements:**

All graduate students who are admitted to candidacy are required to have an annual Thesis Committee meeting.

**Neurobiology**  
**Director of Graduate Study: Amy Arnsten**

*Special Requirements for the M.D./Ph.D.*

**Course Requirements:**

Five courses are required, and students must obtain a grade of Honors in two of these courses and this must be achieved in the first two years of the combined program. Required courses are Principles of Neuroscience (Neuroscience 501a) and Structural and Functional Analysis of the Human Nervous System (Neurobiology 500b). Three more elective graduate level courses are required. The following courses taken during the first two years of medical school will count towards the student's elective requirements in the Neurobiology Program, provided the student has registered to receive a graduate grade in the course. Cell Biology 502, Cell Biology 601, Genetics 500a, MB & B 800a, Physiology 500. In the case of students accepted into the MD-PhD program during their first year of medical school, a letter from the faculty member in charge of the first year course indicating the grade achieved in the course is required and an official transcript from the medical school must be submitted to the Graduate School.

**Laboratory Rotations:**

2 rotations are required; rotations in another department/program will count towards this requirement upon approval of the Neuroscience Track Directors.

**Teaching Requirements:**

MD-PhD students are required to serve as Teaching Fellows (TF) for one term, two terms are preferred. Previous teaching (as TF) in the histology labs or courses in MCDB does count toward this requirement as long as the student has taught while enrolled at Yale as an MD-PhD student.

**Qualifying Exam:**

MD-PhD students must complete their qualifying exam before the end of their first year as an affiliated graduate student. Thus, if the student affiliates at the customary 2 1/2 year point

(beginning of the Spring semester of the third year of matriculation at Yale), they must complete the examination before registering for the Spring semester of the fourth year at Yale.

**Prospectus:**

MD-PhD students must complete and submit their dissertation prospectus (i.e. thesis proposal) by the end of the second year as an affiliated graduate student. Thus, if the student affiliates at the customary 2 1/2 year point, they must submit the approved prospectus before registering for the Spring semester of the fifth year (at the beginning of year 3 as an affiliated graduate student).

Please note that every dissertation prospectus **MUST** be approved by the thesis committee.

**Admission to Candidacy:**

MD-PhD students are required to have been admitted to candidacy by the end of the second year as an affiliated graduate student. Generally, the submission of the dissertation prospectus is the final requirement for admission to candidacy and paperwork for both is submitted to the Graduate School at the same time.

**Other requirements:**

All graduate students who are admitted to candidacy are required to have an annual thesis committee meeting. All graduate students are required to give a student research presentation annually (a brief INP rotation talk early in the graduate career, followed by a longer, Neurobiology Student Research Talk as the student's research advances). All students are expected to attend rotation/student research talks.

Affiliation requirement: A copy of the student's application to the MD-PhD program, a copy of the student's current transcript and notation of rotations completed must be submitted to the Neurobiology Program Business Office. The DGS must have this information in hand before the official MD-PhD student affiliation form can be approved. The Neurobiology Program Business Office requests that copies of transcripts for all affiliated MD-PhD students be forwarded when they are received by the MD-PhD office.

**Timeline:**

Year One: MD-PhD students complete courses in the Medical School and register for selected courses in the Graduate School. Most who identify Neuroscience as their probable PhD field will take the required course, Principles of Neuroscience, in the fall semester. This is the recommended timing. MD-PhD students should take Neurobiology 500b in the spring for graduate school credit/grade. Other electives as listed above may be taken for graduate school credit to fulfill our requirements and indeed, it is recommended that this be done. Two laboratory rotations should be completed in the summer. The DGS's of both the Neurobiology Program and the INP may be of assistance in identifying appropriate laboratories based in the student's interests.

Year Two: Courses in the Medical School are typically taken. Part 1 of the Boards is taken.

Year Three: By January of the third year, a thesis lab should be identified and all paperwork should be completed (affiliation form completed and copy of student's academic record

including application transferred to the Neurobiology Business Office). Student's stipend is supplemented by PI/PI's primary department at time of affiliation.

