Course Requirements for Individual Graduate Programs

Applied Mathematics
Director of Graduate Studies:  Zhiwei Yun
http://applied.math.yale.edu/academics/graduate-program

Biomedical Engineering (BME)
Director of Graduate Studies: Richard E. Carson

The Qualification Procedure (QP) for a Ph.D. in Engineering and Applied Science (ENAS) are described in detail at http://seas.yale.edu/i-am/current-student/forms-and-guides and summarized briefly here. For clarifications, please contact the Engineering Registrar, Ms. Cara Gibilisco at cara.gibilisco@yale.edu.

Course Requirements (8): In Biomedical Engineering, the 5 core courses are: 2 semesters of Special Investigations (see below), Physiological Systems (ENAS 550a), Physical and Chemical Basis of Sensing and Imaging (ENAS 510a), and Advanced Engineering Mathematics (ENAS 549a, 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 (excluding the Special Investigations) 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.

Special Investigations: Like other PhD students, 2 semesters of Special Investigations are required. All students are expected to present their Special Investigation work at a Department Symposium held on the last day of Reading Period.

Qualifying Exam: There are no qualifying exams in ENAS.

Teaching Requirements: In Year 2 of graduate study, each MD/PhD student is required to hold one 10 hour TF position.

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.
BME Seminars are held on Thursdays at 4pm. Attendance at these seminars for graduate students is mandatory.
In the first year after admission to candidacy, students are expected to present their research work at a BME seminar.
Cell Biology
Director of Graduate Studies: Karin Reinisch

M.D./Ph.D. students are required to take a total of five graduate-level courses for a grade, including the CBIO 500/CBIO 501/CBIO 502 sequence (Molecules to Systems; three terms, counts as one course), CBIO 602 (Molecular Cell Biology), and a seminar course that involves the reading and class discussion of research papers. The remaining courses can be in areas such as Genetics, Neuroscience, Immunology, Microbiology, Pharmacology, and Physiology. Students must meet the Graduate School requirement of a grade of Honors in two courses, if necessary taking additional courses beyond the five required in the department to fulfill this requirement. Students must also maintain an average grade of High Pass in all courses. One term of teaching is required.

Courses

CBIO 500a and CBIO 501b and CBIO 502a, Molecules to Systems  Peter Takizawa
This course is designed to provide medical students with a current and comprehensive review of biologic structure and function at the cellular, tissue, and organ system levels. Areas covered include structure and organization of cells; regulation of the cell cycle and mitosis; protein biosynthesis and membrane targeting; cell motility and the cytoskeleton; signal transduction; cell adhesion; cell and tissue organization of organ systems. Clinical correlation sessions, which illustrate the contributions of cell biology to specific medical problems, are interspersed in the lecture schedule. Histophysiology laboratories provide practical experience with an understanding of exploring cell and tissue structure. The course is offered only to M.D. and M.D./Ph.D. students. It runs for three terms from September to December of the next academic year to coincide with the School of Medicine curriculum. Registration and the release of grades takes place in the third term. The course is equivalent to two graduate credits.

CBIO 599a and CBIO 600b and CBIO 601b, Frontiers  Fred Gorelick, Karin Finberg, and Jonathan Bogan
The course emphasizes the connections between diseases and basic science using a lecture and seminar format. It is designed for students who are committed to a career in medical research, those who are considering such a career, or students who wish to explore scientific topics in depth. The first half of the course is organized in four- to five-week blocks that topically parallel CBIO 500 and 501. Examples of blocks from past years include "Diseases of protein folding" and "Diseases of ion channels." Each topic is introduced with a lecture given by the faculty. The lecture is followed by sessions in which students review relevant manuscripts under the supervision of a faculty mentor. The second half of the course focuses on the relationship of basic science to disease processes while emphasizing translational and clinical research. In addition, sessions are devoted to academic careers and cover subjects such as obtaining an academic position, promotions, and grant writing. The course is open to M.D. and M.D./Ph.D. students who are taking or have taken the CBIO 500/501/502 sequence. Student evaluations are based on attendance, participation in group discussions, formal presentations, and a written review of an NIH proposal. It is equivalent to two graduate credits.

CBIO 602a / MB&B 602a / MCDB 602a, Molecular Cell Biology  Charles Lusk, Michael Caplan, Pietro De Camilli, Thomas Pollard, Peter Takizawa, David Calderwood, James Rothman, Valerie Horsley, Thomas Melia, Megan King, and Josephina Van Wolfswinkel. A comprehensive introduction to the molecular and mechanistic aspects of cell biology for graduate students in all programs. Emphasizes fundamental issues of cellular organization, regulation, biogenesis, and function at the molecular level.
CBIO 603a / MCDB 603a, Seminar in Molecular Cell Biology Megan King, Michael Caplan, Pietro De Camilli, Thomas Pollard, Peter Takizawa, David Calderwood, James Rothman, Valerie Horsley, Thomas Melia, Charles Lusk, and Josephina Van Wolfswinkel. A graduate-level seminar course in modern cell biology. The class is devoted to the reading and critical evaluation of classical and current papers. The topics are coordinated with the CBIO 602a lecture schedule. Thus, concurrent enrollment in CBIO 602a is required.

CBIO 604b, Systems Cell Biology Agnes Vignery. Introduction to the organization and function of cells within complex multicellular systems as encountered in the human body. Covers major tissues and organs as well as the cardiovascular, immune, and nervous systems, with special emphasis on the molecular and cellular bases of developmental processes and human diseases. Lectures supplemented by electronic-based tutorials on the histology of tissues and organs.

CBIO 606b, Advanced Topics in Cell Biology Shawn Ferguson, Charles Lusk, and Christopher Burd. This seminar course, which meets once weekly, covers advanced topics in cell biology. Each topic is spread over two or three sessions, which start with an introductory overview and are followed by a discussion of key papers led by an expert in the field.

CBIO 611b, Vascular Cell Biology Martin Schwartz. This course introduces the structure and organ-level physiology of the vascular system, then covers in greater depth the development, regulation, mechanics, and pathology of blood vessels. The major focus is on cellular and molecular mechanisms. The course includes both lectures and reading and discussion of recent literature.

CBIO 655a / GENE 655a, Stem Cells: Biology and Application In-Hyun Park. This course is designed for first-year or second-year students to learn the fundamentals of stem cell biology and to gain familiarity with current research in the field. The course is presented in a lecture and discussion format based on primary literature. Topics include stem cell concepts, methodologies for stem cell research, embryonic stem cells, adult stem cells, cloning and stem cell reprogramming, and clinical applications of stem cell research. Prerequisites: undergraduate-level cell biology, molecular biology, and genetics.

