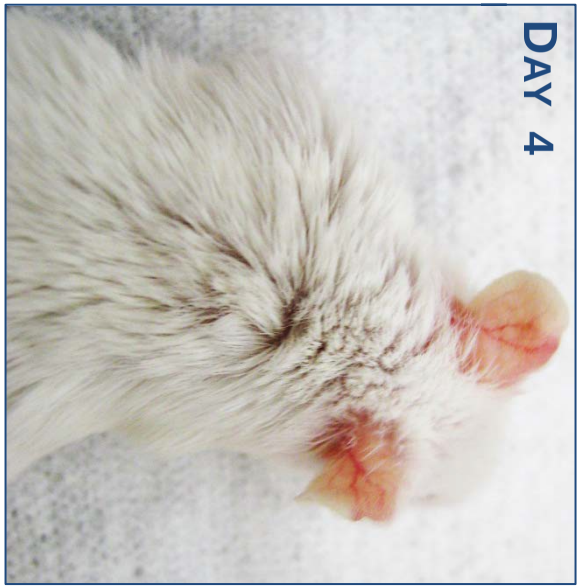
Molecular, Cellular, Developmental Biology

2013 - 2014



This booklet is intended to supplement the Yale College Programs of Study for the Academic Year 2013-2014. The latter contains brief descriptions of all Undergraduate MCDB Courses.

The MCDB major is offered by the department of Molecular, Cellular, Developmental Biology.

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INTRODUCTION

The Major in Molecular, Cellular, Developmental Biology (MCDB) at Yale University

The science of biology is extremely broad, ranging across the domains of molecules, cells, tissues and organs, organisms, and ecosystems. Moreover, biology explores questions of evolutionary history and the processes of evolutionary change as well as the mechanisms by which cells, organisms, and ecosystems function. Students majoring in Molecular, Cellular, and Developmental Biology receive a thorough yet varied liberal education and preparation for professional careers in a diverse array of fields. Practical applications of biology include the development of biologicals and pharmaceuticals, the practice of medicine, and pursuit of the scientific bases for understanding the development and function of biological systems.

Molecular, Cellular, and Developmental Biology (MCDB) offers programs for students wishing to concentrate on molecular biology, cell biology, genetics, and their applications to problems in cell and developmental biology, neurobiology, and various aspects of computational biology. Interdisciplinary opportunities are available within the major in the biotechnology and neurobiology tracks.

The MCDB major offers many opportunities for independent laboratory research. With approval, research can be conducted under the supervision of faculty members in any Yale department.

The teaching and research facilities in biology are distributed in three buildings, Osborn Memorial Laboratories, Kline Biology Tower, and the Environmental Science Facility. There are about 48 faculty members, 20 postdoctoral fellows, and 52 graduate students and approximately 300 undergraduate students 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 MCDB Major do for me?

The major in MCDB 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. MCDB 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.

Official Yale College program and course information is found in *Yale College Programs of Study,* available on line at http://yalecollege.yale.edu/content/yale-college-programs-study.

Courses for Students Majoring in Other Subjects

*(*Note: All courses list the Primary instructor first)*

For students who do not intend to major in MCDB, there are a variety of courses that have no prerequisites.

MCDB 050a, Immunology and Microbes
MCDB 103a, Cancer
MCDB 105a or b, An Issues Approach to Biology
MCDB 106b, Biology of Malaria, Lyme & Other Vector-Borne Diseases
MCDB 109b, Immunity and Contagion
MCDB 123b, Genes and Environment
[MCDB 150b, Global Problems of Population Growth]

MCDB 050a, **Immunology and Microbes**. Paula Kavathas
TTh 2.30-3.45
A complex immune system evolved in multicellular organisms to survive against attacks by pathogens. The human immune system uses multiple strategies to respond to the various classes of pathogens. Most often, the system works well to respond to mutating organisms, but sometimes it may attack one's own cells in autoimmune disease, or even substances that are not threatening as in allergies. In this course, we will cover the variety of responses generated by our immune system, and learn about pathogenic microbes as well as normally not disease-producing microbes in the human microbiome. Specific microbes such as influenza, HIV, and HPV are discussed along with historical analysis of the development of vaccines such as polio and of the AIDs epidemic.

MCDB 103b, **Cancer**. Alexia Belperron
MW 1.00-2.15
Introduction to the biology of cancer, with a focus on leukemia, skin cancer, and cancers linked to infection. Topics include genetics, biochemistry, immunity, infection agents, and challenges for prevention and treatment. *Intended for non–science majors and underclassmen.*

MCDB 105a or b, **An Issues Approach to Biology**. Fall: Timothy Nelson, John Carlson, William Summers; Spring: Dieter Soll, Ronald Breaker, Charles Sindelar
MW 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, **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. Biology of the pathogens including modes of transmission and establishment of infection; immune responses and the associated challenges to prevention and treatment. *Class is designed primarily for underclassmen.*

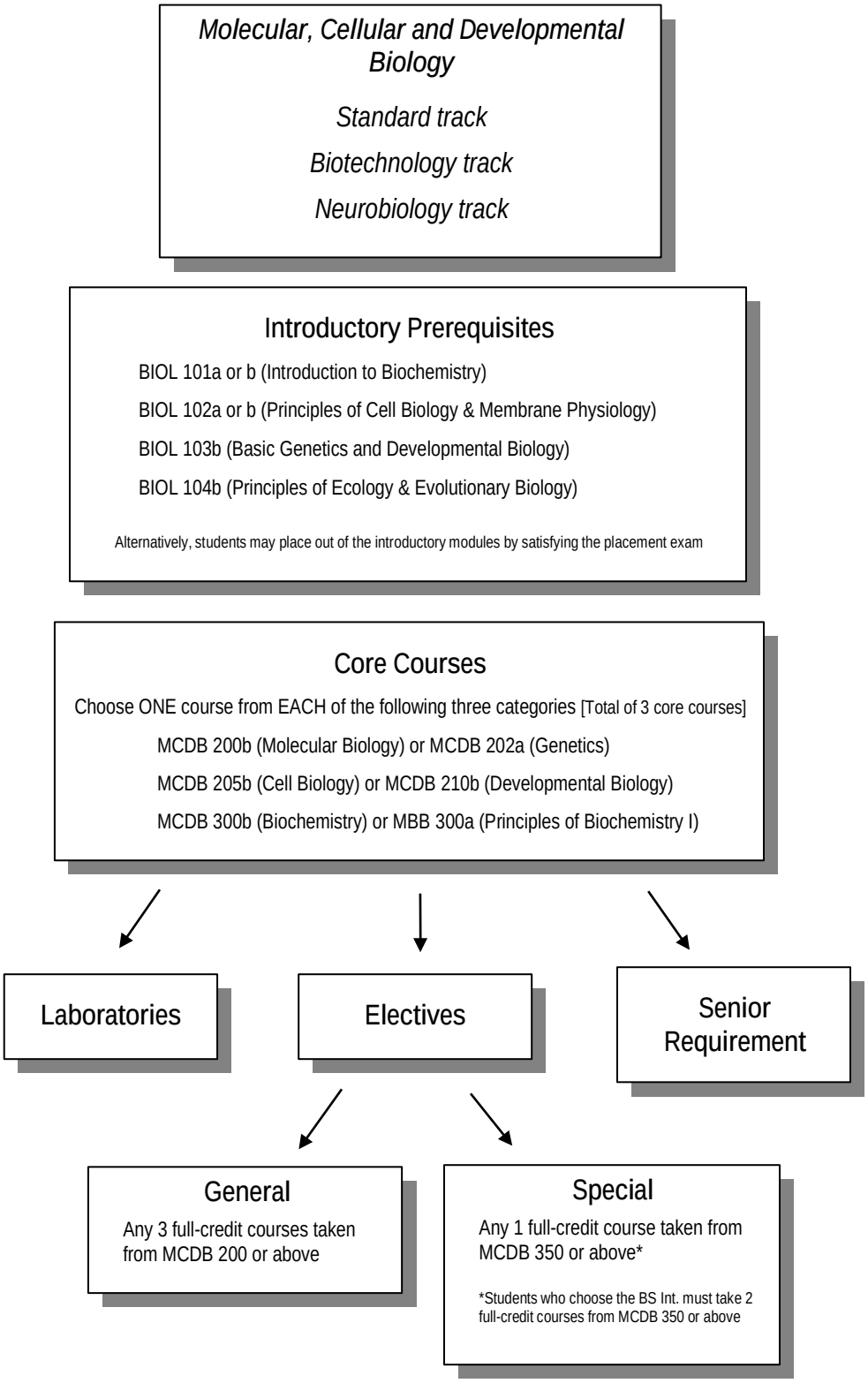
MCDB 109b, **Immunity and Contagion**. Paula Kavathas
TTh 2.30-3.45
Introduction to the human immune system, followed by study of microorganisms such as influenza, HIV, human papilloma virus and human microbiota. Discussion of the biology of each organism and interaction with the host immune system, reinforcing principles of immune function. *Enrollment limited to freshmen and sophomores.*

MCDB 123b, **Genes and Environment**. Nichole Broderick
MW 10.30-11.20, T 2.30-3.20, F 10.30-11.20
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. *Intended for non–science majors.*

[MCDB 150b, **The Human Population Explosion.** Robert Wyman]
MW 2.30-3.45
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.

An Overview of the Programs for Majors

The programs in the MCDB major are designed to enhance a liberal education as well as offer excellent preparation for professional and graduate study in the biological sciences, and in medicine and other health-related fields. The following diagram provides an overview of the major; details are provided on the following pages. In addition to the standard major, MCDB offers two interdisciplinary programs of study in the biotechnology and neurobiology tracks. All MCDB students have the same options 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			
	New Introductory Modules	2 terms ½ credit per module	BIOL 101a or b (Introduction to Biochemistry) BIOL 102a or b (Principles of Cell Biology & Membrane Physiology) BIOL 103b (Basic Genetics and Developmental Biology) BIOL 104b (Principles of Ecology & Evolutionary Biology)
		½ semester per module	Alternatively students with a score of 5 on the Advanced Placement Biology exam may place out of the introductory modules by taking the Yale-administered placement exam.
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 Labs	1 term	Chem 126L or 222L
Physics			
		2 terms	Phys 170a, 171b or higher
Math			
	Calculus	1 term	Math 115 or higher (not including Math 190)

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 MCDB 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/MCDB 215a).

Premedical students will likely need to take the laboratory with introductory physics, although it is not required for the major in MCDB. Premedical students should consider the advisability of taking the introductory MCDB laboratory MCDB 121La or 221L. Note that the premedical requirements and the prerequisites for both MCDB and MB&B majors are substantially the same, so students do not have to choose among these paths during their freshman year.

Official Yale College program and course information is found in *Yale College Programs of Study*, available on line at www.yale.edu/yalecollege/publications/ycps/.

Placement Exam

Students with a 5 on the AP Biology exam, a score of 7 on the IB Biology higher-level exam, a score of A on the GCE Biology A-level exam, or the equivalent on other national standardized exams are eligible to take a placement examination administered at Yale. Based on the results of the examination, a student may place out of one or more courses in the BIOL 101–104 sequence. However, one or more of these introductory Biology courses may be explicitly required as prerequisites for upper-level MCDB courses. More information on the Placement Exam can be found at this website: http://yalecollege.yale.edu/biology-1

Requirements by Major

for the Classes of 2016 and beyond

- *Major:* **Molecular, Cellular, Developmental Biology**
  - **MCDB - Standard Track**
  - **MCDB - Neurobiology Track**
  - **MCDB - Biotechnology Track**

- *Major:* **Molecular, Cellular, Developmental Biology - Intensive**
  - **MCDB, Intensive - Standard Track**
  - **MCDB, Intensive - Neurobiology Track**
  - **MCDB, Intensive - Biotechnology Track**

Students interested in the biotechnology and neurobiology tracks 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)

Neurobiology track advisors:
Paul Forscher, 222 KBT (432-6344)
Haig Keshishian, 640A KBT (432-3478)
Robert Wyman, 610A KBT (432-3475)
Weimin Zhong, 616B KBT (432-9233)

Major: MCDB *(Classes of 2016 and beyond)*

Track: ***Standard*** - BA, BS

Pre-Requisites	BIOL 101a or b (Introduction to Biochemistry) BIOL 102a or b (Principles of Cell Biology & Membrane Physiology) BIOL 103b (Basic Genetics and Developmental Biology) BIOL 104b (Principles of Ecology & Evolutionary Biology) [these 4 modules are ½ semester in length and equal .5 credits each] [Students with an AP Biology score of 5 will be eligible to take the Yale Administered placement exam for these introductory modules – and subsequently place out of one or more.] 2 terms of General Chemistry (112a, 113b or 114a, 115b) (or 1 term of Gen Chem 118a) 2 terms of General Chemistry Labs (or if 118a is taken 1 term is required) 1 term of Organic Chemistry (124a or 220a or 225b) 1 term of Organic Chemistry Lab (126L or 222L) [or 124, 125 with 126L 127L satisfies both General Chemistry and Organic Chemistry requirements] 2 terms of Physics (170a, 171b or higher) 1 term of Math (115 or higher – not including Math 190)
Core Courses	A. Either MCDB 200b (Molecular Biology) or MCDB 202a (Genetics) B. Either MCDB 205b (Cell Biology) or MCDB 210a (Developmental Biology) C. Either MCDB 300b (Biochemistry) or MB&B 300a (Principles of Biochemistry I)
General Electives	Three Credits. The MCDB major requires three general electives from MCDB numbered 200 or above. 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.
Special Electives	One Credit. The MCDB major requires one special elective from MCDB numbered 350 or higher.
Laboratories	Two MCDB laboratories at the level of MCDB 200 or higher (MCDB 121L or MCDB 221L may now be used to fulfill one of these lab requirements.)
Senior Requirement	MCDB, BA (choose One of the following; must be taken in Senior Year) o MCDB 470 a or b (Tutorial in MCDB); o MCDB 475 a or b (Research); o Senior Essay (no credit) MCDB, BS (choose One of the following; must be taken in Senior Year) o Two terms of MCDB 475 a or b (Research) [only if student takes 475b in Spring of Junior year, continues in same lab through summer {no pay} and takes 475a in Fall of Senior year.] o MCDB 485a and 486b (Research in MCDB)

Major: MCDB, Intensive *(Classes of 2016 and beyond)*

Track: ***Standard*** - BS Intensive

Pre-Requisites	BIOL 101a or b (Introduction to Biochemistry) BIOL 102a or b (Principles of Cell Biology & Membrane Physiology) BIOL 103b (Basic Genetics and Developmental Biology) BIOL 104b (Principles of Ecology & Evolutionary Biology) [these 4 modules are ½ semester in length and equal .5 credits each] [Students with an AP Biology score of 5 will be eligible to take the Yale Administered placement exam for these introductory modules – and subsequently place out of one or more.] 2 terms of General Chemistry (112a, 113b or 114a, 115b) (or 1 term of Gen Chem 118a) 2 terms of General Chemistry Labs (or if 118a is taken 1 term is required) 1 term of Organic Chemistry (124a or 220a or 225b) 1 term of Organic Chemistry Lab (126L or 222L) [or 124, 125 with 126L 127L satisfies both General Chemistry and Organic Chemistry requirements] 2 terms of Physics (170a, 171b or higher) 1 term of Math (115 or higher – not including Math 190)
Core Courses	A. Either MCDB 200b (Molecular Biology) or MCDB 202a (Genetics) B. Either MCDB 205b (Cell Biology) or MCDB 210a (Developmental Biology) C. Either MCDB 300b (Biochemistry) or MB&B 300a (Principles of Biochemistry I)
General Electives	Three Credits. The MCDB Intensive major requires three general electives from MCDB numbered 200 or above. 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.
Special Electives	Two Credits. The MCDB Intensive BS major requires two special electives from MCDB numbered 350 or higher.
Laboratories	Two MCDB laboratories at the level of MCDB 200 or higher (MCDB 121L or MCDB 221L may now be used to fulfill one of these lab requirements.)
Senior Requirement	MCDB BS Intensive (must be taken in the Senior Year) o MCDB 495a and 496b (Intensive Research in MCDB)

Interdisciplinary Tracks

As alternatives to the standard MCDB track, 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.