Year Four: Qualifying Examination must be completed within one year of laboratory/program affiliation. This is a graduate school rule and graduate school registration for the following semester may be held up if this requirement is not fulfilled in a timely manner. Typically this will be fulfilled before the Spring Semester of the Fourth year.

Year Five: The Dissertation Prospectus must be approved and submitted to the Graduate School by the end of the second year of laboratory/PI affiliation. Typically, this is by the end of the Fall Semester of Year Five. Registration for the following semester may be held up if this requirement is not fulfilled in a timely manner. The Thesis Committee approves the prospectus and required paperwork is then delivered to the Neurobiology Program Business Office by the student. The Neurobiology Program Business Office will then complete the Admission to Candidacy paperwork and submit it to the Graduate School. The Prospectus must be submitted to the Graduate School at least six months before the dissertation is submitted.

Year Six: Typically an MD-PhD student will complete and defend their dissertation at the end of the Fall semester or the beginning of the Spring semester. We require that MD-PhD students defend their dissertations before returning to fulfill the remaining Medical School requirements.

Year Seven: Student completes all remaining requirements and graduates in May.

While this is considered a guideline for a typical MD-PhD student, we recognize that not every student will follow this path. Any digression from this timeline must be discussed and approved by the DGS, with appropriate notes to the student's file and copies to the MD-PhD office. Continued participation in the Neurobiology Program is subject to the satisfactory completion of requirements in a timely fashion. If any question arises about the satisfactory progress of a student, and the qualifying examination committee or the thesis committee cannot agree on an appropriate resolution, then the Neurobiology faculty will meet to determine a course of action.

## **Pharmacology**

### **Director of Graduate Studies: Elias Lolis**

#### **Course Requirements (6):**

Six courses are required. Students must obtain a grade of Honors in two of these courses. This must be achieved in the first two years of the combined program. Required courses are Seminar (1<sup>st</sup> two semesters) and one semester of Graduate Pharmacology (either 504a or 504b). One additional graduate level course is required as an elective in Cell Biology, Molecular Biology, Pathology, Physiology or Genetics. The following courses taken during the first two years of medical school will count towards the student's Honors and course requirements, provided the student has registered to receive a graduate grade in the course: Pathology, Cell Biology, Genetics, MB&B, Physiology and Pharmacology.

**Laboratory Rotations:**

Two rotations are required; rotations in another department/program will count towards this requirement upon approval of the Director of Graduate Studies.

**Teaching Requirements:**

MD-PhD students are required to TA one term, typically in Pharmacology 504a or b.

**Qualifying Exam:**

MD-PhD students must complete their qualifying exam before the end of their first year as an affiliated graduate student. Thus, if the student affiliates at the customary point of year 3.5 (beginning of the spring semester of the third year of matriculation at Yale), they must complete the examination before registering for the spring semester of the fourth year at Yale. The nature of the qualifying exam in Pharmacology is posted at <http://info.med.yale.edu/pharm>.

**Prospectus:**

MD-PhD students must complete and submit their thesis prospectus by the end of the second year as an affiliated graduate student. The Director of Graduate Studies will work with the student to ensure an optimal thesis committee. The nature of the Prospectus in Pharmacology is posted at <http://info.med.yale.edu/pharm>.

**Admission to Candidacy:**

MD-PhD students are required to have been admitted to candidacy by the end of the second year as an affiliated graduate student. Generally, the submission of the thesis prospectus is the final requirement for admission to candidacy. Paperwork for both candidacy and the thesis prospectus is submitted to the Graduate School at the same time.

**Other requirements:**

All graduate students who are admitted to candidacy are required to have at least one thesis committee meeting per year. All graduate students are required to give a student research presentation annually and are expected to attend rotation/student research talks and Departmental seminars.

**Affiliation requirement:** A copy of the student's application to the MD-PhD Program, a copy of the student's current transcript and the rotations already completed must be submitted to the DGS of Pharmacology. The DGS must have all of this information in hand before the official MD-PhD student affiliation form can be approved. The Pharmacology Department requests that copies of transcripts for all affiliated MD-PhD students be forwarded to the DGS when they are received by the MD-PhD Office.

