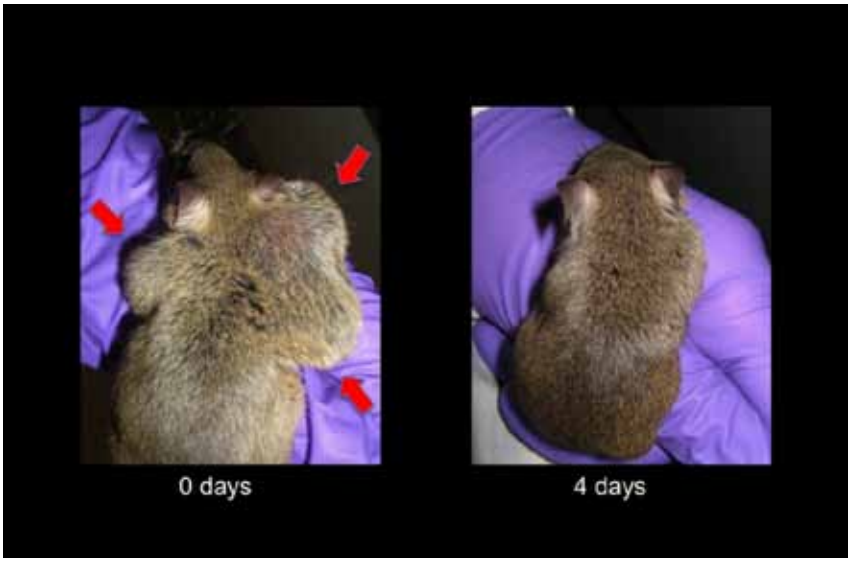
Yale University

The Biology Major



Offered jointly by the Departments of:

Ecology & Evolutionary Biology
Molecular, Cellular & Developmental Biology
2011-2012

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INTRODUCTION

The Major in Biology at Yale University

The life sciences have an underlying cohesiveness that spans the domains of molecules, cells, organisms, and ecosystems and includes investigating the natural processes responsible for the diversity of living forms. Biology is currently undergoing an explosion of discovery, with implications for the analysis and treatment of human disease, biotechnology, and the capacity to recognize and deal with human impact on the environment.

The departments of Ecology and Evolutionary Biology (EEB) and Molecular, Cellular & Developmental Biology (MCDB) offer the major in biology jointly. Each department offers an area of concentration within the major that reflects its perspectives and approaches to research while allowing students flexibility in drawing electives from both departments. There are also two interdisciplinary tracks - in biotechnology and neurobiology - offered within the MCDB area of concentration. The major offers B.A., B.S., intensive B.S., and combined B.S./M.S. programs, the latter two for students who wish to devote more time to research.

Yale is a leading institution for research in the biological sciences, and during their stay at Yale, students have many opportunities to carry out independent research under the supervision of faculty members. In addition to the EEB and MCDB departments, there are over 200 bioscience laboratories on the Yale campus, including those at the School of Medicine and the School of Forestry & Environmental Studies. Hence, the research topics that undergraduates can pursue are as diverse as the interests of the entire bioscience community at Yale. Subjects studied include molecular genetics and biochemistry, developmental biology, neurobiology, human physiology, plant science, organismic biology, evolution, systematics, and ecology. Research is usually taken for either course credit and/or performed during the summer. In addition to lecture, seminar, and research courses, students may arrange tutorials to study topics not covered by the traditional curriculum. Finally, students are encouraged to attend departmental seminars featuring lectures on the research of the Yale faculty and of visiting scientists.

The teaching and research facilities in biology are distributed in three buildings: Osborn Memorial Laboratories, Kline Biology Tower, and the Environmental Science Center. There are about 60 faculty members, 120 postdoctoral fellows, and 83 graduate students and approximately 300 Biology majors that work and study in these buildings. The quality and breadth of expertise in this biological community has made Yale a premier center for both students and scientists.

What can being a Biology Major do for me?

The major in biology contributes to a liberal education as well as providing excellent preparation for a wide range of professional careers in medicine, public health, the pharmaceutical industry, science writing, teaching, conservation, as well as biological research. Biology undergraduates at Yale have a high rate of acceptance at medical and graduate schools. Today, with the use of genetic testing in court cases, the patenting of biological products, and procedures for assessing environmental impact, this major can also be helpful in law and business careers.

Programs for Students Majoring in Other Subjects

For students who do not intend to major in Biology, the two departments offer a variety of courses that have no prerequisites.

EEB115a, Conservation Biology
EEB 122b, Principles of Evolution, Ecology and Behavior
EEB 125b, History of Life
EEB 160b, Diversity of Life
EEB 210a/MCDB 215a, Introduction to Statistics: Life Sciences
EEB 246b/EEB247Lb, Plant Diversity & Evolutionary Biology, & Lab
EEB 250a/EEB251La, Biology of Terrestrial Arthropods, & Lab
EEB 255b/EEB256Lb, Invertebrates, & Lab
EEB 264a/EEB265La, Ichthyology & Lab
EEB 272b, & EEB 373Lb, Ornithology & Lab
MCDB 105a or b, An Issues Approach to Biology
MCDB 107a, Human Biology
MCDB 109b, Immunology and Microorganisms
MCDB 135b, How the Brain Works
MCDB 120a, Principles of Molecular, Cellular & Developmental Biology
MCDB 150b, Global Problems of Population Growth

EEB115a, Conservation Biology, An introduction to ecological and evolutionary principles underpinning efforts to conserve Earth's biodiversity. Efforts to halt the rapid increase in disappearance of both plants and animals. Discussion of sociological and economic issues.

EEB 122b, Principles of Evolution, Ecology, and Behavior, together with MCDB 120a, provides a solid foundation in modern biological science.

EEB 125b, History of Life, an examination of fossil and geologic evidence pertaining to the origin, evolution, and history of life on Earth. Emphasis on major events in the history of life, on what the fossil record tells us about the evolutionary process, on the diversity of ancient and living organisms, and on the evolutionary impact of the changing environment of the Earth.

EEB 160b, Diversity of Life, introduces the diversity of living forms with an emphasis on their evolutionary origins and ecological roles. General evolutionary and ecological principles are taught in the context of understanding diversity of microbes, plants, and animals.

EEB 210a/MCDB 215a, Introduction to Statistics: Life Sciences, presents the statistical and probabilistic analysis of biological problems with a unified foundation in basic statistical theory. Problems are drawn from genetics, ecology, epidemiology, and bioinformatics.

EEB 246b^{G}. Plant Diversity & Evolution, Introduction to the evolutionary relationships of plant lineages. The complexity, diversity, and characteristics of the major plant groups, including the green algae, mosses, ferns, conifers, and flowering plants, within a phylogenetic context. *To be taken concurrently with EEB 247Lb. Prerequisite: a general understanding of introductory biology and evolution.*

EEB 247Lb[G]. Laboratory for Plant Diversity & Evolution, Local flora field research; hands-on experience with the plant groups examined in the accompanying lectures. *To be taken concurrently with EEB 246b*.

EEB 250a[G]. Biology of Terrestrial Arthropods, Evolutionary history and diversity of terrestrial arthropods (body plan, phylogenetic relationships, fossil record); physiology and functional morphology (water relations, thermoregulation, energetics of flying and singing); reproduction (biology of reproduction, life cycles, metamorphosis, parental care); behavior (migration, communication, mating systems, evolution of 32 sociality); ecology (parasitism, mutualism, predator-prey interactions, competition, plant-insect interactions). *After EEB 122b.*

EEB 251La[G] . Laboratory for Biology of Terrestrial Arthropods, Comparative anatomy, dissections, identification and classification of terrestrial arthropods; specimen collection; field trips. *Concurrently with or after EEB 250a.*

EEB 255b[G] . Invertebrates I, A systematic treatment of the invertebrate phyla, with emphasis on anatomy, functional organization, and evolutionary history. *Prerequisite After EEB 122b or G&G 125b or with permission of instructor.*

EEB 256Lb[G] . Laboratory for the Invertebrates I, Study of the anatomy of representative living invertebrates accompanied by examination of museum specimens of living and fossil invertebrates. *Prerequisite Concurrently with EEB 255b.*

EEB 264a[G] . Ichthyology, A survey of fish diversity, including jawless vertebrates, chimaeras and sharks, lungfishes, and ray-finned fishes. Topics include the evolutionary origin of vertebrates, the fossil record of fishes and evolutionary diversification of major extant fish lineages, biogeography, ecology, and reproductive strategies of fishes.

EEB 265La[G] Laboratory for Ichthyology, Laboratory and field studies of fish diversity, form, function, behavior, and classification. This course primarily involves study of museum specimens and of living and fossil fishes. *Concurrently with EEB 264a.*

EEB 272b[G] . Ornithology, A general overview of avian biology and evolution, including the structure, function, behavior, and diversity of birds. Topics include the evolutionary origin of birds, avian phylogeny, anatomy, physiology, neurobiology, breeding systems, and biogeography.

*EEB 273Lb[G] . Laboratory for Ornithology, Laboratory and field studies of avian morphology, diversity, phylogeny, classification, identification, and behavior. *Must be taken concurrently with EEB 272b.*

MCDB 105a or b, An Issues Approach to Biology, focuses on biological concepts in the context of current societal issues such as stem cell research and genetically modified organisms.

MCDB 107a, Human Biology, introduces the fundamentals of human anatomy and physiology.

MCDB 109b, Immunology and Microorganisms, introduces students to immunology, microorganisms, and the interaction between them.

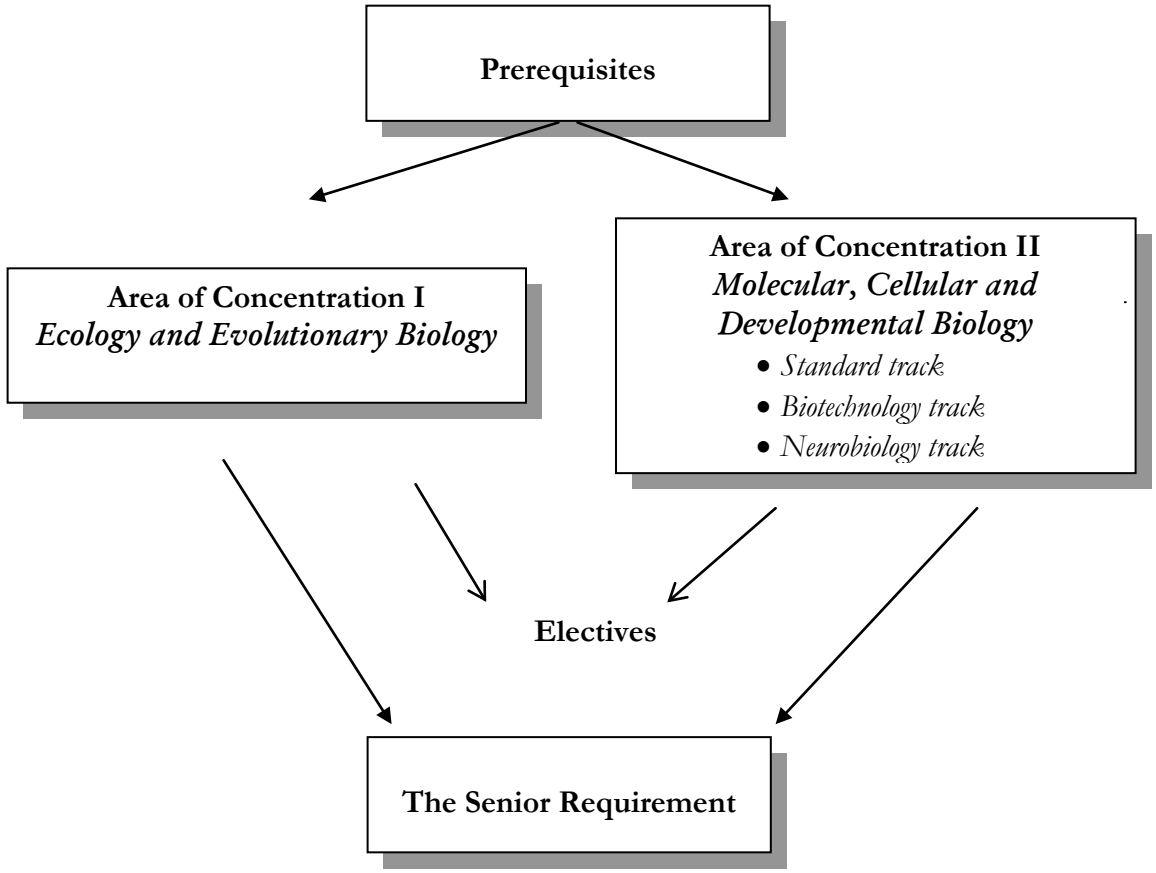
MCDB 120a, Principles of Molecular, Cellular & Developmental Biology, is for prospective majors, premedical students, and others who want a thorough introduction to biology. It is ordinarily followed by EEB 122b.

MCDB 135b, How the Brain Works, is for non-science majors who wish to understand the biology of the brain. In trying to understand how the brain works, the gross anatomy of the brain as well as the cellular components that makes up nervous tissue, will be discussed.

MCDB 150b, Global Problems of Population Growth, introduces students to the human, environmental, and economic consequences of the population explosion. Topics include political, religious, and ethical issues surrounding fertility, including contraception, abortion, human rights, and the status of women.

An Overview of the Programs for Majors

The programs in the Biology major are designed to enhance a liberal education as well as offer excellent preparation for professional and graduate study in the biological or environmental sciences, and in medicine and other health-related fields. After a common set of prerequisite courses, the major is organized around two Areas of Concentration that reflect the interests and perspectives of faculty in the two participating departments. The following diagram provides an overview of the major; details are provided on the following pages.



Each area of concentration has its own core requirements (described below), but the number of required courses is the same for each. In addition to the standard major, MCDB offers two interdisciplinary programs of study in the biotechnology and neurobiology tracks. Once the requirements for the area of concentration have been met, students can choose electives from the other participating department, from Molecular Biophysics and Biochemistry (MB&B), and from certain other departments. When in doubt, consult the director of undergraduate studies in your area of concentration.

All majors in biology have the same choices for meeting the senior requirement. As described below, the requirements differ for the B.A., the B.S., the B.S. intensive major, and the combined B.S./M.S. degrees.

Prerequisites and How They Can Be Met

Prerequisites

Biology		
Introductory	2 terms	MCDB 120a and EEB 122b
Introductory Lab	1 term	MCDB 121La or EEB 123Lb
Chemistry		
General	2 terms	Chem 112a, 113b or 114a, 115b
Or	1 term	Chem 118a
General Labs	2 terms	Chem 116La, 117Lb
	(unless 118a is taken, then 1 term is required)	
Organic	1 term	Chem 124a or 220a or 225b
Organic Lab	1 term	Chem 126L or 222L
Physics		
General	2 terms	Phys 170a, 171b or higher
Math		
Calculus	1 term	Math 115 or higher
	(not including Math 190)	

A number of these prerequisites can be met with acceleration credits. Students who have scored 710 or higher on the SAT subject matter Biology M test (formerly SAT II), or who have scored 5 on the Advanced Placement test in biology, may be exempt from taking MCDB 120a and its associated laboratory. Students scoring 5 on the Advanced Placement biology test may also be exempt from EEB 122b and its associated laboratory, but students are not permitted to place out of EEB 122b and 123Lb using the SAT subject matter test M or E. Students with equivalent scores on one of the corresponding chemistry tests may also be exempt from taking MCDB 120a, but should first discuss their preparation in biology with the director of undergraduate studies in MCDB.

Acceleration credit awarded in chemistry, mathematics, and physics, or completion of advanced courses in those departments, is accepted instead of the relevant prerequisites for the Biology major. Students who already have mathematics preparation equivalent to MATH 115a or b or higher are encouraged to take additional mathematics, such as MATH 120a or b, 222a or b, or 225a or b or statistics (e.g. STAT 101a/EEB 210a/MCDB 215a).

Premedical students will likely need to take the laboratory with introductory physics, although it is not required for the major in Biology. Premedical students should consider the advisability of taking both terms of the introductory biology laboratories (MCDB 121La and EEB 123Lb). Note that the premedical requirements and the prerequisites for both Biology and MB&B majors are substantially the same, so students do not have to choose among these paths during their freshman year.

Core Requirements and Electives in Ecology and Evolutionary Biology

Area I: ***Ecology and Evolutionary Biology***

Core courses Class of 2010 and later
- MCDB 202a (Genetics)
- EEB 210a or the equivalent (Statistics)
- EEB 220a, General Ecology
- EEB 225b, Evolutionary Biology
- Organismal Biology (Choose one)

Electives
- Two electives at 200 level or higher

Laboratories
- Two biology laboratories above the introductory level

Two laboratories are also required for the major. In addition to laboratories associated with the Organismal courses, EEB 251La, 226Lb and MCDB 203La can also be used to fulfill this requirement.

Core Requirements and Electives in Molecular, Cellular & Developmental Biology

The Standard Major

Area II: ***Molecular, Cellular & Developmental Biology***

- *The Standard Track*

Core courses

MCDB 202a (Genetics)
MCDB 300b (Biochemistry) or its equivalent*****
Either MCDB 205b (Cell Biology) *or* MCDB 210b (Developmental Biology)

Electives

Four credits. See notes below

Laboratories

Two biology laboratories at the level of 200 or higher

The standard major requires four electives, including three from MCDB (numbered 150 or above), EEB (numbered 140 or above), or MB&B (numbered 200 or above), and one MCDB elective at the 350 level or higher. A relevant intermediate or advanced course from another department in science, mathematics, or statistics may be accepted as an elective with permission of the director of undergraduate studies. Two laboratory courses from MCDB 342La, 343La, 344Lb and 345Lb can be used together as one elective credit. If used as an elective, these laboratories cannot also fulfill the laboratory requirement.

One of the two required laboratories at the level of 200 or higher can be selected from courses in EEB or MB&B.

*Equivalents for MCDB 300b are defined as either (a) both MB&B 300a and 301b or (b) MB&B 300a only, if the student has also taken MCDB 120a or 200b or has the permission of the director of undergraduate studies in MCDB. For this purpose, placing out of MCDB 120a is not the equivalent of having taken MCDB 120a.

Interdisciplinary Tracks within the MCDB Area of Concentration

As alternatives to the standard MCDB major, students can choose either the biotechnology or the neurobiology tracks. The requirements for each of these interdisciplinary tracks differ somewhat from those of the standard major.

Area II: ***Molecular, Cellular & Developmental Biology***

- *The Biotechnology Track*

Core courses

MCDB 202a (Genetics)
MCDB 300b (Biochemistry) or its equivalent*****
MCDB 205b (Cell Biology)
MCDB 370b (Biotechnology)

Electives

Three credits. See notes below

Laboratories

Two laboratories. See notes below

For electives students can select from the following: any MCDB course numbered 150 or above, MB&B 420a, 421b, 443b, BENG 351a, 352b, 410a, 435b, 457b, 464b, CENG 210a, 411a, 412b, CPSC 437a, 445b, 470a, or 475b.

The laboratories should be chosen from MCDB courses and include one laboratory from MCDB 341L to 345L. With permission of an advisor, BENG 355La, 356Lb or CENG 412b can be substituted for two one-half credit laboratories.

Students interested in the biotechnology track should consult an advisor for the track.

Biotechnology track advisors: Ronald Breaker, 506 KBT (432-9389)
Xing-Wang Deng, 352B OML (432-8908)
Kenneth Nelson, 710A KBT (432-5013)
Joseph Wolenski, 330 KBT (432-6912)

*Equivalents for MCDB 300b are defined as either (a) both MB&B 300a and 301b or (b) MB&B 300a only, if the student has also taken MCDB 120a or 200b or has the permission of the director of undergraduate studies in MCDB. For this purpose, placing out of MCDB 120a is not the equivalent of having taken MCDB 120a.

Area II: ***Molecular, Cellular & Developmental Biology***

- *The Neurobiology Track*

Core courses

MCDB 202a (Genetics)
MCDB 300b (Biochemistry) or its equivalent*****
Either MCDB 205b (Cell Biology) *or* MCDB 210b (Developmental Biology)
MCDB 320a (Neurobiology)

Electives

Three credits. One must be a MCDB elective at 350 or higher. See notes below

Laboratories

Two laboratories. See notes below

One elective must be a MCDB course numbered 350 or above, and two courses chosen from BENG 410a, CPSC 475b, MCDB 240b, 310a, 315b, 410a, 415b, 425a, 430a, 440b, 460b, PSYC 270a, 320a, 376a and either MCDB 215a or PSYC 200b. Other courses may be substituted with the approval of the student's track adviser. (Students should note that PSYC 110a or b is a prerequisite for many psychology courses but does not substitute as an elective in the neurobiology track.). Because it is difficult to monitor course changes in other departments, this list can be incomplete or out of date. Consult with a track advisor if you wish approval for a substitution.