	Biotechnology	***Neurobiology***
Pre-Requisites	See MCDB Standard Track	See MCDB Standard Track
Core Courses	Either MCDB 200b (Molecular Biology) or MCDB 202a (Genetics) Either MCDB 205b (Cell Biology) or MCDB 210a (Developmental Biology) Either MCDB 300b (Biochemistry) or MBB 301a (Principles of Biochemistry I) MCDB 370b (Biotechnology)	Either MCDB 200b (Molecular Biology) or MCDB 202a (Genetics) Either MCDB 205b (Cell Biology) or MCDB 210a (Developmental Biology) Either MCDB 300b (Biochemistry) or MBB 301a (Principles of Biochemistry I) MCDB 320a (Neurobiology)
General & Special Electives	Three credits, see notes below[*B1]	Three credits, see notes below[*N1]
Laboratories	See MCDB Standard Track & notes below[*B2]	See MCDB Standard Track & notes below[*N2]
Senior Requirement	See MCDB Standard Track	See MCDB Standard Track
BS Intensive Degree	See MCDB, Intensive Standard Track	See MCDB, Intensive Standard Track

Biotechnology Notes:

[*B1] For electives students can select from the following: any MCDB course numbered 200 or above, MB&B 420a, 421b, 443b, BENG 351a, 352b, 410a, 435b, 457b, 464b, CENG 210a, 411a, 412b, CPSC 437a, 445b, 470a, or 475b. (one elective must be from MCDB numbered 350 or above)

[*B2] 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. MCDB 121L or MCDB 221L may now be used to fulfill one of these lab requirements.

Neurobiology Notes:

[*N1] 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.

[*N2] The two laboratories should ordinarily be chosen from MCDB courses. MCDB 121L or MCDB 221L may now be used to fulfill one of these lab requirements.

The Senior Requirement

In addition to the course work described on previous pages, all majors in MCDB 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 (MCDB 470a or b); or by successful completion of one credit of individual research (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 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.

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 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 MCDB 475a or b will be taken during the senior year (see text immediately following), 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 MCDB Intensive major

For the MCDB B.S. *intensive major*, students fulfill the senior requirement by taking MCDB 495a and 496b, Intensive Research in MCDB , for four credits and complete two full-credit course electives from MCDB at 350 or above for a total of five elective 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 department and in related departments, including those in the Yale Medical School. This research is in molecular biology, biochemistry, genetics, cell biology, neurobiology, physiology, computational biology, plant sciences, 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 will 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 site: http://www.mcdb.yale.edu . Detailed descriptions of research programs in MCDB can also be found in Appendix I of this booklet.

Research Courses

During the academic year, students, with DUS approval, may take either of three research courses, MCDB 475a or b, MCDB 485a and 486b or MCDB 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 before their senior year, but it does not substitute for other course requirements. MCDB 475 counts toward the 36 credits required for the Yale College degree; but other than meeting the senior requirement, MCDB 475, and indeed all the research courses, do NOT contribute to satisfying the requirements for 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, general elective, or special 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 MCDB 475a or b Research 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 (more detailed explanation can be found under the BS degree on page 12).

MCDB 485a, 486b Research in MCDB, is a year-long research course intended for senior students who wish to do research for the MCDB 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 member(s). At the end of the course a written report on the research accomplished must be submitted before a grade will be given.

MCDB 495a, 496b Intensive Research in MCDB, is intended for senior students who wish to do intensive research for the MCDB B.S. Intensive 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.

*Students seeking the MCDB BS Intensive degree are also required to take two Special Electives from MCDB numbered at 350 or above.

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 MCDB 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 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.

An important issue for prospective MCDB majors is to consider taking chemistry during the first year. This is because a number of courses, including some in MCDB, have prerequisites of two years of chemistry followed by biochemistry. An early start on this sequence can be important. If the student is going to take a second science course, it should be in the MCDB 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. MCDB majors should find an advisor in the program as soon as they decide on the major. Students in the standard MCDB major may contact the MCDB Registrar, Crystal Adamchek to be assigned an advisor or they can select any member of the MCDB 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 in Appendix I of this booklet. Students in the neurobiology or biotechnology tracks 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 MCDB 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 MCDB DUS can be reached by email or through the undergraduate registrar. See the first page of this booklet for names, phone numbers, and email addresses.

Advisors

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 (both primary and secondary) is listed in Appendix I.

Statutorily the DUS is the formal faculty advisor for all double major and BS/MS students.

Note : The MCDB Faculty Advisors are clearly identified under the Research and Faculty Interests listing in this booklet (see Appendix I).

Recommendations for Premedical Students

The Yale Pre-Med Office (Undergraduate Career Services) distributes the following table to students interested in pursuing the Pre-Med track at Yale.

Required Courses for MCAT Preparation

Each medical school has its own individual set of pre-requisite requirements. School websites have the most current information for these requirements, but another comprehensive resource is the online version of the Medical School Admissions Requirements (MSAR).

Grades of C or higher are required in all areas noted below.

Chemistry (General) – required for both the current and MCAT 2015 exams (One year recommended of both lecture and lab, unless placing into advanced level courses and have acceleration credits on transcript)	
Lecture	112a and 113b; 114a and 115b; 115a or 118a
Lab	116La and 117Lb, or 119La
If during freshman year you complete Freshman Organic Chemistry or regular Organic Chemistry and labs, and receive two acceleration credits to fulfill inorganic chemistry, you typically only need an additional term of biochemistry with lab. Check the requirements of medical schools to be certain that they will accept this combination. Refer to the Medical School Admission Requirements.	
Chemistry (Organic) – required for both the current and MCAT 2015 exams (One year recommended of both lecture and lab)	
Lecture	124a and 125b; 220a and 230b; or 225b and 227a
Lab	126La and 127Lb, or 222La and 223Lb
Biochemistry – required for the MCAT 2015 exam (One term of lecture recommended; one term of lab recommended if additional chemistry labs are needed)	
Lecture	MCDB 300b or MB&B 300a (some majors will require MB&B 301b)
Lab	MB&B 251La/MCDB 301La
Biology – required for both the current and MCAT 2015 exams (One year recommended of both lecture and lab)	
Lecture	BIOL 101a, 102a, 103b & 104b modules; MCDB 200b, MCDB 202a, MCDB 205b (Any other upper level MCDB or E&EB courses)
Lab	Any combination of MCDB and/or E&EB labs

Physics – required for both the current and MCAT 2015 exams (One year recommended of both lecture and lab)	
Lecture	170a and 171b, 180a and 181b, 200a and 201b, or 260a and 261b
Lab	165La and 166Lb, or 205L and 206L
College Math – Calculus required for the current exam and Statistics for MCAT 2015 exam (One term recommended of each)	
Calculus	Through MATH 115 or 116; MATH 120 is required for some majors
Statistics	STAT 101-109; or STAT 238; or PSYC 200; or Biostatics in a graduate department
Psychology and Sociology – required for the MCAT 2015 exam (One term recommended of each)	
Psychology	Introductory Psychology
Sociology	Health of the Public, SOCY126b (Many other courses taken for distributional requirements may also provide information useful for MCAT)
English (Two terms recommended)	
• Any course in the English Department; most courses in the Literature Department; courses in literature from cultural departments (taught in English Translation are acceptable to fulfill this requirement. • Some medical schools will accept Writing Intensive (WR) courses to fulfill one term; many medical schools prefer at least one writing course.	

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 MCDB majors to participate in programs that include study abroad. 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 MCDB major requirements depends on the particular program chosen and should be discussed with the DUS early in planning.

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

The combined B.S./M.S. degrees program in MCDB 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) 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 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) MCDB 595, a four-credit, yearlong course (two credits each term) that is similar to 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 MCDB 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.

Facilities

The offices and laboratories of primary faculty members are in two buildings on science hill (Kline Biology Tower (KBT) and Osborn Memorial Laboratories (OML)) and in buildings on Yale's West Campus. Joint appointees are housed in their home departments. In addition to the state of the art laboratories in these 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 Center for Science and Social Science Information (CSSSI), 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.

The CSSSI is located in the concourse level of the Kline Biology Tower and has replaced the Kline Science Library while retaining the library's former collection in the biological sciences and adds to that additional and substantial functionality in computing with their state-of-the-art StatLab. Please visit their web site for additional information. http://csssi.yale.edu/

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.

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. 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 their web site for additional information http://dna-analysis.research.yale.edu//#.

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's West Campus: There are also a series of Core Facilities established on Yale's West Campus these currently include: High Throughput Cell Biology, Small Molecular Discovery Center, Yale Center for Genome Analysis, and HPC-High Performance Computing Center. Please visit their web site for more information: http://www.yale.edu/westcampus/science_core.html

Courses in MCDB 2013-2014

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 2013-2014. *Note: The most current information on courses can always be found on OCI.*

REQUIRED: NEW INTRODUCTORY COURSES

BIOL 101a or b. **Biochemistry and Biophysics.** Fall: Michael Koelle; Spring: Anthony Koleske
M W 11.35-12.50, 1 HTBA (Surjit Chandhoke – Fall Coordinator) ([Kathryn Gardner – Spring Coordinator)
Introduction to the study of life at the molecular level. Topics include the three-dimensional structures and function of large biological molecules, the human genome, and the design of antiviral drugs to treat HIV/AIDS. *Prerequisite: The first of four modules in a yearlong introductory biology sequence; meets for the first half of the fall term.*

BIOL 102a or b. **Principles of Cell Biology and Membrane Physiology.** Fall: Mark Mooseker; Spring: Staff
M W 11.35-12.50, 1 HTBA (Surjit Chandhoke – Fall Coordinator) (Kathryn Gardner – Spring Coordinator)
Introduction to the study of cell biology and membrane physiology. Topics include organization and functional properties of biological membranes, membrane physiology and signaling, rough endoplasmic reticulum and synthesis of membrane/secretory membrane proteins, endocytosis, the cytoskeleton, and cell division. *Prerequisite: The second of four modules in a yearlong introductory biology sequence; meets for the second half of the fall term.*

BIOL 103b. **Genes and Development.** Frank Slack
MW 11.35-12.50, 1 HTBA (Surjit Chandhoke – Spring Coordinator)
Introduction to genes, genetics, and developmental biology. How genes control development and disease; Mendel's rules; examples of organ physiology. *Prerequisite: The third of four modules in a yearlong introductory biology sequence; meets for the first half of the spring term.*

BIOL 104b. **Principles of Ecology and Evolutionary Biology.** Leo Buss
MW 11.35-12.50, 1 HTBA)Surjit Chandhoke – Spring Coordinator)
Introduction to ecology, evolutionary biology, animal behavior, and the history of life. Evolutionary transitions and natural selection. Adaptation at genic, chromosomal, cellular, organismal, and supra-organismal levels. Distributional and social consequences of particular suites of organismal adaptations. *Prerequisite: The fourth of four modules in a yearlong introductory biology sequence; meets for the second half of the spring term.*

INTRODUCTORY COURSES WITHOUT PREREQUISITES

MCDB 050a. **Immunology and Microbes.** Paula Kavathas
TTh 2.30-3.45
Principles of immunology, microbiology, and host-microbe interaction. Innate and adaptive immunity; principles of vaccination. Organisms studied include HIV, influenza, human pappilloma virus, polio, and human microbiota.

MCDB 103b. **Cancer.** Alexia Belperron
MW 1.00-2.15
Introduction to the biology of cancer, with a focus on leukemia, skin cancer, and cancers linked to infection. Topics include genetics, biochemistry, immunity, infection agents, and challenges for prevention and treatment. Intended for non–science majors and underclassmen.

MCDB 105a or b /MB&B 105a or b. **An Issues Approach to Biology.**
Fall: Timothy Nelson, John Carlson, William Summers
Spring: Timothy Nelson, Dieter Soll, Ronald Breaker, Charles Sindelar
MW 11.35-12.25 1 HTBA
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. Class is designed primarily for underclassmen. *Prerequisite: high school biology.*

*MCDB 109b. **Immunity and Contagion.** Paula Kavathas
TTh 2.30-3.45 Meets RP
Introduction to the human immune system, followed by study of microorganisms such as influenza, HIV, human papilloma virus, and human microbiota. 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.*

MCDB 123b. **Genes and Environment.** Nichole Broderick
MW 10.30-11.20, T 2.30-3.20, F 10.30-11.20
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. *Intended for non–science majors.*

[*MCDB 135b/*CGSC 202b. How the Brain Works]

[MCDB 150b[G]/HIST 400b. Global Problems of Population Growth]

MCDB 166b . **From Microbes to Molecules.** Carol Bascom-Slack, Tiffany Tsang
MWF 9.25-11.20
A yearlong introduction to biology and chemistry through research on soil bacteria. Focus on the discovery of antibiotics from soil bacteria isolated from the Yale campus. Diversity of life, structure of biomolecules, components of a cell, molecular basis of gene expression, heritability, and symbiosis. Comparison with eukaryotic molecular and cellular biology. *Enrollment restricted to freshmen.*

MCDB CORE COURSES

Choose ***One From Each*** Category Below (3 total)

Core A: MCDB 200b or MCDB 202a
Core B: MCDB 205b or MCDB 210a
Core C: MCDB 300b or MBB 300a

MCDB 200b. **Molecular Biology.** Anna Pyle, Farren Isaacs
MWF 11.35-12.50
A study of the fundamental principles of molecular biology, including the experimental methodologies used in biological research. Topics include the structure, function, and chemical behavior of biological macromolecules (DNA, RNA, and protein), chromosome and genome organization, replication and maintenance of the genome, transcriptional and translational regulation, microRNAs and other noncoding RNAs, RNA processing, and systems biology. Designed to provide an accelerated venue for MCDB majors and other students seeking to understand the molecular basis for gene expression and biological function. *Prerequisite: CHEM 112 and 113, or 114 and 115, or 118, or a score of 5 on the Advanced Placement test in Biology, or BIOL 101 or equivalent performance on the corresponding biological sciences placement examination; or with permission of instructor.*

MCDB 202a. **Genetics.** Stephen Dellaporta, Martín García-Castro, Murat Acar
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. *Prerequisite: BIOL 103or equivalent performance on the corresponding biological sciences placement examination.*

MCDB 205b. **Cell Biology.** Thomas Pollard, Valerie Horsley, Megan King
TTh 9.00-10.15
A comprehensive introductory course in cell biology. Emphasis on the general principles that explain the molecular mechanisms of cellular function. *Prerequisite: BIOL 101 and 102, or equivalent performance on the corresponding biological sciences placement examinations, or a score of 5 on the Advanced Placement test in Biology, or a score of 710 or above on the SAT Biology M test, or MCDB 200.*

MCDB 210a. **Developmental Biology.** Scott Holley, Vivian Irish, Douglas Kankel
TTh 1.00-2.15
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. *Prerequisites: BIOL 101, 102, and 103, or equivalent performance on the corresponding biological sciences placement examinations.*

MCDB 300b[G]/MB&B 200b. **Biochemistry.** Ronald Breaker, Nicole Clay, Donald Engleman
MWF 9.25-10.15
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. *Prerequisites: BIOL 101, 102, 103, and 104, or equivalent performance on the corresponding biological sciences placement examinations; one term of organic chemistry; or with permission of instructor.*

MBB 300a[G]. **Principles of Biochemistry I.** Thomas Biederer, Michael Koelle
TTh 11.35-12.50
Discussion of the physical, structural, and functional properties of proteins, lipids, and carbohydrates, three major classes of molecules in living organisms. Energy metabolism, hormone signaling, and muscle contraction as examples of complex biological processes whose underlying mechanisms can be understood by identifying and analyzing the molecules responsible for these phenomena. *After BIOL 101; after or concurrently with CHEM 125 or 220*

MCDB LABORATORIES

MCDB 221La. **Molecular Cellular Developmental Biology Lab.** Maria Moreno
TWTh or F 1:30-5:30
An introduction to biological research with an emphasis on the utility of model organisms. Exercises in basic molecular biology techniques, biochemistry, genetic analysis, cell fractionation, microbiology, microscopy and imaging, embryogenesis, and plant and animal development. Introduction to experimental design, data analysis and display, and scientific writing. *Prerequisite: Concurrently with or after BIOL 101, 102, and 103, or equivalent performance on the placement exam, or by permission of instructor.*

MCDB 201Lb. **Molecular Biology Laboratory.** Maria Moreno
M or W 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 MCDB 200. Special registration procedures apply. Interested students must contact the instructor and attend an organizational meeting during the first week of classes.*

MCDB 203La. **Laboratory for Genetics.** Iain Dawson, William Leiserson
MT or W 1.45-5.00
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 241Lb. **Laboratory for Biology of Reproduction and Development.** Mary Klein
TWTh 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 210b or 240b. Not open to freshmen. Special registration procedures apply. Students must consult the instructor prior to the first week of classes.*

MCDB 291Lb. **Laboratory for Microbiology.** Iain Dawson
TTh 2.30-5.20
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. Electronic permission key required; students should contact the instructor.*

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

MCDB 303Lb. **Advanced Molecular Biology Laboratory.** Maria Moreno, Kenneth Nelson
Tu 2.30-3.45
Lab - W 1.00-4.00
A laboratory course that provides advanced biology research skills. Weekly workshops focus on good laboratory practice, advanced molecular biology topics, experimental design, data analysis and display, reading of primary literature, scientific presentations, and scientific writing skills. Application of these skills in project-based laboratory training sponsored by a faculty member. *For juniors who have completed MCDB 121L or 201L and are planning their senior research projects.*

No research laboratory experience required. Special registration procedures apply. Interested students must contact the instructors and attend an organizational meeting in October 2012.