CBIO 701b, Illuminating Cellular Function Derek Toomre and Joerg Bewersdorf. Introduction to the principles and practical methods of live cell imaging. Covers principles of fluorescent microscopy (including genetically encoded probes and physiological indicators), image formation, image detection, and image analysis. Includes hands-on demonstrations of state-of-the-art instrumentation, such as video-rate confocal and super-resolution "nanoscopes." ½ Course cr

CBIO 900a / GENE 900a / MCDB 900a, First-Year Introduction to Research—Grant Writing and Scientific Communication Valerie Horsley. Grant writing, scientific communication, and laboratory rotation talks for Molecular Cell Biology, Genetics, and Development track students.
CBIO 901b / GENE 901b / MCDB 901b, First-Year Introduction to Research—Ethics: Scientific Integrity in Biomedical Research Joerg Bewersdorf. Ethics and laboratory rotation talks for Molecular Cell Biology, Genetics, and Development track students.

CBIO 911a / GENE 911a / MCDB 911a, First Laboratory Rotation Valerie Horsley. First laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

CBIO 912a / GENE 912a / MCDB 912a, Second Laboratory Rotation Valerie Horsley. Second laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

CBIO 913b / GENE 913b / MCDB 913b, Third Laboratory Rotation Valerie Horsley. Third laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

Teaching Requirement: One term of teaching.

Qualifying exam: The qualifying exam consists of 1) a written research proposal based on the prospective thesis project and 2) an oral exam in which the student defends the research proposal before a qualifying exam committee. The qualifying exam must be taken within one year of joining the PhD program. The qualifying exam committee consists of 3 faculty members, with at least one having a primary or secondary appointment in Cell Biology. This committee becomes 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. For further information, please see the Cell Biology Graduate Student Handbook, which can be found on the Cell Biology Department website: http://www.cellbiology.yale.edu/graduate/

Cellular & Molecular Physiology

Director of Graduate Studies: David Zenisek

Required Courses: 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.

Mandated: One C&MP Course that is not part of the Yale Medical School M.D Program. Preferably C&MP 560b, Cellular and Molecular Physiology: Molecular Machines in Human Disease

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

Two grades of Honors: Graduate courses that are part of the Yale Medical School M.D Program and taken for a grade may be counted towards the Honors fulfillment.

One semester of teaching.

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

Chemistry (2015)

Director of Graduate Studies: Patrick Holland

Each sub-discipline has specific course recommendations as outlined below. In some cases, recommended courses are not offered every year, and one should take advantage of the course when it is
offered. The course requirements have been designed for students with a primary interest in some form of preparative chemistry or in physical/biophysical chemistry. The physical chemistry course curriculum is slightly different for those interested in biophysical chemistry than for those interested in physical chemistry or chemical physics, and the preparative chemistry curriculum is slightly different for those interested in organic chemistry, chemical biology, or inorganic chemistry.

**Note:** In addition to the required courses for each sub-discipline, a course in the responsible conduct of research is also required (Chem 590a “Ethical Conduct and Scientific Research”). For MD/PhD Students, the Responsible Conduct of Research Course (B&BS 501) will satisfy this requirement.

**Preparative Chemistry Course Requirements:**

A student who will be conducting research in areas of preparative chemistry, such as coordination chemistry, bioinorganic chemistry, chemical biology, synthetic organic chemistry, physical organic chemistry, organometallic chemistry, materials synthesis, or catalysis, must complete six credits during the first three semesters. These courses should be composed of two elective courses plus one offering from each of the following four distributions (listed in the Table below): synthetic chemistry, biological chemistry, transition metal chemistry, and theoretical and mechanistic chemistry. Electives can be fulfilled with any additional courses listed among these distributions, or alternatively, they can involve coursework in the areas of physical and spectroscopic methods, molecular biology, cell biology, chemical biology, or bioinorganic chemistry. Courses listed in the table of CBI Electives (below) would also be appropriate options. Programs will be designed in consultation with a designated faculty advisor.

Required courses can be completed in several possible formats to fit the schedule of course offerings: you may enroll in three courses each of the two semesters of the first year, four courses the first semester and two the second, or three courses the first semester, two the second semester and one course the first semester of the second year.

The following table provides guidelines on sample series of courses that provide an exposure to synthesis, biological chemistry, transition-metal chemistry and reaction mechanisms.

<table>
<thead>
<tr>
<th>Synthetic Chemistry</th>
<th>Transition Metals</th>
<th>Biological Chemistry</th>
<th>Theory and Mechanism</th>
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<tbody>
<tr>
<td>Synthetic Methods 523</td>
<td>Organometallics 552</td>
<td>Chemical Biology 521</td>
<td>Advanced Organic 519</td>
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<tr>
<td>Organometallics 552</td>
<td>Modern Coordination Chemistry 557</td>
<td>Bioinorganic Chemistry 554</td>
<td>[Transition Metal Reaction Mechanisms 555]</td>
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<tr>
<td>Bioinorganic Chemistry 554</td>
<td>Enzyme Reaction Mechanisms 556</td>
<td>Enzyme Reaction Mechanisms 556</td>
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<tr>
<td>Natural Product Synthesis 528</td>
<td>Physical Methods in Inorganic Chemistry 550b</td>
<td>[Structure and Chemistry of Proteins and Nucleic Acids MBB741]</td>
<td>[Computational Chemistry and Biochemistry 526]</td>
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<tr>
<td>Transition Metal Reaction mechanisms 555</td>
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**Chemistry/Biology Interface Training Program**

Those chemical biology students supported by the Chemistry/Biology Interface (CBI) training grant are expected to take three full-semester courses for credit each term of their first year. Specific courses are chosen in consultation with a designated faculty advisor. It is expected that by the end of the second year in residence, students supported by the Chemistry/Biology Interface (CBI) training grant will possess a solid background in both organic and biological chemistry, as well as a sophisticated understanding of important methodologies in cell and molecular biology. These requirements may, however, be fulfilled in whole or in part through courses taken as an undergraduate.

**Selection of Elective Courses (2):**
In addition to fulfilling the core requirements for Preparative Chemistry, students supported by the Chemistry/Biology Interface (CBI) Training Grant will take one elective from each of the two course listings below. All students will audit the Current Topics in Organic Chemistry Seminar Series (Chem 740), Seminar in Chemical Biology (Chem740), or Seminar in Inorganic Chemistry (Chem760) throughout their residence at Yale.