The two laboratories should ordinarily be chosen from MCDB courses.

Students interested in the neurobiology track should consult an advisor for the track.

Neurobiology track advisors: Paul Forscher, 222 KBT (432-6344)
Haig Keshishian, 640A KBT (432-3478)
Elke Stein, 232 KBT (432-8402)
David Wells, 338A KBT (432-3481
Robert Wyman, 610A KBT (432-3475
Weimin Zhong, 616B KBT (432-9233) [Sp]

*Equivalents for MCDB 300b are defined as either (a) both MB&B 300a and 301b or (b) MB&B 300a only, if the student has also taken MCDB 120a or 200b or has the permission of the director of undergraduate studies in MCDB. For this purpose, placing out of MCDB 120a is not the equivalent of having taken MCDB 120a.

The Senior Requirement

In addition to the course work described on previous pages, all majors in Biology must satisfy the senior requirement of Yale College. This can be accomplished in any of several ways, depending on whether the student is a candidate for a B.A. or B.S. degree. *The senior requirement must be done during the senior year.*

The B.A. degree

The requirement can be met in any one of three ways: by submitting a senior essay of 15-20 pages evaluating current research in a field of biology; by successful completion of one credit of tutorial work (EEB 470a or b or MCDB 470a or b); or by successful completion of one credit of individual research (EEB 475a or b or MCDB 475a or b).

A senior choosing to fulfill the requirement with a senior essay must consult with a faculty advisor on the scope and literature of the topic and submit their written approval to the appropriate director of undergraduate studies at least one month before the paper is due in the student's last term. The senior essay may be related to the subject matter of a course, but the essay is a separate departmental requirement *in addition* to any work done in a course. It does not count toward the grade in any course. The senior essay must be completed and submitted to the office of the director of undergraduate studies by the last day of classes. Students electing this option should obtain an approval form from the office of the director of undergraduate studies. *See EEB Senior Essay Requirement Form at end of booklet.*

The B.S. degree

The B.S. differs from the B.A. in its greater emphasis on individual research. The senior requirement for the standard B.S. is two contiguous terms of EEB 475a or b or MCDB 475a or b, at least one of which must be taken during the senior year, or MCDB 485a and 486b. Ordinarily both terms of EEB 475a or b or MCDB 475a or b will be taken during the senior year, but it is possible for a student to begin work toward the senior requirement in the spring of the junior year, continue it over the summer, and complete it during the final year, an arrangement that may be particularly useful for students doing field work. Yale College does not grant academic credit for summer research unless the student is enrolled in an independent research course in Yale Summer Session.

The B.S. Intensive major

For the B.S. *intensive major* students fulfill the senior requirement by taking EEB 495a and 496b or MCDB 495a and 496b, Intensive Research, for four credits.

Research Opportunities

There are many opportunities for students to carry out research in the laboratory of a faculty member. A broad spectrum of state-of-the-art research activities is performed at Yale in the MCDB and EEB departments and in related departments including the Yale Medical School Medicine and the School of Forestry & Environmental Studies. This research is in molecular biology, biochemistry, genetics, cell biology, neurobiology, physiology, environmental sciences, ecology and evolution. All interested students are encouraged to participate in research. Students may work in laboratories for academic credit and/or experience. Financial support may be available in some cases, but students being paid may not receive course credit.

The choice of a research laboratory should be made in consultation with faculty members and the director of undergraduate studies. Opportunities can be found on the following web sites: http://www.eeb.yale.edu and http://www.biology.yale.edu. Detailed descriptions of research programs in MCDB and EEB can also be found in a booklet entitled, *Faculty and Research Interest*, which can be obtained from the director of undergraduate studies or the director of graduate studies.

Research Courses

During the academic year, students with DUS approval may take either of three research courses, MCDB 475a or b/EEB 475a or b, MCDB 485a and 486b or MCDB 495a and 496b/EEB 495a and 496b. These courses are primarily for students who are culminating their undergraduate experience by doing independent research to fulfill the senior requirement. It is possible for students who wish to do research earlier in their course of study to take MCDB 475a or b/EEB 475a or b before their senior year, but it does not substitute for other course requirements. There is a limit of three terms of 475 that can count towards the major *(MCDB 485a, 486b counts as 2 terms of MCDB 475a or b in this calculation)*. Alternatively, a maximum of one term of 475a or b plus the two-term MCDB 495a, 496b/EEB 495a, 496b during the senior year can count towards the major. For research courses, hours are typically arranged at the mutual convenience of the student and the faculty advisor. ***Please note that taking MCDB 475 at any time does not satisfy the lab requirement or the elective requirement for a course from MCDB at 350 or above.***

Approval from the Yale College Committee on Honors and Academic Standing is required if certain limits are exceeded. A student must petition the committee for permission to enroll in more than one such course credit in any one term before the senior year or in more than two such course credits in any one term during the senior year. Permission is also required for a student to enroll in more than three such course credits in the first six terms of enrollment. In the petition the student must give sound academic reasons for exceeding these limits.

Students taking EEB 475a or b/MCDB 475a or b are expected to spend at least ten hours per week in the laboratory of a faculty member. This course can be taken more than once. Students *must* reapply each semester to be enrolled, and at the completion of *each* term, a paper must be submitted to their professor. This course fulfills the senior requirement if one semester is taken in the senior year.

MCDB 485a, 486b is a year-long research course intended for senior students who wish to do research for the B.S. degree. Students are expected to spend a minimum of ten to twelve hours per week in the laboratory and to attend monthly discussion groups. Research should be

conducted under the supervision of the same faculty. At the end of the course a written report on the research accomplished must be submitted before a grade will be given.

EEB 495a, 496b/MCDB 495a, 496b is intended for senior students who wish to do intensive research for the B.S. degree. It is a year-long course, two credits each term, in which students are expected to spend at least twenty hours per week in the laboratory. At the end of the course, students prepare a paper describing the research they completed. One grade is given at the end of the second semester.

Summer Research

Yale students can also perform research with a faculty member during the summer months, which allows students to devote full-time effort to a research project. Summer research enables students to continue research that was initiated during the previous academic year or to begin research that will be continued during the following academic year. Sometimes the faculty member has grant funds that can support students during the summer. Other possibilities for financial support can be found at http://www.yale.edu/yser/fellowships.html. Interested students should consult a member of the Yale faculty or the director of undergraduate studies. Academic credit is not granted unless the student is registered in (and paying tuition to) the Yale summer school.

Summer research at other institutions is possible through several programs. More information can be found at: http://yalecollege.yale.edu/content/prizes-fellowship-opportunities. Yale does not award academic credit for research done at other institutions, even if done in the context of a course.

Where to Get Advice

The advising system for students majoring in Biology provides a source of clear and readily accessible information regarding programs of study throughout the students' four years at Yale. Each student will have three formal advisors to guide academic choices, but finding the right person for the problem sometimes requires student initiative.

The First Year...

Upon entrance into Yale University, each student is assigned to one of the twelve residential colleges on campus. With this initial assignment, the first-year student encounters a team of three important advisors who will be helpful in answering questions and directing the student's choice of classes.

First, each entering student is assigned a freshman counselor, who is a senior student living with the freshman class. The student counselor gives the freshmen a "student's eye view" of the curriculum, courses and instructors. Valuable as this is, it should not substitute for the advice of a faculty advisor. This is particularly important for freshmen that are considering a major in science. The second advisor is also a member of the student's residential college, is usually a faculty fellow of that student's college, and is sometimes a member of the EEB or MCDB department. This faculty advisor is responsible for advising the student about fulfilling distributional requirements in the first year. The third person on the first-year advising team is, of course, the student's residential college dean. The dean has ultimate authority over the student's decisions for courses and programs of study. If the freshman advisor is not a member of a science department in Yale College, the student is strongly advised to consult with the director of undergraduate studies in the field of the student's primary interest. There are also meetings for prospective science majors that are held in the fall before classes get started.

The most important issue for prospective biology majors is to take chemistry during the first year. This is because many courses, particularly in MCDB, have prerequisites of two years of chemistry followed by biochemistry. An early start on this sequence is therefore essential. If the student is going to take a second science course, it should be in the MCDB/EEB sequence. It is possible to postpone the laboratory for either biology or chemistry until the year after the course is taken, although this is not recommended. Math and physics can be taken in later years.

...and Beyond

At the end of freshman year, the student has the option of continuing with the faculty fellow advisor assigned for the first year or of choosing a new faculty advisor for the sophomore year. Biology majors should find an advisor in the biology program as soon as they decide on the major. EEB students are assigned advisors by year (see below). Students in the standard MCDB major can select any member of the faculty as an advisor, either a fellow of their residential college or an individual with common interests. A list of faculty fellows and their affiliated colleges is presented on the next page. Students in the neurobiology or biotechnology tracks, or those interested in the Plant Sciences should consult the advisors specified above with the tracks. The sophomore year advisor usually remains a student's advisor for the next two years, but it is possible to switch if a student prefers another individual. Note: It is possible to switch areas of concentration, especially in the first two years. If a student changes area, he/she should also change to an appropriate advisor for that area. Students might find it most convenient to consult with the MCDB Undergraduate Registrar to identify an appropriate faculty advisor. However a faculty advisor is identified - communicating that choice to the MCDB Undergraduate Registrar will ultimately be useful to both you and the Department.

The biology faculty advisor's role is four-fold. First, the advisor ensures that the student selects and fulfills the requirements needed for graduation. Second, the advisor ensures that the major's distributional requirements are fulfilled. Third, the advisor gives guidance on the student's curriculum and future career plans. Finally, the faculty advisor may be asked to write letters of recommendation if the student should so desire.

The regular faculty advisor should handle most routine issues, including signing schedules. Certain matters require the attention of the director of undergraduate studies. The EEB and MCDB area of concentration each has a DUS who can be reached by email or through the undergraduate registrars. See the first page of this booklet for names, phone numbers, and email addresses.

Advisors for the EEB Area of Concentration

Students in the EEB area of concentration are assigned advisors by class. Freshmen are assigned to the DUS, but by the sophomore year, students should be regularly consulting with an advisor assigned to their class. This individual assures that you fulfill the requirements for the degree and is available for advice pertaining to your career. *Assigned advisors sign the registration forms that you submit to your college dean.*

Advisors by class are as follows:

Class of 2012: Günter Wagner, gunter.wagner@yale.edu, 2-9998, 327A OML
David Post, david.post@yale.edu, 2-3005, 426B OML

Class of 2013 : Jeffrey Townsend, jeffrey.townsend@yale.edu, 2-4646, 226B OML
Paul Turner, paul.turner@yale.edu, 2-5918, 301A OML

Class of 2014: Leo Buss, leo.buss@yale.edu, 2-3869, 326B OML
Walter Jetz, walter.jetz@yale.edu, 2-7540, 401 OML

Class of 2015: Jeffrey Powell, jeffrey.powell@yale.edu, 2-3887, 170 ESC

Advisors for the MCDB Area of Concentration

All faculty in the MCDB department are available as advisors. You are free to choose your advisor, and you can change advisors should you wish. Students might find it most convenient to consult with the MCDB Undergraduate Registrar to identify an appropriate faculty advisor. However a faculty advisor is identified - communicating that choice to the MCDB Undergraduate Registrar will ultimately be useful to both you and the Department. You are expected to consult your advisor at the start of each term and obtain their signature approving your selection of classes. Because of the size of the major, the DUS does not ordinarily sign schedules but is of course available to help you with any other academic issue. The list of all MCDB faculty begins on the following page.

Faculty and Research Interests

MCDB:

Sidney Altman — **Trumbull College Fellow, 2-3500, sidney.altman@yale.edu, KBT 402** *Role in vivo of an enzyme with a catalytic RNA subunit; mechanism of action of that enzyme*

Carol Bascom-Slack — **Lecturer, 2-5437, carol.bascom-slack@yale.edu, JWG 309C** *Topics in microbiology*

Brett Berke — **Lecturer, 2-3479, brett.berke@yale.edu, KBT 640** *Understanding synapses*

Ronald R. Breaker *(Chairman MCDB)* — **Jonathan Edwards College Fellow, 2-9389, ronald.breaker@yale.edu, KBT 506** *The study of Riboswitches and engineering new RNA and DNA enzymes by in vitro evolution*

John R. Carlson — **Pierson College Fellow, 2-3541, john.carlson@yale.edu, KBT 1132** *Function and development of the Drosophila olfactory system*

Sreeganga Chandra # — **Neurobiology, 5-6172, sreeganga.chandra@yale.edu, BCMM 154D** *Presynaptic Biology; Synapse Maintenance; Parkinson's Disease; Neurodegeneration*

Nicole Clay — **Professor, 2-4540, nicole.clay@yale.edu, OML, 451** *plant innate immunity and bio-defenses*

Lynn Cooley # — **Genetics, 5-5067, lynn.cooley@yale.edu, SHM I 329B** *Molecular genetics of Drosophila oogenesis, control of oocyte growth, ring canals*

Craig M. Crews — **Pierson College Fellow, 2-9364, craig.crews@yale.edu, KBT 452** *Exploration and control of signal transduction pathways using chemical probes*

Iain A. Dawson — **Branford College Fellow, Lecturer, 2-6265, iain.dawson@yale.edu, KBT 600** *Regulation of cell cycle in Drosophila melanogaster*

Stephen L. Dellaporta — **Silliman College Fellow, 2-3895, stephen.dellaporta@yale.edu, OML 450A** *Sex determination and cell death in plants*

Xing-Wang Deng — **Morse College Fellow, 2-8908, xingwang.deng@yale.edu, OML 352B** *Molecular genetic and genomic analysis of light signaling and development mechanism*

Thierry Emonet — **Jonathan Edwards College Fellow, 432-3516, thierry.emonet@yale.edu, KBT1048** *Relating network architecture to biological function using computational modeling and experiments*

Paul Forscher	**Davenport College Fellow, 2-6344, paul.forscher@yale.edu, KBT 222** *Molecular mechanisms of axon guidance: cytoskeletal protein dynamics and related signal transduction*
Martín I. García-Castro *(LOA AY-'11-'12)*	**Berkeley College Fellow, 2-3523, martin.garcia-castro@yale.edu, KBT 1100** *Origin, induction and differentiation potential of neural crest stem cells*
Jo Handelsman	**Jonathan Edwards College Fellow, 2-9119, jo.handelsman@yale.edu, KBT 904** *Studies the structure and function of microbial communities in soil and in insect guts using metagenomics, pathogenesis in a community context, chemical biology, and microbial signaling*
Mark Hochstrasser #	**MB&B, 2-5101, mark.hochstrasser@yale.edu, BASS 224** *Dynamics of cell differentiation; ubiquitin-proteasome system*
Scott A. Holley	**Timothy Dwight College Fellow, 2-3230, scott.holley@yale.edu, KBT 1034** *Molecular, genetic and embryological analysis of segmentation in the zebrafish*
Valerie Horsley *(LOA AY '11-'12)*	**Ezra Stiles College Fellow, 6-9126, valerie.horsley@yale.edu, KBT 226** *Study of the cellular and molecular mechanisms that control stem cell activity and function within the skin epithelium*
Vivian Irish *(LOA F'11)*	**Davenport College Fellow, 2-5572, vivian.irish@yale.edu, OML 252A** *Developmental genetics of flowering in* Arabidopsis; *evolution of floral homeotic genes*
Farren Isaacs	**Professor, 2-3783, farren.isaacs@yale.edu, KBT 802**
Akiko Iwasaki #	**Immunobiology, 5-2919, akiko.iwasaki@yale.edu, TAC S655B** *Immune responses to herpes simplex viruses and influenza*
Christine Jacobs-Wagner	**Saybrook College Fellow, 2-5170, christine.jacobs-wagner@yale.edu, KBT 1032** *Cell shape and cell polarity in Caulobacter crescentus*
Douglas R. Kankel *(DUS MCDB)*	**Silliman College Fellow, 2-3532, douglas.kankel@yale.edu, KBT 1118A** *Nervous system development and function in Drosophila melanogaster*
Michael Kashgarian #	**Pathology, 785-2750, michael.kashgarian@yale.edu, LH-B 20** *Na, KATPase expression: epithelial cell polarity; heat shock protein functions*
Paula Kavathas #	**Immunobiology, 5-6223, paula.kavathas@yale.edu, TAC S641A** *Study of host-pathogen interactions in human trophoblast cells, a bacterial type II secretion system, and lateral gene transfer for genetic manipulation*

Haig S. Keshishian — **Morse College Fellow, 2-3478, haig.keshishian@yale.edu, KBT 640A**
Factors governing the formation of synaptic connections during development

Mary S. Klein — **Lecturer, 2-9861, mary.klein@yale.edu, OML 103A**
Topics in Reproduction

Perry L. Miller # — **Anesthesiology, Silliman College Fellow, 7-2903, perry.miller@yale.edu, 300 George Ste 501** *Areas of bioinformatics including clinical, neuro-, and genome informatics*

Mark S. Mooseker — **Calhoun College Fellow, 2-3468, mark.mooseker@yale.edu, KBT 352** *Molecular mechanisms of motility in eukaryotic cells*

Maria Moreno — **Lecturer, 6-4161, maria.moreno@yale.edu, OML 452**
Cloning of the Yellow Stripe 1 gene and Tapetal Development and Function gene in Oryza sativa japonica

Jon S. Morrow # — **Pathology, 785-3624, jon.morrow@yale.edu, BML 140**
Molecular basis of polarized membrane and cytoskeletal assembly

Kenneth Nelson — **Lecturer, Morse College Fellow, 2-5013, kenneth.nelson@yale.edu, KBT 716** *Host-parasite interactions in human filarial nematode diseases*

Timothy M. Nelson — **Jonathan Edwards College Fellow, 2-3860, timothy.nelson@yale.edu, OML 253A** *Cellular differentiation in leaf development; patterning of venation*

Barry W. Piekos — **Lecturer, 2-3845, barry.piekos@yale.edu, OML 126**
Developing simple techniques that can enhance the resolution of a basic light microscope by at least an order of magnitude beyond the century-old limit imposed by Ernst Abbé

Thomas D. Pollard — **Morse College Fellow, 2-3565, thomas.pollard@yale.edu, KBT 548**
Molecular mechanisms of actin-based cellular movements

Anna Pyle — **Professor, 2-5633, anna.pyle@yale.edu, KBT 826** *Structure and function of catalytic RNA, RNA helicase mechanisms and the computational analysis of RNA structure.*

Matthew Rodeheffer # — **Comparative Medicine, 7-3370, matthew.rodeheffer@yale.edu, LSOG 205A** *Determining how white adipose tissue (fat) mass is regulated in vivo*

Shirleen Roeder — **Saybrook College Fellow, 2-3501, shirleen.roeder@yale.edu, KBT 804** *Meiosis in yeast: homolog pairing, chromosome synapsis, and cell-cycle checkpoints*

Joel L. Rosenbaum — **Silliman College Fellow, 2-3472, joel.rosenbaum@yale.edu, KBT 310A** *Cell organelle assembly; IFT and flagellar assembly, sensory function of cilia/flagella*

Alanna Schepartz #	**Chemistry, 2-5094, alanna.schepartz@yale.edu, CRB 310** *Chemical Biology: protein design and evolution; molecular mechanism of transcriptional accessory factors; proline-rich motifs in cell signaling*
Frank Slack *(DGS of MCDB)*	**Morse College Fellow, 2-3492, frank.slack@yale.edu, KBT 936** *The role of microRNAs in development, aging and cancer*
Elke Stein	**Ezra Stiles College Fellow, 2-8402, elke.stein@yale.edu, KBT 232** *Axon guidance and synapse formation in the mammalian nervous system*
Hugh S. Taylor #	**OB/GYN, 785-4005, hugh.taylor@yale.edu, LSOG 304B** *The molecular regulation of reproductive track development and function*
David G. Wells	**Lecturer, Ezra Stiles College Fellow, 2-3481, david.wells@yale.edu, KBT 338A** *Cellular and molecular mechanisms regulating synaptic plasticity in mammalian CNS*
Joseph S. Wolenski	**Lecturer, Berkeley College Fellow, 2-6912, joseph.wolenski@yale.edu KBT 330** *Molecular analysis of myosin mechanochemistry*
Robert J. Wyman *(LOA S'12)*	**Calhoun College Fellow, 2-3475, robert.wyman@yale.edu, KBT 610A** *Molecular biology and neurophysiology of gap junctions; genetic control of neural circuit development*
Weimin Zhong	**Davenport College Fellow, 2-9233, weimin.zhong@yale.edu, KBT 616B** *Regulation of neural stem cells and development of the mammalian neocortex*