MCDB 321La[G]. **Laboratory for Neurobiology.** Haig Keshishian, Paul Forscher
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. *Concurrently with or after MCDB 320a.*

*MCDB 341La&b. **Laboratory in Electron Microscopy.** Barry Piekos
W 1.30-4.30 (Fall)
T or W 1.30-4.30 (Spring)
Techniques in light and electron microscopy. *Enrollment limited; preference given to MCDB 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. Meets during January and February. Enrollment limited. Prerequisite: MCDB 205b. Special registration procedures apply. Students must contact the instructor in advance and are interviewed prior to enrollment.*

*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 12 months in advance.

MCDB GENERAL ELECTIVE COURSES

NOTE: BIOL 101, 102, 103 and 104, or equivalent performance on the corresponding biological sciences placement examinations are prerequisites for MCDB courses numbered 200 and above.

STAT 101a[G] **Introduction to Statistics: Life Sciences.** Jonathan Reuning-Scherer, Walter Jetz
(This course was previously cross-listed as MCDB 215)
TTh 1-2:15
Statistical and probabilistic analysis of biological problems, presented with a unified foundation in basic statistical theory. Problems are drawn from genetics, ecology, epidemiology, and bioinformatics.

A basic introduction to statistics, including numerical and graphical summaries of data, probability, hypothesis testing, confidence intervals, and regression. Each course focuses on applications to a particular field of study and is taught jointly by two instructors, one specializing in statistics and the other in the relevant area of application. The first seven weeks of classes are attended by all students in STAT 101–106 together, as general concepts and methods of statistics are developed. The remaining weeks are divided into field-specific sections that develop the concepts with examples and applications. Computers are used for data analysis. These courses are alternatives; they do not form a sequence and only one may be taken for credit. No prerequisites beyond high school algebra. *May not be taken after STAT 100 or 109.*

Students enrolled in STAT 101–106 who wish to change to STAT 109, or those enrolled in STAT 109 who wish to change to STAT 101–106, must submit a course change notice, signed by the instructor, to their residential college dean by Friday, September 28. The approval of the Committee on Honors and Academic Standing is not required.

*MCDB 230b/*MB&B 230b. **Rain Forest Expedition and Laboratory.** Scott Strobel, Carol Bascom-Slack, Kaury Kucera
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: BIOL 101, 102, and 103, or equivalent performance on the corresponding biological sciences placement examinations, or a score of 5 on the Advanced Placement test in Biology, or a score of 710 or above on the SAT Biology M test.*

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. *Prerequisites: BIOL 101, 102, and 103, or equivalent performance on the corresponding biological sciences placement examinations; two terms of organic chemistry; one term of biochemistry, cell biology, or genetics; or with permission of instructor.*

MCDB 310a[G]/BENG 350a[G]. **Physiological Systems.** Mark Saltzman, Emile Boulpaep and Staff
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>, or BIOL 101 and 102.*

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 SPECIAL ELECTIVE COURSES

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

[MCDB 361b[G]/AMTH 465b. Systems Modeling in Biology]

*MCDB 370b[G]. **Biotechnology.** Xing-Wang Deng, Kenneth Nelson, Farren Isaacs, 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. Prerequisites: BIOL 101, 102, and 103, or equivalent performance on the corresponding biological sciences placement examinations; MCDB 202 or 205. 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.** Frederick Sigworth, Emile Boulpaep
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, Marc Hammarlund, Tae-Hoon Kim, Richard Lifton
MW 11.35-12.50
The universal principles of genetic analysis in eukaryotes. Reading and analysis of primary papers that illustrate the best of genetic analysis in the study of various biological issues. Focus on the concepts and logic underlying modern genetic analysis. *Prerequisite: MCDB 200 or equivalent.*

MCDB 430a[G]. **Biology of the Immune System.** Carla Rothlin, Tian Chi, Peter Cresswell, Kevan Herold, Akiko Iwasaki, Ruslan Medzhitov, Eric Meffre, Joao Pedro Pereira, David Schatz

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
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, Sreeganga Chandra, Michael Crair
MW 2.30-3.45
Recent advances in scientific understanding of brain development and plasticity, including neuronal determination, axon guidance, synaptogenesis, and developmental plasticity. *Prerequisite: BIOL 101, 102, 103, and 104, or equivalent performance on the corresponding biological sciences placement examinations; MCDB 320 or permission of instructor.*

MCDB 450b. **The Human Genome.** Stephen Dellaporta
M 3.30-5.30
A focus on the primary scientific literature covering the principles of genomics and its application to the investigation of complex human traits and diseases. Topics include the technology of genome sequencing and resequencing, the characterization of sequence and structural variation in human populations, haplotype and linkage disequilibrium analysis, genome-wide association studies, the comparative genomics of humans and our closest relatives, and personalized genomics and medicine. *Enrollment limited to 15. Students should contact the instructor prior to the first week of classes. Prerequisite: MCDB 202; a course in statistics is strongly recommended.*

MCDB 452a[G]/CPSC 452a/MB&B 452a[G]. **Bioinformatics: Practical Application of Simulation and Data Mining.** Mark Gerstein
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 115, or permission of instructor.*

[*MCDB 460b[G]. Cell Biology of the Neuron]

MCDB 482a **Advanced Seminar in Cell Biology: Intracellular Signal Transduction.** Craig Crews
M 7.00-8.50 p
Discussion of intracellular signal transduction pathways. Detailed critique of experimental approaches, controls, results, and conclusions of selected current and classic papers in this field.

MCDB RESEARCH AND TUTORIALS

*MCDB 470a or b. **Tutorial in MCDB.** 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 by the 1st week of the semester. 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.** Scott Holley, Weimin Zhong
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 by the end of the first week of the semester. *Fulfills the senior requirement for the B.A. degree if taken in the senior year.*

*MCDB 485a and 486b. **Research in MCDB.** Scott Holley, Weimin Zhong
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 by the end of the first week of the semester. *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 MCDB.** Scott Holley, Weimin Zhong
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 the end of the first week of the semester. *Fulfills the senior requirement and leads to the B.S. Intensive major.*

BS/MS COURSES

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

MCDB 585b. **Research in MCDB for B.S./M.S. Candidates.** Scott Holley, Weimin Zhong
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.

MCDB 595. **Intensive in MCDB for B.S./M.S. Candidates.** Scott Holley, Weimin Zhong
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.

MCDB GRADUATE COURSES

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.

MCDB 500b^{U}/MB&B 500b^{U}. **Biochemistry.** Ronald Breaker, Donald Engelman, Nicole Clay
MWF 9.25-10.15
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.** Lynne Regan, Enrique De La Cruz, Eric Dufresne, Thierry Emonet, Paul Forscher, Megan King, Michael Levene, Simon Mochrie, Corey O'Hern, Thomas Pollard, Anna 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.** Carla Rothlin, Tian Chi, Peter Cresswell, Kevan Herold, Akiko Iwasaki, Ruslan Medzhitov, Eric Meffre, Joao Pedro Pereira, David Schatz
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.

MCDB 550a^{U}/C&MP 550a^{U}/ENAS 550a^{U}. **Physiological Systems.** Emile Boulpaep, W. Mark Saltzman, Peter Aronson, Stuart Campbell, Elizabeth Holt
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]

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 591b/ENAS 991b/MBB 591b/PHYS 991b. **Integrated Workshop.** Lynne Regan, Joerg Bewersdorf, Simon Mochrie, Corey O'Hern

This required course for students in IGPPEB involves hands-on laboratory modules with students working in pairs. A biology student is paired with a physics or engineering student; a computation/theory student is paired with an experimental student. The modules are devised so that a range of skills are acquired, and students learn from each other.

MCDB 602a/CBIO 602a/MB&B 602a. **Molecular Cell Biology.** Sandra Wolin, Michael Caplan, Craig Crews, Pietro De Camilli, Megan King, Thomas Melia, In-Hyun Park, Thomas Pollard, James Rothman, Martin Schwartz

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.** Megan King, Michael Caplan, Craig Crews, Pietro De Camilli, Thomas Melia, In-Hyun Park, Thomas Pollard, James Rothman, Martin Schwartz, Sandra Wolin

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, Marc Hammarlund, Tae-Hoon Kim, Richard Lifton

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.** 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 4.00-5.15

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

W 1.30-3.20

New aspects of the molecular biology of RNA, ribonucleoproteins, and prions. Topics include the localization and function of RNA and ribonucleoproteins, siRNAs and microRNAs; the role of RNA in dosage compensation, chromosome silencing, and gene regulation; novel ribozymes and RNA technology; prions. Discussion; involvement and attendance are required.

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

F 1.30–3.20

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 735b/NSCI 504b. **Seminar in Brain Development and Plasticity.** Weimin Zhong, Sreeganga Chandra, Michael Crair

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, 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]

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}. The Human Population Explosion]

MCDB 900a/CBIO 900a/GENE 900a. **First-Year Introduction to Research and Rotations – Grant Writing and Scientific Communication.** Frank Slack and Staff

M 4.00-5.30

Grant writing, scientific communication, and laboratory rotation talks 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.** Megan King

Th 4.00-5.30

Ethics and laboratory rotation talks for Molecular Cell Biology, Genetics, and Development track students.

MCDB 902a/903b. **Advanced Graduate Seminar.** Fall: Valerie Horsley, Matthew Rodeheffer Spring: Timothy Nelson

T 9.00-10.00

This course allows students to hone their presentation skills through yearly presentation of their dissertation work. Two students 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 911a,/CBIO 911a/GENE 911a. **First Laboratory Rotation.** Carl Hashimoto and faculty HBTA
First laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

MCDB 912b/ CBIO 912b/GENE 912b. **Second Laboratory Rotation.** Valerie Reinke and faculty. HTBA
Second laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

MCDB 913b /CBIO 913a/GENE 913b**. Third Laboratory Rotation.** Frank Slack and faculty HTBA
Third laboratory rotation for Molecular Cell Biology, Genetics, and Development track students.

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

Undergraduate Research Projects

Research Faculty *Dept.*	*Project Titles*
Abrahams, Vikki *OB/GYN*	The Role of microRNAs and MMPs in Regulating First Trimester Trophoblast Cell Migration and Invasion in Response to Antiphospholipid Antibodies
Arnsten, Amy *Neurobiology*	KCNQ Mechanisms in Prefrontal Cortex
Ben Mamoun, Choukri *Internal Med*	Testing the Transfection Efficiency of Lipid-Enveloped Dendrimer (LED) and Micelle Nanoparticles into P. falciparum-infected Erythrocytes
	Testing the Transfection Efficiency of LED Nano-particles into *P. falciparum*- infected Erythrocytes
Bender, Jeffrey *Immuno*	Integrin-Mediated VEGF-C mRNA Stabilization in Macrophages and Integrin-Mediated VEGF-C mRNA Stabilization in Macrophages and its Role in Lymphangiogenesis
Bindra, Ranjit *Ther Rad*	Development of Novel Live Cell Multicolor Competition Assay for High-Throughput Screeening
Blumenfeld, Hal *Neurology*	Event-Related Potential Analysis of Interictal EEG in Patients with Childhood Absence Epilepsy
	Investigating Spike-Wave Discharges in Ferrets:A Potential Animal Model of Childhood Absence Epilepsy
Bogan, Jonathan *Endocrinolog*	SIRT2 modulates GLUT4 glucose transporter trafficking by controlling TUG acetylation
Bogue, Clifford *Pediatrics*	Chromatin Immunoprecipitation Sequencing (ChIP-Seq) to find the Direct Target Genes of the Transcription Factor Hhex
Bordey, Angelique *Neurosurgery*	mTOR and GABAa Signaling in the Subventricular Zone of the Adule Mammalian Brain
Brueckner, Martina *Cardiology*	The Role of Nuclear Pore Complex Components in the Development of Left-Right Asymmetry
Caccone, Adalgisa *EEB*	A study of the genetic differentiation of *Glossina fuscipes fuscipes* in the Lake Victoria Basin
	Developing genetic markers to identify interceptions of Asian gypsy moth in North America

	Tsetse Flies: A Look at the Glossina Tuscipes Species, Complex Level of Genetic Differentiation within and among G.E. Tuscipes. G.E. Mutation and G.F. Quanzenesis
Cafferty, William *Neurology*	A Role for the Nogo - Nogo Receptor Axis in Nociceptive Processing
Carling, Tobias *Endocrine Surgery*	A Cooperative Association between Oncosuppressor *RASSF1A* Silencing and Beta-Catenin Dysregulation in Adrenocortical Carcinoma
Clay, Nicole *MCDB*	Variation in an Increase in Secondary Metabolite Production in Amazonian Endophytic Fungi Infecting Arabidopsis thaliana
	A Survey of Secondary Metabolites Produced by Amazonian Endophytic Fungi Infecting Immuno-Compromised Arabidopsis thaliana
Cooley, Lynn *Genetics*	Genetic analysis of Drosophila ovary muscles: a model system for studying striated muscle disease
Craft, Joseph *Immunobiology*	The Role of Neutrophilic Tyrosine Receptor Type 3 (TrkC) in Follicular Helper T Cell (Tfh) Differentiation
Crair, Michael *Neurobiology*	Role of NMDARs in Mediating Neural-Activity Dependent Plasticity of the Sensory Maps in the Thalamus
Crews, Craig *MCDB*	The Role of LY6E in Urodele Limb Regeneration
	Screening Natural Products from Rainforest Endophytes for Compounds that Downregulate ER Stress Signaling
	Identification and Characterization of Inhibition of Hypoxia Inducible Factor (HIF) Degradation
	Methods of Transgenesis in the Axolotl
DeCamilli, Pietro *Cell Biology*	Optimizing Optogenetic Systems for Investigation of Phosphoinositide Metabolism in Neuronal Development and Morphology
Dellaporta, Stephen *MCDB*	Iron Homeostasis in Maize: The Biofortification of Maize Through the Upregulation of Iron Homeostasis Genes
	Development of an Amplification Protocol for Placozoan Mitochondrial DNA

DiLeone, Ralph *Psychiatry*	Optogenetic Approaches for Studying Feeding in Mice Role of Lipoprotein Lipase in Nucleus Accumbens and Ventral Tegmental Area in the Regulation of Food Intake
Egan, Marie *Pediatrics*	Nifedipine Treatment Decreases Cytokine Secretion in a Cystic Fibrosis Murine Model
Fahmy, Tarek *Biomed Eng*	Co-Encapsulation of G4 Dendrimers, CpG, and OVA antigen into B16-F10-OVA Melanoma Vaccine
Flannery, Clare *OB/GYN*	Insulin Receptor Expression in Endometrial Hyperplasia and Cancer Cells
Flavell, Richard *Immunobiology*	Effector Mechanisms of Anti-inflammatory Caspases Characterization of the Immune Response in a Microbiome-Mediated Model of Colitis Cell Adhesion and Growth Differentiation of Bag Cell Neurons on Polydimethylsiloxane
Garcia-Castro, Martin *MCDB*	Characterization of Pax7 Regulation in Myogenic Differentiation and Neural Crest Specification FGF/MAPK signaling in avian neural crest induction
Grigorenko, Elena *Child Study Center*	Macrophage Migration Inhibitory Factor (MIF) and Stress
Gunel, Murat *Neurosurgery*	Study of the Molecular Genetics Underlying Ependymoma and Mesothelioma
Hammarlund, Marc *Genetics*	Insulin Signaling Regulates Axon Regeneration Independently of Lifespan
Han, Christina *OB/GYN*	The Role of Metformin and N-acetylcysteine as therapeutic Agents in the Reversal of Hyperglycemia-Induced First Trimester Trophoblast Dysfunction
Handelsman, Jo *MCDB*	Fungal Natural Products as a Source of Antibiotics: Identification of Novel Antibacterial Compounds from Ecuadorian Rainforest Fungi Host-microbe interactions in *Drosophila melanogaster*: effects on obesity, food preference, and development

	Egg-laying and position preferences for a commensal organism Lactobacillus plantarum are mediated via olfaction in Drosophila melanogaster
Herold, Kevan *Immunobiology*	Characterizing the Immunomodulatory Effects of Anti-CD3 Therapy in Patients with Type 1 Diabetes
Holley, Scott *MCDB*	BMP signaling in the zebrafish tailbud regulates cell flow during axis elongation
	Fusaric Acid Induces Notochord Malformation in Zebrafish Embryos
Horowitz, Mark *Orthopaedics*	Identification of Unknown Pax5-/- Conditioned Media Cytokine Priming for Osteoclasts
Horsley, Valerie *MCDB*	Lentiviral Knockdown of Notch Signaling in Basal Keratinocyte Differentiation
	Collective Mechanics in Epithelial Keratinocytes
	Macrophage Phenotype During Dermal Wound Healing
Isaacs, Farren *MCDB*	Multiplex Automated Genome Engineering (MAGE) in Naturally Competent Organisms
Iwasaki, Akiko *Immunobiology*	Effects of Mucous Metaplasia on Susceptibility of the Airway Epithelium to Rhinovirus
Kaech, Susan *Immunobiology*	The Role of Folic Acid in CD4+ T Cell Differentiation
Kibbey, Richard *Endocrinology*	Role of mitochondrial GTP in ƒÀ]cell Insulin Secretion
	Investigation of the Conversion of Pyruvate Kinase Oligomeric States in INS-1 Cells
King, Megan *Cell Biology*	Telomere sequencing and live cell microscopy yield insights into ALT pathway telomere maintenance in fission yeast
Ko, Albert *Public Health*	A Novel Flagellar Protein is Required for Wild-Type Motility in Leptospira
Kocsis, Jeffery *Neurology*	Assessing the in vivo Distribution and Functional Recovery of the Injured Peripheral Nerve of Rats Microinjected with Embryonic Stem Cells (ESCs) and Inducible Pluripotent Stem (iPS) Cells
Kyriakides, Themis	Investigating the role of TSP2 in Vascular Injury