**CBI Electives (One elective from each list is required):**

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<thead>
<tr>
<th>Biochemistry/Structural Biology</th>
<th>Cell and Molecular Biology</th>
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<tr>
<td>MBB600 Principles of Biochemistry I</td>
<td>MCDB603 Cell Biology</td>
</tr>
<tr>
<td>MBB601 Principles of Biochemistry II</td>
<td>MCDB625 Genetic Analysis</td>
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<tr>
<td>MBB720 Macromolecular Structure and Biophysical Analysis</td>
<td>MBB705 Mol Genetic Prokaryotes</td>
</tr>
<tr>
<td>MBB721 Macromolecular Interactions and Dynamic Properties</td>
<td>MBB734 Advanced Eukaryotes</td>
</tr>
<tr>
<td>Chem556 Biochemical Kinetics and Dynamics</td>
<td>MCDB570 Biotechnology</td>
</tr>
<tr>
<td>MCDB630 Biochemical and Biophysical Approaches</td>
<td>PHAR502 Pharmacology I/II</td>
</tr>
<tr>
<td>MBB800 Advanced Topics in Molecular Medicine</td>
<td>PHAR504 Principles of Pharmacology</td>
</tr>
<tr>
<td>Mechanisms of Disease: Organs and Systems (Second-year Yale Medical School pharmacology course)</td>
<td>CBIO601 Molecular &amp; Cellular Basis Of Human Disease</td>
</tr>
<tr>
<td>C&amp;MP500 From Molecules to Systems: Medical Physiology</td>
<td>C&amp;MP600, Medical Physiology Case Conferences</td>
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</tbody>
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**Second-Year Oral Examinations in Preparative Areas of Chemistry.** The requirements for the second year oral examination are slightly different for students formally enrolled in Organic Chemistry and Chemical Biology compared with those in Inorganic Chemistry. The specific requirements for the two different types of student are outlined below:

a. **Organic Chemistry and Chemical Biology.**
   The oral examination will consist of a two-hour-long examination based on a proposal for research on the topic of your thesis work. This proposal uses the format of an NIH fellowship proposal, and details are given in the Chemistry Graduate Student Handbook. You will be expected to demonstrate a thorough knowledge of the thesis area and related areas of chemistry and to discuss competently the results that have been obtained and the future direction of the project. The exam will emphasize fundamental chemistry, including the material of your course work. In addition to your performance during the oral and written part of the exam, you will be judged on progress in research. The chair of the examining committee will provide to the student and Registrar a written summary of recommendations. You should obtain a form for this purpose from the Registrar and bring it to the examination. The examination must be taken by May 31.

b. **Inorganic Chemistry**
   The oral examination in Preparative Inorganic Chemistry consists of two parts that will be administered on the same day. One part consists of a proposal for research on the topic of your thesis work, and the second part consists of a proposal on a topic separate from the thesis research. You will be expected to demonstrate a thorough knowledge of the thesis area and related areas of chemistry and to discuss competently the results that have been obtained and the future direction of the project. Both sections of the exam will emphasize fundamental chemistry, including the material of your course work. In addition to your performance during the oral and written part of the exam, you will be judged on progress in research. The chair of the examining committee will provide to the student and Registrar a written summary of recommendations. You should obtain a form for this purpose from the Registrar and bring it to the examination. The examination must be taken by May 31.
Biophysical Chemistry Course Requirements

Students are expected to carry three full-semester courses for credit each term of their first year for a total of **six credits**. These six courses are composed of the four required courses (see below), along with two additional elective courses. Programs will be designed in consultation with a designated faculty advisor using the following guidelines.

By the end of the second year in residence, it is expected that students will have obtained a solid background in physical and biological chemistry and an understanding of the major molecular biophysical methods (magnetic resonance and X-ray crystallography). The specific course requirements are listed below. Requirements may, however, be fulfilled in whole or in part through courses taken as an undergraduate.

In addition to the six required courses listed above, students supported by the Biophysics Training Grant will take the Biophysics Research Rotations and Ethics course, Chem 700, in their first year. Biophysical Chemistry students not supported on this training grant are encouraged to audit Chem 700. All students will audit Biophysical Chemistry Seminar Series (Chem 750) throughout their residence at Yale.

**Course requirements:**

1. Four one-semester courses in biophysical/physical chemistry:
   - Molecules and Radiation I (normally Chem 540a),
   - Biochemical Kinetics & Dynamics (normally Chem 556b),
   - Statistical Methods and Thermodynamics (normally Chem 530b),
   - Biophysical I (Chem 551a)

2. Two elective one-semester courses. We recommend that one be an advanced biological course, such as molecular biology, cell biology, chemical biology, or bioinorganic chemistry, and the other an advanced course on physical methods such as Biophysics II (Chem 558b) or computational chemistry. For students who have not taken biochemistry as an undergraduate, MB&B 600a/601b is required in addition to the above course requirements.

**Second-Year Oral Exams in Biophysical Chemistry.** Two oral exams with accompanying written reports must be passed during the second year: a thesis-area exam in the Fall term and an independent research proposal exam in the Spring term. The thesis-area exam covers the area of proposed thesis research and is intended to be more an advisory procedure than an academic hurdle. The second oral examination evaluates your design and research of a research project that is outside of your thesis research area.

For the first oral exam, it is expected that each student will think through, in detail, the particular research project about to be pursued. Students are encouraged to consult with other members of the faculty prior to making a long-term commitment to their research project. The examination will be administered by the two members of the student’s thesis committee and chaired by a third member substituting for the advisor. The written report is due on October 15, and the oral exam must take place before November 1.

The first Oral examinations should begin with no more than a ten-minute oral presentation by the student of the topic under question. Questions and responses that follow should probe the student’s knowledge of necessary background material and go beyond that specifically related to the thesis.

The second oral examination will be carried out in two steps. First, a written one paragraph summary detailing the project goals and the steps taken to achieve them is submitted for approval to the committee by the first Monday after spring break of the second year of residence. The final proposal is typically limited to about 10 pages and will follow the outline for an NIH-style grant application as for the first exam, except ‘Preliminary Results’ will, of course, not be included. This proposal is designed to test the student’s ability to assess the literature and successfully develop an independent project. The second oral must be original with the student, should be outside the area of thesis research, not too closely related to work currently being carried out within the department, and should not include a student’s previous undergraduate or industrial research or a trivial derivative thereof. In general, a proposal will be deemed to lie outside the thesis area if
the advanced literature survey required for its preparation shows, at most, minor overlap with that required for the thesis. The candidate must schedule the second oral examination before or during the week prior to final examinations. In addition to assessing the student’s progress in research, it is expected that the oral exam will explore questions of basic physical or biophysical chemistry to establish the broader context of the specific research plan. The focus of these broader issues will be drawn from the list of references explicitly stated in advance as part of the committee’s comments on the written progress report.

The committee should meet immediately before the second oral examination to discuss the student’s performance thus far in graduate school. The research supervisor should bring all of the student’s records kept by the graduate secretary to this meeting. In both exams, the committee chairman should provide to the student and registrar a written summary of recommendations. A form for this purpose should be obtained by the student from the registrar and brought to the examination.

**Time Required for Completion of Degree.** Although it is difficult to stipulate the exact time required for completion of the Ph.D. degree, 4-5 years is normal. Progress toward a degree after advancement to candidacy is evaluated largely on the basis of research potential. Yearly reports from the student are reviewed by the thesis advisor and submitted to the Graduate School. During the third or fourth year, if a student's advisor feels that the student is struggling, the thesis committee may be asked to provide an evaluation of the likelihood that the student will complete the thesis research project. **Teaching.** Being a Teaching Fellow for 2 semesters at the TF20 level is required for the Ph.D. in Chemistry.