EEB:

Suzanne H. Alonzo	**Davenport College Fellow, 2-0690, suzanne.alonzo@yale.edu, OML 427A** *Behavioral and evolutionary ecology; theoretical and empirical research on the evolution and ecology of reproductive strategies, conflict between the sexes, predator-prey interactions and the links between population dynamics and life history patterns*
Leo W. Buss *(LOA S'12)*	**Saybrook College Fellow, 2-3869, leo.buss@yale.edu, OML 326B** *Theoretical research on ontological foundations of evolutionary theory; empirical research on hydroid biology*
Adalgisa Caccone	**Saybrook College Fellow, Director of the YIBS-MSCB Laboratory, 2-5259, adalgisa.caccone@yale.edu, ESC 140** *Molecular evolution and conservation genetics*
Wendy Clement	**Lecturer, 6-4992, wendy.clement@yale.edu, ESC 366** *Plant evolution and systematics*

Peter Crane #	**Davenport College Fellow, Forestry & Environmental Studies, 2-5109, peter.crane@yale.edu, KRN 238** *Large-scale patterns and processes of plant evolution, plant paleontology; integrated paleobotanical and neobotanical studies of plant diversity and evolution; conservation of plant diversity, including crop diversity*
Mary Beth Decker	**Lecturer, Forestry & Environmental Studies, 2-6293, *marybeth.decker@yale.edu*, OML 316B** *Biological oceanography, jellyfish blooms in changing coastal and estuarine ecosystems*
Michael J. Donoghue *(LOA F'11 & S'12)*	**Calhoun College Fellow, 2-2074, michael.donoghue@yale.edu, ESC 364** *Plant evolution; phylogenetic biology*
Alison P. Galvani #	**Berkeley College Fellow, Epidemiology and Public Health, 5-2642, alison.galvani@yale.edu, #235 at 135 College** *Modeling epidemiological and evolutionary dynamics of infectious diseases*
Vivian F. Irish # *(LOA F'11)*	**Davenport College Fellow, Molecular, Cellular & Developmental Biology, 2-5572, vivian.irish@yale.edu, OML 252A** *Evolution of floral development; Arabidopsis developmental genetics*
Walter Jetz	**Saybrook College Fellow, 2-5740, walter.jetz@yale.edu, OML401** *Macroecology; community ecology; biogeography; global change biology; conservation; ecology and evolution of terrestrial vertebrates*
Kenneth Kidd # *(LOA S'12)*	**Morse College Fellow, Genetics, 5-2654, kenneth.kidd@yale.edu, SHM I342B** *Human DNA polymorphism and microevolution studies; forensic genetics; population and behavior genetics*
Antónia Monteiro	**Jonathan Edwards College Fellow, 2-3109, antonia.monteiro@yale.edu, OML 326A** *Butterfly and moth wing patterns; evolutionary developmental biology*
Nancy Moran	**Ezra Stiles College, 7-3087, nancy.moran@yale.edu, OML 327B and YWC B-31, Room 201B** *Evolution and genomics of bacteria and insects; biology of symbiosis*
Thomas Near *(LOA F'11 & S'12)*	**Saybrook College Fellow, 2-3002, thomas.near@yale.edu, 370A ESC** *Evolutionary biology of fishes – retracing how species are treated to one another, primarily using DNA sequence data to reconstruct the evolutionary relationships of species represented through branching diagrams or Phylogenies*

Howard Ochman	**Morse College Fellow, 7-3088, howard.ochman@yale.edu, OML 327C and YWC B-31, Room 271A** *Evolutionary Genomics*
David M. Post *(DGS EEB)*	**Timothy Dwight Fellow, 2-3005, david.post@yale.edu, OML 426B** *Aquatic ecology; food-web structure and dynamics*
Jeffrey R. Powell *(DUS of EEB)*	**Calhoun College Fellow, 2-3887, jeffrey.powell@yale.edu, ESC 172** *Evolutionary genetics; molecular evolution and conservation genetics*
Richard O. Prum *(LOA F'11 & S'12)*	**Calhoun College Fellow, 2-9423, richard.prum@yale.edu, ESC 164** *Evolutionary ornithology, including phylogenetics, behavior, feathers structural color, evolution and development, sexual selection, and historical biogeography*
Eric J. Sargis #	**Trumbull College Fellow**, **Anthropology, 2-6140, eric.sargis@yale.edu, 10 Sachem Room 208** *Mammalian systematics and evolution*
Oswald J. Schmitz #	**Ezra Stiles College Fellow, Forestry & Environmental Studies, 2-5110, oswald.schmitz@yale.edu, GML 108** *Dynamics and structure of terrestrial ecosystems with a focus on predator-herbivore plant food chains*
David K. Skelly #	**Forestry & Environmental Studies, 2-3603, david.skelly@yale.edu, GML 119** *Community ecology, spatial ecology, ecology of disease*
Melinda D. Smith	**Davenport College Fellow, 2-9422, melinda.smith@yale.edu, OML 426A** *Biodiversity-ecosystem function; effects of species loss on ecosystems; factors influencing invasion by exotic plant species; grassland ecology; impacts of global change on community and ecosystem processes; scale-dependence of ecological patterns and processes*
Stephen C. Stearns *(LOA F'11)*	**Saybrook College Fellow, 2-8452, stephen.stearns@yale.edu, OML 560** *Life history evolution, evolution of sex, evolutionary genetics; population biology; functional genomics*
Jeffrey Townsend	**Berkeley College Fellow, 2-4646, jeffrey.townsend@yale.edu, OML 226B, http://www.yale.edu/townsend/joinus.html** *Comparative and functional evolutionary genomics*
Paul E. Turner *(Chairman EEB)*	**Trumbull College Fellow, 2-5918, paul.turner@yale.edu**, **OML 301A** *Experimental evolution of bacterial and animal viruses; ecology and evolution of infectious diseases and pathogen emergence; host parasite interactions; evolution of sex; evolution of robustness*

J. Rimas Vaisnys #	**Jonathan Edwards College Fellow, Electrical Engineering, 2-4253, juozas.vaisnys@yale.edu, BC 311** *Identification of dynamics of diverse biological systems*
David A. Vasseur	**Saybrook College Fellow, 2-2719, david.vasseur@yale.edu, OML 550** *Theoretical ecology; biodiversity-ecosystem function; impacts of environmental variability on population, community, and ecosystem processes; spatial population synchrony*
Günter P. Wagner *(LOA S'12)*	**Silliman College Fellow, 2-9998, gunter.wagner@yale.edu, OML 327A and YWC B-31 Room 271B** *Population genetics theory; evolutionary theory*
Marta Lucia Martínez Wells	**Senior Lecturer, 2-6294, marta.wells@yale.edu, OML 103** *Evolution of mating signals and their role on speciation (behavior, techniques and phylogeny reconstruction)*

Joint faculty

Recommendations for Premedical Students

Most medical schools require:

- One year of Biology plus one year of laboratories. (University of Texas state medical schools require two years of biology)
- Two years of Chemistry plus two years of laboratories

  Either

  One year of General Chemistry (Chem 112a and 113b; 114a and 115b) or Chem 118a -intensive gen chem and Chem 252b or Biochem) and One year of Organic Chemistry and labs

  Or

  One year of Organic Chemistry as a freshman (Chem 124a and 125b or Chem 220a and 221b or 225b and 227a) plus one term of Biochemistry and Biochemistry laboratory
- One year of Physics plus laboratories
  (Note: the requirements of the Biology major do not include physics laboratories)
- At least one term of calculus; some require a full year of math

Biochemistry plus laboratory is often recommended by medical schools for premedical students and is listed by them under the Chemistry requirements, not Biology.

Many medical schools require two terms of English; some require 2-3 terms.

Increasingly, medical schools are recommending/requiring courses in statistics, psychology, and other social sciences as well as Biochemistry.

Medical schools require that all courses used to fulfill the basic premedical requirements must be taken for a letter grade, not Credit/D/Fail. In addition, only grades of C or higher are accepted. C- and lower grades are not acceptable.

Students who expect to apply to medical school should consult the Health Professions Advisory Board (HPAB) at Undergraduate Career Services (UCS) located at 55 Whitney Avenue (phone: 432-0818), preferably during the first term of enrollment at Yale. Catalogues for every American and most Canadian medical schools are available on the WEB.

Some state-supported medical schools and a few private medical schools have additional course requirements in the humanities and social sciences. All premedical students should check the requirements of their state-supported medical schools, since over 70% of applicants matriculate in one of these schools. Individual medical school course requirements for American and Canadian applicants can be found in the AAMC publication, Medical School Admission Requirements, which is available in the Health Professions Department at the Office of Undergraduate Career Services.

The HPAB publishes an informational bulletin that contains general information, *Preparing to Become a Health Care Professional*, and a second bulletin with specific information for those about to apply for admission to medical school (primarily juniors and seniors), *Applying to Medical School*. Students who are interested in applying as MD/PhD applicants should obtain a copy of the UCS publication, *General Information About MD/PhD Programs*. All are available on the UCS website at www.yale.edu/career/students/gradprof/medschool/ or at the UCS office.

Studies Abroad

It is possible for Biology majors to participate in programs that include study abroad. This may be especially appropriate for majors in the EEB area of concentration. Programs approved for a full semester of credit by the Yale College Studies Abroad Program include the Organization for Tropical Studies (OTS) in Costa Rica and School for Field Studies in several localities. More detailed information can be found on the web site: http://www.yale.edu/yalecollege/international/opportunities/type/study/yta_summer.html. Application to both the programs and to the Studies Abroad Committee should be done early in the semester preceding the semester spent abroad. Summer programs also exist that may be used to fulfill some degree requirements and, in some cases, credit can be transferred. How the credit earned in programs abroad can be applied to fulfilling the biology major requirements depends on the particular program chosen and should be discussed with the DUS early in planning.

Information on some studies abroad in EEB is available in 101 OML as well as information on current students who have participated in the programs.

The Combined B.S./M.S. Degree Program

The combined B.S./M.S. degrees program in Biology is designed to allow exceptional students with a strong interest in biology to accelerate their professional education. This program is to be completed in eight terms of enrollment. The requirements are as follows:

1. Candidates must satisfy the Yale College requirements for the B.S. degree. In addition to the three or four core requirements (depending on the track) specified for the standard track, the three or four electives must be graduate-level courses designated "G." One of these is a graduate seminar selected with the approval of the director of undergraduate studies. Students must earn a grade of A or A- in two graduate-level courses and a grade of B- or higher in the rest.

2. Six credits outside the major must be taken in the last two years, and at least two undergraduate courses in the last two terms.

3. In addition to the courses specified above, students must complete two graduate research courses for six course credits:

   a) EEB 575 or MCDB 585, a two-credit course typically taken in the second term of the junior year. At the start of the course, each student forms a committee comprised of their adviser and two faculty members that meets to discuss the research project. Two of the members of this committee must be members of either the EEB or MCDB faculty, as appropriate to the thesis topic. At the end of the course, the student completes a detailed prospectus describing the thesis project and the work completed to date. The committee evaluates an oral and written presentation of the prospectus and whether the student may continue in the combined program.

   b) EEB 575/MCDB 595, a four-credit, yearlong course (two credits each term) that is similar to EEB 495 and MCDB 495a, 496b and is taken during the senior year. During the course, the student gives an oral presentation describing the work. At the end of the course, the

student is expected to present his or her work to the department in the form of a poster presentation. In addition, the student is expected to give an oral thesis defense, followed by a comprehensive examination of the thesis conducted by the thesis committee. Upon successful completion of this examination, as well as all other requirements, the student is awarded the combined B.S./M.S. degree.

Students must also satisfy the requirements of Yale College for the simultaneous award of the bachelor's and master's degrees, including the following:

- Students must apply in writing to the director of undergraduate studies and obtain departmental approval no later than the beginning of the second term of their Junior year. Students must have the approval of both the director of undergraduate studies and the director of graduate studies to receive graduate credit for the graduate courses they select.

- At the time of the application, only those students with two-thirds A or A- grades in all their courses and with two-thirds A or A- grades in Biology courses, including prerequisites, will be admitted to the program.

- Students must have this program approved by the undergraduate affairs committee of the major and the relevant departmental faculty by the end of the first term of their junior year. Because faculty meetings are held irregularly, the director of undergraduate studies should receive proposed programs by November 1.

Five Year Program for the Combined B.S./M.S. in Forestry & Environmental Studies

The School of Forestry & Environmental Studies offers a program whereby a Yale student can earn a Masters Degree in F&ES with an additional year of study. Students must fulfill the requirements for a Yale College bachelor's degree that includes the appropriate prerequisites for acceptance into F&ES. Two summers and one further academic year are used to fulfill the Masters requirements. Interested students should contact Gordon Geballe in F&ES.

Facilities

The offices and laboratories of the primary members of the two departments are in three buildings clustered on science hill: Kline Biology Tower (KBT), Osborn Memorial Laboratories (OML), and the Environmental Sciences Facility (ESC). Joint appointees are housed in their home departments. In addition to the state of the art laboratories in the three buildings, listed below are additional facilities accessible to students for research and study at Yale.

Libraries: The several science libraries collectively constitute one of the great collections of biological literature in the world. The Kline Science Library (biological sciences), Peabody Museum (ornithology and entomology), Kline Geology Library (paleobiology), School of Forestry & Environmental Studies (forest and environmental biology), Engineering Library and Medical Library (biomedical sciences) together represent a total collection of approximately one million volumes.

Computer Facilities: Yale Information and Technology Services (ITS) provides both mainframe and microcomputer resources to the student community. A variety of computer languages and programs are supported. Biomedical Computer Facilities, located at the Medical School, and accessed through remote or local terminals, are available for DNA and protein sequence analysis. The residential colleges are fully networked for access to Yale computing facilities and the Internet.

Peabody Museum of Natural History: With collections dating to 1825 and now numbering over 2,000,000 units, Yale's Peabody Museum is a major resource for research and teaching in the biological sciences. Of particular interest to those studying the history and diversity of life are its world-famous holdings of fossil vertebrates, including dinosaurs (150,000 units), fossil invertebrates (275,000 units), and fossil plants (100,000 units), as well as its collections of modern birds (100,000 units), insects (1,250,000 units), other animals (300,000 units), and plants (250,000 units). Research and work-study opportunities with any of the scientific staff members of the Museum are accessible to students.

Genomics and Molecular Biology Facilities: University services for all aspects of molecular biological investigations are available in various Yale facilities. These include oligonucleotide synthesis, DNA sequencing, monoclonal and polyclonal antibody preparation, peptide synthesis, cell sorting, and amino acid analysis. In addition, facilities are available for mass spectrometry and X-ray crystallography. Equipment to generate and analyze DNA chips and protein microarrays are located both at the Yale Medical School and in the MCDB Department. Mass spectrometry, high through put chemical genomic screening, and new technologies of next generation genomic DNA sequencing such as Roche/454 and Illumina/Solexa are available in the MCDB Department. In addition, the laboratories for teaching and for faculty research are well equipped with state of the art instrumentation and equipment for specific projects.

Imaging Facilities: The MCDB Department operates a modern light microscope imaging facility supervised by Dr. Joseph Wolenski. These microscopes are available to the Yale scientific community at competitive hourly rates. Equipment includes two Zeiss LSM 510 confocal inverted microscopes, including one with near infrared two-photon imaging capabilities and a temperature controlled stage. The Department also houses a spinning disk confocal microscope and a Nikon widefield microscope equipped with a color camera for histological slides and a sensitive CCD camera for excellent fluorescence imaging.

Structural Analysis/Electron Microscopy Facilities: The MCDB Department operates a Structural Analysis Laboratory that includes both scanning and transmission electron microscopes and related equipment for processing, sectioning, and imaging support. These facilities are used in both teaching and research, and are core resources also available to members of EEB and other Science Hill departments.

DNA Analysis Facility on Science Hill (DAFSH): We are a non-profit academic Core Facility for DNA Sequencing and Fragment Analysis. This service facility is located on the first floor of the ESC within the YIBS-MSCG Center (see above). Its services are utilized by over 600 users from Yale as well as other academic institutions and private companies from across the United States and around the world. Yale users have priority over external customers and reduced rates. Training and job opportunities for Yale students are available during both academic and summer months. Please visit our web site for additional information (http://dna-analysis.research.yale.edu//#).

YIBS (Yale Institute for Biospherics Studies) Conservation Genetics Center: This center (YIBS-MSCG) is located on the first floor of the Environmental Science Center. Our support is for scientists at any level that would like to address environmental, biodiversity, epidemiological, and conservation questions using DNA analyses, but lack the equipment and or knowledge to do so. A variety of learning opportunities and funding support are available to EEB and other Yale departments and schools members including rotations, seminars, one-on-one training sessions, and summer opportunities. For additional information please visit: http://www.yale.edu/caccone/ecosave/index.html.

YIBS Center for Earth Observation: A computer laboratory for the analysis of remote sensing data is available for research. The Center also offers courses in remote sensing on a regular basis to students, which provide students with the skills to use the facility. This Center is housed in Geology and Geophysics.

Plant and Animal Husbandry: Numerous controlled environment growth chambers, constant temperature rooms, green houses and plant tissue culture facilities are available for environmentally controlled growth of plant materials. The major animal care facility for small mammals for the Arts and Sciences campus is also located on Science Hill.

Herbarium: The Yale Herbarium consists of 350,000 systematically arranged plant specimens from the algae to vascular plants. The collection includes significant type specimens in the mosses and ferns with a representation of most families and important genera of the flowering plants.

Peabody Museum Field Station: The Marine Biology facility on Long Island Sound is comprised of an on-shore laboratory, a 40-acre salt marsh, and a 17-acre island. Facilities include salt water holding tanks, a shop, and a small boat fleet. It is approximately 30 minutes from the Yale campus.

Marsh Botanical Garden: The University's botanic garden and arboretum is located north of OML on the grounds of Marsh Hall at Prospect Street and Hillside Terrace. The garden features a diverse collection of native and exotic trees, shrubs, and perennials highlighting plant communities and environmental change. The greenhouses feature plants from tropical regions and arid climates as well as economically important crops. Eric Larson, the garden manager leads a staff that includes David Garinger, indoor plant curator, Chris Bolick research plant curator and Bobby Rak, research aide .

Yale Natural Preserve: This tract of acres in the Westville section of New Haven adjoins the Yale Golf Course. It is heavily wooded and has a central pond. Many groups of terrestrial and freshwater organisms are well represented in natural communities.

Yale Forests: There are more than 10,000 acres of Yale Forests managed as working forests by the School of Forestry & Environmental Studies. They are also available by arrangement for research and instruction. The largest and closest is the 7,800-acre Yale-Meyers Forest in northeastern Connecticut. It has some small lakes and a diversity of fauna, flora, and natural habitats.

Appendices

I. Courses in the Departments of EEB and MCDB

II. Worksheets for Area I (EEB) and Area II (MCDB)

III. Undergraduate Research Projects

IV Undergraduate Prizes

V. Forms for Tutorial and Research Courses

Appendix I: Courses in the Departments of EEB and MCDB 2011-2012

Note: The letter "a" following a course number indicates a fall term course; "b" indicates a spring term course; "G" indicates courses offered to undergraduate and graduate students; courses without an "a" or "b" are year-long; "*" indicates permission from the instructor is needed. Bracketed courses are not offered in the academic year 2011-2012.

INTRODUCTORY COURSES WITHOUT PREREQUISITES:

*MCDB 060/061. **Topics in Reproductive Biology.** Harvey Kliman
M 2.30-4.00 Cr/Year Only Fr sem
An introduction to reproductive biology, focused on selected topics in reproductive system development; physiology and endocrinology; sexuality and gender differences; and assisted reproductive technologies. Exploration of primary literature in model system and human reproductive biology. *Enrollment limited to freshmen with a score of 5 on the Advanced Placement test in Biology. Credit only on completion of both terms. May be applied as an elective toward the Biology major. Pre-registration required; see under Freshman Seminar Program.*

MCDB 105a or b/MB&B 105a or b. **An Issues Approach to Biology.**
105a: Timothy Nelson, William Summers, David Wells
105b: Ronald Breaker, Andrew Miranker, Dieter Söll
MWF 11.35-12.25
Biological concepts taught in context of current societal issues, such as stem cell research and genetically modified organisms. Emphasis on biological literacy to enable students to evaluate scientific arguments.