Pathology	
	Investigating the role of TSP2 in Smooth Muscle Cell Differentiation and Function
Lin, Haifan *Cell Biology*	Investigating Piwi and piRNA function in Hydra stem cells
Lombroso, Paul *Child Study Center*	TC2153, a synthetic derivative of the natural product varacin, as an inhibitor of the PTP STriatal-Enriched protein tyrosine Phosphatase (STEP)
Lusk, Patrick *Cell Biology*	Investigating the assembly and turnover of nups of the nuclear pore complex
Manuelidis, Laura *OB/GYN*	The Use of a Rapid Accurate Culture Assay to Test the Effects of Potentially Disruptive Conditions for Infectivity in Transmissible Encephalopathies
	Characterization of sEGFR in endometrial cancer patients
McCormick, David *Neurobiology*	Cortical Correlates of Auditory Plasticity
	Functional connectivity of entorhinal cortex layer 1 neurons as revealed by recurrent network activity
	The Impact of Behavior on Auditory Cortex Plasticity
	The Influence of Behavior on Auditory Neuronal Activity
Medzhitov, Ruslan *Immunobiology*	NFIL3 Supports IL-4 Induced M2 Macrophage Polarization
	NF-êB Mediated Immediate Early Transcriptional Repression upon TLR4 Ligation
	Yap's Role in the Mechanism of Cell Number Sensing and Liver Size Control
Melia, Thomas *Cell Biology*	The Role of Membrane Curvature in Autophagosome Formation
Miller, George *Pediatrics*	Using c-Jun to Study Zebra: Effects of Mutations in c-Jun on Sub-Nuclear Localization
	Knockdown of a Long Non-Coding RNA in the Epstein-Barr Virus

Mor, Gil *OB/GYN*	Twist1 and CBX7: Characterizing the Molecular Mechanism of the Mesenchymal-Epithelial Transition (MET) in Ovarian Cancer
	Slug and Klf4 Induce Chemoresistance in Ovarian Cancer Cells
Near, Thomas *EEB*	The Molecular Rate of Evolution of the Rhodopsin Gene in Ray-finned Fishes
Nguyen, Don *Pathology*	The Role of Long Noncoding RNAs in Lung Adenocarcinoma Metastasis
Picciotto, Marina *Psychiatry*	The Effect of the Conditional Knockdown of β4-nAChRs in ChAT Neurons of the Medial Habenula on Nicotine Withdrawal/ Anxiety
	Effects of Cholinergic Modulation of the Amygdala on Mood
Politi, Katerina *Pathology*	Validation of Secondary Mutations contributing to Lung Adenocarcinomas in Myc Transgenic Mice
Pollard, Thomas *MCDB*	The Kinase Domain of Cdr2p Targets Blt1p to the Cortical Broad Band Prior to Contractile Ring Assembly
Rodeheffer, Matthew *Comparative Med*	The Effect of Diet-Induced Obesity on Adipose Tissue Set Point and the Development of Metabolic Disorders During High-Fat Diet Cycling
Rothman, James *Cell Biology*	Molecular Details of Synchronous Synaptic Transmission
Saltzman, Mark *Chemistry*	Exploring Surface Modifications to Increase Nanoparticle Uptake in Leukemic Cells
Schafe, Glenn *Psychology*	Chronic Exposure to Corticosterone Persistently Enhances the Consolidation of Fear Memories and the Expression of Synaptic Plasticity-Associated Proteins in the Lateral Amygdala
Schlessinger, Joseph *Pharmacology*	RAC1 P29S and its Role in Stimulation of Reactive Oxygenating Species
Slack, Frank *MCDB*	The Mechanism Behind OncomiR Addiction in the miR-155 Pathway
Stevens, Hanna *Child Study Center*	The Role of Fibroblast Growth Factor Receptors in Glial Cells
Strobel, Scott *MB&B*	Exploring Polystyrene Degradation by Fungal Endophytes

	In-vitro antiplasmodial properties of Bornean endophytes inhabiting plants used ethnobotanically to treat malaria
Tattersall, Peter *Genetics*	Understanding the Role of NS1-Binding Sites in MVM
Taylor, Hugh *Psychiatry*	Selective Gene Expression in the Presence of Estradiol (E2)
	Estradiol Specifically Alters Gene Expression During Female Development in GABRP, RAMP3, & TFRC genes
Taylor, Jane *Psychiatry*	Cognitive Deficits Observed in Neuropsychiatric Disorders such as Addiction, Obsessive Compulsive Disorder, and Schizophrenia
Vaccarino, Flora *Child Psychiatry*	Characterization of Cortical Astrocyte-derived Neurospheres in in vitro Hypoxia
Wajapeyee, Narendra *Pathology*	Integrative Genomics Approach to Identify Metabolic Drivers of Pancreatic Cancer
Weidhaas, Joanne *Ther Rad*	A germ-line KRAS 3'UTR mutation causes an epithelial to mesenchymal transition
Wolin, Sandra *Cell Biology*	Identification of a TRAMP Ortholog in Mammalian Cells
Yan, Qin *Pathology*	Elucidating the function of histone demethylase RBP2 in cancer invasion and metastasis using overexpression constructs
Zenisek, David *C&MP*	Isolation and Characterization of Candidate Ribbon Proteins Involved in Synaptic Transmission in the Retina
Zhong, Weimin *MCDB*	Using Yeast-Two Hybrid to Identify Genetic Factors Moderating Asymmetric Neural Stem Cell Division

Undergraduate Prizes and Awards

The department gives awards to graduating seniors for both Excellence in Research , *MCDB Edgar J. Boell Prize (Boell)* and Excellence in Academic Performance *MCDB William R. Belknap Prize (Belknap).* For the past academic year 3 students were awarded the Boell and 4 students were awarded the Belknap.

Appendix I

MCDB Faculty and Research Interests

MCDB Faculty & Research Interests

(secondary faculty are denoted with #)

Murat Acar
Asst Prof Mol Cell & Dev Biology
300 Heffernan Dr #B31, West Haven, CT 06516
murat.acar@yale.edu
Phone: 203-737-3255
[Ezra Stiles College Fellow & MCDB Faculty Advisor]

Systems biology, synthetic biology, gene regulatory networks, noise in gene expression, aging, evolution of gene networks

Sidney Altman
Sterling Prof Mol Cell & Dev Biology and Chemistry
KBT 402, 219 Prospect St, New Haven, CT 06511-2106
sidney.altman@yale.edu
Phone: 203-432-3500
[Trumbull College Fellow & MCDB Faculty Advisor]

Role in vivo of an enzyme with a catalytic RNA subunit; mechanism of action of that enzyme; synthesis and testing of a new antibiotic

Carol Bascom-Slack
Assoc Rsrch Scientist Mol Cell & Dev Biology; Lect Mol Cell & Dev Biology
JWG 309c, 266 Whitney Ave, New Haven, CT 06511-8902
carol.bascom-slack@yale.edu
Phone: 203-432-5437
[Davenport College Fellow & MCDB Faculty Advisor]

Microbiology, course-based undergraduate research experiences (CUREs)

Alexia Belperron #
Res Sci Medicine (Rheumatology) & Lect Mol Cell & Dev Biology
TAC S-520, 333 Cedar Street
New Haven, CT 06520-8056
alexia.belperron@yale.edu
Phone: 203-785-7665

Development of novel Magnetic Resonance Spectroscopy (MRS) techniques

Brett Berke
Assoc Rsrch Sci & Lect Mol Cell & Dev Biology
KBT 650, 219 Prospect St, New Haven, CT 06511-2106
brett.berke@yale.edu
Phone: 203-432-3479

Understanding synapses

Ronald R. Breaker
Henry Ford II Prof Mol Cell & Dev Biology; Investigator in Howard Hughes Med Inst; Chn Mol Cell & Dev Biology
KBT 506, 219 Prospect St, New Haven, CT 06511-2106
ronald.breaker@yale.edu
Phone: 203-432-9389
[Jonathan Edwards College Fellow & MCDB Faculty Advisor]

The discovery and analysis of noncoding RNAs, including riboswitches and ribozymes, and the engineering of novel RNA and DNA enzymes by directed evolution

John R. Carlson
Eugene Higgins Prof of Molecular, Cellular & Developmental Biology
KBT 1128, 219 Prospect St, New Haven, CT 06511-2106
john.carlson@yale.edu
Phone: 203-432-3541
[Pierson College Fellow & MCDB Faculty Advisor]

Olfaction and Taste in Drosophila and Malaria Mosquitoes

Surjit K. Chandhoke
Lect Mol Cell & Dev Biology; Assoc Rsrch Scientist Mol Cell & Dev Biology
KBT 338a, 219 Prospect St, New Haven, CT 06511-2106
surjit.chandhoke@yale.edu
Phone: 203-432-3481

Molecular mechanisms of cell motility and epithelial barrier regulation in the gastrointestinal tract

Sreeganga Chandra #
Asst Prof of Neurology/CNNR and Mol Cell & Dev Biology
BCMM 154d, 295 Congress Ave, New Haven, CT 06519-1418
sreeganga.chandra@yale.edu
Phone: 203-785-6172

Presynaptic Biology; Synapse Maintenance; Parkinson's Disease; Neurodegeneration

Damon Clark
Asst Prof Mol Cell & Dev Biology
KBT 232, 219 Prospect St, New Haven, CT 06511-2106
damon.clark@yale.edu
Phone: 203-432-8402
[Calhoun College Fellow & MCDB Faculty Advisor]

Drosophila visual behaviors and circuitry; computational and modeling approaches to neural computation

Nicole Clay
Asst Prof Mol Cell & Dev Biology
KBT 734, 219 Prospect St, New Haven, CT 06511-2106
nicole.clay@yale.edu
Phone: 203-432-4540
[Branford College Fellow & MCDB Faculty Advisor]

Plant innate immunity and bio-defenses

Lynn Cooley #
C.N.H. Long Prof Genetics & Prof Cell Biology and Mol Cell & Dev Biology and Cell Biology
SHM I329b, 333 Cedar St, New Haven, CT 06510-3206
lynn.cooley@yale.edu
Phone: 203-785-5067
[Jonathan Edwards College Fellow]

Molecular genetics of Drosophila oogenesis, control of oocyte growth, ring canals

Craig M. Crews
Lewis B. Cullman Prof Mol Cell & Dev Biology, Prof Pharmacology & Chemistry
KBT 400, 219 Prospect St New Haven, CT 06511-2106
craig.crews@yale.edu
Phone: 203-432-9364
[Pierson College Fellow & MCDB Faculty Advisor]

Exploration and control of signal transduction pathways using chemical probes

Iain A. Dawson
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iain.dawson@yale.edu
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[Branford College Fellow & MCDB Faculty Advisor]

Regulation of cell cycle in Drosophila melanogaster

Stephen L. Dellaporta
Prof Mol Cell & Dev Biology
OML 450a, 219 Prospect St, New Haven, CT 06511-2106
stephen.dellaporta@yale.edu
Phone: 203-432-3895
[Silliman College Fellow & MCDB Faculty Advisor]

Sex determination and cell death in plants

Xing Wang Deng
Daniel C Eaton Prof Plant Biology, Dir Peking Yale Ctr for Plant Mol Gen & Agribiotechnology
OML 352b, 219 Prospect St, New Haven, CT 06511-2106
xingwang.deng@yale.edu
Phone: 203-432-8908
[Morse College Fellow & MCDB Faculty Advisor]

Molecular genetic and genomic analysis of light signaling and development mechanism

Thierry Emonet
Assoc Prof Mol Cell & Dev Biology and Physics
KBT 1048, 219 Prospect St, New Haven, CT 06511-2106
thierry.emonet@yale.edu
Phone: 203-432-3516
[Jonathan Edwards College Fellow & MCDB Faculty Advisor]

We study how live cells and animals process information, interact, and make decisions using wet lab experiments and computational modeling

Paul Forscher
Prof Mol Cell & Dev Biology
KBT 222, 219 Prospect St, New Haven, CT 06511-2106
paul.forscher@yale.edu
Phone: 432-6344, 432-6345
[Davenport College Fellow & MCDB Faculty Advisor]

Molecular mechanisms of axon guidance: cytoskeletal protein dynamics and related signal transduction

Martín I. García-Castro
Assoc Prof Mol Cell & Dev Biology
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Phone: 203-432-3523
[Berkeley College Fellow & MCDB Faculty Advisor]

Neural crest cells (NCCs) arise early in development, migrate extensively, and give rise to an impressive array of diverse derivatives, including melanocytes, peripheral neurons and glia, heart-valve cells, and craniofacial muscle, adipose cells, odontoblasts, bone and cartilage. NCCs are at the center of vertebrate evolution and diversity, and their dysregulation lead to many human health conditions. We are invested in advancing our understanding of their embryonic induction, and differentiation potential using multiple animal models and human embryonic stem cells

Jo Handelsman
Frederick Phineas Rose Prof & Howard Hughes Med Inst, Prof Mol Cell & Dev Biology
KBT 904, 219 Prospect St, New Haven, CT 06511-2106
jo.handelsman@yale.edu
Phone: 203-432-9119
[Jonathan Edwards College Fellow & MCDB Faculty Advisor]

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

Scott A. Holley
Assoc Prof Mol Cell & Dev Biology
KBT 1034, 219 Prospect St, New Haven, CT 06511-2106
scott.holley@yale.edu
Phone: 203-432-3230
[Timothy Dwight College Fellow & MCDB Faculty Advisor]

Molecular, genetic and embryological analysis of segmentation in the zebrafish

Valerie Horsley
Maxine F Singer PhD Asst Prof Mol Cell & Dev Biology
KBT 226, 219 Prospect St, New Haven, CT 06511-2106
valerie.horsley@yale.edu
Phone: 203-436-9126
[Ezra Stiles College Fellow & MCDB Faculty Advisor]

Study of the cellular and molecular mechanisms that control stem cell activity and function within the skin epithelium

Vivian Irish
Prof Mol Cell & Dev Bio, Prof Ecology/Evolutionary Bio
OML 252a, 219 Prospect St, New Haven, CT 06511-2106
vivian.irish@yale.edu
Phone: 203-432-5572
[Davenport College Fellow & MCDB Faculty Advisor]

Developmental genetics of flowering in Arabidopsis; evolution of plant development

Farren Isaacs
Asst Prof Mol Cell & Dev Biology
BC # 209, 300 Heffernan Dr #B31, West Haven, CT 06516
farren.isaacs@yale.edu
Phone: 203-432-3783
[Jonathan Edwards College Fellow & MCDB Faculty Advisor]

Developing foundational cellular and biomolecular engineering technologies to understand and engineer biological systems

Akiko Iwasaki #
Prof Immunobiology and Mol Cell & Dev Biology and Mol Cell & Dev Biology
TAC S-655b, 300 Cedar St, New Haven, CT 06519-1612
akiko.iwasaki@yale.edu
Phone: 203-785-2919

Immune responses to herpes simplex viruses and influenza

Christine Jacobs-Wagner
Prof Mol Cell & Dev Biology; Investigator Howard Hughes Med Inst; Prof Microbial Pathogenesis; Dir Grad Studies Mol Cell & Dev Biology
KBT 1032, 219 Prospect St, New Haven, CT 06511-2106
christine.jacobs-wagner@yale.edu
Phone: 203-432-5170
[Saybrook College Fellow & MCDB Faculty Advisor]

Mechanisms underlying bacterial multiplication and physiology

Douglas R. Kankel
Prof & Dir Undergrad Studies Mol Cell & Dev Biology
KBT 1220, 219 Prospect St, New Haven, CT 06511-2106
douglas.kankel@yale.edu
Phone: 203-432-3839
[Silliman College Fellow & MCDB Faculty Advisor]

Nervous system development and function in Drosophila melanogaster

Paula Kavathas #
Prof Lab Med, Genetics, Immunobiology and Mol Cell & Dev Biology; Assoc Chair Research; Dir, Sci Educ Outreach Prog
TAC S-641a, 300 Cedar Street, New Haven, CT 06519
paula.kavathas@yale.edu
Phone: 203-785-6223

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
Prof Mol Cell & Dev Biology
KBT 640a, 219 Prospect St, New Haven, CT 06511-2106
haig.keshishian@yale.edu
Phone: 203-432-3478
[Morse college Fellow & MCDB Faculty Advisor]

Factors governing the formation of synaptic connections during development

Mary S. Klein
Lect Mol Cell & Dev Biology
OML 103a, 219 Prospect St, New Haven, CT 06511-2106
mary.klein@yale.edu
Phone: 203-432-9861
[MCDB Faculty Advisor]

Topics in Reproduction

Kathryn Miller-Jensen #
Asst Prof Bio Eng & Mol Cell Dev Biology
MEC 311, 55 Prospect Street, New Haven, CT 06511
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Phone: (203) 432-4265
[Calhoun College Fellow]

We use quantitative systems biology approaches to study signaling in innate immunity and viral infection.