**Anthropology**  
**Director of Graduate Studies: Joseph Errington**

**Special Requirements for the Ph.D. Degree**

Although there are a few required courses or seminars for each subfield, more than three-fourths of a student's program consists of electives, including course work in other departments.

Admission to candidacy requires: (1) completion of two years of course work (sixteen term courses); (2) independent study and research; (3) satisfactory performance on qualifying examinations; and (4) a dissertation research proposal submitted and approved before the end of the third year. Qualifying examinations, normally taken at the end of the second year, consist of eight hours written (four hours on one of the subfields, four hours on the student's special interest), and two hours oral. Dissertations are normally based on field or laboratory research.

## **Social Sciences and Humanities**

Yale is one of the few MD-PhD Programs that offer the possibility to do your PhD in the social sciences or humanities. This guide was written by current MD-PhD students in social science and is intended to help you understand special features of the program with regard to social science and humanities degrees, and to help you prepare your application.

### **Applying**

Just like applying in the biomedical sciences, the MD-PhD Faculty Committee would like to see a strong commitment to research in your field of choice. In your application to Yale, it is important to state your research goals clearly, especially how you plan to incorporate both the MD and the PhD into the body of your future work. Identify potential advisors before you apply and speak to them at length about your research ideas. At the interview, be prepared to explain your research, what specific contributions a joint degree will help you to make, and why the potential advisors you have identified would be a good fit.

Everyone's research interests change as they go through the Program. However, the Committee will be looking to see that you have thought through a potential social science or humanities research project, that your interests coincide with the interests of people on Yale's faculty, and that members of the Yale department you are interested in working with agree that this would be a good project. The Committee wants to make sure you are dedicated to research in the social sciences or humanities, and that you are prepared for your role in trying to bridge the gap between social science/humanities research and medicine.

### **Academic Plan**

Like other MD-PhD students, you will begin with your medical curriculum, completing 2 years of medical coursework before starting the PhD. During the first two years of medical classes you may take other classes in the Graduate School to start fulfilling your PhD requirements. Most MD-PhD students in social science or humanities take no more than one additional course per semester during their first two years of medical school. You will need to officially affiliate with a department by the end of your second year. Each department has their own rules regarding affiliation. Some require a short research prospectus. Others may require a formal application to their department. The departmental application process must be outlined on an individual basis between the student and the Director of Graduate Studies in the department of choice.

### **The PhD Years**

You must complete all of the course and teaching requirements in any department that you choose. This affects how fast you can complete the program. The Anthropology

Department for example requires 16 courses, the equivalent of two years of coursework. All MD-PhD students are encouraged to participate in longitudinal clinics (the Wednesday Evening Clinic, Ambulatory clinic at the VA, or the Pediatric Neurology Clinic) during their research years.

### **Funding**

The MD-PhD Program provides substantial funds for both the medical education and a limited number of years of PhD training, up to six years of total funding support. While all four years of medical school are covered under the Program, this leaves only two years of funding for the PhD. In the social sciences and humanities this is sufficient time to complete the required coursework, but insufficient to complete a research project. Because of this situation, MD-PhD candidates in the social sciences and humanities will need to seek funding to help support them during their research years. Many competitive internal and external funding opportunities exist for PhD research in all disciplines in the social sciences. The Graduate School of Arts and Sciences offers one year of support during dissertation writing. In addition, Teaching Fellowships (essentially being a teaching assistant for undergraduate courses) are another possible, though not ideal, way for a social science student to secure funding during their dissertation research and writing.

### **Caveats**

Because the course load requirement for MD-PhDs in the social sciences is much higher than that of MD-PhDs in the biological sciences, successful completion of the program will usually take between 8-10 years.

The Yale School of Public Health does not offer a PhD in International Health. Therefore students interested in applying their research interests abroad should look for other departments that would suit their research interests.