MCDB 106a/HLTH 155a. **Biology of Malaria, Lyme, and Other Vector-Borne Diseases.** Alexia Belperron
MW 1.00-2.15
Introduction to the biology of pathogen transmission from one organism to another by insects; special focus on malaria and Lyme disease. Modes of transmission and establishment of infection; immune responses and the associated challenges to prevention and treatment and the development of vaccines. Intended for non–science majors. *Prerequisite: high school biology.*

*MCDB 107a. **Human Biology.** William Segraves, Mitchell Kundel
TTh 2.30-3.45
An introduction to the fundamentals of human anatomy and physiology. *Enrollment limited to freshmen and sophomores.*

*MCDB 109b. **Immunology and Microorganisms.** Paula Kavathas
TTh 1-2.15 Meets RP
Introduction to the human immune system, followed by study of microorganisms such as influenza, HIV, human papilloma virus, Chlamydia trachomatis, and commensal bacteria. Discussion of the biology of each organism and interaction with the host immune system, reinforcing principles of immune function. *Enrollment limited to freshmen and sophomores.*

EEB 115a[G]/F&ES 315a. **Conservation Biology.** Jeffrey Powell, Walter Jetz
WF 10.30-11.20 1 HTBA
An introduction to ecological and evolutionary principles underpinning efforts to conserve Earth's biodiversity. Efforts to halt the rapid increase in disappearance of both plants and animals. Discussion of sociological and economic issues.

[EEB 118a/ER&M 180a. Human Genetic Variation and Evolution]

MCDB 120a. **Principles of Molecular, Cellular & Developmental Biology.** John R. Carlson, Carol Bascom-Slack, Frank Slack
MWF 11.35-12.25
Introduction to biochemistry, genetics, cell biology, and development. Emphasis on the cell as the basic unit of life; its composition, functions, replication, and differentiation. Suitable as the first step in any biological sciences major, and also for any student wishing to understand the fundamentals of biology at the molecular and cellular level. *This course is a prerequisite to MCDB courses numbered 202 or higher.*

MCDB 121La. **Laboratory for Principles of Molecular, Cellular & Developmental Biology.** Maria Moreno
TWTh or F 1.30-5.30
A survey of the experimental techniques used in Molecular, Cellular & Developmental Biology with an emphasis on the utility of model organisms. Exercises in basic molecular biology techniques, protein chemistry, genetic analysis, cell fractionation, microbiology, microscopy and imaging, embryogenesis, plant and animal development. *Concurrently with or after MCDB 120a*.

EEB 122b. **Principles of Evolution, Ecology, and Behavior.** Stephen Stearns
MWF 11.35-12.50 WR
The major principles of evolution, ecology, and behavior explained and illustrated by recent advances that have changed the field. Emphasis on major events in the history and key transitions in the organization of life. Ecological processes from organisms through populations and communities to the biosphere. Foraging, mating, selfish and cooperative behavior placed in evolutionary and ecological context. *Recommended preparation: MCDB 120a or equivalent. This course is a prerequisite to EEB 225.*

EEB 123Lb. **Laboratory for Principles of Evolution, Ecology, and Behavior.** Marta Martínez Wells
TWTh 1.30-4.30
Experimental approaches to organismal and population biology, including study of the diversity of life. *Concurrently with or after EEB 122b.*

MCDB 123b. **Genes and Environment.** Jo Handelsman
MW 10.30-11.20 & 1 HTBA
The nature of biological thought and inquiry explored through study of the interplay between genes and the environment. Influence of the microbial world on the physiology and evolution of organisms. Tools from molecular biology and genomics are used to examine the effects of internal and external factors on gene expression, how the process of gene expression leads to observable characteristics, and the relationship between bacterial gene expression and human survival.

EEB 125b/G&G 125b. **History of Life.** Derek Briggs, Jacques Gauthier, Leo Hickey
TTh 11.35-12.50
Examination of fossil and geologic evidence pertaining to the origin, evolution, and history of life on Earth. Emphasis on major events in the history of life, on what the fossil record tells us about the evolutionary process, on the diversity of ancient and living organisms, and on the evolutionary impact of the changing environment of the Earth.

*MCDB 135b/*CGSC 202b. **How the Brain Works.** David Wells, Mitchell Kundel
MW 2.30-3.45
For non-science majors. The biology of the brain: gross anatomy of the brain and the cellular components that make up nervous tissue. Neurodegenerative diseases such as Alzheimer's, Parkinson's, and ALS; sensory processing such as vision, and pain; psychoactive drugs and their use in treating brain disorders and recreation. *Enrollment limited to freshmen and sophomores.*

EEB 150b[G] **Genomics, Evolution, and Human Biology.** Howard Ochman
MW 2.30-3.45
The biology of humans from an evolutionary perspective. Human genetics, genomics, and evolution as context for understanding the features that link us to all other organisms and those that make us unique. Designed for, but not limited to, majors in Biology.

MCDB 150b[G]/HIST 400b. **Global Problems of Population Growth.** Robert Wyman, Fabian Drixler
MWF 9.25-10.15
The worldwide population explosion in its human, environmental, and economic dimensions. Sociobiological bases of reproductive behavior. Population history and the cause of demographic change. Interactions of population growth with economic development and environmental alteration. Political, religious, and ethical issues surrounding fertility; human rights and the status of women.

EEB 160a. **Diversity of Life**. Wendy Clement
TTh 2.30-3.45
A survey of the diversity of organisms on Earth with a focus on their evolutionary history, biology, and adaptations to their environment.

EEB 171a. **The Collections of the Peabody Museum** Leo Buss
TTh 2.30-3.45
Exploration of selected scientific problems through use of the biological and geological collections of the Peabody Museum. Enrollment limited to freshmen and sophomores.

INTERMEDIATE EEB COURSES

EEB202a/MCDB202a. **Genetics.** Shirleen Roeder, Martín García-Castro
TTh 11.35-12.50
An introduction to classical, molecular, and population genetics of both prokaryotes and eukaryotes and their central importance in biological sciences. Emphasis on analytical approaches and techniques of genetics used to investigate mechanisms of heredity and variation. Topics include transmission genetics, cytogenetics, DNA structure and function, recombination, gene mutation, selection, and recombinant DNA technology.

STAT 101a^{G}/EEB 210a^{G}/MCDB 215a. **Introduction to Statistics: Life Sciences.** Günter Wagner, Jonathan Reuning-Scherer and staff
TTh 1.00-2:15
For description see Statistics.

EEB 220a^{G}. **General Ecology.** David Post, David Vasseur
MWF 10.30-11.20
A broad consideration of the theory and practice of ecology, including the ecology of individuals, population dynamics and regulation, community structure, ecosystem function, and ecological interactions at broad spatial and temporal scales. Topics such as climate change, fisheries management, and infectious diseases are placed in an ecological context. *Prerequisite: MATH 112a or b or equivalent.*

EEB 225b^{G}. **Evolutionary Biology.** Nancy Moran, Paul Turner
TTh TBA
An overview of evolutionary biology as the discipline uniting all of the life sciences. Evolution explains the origin of life and Earth's biodiversity, and how organisms acquire adaptations that improve survival and reproduction. *Recommended preparation: EEB 122.*

EEB 226Lb^{G}. **Laboratory for Evolutionary Biology.** Gisella Caccone
Th 1.30-4.30
The companion laboratory to EEB 225b. Patterns and processes of evolution, including collection and interpretation of molecular and morphological data in a phylogenetic context. Focus on methods of analysis of species-level and population-level variation in natural populations. *Concurrently with or after EEB 225b or with permission of instructor.*

[*EEB 228 bG. Ecology and Evolution of Infectious Diseases**.]**

[EEB 235a. Evolution and Medicine**.]**

EEB 240a^{G}. **Animal Behavior.** Suzanne Alonzo
MW 9.00-10.15
An introduction to the study of animal behavior from an evolutionary and ecological perspective. History and methods of studying animal behavior. Topics include foraging, predation, communication, reproduction, cooperation, and the role of behavior in conservation.

EEB 246b[G]. **Plant Diversity & Evolution.** Wendy Clement
MW 1.00-2.15
Introduction to the evolutionary relationships of plant lineages. The complexity, diversity, and characteristics of the major plant groups, including the green algae, mosses, ferns, conifers, and flowering plants, within a phylogenetic context. *To be taken concurrently with EEB 247Lb. Prerequisite: a general understanding of introductory biology and evolution.*

EEB 247Lb[G]. **Laboratory for Plant Diversity & Evolution.** Wendy Clement
T 1.00-4.00
Local flora field research; hands-on experience with the plant groups examined in the accompanying lectures. *To be taken concurrently with EEB 246b*.

[EEB 248b[G]. Insect Development and Evolution]

[EEB 249Lb. Laboratory for Insect Development and Evolution]

EEB 250a[G]. **Biology of Terrestrial Arthropods.** Marta Martínez Wells
TTh 11.35-12.50
Evolutionary history and diversity of terrestrial arthropods (body plan, phylogenetic relationships, fossil record); physiology and functional morphology (water relations, thermoregulation, energetics of flying and singing); reproduction (biology of reproduction, life cycles, metamorphosis, parental care); behavior (migration, communication, mating systems, evolution of sociality); ecology (parasitism, mutualism, predator-prey interactions, competition, plant-insect interactions). *After EEB 122b.*

EEB 251La[G]. **Laboratory for Biology of Terrestrial Arthropods.** Marta Martínez Wells
W 1.30-5:00
Comparative anatomy, dissections, identification and classification of terrestrial arthropods; specimen collection; field trips. *Concurrently with or after EEB 250a.*

[EEB 255b[G]. Invertebrates I**.**]

[EEB 256Lb[G]. Laboratory for the Invertebrates I.

EEB 257a[G]. **Invertebrates II.** Leo Buss
MW 1.00-2.15
A comprehensive survey of the phyla comprising the *Lophotrochozoa* and the *Ecdysozoa* emphasizing anatomy, functional organization, systematics, and evolutionary history. Prerequisite: E&EB 255

EEB 258La[G]. **Laboratory for the Invertebrates I.** Leo Buss
M 2.30-5.30
Study of the anatomy of representative living invertebrates comprising the *Lophotrochozoa* and the *Ecdysozoa,* accompanied by examination of museum specimens of both extant and fossil invertebrates. Prerequisite: E&EB 256L

[EEB 264a[G]. Ichthyology**.]**

[EEB 265La[G]. Laboratory for Ichthyology**.**]

[EEB 272b[G]. Ornithology**.**]

[*EEB 273Lb[G]. Laboratory for Ornithology**.**]

*EEB 275a[G]/*EVST 400a. **Biological Oceanography.** Mary Beth Decker
T Th 11.35-12.50
For description see under Environmental Studies.

*EEB 280b[G]/*ANTH810/ANTH310. **Mammalogy.** Eric Sargis
TTh 2.30-3.45
The evolution and diversity of mammals, including primates. Origins, evolutionary history, systematics, morphology, biogeography, physiology, behavior, and ecology of major mammalian lineages. Accompanying laboratories focus on diagnostic morphological features of mammalian groups through examination of specimens from the Peabody Museum.

ADVANCED EEB COURSES

[*EEB 310b[G]. Evolutionary Genetics**.**]

*EEB 315a[G] **Ecology and Evolution of Plant-Insect Interactions.** Wendy Clement
TTh 4.00-5.15
The ecology and evolution of plant-insect interactions examined in three parts: insect pollination of plants, herbivory, and ant-plant interactions.

[*EEB 320b[G] **Conservation Genetics.]** Gisella Caccone
TTh 2.30-4.20

EEB 330a/F&ES 330a. **Ecosystem Ecology.** Melinda Smith
Th 1.00-5.00
An outdoor overview of the study of ecosystems. How the structure of ecosystems develops (e.g., biodiversity) and how ecosystems function (e.g., process nutrients or pollutants). The impact of global changes, such as climate change and eutrophication, on ecosystem structure and function. Field-based group and independent projects focused on New England ecosystems.

[EEB 340b[G]/EVST 363b/F&ES 340b[G]. Community Ecology]

EEB 365a/EVST 365a/F&ES 365a[G]. **Landscape Ecology.** David Skelly
MW 9.00-10.15
An introduction to the study of large-scale ecological patterns and processes. Topics include species-area relationships, island biogeography, metapopulation theory, individual-based models, cellular automata, and models of biodiversity. Emphasis on when and how to integrate a spatial perspective into consideration of major ecological questions.

[*EEB 370a[G]/*EVST 370a/*F&ES 370a[G]. Aquatic Ecology]

EEB 390a[G]. **Evolution of Development.** Antónia Monteiro
TTh 9.00-10.15
An introduction to the ways that developmental mechanisms change through time to give rise to organismal diversity. Topics include how mutations influence the processes of gene regulation, tissue growth, and cell and organ differentiation.

[EEB 426a[G]. Phylogenetics and Macroevolution]

[EEB 427La[G]. Phylogenetics Laboratory]

EEB 460b[G]. **Studies in Evolutionary Medicine I.** Stephen Stearns, Durland Fish, Alison Galvani, Paul Turner
TTh 4.00-5.15
This two-term course begins in January. Students learn the major principles of evolutionary biology and apply them to issues in medical research and practice by presenting and discussing original papers from the current research literature. Such issues include lactose and alcohol tolerance; the Hygiene Hypotheses and autoimmune disease; human genetic variation in drug response and pathogen resistance; spontaneous abortions, immune genes, and mate choice; parental conflicts over reproductive investment mediated by genetic imprinting; life history tradeoffs and the evolution of aging; the evolution of virulence and drug resistance in pathogens; the evolutionary genetics of humans and their pathogens; the ecology and evolution of disease; the evolutionary origin of diseases; and the emergence of new diseases. Students are required to develop a research proposal based on one of their own questions in spring term, to spend the summer on a research project related to their research proposal, and to write a paper based on the results of their research in fall term. Students must take both terms, fulfill the summer research project, and attend additional lectures to be scheduled in both terms. Admission is by competitive application only. Forms are available on the EEB department web site.

*EEB 461a[G]. **Studies in EvolutionaryMedicine II.** Paul Turner
TTh 4.00-5.15
Continuation of EEB 460b. *Prerequisite: EEB 460b or with permission of instructor.*

EEB RESEARCH AND TUTORIALS

*EEB 470a or b. **Tutorial.** Marta Martínez Wells
HTBA
Individual or small-group study for qualified students who wish to investigate an area of ecology or evolutionary biology not presently covered by regular courses. A student must be sponsored by a faculty member who sets requirements and meets weekly with the student. One or more written examinations and/or a term paper are required. To register, the student must submit a written plan of study approved by the faculty instructor to the director of undergraduate studies. Students are encouraged to apply during the term preceding the tutorial. The proposal must be submitted by Wednesday, September 7, for the fall term and Wednesday, January 18, for the spring term. The final paper is due in the hands of the director of undergraduate studies by Friday, December 9, for the fall term and Monday, April 23, for the spring term. In special cases, with approval of the

director of undergraduate studies, this course may be elected for more than one term, but only one term will count as an elective for the major. Normally, faculty sponsors must be members of the EEB department. Fulfills the senior requirement for the B.A. degree if taken in the senior year.

*EEB 475a or b. **Research.** Marta Martínez Wells
HTBA
One term of original research in an area relevant to ecology or evolutionary biology. This may involve, for example, laboratory work, fieldwork, or mathematical or computer modeling. Students may also work in areas related to environmental biology such as policy, economics, or ethics. The research project may not be a review of relevant literature but must be original. In all cases students must have a faculty sponsor who oversees the research and is responsible for the rigor of the project. Students are expected to spend ten hours per week on their research projects. Using the form available from the office of undergraduate studies or from the Classes server, students must submit a research proposal that has been approved by the faculty sponsor to the director of undergraduate studies, preferably during the term preceding the research. Proposals are due Wednesday, September 7, for the fall term and Wednesday, January 18, for the spring term. The final research paper is due in the hands of the director of undergraduate studies by Friday, December 9, for the fall term and Monday, April 23, for the spring term.*Fulfills the senior requirement for the B.A. degree if taken in the senior year.*

*EEB 495a, **Intensive Senior Research.** Marta Martínez Wells
HTBA
Two terms of intensive original research during the senior year under the sponsorship of a faculty member. Similar to other research courses except that a more substantial portion of the student's time should be spent on the research project (an average of twenty hours per week). A research proposal approved by the sponsoring faculty member must be submitted to the director of undergraduate studies by September 7, using the form available from the office of undergraduate studies or from the Classes server. Interim oral reports and a final written research paper are required. The final paper is due Monday, April 23.*Fulfills the senior requirement and leads to the intensive B.S. degree.*

*EEB, 496b. **Intensive Senior Research.** Marta Martínez Wells
HTBA
Two terms of intensive original research during the senior year under the sponsorship of a faculty member. Similar to other research courses except that a more substantial portion of the student's time should be spent on the research project (an average of twenty hours per week). A research proposal approved by the sponsoring faculty member must be submitted to the director of undergraduate studies by September 7, using the form available from the office of undergraduate studies or from the Classes server. Interim oral reports and a final written research paper are required. The final paper is due Monday, April 23. *Fulfills the senior requirement and leads to the intensive B.S. degree.*

MCDB COURSES

MCDB 200b. **Molecular Biology.** Stephen Dellaporta, Thomas Pollard, Matthew Rodeheffer
MWF 11.35-12.50
A study of the central dogma and fundamental principles of molecular biology, including a detailed discussion of model organisms and experimental methodologies in biological research. Topics include chemistry of biological macromolecules, DNA and RNA structure and function, chromosome and genome organization, transcriptional and translational regulation, microRNAs, protein structure and function, genomics, and bioinformatics. Designed to provide an accelerated venue for MCDB majors entering the department's core curriculum. *Prerequisite: score of 5 on the Advanced Placement test in Biology or permission of instructor.*

MCDB 201Lb. **Molecular Biology Laboratory.** Maria Moreno
MWF 1.30-5.30 Meets RP WR
Basic molecular biology training in a project-based laboratory setting. Experiments analyze gene function through techniques of PCR, plasmid and cDNA cloning, DNA sequence analysis, and protein expression and purification. Instruction in experimental design, data analysis, and interpretation. *For freshmen and sophomores. Concurrently with or after 200b. Special registration procedures apply. Interested students must contact the instructor and attend an organizational meeting during the first week of classes.*

MCDB 120a is a prerequisite for the courses below

MCDB 202a. **Genetics.** Shirleen Roeder, Stephen Dellaporta, Martín García-Castro
TTh 11.35-12.50
An introduction to classical, molecular, and population genetics of both prokaryotes and eukaryotes and their central importance in biological sciences. Emphasis on analytical approaches and techniques of genetics used to investigate mechanisms of heredity and variation. Topics include transmission genetics, cytogenetics, DNA structure and function, recombination, gene mutation, selection, and recombinant DNA technology.

MCDB 203La. **Laboratory for Genetics.** Iain Dawson, Gregory Fitzgerald
MT or W 1.45-5
Introduction to laboratory techniques used in genetic analysis. Different genetic model organisms - bacteria, yeast, *Drosophila*, and *Arabidopsis* - are used to provide practical experience with various classical and molecular genetic techniques including cytogenetics, mutagenesis and mutant analysis, recombination and gene mapping, isolation and manipulation of DNA, and DNA sequence analysis. *Concurrently with or after MCDB 202a.*

MCDB 205b. **Cell Biology.** Thomas Pollard, Craig Crews, Valerie Horsley
TTh 9-10.15
A comprehensive introductory course in cell biology. Emphasis on the general principles that explain the molecular mechanisms of cellular function.

MCDB 210b. **Developmental Biology.** Vivian Irish, Scott Holley, Douglas Kankel
MW 9-10.15
Cellular differentiation and its genetic and molecular control; fertilization, cleavage, and morphogenesis of plants and animals; polarity and positional information; organogenesis and development of specialized tissues; evolution and development.