Mark S. Mooseker
Ross Granville Harrison Prof of Mol Cell & Dev Biology
KBT 352, 219 Prospect St, New Haven, CT 06511-2106
mark.mooseker@yale.edu
Phone: 203-432-3468
[Calhoun College Fellow & MCDB Faculty Advisor]

Functional characterization of the myosin family of actin filament based molecular motors

Maria Moreno
Lect Mol Cell & Dev Biology; Assoc Rsrch Scientist Mol Cell & Dev Biology
OML 452, 219 Prospect St, New Haven, CT 06511-2106
maria.moreno@yale.edu
Phone: 203-436-4161
[MCDB Faculty Advisor]

Cloning of the Yellow Stripe 1 gene and Tapetal Development and Function gene in Oryza sativa japonica

F. Kenneth Nelson
Lect Mol Cell & Dev Biology; Assoc Rsrch Scientist Mol Cell & Dev Biology
KBT 716, 219 Prospect St, New Haven, CT 06511-2106
kenneth.nelson@yale.edu
Phone: 203-432-5013
[Morse College Fellow & MCDB Faculty Advisor]

Human genome sequencing and transcription factor activity analysis

Timothy M. Nelson
Prof Mol Cell & Dev Biology & Dir Marsh Botanical Garden
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timothy.nelson@yale.edu
Phone: 203-432-3860
[Jonathan Edwards College Fellow & MCDB Faculty Advisor]

Cellular differentiation in leaf development; patterning of venation; C4 photosynthesis

Barry W. Piekos
Lect Mol Cell & Dev Biology; Assoc Rsrch Scientist Mol Cell & Dev Biology
OML 126, 219 Prospect St, New Haven, CT 06511-2106
barry.piekos@yale.edu
Phone: 203-432-3845

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
Dean Grad Sch, Sterling Prof MCDB, Prof MBB; Dean Grad Sch, Sterling Prof MCDB, Prof MMBB
KBT 548, 219 Prospect St, New Haven, CT 06511-2106
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Phone: 203-432-3565
[Morse College Fellow & MCDB Faculty Advisor]

Molecular mechanisms of actin-based cellular movements

Anna Pyle
William Edward Gilbert Prof of Mol Cell & Dev Biology; Investigator Howard Hughes Med Inst; Prof Chemistry
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[MCDB Faculty Advisor]

Structure and function of catalytic RNA, RNA helicase mechanisms and the computational analysis of RNA structure

Matthew Rodeheffer #
Asst Prof Comparative Med and Mol Cell & Dev Biology
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Phone: 203-737-3370

Obesity, which is defined as an excessive increase in white adipose tissue (fat) mass, is the leading public health concern of modern society. Despite the importance of fat in human disease our understanding of the regulation of fat mass is extremely limited. The research in my laboratory is directed toward elucidating the cellular and molecular mechanisms that regulate fat mass and contribute to the development of obesity and obesity associated pathologies, such as diabetes and heart disease.

Joel L. Rosenbaum
Prof Mol Cell & Dev Biology
KBT 310a, 219 Prospect St, New Haven, CT 06511-2106
joel.rosenbaum@yale.edu
Phone: 203-432-3472
[Silliman College Fellow & MCDB Faculty Advisor]

Cell organelle assembly; IFT and flagellar assembly, sensory function of cilia/flagella and the roll of cilia in disease (ciliopathies. Most of the current interest in cilia stems from our original research on IFT as defined in Chlamydomonas.

Alanna Schepartz #
Milton Harris PhD Prof Chemistry, Prof Mol Cell & Dev Biology
CRB 310, 225 Prospect St, New Haven, CT 06511-8499
alanna.schepartz@yale.edu
Phone: 203-432-5094

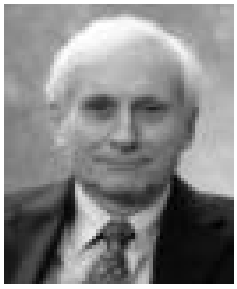
The Schepartz laboratory develops chemical tools to study and manipulate protein–protein and protein–DNA interactions inside the cell

Frank Slack
Prof Mol Cell & Dev Biology
KBT 936, 219 Prospect St, New Haven, CT 06511-2106
frank.slack@yale.edu
Phone: 203-432-3492
[Morse College Fellow & MCDB Faculty Advisor]

The role of microRNAs in development, aging and cancer

Joseph S. Wolenski
Rsrch Scientist & Lecturer Mol Cell & Dev Biology, Assoc Dir Summer Programs
KBT 330, 219 Prospect St, New Haven, CT 06511-2106
joseph.wolenski@yale.edu
Phone: 203-432-6912
[Berkeley College Fellow & MCDB Faculty Advisor]

Molecular analysis of myosin mechanochemistry



Robert J. Wyman
Prof Mol Cell & Dev Biology
KBT 610a, 219 Prospect St, New Haven, CT 06511-2106
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Phone: 203-432-3475
[Calhoun College Fellow & MCDB Faculty Advisor]

Molecular biology and neurophysiology of gap junctions; genetic control of neural circuit development

Weimin Zhong
Assoc Prof Mol Cell & Dev Biology
KBT 616b, 219 Prospect St, New Haven, CT 06511-2106
weimin.zhong@yale.edu
Phone: 203-432-9233
[Davenport College Fellow & MCDB Faculty Advisor]

Regulation of neural stem cells and development of the mammalian neocortex

Appendix II

Worksheets for MCDB (Standard, Biotechnology & Neurobiology)

MCDB MAJOR

(Standard Worksheet)

Degree Sought: BA or BS

Student Name: _____

MCDB Faculty Advisor: _____

Research Lab Mentor: _____

Prerequisites:

	Placement Exam Results
BIOL 101a Introduction to Biochemistry	
BIOL 102a Principles of Cell Biology & Membrane Physiology	
BIOL 103b Basic Genetics and Developmental Biology	
BIOL 104b Principles of Ecology & Evolutionary Biology	

	Course #	Semester	Grade	Place Out
2 terms of General Chemistry *(112a, 113b or 114a, 115b)*				
(or 1 term of General Chem 118a)				
2 terms of General Chemistry Labs				
(If 118a is taken 1 term is required)				
1 term of Organic Chemistry *(124a or 220a or 225b)*				
1 term of Organic Chemistry Lab *(126L or 222L)*				
(or 124,125 with 126L,127L satisfies both chem reqs)				
2 terms of Physics *(17 0a, 1 71b o r higher)*				
1 term of Math 115 or higher *(not including Math 190)*				

Core courses: One Course to be taken from each of the 3 following categories

		Course #	Semester	Grade
A.	MCDB 200b ***OR*** MCDB 202a			
B.	MCDB 205 b ***OR*** MCDB 210a			
C.	MCDB 300b ***OR*** MB&B 300a			

General Electives:

Any 3 full-credit courses taken from courses numbered MCDB 200 or above.

Usually does not apply to labs, but some exceptions can be made.

Does NOT apply to independent research coures

Course #	Semester	Grade

Special Elective:

Any 1 full-credit course taken from **MCDB 350 or above.**

Course #	Semester	Grade

Laboratories: *(Choose 2 labs from MCDB)*

Lab #	Semester	Grade

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

MCDB 470a or b (Tutorial); MCDB 475a or b (Research) or Senior Essay

Course #	Semester	Grade

B.S. degree only: *(Choose either 2 terms of MCDB 475a or b or MCDB 485/486)*

MCDB 475a or b *(Research)*

MCDB 475a or b (Research)

MCDB 485a/486b (Research in Biology)

Course #	Semester	Grade

B.S. Intensive major only:

MCDB 495a, 496b (Intensive Research)

Additional Elective from MCDB 350 or above

Course #	Semester	Grade

MCDB - BIOTECHNOLOGY TRACK

Degree Sought: BA or BS

Student Name: _____

MCDB Faculty Advisor: _____ Research Lab Mentor: _____

Prerequisites:	Placement Exam Results	*Course #*	*Semester*	*Grade*	*Place Out*
BIOL 101a Introduction to Biochemistry					
BIOL 102a Principles of Cell Biology & Membrane Physiology					
BIOL 103b Basic Genetics and Developmental Biology					
BIOL 104b Principles of Ecology & Evolutionary Biology					
2 terms of General Chemistry *(112a, 113b or 114a, 115b)*					
(or 1 term of General Chem 118a)					
2 terms of General Chemistry Labs					
(If 118a is taken 1 term is required)					
1 term of Organic Chemistry *(124a or 220a or 225b)*					
1 term of Organic Chemistry Lab *(126L or 222L)*					
(or 124,125 with 126L,127L satisfies both chem reqs)					
2 terms of Physics *(17 0a, 1 71b o r higher)*					
1 term of Math 115 or higher *(not including Math 190)*					

Required Core Courses	*Course #*	*Semester*	*Grade*
A. MCDB 200b ***OR*** MCDB 202a			
B. MCDB 205b ***OR*** MCDB 210a			
C. MCDB 300b ***OR*** MB&B 300a			
D. MCDB 370b Biotechnology			

General Electives: (Choose 2)		*Course #*	*Semester*	*Grade*
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			
MBB 420a	Macromolecular Structure			
MBB 421b	Macromolecular dynamics			
MBB 443b	Eukaryotic Molecular Biology			

Special Elective:	*Course #*	*Semester*	*Grade*
Any 1 full-credit course taken from **MCDB 350 or above.**			

Laboratories: *(Choose 2 labs from MCDB) MCDB 121L or 221L can be used to fulfill one lab credit*	*Lab #*	*Semester*	*Grade*
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)*	*Course #*	*Semester*	*Grade*
MCDB 470a or b (Tutorial in MCDB); MCDB 475a or b (Research) or Senior Essay			

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

B.S. Intensive major only:	*Course #*	*Semester*	*Grade*
MCDB 495a, 496b (Intensive Research in MCDB)			
Additional Elective from MCDB 350 or above			

MCDB - NEUROBIOLOGY TRACK

Degree Sought: BA or BS

Student Name: _____

MCDB Faculty Advisor: _____ Research Lab Mentor: _____

Prerequisites:	Placement Exam Results	Course #	Semester	Grade	Place Out
BIOL 101a Introduction to Biochemistry					
BIOL 102a Principles of Cell Biology & Membrane Physiology					
BIOL 103b Basic Genetics and Developmental Biology					
BIOL 104b Principles of Ecology & Evolutionary Biology					
2 terms of General Chemistry *(112a, 113b or 114a, 115b)* *(or 1 term of General Chem 118a)*					
2 terms of General Chemistry Labs *(If 118a is taken 1 term is required)*					
1 term of Organic Chemistry *(124a or 220a or 225b)*					
1 term of Organic Chemistry Lab *(126L or 222L)* *(or 124,125 with 126L,127L satisfies both chem reqs)*					
2 terms of Physics *(17 0a, 1 71b o r higher)*					
1 term of Math 115 or higher *(not including Math 190)*					

Required Core Courses	Course #	Semester	Grade
A. MCDB 200b ***OR*** MCDB 202a			
B. MCDB 205b ***OR*** MCDB 210a			
C. MCDB 300b ***OR*** MB&B 300a			
D. MCDB 320a Neurobiology			

General Electives: (Choose 2)	Course #	Semester	Grade
BENG 410a Basis of Bioimaging and Biosensing			
CPSC 475b Computational Vision & Biol. Perception			
MCDB 205b or 210a (whichever is not chosen above)			
MCDB 240b Biololgy of Reproduction			
MCDB 310a Physiological Systems			
MCDB 315b Biological Mech. Of Reaction to Injury			
MCDB 415b Cellular & Molecular Physiology			
MCDB 425a Basic Concepts of Genetic Analysis			
MCDB 430a Biology of the Immune System			
MCDB 440b Brain Development & Plasticity			
PSYC 200 Statistics (not if STAT 101-9 is taken)			
PSYC 270a Research Methods in Behavorial Neuroscience			
PSYC 320a Cognitive Neuroscience			
PSYC 376a Basics of Learning and Memory			

Special Elective:	Course #	Semester	Grade
Any 1 full-credit course taken from **MCDB 350 or above.**			

Laboratories: *(Choose 2 labs from MCDB)*	Lab #	Semester	Grade

B.A. degree only: *(Choose one; must be taken in senior year)*	Course #	Semester	Grade
MCDB 470a or b (Tutorial in MCDB); MCDB 475a or b (Research) or Senior Essay			

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

B.S. Intensive major only:	Course #	Semester	Grade
MCDB 495a, 496b (Intensive Research in MCDB)			
Additional Elective from MCDB 350 or above			

Appendix III

Forms and Guidelines

for Independent Research Courses:

MCDB 470a or b
MCDB 475a or b
MCDB 485/486
MCDB 495/496
MCDB 585b
MCDB 595a and b
Senior Essay

Instructor in charge: Douglas Kankel Office: 1220B KBT (2-3839)

MCDB 470a (Tutorial in MCDB)

Date _____

Student's Name _____ Class _____

Email _____ Phone _____

Title for Research _____

_____

Tutorial Mentor's Name _____ Phone _____

Tutorial Mentor's Email _____

Senior Requirement: YES or NO Number of papers submitting: 1 or 2

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 **and a written plan of study and bibliography**, approved by the tutorial mentor, and submit them to the Office of the Director of Undergraduate Studies or upload them to the Classes server by **September 6, 2013 (Fall) or January 20, 2014 (Spring)**. The final paper is due in the hands of the tutorial mentor with a copy to the course instructor in charge by the last day of classes, **December 6, 2013 (Fall) or April 25, 2014 (Spring)**. Electronic submission is acceptable and preferred to the office of the director of undergraduate studies: 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.)

Student Signature: _____

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 DUS Office based on exam(s) or term paper. This should be reported no later than the end of reading period, **December 11, 2013 (Fall) or April 30, 2014 (Spring).** Notification by email is acceptable and preferred to the office of the director of undergraduate studies: crystal.adamchek@yale.edu.

Tutorial Mentor's Signature _____

Please attach this form to your proposal and return to the DUS Office (1220B KBT)
crystal.adamchek@yale.edu

Guidelines for MCDB 470 (Tutorial in MCDB)

The following are some guidelines in addition to the requirements listed in the MCDB 470 form:

1. MCDB 470 is **a single-term** tutorial course. A student may take more than one term of MCDB 470, but each term is a separate course and only one term will count towards the major. The student must submit the required Tutorial Form and term papers each term, even if he/she takes multiple terms of MCDB 470 with the same tutorial mentor.

2. MCDB 470 is a tutorial course on a chosen subject not offered in our regular course offerings. This course deals with published literature and does not include original laboratory research.

3. An MCDB 470 student is expected to spend a minimum of **10 hours weekly** on this course. We do **not** approve double credit for students taking this course.

4. A student must be sponsored by a **Yale faculty member** who teaches undergraduates regularly and who is willing to meet with the student on a weekly basis. No postdoc or research associate can sponsor an MCDB 470 student.

5. Students are strongly advised to contact the tutorial mentor early (in the preceding semester) to arrange a subject and develop a proposal. The proposal should include: Introduction and the subject, why it was chosen, tentative schedule of weekly meetings, term papers to be developed, and 3 to 5 references cited. The tutorial form and the proposal (plan) are due to the office of Director of Undergraduate Studies or uploaded to the Classes server **no later than one week after the semester begins *(September 6, 2013 – Fall, or January 20, 2014 – Spring)***.

6. An extensive written report is due in the hands of the tutorial mentor, along with a copy to the instructor in charge, by **the last day of classes *(December 6, 2013-Fall, or April 25, 2014-Spring).*** This report is on the order of 10 or more pages (single spaced), and should include: Abstract, Introduction to the project, Methods, Results, Discussion, and References. Or, you may choose to write two reports of 5 pages or more single spaced, one by the midterm and one by the end of semester. You need to clearly state in your student contract whether you plan to submit one or two term papers. Your grade can not be given without your report.

7. Only MCDB 470 taken during the senior year can be used for senior requirement.

MCDB 475 – Research

MCDB 475 Student Contract

As a student conducting independent research for Yale College course credit and if relevant, the Senior requirement, I agree to the following:

I am expected to devote, on average, 10-12 hr/week to this research. I am aware that failure to do so will result in my withdrawal from the course.