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**Experimental Pathology (“ExPath”)**  
**Director of Graduate Studies: Themis Kyriakides, PhD**

**Course requirements:**
Generally, there are three to four terms of coursework required: two Pathology "core" courses (Pathology 650b- Cellular and Molecular Biology of Cancer, and Path 690a- Molecular Mechanisms of Disease), plus four other electives that can be tailored to meet the specific needs and interests of the individual student in consultation with the DGS. In the first year, there is also a required seminar course, in which students learn how to critically evaluate and present primary scientific literature. Some of these requirements may have been met during didactic training in Medical School, and the Path 690a 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:**
The Qualifying Exam of the Ex Path graduate program comprises: 1) two literature reading periods; 2) a research proposal based on the proposed thesis research project; and 3) an oral exam, in which the student is examined by the Qualifying Exam Committee on the research proposal, the reading periods, and general knowledge of experimental pathology. This exam is taken in the second term of the second year. The three components of the qualifying exam are described in detail below, as is the composition of the qualifying exam committee, and specific roles of those involved:

**The Qualifying Exam Committee:** This committee consists of three faculty members, with at least one having a primary or secondary appointment in the Department of Pathology. The qualifying exam committee is chosen by the student, in consultation with their thesis advisor, but its final composition requires approval by the DGS. The student will read with two committee members (see “Literature Reading Periods” section below) and write the research proposal with initial guidance from the third committee member. At the oral exam itself, one member of the committee will be selected as the chairperson and is responsible for documenting the results of the exam for submission to the DGS.
**Literature Reading Periods:** The first stage of the qualifying exam is the organization of the literature reading periods with two of the members of the examination committee. The subject for each reading period will be agreed upon by the student and the faculty member involved, and is to be broadly related to the thesis project. That is, in choosing the topics, care should be taken to avoid too narrow a focus, so that a greater depth of knowledge is achieved.

**Research Proposal:** The research proposal is based on the student’s thesis project research area. However, it is distinct from the “thesis prospectus.” The proposal should demonstrate the student's ability to recognize important, unsolved questions and to design experiments to answer them. The proposal, which is limited to 10 pages (with a minimum of 8 pages), should be written in the same general format as an NRSA postdoctoral fellowship proposal and concisely review the pertinent background information, logically and clearly state the questions being asked, and intelligibly lay out the experimental plan.

**The Oral Exam:** The oral examination will focus on the student’s ability to present and defend the research proposal. The student should come to the exam with a short (~30-40 minute) presentation of the thesis-related proposal with visual aids. The committee can also ask questions on topics covered during the reading period and general topics in experimental pathology that will have been covered in courses.

**Prospectus:**
Upon successful completion of the qualifying examination, the student will constitute a Dissertation Committee, including (at minimum) three 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 then be admitted to candidacy for the Ph.D. degree.

After completing their thesis research, the student must then submit a written thesis describing the research and present a public thesis research seminar.

**Courses**

**PATH 620a, PATH 621 a/b, PATH 622b, Laboratory Rotations in Experimental Pathology**
Themis Kyriakides
Laboratory rotations for first-year graduate students.

**PATH 640a/BBS 640a, Developing and Writing a Scientific Research Proposal**
Katerina Politi and Britta Kunkemoeller *(required for 2nd year students in Experimental Pathology)*
The course will cover the intricacies of scientific writing and guide students in the development of a scientific research proposal on the topic of their research. All elements of an NIH fellowship application will be covered and eligible students will submit their applications for funding. T 2-4:00 pm

**PATH 630b/ENAS 535bU, Biomaterial-Tissue Interactions**
Themis Kyriakides
The course addresses the interactions between tissues and biomaterials, with an emphasis on the importance of molecular- and cellular-level events in dictating the performance and longevity of clinically relevant devices. In addition, specific areas such as biomaterials for tissue engineering and the importance of stem/progenitor cells, and biomaterial-mediated gene and drug delivery are addressed. TTH 9–10:15
PATH 650b, Cellular and Molecular Biology of Cancer  David Stern, Qin Yan
A comprehensive survey of cancer research from the cellular to the clinical level. The relation of cancer to intracellular and intercellular regulation of cell proliferation is emphasized, as are animal models for cancer research. Background in molecular genetics and cell biology is assumed. Open to advanced undergraduates with permission of the organizers. MWF 1–2

PATH 660b/C&MP 650b/PHAR 580b, The Responsible Conduct of Research Barbara Ehrlich, Demetrios Braddock
Organized to foster discussion, the course is taught by faculty in the Pharmacology, Pathology, and Physiology departments and two or three senior graduate students. Each session is based on case studies from primary literature, reviews, and two texts: Francis Macrina’s Scientific Integrity and Kathy Barker’s At the Bench. Each week, students are required to submit a reaction paper discussing the reading assignment. Students take turns leading the class discussion; a final short paper on a hot topic in bioethics is required. TH 11–12:15

PATH 670b, Biological Mechanisms of Reaction to Injury S. David Hudnall, Joanna Gibson, Gilbert Moeckel, Jon Morrow, Jeffrey Sklar
An introduction to human biology and disease as a manifestation of reaction to injury. Topics include organ structure and function, cell injury, circulatory and inflammatory responses, disordered physiology, and neoplasia. TTH 11:35–12:50

PATH 680a/C&MP 630a/PHAR 502a, Seminar in Molecular Medicine, Pharmacology, and Physiology  Don Nguyen, Titus Boggon
Readings and discussion on a diverse range of current topics in molecular medicine, pharmacology, and physiology. The class emphasizes analysis of primary research literature and development of presentation and writing skills. Contemporary articles are assigned on a related topic every week, and a student leads discussions with input from faculty who are experts in the topic area. The overall goal is to cover a specific topic of medical relevance (e.g., cancer, neurodegeneration) from the perspective of three primary disciplines (i.e., physiology: normal function; pathology: abnormal function; and pharmacology: intervention). M 3-5:00 pm

PATH 681a/BBS 681a, Advanced Topics in Cancer Biology Qin Yan
This advanced graduate level course focuses on readings and discussion on 3-4 major topics in cancer biology, such as targeted therapy, tumor immunology, tumor metabolism, and genomic evolution of cancer. For each topic, the class starts with an interactive lecture, followed by critical analysis of primary research literature. Recent research articles are assigned on these topics, and a student leads discussions with input from faculty who are experts in the topic area. Pre-requisites: PATH 650b or at the discretion of the instructor. FRI 2-4:00 pm

PATH 690a, Molecular Mechanisms of Disease  Narendra Wajapeyee and Demetrios Braddock
This course covers aspects of the fundamental molecular and cellular mechanisms underlying various human diseases. Many of the disorders discussed represent major forms of infectious, degenerative, vascular, neoplastic, and inflammatory disease. Additionally, certain rarer diseases that illustrate good models for investigation and/or application of basic biologic principles are covered in the course. The objective is to highlight advances in experimental and molecular medicine as they relate to understanding the pathogenesis of disease and the formulation of therapies. T-TH 2–3:30

Genetics
Director of Graduate Studies: Mark Hammarlund
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. Apart from 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**

- GENE 760b, Genomic Methods for Genetic Analysis. James Noonan
- Graduate Student Seminar (2 semesters; GENE 675, graded Sat/Unsat)
- Scientific Ethics (GENE 901b, graded Sat/Unsat)

**Recommended Courses**

- Advanced Eukaryotic Molecular Biology (MB&B 743b)
- Biochemical and Biophysical Approaches in Molecular and Cellular Biology (MCDB 630b)
- 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 30th 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.