STAT 101a^{G}/EEB210a^{G}/MCDB 215a. **Introduction to Statistics: Life Sciences.** Günter Wagner, Jonathan Reuning-Scherer
TTh 1-2:15
For description see under Statistics in the YCPS book.

*MCDB 230b/*MB&B 230b. **Rain Forest Expedition and Laboratory.** Scott Strobel, Carol Bascom-Slack, Lori-Ann Boulanger
MWF 10.30-11.20
Preparation for a two-week expedition to one of the world's rain forests during spring break and for a ten-week summer laboratory experience using samples collected during the expedition. Integrated topics draw on the fields of ecology, microbiology, chemistry, pharmacology, molecular biology, and bioinformatics. Students participate in an original scientific project from field biology to natural product characterization. *After one year of introductory biology or equivalent; after or concurrently with one term of organic chemistry. Limited enrollment. Funding for major travel expenses and summer research provided.*

MCDB 240b. **Biology of Reproduction.** Hugh Taylor, Mary Klein
MWF 10.30-11.20
Introduction to reproductive biology, with emphasis on human reproduction: development and hormonal regulation of reproductive systems; sexuality, fertilization, and pregnancy; modern diagnosis and treatment of reproductive and developmental disorders; social and ethical issues. *Preference to upperclassmen and to students who have completed MCDB 120a or 200b or higher. Prerequisite: MCDB 120a, score of 5 on the Advanced Placement test in Biology, or score of 710 or above on the SAT Biology M test.*

MCDB 241Lb. **Laboratory for Biology of Reproduction and Development.** Mary Klein
T or Th 1.30-5.00
Laboratory investigation of reproductive and developmental processes. Emphasis on mammalian reproduction and embryonic development in classic vertebrate and invertebrate systems. Topics include gametogenesis, ovulation, hormonal control of reproduction, and investigation of embryogenesis in the frog and the fruit fly *Drosophila. Enrollment limited. Concurrently with or after MCDB 240b or 210b. Not open to freshmen. Special registration procedures apply. Students must consult the instructor prior to the first week of classes.*

MCDB 290b. **Microbiology.** Christine Jacobs-Wagner, Carol Bascom-Slack
TTh 1.00-2.15
Cell structure of microorganisms, bacterial genetics, microbial evolution and diversity, microbial development, microbial interaction, chemotaxis and motility, gene regulation, microbial genomics, host defense systems, infectious diseases, viruses, and biological weapons. *After MCDB 300b and CHEM 220a, 221b, or with permission of instructor.*

MCDB 291Lb. **Laboratory for Microbiology.** Iain Dawson
T or Th 2.30-5.30
Practical approaches used when working with microbes, primarily bacteria. Topics include microscopy, culture techniques, biochemical/metabolic assays, and basic environmental and medical microbiology. *Concurrently with or after MCDB 290b.*

MCDB 300b[G]/MB&B 200b. **Biochemistry.** Ronald Breaker, Donald Engelman
MWF 9.25-10.15
SPRING COURSE THIS YEAR. An introduction to the biochemistry of animals, plants, and microorganisms, emphasizing the relations of chemical principles and structure to the evolution and regulation of living systems. *After one term of organic chemistry.*

MCDB 301La/MB&B 251La. **Laboratory for Biochemistry.** William Konigsberg, Aruna Pawashe
TTh 1.00-5.00
An introduction to current experimental methods in molecular biology. *After or concurrently with MB&B 200a or 300b. Limited enrollment. Preregistration required; e-mail William Konigsberg prior to the first week of classes.*

MCDB 302La. **Advanced Biology Laboratory.** Maria Moreno
W 1.00-4.00
A two-term laboratory course that provides advanced biological research skills. Weekly workshops focus on grantsmanship, experimental design, data analysis, reading of primary literature, scientific presentations, and scientific writing skills. Application of these skills in project-based laboratory training sponsored by a faculty member.

MCDB 303Lb. **Advanced Biology Laboratory.** Maria Moreno
W 1.00-4.00
A two-term laboratory course that provides advanced biological research skills. Weekly workshops focus on grantsmanship, experimental design, data analysis, reading of primary literature, scientific presentations, and scientific writing skills. Application of these skills in project-based laboratory training sponsored by a faculty member.

MCDB 310a[G]/BENG 350a[G]. **Physiological Systems.** Mark Saltzman, Emile Boulpaep
MWF 9.25-10.15
Regulation and control in biological systems, emphasizing human physiology and principles of feedback. Biomechanical properties of tissues emphasizing the structural basis of physiological control. Conversion of chemical energy into work in light of metabolic control and temperature regulation. *Prerequisites: CHEM 113 or 115 or PHYS 180a and 181b, MCDB 120a.*

MCDB 315b. **Biological Mechanisms of Reaction to Injury.** Joseph Madri, Michael Kashgarian, Jon Morrow, Jeffrey Sklar, A. Brian West
TTh 11.35-12.50 Meets RP
Human biology and disease as a manifestation of reaction to injury. Organ structure and function, cell injury, circulatory and inflammatory responses, disordered physiology, and neoplasia.

Enrollment limited; preference given to junior and senior majors in MCDB or MB&B. Prerequisite: MCDB 205b or 300b or 310a.

MCDB 320a[G]. **Neurobiology.** Haig Keshishian, Paul Forscher
MWF 11.35-12.25
The excitability of the nerve cell membrane as a starting point for the study of molecular, cellular, and intercellular mechanisms underlying the generation and control of behavior. *After a year of chemistry; a course in physics is strongly recommended.*

MCDB 321La[G]. **Laboratory for Neurobiology.** Haig Keshishian, Robert Wyman
T or W 1.30- 4.30
Optional laboratory. Introduction to the neurosciences. Projects include the study of neuronal excitability, sensory transduction, CNS function, synaptic physiology, and neuroanatomy. *Concurrently with or after MCDB 320a.*

*MCDB 341Lb. **Laboratory in Electron Microscopy.** Barry Piekos
T or W 1.30-4.30
Techniques in light and electron microscopy. *Enrollment limited; preference given to Biology and MB&B majors; students must devote two to three additional laboratory hours per week. Students should contact the instructor prior to the first week of classes. After or concurrently with MCDB 205b.*

*MCDB 342La. **Laboratory in Nucleic Acids I.** Kenneth Nelson
TTh 1.30-4.30
A project from a research laboratory within the MCDB department, using many of the technologies from molecular and cell biology. Laboratories meet twice a week for the first half of the term. *With or after MCDB 202a, 205b, or 300b. Enrollment limited.*
Special registration procedures apply. Students must consult the instructor prior to the first week of classes.

*MCDB 343La. **Laboratory in Nucleic Acids II.** Kenneth Nelson
TTh 1.30-4.30
Continuation of MCDB 342La to more advanced methods and techniques in molecular and cell biology, including projects such as making and screening cDNA libraries or microarray screening and analysis. Laboratories meet twice a week for the second half of the term. *Prerequisite:* MCDB 342La *or with permission of instructor. Enrollment limited. Special registration procedures apply. Students must consult the instructor prior to the first week of classes.*

*MCDB 344Lb. **Experimental Techniques in Cellular Biology.** Joseph Wolenski
MW 1.30-6.30
A problems-based approach to questions in cell and molecular biology, with emphasis on experimental strategies and techniques. Topics include SDS-PAGE, immunoblots, column chromatography, mammalian cell culture, cell fractionation, light microscopy, drug studies, bacterial cultures, and methods of transfection and transformation. *Prepares for MCDB 475a or b or 485a, 486b or 495a, 496b. Enrollment limited. Prerequisite: MCDB 205b.*
Special registration procedures apply. Students must contact the instructor by October of the fall term for spring registration.

*MCDB 345Lb. **Experimental Strategies in Cellular Biology.** Joseph Wolenski
MW 1.30-6.30
Continuation of MCDB 344Lb, with increased emphasis on experimental design and interpretation of data. Research projects involving protein purification are semi-independent. Focus on developing an independent research project in modern biomedical research. Students participate in journal discussions, formal seminars, and presentations of data to peers. *Prepares for MCDB 475a or b or 485a, 486b or 495a, 496b. Enrollment limited. Meets during March and April. Prerequisite: MCDB 344Lb.*

Special preregistration procedures apply. Students must contact the instructor by October of the fall term for spring registration.

[MCDB 356a. Experimental Strategies in Molecular Cell Biology]

MCDB 361b[G]/AMTH 465b. **Systems Modeling in Biology.** Thiery Emonet, Steven Kleinstein, Simon Mochrie, Xiao Jing Wang, Steven Zucker
TTh 2.30-3.45
Introduction to the techniques of integrating mathematics, physics, and engineering into the analysis of complex living systems. Use of these techniques to address questions about the design principles of biological systems. Discussion of experiments and corresponding mathematical models. Students build their own models using MATLAB.

*MCDB 370b[G]. **Biotechnology.** Xing-Wang Deng, Kenneth Nelson, Ronald Breaker, Joseph Wolenski
MW 11.35-12.50
The principles and applications of cellular, molecular, and chemical techniques that advance biotechnology. Topics include the most recent tools and strategies used by government agencies, industrial labs, and academic research to adapt biological and chemical compounds as medical treatments, as industrial agents, or for the further study of biological systems. *Prerequisites: MCDB 200b or 202a or 300b.*

[*MCDB 375b[G]. Advances in Plant Molecular Biology]

*MCDB 387b. **The Eukaryotic Cell Cycle.** Iain Dawson
T or Th 7.00-8.50 p.m.
The regulation and coordination of the eukaryotic cell cycle examined by means of a detailed critique of primary literature. Particular attention to the processes of development, differentiation, and oncogenic disease. *Enrollment limited, with preference to juniors and seniors. Prerequisite or corequisite: MCDB 202a or 205b. Electronic permission key required. Students must contact the instructor prior to the first week of classes.*

[MCDB 410a[G]. Molecular Basis of Development]

MCDB 415b[G]. **Cellular and Molecular Physiology.** Emile Boulpaep, Frederick Sigworth
MWF 9.25-10.15
Study of the processes that transfer molecules across membranes. Topics include the different classes of molecular machines that mediate membrane transport. Emphasis on interactions among transport proteins in determining the physiologic behaviors of cells and tissues. *Intended for seniors majoring in the biological sciences. Recommended preparation: MCDB 205b, 310a, 320a, or permission of instructor.*

MCDB 425a[G]/MB&B 425a[G]. **Basic Concepts of Genetic Analysis.** Tian Xu, Lynn Cooley, Tae-Hoon Kim, Michael Koelle, Richard Lifton, Shirleen Roeder

MW 11.35-12.50

An examination of the universal principles of genetic analysis in eukaryotes. Reading and analysis of primary papers illustrating the best of genetic analysis in the study of a variety of biological issues. Focus on the concepts and logic underlying modern genetic analysis. *Prerequisite: MCDB 202a or equivalent.*

MCDB 430a[G]. **Biology of the Immune System.** Akiko Iwasaki, Peter Cresswell, Kevan Herold, Susan Kaech, Ruslan Medzhitov, Eric Meffree, Carla Rothlin, David Schatz, Mark Shlomchik

MWF 9.25-10.15

The development of the immune system. Cellular and molecular mechanisms of immune recognition. Effector responses against pathogens; autoimmunity, immunodeficiency, HIV/AIDS. *After MCDB 300b.*

*MCDB 435a. **Landmark Papers in Cell Biology.** Joel Rosenbaum, Mark Mooseker

2 HTBA

Discussion and critical evaluation of selected research papers that were important in determining the directions of modern cell biological research. Emphasis on the nature of the problem, evaluation of experimental approaches and results, and the authors' interpretation of the results. *Students should contact the instructor prior to the first week of classes. Prerequisites: courses in cell biology, biochemistry and genetics, or permission of instructor.*

*MCDB 440b[G]. **Brain Development and Plasticity.** Weimin Zhong, Elke Stein

MW 2.30-3.45

Recent advances in our understanding of brain development and plasticity, including neuronal determination, axon guidance, synaptogenesis, and developmental plasticity. *Prerequisite: MCDB 320a or permission of instructor.*

MCDB 450a. **The Human Genome.** Stephen Dellaporta

M 3.30-5.30

Principles of genomic sciences as they are used to understand complex human traits and diseases. How the human genome was sequenced; organization of the genome; the amount and characterization of variation in the human population; variation and phenotypic differences; the human genome compared to that of our closest relatives; genome resequencing and genome association studies. *Enrollment limited to 20. Students should contact the instructor prior to the first week of classes. Prerequisite: a course in genetics or permission of instructor.*

MCDB 452b[G]/CPSC 452b/MB&B 452b[G]. **Genomics and Bioinformatics.** Mark Gerstein, Dieter Söll

MW 1.00-2.15

Techniques in data mining and simulation applied to bioinformatics, the computational analysis of gene sequences, macromolecular structures, and functional genomics data on a large scale. Sequence alignment, comparative genomics and phylogenetics, biological databases, geometric analysis of protein structure, molecular-dynamics simulation, biological networks, microarray normalization, and machine-learning approaches to data integration. *Prerequisites: MB&B 301b and MATH 115a or b, or permission of instructor.*

*MCDB 460b[G]. **Cell Biology of the Neuron.** Elke Stein and Staff
TTh 4.00-5.15
A comprehensive course to neural cell biology. Principles of cell biology will be reviewed in the context of the developing nervous system. Discussion topics include membrane trafficking, receptor mechanisms, neurotrophin signaling, neuronal cytoskeleton, axon guidance, and synapse formation and maintenance. *Prerequisite: one course in cell biology.*

MCDB RESEARCH AND TUTORIALS

*MCDB 470a or b. **Tutorial.** Douglas Kankel
HTBA
Individual or small-group study for qualified students who wish to investigate a broad area of experimental biology not presently covered by regular courses. A student must be sponsored by a Yale faculty member, who sets the requirements. The course must include one or more written examinations and/or a term paper. This is intended to be a supplementary course and, therefore, to have weekly or biweekly discussion meetings between the student and the sponsoring faculty member. To register, the student must prepare a form, available in the office of the director of undergraduate studies, and a written plan of study with bibliography, approved by the adviser. The form and proposal must be uploaded to the Classes server or submitted to the course instructor in 754 KBT by Friday, September 9, for the fall term and Tuesday, January 17, for the spring term. The final paper is due in the hands of the sponsoring faculty member, with a copy to the course instructor, by the beginning of reading period. *In special cases, with approval of the director of undergraduate studies, this course may be elected for more than one term, but only one term will count as an elective for the major. Additional sections offered in Beijing, China, under the supervision of Xing-Wang Deng. See under Peking University-Yale University Joint Undergraduate Program.*

MCDB 475a or b. **Research.** Staff
HTBA
Research projects under faculty supervision, ordinarily taken to fulfill the senior requirement. This course may be taken before the senior year, but it cannot substitute for other requirements. Students are expected to spend approximately ten hours per week in the laboratory, and to make presentations to students and advisers at monthly section meetings. Written assignments include a short research proposal summary, at the beginning of the term, approved by the Yale faculty sponsor and the instructor in charge of the course. A final research report is required at the end of the term, before a grade is given. Seniors taking this course to fulfill the senior requirement must give an oral presentation of their research at the end of the term. Students who take this course more than once must reapply each term; students planning to conduct two terms of research should consider enrolling in MCDB 485a, 486b. Students should line up a research laboratory during the term preceding the research. Guidelines for the course should be obtained from the office of the director of undergraduate studies or downloaded from the Classes server. Written proposals are due Friday, September 9, for the fall term and Tuesday, January 17, for the spring term. *Fulfills the senior requirement for the B.A. degree if taken in the senior year.*

*MCDB 485a and 486b. **Research in Biology.** Staff
HTBA Credit/Year Only
Individual two-term laboratory research projects under the supervision of a faculty member. Students are expected to spend ten to twelve hours per week in the laboratory, and to make presentations to students and advisers at monthly discussion groups. Written assignments include a short research proposal summary due at the beginning of the first term, a grant proposal due at the end of the first term, and a research report summarizing experimental results due at the end of the second term. Students are also required to present their research in either the fall or the spring term. A poster session is held at the end of the spring term. Students should line up a research laboratory during the term preceding the research. Guidelines for the course should be obtained from the office of the director of undergraduate studies or downloaded from the Classes server. Written proposals are due Friday, September 9, 2011. *Fulfills the senior requirement if taken in the senior year. Additional sections offered in Beijing, China, under the supervision of Xing-Wang Deng. See under Peking University–Yale University Joint Undergraduate Program.*

*MCDB 495a and 496b. **Intensive Research in Biology.** Staff
HTBA Credit/Year Only
Qualified students may undertake directed research in some field of biology during the senior year. Before registering for this course, the student must be accepted for a research project by a Yale faculty member with a research program in experimental biology and obtain the approval of the instructor in charge of the course. Students spend approximately twenty hours per week in the laboratory, and make written and oral presentations of their research to students and advisers. Written assignments include a short research proposal summary due at the beginning of the first term, a grant proposal due at the end of the first term, and a research report summarizing experimental results due at the end of the second term. Students must attend a minimum of three research seminar sessions (including their own) per term. Students are also required to present their research during both the fall and spring terms. A poster session is held at the end of the spring term. Guidelines for the course are covered in detail in an information sheet that students should obtain from the office of the director of undergraduate studies early in the final term of the junior year. A written proposal must be submitted by Friday, September 9,2011. *Fulfills the senior requirement and leads to the intensive B.S. major.*

The following courses are required for students in the joint B.S./M.S. Program with Yale College:

EEB 575b/MCDB 585b. **Research in MCDB for B.S./M.S. Candidates.** Douglas Kankel
HTBA
A two-credit course taken in the third-to-last term (typically the second term of the junior year). At the start of this course, each student forms a committee composed of their adviser and two faculty members that meets to discuss the research project. At the end of this course, students complete a detailed prospectus describing their thesis project and the work completed thus far. The committee evaluates an oral and written presentation of this prospectus; the evaluation determines whether the student may continue in the combined program.

EEB 575/MCDB 595. **Intensive Research in MCDB for B.S./M.S. Candidates.** Douglas Kankel
HTBA

A four-credit, yearlong course (two credits each term) that is similar to MCDB 495a, 496b and is taken during the senior year. During this course, students give an oral presentation describing their work. At the end of the course, a student is expected to present his or her work to the department in the form of a poster presentation. In addition, the student is expected to give an oral thesis defense, followed by a comprehensive examination of the thesis conducted by the thesis committee. Upon successful completion of this examination, as well as other requirements, the student is awarded the combined B.S./M.S. degree.

With permission of the instructor, advanced undergraduates may take graduate courses for credit. If you are interested in one of these consult the instructor and you will need to fill out a special form that should be available in your college dean's office.

EEB GRADUATE COURSES -- 2011-2012

EEB 500a/b. **Advanced Topics in Ecology and Evolutionary Biology.** Staff
M 2.30-4.30
This seminar course meets on Mondays from 2 to 4 pm, during both the fall and spring semesters. The year-long course is required for all 1st - year grad students, and the primary goals are to acquaint new students with the research going on in the department, and for students to get to know the faculty. Topics to be announced.

STAT 101a^{G}/EEB 510a^{G}/MCDB 215a. **Introduction to Statistics: Life Sciences.** Günter Wagner, Jonathan Reuning-Scherer and Staff
TTh 1.00-2:15
For description see Statistics.

EEB 515a^{G}/ **Conservation Biology.** Jeffrey Powell, Walter Jetz
WF 10.30-11.20 1 HTBA
An introduction to ecological and evolutionary principles underpinning efforts to conserve Earth's biodiversity. Efforts to halt the rapid increase in disappearance of both plants and animals. Discussion of sociological and economic issues.