I will make every effort to attend my research mentor's laboratory meetings.

(For seniors taking this course for the senior requirement) I will attend at least three of the MCDB 475-595 student research seminars. I understand that failure to do so will result in a half letter grade reduction.

I will make every effort to schedule my final oral presentation at the time that fits with my mentor's schedule.

Name: _____ (Please Print)

Signature: _____ Phone: _____Class _____

MCDB Senior requirement: Yes No

Email Address: _____

Research Mentor: _____Dept.: _____(Please Print)

Title for Research: _____

_____

Please return this form to the Office of the Director of Undergraduate Studies: 1220B KBT, crystal.adamchek@yale.edu.

Due dates: Student Contract, Mentor Contract, Summary: September 6, 2013
Oral Presentations meet at 6pm in KBT 1214 on:
Fall-November 18, 19 20, December 2, 3 *(starts at 6:30)*, 4
Spring – March 31, April 1 *(starts at 6:30)*, 2, 7, 8, 9
Poster: April 18th 2-4 pm (Location TBD)
Final Report: Fall-December 6, 2013, and Spring-April 25, 2014

MCDB 475 – Research

MCDB 475 Research Mentor Contract:

One of the provisions for agreeing to accept a student into your laboratory for course credit in MCDB 475 is that you agree to the following:

I will expect that each 475 student in my laboratory commit an average of 10-12 hours of effort per week. If this is not the case, by mid semester of the term I will notify the student and the MCDB 475 coordinators that an increase in effort is expected. I am aware that failure to meet this expectation will result in the student's withdrawal from the course.

I expect 475 students in my laboratory to attend our laboratory meetings and present their research at the end of the term.

If my student is using 475 to fulfill the senior requirement, I will attend my student's oral presentation. If I am unable to attend, I will ask another member of my laboratory to attend.

Student: _____ (Please Print)

Research Mentor: _____ (Please Print)

Signature of Research Mentor: _____

Department: _____ Phone: _____

Email Address: _____

Please return this form to the Office of the Director of Undergraduate Studies: 1220B KBT, crystal.adamchek@yale.edu.

Due dates: Student Contract, Mentor Contract, Summary: September 6, 2013
Oral Presentations meet at 6pm in KBT 1214 on:
Fall-November 18, 19 20, December 2, 3 *(starts at 6:30)*, 4
Spring – March 31, April 1 *(starts at 6:30)*, 2, 7, 8, 9
Poster: April 18th 2-4 pm (Location TBD)
Final Report: Fall-December 6, 2013, and Spring-April 25, 2014

MCDB 475 – Research

To: Prospective MCDB 475a or b Students
From: Independent Research Courses Coordinators: Professors Scott Holley & Weimin Zhong

This is intended to give you an introduction and guidelines to the MCDB 475 (a and b) course

I. Course Overview

The main purpose of this course is to enable you to obtain hands on experience with basic research as part of your education at Yale. The course entails one semester of experimental work (the minimum time expectation is 10-12 hr/week) aimed at generating data using experimental strategies designed to test a specific hypothesis (or set of hypotheses). *For seniors taking this course for the Senior Requirement, you are expected to give an oral presentation of your results at one of the research seminar sessions held jointly with students in MCDB 485, 495 and 595.* The course also involves a final written paper in the format of a research article.

The types of proposal that are inappropriate include simply analyzing data gathered by someone else, for example entering previously obtained data into a computer and running a statistical analysis program. An unsuitable proposal at the other extreme would be gathering data for another person to analyze, for example taking medical histories or clinical measurements that will be passed on to someone else for study. Projects involving allelic screening of patient populations for SNPs associated with a given disease are also not acceptable unless there is substantive experimental design/content. ***If you are considering a project that may fall into one of the categories above, please discuss this with the instructor in charge prior to committing to that laboratory or project (there may be suitable alternative projects in the same lab).***

At the beginning of the course, a summary of your proposed research is due (guidelines below). As noted above, near the end of the term seniors will give an oral presentation detailing your project and results obtained. There is also a final report due on the ***last day of classes (Fall-12/6/13, Spring-4/25/14).*** The final grade will be based primarily on the recommendations from your research mentor on a) level and quality of effort in the laboratory, b) quality of the final research report and for seniors, quality of research presentation. The MCDB research coordinator retains final grade determination if the recommended grade is at variance with the overall quality/scope of the course participants.

All papers should be uploaded to the drop box in Classes V2 by the deadlines stated. Additionally, please follow these formatting instructions: include a title page with the following information: (a) Title of Research, (b) Student Name, (c) Course & Term (i.e., MCDB 475 Sp14), and (e) PI Name. Make sure to include a header on pages 2 through end with (a) Student Name, (b) Course & Term (i.e, MCDB 475 Sp13), and (c) Page Number. Save papers in pdf format using the following nomenclature: *StudentLastName_FirstName_MCDBCourse_Term&Year.pdf.*
Don't forget to send a copy to your PI!

We are particularly concerned that each student fulfills the minimum 10-12 hr/week research commitment; part of the Research Mentor's Contract is to verify that level of participation by mid-semester. If for any reason you are unable to fulfill your commitment to the course and laboratory, you will be asked to withdraw from the course. Note, if you are a senior planning on attending multiple interviews for medical school in the fall, we recommend taking the course in the spring unless you are able to make up for lost time nights and/or weekends.

II. Safety Requirements

Note that you will need to fulfill various safety and associated requirements to begin research, depending on your field of study.

If you will be working with radioisotopes in a laboratory you must have attended a radiation safety training seminar at Yale! You will not be able to start your experiments unless this requirement is fulfilled. In addition, you should discuss with your supervisor whether you should take a chemical safety course. For further information on both these topics call the University Safety Dept. at Tel. 5-3550.

If your proposed research involves animal use your professor **must** have an approval for this protocol from IACUC. Your professor must send a new form to IACUC to include you in the protocol once your project has been approved. Finally, if you have not already done so, you need to complete an IACUC course before research can begin.

III. Course Requirements:

As noted above a 1-2 page summary of your research (written in collaboration with your research mentor) is due at the beginning of the term (***one week after start of classes; Fall-9/6/13, Spring-1/20/14***). This should include ~ 0.5-1 page overview/background of the project (with a short bibliography) and a section describing in the general objectives, hypothesis to be tested and most importantly, the specific aims of your project. For guidance, ask your research mentor to see a Specific Aims section of one of her/his NIH or NSF grants. The signed student and research mentor contracts are also due at this time. At the end of the term a final report (guidelines below) is due on the ***last day of classes (Fall-12/6/13, Spring-4/25/14).*** Seniors will be scheduled for a research presentation ***and are also expected to attend a total of 3 sessions, including their own.*** **Fall semester sessions will begin at 6:00 pm in KBT 1214 on November 18, 19 and 20 and December 2, 3 *(start at 6:30)*, and 4. Spring semester presentations will continue at 6:00 pm in KBT 1214 on March 31, April 1 *(start at 6:30)*, 2, 7, 8, and 9.** Failure to attend three sessions will result in a half grade deduction. MCDB 475 Student presentations will be scheduled in later sessions to maximize time available for data collection. Non-seniors in 475 are encouraged to attend at least one session to familiarize yourself with the process.

IV. MCDB 475 Senior Oral Presentations

Oral Presentation sign-ups will begin October 1 (for Fall) and February 1 (for Spring). Sign-ups will be handled through the Classes V2 server. 485 Students will be notified via email (approximately 1 week before sign-ups begin) which semester they have been selected to give their oral presentation in. All students should try to find a mutually agreeable time with their Research Mentor for their oral presentation. We have tried to be as flexible as possible in making these arrangements. Students will be expected to adhere to the time schedule as noted on Classes V2 -- any "after-the-fact" switching will need to be done between students - HOWEVER - students are required to notify the office of the DUS (crystal.adamchek@yale.edu) of any changes. Each student must have a verified time slot for their presentation.

These presentations should be made using Powerpoint. We will have a digital projector available – however, you should plan on bringing your own laptop to plug into the system. Talks are 10 minutes followed by 2 minutes for discussion/questions. Time is strictly enforced.

Remember that scientific content takes precedence over flashy presentations. Individual slides should be relatively simple and not overloaded with text. Generally, one slide per minute is a good parameter to start with when you are organizing your presentation. Your talk should include introduction of the overall biological question that you addressed, the approach you took to tackle this question, the results and conclusions. Your objective will be to make your presentation clear and interesting to individuals who do not share your research background. Define technical terms and avoid acronyms. **Practice your talk**. Give your talk to the lab you are working in before you give it to us. As noted in the Research Mentor's contract, his/her attendance at the session at which you are presenting is expected; if she/he cannot attend, arrange for someone else from your lab to attend. This is a critical aspect of the course. Consequently, consult your research mentor at the beginning of each term to pick a date that fits with her/his schedule.

V. MCDB 475,485, 495, 595 Poster Session/Research Fest:

Students taking the course (Fall/Spring terms) to fulfill the senior requirement are expected to participate in the year-end poster session. Those of you taking the course in the Fall should prepare your poster early in the Spring term when your work is still "fresh" on your mind. The Poster Session/Undergraduate Research Fest will be held April 18th – location to be determined. The purpose of the festival is to share information and more specifically to highlight undergraduate research at Yale. Refreshments will be provided courtesy of the MCDB Dept. The poster session will be open to anyone wishing to attend, so please encourage friends, colleagues and other students to come. Your research mentor is strongly urged to attend.

Each student will prepare a poster.

Posters can be as large as 3' X 5', but may be smaller. We will have poster boards and easels available to put your poster on. Posters may be printed professionally **(please note that there is no funding available for this expense from MCDB),** or the student may print them on a color printer and assemble individual sheets onto the poster board at the poster session.

Posters should have a title, and the authors (including you, the grad students or postdocs you worked with and your research mentor) should be listed as well, usually in large letters at the top; indicate which research course you are in (MCDB 475). The poster should include three sections: Introduction, Results, and Conclusions. The Introduction explains the purpose of your project; the Results section contains figures and/or tables showing your data, with legends or commentary; the Conclusions summarizes what you learned. Feel free also to include what you would do next were you to continue working on the project.

If you continue in research, the first presentation you are likely to give at a scientific meeting is a poster, so this will be good practice. Here is the bottom line on posters. At a meeting there is never enough time to see all the posters in a session. Your poster is more likely to be examined if:

(1) it is in a good location

(2) you are standing next to it to explain what is going on

(3) **IT IS AS SIMPLE AS POSSIBLE!**

The fewer words and the LARGER THEY ARE WRITTEN make it easier for people to notice and examine your poster. If you write lots of stuff in small font people will not bother to look at it. The same goes for data. If you present a table with 50 columns and 50 samples no one will look at it. Simple figures with a two sentence bottom line for each is optimum. Get organized early and allow at least one day for planning and layout and another for putting it all together. Bring it to the session already assembled. Please keep in mind that content should take precedence over form. It is much more important that your poster be clear, informative, and thoughtful than that it looks highly professional. Aesthetic appeal is of course always nice, but the science is paramount. Finally, **discuss your presentation with your colleagues and research mentor well before the session** and if you have any further questions/concerns bring the preliminary poster to show the instructor in charge.

VI. MCDB 475 Final Report

The final report is due on the ***last day of classes (Fall-12/6/13, Spring-4/25/14)*** and should be turned in to your research mentor to be graded, with a copy to the Office of the Director of Undergraduate Studies. Well in advance of this deadline, you should meet with your research mentor to plan a general outline for your paper and engage them in continued discussions throughout the writing process. The research mentor should grade the final version of the report and return it to us with comments electronically along with a recommendation for an overall course grade. Your research mentor will be contacted directly with grading information near the end of the term.

The report should be written in a style similar to that of a paper in a typical research journal and should include the following sections:

- *Abstract:* This is a brief summary of the project and the results obtained.
- *Introduction:* What is the biological problem, why is it important, and what's known about it already?
- *Experimental Procedures* (Material and Methods).
- *Results:* Describe what you have done. Include bar graphs, sketches, diagrams, tables, photographs etc. -- whatever is needed to represent your data.
- *Discussion:* If your project was successful, describe the significance of the results. If your project did not work, describe what your think went wrong, and what your expectations were. Regardless of outcome, describe what you would try next if you were to continue the project.
- *References:* References to previous work discussed as well as methods used should be cited as in any other research paper.

The expected length of this report is approximately 12-15 double-spaced pages. Consult your research mentor on further questions that you might have. You should conform to any other specifics that your mentor might expect in your write-up.

MCDB 485 – Research in MCDB

MCDB 485 Student Contract:

As a student conducting year-long independent research for Yale College course credit and if relevant, the Senior requirement, I agree to the following:

I am expected to devote an average of 10-12 hr/week to this research. I am aware that failure to do so will result in my withdrawal from the course.

I will make every effort to attend my research mentor's laboratory meetings.

Senior Requirement Only: I will attend at least 3 of the MCDB Oral Presentation sessions each term. I understand that failure to do so will result in a half letter grade reduction.

I will make every effort to schedule my MCDB Oral Presentation at the time that fits with my mentor's schedule.

Name: _____ (Please Print)

Signature: _____ Phone: _____Class _____

Email Address: _____

Research Mentor: _____ Dept.: _____(Please Print)

Title for Research: _____

_____

Please return this form to the Office of the Director of Undergraduate Studies: 1220 KBT, crystal.adamchek@yale.edu.

Due dates: Student Contract, Mentor Contract, Summary: September 6, 2013
Oral Presentations meet at 6pm in KBT 1214 on:
Fall-November 18, 19 20, December 2, 3 *(starts at 6:30)*, 4
Spring – March 31, April 1 *(starts at 6:30)*, 2, 7, 8, 9
Poster: April 18th 2-4 pm (Location TBD)
Final Report: Fall-December 6, 2013, and Spring-April 25, 2014

MCDB 485 – Research in MCDB

MCDB 485 Research Mentor Contract:

One of the provisions for agreeing to accept a student into your laboratory for course credit in MCDB 485 is that you agree to the following:

I will expect that each 485 student in my laboratory commit an average of 10-12 hours of effort per week. If this is not the case, by mid semester of the term, I will notify the student and the MCDB 485 coordinators that an increase in effort is expected. I am aware that failure to meet this expectation will result in the student's withdrawal from the course.

I expect 485 students in my laboratory to attend our laboratory meetings and present their research at least once/term.

I will attend my student's MCDB Oral Presentation. If I am unable to attend, I will ask another member of my laboratory to attend.

Student: _____ (Please Print)

Research Mentor: _____ (Please Print)

Signature of Research Mentor: _____

Department: _____ Phone: _____

Email Address: _____

Please return this form to the Office of the Director of Undergraduate Studies: 1220 KBT, crystal.adamchek@yale.edu.

Due dates: Student Contract, Mentor Contract, Summary: September 6, 2013
Oral Presentations meet at 6pm in KBT 1214 on:
Fall-November 18, 19 20, December 2, 3 *(starts at 6:30)*, 4
Spring – March 31, April 1 *(starts at 6:30)*, 2, 7, 8, 9
Poster: April 18th 2-4 pm (Location TBD)
Final Report: Fall-December 6, 2013, and Spring-April 25, 2014

MCDB 485 – Research in MCDB

To: Prospective MCDB 485 students
From: Independent Research Courses Coordinators: Professors Scott Holley & Weimin Zhong

This is intended to give you an introduction and guidelines to the MCDB 485 course.

I. Course Overview

The main purpose of this course is to enable you to obtain hands on experience with basic research as part of your education at Yale. The course entails two semesters of experimental work (the minimum time expectation is 10-12 hr/week) aimed at generating data using experimental strategies designed to test a specific hypothesis (or set of hypotheses). For seniors taking this course for the Senior Requirement, you are expected to give one oral presentation of your results (either Fall or Spring) at one of the MCDB Oral Presentation sessions held jointly with senior students in MCDB 475, 495 and 595. The course also involves written reports at the end of each term.

The types of proposal that are inappropriate include simply analyzing data gathered by someone else, for example entering previously obtained data into a computer and running a statistical analysis program. An unsuitable proposal at the other extreme would be gathering data for another person to analyze, for example taking medical histories or clinical measurements that will be passed on to someone else for study. Projects involving allelic screening of patient populations for SNPs associated with a given disease are also not acceptable unless there is substantive experimental design/content. ***If you are considering a project that may fall into one of the categories above, please discuss this with the instructor in charge prior to committing to that laboratory or project (there may be suitable alternative projects in the same lab).***

At the beginning of the course, a summary of your proposed research is due (guidelines below). As noted above, seniors will give an MCDB Oral Presentation either in the ***Fall or Spring semester***. Those students selected to present in the Fall term will give a summary of the proposed research and any preliminary results obtained. Students presenting in the Spring term will presumably have more results to report but the main goal of these presentations, Fall or Spring is to provide a clear overview of the problem, your hypotheses, and experimental approaches. In the Fall term, a final report in the form of a grant proposal is due on the ***last day of classes (12/6/13).*** The final report for the Spring term should be in the format of a research paper (see below). This final report is also due on the ***last day of classes (4/25/14).*** The final grade will be based primarily on the recommendations from your lab mentor on a) level and quality of effort in the laboratory, b) quality of the final research reports and for seniors, quality of research presentation. The MCDB research coordinator retains final grade determination if the recommended grade is at variance with the overall quality/scope of the course participants. As noted below, a final grade deduction will be taken if a student fails to attend at least 3 MCDB Oral Presentations per term.