History of Science and Medicine (2017)
Director of Graduate Studies: Paola Bertucci

Special Requirements for the Ph.D. Degree
All students must show proficiency in two languages in addition to English relevant to the student’s research interests and approved by the Director of Graduate Studies (DGS) (in recent years these have included Bulgarian, French, German, Hebrew, Hindi, Italian, Japanese, Korean, Mandarin, Norwegian, Spanish and Swedish). Students may fulfill the requirement by passing an approved language course for credit, by passing a language test administered by the program faculty, by DGS approval of demonstrated command of a native language other than English, or by graduation from an approved foreign university where teaching was conducted in a language other than English.

Students will ordinarily take twelve courses during the first two years. All students will normally take the three core “Problems” seminars: Problems in History of Science, Problems in History of Medicine, and Problems in Science Studies. In addition, students will take four graduate seminars in history of science or medicine and at least one graduate course in a field of history outside of science or medicine. The remaining courses can be taken in history of medicine or science, history, science, or any other field of demonstrated special relevance to the student’s scholarly objectives. Two of the twelve courses must be graduate research seminars in the History of Science and Medicine.

At the end of each semester, the DGS will ask faculty members whether they have serious concerns about the academic progress of any first- or second-year students in the Ph.D. program. Faculty members who have such concerns will provide written feedback to the DGS at his or her request. The DGS will use his or her discretion to ensure that feedback is provided to any students about whom there are concerns in a clear and effective manner.

At the end of the academic year, the HSHM faculty will hold a special meeting to review each first- and second-year student in the program. The purpose of the meeting is to assess students’ academic progress. In order for second years to proceed to the third year, they must demonstrate through written work, classroom performance, and participation in departmental activities that they have the ability to: a) speak and write clearly; b) conduct independent research at a high level; and c) develop coherent scholarly arguments. A faculty vote will be taken at the conclusion of the review meeting to decide whether each second-year student may continue in the program. If a majority of faculty present and voting determine that a student may not continue, the student will be informed in writing and withdrawn from the program. The review meeting must be a full faculty meeting, but faculty members with no knowledge of the students under review may abstain from the vote, and their abstentions will not count in the total. Those members of the faculty who have worked with or know the students being evaluated are required to attend. In the event that any necessary faculty members absolutely cannot be present, they may send their views in writing to the DGS who will read them at the meeting.
Students who enter having previously completed graduate work may obtain up to three course credits toward the completion of the total course requirement, the amount being contingent on the extent and nature of the previous work and its fit with their intended course of study at Yale.

The Qualifying Examination
Prior to entering on their dissertation work, all students are expected to develop a broad general knowledge of the discipline. This knowledge will be acquired through a combination of course work, regular participation in the Program colloquia and workshops, and dedicated preparation for the qualifying oral examination. Students will normally spend the summer following their second year preparing for the oral Qualifying Examination, which will be taken in the third year, preferably during the first half of it.

The Qualifying Examination will normally consist of four fields, each of which will be examined by a separate faculty member:

- Two fields in the history of science and/or history of medicine.
- One field in an area of history outside of medicine and/or science.
- One field of special interest, the content and boundaries of which will be established in consultation with the student’s advisor.

Possibilities for the field of special interest include a second field in history outside of history of science or medicine, a field with a scientific or medical focus (such as bioethics, health policy, public health, medical anthropology, or medical sociology), or a field at the intersection of science, medicine, and other subjects (such as law, national security, religion, culture, biotechnology, gender, race, literature, the environment, and so on).

Teaching
Teaching is an important part of the professional preparation of graduate students in History of Medicine and Science. Students will teach, usually in the third and fourth years of study. They may, however, teach in the second semester of the second year, deferring the completion of their required course work to the first semester of the third year. Students are also encouraged to participate in the programs to develop teaching skills offered by the Graduate School. At least two terms of teaching are required of all students; four terms are required of students on Yale-supported fellowships.

Immunobiology
Director of Graduate Studies: Susan Kaech

M.D./Ph.D. Students Who Join Immunobiology
An M.D./Ph.D. student affiliates with the Immunobiology Graduate program through the MD/Ph.D. program. You will have chosen your research Ph.D. course of study after matriculating through the YSM, and completing one or more research rotations during the course of your first two years of medical school. In many cases, the first rotation is done during the summer between years one and two of medical school. MD-PhD are required to do a minimum of two rotations, which can be done during a single summer.

Once a thesis laboratory is selected, the student completes an application for a Ph.D. department filing it with both Cheryl DeFilippo and Barbara Cotton. M.D./Ph.D. students with interests in the Immunobiology Graduate Program should discuss their situation with the Director of Graduate Studies as early as possible and notify Barbara Cotton so that your graduate school paperwork can be processed.

You are typically further advanced than the traditional first year BBS graduate student, by the time you have joined Immunobiology. It is possible to defend your preprospectus (preliminary description of your
prospectus research) after the first semester and prospectus (preliminary description of your thesis project) after the second semester. Typically a student presents the preprospectus during a RIP research in progress seminar to the department at large. This is a good format for the student to gather further insight for the project.

Courses / Requirements

1. Six graduate level (science) courses, taken for a grade.
2. Ibio 530a: Biology of the Immune System
   a. Required unless consultation with DGS and course director determines that passing the previous year final exam shows sufficient knowledge in subject. Does not reduce the six course requirement
3. Ibio 531b: Advanced Immunology
4. Two advanced seminar courses (choose from IBIO 536, 537, 538, 539)
   b. Seminar courses are typically available every Fall and every other Spring. First seminar must be taken for a grade. If the student has completed six courses, then the seventh class (seminar) can be audited.
5. Ibio 601b, Responsible Conduct in Research, unless taken in medical school (Pass/Fail)
6. Ibio 503b, Responsible Conduct in Research, Refresher Course, 4th year students, unless taken in medical school.
7. Teaching: one semester–long science courses.
   –The Yale McDougal Center offers a one day seminar entitled “Teaching at Yale” Attending this seminar is recommended prior to teaching
8. Pre-prospectus and successful completion of prospectus exam, both oral and written components.
9. First committee meeting post your prospectus with a signed committee form verifying student is in good standing, together with advisor summary report of meeting, including IDP certificate.
10. Advance to Candidacy (all requirements met and committee report submitted, as discussed in #9)
11. Written dissertation, approved by Thesis Committee and an outside reader.
12. There is a very strong expectation that your thesis research will result in at least one first author primary research paper, published (or at the very least submitted) prior to the oral defense of your dissertation. Exceptions must be approved by your thesis committee and the DGS.
13. Oral Dissertation defense

In addition, students must fulfill all requirements set forth in the Yale University Graduate School Programs and Policies Manual.