EEB 520a^{G}. **General Ecology.** David Post
MWF 10.30-11.20
A broad consideration of the theory and practice of ecology, including the ecology of individuals, population dynamics and regulation, community structure, ecosystem function, and ecological interactions at broad spatial and temporal scales. Topics such as climate change, fisheries management, and infectious diseases are placed in an ecological context. *Prerequisite: MATH 112a or b or equivalent.*

EEB 522b. **Principles of Evolution, Ecology, and Behavior.** Stephen Stearns
MWF 11.30-12.20 WR
The major principles of evolution, ecology, and behavior explained and illustrated by recent advances that have changed the field. Emphasis on major events in the history and key transitions in the organization of life. Ecological processes from organisms through populations and communities to the biosphere. Foraging, mating, selfish and cooperative behavior placed in evolutionary and ecological context. *Recommended preparation: MCDB 120a or equivalent. This course is a prerequisite to EEB 225.*

EEB 523Lb. **Laboratory for Principles of Evolution, Ecology, and Behavior.** Marta Martínez Wells

TWTh 1.30-4.30

Experimental approaches to organismal and population biology, including study of the diversity of life. *Concurrently with or after EEB 122b.*

EEB 525b[G]. **Evolutionary Biology.** Antónia Monteiro, Jeffrey Townsend

TTh 11.35-12.50

An overview of evolutionary biology as the discipline uniting all of the life sciences. Evolution explains the origin of life and Earth's biodiversity, and how organisms acquire adaptations that improve survival and reproduction. *Recommended preparation: EEB 122.*

EEB 526Lb[G]. **Laboratory for Evolutionary Biology.** Gisella Caccone

Th 1.30-4.30

The companion laboratory to EEB 225b. Patterns and processes of evolution, including collection and interpretation of molecular and morphological data in a phylogenetic context. Focus on methods of analysis of species-level and population-level variation in natural populations. *Concurrently with or after EEB 225b or with permission of instructor.*

[*EEB 528 b[G]. Ecology and Evolution of Infectious Diseases.**]**

[EEB 535a. Evolution and Medicine.]

EEB 540a[G]. **Animal Behavior.** Suzanne Alonzo

MW 9.00-10.15

An introduction to the study of animal behavior from an evolutionary and ecological perspective. History and methods of studying animal behavior. Topics include foraging, predation, communication, reproduction, cooperation, and the role of behavior in conservation.

EEB 545b. **Problems in Bioethics/Ethics course for Advanced Topics.** David Post

M 2.30-4.30

The eight hour bioethics training in the Yale Department of Ecology and Evolutionary Biology is held as a four week module of the first year graduate student course EEB 500- Advanced Topics in Research. All first year graduate students in EEB will be required to attend.

EEB 546b[G]. **Plant Diversity & Evolution.** Wendy Clement

MW 1.00-2.15

Introduction to the evolutionary relationships of plant lineages. The complexity, diversity, and characteristics of the major plant groups, including the green algae, mosses, ferns, conifers, and flowering plants, within a phylogenetic context. *To be taken concurrently with EEB 247Lb. Prerequisite: a general understanding of introductory biology and evolution.*

EEB 547Lb[G]. **Laboratory for Plant Diversity & Evolution.** Wendy Clement

T 1.00-4.00

Local flora field research; hands-on experience with the plant groups examined in the accompanying lectures. *To be taken concurrently with EEB 246b*.

EEB 550a[G]. **Biology of Terrestrial Arthropods.** Marta Martínez Wells

TTh 11.35-12.50

Evolutionary history and diversity of terrestrial arthropods (body plan, phylogenetic relationships, fossil record); physiology and functional morphology (water relations, thermoregulation, energetics of flying and singing); reproduction (biology of reproduction, life cycles, metamorphosis, parental care); behavior (migration, communication, mating systems, evolution of 32sociality); ecology (parasitism, mutualism, predator-prey interactions, competition, plant-insect interactions). *After EEB 122b.*

EEB 551La[G]. **Laboratory for Biology of Terrestrial Arthropods.** Marta Martínez Wells
W 1.30-5:00
Comparative anatomy, dissections, identification and classification of terrestrial arthropods; specimen collection; field trips. *Concurrently with or after EEB 250a.*

EEB 557a[G]. **Invertebrates II.** Leo Buss
MW 1.00-2.15
A comprehensive survey of the phyla comprising the *Lophotrochozoa* and the *Ecdysozoa* emphasizing anatomy, functional organization, systematics, and evolutionary history.

EEB 558La[G]. **Laboratory for the Invertebrates II.** Leo Buss
M 2.30-5.30
Study of the anatomy of representative living invertebrates comprising the *Lophotrochozoa* and the *Ecdysozoa,* accompanied by examination of museum specimens of both extant and fossil invertebrates..

[EEB 564a[G]. Ichthyology**.]**

[EEB 565La[G]. [Laboratory for Ichthyology**.]**

EEB 575a. **Biological Oceangraphy.** Mary Beth Decker
MW 11.35-12.50
Exploration of a range of coastal and pelagic ecosystems and how these environments function as coupled physical/biological systems. This natural science course provides a foundation for those interested in the ecology of marine systems and in the management of coastal zones. (Three hours lecture, field trips.)

[EEB 602a[G]. Evolutionary Inference of Ancestral States.**]**

[*EEB 610b[G]. Evolutionary Genetics.]

[EEB 626a. Molecular Ecology]

[EEB 627a or b. Research Topics in Molecular Ecology]

EEB 630a **Ecosystem Ecology.** Melinda Smith
Th 1.00-5.00
An outdoor overview of the study of ecosystems. How the structure of ecosystems develops (e.g., biodiversity) and how ecosystems function (e.g., process nutrients or pollutants). The impact of global changes, such as climate change and eutrophication, on ecosystem structure and function. Field-based group and independent projects focused on New England ecosystems.

[EEB 632b. The Analysis of Ecological Time-Series]

[EEB 640b. Community Ecology]

[EEB 660b[G] **Conservation Genetics.]** Gisella Caccone
TTh 2.30-4.20

EEB 665a/[G]. **Landscape Ecology.** David Skelly
MW 9.00-10.15
An introduction to the study of large-scale ecological patterns and processes. Topics include species-area relationships, island biogeography, metapopulation theory, individual-based models, cellular automata, and models of biodiversity. Emphasis on when and how to integrate a spatial perspective into consideration of major ecological questions.

[EEB 672b [G]. Ornithology.]

[*EEB 673Lb[G]. Laboratory for Ornithology.]

[EEB 678b. Mathematical Models and Quantitative Methods in Evolution and Ecology]

EEB 690a[G]. **Evolution of Development.** Antónia Monteiro
TTh 9.00-10.15
An introduction to the ways that developmental mechanisms change through time to give rise to organismal diversity. Topics include how mutations influence the processes of gene regulation, tissue growth, and cell and organ differentiation.

[EEB 710b. Sexual Selection and Social Evolution**.]**

[*EEB 728b. Ecology and Evolution of Infectious Diseases.]

[EEB 729a. Microbial Ecology and Evolution]

[EEB 810a. Dynamics of Evolving Systems]

EEB 900a/b. **First-Year Introduction to Research and Rotations.**
The primary purpose of the rotations is to identify a laboratory in which to carry out dissertation research. Rotations also serve to introduce students to new techniques, gain a broader background in EEB.

EEB 930a. **Seminar in Systematics.** Staff
A graduate level seminar is offered in the spring semester on the topic of using molecularevolutionary models in Bayesian phylogenetic analyses. Topics will include thosechosen by the participants, but may include the following: models in phylogenetics, understanding and comparison of model selection criteria, effects of model under- and overparameterization on parameter value estimatesand phylogenetic inferences, and accommodating model uncertainty and model-averaging.

EEB 950a or b. **Second-Year Research.** By arrangement with Staff.

EEB 960b[G]. **Studies in Evolutionary Medicine I.** Stephen Stearns, Durland Fish, Alison

Galvani, Paul Turner
TTh 3:30-5:20
This two-term course begins in January. Students learn the major principles of evolutionary biology and apply them to issues in medical research and practice by presenting and discussing original papers from the current research literature. Such issues include lactose and alcohol tolerance; the Hygiene Hypotheses and autoimmune disease; human genetic variation in drug response and pathogen resistance; spontaneous abortions, immune genes, and mate choice; parental conflicts over reproductive investment mediated by genetic imprinting; life history tradeoffs and the evolution of aging; the evolution of virulence and drug resistance in pathogens; the evolutionary genetics of humans and their pathogens; the ecology and evolution of disease; the evolutionary origin of diseases; and the emergence of new diseases. Students are required to develop a research proposal based on one of their own questions in spring term, to spend the summer on a research project related to their research proposal, and to write a paper based on the results of their research in fall term. Students must take both terms, fulfill the summer research project, and attend additional lectures to be scheduled in both terms. Admission is by competitive application only. Forms are available on the EEB department web site.

*EEB 961a ^{G}. **Studies in EvolutionaryMedicine II.** Stephen Stearns, Paul Turner
TTh 4.00-5.15
Continuation of EEB 460b. *Prerequisite: EEB 460b or with permission.*

MCDB GRADUATE COURSES -- 2011-2012

MCDB 500b^{U}/MB&B 500b^{U}. **Biochemistry.** Ronald Breaker, Donald Engelman, Nicole Clay
MWF 9.25-10.15
SPRING COURSE THIS YEAR. An introduction to the biochemistry of animals, plants, and microorganisms, emphasizing the relations of chemical principles and structure to the evolution and regulation of living systems.

[MCDB 505a/GENE 705a/MB&B 705a^{U}. Molecular Genetics of Prokaryotes.]

MCDB 517b/ENAS 517b/MB&B517b/Phys 517b/MCDB 517b. **Methods and Logic in Interdisiplinary Research.** Corey O'Hern, Enrique De La Cruz, Eric Dufresne, Thierry Emonet, Paul Forscher, Christine Jacobs-Wagner, Michael Levene, Simon Mochrie, Thomas Pollard, Lynne Regan, Elizabeth Rhoades, Corey Wilson
MW 5.00-7.00
This half-term IGPPEB class is intended to introduce students to integrated approaches to research. Each session is led by faculty with complementary expertise and discusses papers that use different approaches to the same topic (for example, physical and biological or experiment and theory). *Counts as 0.5 credit toward graduate course requirements. Required for students in IGPPEB.*

MCDB 530a^{U}/IBIO 530a. **Biology of the Immune System.** Akiko Iwasaki, Peter Cresswell, Kevan Herold, Susan Kaech, Joseph Meffree, Ruslan Medzhitov, Joao Pedro Pereira, Carla Rothlin, David Schatz, Mark Schlomchik
MWF 9.25-10.15
The development of the immune system. Cellular and molecular mechanisms of immune

recognition. Effector responses against pathogens. Immunologic memory and vaccines. Human diseases including allergy, autoimmunity, immunodeficiency, HIV/AIDS.

MCDB 550a[U]/C&MP 550a[U]/ENAS 550a[U]. **Physiological Systems.** Emile Boulpaep, W. Mark Saltzman

MWF 9.25-10.15

The course develops a foundation in human physiology by examining the homeostasis of vital parameters within the body, and the biophysical properties of cells, tissues, and organs. Basic concepts in cell and membrane physiology are synthesized through exploring the function of skeletal, smooth, and cardiac muscle. The physical basis of blood flow, mechanisms of vascular exchange, cardiac performance, and regulation of overall circulatory function are discussed. Respiratory physiology explores the mechanics of ventilation, gas diffusion, and acid-base balance. Renal physiology examines the formation and composition of urine and the regulation of electrolyte, fluid, and acid-base balance. Organs of the digestive system are discussed from the perspective of substrate metabolism and energy balance. Hormonal regulation is applied to metabolic control and to calcium, water, and electrolyte balance. The biology of nerve cells is addressed with emphasis on synaptic transmission and simple neuronal circuits within the central nervous system. The special senses are considered in the framework of sensory transduction. Weekly discussion sections provide a forum for in-depth exploration of topics. *Graduate students evaluate research findings through literature review and weekly meetings with the instructor.*

[MCDB 551a[U]. Experimental Strategies in Molecular Cell Biology]

[MCDB 555a[U]. Molecular Basis of Development]

MCDB 560b[U]/C&MP 560b[U]/ENAS 570b[U]. **Cellular and Molecular Physiology: Molecular Machines in Human Disease.** Emile Boulpaep, Fred Sigworth

MWF 9:25–10:15

The course focuses on understanding the processes that transfer molecules across membranes at the cellular, molecular, biophysical, and physiologic levels. Students learn about the different classes of molecular machines that mediate membrane transport, generate electrical currents, or perform mechanical displacement. Emphasis is placed on the relationship between the molecular structures of membrane proteins and their individual functions. The interactions among transport proteins in determining the physiologic behaviors of cells and tissues are also stressed. Molecular motors are introduced and their mechanical relationship to cell function is explored. Students read papers from the scientific literature that establish the connections between mutations in genes encoding membrane proteins and a wide variety of human genetic diseases.

MCDB 561b[U]/AMTH 665b[U]/PHYS 529b. **Systems Modeling in Biology.** Thierry Emonet, Kathryn Miller Jensen, Steven Kleinstein, Xiao-Jing Wang, Steven Zucker

TTh 2.30-3.45

An introduction to the techniques of integrating knowledge from mathematics, physics, and engineering into the analysis of complex living systems. Use of these techniques to address key questions about the design principles of biological systems. Discussion of experiments and corresponding mathematical models. Reading of research papers from the literature. Students build their own models using MATLAB.

MCDB 570b[U]. **Biotechnology.** Xing-Wang Deng, Farren Isaacs, Kenneth Nelson, Joseph Wolenski

MW 11.35-12.50

The principles and applications of cellular, molecular, and chemical techniques that advance biotechnology. Topics include the most recent tools and strategies used by government agencies, industrial labs, and academic research to adapt biological and chemical compounds as medical treatments, as industrial agents, or for the further study of biological systems.

MCDB 602a/CBIO 602a/MB&B 602a. **Molecular Cell Biology.** Sandra Wolin, Thomas Melia, Thomas Pollard, Michael Caplan, Craig Crews, Pietro De Camilli, Haifan Lin, Joseph Madri, Mark Mooseker, James Rothman, Megan King

MW 1:45–3.00

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.

MCDB 603a/CBIO 603a. **Seminar in Molecular Cell Biology.** Sandra Wolin, Thomas Melia, Thomas Pollard, Michael Caplan, Craig Crews, Pietro De Camilli, Joseph Madri, Mark Mooseker, James Rothman, Megan King

Th 9.00–11.00

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 MCDB 602a lecture schedule. *Concurrent or previous enrollment in MCDB 602a is required.*

MCDB 625a^{U}/GENE 625a/MB&B 625a^{U}. **Basic Concepts of Genetic Analysis.** Tian Xu, Lynn Cooley, Tae-Hoon Kim, Michael Koelle, Richard Lifton, Shirleen Roeder

MW 11.35-12.50

The universal principles of genetic analysis in eukaryotes are discussed in lectures. Students also read a small selection of primary papers illustrating the very best of genetic analysis and dissect them in detail in the discussion sections. While other Yale graduate molecular genetics courses emphasize molecular biology, this course focuses on the concepts and logic underlying modern genetic analysis.

MCDB 630b/MB&B 630b. **Biochemical and Biophysical Approaches in Molecular and Cellular Biology.** Thomas Pollard, Enrique De La Cruz, Anna Pyle

TTh 2.30–3.45

This graduate course introduces the theory and application of biochemical and biophysical methods to study the structure and function of biological macromolecules. The course considers the basic physical chemistry required in cellular and molecular biology but does not require a previous course in physical chemistry. One class per week is a lecture introducing a topic. The second class is a discussion of one or two research papers utilizing those methods.

MCDB 660a. **Structure, Function, and Development of Vascular Plants.** Graeme Berlyn

MW 9.00-10.15

Morphogenesis and adaptation of vascular plants considered from seed formation and germination to maturity. Physiological and developmental processes associated with structural changes in response to environment discussed from both a phylogenetic and an adaptive point of view.

MCDB 670b. **Advanced Seminar in Biochemistry and Genetics.** Sid Altman, Ronald Breaker, Frank Slack

W 1.30-3.30

MCDB 677b/GENE 777b. **Mechanisms of Development.** Valerie Reinke, and Staff

M 9.00–10.15, F 2.30–3.45

An advanced course on the mechanisms of animal development focusing on the genetic specification of cell organization and identity during embryogenesis and somatic differentiation. The use of evolutionarily conserved signaling pathways to carry out developmental decisions in a range of animals is highlighted. Course work includes student presentations, critical analysis of primary literature, and a research proposal term paper.

MCDB 720a[U]/NBIO 720a/NSCI 720a. **Neurobiology.** Haig Keshishian, Paul Forscher

MWF 11.35-12.25

Examination of the excitability of the nerve cell membrane as a starting point for the study of molecular, cellular, and intercellular mechanisms underlying the generation and control of behavior.

MCDB 721La[U]. **Laboratory for Neurobiology.** Haig Keshishian, Robert Wyman

T or W 1.30-5.30

Optional laboratory. Introduction to the neurosciences. Projects include the study of neuronal excitability, sensory transduction, CNS function, synaptic physiology, and neuroanatomy.

MCDB 730b[U]/MCDB 460b/NSCI 502. **Cell Biology of the Neuron.** Elke Stein

TTh 4.00-5.15

A comprehensive course on neuronal cell biology. Basic principles of cell biology reviewed in the context of the developing and injured nervous system. Areas that will be discussed include: Membrane trafficking, receptor signaling mechanisms, neurotrophin signaling, neuronal cytoskeleton, axon guidance, and synapse formation and maintenance. *Prerequisite: one course in cell biology.*

MCDB 735b/NSCI 504b. **Seminar in Brain Development and Plasticity.** Weimin Zhong, Elke Stein

MW 2.30-3.45

Weekly seminars and discussion sessions to explore recent advances in our understanding of brain development and plasticity, including neuronal determination, axon guidance, synaptogenesis, and developmental plasticity.

MCDB 743b/GENE 743b/MB&B 743b[U]. **Advanced Eukaryotic Molecular Biology.** Mark Hochstrasser, Anthony Koleske, Patrick Sung

TTh 11.35–12.50

Selected topics in transcriptional control, regulation of chromatin structure, mRNA processing, mRNA stability, RNA interference, translation, protein degradation, DNA replication, DNA repair, site-specific DNA recombination, somatic hypermutation. *Prerequisite: biochemistry or permission of the instructor.*

MCDB 750a/CB&B 750a. **Core Topics in Biomedical Informatics.** Perry Miller and Staff
HTBA
Introduction to common unifying themes that serve as the foundation for different areas of biomedical informatics, including clinical, neuro-, and genome informatics. The course is designed for students with significant computer experience and course work who plan to build computational tools for use in bioscience research. Emphasis is on understanding basic principles underlying informatics approaches to biomedical data modeling, interoperation among biomedical databases and software tools, standardized biomedical vocabularies and ontologies, modeling of biological systems, and other topics of interest. The course involves lectures, class discussions, student presentations, and computer programming assignments. *Prerequisite: previous computer programming experience and permission of the instructor.*

MCDB 752b^{U}/CB&B 752b/CPSC 752b^{U}/MB&B 752b^{U}. **Bioinformatics: Practical Application of Simulation and Data Mining.** Mark Gerstein
MW 1.00-2.15
Bioinformatics encompasses the analysis of gene sequences, macromolecular structures, and functional genomics data on a large scale. It represents a major practical application for modern techniques in data mining and simulation. Specific topics to be covered include sequence alignment, large-scale processing, next-generation sequencing data, comparative genomics, phylogenetics, biological database design, geometric analysis of protein structure, molecular-dynamics simulation, biological networks, normalization of microarray data, mining of functional genomics data sets, and machine learning approaches for data integration. *Prerequisites: MB&B 301b and MATH 115a or b, or permission of the instructor.*

[MCDB 861b^{U}. Global Problems of Population Growth]

MCDB 900a/CBIO 900a/GENE 900a. **First-Year Introduction to Research and Rotations.** Frank Slack and Staff
M 4.00-5.30
Lab rotations, grant writing, and ethics for Molecular Cell Biology, Genetics, and Development track students.

MCDB 901b/CBIO 901b/GENE 901b. **First-Year Introduction to Research-Ethics: Scientific Integrity in Biomedical Resarch.** Valerie Horsley
Th 4.00-5.30
Lab rotations and ethics for Molecular Cell Biology, Genetics, and Development track students.
MCDB 902a/903b. **Advanced Graduate Seminar.** Valerie Horsley, Jo Handelsman
T 11.30-1.00
This course will allow students to hone their presentation skills through yearly presentation of their dissertation work. Two students will each give 30-minute presentations in each class session. Students will be required to present every year beginning their third year in the MCDB program. Each MCDB graduate student will be required to attend at least 80% of the class sessions. Two faculty members will co-direct the course, attend the seminars, and provide feedback to the students.

MCDB 950a and 951b. **Second-Year Research.** *By arrangement with Staff.*

Appendix II: Worksheets for Area I (EEB) and Area II (MCDB)

The following pages contain worksheets that will aid the potential major in planning their course of studies. Students may wish to make copies, especially the one for advising, to share with their advisors and/or to play around with to optimize their programs.