All papers should be uploaded to the drop box in Classes V2 by the deadlines stated. Additionally, please follow these formatting instructions: include a title page with the following information: (a) Title of Research, (b) Student Name, (c) Course & Term (i.e., MCDB 486 Sp14), and (e) PI Name. Make sure to include a header on pages 2 through end with (a) Student Name, (b) Course & Term (i.e, MCDB 486 Sp13), and (c) Page Number. Save papers in pdf format using the following nomenclature: *StudentLastName_FirstName_MCDBCourse_Term&Year.pdf.*
Don't forget to send a copy to your PI!

We are particularly concerned that each student fulfills the minimum 10-12 hr/week research commitment; part of the Mentor's Contract is to verify that level of participation by mid-semester. ***If for any reason you are unable to fulfill your commitment to the course and laboratory, you will be asked to withdraw from the course***. Note, if you are a senior planning on attending multiple interviews for medical school in the Fall, you are expected to make up for lost time by working nights and/or weekends.

II. Safety Requirements

Note that you will need to fulfill various safety and associated requirements to begin research, depending on your field of study.

If you will be working with radioisotopes in a laboratory you must have attended a radiation safety training seminar at Yale! You will not be able to start your experiments unless this requirement is fulfilled. In addition, you should discuss with your supervisor whether you should take a chemical safety course. For further information on both these topics call the University Safety Dept. at Tel. 5-3550.

If your proposed research involves animal use your professor **must** have an approval for this protocol from IACUC. Your professor must send a new form to IACUC to include you in the protocol once your project has been approved. Finally, if you have not already done so, you need to complete an IACUC course before research can begin.

III. The Fall Semester

As noted above, a 1-2 page summary of your research (written in collaboration with your research mentor) is due at the beginning of the term. This should include ~ 1 page overview/background of the project (documented with a short bibliography) and a section describing the general objectives, hypothesis to be tested and most importantly, the specific aims of your project. For guidance, ask your mentor to see a Specific Aims section of one of her/his NIH or NSF grants. This summary is due ***one week after start of classes (9/6/13)***. At the end of the term a short ~5 page (double spaced) grant proposal in the format of an NIH or NSF grant is due on the ***last day of classes (12/6/13)***. In addition, all seniors are expected to attend a minimum of 3 MCDB Oral Presentation sessions per term. **The sessions will begin at 6:00 pm in KBT 1214 on November 18, 19 and 20 and December 2, 3 *(start at 6:30)*, and 4.** This is an important component of the Senior Requirement. Failure to attend the 3 sessions will result in a loss of a half grade (e.g. a recommended A- will be lowered to a B+). Your mentor will be asked to recommend an interim grade of satisfactory (S) or unsatisfactory (U) at the end of the term based on your laboratory effort and research proposal. Students receiving an unsatisfactory grade will be asked to meet with the instructor in charge and your mentor to identify problems and outline strategies for improvement.

IV. The Spring Semester:

MCDB Oral Presentations will continue at 6:00 pm in KBT 1214 on March 31, April 1 *(start at 6:30)*, 2, 7, 8, and 9. These will be held jointly with students in MCDB 475, 495 and 595. Attendance at a minimum of three sessions is required (for a total of 6 sessions during the year). As noted above, failure to fulfill this requirement will result in a half grade deduction. There will be a poster session and a final paper (see below) is due on the ***last day of classes (4/25/14).***

V. MCDB 485 Senior MCDB Oral Presentations:

Oral Presentation sign-ups will begin October 1 (for Fall) and February 1 (for Spring). Sign-ups will be handled through the Classes V2 server. 485 Students will be notified via email (approximately 1 week before sign-ups begin) which semester they have been selected to give their oral presentation in. All students should try to find a mutually agreeable time with their Research Mentor for their oral presentation. We have tried to be as flexible as possible in making these arrangements. Students will be expected to adhere to the time schedule as noted on Classes V2 -- any "after-the-fact" switching will need to be done between students - HOWEVER - students are required to notify the office of the DUS (crystal.adamchek@yale.edu) of any changes. Each student must have a verified time slot for their presentation.

These presentations should be made using Powerpoint. We will have a digital projector available – however, you should plan on bringing your own laptop to plug into the system. Talks are 10 minutes followed by 2 minutes for discussion/questions. Time and presentation order will be strictly enforced.

Remember that scientific content takes precedence over flashy presentations. Individual slides should be relatively simple and not overloaded with text. Generally, one slide per minute is a good parameter to start with when you are organizing your presentation. Your talk should include an introduction of the overall biological question that you addressed, the approach you took to tackle this question, the results and conclusions. Your objective will be to make your presentation clear and interesting to individuals who do not share your research background. Define technical terms and avoid acronyms. **Practice your talk**. Give your talk to the lab you are working in before you give it to us. As noted in the Research Mentor's contract, his/her attendance at the session at which you are presenting is expected; if she/he cannot attend, arrange for someone else from your lab to attend. Mentor participation is a critical aspect of the course. Consequently, consult your research mentor at the beginning of the term in which you have been scheduled to present to pick a date that fits with her/his schedule.

VI. MCDB 475, 485, 495, 595 Poster Session/Research Fest:

The Poster Session/Undergraduate Research Fest will be held April 18th – location to be determined. The purpose of the festival is to share information and more specifically to highlight undergraduate research at Yale. Refreshments will be

provided courtesy of the MCDB Dept. The poster session will be open to anyone wishing to attend, so please encourage friends, colleagues and other students to come. Your research mentor is strongly urged to attend.

Each student will prepare a poster.

Posters can be as large as 3' X 5', but may be smaller. We will have poster boards and easels available to put your poster on. Posters may be printed professionally **(please note that there is no funding available for this expense from MCDB)**, or the student may print them on a color printer and assemble individual sheets onto the poster board at the poster session.

Posters should have a title, and the authors (including you and your research mentor) should be listed as well, usually in large letters at the top. Indicate which research course you are in (MCDB 485). The poster should include three sections: Introduction, Results, and Conclusions. The Introduction explains the purpose of your project; the Results section contains figures and/or tables showing your data, with legends or commentary; the Conclusion summarizes what you learned. Feel free also to include what you would do next were you to continue working on the project.

If you continue in research, the first presentation you are likely to give at a scientific meeting is a poster, so this will be good practice. Here is the bottom line on posters. At a meeting there is never enough time to see all the posters in a session. Your poster is more likely to be examined if you are standing next to it to explain what is going on, and **IT IS AS SIMPLE AS POSSIBLE!**

The fewer words and the LARGER THEY ARE WRITTEN make it easier for people to notice and examine your poster. If you write lots of stuff in small font people will not bother to look at it. The same goes for data. If you present a table with 50 columns and 50 samples no one will look at it. Simple figures with a two sentence bottom line for each is optimal. Get organized early and allow at least one day for planning and layout and another for putting it all together. Bring it to the session ready to assemble. Please keep in mind that content should take precedence over form. It is much more important that your poster be clear, informative, and thoughtful than that it looks highly professional. Aesthetic appeal is of course always nice, but the science is paramount. Finally, **discuss your presentation with your colleagues and research mentor well before the session** and if you have any further questions/concerns bring the preliminary poster to show the instructor in charge.

VII. MCDB 485 Final Report

The final report is due on the ***last day of classes (4/25/14)*** following the instructions above. Well in advance of this deadline, you should meet with your research mentor to plan a general outline for your paper and engage them in continued discussions throughout the writing process. The research mentor should grade the final version of the report and return it to us with comments electronically along with a recommendation for an overall course grade. Your research mentor will be contacted directly with a form for grading near the end of the term.

The report should be written in a style similar to that of a paper in a typical research journal and should include the following sections:

- *Abstract:* This is a brief summary of the project and the results obtained.
- *Introduction:* What is the biological problem, why is it important, and what's known about it already?
- *Experimental Procedures* (Material and Methods).
- *Results:* Describe what you have done. Include bar graphs, sketches, diagrams, tables, photographs etc. -- whatever is needed to represent your data.
- *Discussion:* If your project was successful, describe the significance of the results. If your project did not work, describe what your think went wrong, and what your expectations were. Regardless of outcome, describe what you would try next if you were to continue the project.
- *References:* References to previous work discussed as well as methods used should be cited as in any other research paper.

The expected length of this report is approximately 12-15 double-spaced pages. Consult your research mentor with any further questions that you might have. You should conform to any other specifics that your research mentor might expect in your write-up.

MCDB 495 – Intensive Research in MCDB

MCDB 495 Student Contract:

As a student conducting year-long independent research for Yale College course credit and the Senior requirement, I agree to the following:

I am expected to devote an average of 20 hr/week to this research. I am aware that failure to do so will result in converting my 495 enrollment to either MCDB 485 or 475 (single course credit), with the requisite requirements for those courses replacing those of 495. (For MCDB 595 students: I understand that this would result in withdrawal from the masters program as well.)

I will make every effort to attend my research mentor's laboratory meetings.

I will attend at least three of the student MCDB Oral Presentation sessions each term. I understand that failure to do so will result in a half letter grade reduction.

I will make every effort to schedule my oral presentation at the time that fits with my mentor's schedule.

Name: _____ (Please Print)

Signature: _____ Phone: _____Class _____

Email Address: _____

Research Mentor: _____ Dept.: _____(Please Print)

Title for Research: _____

_____

_____

Please return this form to the Office of the Director of Undergraduate Studies: 1220 KBT, crystal.adamchek@yale.edu.

Due dates: Student Contract, Mentor Contract, Summary: September 6, 2013
Oral Presentations meet at 6pm in KBT 1214 on:
Fall-November 18, 19 20, December 2, 3 *(starts at 6:30)*, 4
Spring – March 31, April 1 *(starts at 6:30)*, 2, 7, 8, 9
Poster: April 18th 2-4 pm (Location TBD)
Final Report: Fall-December 6, 2013, and Spring-April 25, 2014

MCDB 495 – Intensive Research in MCDB

MCDB 495 Research Mentor Contract:

One of the provisions for agreeing to accept a student into your laboratory for course credit in MCDB 495 is that you agree to the following:

I will expect that each 495 student in my laboratory commit an average of at least 20 hours effort per week. If this is not the case, by mid semester of the term I will notify the student and the MCDB 495 coordinators that an increase in effort is expected. I am aware that failure to meet this expectation will result in conversion of MCDB 495 into either MCDB 485 or 475 (reduction to 1 course unit/term).

I expect 495 students in my laboratory to attend our laboratory meetings and present their research at least once/term.

I will attend my student's MCDB Oral Presentations both Fall and Spring terms. If I am unable to attend, I will ask another member of my laboratory to attend.

Student: _____ (Please Print)

Research Mentor: _____ (Please Print)

Signature of Research Mentor: _____

Department: _____ Phone: _____

Email Address: _____

Please return this form to the Office of the Director of Undergraduate Studies: 1220 KBT, crystal.adamchek@yale.edu.

Due dates: Student Contract, Mentor Contract, Summary: September 6, 2013
Oral Presentations meet at 6pm in KBT 1214 on:
Fall-November 18, 19 20, December 2, 3 *(starts at 6:30)*, 4
Spring – March 31, April 1 *(starts at 6:30)*, 2, 7, 8, 9
Poster: April 18th 2-4 pm (Location TBD)
Final Report: Fall-December 6, 2013, and Spring-April 25, 2014

MCDB 495 – Intensive Research in MCDB

To: Prospective MCDB 495 students
From: Independent Research Courses Coordinators: Professors Scott Holley & Weimin Zhong

This is intended to give you an introduction and guidelines to the MCDB 495 course.

I. Course Overview

The main purpose of this course is to enable you to obtain hands on experience with basic research as part of your education at Yale. The course entails two semesters of experimental work (the minimum time expectation is 20 hr/week) aimed at generating data using experimental strategies designed to test a specific hypothesis (or set of hypotheses). Students are expected to give a total of two MCDB Oral Presentations of your proposed studies (Fall) and results obtained (Spring) at one of the MCDB Oral Presentations held jointly with senior students in MCDB 475, and 485. The course also involves written reports at the end of each term.

The types of proposal that are inappropriate include simply analyzing data gathered by someone else, for example entering previously obtained data into a computer and running a statistical analysis program. An unsuitable proposal at the other extreme would be gathering data for another person to analyze, for example taking medical histories or clinical measurements that will be passed on to someone else for study. Projects involving allelic screening of patient populations for SNPs associated with a given disease are also not acceptable unless there is substantive experimental design/content. ***If you are considering a project that may fall into one of the categories above, please discuss this with the instructor in charge prior to committing to that laboratory or project (there may be suitable alternative projects in the same lab).***

At the beginning of the course, a summary of your proposed research is due (guidelines below). As noted above, seniors will give an oral presentation in ***both the Fall and Spring*** semester. In the Fall term, a final report in the form of a grant proposal is due on the ***last day of classes (12/6/13).*** The final report for the Spring term should be in the format of a research paper (see below). The final report is also due on the ***last day of classes (4/25/14).*** The final grade will be based primarily on the recommendations from your research mentor on a) level and quality of effort in the laboratory, b) quality of the final research reports and, (for seniors) quality of MCDB Oral Presentations. The MCDB research coordinator retains final grade determination if the recommended grade is at variance with the overall quality/scope of the course participants.

All papers should be uploaded to the drop box in Classes V2 by the deadlines stated. Additionally, please follow these formatting instructions: include a title page with the following information: (a) Title of Research, (b) Student Name, (c) Course & Term (i.e., MCDB 495 Sp13), and (e) PI Name. Make sure to include a header on pages 2 through end with (a) Student Name, (b) Course & Term (i.e, MCDB 495 Sp13), and (c) Page Number. Save papers in pdf format using the following nomenclature: *StudentLastName_FirstName_MCDBCourse_Term&Year.pdf.*

Don't forget to send a copy to your PI!

We are particularly concerned that each student fulfills the minimum 20 hr/week research commitment; part of the Research Mentor's Contract is to verify that level of participation by mid-semester of each term. ***If for any reason you are unable to fulfill your commitment to the course and laboratory, your course affiliation and credit will be converted to 485 (or 475 if you decide not to continue in the Spring term).*** If you fail to meet the course commitment for 475/85 (10-12 hr./week), you will be asked to withdraw from the course. Note, if you are planning on attending multiple interviews for medical school in the Fall, you are expected to make up for lost time by working nights and/or weekends.

II. Safety Requirements

Note that you will need to fulfill various safety and associated requirements to begin research, depending on your field of study.

If you will be working with radioisotopes in a laboratory you must have attended a radiation safety training seminar at Yale! You will not be able to start your experiments unless this requirement is fulfilled. In addition, you should discuss

with your research mentor whether you should take a chemical safety course. For further information on both these topics call the University Safety Dept. at Tel. 5-3550.

If your proposed research involves animal use your professor **must** have an approval for this protocol from IACUC. Your professor must send a new form to IACUC to include you in the protocol once your project has been approved. Finally, if you have not already done so, you need to complete an IACUC course before research can begin.

III. The Fall Semester

As noted above, a 1-2 page summary of your research (written in collaboration with your research mentor) is due at the **beginning of the term (*one week after start of classes; 9/6/13*).** This should include ~ 1 page overview/background of the project (documented with a short bibliography) and a section describing in the general objectives, hypothesis to be tested and most importantly, the specific aims of your project. For guidance, ask your research mentor to see a Specific Aims section of one of her/his NIH or NSF grants. This summary is due one week after the start of classes. At the end of the term a short 5-10 page (double spaced) grant proposal in the format of an NIH or NSF grant is due on the ***last day of classes (12/6/13)***. In addition, all seniors are expected to attend a minimum of 3 MCDB Oral Presentations (including your own). **The sessions will begin at 6:00 pm in KBT 1214 on November 18, 19 and 20 and December 2, 3 *(start at 6:30)*, and 4.** This is an important component of the Senior Requirement. Failure to attend the 3 sessions each semester (6 total for the year) will result in a loss of a half grade (e.g. a recommended A- will be lowered to a B+). Your research mentor will be asked to recommend an interim grade of satisfactory (S) or unsatisfactory (U) at the end of the term based on your laboratory effort and research proposal. Students receiving an unsatisfactory grade will be asked to meet with the instructor in charge and your research mentor to identify problems and outline strategies for improvement.