Interdepartmental Computational Biology and Bioinformatics

Co-Directors of Graduate Studies: Mark Gerstein, Hongyu Zhao

Course Requirements (9): Nine courses are required plus a seminar on responsible conduct of research. Course distribution is: 3 required 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. With DGS approval, some courses taken toward the M.D. degree can be counted toward the nine required courses. Such courses must have a graduate course number and the student must register for them as graduate courses (in which grades are received). Students must fulfill the Graduate School requirement of 2 honors grades.
**Laboratory Rotations:** Rotations are available but not required.

**Teaching:** One teaching assistantship is required.

**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 4th term after CBB affiliation.

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

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

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**Interdepartmental Neuroscience Program (INP) - 2016**

**Director of Graduate Studies: Charles Greer**

**Course Requirements (3):**
Three courses are required, and students must obtain a grade of Honors in two of these courses. This must be completed by the end of the second year of full time graduate work. Required courses are Principles of Neuroscience (INP 701a) and Structural and Functional Analysis of the Human Nervous System (Neurobiology 500b). One more elective graduate level course is required. Graduate courses taken during the first two years of medical school will count towards the student's elective requirement in the INP, provided the student has registered to receive a graduate grade in the course. Examples are CBIO 601 and 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. The INP also requires affiliated MD/PhD students to register for INP 513 a/b Second-Year Thesis Research in the first two semesters of affiliation with the graduate program.

**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. If affiliation begins in September of the third year, then the qualifying exam must be completed by the end of May of that year.

**Prospectus:**
MD-PhD students must complete and submit their thesis prospectus by the end of the second year as an affiliated graduate student. If affiliation begins in September of the third year, then the prospectus must be submitted and approved by the end of May of the fourth year.
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 student research talks as well as INP-sponsored journal clubs and other INP-sponsored events.

**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.

**Typical 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 requirement 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:** With the advent of the new curriculum, students will affiliate with their thesis lab in September of the third year. All paperwork should be completed (affiliation form completed and copy of student’s academic record including application transferred to the Interdepartmental Neuroscience Program Office). 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.

**Year Four:** The Thesis Prospectus must be approved and submitted to the Graduate School by the end of the second year of laboratory/PI affiliation. 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 Five:** Dissertation research in residence continues.

**Year Six:** 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.

Medical Anthropology (2015)
Director of Graduate Studies: David Watts

Course Requirements
All students in the MD-PhD program in Medical Anthropology will complete six graduate courses and original doctoral research as follows:

- One graduate theory seminar (“Medical Anthropology at the Intersections: Theory and Ethnography,” “Topics and Issues in Evolutionary Theory,” or “Evolutionary Perspectives on Health and Disease”)
- One graduate topical seminar in medical anthropology and global health (“Global Health: Ethnographic Perspectives” or “Health Disparities and Health Inequities”)
- One graduate research seminar that includes professional development in research methods (“Research in Sociocultural Anthropology: Design, Methods, and Proposal Writing” or other courses with the approval of the Medical Anthropology faculty)
- Three distributional seminars from a list of elective graduate courses in medical anthropology (see below)
- Completion of a dissertation prospectus approved by the dissertation advisory committee (DAC) chair (due before registration for the 4th year)
- Completion of a doctoral project, which includes field research conducted during the fourth (and possibly fifth) year of the program
- Completion of a PhD dissertation, approved by the dissertation advisory committee, which will consist of the chair and at least two other faculty members, one of whom must be a Yale ladder track faculty member.

Dissertation Advisory Committee (DAC)
The DAC must consist of at least 3 full-time Yale faculty members, at least one of whom must be ladder faculty in the Department of Anthropology (Assistant, Associate on Term, Associate, or full Professor). A third committee member may be from outside Yale, if appropriate.

Qualifying Examination
Each student will take written and oral qualifying examinations, usually at the end of the second year of medical anthropology coursework. With consultation from the student’s dissertation advisory committee, the student will cover three areas of chosen concentration in medical anthropology, based on coursework completed. Following the written examination, each student will undertake an oral examination with the dissertation advisory committee, with questions and answers expanding upon the written exams. Students who are successful in their qualifying exams will advance to PhD candidacy. Some students may pass their qualifying exams with distinction. Those who do not pass may petition for a terminal M.Phil. degree in accordance with the rules set forth by the Graduate School of Arts and Sciences.
Courses for Medical Anthropology MD-PhD students

Theory Seminar

ANTH 548b, Medical Anthropology at the Intersections: Theory and Ethnography. Marcia C. Inhorn. The subfield of medical anthropology boasts a rich theoretical and empirical scholarly tradition, in which a significant number of critically acclaimed, award-winning ethnographies have been written on topics ranging from embodiment and local biologies to the health problems engendered by structural and political violence. Many medical anthropology scholars engage across the social science and humanities disciplines, drawing upon history, philosophy, political science, cultural studies, science and technology studies, and gender studies perspectives in their writing. In addition, medical anthropology intersects with medicine and public health, offering both critiques and applied interventions. This graduate seminar showcases the theoretical and ethnographic engagements of more than a dozen disciplinary leaders in the subfield of medical anthropology. Guided by the key text, Medical Anthropology at the Intersections: Histories, Activisms, and Futures—which was based on Yale’s historic medical anthropology conference held in 2009—the course will explore the canonical works of a number of leading medical anthropological theorists. Three major foci of medical anthropological engagement will be highlighted, including 1) structural violence and social suffering, 2) gender, technoscience, and embodiment, and 3) global health and humanitarianism.

ANTH 851a, Topics and Issues in Evolutionary Theory. Biological Anthropology Faculty. This seminar aims to provide students with a basic understanding of the theory of evolution by natural selection. Readings are drawn from various sources including the paleontological, comparative, and human evolutionary biology literature. The goal is to provide students with a comprehension of the biological mechanisms that have shaped our species as well as the historical context in which this theory has been developed.

ANTH 8xx, Evolutionary Perspectives on Health and Disease. Biological Anthropology Faculty. This seminar aims to introduce students to advanced concepts related to the role of evolutionary biology in the understanding, development, and treatment of health and disease. This includes the application of evolutionary and life history theory towards questions of degenerative and infectious disease, diseases of modern society and globalization such as obesity and reproductive cancers, health disparities, epidemiology, and demography.

Topical Seminar in Medical Anthropology and Global Health

ANTH 523/GLBL 823, Health Disparities and Health Equity. Catherine Panter-Brick. Current debates in medical anthropology and global health specifically focus on health disparities and health equity. Faculty working in this area adopt a biocultural approach, based on the understanding that biological and cultural issues intersect in matters of health research and health intervention. Four thematic areas are addressed including: biomedical perspectives on health; poverty, inequality, and health; health interventions; and structural violence and health. Knowledge of conceptual and theoretical issues and debates in the field of health disparities is emphasized, especially those located at the intersection of biology and society. Faculty in this area encourage critical thinking regarding health disparity and equity issues across cultures and their relevance for research and policy, using compelling case studies of health disparities and equity issues in a variety of global sites.