CLASS of 2012 and beyond

Area I: **EEB** B.A.___ B.S.___

Name _____ Year _____ College _____ Phone _____

Prerequisites:	Course #	Taken	(will be) taken	Placed out
1 term of Principles of MCDB	120a			
1 term of Principles of EEB	122b			
1 term of either MCDB 121La or EEB 123Lb				
2 terms of General Chemistry (112a, 113b or 114a, 115b)				
(or 1 term of General Chem 118a)				
2 terms of General Chemistry Labs	116La			
(If 118a is taken 1 term is required)	117Lb			
1 term of Organic Chemistry (124a or 220a or 225b)				
1 term of Organic Chemistry Lab (126L or 222L)	126L/222L			
(or 124,125 with 126L,127L satisfies both chem reqs)				
2 terms of Physics (170a, 171b or higher)				
1 term of Math 115 or higher (not including Math 190)				

Core courses:			*Term Taken*	*will be taken*
Required:	MCDB 202a	Genetics		
Required:	EEB210/STAT 101	Statistics		
Required:	EEB 220a	General Ecology		
Required:	EEB 225b	Evolutionary Biology		

Organismal Diversity *(choose one)*	*Course #*	*Term Taken*	*will be taken*

Electives:

Choose two (2) at 200 level or higher)

Course #	*Term Taken*	*will be taken*

Laboratories:	*Course #*	*Term Taken*	*will be taken*
(Choose 2 above intro level at 200 or higher)			

B.A. degree only: (Choose one; must be taken in senior year)

EEB 470a or b (Tutorial)	470		
EEB 475a or b (Research)	475		
Senior Essay (no credit)	Sr. Essay		

B.S. degree only: (2 credits required; one must be taken in senior year)

EEB 475a or b (Research)	475		
EEB 475a or b (Research)	475		

B.S. Intensive major only:

EEB 495a, 496b (Intensive Senior Research)	495/496		

CLASS of 2012 and beyond

Area II: MCDB - STANDARD

B.A.___ B.S.___

Name _____ Year _____ College _____ Phone _____

Prerequisites:	Course #	Taken	(will be taken)	Placed out
1 term of Principles of MCDB	120a			
1 term of Principles of EEB	122b			
1 term of either MCDB 121La or EEB 123Lb				
2 terms of General Chemistry (112a, 113b or 114a, 115b)				
(or 1 term of General Chem 118a)				
2 terms of General Chemistry Labs	116La			
(If 118a is taken 1 term is required)	117Lb			
1 term of Organic Chemistry (124a or 220a or 225b)				
1 term of Organic Chemistry Lab (126L or 222L)	126L/222L			
(or 124,125 with 126L,127L satisfies both chem reqs)				
2 terms of Physics (170a, 171b or higher)				
1 term of Math 115 or higher (not including Math 190)				

Core courses:

			Term Taken	*Will be Taken*
Required:	MCDB 202a	Genetics		
Required:	MCDB 300b	Biochemistry (or equivalent)		
Choose 1	MCDB 205b	Cell Biology		
	MCDB 210b	Developmental Biology		

(If both 205b and 210b are taken, only one counts as a core, the other as an elective)

Electives: (Choose 4 credits)

	Course/Lab #	*Term Taken*	*Will be Taken*
(Choose any 3 courses from MCDB at 150 or above,			
EEB at 140 or above, **or** MB&B at 200 or above			
and 1 from MCDB at 350 or above)			

[Two laboratory courses from 342La, 343La, 344Lb, 345Lb can be used together as one elective credit]

Laboratories: (Choose 2)

(Must be at 200 or higher; One can be chosen			
from EEB or MB&B)			

B.A. degree only: (Choose one; must be taken in senior year)

MCDB 470a or b (Tutorial)	470		
MCDB 475a or b (Research)	475		
Senior Essay (no credit)	Sr. Essay		

B.S. degree only: (Choose either two terms of MCDB 475a or b or MCDB 485a, 486b)

MCDB 475a or b (Research)			
MCDB 475a or b (Research)			
MCDB 485a/486b (Research in Biology)			

B.S. Intensive major only:

MCDB 495a, 496b (Intensive Research)	495/496		

CLASS of 2012 and beyond

Area II: MCDB - NEUROBIOLOGY TRACK

B.A.___ B.S.___

Name _____ Year _____ College _____ Phone _____

	Course #	Taken	(will be taken)	Placed out
1 term of Principles of MCDB	120a			
1 term of Principles of EEB	122b			
1 term of either MCDB 121La or EEB 123Lb				
2 terms of General Chemistry (112a, 113b or 114a, 115b)				
(or 1 term of General Chem 118a)				
2 terms of General Chemistry Labs	116La			
(If 118a is taken 1 term is required)	117Lb			
1 term of Organic Chemistry (124a or 220a or 225b)				
1 term of Organic Chemistry Lab (126L or 222L)	126L/222L			
(or 124,125 with 126L,127L satisfies both chem reqs)				
2 terms of Physics (170a, 171b or higher)				
1 term of Math 115 or higher (not including Math 190)				

Core Courses:

			Term Taken	*Will be Taken*
Required:	MCDB 202a	Genetics		
Required:	MCDB 300b	Biochemistry (or equivalent)		
Required:	MCDB 320a	Neurobiology		
Choose 1	MCDB 205b	Cell Biology		
	MCDB 210b	Developmental Biology		

Choose any 3 - (1 MUST be from MCDB at 350 or above)

		Term Taken	*Will be Taken*
BENG 410a	Basis of Bioimaging and Biosensing		
CPSC 475b	Computational Vision & Biol. Perception		
MCDB 205b or 210b (whichever is not chosen above)			
MCDB 215a	(not if Psych 200 is taken) Intro to Stats		
MCDB 240b	Biology of Reproduction		
MCDB 310a	Physiological Systems		
MCDB 315b	Biological Mech. of Reaction to Injury		
MCDB 410a	Molecular Basis of Development		
MCDB 415b	Cellular and Molecular Physiology		
MCDB 425a	Basic Concepts of Genetic Analysis		
MCDB 430a	Biology of the Immune System		
MCDB 440b	Brain Development & Plasticity		
MCDB 460b	Cell Biology of the Neuron		
PSYC 200	(not if MCDB 215a is taken) Statistics		
PSYC 270a	Research Methods in Behavioral Neuroscience		
PSYC 320a	Cognitive Neuroscience		
PSYC 376a	Basics of Learning and Memory		

Laboratories: (Choose 2 from MCDB)	*Course/Lab #*	*Term Taken*	*Will be Taken*

B.A. degree only: (Choose one; must be taken in senior year)

MCDB 470a or b (Tutorial)	470		
MCDB 475a or b (Research)	475		
Senior Essay (no credit)	Sr. Essay		

B.S. degree only: (Choose either two terms of MCDB 475 or MCDB 485a, 486b)

MCDB 475a or b (Research)			
MCDB 475a or b (Research)			
MCDB 485a, 486b (Research in Biology)			

B.S. Intensive major only:

MCDB 495a, 496b (Intensive Research)	495/496		

CLASS of 2012 and beyond

Area II: MCDB - BIOTECHNOLOGY TRACK

B.A.___ B.S.___

Name _____ Year _____ College _____ Phone _____

Prerequisites:	Course #	Taken	(will be taken)	Placed out
1 term of Principles of MCDB	120a			
1 term of Principles of EEB	122b			
1 term of either MCDB 121La or EEB 123Lb				
2 terms of General Chemistry (112a, 113b or 114a, 115b)				
(or 1 term of General Chem 118a)				
2 terms of General Chemistry Labs	116La			
(If 118a is taken 1 term is required)	117Lb			
1 term of Organic Chemistry (124a or 220a or 225b)				
1 term of Organic Chemistry Lab (126L or 222L)	126L/222L			
(or 124,125 with 126L,127L satisfies both chem reqs)				
2 terms of Physics (170a, 171b or higher)				
1 term of Math 115 or higher (not including Math 190)				

Core Courses:			*Term Taken*	*Will be Taken*
Required:	MCDB 202a	Genetics		
Required:	MCDB 205b	Cell Biology		
Required:	MCDB 300b	Biochemistry (or equivalent)		
Required:	MCDB 370b	Biotechnology		

Choose any 3:		*Term Taken*	*Will be Taken*
Any MCDB course numbered 150 or above			
BENG 351a	Biomedical Engineering I		
BENG 352b	Biomedical Engineering II		
BENG 410a	Basis of Bioimaging and Biosensing		
BENG 435b	Biomaterial-Tissue Interactions		
BENG 457b	Biomechanics		
BENG 464b	Tissue Engineering		
CENG 210a	Chem. Eng. & Process Modeling		
CENG 411a	Separation & Purification Processes		
CENG 412b	Chemical Engineering Laboratory		
CPSC 437a	Introduction to Databases		
CPSC 445b	Introduction to Data Mining		
CPSC 470a	Artificial Intelligence		
CPSC 475b	Comp. Vision & Bio Perception		
MB&B 420a	Macromolecular Structure		
MB&B 421b	Macromolecular Dynamics		
MB&B 443b	Eukaryotic Molecular Biology		

Laboratories: (Choose 2 from MCDB)	*Course/Lab #*	*Term Taken*	*Will be Taken*
[At least one lab must be MCDB 341L-345L; BENG 355L			
or CENG 412b can substitute for two 1/2-credit labs]			

B.A. degree only: (Choose one; must be taken in senior year)			
MCDB 470a or b (Tutorial)	470		
MCDB 475a or b (Research)	475		
Senior Essay (no credit)	Sr. Essay		

B.S. degree only: (Choose either two terms of MCDB 475 **or** MCDB 485a, 486b)			
MCDB 475a or b (Research)			
MCDB 475a or b (Research)			
MCDB 485a, 486b (Research in Biology)			

B.S. Intensive major only:			
MCDB 495a, 496b (Intensive Research)	495/496		

Appendix III: Undergraduate Research Projects

Senior Research Projects in EEB

Student	Project Title	**Project Advisor**
Lauren Elizabeth Pippin	Invertebrate Anatomy made Accessible	Leo Buss (EEB)
Jeremy Richard Leonard	Mutation Accumulation in bacteriophage phi 6 : A novel, automated method to demonstrate decreased fitness	Paul Turner (EEB)
Melissa Anne Chiasson	Evolution of an RNA Virus Under Acid Shock.	Paul Turner (EEB)
Thanh Kien Huynh	Patterns of Dispersal and Vicariance in Poecilichthys Darters (Teleostei: Percidae)	Thomas Near (EEB)
Britney Nicole Kajdacsi	Phylogeny of Galapagos tortoises from a nuclear DNA marker: Resolving a rapid radiation	Gisella Caccone (EEB)
Tse Yan Lim	Third Wheels and Wingmen: The role of satellite males in the ocellate wrasse Symphodus ocellatus	Suzanne Alonzo (EEB)
Gregg Steven Gonsalves	The Interleukin-17 Family and the Evolution of Immunopathology	Richard Flavell (Immunobiology)

Research Projects in MCDB

MCDB 470 (Tutorial)

Student	Project Title	Project Advisor
Linna Duan	From the Bowel to the Brain and Back Again: Understanding the Relationship between the Gut-Brain Axis and Irritable Bowel Syndrome	Paula Kavathas (Immunobiology)
Zhuo (Tony) Su	Evolutionary Relationships Among Species by Comparing Genetic Sequences of Different Species	Jeffrey Townsend (EEB)

MCDB 475 (Research)

Student	Project Title	Project Advisor
Brandon Araki	Spatial and Temporal Regulation of Genes in Arabidopsis theliena using the APETALA3 and RABBIT EARS Promoters as Driver Genes in a GAL4-UAS System	Vivian Irish (MCDB)
Daria Brinzevich	Spatial and Temporal Expression of NOPE and Protogenin in the Developing Mouse Nervous System	Elke Stein (MCDB)
Adriana Briones	Bacterial and Host Factors Involved in *Lysteria Monocytogenes* Protrusion Formation	Weimin Zhong (MCDB)
Kelly Chacon	Localization of Artificial Transmembrane Proteins that Target Specific Membrane Domains	Daniel DiMaio (Genetics)
Yifan Chen	Retrograde Regulation of Dendritic Structures in Mice Retinal Ganglion Cells	Michael Crair (Neurobiology)
Gina Choe	Role of OAS/RNaseL Pathway in the Pathogenesis of COPD	Min-Jong Kang (Pulmonary)
Regina de Luna	Elucidating the Role of Slit/Robo Signaling in Axon Guidance	Elke Stein (MCDB)
Jerry Du	Characterization of Ring Canal Correlation with Signaling Proteins and Effects of Ring Canal Knockout	Lynn Cooley (Genetics)
Byron Edwards	Association with Dyslexia and Functional Analysis of a Putative Regulatory Element in DCDC2	Jeffrey Gruen (Pediatrics)

Andrew Esposito	Testing the Calcineurin/CaMKII Switch Hypothesis for Synaptic Refinement	Haig Kesheshian (MCDB)
Adrian Godoy	A Spatio-Temporal Survey of Super-KDR Alleles (M918T+L1014F/S) Conferring Insecticidal Resistance to Pyrethroids as a Consequence of Anti-Malarial Interventions in Equatorial Guinea	Gisella Caccone (EEB)
Haiyan Guo	Relationship Between Meiosis Checkpoint and Ascus Wall Endolysis in Schizosaccharomyces Pombe	Megan King (Cell Biology)
Minjung Han	Key Promoter Elements Controlling the Cell Type-Specific Expression of the Interferon Veceptor	Michael Robek (Pathology)
Kyra Jefferson-George	Characterization of Endophytic Hypoxylon Fungi and their Cineoloe Production	Scott Strobel (MB&B)
Kristin Johnson	Analysis of Rare Variant Mutations in Autism in a Zebrafish Model	Matthew State (CSC)
Eun-Bin Kim	Identification of Anopheles Mosquito Midgut Microbiome that Increase Plasmodium Resistance	Erol Fikrig (Infectious Disease)
Janice Kim	Neurogenesis in the Cortex of Hypoxic versus Normoxic Transgenic Mice	Flora Vaccarino (CSC)
Alice Kong	Gene Expression During the Proliferative Stage of the Menstrual Cycle	Hugh Taylor (OB/GYN)
Benjamine Liu	Neural Control of Oral Ingested Behavior	Mark Laubach (Neurobiology)
Michelle Maust	Investigating the Potential of Endophytes to Kill Trypanosoma Brucei	Scott Strobel (MB&B)
Kaitlin McLean	Mechanisms of Limb Regeneration in Urodele Amphibians	Craig Crews (MCDB)
Samantha Mosha	Role of Myosin II Activity in Contractile Ring Assembly in Fission Yeast	Thomas Pollard (MCDB)
Rachel O'Keefe	Molecular Mechanisms of Cognitive Impairment in Tuberous Sclerosis Complex Model Mice	Angelique Bordey (Neurosurgery)
Alix Perry	Circadian Rhythm and the Evolution of the Clock Gene	Kenneth Kidd (Genetics)

Hai Pham	Biofortification of Maize Through Upregulation of Iron Homeostasis Genes	Stephen Dellaporta (MCDB)
Anusha Raja	Examining the Effects of 1 Hour Restraint Stress on the Spatial Working Memory of DISC1 Knockdown Rats	Amy Arnsten (Neurobiology)
Malika Rakhmankulova	Screen of Endophyte Extract Library for Novel Bioactive Small Molecules Using Zebrafish Embryos	Scott Holley (MCDB)
Vicky Ren	Genetic Studies of Ichthyosis	Leonard Milstone (Dermatology)
Courtney Rubin	Characterization of Transcription Factor Mediated Odorant Receptor Expression in the Olfactory System	Charles Greer (Neurosurgery)
Deniz Sancaktar	Role of SLC26A6 in Oxalate Secretion in Wild-Type Rat	Peter Aronson (Internal Medicine)
Dushika Setukavala	Tethered Toxin Project	Michael Nitabach (C&MP)
Matthew Sheehan	The Influence of Adenosine Signaling on Adipocyte Differentiation	Scott Rivkees (Pediatrics)
Melissa Stone	A Study of Ancillary Non-Structural Proteins in Parvoviruses	Peter Tattersall (Genetics)
Zhuo Su	Incorporating Multiple Models of Molecular Evolution to Model Phylogenetic Convergence	Jeffarey Townsend (EEB)
Rebecca Treger	Defining Target Specificity of Oxadiazole 2-Oxides in Ancylostoma Ceylanicum	Michael Cappello (Pediatrics)
Robert Tunney	Developing Small Molecules for Isoform selective inhibition of histone deacetylase	Andrew Phillips (Chemistry)
Ee-Lynn Yap	Synthesis of Urea-Based Mimics of Natural Folyl-Polyglutamate Substrates of Prostate Specific Membrane Antigen	David Spiegel (Chemistry)
Jennifer Yoon	Investigating the Role of apl-1 Gene on the Development of C. elgans	Frank Slack (MCDB)
Angela Yu	DNA Methylation Patterns in Language and non-language areas of the brain	Elena Grigorenko (CSC)
Xiao-Qiao Zhou	Celia in Cardiac Development	Martina Brueckner (Pediatrics)

MCDB 485 (Research in Biology)

Student	Project Title	Project Advisor
Aimee Alphonso	The Role of Syp1p in Fission Yeast Endocytosis	Thomas Pollard (MCDB)
Sarah Ballatori	The Role of *HOXA13* in the ECM Remodeling of Vaginal Tissue: Implications for Pelvic Organ Prolapse	Kathleen Connell (OB/GYN)
Ezra Baraban	Screening Endophytic Extracts for Quorum Sensing Molecules	Scott Strobel (MB&B)
Alexandra Bercow	miRNA-132 Regulates the Differentiation and Synaptic Integration of Postnatally Generated Interneurons in the OB	Angelique Bordey (Neurosurgery)
So Yeon Choe	Identification and Characterization of Zebrafish Mutants of Genes associated with Autism Spectrum Disorders and Tourette Syndrome	Matthew State (CSC)
Laura Colman	Novel Co-Chaperone DnaJ C15 Required for Efficient SV40 Infection	Daniel DiMaio (Genetics)
Nicole de Paz	Decidual Cell Expression of Matrix Metalloproteinase-9: Implications for pre-eclampsia	Frederick Schatz (OB/GYN)
Lauren Eyler	The Applications of Compounds Produced by Endophytes in the Treatment of Leishmaniasis	Scott Strobel (MB&B)
Aiden Yuzhe Feng	Cardiomyocytes Differentiationfrom Endometrial Stem Cells	Hugh Taylor (OB/GYN)
Wambura Fobbs	A Neural and Perceptual Dose-Response Curve for Flavor-Nutrient Conditioning in Humans	Dana Small (Psychiatry)
Eva Galvan	Using Differentially Methylated Circulating DNA to Detect β-cell Death in Type 1 Diabetes	Herold Kevan (Immunobiology)
Kelsy Greenwald	Calmodulin (Cam1p) May Be Recruited by Myo1p to the Contractile Ring in *S. pombe* Cells	Thomas Pollard (MCDB)
Daniel Hausrath	Increased α-CaMKII Expression is Mediated by CPEB-1 in Migrating Astrocytes	David Wells (MCDB)