IV. The Spring semester:

MCDB Oral Presentations will continue at 6:00 pm in KBT 1214 on March 31, April 1 *(start at 6:30)*, 2, 7, 8, and 9. These will be held jointly with students in MCDB 475, 485 and 595. Attendance at a minimum of three sessions is required (for a total of 6 sessions during the year). As noted above, failure to fulfill this requirement will result in a half grade deduction. There will be a poster session and a final paper (see below) is due on the ***last day of classes (4/25/14).***

V. MCDB 495 MCDB Oral Presentations

Oral Presentation sign-ups will begin October 1 (for Fall) and February 1 (for Spring). Sign-ups will be handled through the Classes V2 server. 485 Students will be notified via email (approximately 1 week before sign-ups begin) which semester they have been selected to give their oral presentation in. All students should try to find a mutually agreeable time with their Research Mentor for their oral presentation. We have tried to be as flexible as possible in making these arrangements. Students will be expected to adhere to the time schedule as noted on Classes V2 -- any "after-the-fact" switching will need to be done between students - HOWEVER - students are required to notify the office of the DUS (crystal.adamchek@yale.edu) of any changes. Each student must have a verified time slot for their presentation.

These presentations should be made using Powerpoint. We will have a digital projector available – however, you should plan on bringing your own laptop to plug into the system. Talks are 10 minutes followed by 2 minutes for discussion/questions. Time and presentation order will be strictly enforced.

Remember that scientific content takes precedence over flashy presentations. Individual slides should be relatively simple and not overloaded with text. Generally, one slide per minute is a good parameter to start with when you are organizing your presentation. Your talk should include introduction of the overall biological question that you addressed, the approach you took to tackle this question, the results and conclusions. Your objective will be to make your presentation clear and interesting to individuals who do not share your research background. Define technical terms and avoid acronyms. **Practice your talk**. Give your talk to the lab you are working in before you give it to us. As noted in the Research Mentor's contract, his/her attendance at the session at which you are presenting is expected; if she/he cannot attend, arrange for someone else from your lab to attend. Mentor participation is a critical aspect of the course. Consequently, consult your research mentor at the beginning of the term to pick a date that fits with her/his schedule.

VI. MCDB 475, 485, 495, 595 Poster Session/Research Fest:

The Poster Session/Undergraduate Research Fest will be held April 18th – location to be determined. The purpose of the festival is to share information and more specifically to highlight undergraduate research at Yale. Refreshments will be

provided courtesy of the MCDB Dept. The poster session will be open to anyone wishing to attend, so please encourage friends, colleagues and other students to come. Your research mentor is strongly urged to attend.

Each student will prepare a poster.

Posters can be as large as 3' X 5', but may be smaller. We will have poster boards and easels available to put your poster on. Posters may be printed professionally **(please note that there is no funding available for this expense from MCDB)**, or the student may print them on a color printer and assemble individual sheets onto the poster board at the poster session.

Posters should have a title, and the authors (including you and your research mentor) should be listed as well, usually in large letters at the top. Indicate which research course you are in (MCDB 495). The poster should include three sections: Introduction, Results, and Conclusion. The Introduction explains the purpose of your project; the Results section contains figures and/or tables showing your data, with legends or commentary; the Conclusion summarizes what you learned. Feel free also to include what you would do next were you to continue working on the project.

If you continue in research, the first presentation you are likely to give at a scientific meeting is a poster, so this will be good practice. Here is the bottom line on posters. At a meeting there is never enough time to see all the posters in a session. Your poster is more likely to be examined if you are standing next to it to explain what is going on, and **IT IS AS SIMPLE AS POSSIBLE!**

The fewer words and the LARGER THEY ARE WRITTEN make it easier for people to notice and examine your poster. If you write lots of stuff in small font people will not bother to look at it. The same goes for data. If you present a table with 50 columns and 50 samples no one will look at it. Simple figures with a two sentence bottom line for each is optimal. Get organized early and allow at least one day for planning and layout and another for putting it all together. Bring it to the session already assembled. Please keep in mind that content should take precedence over form. It is much more important that your poster be clear, informative, and thoughtful than that it looks highly professional. Aesthetic appeal is of course always nice, but the science is paramount. Finally, **discuss your presentation with your colleagues and research mentor well before the session** and if you have any further questions/concerns bring the preliminary poster to the instructor in charge.

VII. MCDB 495 Final Report

The final report is due on the ***last day of classes (4/25/14)*** following the instructions above. Well in advance of this deadline, you should meet with your research mentor to plan a general outline for your paper and engage them in continued discussions throughout the writing process. The research mentor should grade the final version of the report and return it to us with comments electronically along with a recommendation for an overall course grade. Your research mentor will be contacted directly with a form for grading near the end of the term.

The report should be written in a style similar to that of a paper in a typical research journal and should include the following sections:

- *Abstract:* This is a brief summary of the project and the results obtained.
- *Introduction:* What is the biological problem, why is it important, and what's known about it already?
- *Experimental Procedures:* (Material and Methods).
- *Results:* Describe what you have done. Include bar graphs, sketches, diagrams, tables, photographs etc. -- whatever is needed to represent your data.
- *Discussion:* If your project was successful, describe the significance of the results. If your project did not work, describe what you think went wrong, and what your expectations were. Regardless of outcome, describe what you would try next if you were to continue the project.
- *References:* References to previous work discussed as well as methods used should be cited as in any other research paper.

The expected length of this report is approximately 15-20 double-spaced pages. Consult your research mentor on further questions that you might have. You should conform to any other specifics that your research mentor might expect in your write-up.

MCDB 585 Student Contract

As a student conducting independent research for Yale College course credit and the BS/MS Senior requirement, I agree to the following:

- I am expected to devote an average of 20 hr/week to this research. I am aware that failure to do so will result in withdrawal from the masters program.
- I will make every effort to attend my research mentor's laboratory meetings.
- I will attend at least three of the student MCDB Oral Presentation. I understand that failure to do so will result in a half letter grade reduction.

Name: _____ (Please Print)

Signature: _____ Phone: _____

Email Address: _____

Research Mentor: _____Dept.: _____(Please Print)

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Title for Research: _____

_____

_____

Please return this form to the Office of the Director of Undergraduate Studies: 1220 KBT, crystal.adamchek@yale.edu.

Due dates: Student Form (Contract) due January 20, 2014
Poster Session: April 18th 2-4pm (Location TBD) [Optional for MCDB 585 students]
Proposal with Research Plan to Committee & Office of DUS:
(before February 3, 2014)
MCDB Oral Presentations sessions meeting at 6pm in KBT 1214 on March 31, April 1 *(starts at 6:30)*, 2, 7, 8, and 9.
Presentation of Prospectus to Committee (schedule before April 25, 2014)
Written Prospectus due to Committee and office of the DUS via email to (crystal.adamchek@yale.edu) approximately 1 week before presentation.

Guidelines for MCDB 585

Interested students should contact the instructor prior to their second semester junior year.

For 585 (Juniors-Spring Semester):

1) Research: Students choose a research mentor. It is expected that the same research mentor will be used for 585 and 595. Assistance in selection of a research mentor can be arranged through the student's regular academic advisor. Students are expected to devote 20 hrs/week to their research.

2) Committee: Students need to form an advisory committee comprised of three faculty members. One is the research mentor and at least two faculty members must come from the Department of MCDB. The members of the committee should be arranged in consultation with the student's research mentor. **The committee should meet once within the first two weeks of the semester to discuss and approve of the research project.** Students should set up individual meetings with each member of the committee and present your work mid-semester. *A Committee Meeting Form should be completed for all committee meetings and returned to the office of the DUS.

3) Proposal: Students should prepare a one page proposal stating the hypothesis and aims of your project and a short paragraph describing the approach. This proposal should be distributed to your committee and the office of the DUS a few days before this first committee meeting.

4) Written Prospectus: At the end of the course, students will prepare a written prospectus that will review their field, discuss their research accomplished and their research plan for 595. The paper should be approximately 8-10 pages single spaced, not including references.

5) Prospectus Presentation: Students will present their prospectus to their advisory committee before the end of the Spring semester. Students must notify the office of the DUS of the date of the scheduled presentation. The committee will question the student about their knowledge of both their field and research project. The committee will decide on a grade for the student.

6) Oral Presentations: 585 Students are also expected to attend 3 of the MCDB Oral Presentations sessions meeting at 6pm in KBT 1214 on March 31, April 1 *(starts at 6:30)*, 2, 7, 8, and 9. 585 students are not expected to give an oral presentation during these sessions.

7) Poster: Students are invited to attend the MCDB Poster Session on April 18, and may (but are not required to) present a poster.

MCDB 585 Committee Meeting Form – Spring

Student: _____ Date of Committee Meeting: _____

Thesis Advisor: _____Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Research: _____

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Proposal/Plan: _____

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Please return this form to the Office of the Director of Undergraduate Studies:
1220 KBT, crystal.adamchek@yale.edu.
Copies to be provided to all Committee Members and Student from DUS office

MCDB 595 Student Contract

As a student conducting year-long independent research for Yale College course credit and the BS/MS Senior requirement, I agree to the following:

- I am expected to devote an average of 20 hr/week to this research. I am aware that failure to do so will result in withdrawal from the masters program.
- I will make every effort to attend my research mentor's laboratory meetings.
- I will attend at least three of the student MCDB Oral Presentation sessions each term. I understand that failure to do so will result in a half letter grade reduction.
- I will make every effort to schedule my oral presentation at the time that fits with my mentor's schedule.

Name: _____(Please Print)

Signature: _____ Phone: _____Class _____

Email Address: _____

Research Mentor: _____Dept.: _____(Please Print)

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Title for Research: _____

_____

_____

Please return this form to the Office of the Director of Undergraduate Studies:
1220 KBT, crystal.adamchek@yale.edu.

Due dates: Committee Meetings: Fall and Spring
Oral Presentations meet at 6pm in KBT 1214 on:
Fall-November 18, 19 20, December 2, 3 *(starts at 6:30)*, 4
Spring – March 31, April 1 *(starts at 6:30)*, 2, 7, 8, 9
Poster: April 18th 2-4pm (Location TBD)
Thesis due to committee at least one week before Thesis defense
Thesis defense (schedule and defend before April 25, 2014)

Guidelines for MCDB 595

For 595:

1) Research: Students are expected to devote 20 hrs/week to their research.

2) Oral Presentations: Students should attend a total of 3 oral presentation sessions per semester, and make an oral presentation in each of the two academic terms; but does not require the 495 written reports which are less comprehensive than the thesis required for 595. Oral Presentation sign-ups will begin October 1 (for Fall) and February 1 (for Spring). Sign-ups will be handled through the Classes V2 server. 485 Students will be notified via email (approximately 1 week before sign-ups begin) which semester they have been selected to give their oral presentation in. All students should try to find a mutually agreeable time with their Research Mentor for their oral presentation. We have tried to be as flexible as possible in making these arrangements. Students will be expected to adhere to the time schedule as noted on Classes V2 -- any "after-the-fact" switching will need to be done between students - HOWEVER - students are required to notify the office of the DUS (crystal.adamchek@yale.edu) of any changes. Each student must have a verified time slot for their presentation.

3) Poster: Students should present a poster for the research symposium in April.

4) Committee Meetings: Students are to schedule committee meetings in each of the two academic terms to discuss their thesis and research. The format of the meeting can be arranged by the research mentor. Students should notify the office of the DUS as to the date of the committee meetings. The student should complete the top portion of the attached Committee Meeting Form (attached) and provide to the Research Mentor for completion. The Research Mentor is expected to provide the completed form to the office of the DUS.

5) Thesis Defense: The student is expected to give an oral thesis defense to the committee, followed by a comprehensive examination of the thesis conducted by the thesis committee. Students should notify the office of the DUS as to the date of the thesis defense – and provide the attached form to the research mentor before the defense. The Research Mentor is expected to provide the completed form to the office of the DUS.

6) Written Thesis:
    a) One chapter should be Introduction/Review of the field. Subsequent chapter(s) will discuss the student's research and a thorough discussion of it.
    b) The length of the thesis should be 40-100 pages.
    c) Each committee member should receive a copy of the thesis at least one week prior to meeting with the committee.
    d) Additional guidelines for thesis should to be arranged in consultation with the student's research mentor.

There will be one grade at the end of the year. The grade will be determined by the student's faculty committee.

MCDB 595 Committee Meeting Form - Fall

Student: _____ Date of Committee Meeting: _____

Thesis Advisor: _____Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Research: _____

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Progress/Plan: _____

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Please return this form to the Office of the Director of Undergraduate Studies:
1220 KBT, crystal.adamchek@yale.edu.

Copies to be provided to all Committee Members and Student from DUS office

Fall Proposed Grade: SAT or UNSAT (please circle appropriate status)

MCDB 595 Committee Meeting Form – Spring

Student: _____ Date of Committee Meeting: _____

Planned Thesis Date: _____

Thesis Advisor: _____Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Research: _____

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Progress/Plan: _____

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Please return this form to the Office of the Director of Undergraduate Studies:
1220 KBT, crystal.adamchek@yale.edu.
Copies to be provided to all Committee Members and Student from DUS office

MCDB 595 Thesis Defense Form

Student: _____ Date of Committee Meeting: _____

Thesis Defense Date: _____

Thesis Advisor: _____Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Committee Member: _____ Dept: _____

Research: _____

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Comments: _____

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Please return this form to the Office of the Director of Undergraduate Studies:
1220 KBT, crystal.adamchek@yale.edu.
Copies to be provided to all Committee Members from DUS office

Additional Factors for Consideration by the Committee:

1. Progress made since last Committee meeting
2. Knowledge of scientific literature relevant to the research project
3. Thinking critically about research project
4. Demonstrating initiative and independence in experimental design and project directions
5. Motivation and work ethic
6. Technical competence at the bench, trouble-shooting ability
7. Quality and clarity of oral presentations

Proposed MCDB 595 Grade: _____

**Grade should reflect oral presentation, thesis defense, written thesis, poster presentation and lab performance.*

MCDB – Senior Essay Topic Approval Form

*attach thesis paragraph describing topic and submit to office of Director of Undergraduate Studies (1220B KBT). Electronic submission is acceptable and preferred to the office of the Director of Undergraduate Studies: crystal.adamchek@yale.edu.

Form and topic paragraph due ***at least*** one month before the end of classes

Essay Due by Friday, December 6, 2013 for Fall 2013 graduation
Essay Due by Friday, April 25, 2014 for Spring 2014 graduation

Student's Name: _____(please print)

College: _____ Phone No. _____

Topic for Senior Paper: _____

_____

_____

To the Senior Essay Faculty Member:
By signing this form, I approve the choice of the above topic and submitted paragraph for a senior essay. I also agree to read and grade the final paper and report the grade to the DUS Office.

_____ _____
Faculty Member Signature Date Student's Signature Date

_____
Faculty Member Printed Name

_____ _____
Director Undergraduate Studies Signature Date

MCDB SENIOR ESSAY

Graduation from Yale College requires the passing of a departmental examination or the equivalent. The MCDB requirement is met by having each student do an individual research course (usually MCDB 475, 485, or 495) or submit a senior essay. *The senior essay is graded, but it carries no course credit.* The **deadline** for seniors finishing in the fall term is **December 6, 2014.** For those finishing in the spring term it is **noon on April 25, 2014.**

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 faculty member of the MCDB 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 Director of Undergraduate Studies (1220B KBT) ***at least one month before the paper is due*** (**March 25, 2014**). Students should attach a thesis paragraph describing the chosen topic.

The paper is to be *15-20 double-spaced pages, including bibliography.* It is the student's obligation to procure a faculty advisor to read and grade each paper. If a student needs assistance in this area, the office of the DUS is available for assistance. Papers are to be submitted to the office of the Director of Undergraduate Studies (1220B KBT). Electronic submission is acceptable and preferred to the office of the director of undergraduate studies: crystal.adamchek@yale.edu. Normally, a grade of "Satisfactory" is reported to the registrar by the Director of Undergraduate Studies. 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

In choosing a faculty member to advise on your senior essay, first decide on the general area you would like to explore in your senior essay. Then determine which faculty member might have interest or expertise in that area. The best source is the MCDB Department booklet, available from the office of the Director of Undergraduate Studies, under the section "Faculty and Research Interests". Second, if a faculty member discussed the topic in a course, he/she would be a good choice or source for suggestions. Otherwise, the Yale College Program of Study (Blue Book) provides a list of faculty member and courses that may include 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.

Legend for Front Cover:

Top: During this lab section students are introduced to the Polymerase Chain Reaction (PCR) and its use for studying Variable Nucleotide Tandem Repeats (VNTRs) in human populations. Student are preparing their own gDNA samples to check for quality and quantity.
[*MCDB 221La. Instructor: Maria Moreno; Fall semester; TWThF 1.30-5.30]*

Bottom: Left, a mouse with lymphoma caused by inappropriate expression of the miR-155 microRNA. On the right is the same mouse that has been treated to turn off miR-155. (Frank Slack)

Legend for Back Cover:

Upper Left: Kline Biology Tower

Upper Right: Osborn Memorial Laboratory

Bottom: Kline Biology Tower Lobby (credit: Joseph Wolenski)