ANTH 640/GLBL 624, Global Health: Ethnographic Perspectives. Marcia C. Inhorn. This interdisciplinary seminar, designed for graduate students in Anthropology and Global Health, explores in an in-depth fashion anthropological ethnographies on many of the serious health problems facing populations in resource-poor societies around the globe. The course focuses on three major issues: (1) poverty, structural violence, and health as a human right; (2) struggles with infectious disease; and (3) the health of women and
children (and men, too). Within these three themes, many major issues of global health concern are addressed, including the health-demoting effects of poverty, racism, patriarchy, and inhumane conditions of life and labor in many countries; men's and women's sexuality in the era of HIV/AIDS; the politics of epidemic disease control and other disasters, and the role of communities, nation-states, and international organizations in responding to such crises; issues of coercion in population control and the quest for reproductive rights; and how child health is ultimately dependent on the health and well-being of mothers. The underlying purpose of the course is to develop students' awareness of the political, socioeconomic, ecological, and cultural complexity of most health problems in so-called developing nations and the consequent need for anthropological sensitivity, contextualization, and activist involvement in the field of global health. The course is also designed to expose students to salient health issues in many parts of the world from the United States to China. However, the primary focus is on global health issues facing sub-Saharan Africa and Latin America.

Research Seminar
ANTH 502, Research in Sociocultural Anthropology: Design, Methods, and Proposal Writing. Marcia C. Inhorn. This graduate seminar for anthropology doctoral students is designed to provide a comprehensive overview of the ethnographic research enterprise. The course focuses on ethics and entrée to the research setting, ethnographic research design, interview-based and observational methods of data collection and documentation, and ethnographic data analysis. A major goal of the course is preparation of a doctoral dissertation field research proposal, in National Science Foundation (NSF) Cultural Anthropology format, which incorporates the skills and approaches discussed in class

Distributional Seminars: Elective Courses for Medical Anthropology MD-PhD students
ANTH/WGSS 651, Intersectionality and Women’s Health: Ethnographic Approaches to Race, Class, Gender, and “Difference.” Marcia C. Inhorn. This interdisciplinary, graduate seminar, designed for students in medical anthropology, women’s studies, and related fields, explores contemporary intersectionality theory: namely, how the intersections of race/class/gender and other axes of oppression (e.g., based on age, ethnicity, ability) affect women’s lives and women’s health in the contemporary United States. In this course, recent feminist approaches to intersectionality theory will first be introduced. Then intersectionality will be explored through anthropological ethnographies that highlight the multiple forms of oppression faced by poor women of color in the United States.

ANTH 655/WGSS 659, Masculinity and Men’s Health. Marcia C. Inhorn. This interdisciplinary seminar, designed for students in Anthropology; Women's, Gender, and Sexuality Studies; and Global Health, explores in an in-depth fashion ethnographic approaches to masculinity and men's health around the globe. The course begins with two theoretical texts on masculinity, followed by eleven anthropological ethnographies on various dimensions of men's health and well-being. Students gain broad exposure to a number of exigent global men's health issues, issues of ethnographic research design and methodology, and the interdisciplinary theorizing of masculinity scholars in anthropology, sociology, and cultural studies. In particular, the course demonstrates how anthropologists studying men's health issues in a variety of Western and non-Western sites, including the Middle East, Africa, Latin America, and Asia, have contributed to both social theory and ethnographic scholarship of importance to health policy.

ANTH/GLBL 628a, Conflict, Resilience, and Health. Catherine Panter-Brick. This course reviews issues at the nexus of health, resilience, and conflict — including military, ethnic, religious, and interpersonal types of violence. We draw readings from the health-related social sciences literature to examine three main issues: (i) the impact of violence on physical, emotional, and social suffering; (ii) the nature and drivers of collective, interpersonal, and structural violence; and (iii) the personal, family, community, and governmental dimensions of resilience, namely the ability to bounce back from significant life adversity. We also examine specific
work in humanitarian settings to discuss the global agenda and the ethics of research and intervention projects. Materials from this course include case studies encompassing different cultural and geographic contexts, and work across the fields of health, social sciences, humanitarian policy, and human rights. The course thus offers an interdisciplinary overview and a practical understanding of issues related to health, resilience, and governance in conflict settings, at global and local level. For example, we examine which types of conflict exposures – from military to domestic violence – are the most salient for local communities in contexts such as the Gaza strip and Afghanistan. We review current debates on trauma, social suffering, and structural violence for displaced populations such as refugees and asylum-seekers. We look at responses to violent conflict for under-studied groups such as the next generation of adolescent youth. We examine the scope and implementation of health programs and the work of human rights and international aid workers in the midst of intractable conflicts and fragile states.

**ANTH 803b, Reproductive Ecology. Richard Bribiescas.** This course will survey various topics and issues relating to the proximate mechanisms of human and comparative reproductive biology, with specific attention devoted to life history trade-offs, human biological variation, phenotypic plasticity, as well as ecological and social stresses. Critical analysis of the validity of life history hypotheses as illustrated by experimental tests and clinical data will be the primary focus of discussion.

**ANTH 843a, Evolutionary Biology of Human Aging. Richard Bribiescas.** Aging is an aspect of evolutionary biology that is common to the life histories all organisms, including humans. Moreover, humans exhibit biological characteristics of aging that are both unique to our species and common to other organisms. This seminar aims to address how human aging has evolved and how it may inform our present understanding of age-related diseases. Topics to be covered include the somatic and behavioral aspects of aging, male and female reproductive senescence, the relationship between investment in reproduction and rates of aging, as well as the comparative physiology of aging.

**ANTH 890, Health of Indigenous Peoples. Claudia Valeggia.** From the highlands of the Andes to the lowlands of the Amazon basin and the frozen circumpolar steppes, from subsistence farmers and herders to hunter-gatherer groups, indigenous populations are changing their lifestyle so rapidly, and sometimes so profoundly, that it is difficult to follow the pace of the transformation. Indigenous peoples always fare far worse than non-indigenous ones in terms of health status. No matter where one looks, there are substantial health disparities between indigenous and non-indigenous populations in the form of mortality and morbidity gaps. This seminar will go over the epidemiological landscape of indigenous populations and discuss causes of death and sickness, which vary from population to population. We will then expand on some of the possible interactive causes of these disparities, particularly the role that globalization and market integration is having in shaping the health situation of indigenous peoples. Finally, we will discuss the current surge of Global Health Programs, mainly at academic or research institutions in the northern hemisphere and the contribution of anthropology to those programs.