Josephine Jung	Isolation and Characterization of Endophyte Natural Products that Inhibit Growth of Human Parasxite Plasmodium Falciparum	Scott Strobel (MB&B)
Kim Krisdada	Characterization of the Olfactory System in a Model of Renal Cystic Disease	Charles Greer (Neurosurgery)
Matthew Lee	Elucidating Functions and Mechanisms of Otx2	Natalia Ivanova (Genetics)
Rachel Lee	Role of Myosin II in Cytokinetic Contractile Ring Formation in Fission Yeast	Thomas Pollard (MCDB)
Marysa Leya	Characterization of Myosin ie Expresion, Localization and Loss of Function During Wound Healing in Hela and caco2 - bbe ceu Lines and a Knockout Mouse Model	Mark Mooseker (MCDB)
Ian Marpuri	Genetic Variation in *Wigglesworthia glossinidia fuscipes*, an Endosymbiont of the Tsetse Fly in Uganda	Gisella Caconne (EEB)
Matthew Mezilish	Characterization of the Localized Immune Response in Human Tumors	Kevin O'Connor (Neurology)
Carl Nunziato	Investigation of RFK3 Regulation of MHC I and Viral Immune Evasion	Robert Means (Pathology)
Vanessa Obas	The Temporal Genetic Variation and Phylogeography of Aeoles Aegypti Populations in the Florida Keys	Jeffrey Powell (EEB)
Adetokunbo Obayemi	Examining the Role of Hippocampal Acetylcholinesterase in Mouse Models of Major Depressive Disorder	Yann Mineur (Neuroscience)
Oluwadamilola Oladeru	Study of Antiplasmodial Activity & Toxicity of Endophytic Extracts Isolated from Amazonian Plants	Choukri Ben-Mamoun (Infectious Disease)
Gabrielle Rabinowitz	Identification and Classification of a Novel Target of an Epstein-Barr Virus Encoded Micro RNA	Joan Steitz (MB&B)
Amanda Sandoval	Antibacterial Activity of Endophytic Fungal Natural Products	Scott Strobel (MB&B)
Valentia Savath	Mitochondrial Guanosine Triphosphate Affects Phosphoenolpyruvate Cycling in INS-1832/13 Cells and Pancreatic B-Cells	Richard Kibbey (Int Med)
Sarah Selem	Role of E-cadherin in Hair Follicle Stem Cell Renewal OR Hair Germ Stem Cell Potential	Valentina Greco (Genetics)

Tina Su	Mechanisms of Prenatal Stress Affecting GABAergic Neuron Populations in Embryonic Mice	Hanna Stevens (CSC)
Pritha Subramanyam	Estimated Placental Volume (EPV) to Reduce Preterm Birth, IUGR, and IUF	Harvey Kliman (OB/GYN)
Apoorva Tiwari	Homodimeric Interactions of Aptamer 2 of Glycine Binding Riboswitch as Insight into Cooperativity of Wild Type Riboswitch's Aptamers 1 and 2	Scott Strobel (MB&B)
Andromahi Trivellas	Nanoparticles' Role in B16 Melanoma Vaccine	Tarek Fahmy (Biomedical Engineering)
Myra Trivellas	Therapeutic Revascularization: An In Vitro Model for Cell Transplantation	Mark Saltzman (Biomedical Engineering)
Lianna Valdes	Investigating Mutations in Histamine Receptor, Histamine n-Methyl Transferase, and SLITRK Genes in Tourette Syndrome Patients	Matthew State (CSC)
Jingying Yang	Test Tube Evolution of Glucose Binding Aptamer	Ronald Breaker (MCDB)
Michael Yao	Limb Regeneration in Urodele Amphibians	Craig Crews (MCDB)

MCDB 495 (Intensive Research)

Student	Project Title	Project Advisor
Julia Chang	Mechanisms of Graft-Versus-Leukemia Resistance in Chronic Myelogenous Leukemia Stem Cells	Warren Shlomch (Cancer Center)
Rachel Chen	Role of Actin Polymenization in Megakaryouyle Differentiation	Diane Krause (Laboratory Medicine)
Rachel Corbin	Manipulating the Calcium Sensing Domains of a Polycystic Kidney Disease Protein	Barbara Ehrlich (Pharmacology)
Alex Gornitzky	The Role of Chitotriosidase in Bacterial Lung Infection	Charles Dela Cruz (Internal Medicine)
Ellie Hong	Identifying MAP Kinase Targets that Promote Axon Regeneration in c. Elegans	Marc Hammarlund (Genetics)

Linda Li	Regulation of Striatal-Enriched Protein Tyrosine Phosphatase (STEP) by Fragile X Mental Retardation Protein (FMRP)	Paul Lombroso (CSC)
David Light	Developing the Utility of Streptomyces Bacteria via Novel Endophytes and Multiplex Automated Genetic Engineering (MAGE) for the Enhanced Inhibition of the mTOR Pathway	Scott Strobel (MB&B)
Monica Lu	Glucocorticoid Receptor Interactions in the Mesocorticolimbic Circuits with Food Restriction	Ralph DiLeone (Psychiatry)
Roy Luo	In Vitro Selection and Characterization of Insulin Binding RNA Aptamers Using Isothereial Amplification	Ronald Breaker (MCDB)
Brynna Nelson	Transcriptional Control of Pluripotency in Human ES Cells	Natalia Ivanova (Genetics)
Cecilia Wright	Characterization of Cellular and Molecular Aspects of Impaired Follicle Development in ePAB-Deficient Female Mice	Emre Seli (OB/GYN)
Shin-Rong Wu	Investigating the Functions of Hrq1 and Irc20 in DNA Repair	Patrick Sung (MB&B)

MCDB 595 (Combined B.S./M.S. Degree Program)

Student	Project Title	Project Advisor
David Colognori	eIF4AIII Interacts with NOM1 in a Novel Evolutionarily Conserved Role in 18S rRNA Biogenesis	Joan Steitz (MB&B)
Monica Yun Liu	The D190N and S186W Mutations Thermally Destabilize Rhodopsin: A Pathogenic Mechanism for Retinitis Pigmentosa	Elsa Yan (Chemistry)

Senior Essays in MCDB

Student	Essay Title	Project Advisor
Samba Binagi	Proposals to Investigate the Relationship Between Alcohol Use and Weight Maintenance and Loss	Cary Caldwell (Internal Medicine)
Nathan Calixto	Novel Co-Chaperone DnaJ C15 Required for Efficient SV40 Infection	Matthew Rodeheffer (MCDB)
Sara Chavez	Anticancer Treatments Targeting mTOR Function	Valerie Horsely (MCDB)
Katharine Dryden	Positioning the Cytokinetic Furrow	Iain Dawson (MCDB)
Janelle Duah	Faulty Catabolism: Genetics of Obesity	Joseph Wolenski (MCDB)
Danielle Kolitz	An Exploration of the Role of HDAC4 in its Inhibition of the Neuronal Cell Cycle via Interaction with Cdk1	Joseph Wolenski (MCDB)
Nancy Luong	Electromagnetic Fields and How They May Relate to Neuronal Firing	David Wells (MCDB)
Usama Qadri	Super-resolution Microscopy and its Application to Neurobiology	Joerg Bewersdorf (Cell Biology)
Amy Radding	Playing "it": Chasing the Synaptic Tagging Hypothesis from its Introduction to Current Research and Reconception	Haig Keshishian (MCDB)
Stasha Rosen	Understanding Bacterial Subcellular Organization Through Recent Advances in Microscopy	Christine Jacobs-Wagner (MCDB)
Rebecca Russ	Cigarette Smoke Induced Dysregulation of microRNA Expression and its Role in Lung Carcinogenesis	Frank Slack (MCDB)
Lana Verkuil	The Role of Dominant Gene Mutations in Parkinson's Disease	Sreeganga Chandra (Neurology)
Kisho Watanabe	Microglial Activation in Alzheimer's Disease	Joseph Wolenski (MCDB)
McKynlee Westman	HER2 Signaling Pathways Biological Effect on Breast Cancer, Its Resistance to Endocrine Therapy and New Treatments	Minoti Hiremath (Endocrinology)

Appendix IV: Undergraduate Prizes and Awards

Edgar J. Boell Prize

"For Excellence in Senior Research"

Student	Class	Project Title	Advisor
Melissa Anne Chiasson	2011	Evolution of an RNA Virus Under Acid Shock.	Paul Turner (EEB)
Britney Nicole Kajdacsi	2011	Phylogeny of Galapagos tortoises from a nuclear DNA marker: Resolving a rapid radiation	Gisella Caccone (EEB)
David A. Colognori	2011	*eIF4AIII Interacts with NOM1 in a Novel Evolutionarily Conserved Role in 18S rRNA Biogenesis*	Joan Steitz (MB&B)
Alex Gornitzky	2011	*The Role of Chitotriosidase in Bacterial Lung Infections*	Charles Dela Cruz (Pulmonary & Critical Care)
Monica Yun Liu	2011	*The D190N and S186W Mutations Thermally Destabilize Rhodopsin: A Pathogenic Mechanism for Retinitis Pigmentosa*	Elsa C. Y. Yan (Chemistry)

William R. Belknap Prize

"For Excellence in Biology"

Student	Class	Project Title	Advisor
David A. Colognori	2011	*eIF4AIII Interacts with NOM1 in a Novel Evolutionarily Conserved Role in 18S rRNA Biogenesis*	Joan Steitz (MB&B)
Gregg Steven Gonsalves	2011	The Interleukin-17 Family and the Evolution of Immunopathology	Richard Flavell Immunobiology

Environmental Internships 2010 Awards

Name	Major	Class	Project
Armitage, Sarah	HIST	2012	Danish Architecture Centre
Aronson, Lucas	EVST	2012	Summer Internship and Senior Project Research at Verno Systems in Seattle
Choi, Joanne	EVST	2011	Sea Education Association Summer Program: Marine Plastics Research
Douglas, Frances	EVST	2011	The Role of NGO's in Conservation: An Internship with the International Union for Conservation of Nature (IUCN)
Faxon, Hilary	EVST	2012	Research for Senior Project in Taos, New Mexico
Fischer-Baum, Reuben	EVST	2011	Greening the Compact Urban Core: Old Istanbul and Lower Manhattan
Gants, Rachel	ANTH	2012	Fundación Ecológica Arcoiris
Gregoire-Wright, Taylor	EVST	2012	Summer Internship with La Fundación Futuro Latinoamericano
Kajdacsi, Brittney	MCDB	2011	Phylogeny of Galapagos Tortoises from Nuclear DNA Markers
Mitchell-Larson, Eli	EVST	2012	Research in Old Growth and Primeval Forest Ecology in the Balkans: An Independent Project in Remote Sensing and Forest Dynamics
Nash, Caroline	EVST	2011	Ecological, Social, and Political Implications of Dam Removal on the Lower Klamath River Basin
Roberson, Leslie	EVST	2011	Saving the Tropics, one Sea Turtle at a Time?
Rosell, Kalani	EVST	2011	Agriculture in Ethiopia: How Can it Provide a Sustainable Future?
Scher, Hazel	EVST	2011	Sustainable Spaces: Investigating Opportunity for Urban Infrastructure in Networks of Abandoned Real Estate
Sheard, Catherine	MATH	2012	Tropical Rain Forest and Canopy Ecology, Institute for Tropical Ecology and Conservation
Srivastava, Chandrika	EVST	2012	Research Project on First Application of Carbon Sequestration to a Full Scale Power Plant
Tang, Brian	EVST	2012	Neighborhood Activism with SeeClickFix in New Haven, CT
Thompson, Dacia	EVST	2012	Summer Internship with Semilla Nueva
Twining, Cornelia	EVST	2011	The Ecological History of Two Watersheds in South-Central Connecticut
Vu, Quoc-Kha	EVST	2011	Integrating the Principles of Developmental Psychology, Architecture, and Environmental Studies to Design Early Childhood Learning Environments
Zhu, Charles	EVST	2011	Biking in Cities: Cycling and its Relation to Urban Form and Individual Attitudes in Copenhagen, Denmark
Zhu, Julie	MATH	2012	Organization for Tropical Studies in Costa Rica

Appendix V: Forms for Tutorial and Research Courses

EEB 470/MCDB 470 (Tutorial)

Date _____

Student's Name _____ Class _____

E-mail Address _____ Phone _____

Title for Tutorial _____

_____

Mentor's Name _____ Phone _____

Mentor's E-mail Address _____

Mentor's Signature _____

Senior Requirement: Yes No

Individual or small-group study for qualified students who wish to investigate a broad area of biology not covered by regular courses. A student must be sponsored by a faculty member, who will set the requirements. The course must include one or more written examinations and/or term paper. To register, the student must prepare this form *(can be downloaded from the Classes server)* and a written plan of study and bibliography, approved by his advisor, and submit them to the office of the director of undergraduate studies in EEB by Wednesday, September 7th (fall term) and Wednesday, January 18th (spring term) or in MCDB by Friday, September 9th (fall term) and Tuesday, January 17th (spring term). **The final paper** is due in the hands of the sponsoring faculty member with a copy to the course instructor in EEB by Friday, December 9th (fall term) and Monday, April 23th (spring term) or in MCDB by the last day of classes. Electronic submission is acceptable and preferred to the office of the appropriate director of undergraduate studies: EEB – karen.broderick@yale.edu; MCDB – crystal.adamchek@yale.edu. In special cases, with approval of the director of undergraduate studies, this course may be elected for more than one term, but only one term will count as an elective for the major.

To the Tutorial Mentor:

By signing this form, you agree to supervise the student's project. You also agree to grade the final paper and report a grade to the appropriate DUS based on exam(s) or term paper. This should be reported no later than the end of reading period. Notification by email is acceptable and preferred to the office of the appropriate director of undergraduate studies: EEB – karen.broderick@yale.edu; MCDB – crystal.adamchek@yale.edu.

Please attach this form to your proposal and return to appropriate DUS Office
(Students can upload the form and proposal to the Classes server

EEB 475/MCDB 475 (Research)

Date _____

Student's Name _____ Class _____

E-mail Address _____ Phone _____

Title for Research _____

_____

Mentor's Name _____ Phone _____

Mentor's E-mail Address _____

Mentor's Signature _____

Senior Requirement: Yes No

Single-term research projects under faculty supervision. A student must be sponsored by a faculty member, who will guide the project. Students are expected to spend ten hours per week on their research projects. To register, the student must prepare this form *(can be downloaded from the Classes server)* and a written plan of study and bibliography, approved by the research mentor, and submit them to the office of the director of undergraduate studies in EEB by Wednesday, September 7th (fall term) and Wednesday, January 18th (spring term) or in MCDB by Friday, September 9th (fall term) and Tuesday, January 17th (spring term). During this course, students give *an oral presentation* describing their work. At the end of the course a written report on the research accomplished must be submitted before a grade will be given. **The final paper** (written report) is due in the hands of the sponsoring research mentor with a copy to the course instructor in charge in EEB by Friday, December 9th (fall term) and Monday, April 23th (spring term) or in MCDB by the last day of classes. Electronic submission is acceptable and preferred to the office of the appropriate director of undergraduate studies: EEB – karen.broderick@yale.edu; MCDB – crystal.adamchek@yale.edu. Students who take this course more than once must reapply each term.

To the Research Mentor:

By signing this form, you agree to supervise the student's research project and provide the necessary materials, e.g. supplies, equipment, etc. You also agree to grade the final research paper and report a grade to the appropriate DUS based on oral presentation, research performance and paper. This should be reported no later than the end of reading period. Notification by email is acceptable and preferred to the office of the appropriate director of undergraduate studies:
EEB – karen.broderick@yale.edu; MCDB – crystal.adamchek@yale.edu.

Please attach this form to your proposal and return to appropriate DUS Office
(Students can upload the form and proposal to the Classes server)

MCDB 485a and 486b (Research in Biology)

Date _____

Student's Name _____ Class _____

E-mail Address _____ Phone _____

Title for Research _____

_____

Mentor's Name _____ Phone _____

Mentor's Email Address _____

To the Student and Research Mentor:

MCDB 485a/486b is a two-term research course conducted under faculty supervision. A student must be sponsored by a Yale faculty research mentor who will guide the project. To register, the student must prepare this form and a short written plan of research (1-2 pages) with bibliography of 3 or 4 references. The research plan must be approved by the research mentor. The registration form (downloaded from the Classes server) and the research proposal should be submitted to the Office of the Director of Undergraduate Studies**,** by Friday September 9th (no later than 5:00 PM). Students are required to spend an average of 10-12 hours on their project. During this course, students are required to attend discussion groups (see syllabus) in which students will discuss their research projects in an oral presentation. The research advisor is expected to attend sessions at which her/his student is presenting. In addition, all students are asked to present a Poster displaying their research accomplishments at the YALE Undergraduate Research Symposium in the Biological Sciences which is held at the end of the spring semester. At the end of the course a written report on the research accomplished must be submitted before a grade will be given. This written report is due in the hands of the faculty research mentor with a copy to the course instructor in charge by the end of the reading period. Electronic submission is acceptable and preferred to the office of the director of undergraduate studies: crystal.adamchek@yale.edu. *Credit only on completion of both terms.*

To the Research Mentor:

By signing this form, you agree to supervise the student's research project and provide the necessary materials, e.g. supplies, equipment, etc. You also agree to grade the final research paper and report a grade to the DUS Office based on oral presentation, research performance and research paper. This should be reported no later than the end of reading period. Notification by email is acceptable and preferred to the office of the director of undergraduate studies: crystal.adamchek@yale.edu.

Mentor's Signature _____

Please attach this form to your proposal and return to appropriate DUS Office
(Students can upload the form and proposal to the Classes server)

EEB 495a and 496b/MCDB 495a and 496b
(Intensive Research)

Date _____ Class _____ Phone No. _____

Student's Name _____

E-mail Address _____

Project Title _____

_____

Mentor's Name _____

Mentor's E-mail Address _____

Mentor's Phone No. _____

To the Research Mentor:

Please note that the research mentor supervising 495a/496b students are expected to spend a considerable amount of time interacting directly with the student. This includes helping to write the initial proposal, supervising a grant proposal due in the first semester, attending meetings involving students in both semesters, assisting the student with their poster presentation in the spring semester and grading the final report. In addition, the research mentor is expected to meet with the student on a routine basis to discuss, analyze and plan experiments. Students are expected to spend approximately twenty hours per week in the laboratory and prepare written and oral presentations of their research. You also agree to grade the final research paper and report a grade to the appropriate DUS based on research performance and paper. This should be reported no later than the end of reading period. Notification by email is acceptable and preferred to the office of the appropriate director of undergraduate studies: EEB–karen.broderick@yale.edu; MCDB–crystal.adamchek@yale.edu. *Credit only on completion of both terms.*

Mentor's Signature _____

Students should attach a two-page proposal of the planned research. This should include an introduction covering why this research is interesting and important and an outline of the research methodology to be used. Electronic submission is acceptable and preferred to the office of the appropriate director of undergraduate studies: EEB – karen.broderick@yale.edu; MCDB – crystal.adamchek@yale.edu.

Please attach this form to your proposal and return to appropriate DUS Office
(Proposals are due in EEB by Wednesday, September 7th and MCDB by Friday, September 9th)

EEB SENIOR ESSAY

The senior essay is graded, but it carries no course credit. The **deadline** for seniors finishing in the fall term is Friday, December 9. For those finishing in the spring term it is **noon on Monday, April 30.**

The senior essay should be a critical evaluation of some portion of the current, primary biological literature. The topic may be anything within the realm of biology or it may explore the relationships of biology to other fields. Each student must obtain approval of the paper topic from a member of the EEB department to assure that the subject is a promising one. A **form** for this is attached and must be returned to the office of the faculty in charge of senior projects and Karen Broderick (OML 122) within the first month after the beginning of term. Students may seek additional advice as they wish.

The paper is to be ***20 double-spaced pages, not including bibliography***. The DUS or the faculty in charge of senior projects will ask a faculty advisor to read and grade each paper. *Students may suggest readers if they wish*. Papers are to be submitted to the student's senior essay adviser and a copy to the faculty in charge of the senior projects. Normally, a grade of "Satisfactory" is reported to the registrar by the faculty in charge. However, honor candidates must achieve a grade of A, which is of course reported.

If the essay is "*Unsatisfactory*", the student may make arrangements with the director of undergraduate studies to submit another paper. Papers received late may not be processed before Commencement.

** Hints for finding a faculty member to advise on senior essay **

First decide on the general area you would like to explore in your senior essay. Then try to find which faculty member might have interest or expertise in that area. The best source is the EEB Department booklet, available from the office of the director of undergraduate studies (OML 122), on "Faculty Research Interests". Second, if a faculty member discussed the topic in a course, he/she would be a good choice. Otherwise look through the Yale College Program of Study (blue book) to see which faculty member teaches a course that includes your prospective topic.

Approach the faculty member identified above. If he/she is not the best person to advise you on your topic, the faculty member should know who would be more knowledgeable in your area. Your senior essay advisor will often not be the same advisor that signs your course listings.

In discussion with the essay advisor, narrow your area of interest to a focused topic on which you can write in depth; a superficial review of a broad field is not appropriate. The advisor may also suggest a few references to start off your reading in the field.

EEB - Senior Essay Topic Approval Form

Student's Name: _____ Phone _____

College: _____ Year _____ Email: _____

Topic for Senior Paper:

_____

_____

I approve the choice of the above topic for a senior essay.

_____ _____

Faculty Member's Signature DATE

_____ _____

Student's Signature DATE

To the Faculty Mentor:

By signing this form, you agree to supervise the student's senior essay project and provide the necessary support.