**ANTH 8xx, Ethnopediatrics. Claudia Valeggia.** Women in certain cultures wean their babies when they are days old, while others do so when the child decides to wean him/herself (years). Babies in some hunter-gatherer populations never crawl and only start walking when they are 18 months old and older. Babies in Western, industrialized populations are encouraged to crawl and walk at much earlier ages. Many infants are circumcised at birth and others at puberty. In most populations, babies sleep with their mothers for several years, while in the US, it is expected that they sleep through the night in a separate room as early as possible. How do all these ways of raising children affect their growth and development? Are there universal patterns on child rearing? Can an evolutionary perspective contribute to a better understanding of variation in the way we raise our children and in their health patterns? In this course, we will discuss how the health, growth, and
development of children are shaped by the interactive actions of human evolutionary biology, ecology, and local cultural patterns. Examples from current and past cultures as well as from non-human primate species, will be analyzed. This seminar-style graduate and advanced undergraduate course has two main objectives: 1) to provide an overview of the latest advances in ethnopediatrics, and 2) the mechanics of writing a research proposal in biological anthropology and related fields. We will discuss readings and exchange ideas on the different directions that this relatively new discipline may take. As a way of reviewing the material and train ourselves to present our ideas to a funding agency, we will write individual research proposals.

Microbiology
Director of Graduate Studies: Walther Mothes

Required Courses (3): MD-PhD students must take a minimum of three courses, two of which must be Microbiology courses. All students must obtain two Honors grades in their courses to remain in good academic standing. Credit may be given for advanced courses taken in the 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: MD/PhD students are encouraged to think carefully about choosing a mentor and may need to perform up to three rotations to make this important choice. They are encouraged to begin rotations during the summer after their first year at Yale. However, if the MD/PhD student identifies a mentor early during the course of the rotations, he or she is not be required to complete three rotations if the proposed mentor and DGS support the choice of the student.

Teaching: MD-PhD students are required to fulfill 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 exam should take place as soon as practical, and certainly before entering their third year in the PhD program. For details on the exam, please consult the Microbiology Program Handbook.

Prospectus: MD-PhD students should submit their prospectus after experimental work has validated that the qualifying proposal represents a good outline for the thesis project. In this case the qualifying proposal will be accepted as the prospectus. If the project changes significantly the student is encouraged to write a new prospectus.

Candidacy: MD-PhD students will be admitted to candidacy once they have completed their coursework and obtained two 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: Yong Xiong

Required Courses (3): All students are required to fulfill the following requirements:
- MB&B 800, Advanced Topics in Molecular Medicine. Students must register for this course, which is taken in the first year of Medical School, and take it for a grade.
• MB&B 720, Macromolecular Structure and Biophysical Analysis.
• A second course in molecular biophysics. Lists of approved courses fulfilling this requirement are available from the DGS and are listed in the MB&B and BQBS handbooks.

Students are also encouraged to take MB&B 730, Methods & Logic in Molecular Biology, although it is not required. Enrollment is limited to students who have already joined the MB&B department. In addition, students with weak backgrounds in molecular biology should take MB&B 743 and students who have not had a course in Physical Chemistry (Thermodynamics) should take CHEM 328. It is anticipated that students who affiliate with MB&B will have taken such courses in college and that few students will need to take either MB&B 743 or CHEM 328. Please consult the DGS for a discussion of individual circumstances.

Students are required to attain at least two grades of Honors and to maintain a High Pass average.

Participation in a short discussion course in Responsible Conduct of Research (MB&B 676) is required but may be replaced with the MD/PhD RCR course.

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

**Teaching in one course is required of MD-PhD students.** Additional teaching is available.

**Qualifying exam:** One written proposal with two parts that must be defended orally. One part is in a chemical/biophysical area and one in a biochemical/molecular biological area. One of these parts must be the proposed thesis research. The other must be extended goals with unrelated approaches and distinct angles toward solving the proposed biological problems.

**Molecular, Cellular and Developmental Biology**

**Director of Graduate Studies: Farren Isaacs**

**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 for MDPhD students.**

**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 Fall semester of the student’s second year to be 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. Students must also attend a weekly student research in progress seminar where each student will present yearly.

Pharmacology
Director of Graduate Studies: Elias Lolis

Course Requirements (5):
Graduate students are required to take PHAR 504a Principles in Pharmacology, a two-semester seminar course PHAR 502a/b or equivalent from another department, and two of the three other Pharmacology courses in the curriculum. These three courses are, PHAR 528a Principles of Signal Transduction, PHAR 529b Structural Pharmacology and PHAR 550a Physiological Systems; PHAR 560b Cellular and Molecular Physiology: Molecular Machines in Human Disease may be substituted for PHAR 550a. The Graduate School requires a grade of Honors in two of these courses, which does not include the seminar course. Courses taken during the first two years of medical school in the Departments of Pathology, Cell Biology, Genetics, Physiology, and Pharmacology will count towards the student's Honors and course requirements, provided the student has registered to receive a graduate grade in the course. Students must maintain an overall High Pass average for the Graduate School courses.

Laboratory Rotations: Two rotations (PHAR 506a/b) 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 semester.

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. Prior to registering for a second year of study as a graduate student, students must successfully complete PHAR 580, Responsible Conduct of Research. In addition, two lectures from PHAR 580b and one lecture from B&BS 503b RCR Refresher for senior students, must be completed prior to end of the fourth year as an affiliated graduate student.
Affiliation Requirement:
For affiliation with the Pharmacology Department, copies of the student’s application to the MD-PhD Program, and the student’s current transcript must be submitted to the DGS of Pharmacology.

Public Health
Director of Graduate Studies: Christian Tschudi
All MD-PhD students must meet with the Director of Graduate Studies (DGS) in Public Health (PH), if they are considering affiliating with PH. 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 term of teaching will be required. If students teach beyond this requirement, they can be compensated. If a student has served as a teaching fellowship elsewhere on campus, this experience may be counted toward the requirement. DGS approval is required to waive the teaching requirement on the basis of previous Yale teaching experience.

Rotations/Internships: Students should do two research rotations/internships with potential advisors in PH. The purpose of these rotations/internships is to learn lab technique and/or to allow the student time to determine if the PI’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 course work. In some cases students may need to defer this requirement 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. Departmental 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 in years one and two. Students can take PH doctoral courses in years one and two before they affiliate if scheduling allows. Once affiliated with the PH program, students will complete all course requirements for the department. This generally takes a minimum of two terms but can take up to four terms after affiliating with PH. The qualifying exam is commonly completed after the fourth term of affiliation with the PhD program in PH but can sometimes be done earlier with approval of the PhD advisor and DGS.

Prospectus Timeline: Following completion of the qualifying exam, students should focus on the prospectus, which has to be approved by the PH Graduate Studies Executive Committee (GSEC) before the end of their 6th term as an affiliated PhD student in PH.

Admission to Candidacy: To be admitted to candidacy, students must: (1) satisfactorily complete the course requirements for their department as outlined above, achieve grades of Honors in at least two full-term courses, and achieve an overall High Pass average; (2) obtain an average grade of High Pass on the qualifying exam; and (3) have the dissertation prospectus approved by the Graduate Studies Executive Committee. All PhD students must be admitted to candidacy before the start of the fourth year in the PhD program (i.e., before the start of the 7th term).